SEI/ASCE 37-02

ASCE STANDARD

American Society of Civil Engineers

Design Loads on Structures During Construction

ASCE

SEI

Structural Engineering Institute

of the American Society of Civil Engineers

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Design Loads on Structures During Construction

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ABSTRACT
The purpose of this standard is to provide minimum design load requirements during construction for buildings and other structures. This standard addresses partially completed structures, and temporary structures used during construction. The loads specified herein are suitable for use either with strength design (such as USD and LRFD) or with allowable stress design (ASD) criteria. The loads are equally applicable to all conventional construction materials.

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STANDARDS

In April 1980, the Board of Direction approved ASCE Rules for Standards Committees to govern the writing and maintenance of standards developed by the Society. All such standards are developed by a consensus standards process managed by the Management Group F (MGF), Codes and Standards. The consensus process includes balloting by the balanced standards committee made up of Society members and nonmembers, balloting by the membership of ASCE as a whole, and balloting by the public. All standards are updated or reaffirmed by the same process at intervals not exceeding 5 years.

The following Standards have been issued:

ANSI/ASCE 1-82 N-725 Guideline for Design and Analysis of Nuclear Safety Related Earth Structures
ANSI/ASCE 2-91 Measurement of Oxygen Transfer in Clean Water
ANSI/ASCE 3-91 Standard for the Structural Design of Composite Slabs and ANSI/ASCE 9-91 Standard Practice for the Construction and Inspection of Composite Slabs
ASCE 4-98 Seismic Analysis of Safety-Related Nuclear Structures
Building Code Requirements for Masonry Structures (ACI 530-99/ASCE 5-99/TMS 402-99) and Specifications for Masonry Structures (ACI 530.1-99/ASCE 6-99/TMS 602-99)
ASCE 7-98 Minimum Design Loads for Buildings and Other Structures
ANSI/ASCE 8-90 Standard Specification for the Design of Cold-Formed Stainless Steel Structural Members
ANSI/ASCE 9-91 listed with ASCE 3-91
ASCE 10-97 Design of Latticed Steel Transmission Structures
SEI/ASCE 11-99 Guideline for Structural Condition Assessment of Existing Buildings
ANSI/ASCE 12-91 Guideline for the Design of Urban Subsurface Drainage
ASCE 13-93 Standard Guidelines for Installation of Urban Subsurface Drainage
ASCE 14-93 Standard Guidelines for Operation and Maintenance of Urban Subsurface Drainage
ASCE 15-98 Standard Practice for Direct Design of Buried Precast Concrete Pipe Using Standard Installations (SIDD)
ASCE 16-95 Standard for Load and Resistance Factor Design (LRFD) of Engineered Wood Construction
ASCE 17-96 Air-Supported Structures
ASCE 18-96 Standard Guidelines for In-Process Oxygen Transfer Testing
ASCE 19-96 Structural Applications of Steel Cables for Buildings
ASCE 20-96 Standard Guidelines for the Design and Installation of Pile Foundations
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ASCE 21-98 Automated People Mover Standards—Part 2
ASCE 21-00 Automated People Mover Standards—Part 3
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ASCE 26-97 Standard Practice for Design of Buried Precast Concrete Box Sections
ASCE 27-00 Standard Practice for Direct Design of Precast Concrete Pipe for Jacking in Trenchless Construction
ASCE 28-00 Standard Practice for Direct Design of Precast Concrete Box Sections for Jacking in Trenchless Construction
EWRI/ASCE 33-01 Comprehensive Transboundary International Water Quality Management Agreement
EWRI/ASCE 34-01 Standard Guidelines for Artificial Recharge of Ground Water
EWRI/ASCE 35-01 Guidelines for Quality Assurance of Installed Fine-Pore Aeration Equipment
CI/ASCE 36-01 Standard Construction Guidelines for Microtunneling
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FOREWORD

The material presented in this publication has been prepared in accordance with recognized engineering principles. This Standard and Commentary should not be used without first securing competent advice with respect to their suitability for any given application. The publication of the material contained herein is not intended as a representation or warranty on the part of the American Society of Civil Engineers, or of any person named herein, that this information is suitable for any general or particular use or promises freedom from infringement of any patent or patents. Anyone making use of this information assumes all liability from such use.

Earlier drafts of the proposed standard were reviewed and balloted several times by the full Standards Committee. The votes and comments returned by the members were reviewed, and their proposed resolutions developed by the appropriate subcommittees. The resulting approved changes in the text are included in this volume.

Some of the provisions were adopted from other codes, standards, regulations and specifications; some reflect prevailing industry design and construction practices; some grew out of the experiences, practices and opinions of members of the Committee; and some others were developed through research conducted specifically for this Standard by members of the Committee.

Preparation of a standard for Design Loads on Structures During Construction and its outline were proposed to ASCE by Robert T. Ratay in early 1987. Work on the proposed Standard was approved by ASCE's Board of Directors in October 1987. A meeting of twenty-five construction industry officials was convened in May 1988 to outline the general direction of the proposed Standard. Seven key ASCE participants met in September 1988 to begin the organization of the Standards Committee, and issue a Call for Members. The response by members and non-members of ASCE was overwhelming. The Committee, through its subcommittees, has been working on the development of this proposed Standard since the fall of 1988. Prior to this volume, drafts of the proposed standard had been issued for committee balloting in 1996, 1997, 1998, early 1999, late 1999; for public comments in October 2000; and for a final committee balloting in 2001.

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ACKNOWLEDGMENTS

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Robert T. Ratay, Chairman
Rubin M. Zallen, Chapter 1.0, Purpose and Scope
John F. Duntemann, Chapter 2.0, Loads and Load Combinations
Cosema E. Crawford, Chapter 3.0, Dead and Live Loads
John S. Deerkoski, Chapter 4.0, Construction Loads
Peter Edinger, Chapter 5.0, Lateral Earth Pressures
Donald Dusenberry, Chapter 6.0, Environmental Loads

The particularly active long-term participation and valuable contribution of the following members, in addition to the six subcommittee chairs, is acknowledged: Charles G. Culver, David Rosowsky, James R. Harris, Alan Fisher, Gilliam S. Harris, Daniel M. McGee, and Cris Subrizi.

ASCE acknowledges the work of the Design Loads on Structures During Construction Standard Committee of the CSAD of SEI, and of the CSAC of ASCE. The Standard Committee comprises individuals from many backgrounds including design, analysis, research, consulting engineering, construction, education, government, and private practice.

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CONTENTS

Design Loads on Structures During Construction

STANDARD

1.0 GENERAL

1.1 Purpose

The purpose of this standard is to provide minimum design load requirements during construction for buildings and other structures.

1.2 Scope

This standard addresses partially completed structures, as well as temporary structures used during construction. The loads specified herein are suitable for use either with strength design (such as USD and LRFD) or with allowable stress design (ASD) criteria. The loads are equally applicable to all conventional construction materials.

1.3 Basic Requirements

1.3.1 Safety

The design loads shall provide for a level of safety of partially completed structures, as well as temporary structures used in construction, that is comparable to the level of safety of completed structures.

1.3.2 Structural Integrity

Partially completed structures and temporary structures shall have sufficient structural integrity, in all stages of construction, to remain stable and resist the loads specified herein.

Stability of the incomplete structure and the possibility of progressive collapse shall be considered.

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C1.0 GENERAL

C1.1 Purpose

The construction loads, load combinations, and load factors contained herein account for the often short duration of loading and for the variability of temporary loads. Many elements of the completed structure that are relied upon implicitly to provide strength, stiffness, stability, or continuity may not be present at certain times during construction.

The requirements in this standard complement those in ASCE 7-95.

This standard does not specify who the responsible party is for the design of temporary structures or temporary supports or for the temporary use of incomplete structures.

C1.2 Scope

This standard is intended for use by engineers knowledgable in the performance of structures.

The requirements contained herein are not intended to adversely affect the selection of a particular construction material or type of construction.

C1.3.1 Safety

This standard is not intended to account for loads caused by gross negligence or error.

C1.3.2 Structural Integrity

Structural integrity shall be provided by sequencing the construction in order to avoid creating vulnerable partially completed portions of the structure; by completing the system to support lateral loads as the dependent portion of the structure is erected or by providing suitable temporary lateral bracing; by avoiding conditions that result in loads that exceed the capacity of structural elements; and by promptly completing connections for all installed elements.

During erection of a structure, the structural system that will provide stability and structural integrity for the finished structure generally is not complete. In this interim state, elements of the structural system that are essential to the overall performance of the structure may not be in place or may be only partially secured.

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As such, the structure may be vulnerable to severe and widespread damage if a single local failure or mishap occurs. An example of catastrophic failure caused by a localized initial failure is the collapse of L'Ambiance Plaza in Bridgeport, Connecticut. Both wings of this 16-story lift-slab apartment building totally collapsed while under construction when a failure occurred at one location.

Consideration of construction sequence, loadings on partially completed elements and systems, bracing, and connection requirements is essential to minimize the risk of general collapse and disproportionate damage. The structural system(s) designed to carry lateral loads should be installed at the same time the rest of the structure that is dependent on these systems is erected. If this is not practical, suitable temporary bracing with adequate stiffness to control drift must be installed.

For some configurations, the loads on a structure during construction may exceed the loads on the finished structure and hence will govern the design of the structure. Due consideration must be given to the ability of the structure as a whole to remain stable and support these higher construction loads without damage. As soon as practical after erection of each element, all of its connections should be fully completed to provide full strength and performance.

1.3.3 Serviceability

The effects of construction loads or conditions shall not adversely affect the serviceability or performance of the completed structure.

C1.3.3 Serviceability

An example of adverse effect on serviceability is excessive permanent deformation.

1.3.4 Types of Loads

Loads considered in this standard are dead, live, construction, environmental, and lateral earth pressure. In addition, forces resulting from the interaction between the partially completed structure and temporary supporting or bracing structures shall be accounted for.

C1.3.4 Types of Loads

The loads in this standard may be different from those used in the design of the completed structures.

Although this standard is limited to the determination of the types of loads listed in 1.3.4, the consideration of other loads, effects, and hazards may also be appropriate in specific conditions or when specified by the authority having jurisdiction.

1.3.5 Construction Methods

The effects on the loads created by the methods and sequencing (scheduling) of construction during the progressive stages of the work shall be considered.

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1.3.6 Analysis

Load effects on incomplete structures, on temporary structures, and on their respective individual components shall be determined by accepted methods of structural and, where appropriate, geotechnical analysis, taking into account equilibrium, stability, geometric compatibility, and material properties.

REFERENCE

ASCE 7-95, "Minimum design loads for buildings and other structures," American Society of Civil Engineers, 1995, Reston, Va.

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2.0 LOADS AND LOAD COMBINATIONS

2.1 Loads Specified

Structures within the scope of this standard shall resist the effects of the following loads and combinations thereof:

Final loads–see Section 3
D–dead load
L–live load

Construction loads–see Section 4
Weight of temporary structures
C_D–construction dead load

Material loads
C_{FML}–fixed material load
C_{VML}–variable material load

Construction procedure loads
C_P–personnel and equipment loads
C_H–horizontal construction loads
C_F–erection and fitting forces
C_R–equipment reactions
C_C–lateral pressure of concrete

Lateral earth pressures–see Section 5
C_{EH}–lateral earth pressures

Environmental loads–see Section 6
W–wind
T–thermal loads
S–snow loads
E–earthquake
R–rain
I–ice

The specified loads are nominal loads that are intended to be suitable for use in either conventional allowable stress design (ASD) or load and resistance factor design (LRFD), provided that appropriate load factors and combinations are used.

2.2 Load Combinations and Load Factors for Strength Design

Specified loads shall be combined according to the principles in this section to obtain the maximum design load effects for members and systems.

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C2.0 LOADS AND LOAD COMBINATIONS

C2.1 Loads Specified

The loads are only defined by name and symbol in this section. The complete definition and specification of each load is in the referenced section.

Additional construction and environmental loads may include (and be accounted for in the load combinations) such items as differential settlement, prestressing, shrinkage, rib shortening, stream flow pressure, buoyancy, and other items as appropriate.

C2.2 Load Combinations and Load Factors for Strength Design

The selection of load factors is intended to be compatible with ASCE 7-95. Because little independent research has been done, the load factor 2.0 is suggested for those loads that may vary substantially or about which we have little information. AASHTO (1996) and FHWA (1993) provide additional guidance for load combinations and factors for use with bridge temporary works.

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2.2.1 Additive Combinations

When the effects of different loads are of the same sense, and when structures are subjected to more than one variable load, sufficient load combinations shall be evaluated as follows. The total design load for each combination shall be the sum of the factored dead and/or material loads present, the variable load(s) at their maximum values, and the other uncorrelated loads at their arbitrary point-in-time (APT) values. Correlated variable loads, such as vertical and horizontal construction loads, shall be taken to have their maximum values occurring simultaneously. The generalized form of the load combinations (U) can be written as:

Combined Design Load =
Dead and/or Material Loads
+ Loads at their Maximum Values
+ Loads at their APT Reduced Values.

$$U = \sum_k c_{D,k}\, D_{n,k} + \sum_i c_{\max,}\, Q_{n,i} + \sum_j c_{APTj}\, Q_{n,j} \qquad (2\text{-}1)$$

where c_D = dead load factor, $c_{\max}$ = load factor for the maximum value of variable load, c_{APT} = load factor for the APT value of variable load, D_n = nominal dead or construction material load, Q_n = nominal variable load, k = all dead and construction material loads, i = all loads occurring at maximum value, and j = all relevant simultaneously occurring variable loads at APT values.

Whenever different variable loads are correlated, such as horizontal and vertical loads from the same source or operation, the same load factor, c_{MAX} or c_{APT}, should be used in Equation 2-1 for these loads.

2.2.2 Load Factors

Minimum load factors for use with strength design are as follows:

Load	Load factor ($c_{\max}$)	Arbitrary point-in -time load factor (c_{APT})
D	0.9 (when counteracting wind or seismic loads)	–
	1.4 (when combined with only construction and material loads)	–
	1.2 (for all other combinations)	
L	1.6	0.5

COMMENTARY

C2.2.1 Additive Combinations

The loads suggested herein for consideration in load combinations are not all inclusive; therefore, their selection will require judgment in many situations. Design should be based on the load combination causing the most unfavorable effect. In some cases, this may occur when more than one load is not applied simultaneously. Furthermore, the critical load effect may result from the application of one or more loads on only part of the structure. Finally, concentrated loads may be applied in place of or in addition to the assumed uniformly distributed loads.

Load combinations should be considered based on the specific type of construction and procedures. Consideration should be given to construction loads that may be mutually exclusive, may be strongly correlated, or may occur with such a low probability that they may effectively be neglected.

The unfactored loads to be used in the combinations herein are the nominal loads in Sections 3 through 6 of this standard. The concept of using maximum and APT loads and corresponding load factors is consistent with ASCE 7-95. Here, in addition to the dead load, which is assumed to be permanent, one or more of the variable loads takes on its maximum value while the other variable loads occurring simultaneously assume APT values (i.e., those values measured at any instant of time). This is consistent with the way loads actually combine in situations in which strength limit states are approached. The nominal loads in Sections 3 through 6 are substantially in excess of the APT values. Rather than providing both a maximum and an APT nominal load value for each load type, load factors of less than 1.0 are provided for APT loads.

C2.2.2 Load Factors

The load factors provided herein are intended to reflect the relative uncertainty in the particular action. This uncertainty can arise from (1) inherent or natural variability, (2) range of applications, and (3) possibilities for misuse or error. It may therefore be reasonable to make certain modifications to load factors in the presence or absence of additional information.

For example, a lower load factor is specified for conditions of full fluid head when designing for lateral pressure of concrete because this condition suggests less uncertainty than partial (unknown) fluid head.

Factors on heavy equipment reactions are for maximum load values only. Because this is considered only in combinations when it is actually *present*, no APT

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C_D	0.9 (when counteracting wind or seismic loads)	–
	1.4 (when combined with only construction and material loads)	–
	1.2 (for all other combinations)	–
C_{FML}	1.2	–
C_{VML}	1.4	*by analysis*
C_P	1.6	0.5
C_C	1.3 (full head)	–
	1.5 (otherwise)	–
C_{EH}	1.6	–
C_H	1.6	0.5
C_F	2.0	*by analysis*
C_R	2.0 (unrated)	0
	1.6 (rated)	0
W	1.3	0.5
T	1.4	–
S	1.6	0.5
E	1.0	–
R	1.6	–
I	1.6	–

Basic combinations are presented in Section 2.2.3.

2.2.3 Basic Combinations

Except where applicable codes and standards specify otherwise, structures and their components shall be designed so that their strength exceeds the effects of factored loads in the following combinations:

$$1.4D + 1.4C_D + 1.2C_{FML} + 1.4C_{VML} \quad (2\text{-}2)$$

$$1.2D + 1.2\,C_D + 1.2C_{FML} + 1.4C_{VML} + 1.6C_P + 1.6C_H + 0.5L \quad (2\text{-}3)$$

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factor is provided. Further, the load factor is much lower (1.6) when the equipment is rated such that the reactions are specified by the manufacturer or are otherwise known. Also, if any equipment is used that generates dynamic loads (i.e., pumps, unbalanced rotors), the load effect must be determined separately first and then multiplied by a factor of 1.3.

Environmental loads are considered in a similar way as those in ASCE 7-95. However, the following differences for environmental loads during construction must be kept in mind: (1) modifications to the design load values for the possibility of a reduced exposure period is appropriate, (2) certain loads may be disregarded for most practical purposes because of the generally very short reference period associated with typical construction projects, and (3) certain loads in combinations may effectively be ignored because of the practice of shutting down work sites during these events (e.g., snow and wind, snow and certain equipment forces, extreme winds and personnel loads). Regional and project-specific conditions should be considered when deciding which combinations of environmental and structural loads to use.

OSHA (1977) requires that “scaffolds shall be capable of supporting, without failure, their own weight and at least four times the maximum intended load.” ANSI (1989) has a similar requirement. To satisfy the OSHA criterion, the load factor for personnel and equipment load, C_P, fixed material load, C_{FML}, and variable material load, C_{VML}, should be 4.0 and the load factor for construction dead load, C_D, should be 1.0. Also, capacity reduction factors (f factors) used with these load factors should be 1.0. The OSHA requirement may change in the future.

The designer should be aware that temporary structures used repeatedly are subject to abuse and loss of capacity and that f factors may need to be lower than those used for ordinary strength design to compensate for this loss of capacity.

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$$1.2D + 1.2\,C_D + 1.2C_{FML} + 1.3W + 1.4C_{VML} + 0.5C_P + 0.5L \quad (2\text{-}4)$$

$$1.2D + 1.2\,C_D + 1.2C_{FML} + 1.0E + 1.4C_{VML} + 0.5C_P + 0.5L \quad (2\text{-}5)$$

$$0.9D + 0.9\,C_D + (1.3W \text{ or } 1.0E) \quad (2\text{-}6)$$

where *D* is the dead load in place at the stage of construction being considered; *L* is the live load, which may be less than or greater than the final live load; and *W* is the wind load computed using the design velocity reduction per Section 6.2.1.

The most unfavorable effects from both wind and earthquake loads shall be considered, where appropriate, but they need not be assumed to act simultaneously. Similarly, C_H need not be assumed to act simultaneously with wind or seismic loads. Lateral earth pressure, environmental loads, and other construction loads shall be considered if applicable; they are listed in Section 2.2.2. Consideration of these other loads will require the use of load combinations in addition to the basic combinations listed above.

2.2.4 Counteracting Combinations

Where the effect of one load is partially or wholly resisted by another load, the factor on the resisting load shall be taken as zero for variable loads and 0.85 for permanent and controlled loads.

2.3 Allowable Stress Design

Specified loads shall be combined according to the principles in this section to obtain the maximum design load effects for members and systems.

The factors for APT loads shall also be used for allowable stress design; however, traditional increases in allowable stresses, except those due to load duration, shall not be used in combination with such factors.

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C2.2.4 Counteracting Combinations

A controlled load is a material that is placed in a specific location to counteract the effect of a specific load.

C2.3 Allowable Stress Design

Designers are cautioned against mixing allowable stress design (ASD) and load and resistance factor design (LRFD) load combinations. However, if the nominal design loads provided in this document are used in an ASD format, the following commentary is provided.

OSHA (1977) requires that "scaffolds shall be capable of supporting, without failure, their own weight and at least four times the maximum intended load." ANSI (1989) has a similar requirement. Allowable stress design ordinarily provides for safety factors somewhat less than 2. Thus, to satisfy OSHA criteria, the superimposed design loads effectively must be close to doubled. The OSHA requirement may change in the future.

The designer should be aware that temporary structures used repeatedly are subject to abuse and loss of capacity and that safety factors may need to be higher than those used for ordinary allowable stress design to compensate for this loss of capacity.

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2.3.1 Additive Combinations

When using load values provided in this standard for ASD, sufficient additive load combinations shall be considered to obtain the maximum design load effects for members and systems.

The following basic combinations shall be investigated as a minimum:

$$D + C_D + C_{FML} + C_{VML} \quad (2\text{-}7)$$

$$D + C_D + C_{FML} + C_{VML} + C_P + C_H + L \quad (2\text{-}8)$$

$$D + C_D + C_{FML} + C_{VML} + W + C_P + L \quad (2\text{-}9)$$

$$D + C_D + C_{FML} + C_{VML} + 0.7E + C_P + L \quad (2\text{-}10)$$

$$D + C_D + (W \text{ or } 0.7E) \quad (2\text{-}11)$$

where *D* is the dead load in place at the stage of construction being considered; *L* is the live load, which may be less than or greater than the final live load; and *W* is the wind load computed using the design velocity factor where appropriate per Section 6.2.1.

The most unfavorable effects from both wind and earthquake loads shall be considered where appropriate, but they need not be considered simultaneously. Similarly, C_H need not be assumed to act simultaneously with wind or seismic loads. Other construction loads that shall be considered if applicable are defined in Section 2.1.

2.3.2 Load Reduction

When structural effects due to two or more variable loads in combination with dead load are investigated in load combinations of Section 2.3.1, the combined effects shall comply with both of the following requirements: (1) the combined effects of the two or more variable loads multiplied by 0.75 plus effects of dead loads shall not be less than the effects of the combination of the dead load plus the load producing the largest effects; and (2) the allowable stress shall not be increased to account for these combinations.

2.3.3 Overturning and Sliding

Buildings and other structures shall be designed so that the overturning moment caused by lateral forces (wind or flood) acting singly or in combination does not exceed two thirds of the dead load stabilizing moment unless the building or structure is anchored to resist the excess moment. The base shear caused by lateral forces (wind or flood) shall not exceed two thirds of the total resisting force caused by friction and adhe-

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C2.3.1 Additive Combinations

As with the strength provisions described previously, the possible loads shown in this document are not all inclusive, and designers must exercise judgment in selecting the appropriate loads to be considered in combination for the given construction situation. Design should be based on the load combination causing the most unfavorable effect. In some cases, this may occur when one or more loads are not acting. In other cases, the governing load effect may result from loads not applied over the entire element being designed. As described previously, designers also need to be aware of construction loads that may be mutually exclusive, may be strongly correlated, or occur with such a low probability that they may be neglected.

Most loads, other than dead loads, vary significantly with time. Although these loads are combined with dead loads in the design load combination, it may be highly unlikely that multiple (independent) variable loads will reach maximum values at the same time. Accordingly, some reduction in the total combined load effect may be justified. However, the designer is cautioned that when correlated variable loads are considered in a combination, no increase in the allowable stresses should be used.

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sion unless the building or structure is anchored to resist the excess sliding force.

2.3.4 Counteracting Loads

Stress reversals shall be accounted for when the effects of design loads counteract one another in a structural member or joint.

2.4 Bridges

Load combinations for design loads on bridges during construction shall be in accordance with the AASHTO (AASHTO 1995) AREA or other applicable specifications.

REFERENCES

American Association of State Highway and Transportation Officials (AASHTO). "Standard specifications for highway bridges," 16th Ed., 1996, Washington, D.C.

AASHTO. "Guide design specifications for bridge temporary works," 1995, Washington, D.C.

American National Standards Institute (ANSI). "Scaffolding—safety requirements for construction and demolition operations," 1989, *ANSI A10.8-1988*, New York.

ASCE 7-95. "Minimum design loads for buildings and other structures," American Society of Civil Engineers, 1995, Reston, Va.

Federal Highway Administration (FHWA). "Guide design specification for bridge temporary works," 1993, *FHWA-RD-93-032,* McLean, Va.

Occupational Safety and Health Administration (OSHA). *Code of Federal Regulations,* Title 29, Chapter 17, Department of Labor, Part 1926, "Safety and health regulations for construction, subpart L," 1977, Washington, D.C.

COMMENTARY

C2.4 Bridges

See FHWA (1993) for further information.

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3.0 DEAD AND LIVE LOADS

3.1 Dead Loads

For the purposes of this standard, dead load, D, is the weight of the permanent construction in place at the particular time in the construction sequence that is under consideration. The dead load includes all construction in place that is temporarily shored or braced. It includes construction for which the primary structural system is complete, but which is being used to support construction materials and construction equipment. The weights of scaffolding, shoring, concrete forms, runways for construction equipment, temporary bridges, and other temporary structures are not included; these loads are considered construction dead load, C_D, as defined in Section 4.1.1.

The weight of the permanent construction that is in place includes all nonstructural loads such as cladding, partitions, ceilings, railings, and so on that are expected to be in place at the particular time being considered.

3.2 Live Loads

The live load, L, is the load produced by the use or occupancy of a structure that is under construction. These loads may be imposed on construction in place, on partially demolished structures, or on temporary structures. The live load, L*,* may vary at different stages of construction.

For bridge structures and other transportation structures, live load shall include impact, longitudinal force*s* from vehicles, centrifugal forces from vehicles, and wind loads on vehicles, as applicable.

REFERENCE

ASCE 7-95. “Minimum design loads for buildings and other structures,” American Society of Civil Engineers, 1995, Reston, Va.

COMMENTARY

C3.0 DEAD AND LIVE LOADS

C3.1 Dead Loads

The contractor usually controls the sequence of construction and thus controls what loads will be on the structure at the various construction stages. The design of temporary shoring and bracing must include these dead loads as well as the temporary loads described in Sections 3, 4, 5, and 6, as applicable.

Tables of common construction dead loads are provided in ASCE 7-95, in building codes, and in various engineering handbooks.

C3.2 Live Loads

Live load may be present in a structure that is being remodeled, underpinned, or otherwise repaired, replaced, or demolished in stages.

The live loads during construction may be different than the live loads applied on the completed structure. For example, during reconstruction of a bridge designed for trucks, a lane may be restricted to cars, resulting in a lower live load. On the other hand, temporary overcrowding of a completed section of a building would warrant an increase in live load. Reduction of the live load from the final design value shall not be made unless the use of the facility is strictly monitored and enforced.

The partially completed structure, or partially demolished structure, should expose the occupants or users to no greater risk than inherent in the codes and standards of practice that pertain to the completed structure.

Ideally, the design drawings will identify live loads to be applied during construction, if applicable.

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4.0 CONSTRUCTION LOADS

4.1 General Requirements

The provisions of this section shall be used to define the construction loads for the design of both temporary structures and permanent structures subject to loads during construction. These loads are to be combined with other applicable loads per the requirements of Section 2.

When a construction loading is covered in another document that is acceptable to the authority having jurisdiction and written to address a specific material or method of construction, the more applicable document shall be permitted to be followed.

Stairs, ladders, and elevators are not addressed in this standard.

4.1.1 Definitions

Construction loads: those loads imposed on a partially completed or temporary structure during and as a result of the construction process. Construction loads include, but are not limited to, materials, personnel, and equipment imposed on the temporary or permanent structure during the construction process.

Construction dead load, C_D: the dead load of temporary structures that are in place at the stage of construction being considered. The dead load of the permanent structure, either partially complete or complete, is not included in C_D; the dead load of the permanent structure is defined as *dead load, D*, in Section 3.1.

Individual personnel load: a concentrated load of 250 lb (1.1 kN) that includes the weight of one person plus equipment carried by the person or equipment that can be readily picked up by a single person without assistance.

Working surfaces: floors, decks, or platforms of temporary or partially completed structures which are or are expected to be subjected to construction loads during construction.

4.2. Material Loads

The material dead loads consist of two categories:

1. fixed material loads (FML)
2. variable material loads (VML)

The FML is the load from materials that is fixed in magnitude. The VML is the load from materials that varies in magnitude during the construction process. If the local magnitude of a material load varies during the

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C4.0 CONSTRUCTION LOADS

C4.1 General Requirements

The loads for some temporary structures, such as those that retain lateral pressures of earth, are not defined in Section 4; refer to Section 5 for lateral pressures of earth.

Standards and other documents applicable to specific materials or methods of construction have been developed and are recognized and used extensively.

C4.2. Material Loads

This section separates material dead loads into two categories: FML and VML, which are separated to permit the use of an appropriate load factor for each category in strength design. This approach recognizes the difference in the variability of the load between the two categories.

This section addresses the loads from materials and is not intended to apply to equipment loads. Per-

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construction process, then that load must be considered a VML.

4.2.1 Concrete Load

The weight of concrete placed in a form for the permanent structure is a material load. When the concrete gains sufficient strength so that the formwork,

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sonnel and equipment loads are considered separately in Section 4.3.

Material loads may be either distributed or concentrated loads. The designer must consider the pattern of uniformly distributed loads and the location of concentrated loads that create the most severe strength and/or serviceability condition.

The designer must determine whether the superimposed material load during the construction process is essentially fixed in magnitude, is variable, or can be adjusted during the construction process. For example, the load from formwork becomes a FML once it is installed, and the load created by the concrete during fresh concrete placement is considered a VML. The load caused by concrete placement is considered a VML because fresh concrete can be piled higher than the finished thickness of the slab.

The distinction between a FML and a VML is not location or position on the structure; rather, it is the variability of the loading magnitude.

The stockpiling of any material is considered a VML (scaffold, forms, rebar, metal deck, barrels, drywall, ceiling tile, roofing materials, and so on). Some materials, such as scaffold or forms, are considered VMLs when they are stockpiled but may be considered FMLs when they are placed in their final end use position. Engineering judgment must be used to determine whether the stockpiled material should be considered a uniformly distributed or a concentrated load.

Stockpiled materials should be positioned on the structure to minimize the effects of early loading on the serviceability or performance of the completed structure.

Careful consideration should be given to the placement of stockpiled materials on early-age concrete structures. Early loading of low-strength concrete has been shown to increase long-term deflection (Fu and Gardner 1986; Sbarounis 1984; Yamamoto 1982). It is recommended that materials be stockpiled at columns, avoiding placement in the middle of long spans. This practice serves to decrease long-term deflections of reinforced concrete beams and to deter lateral buckling of unsupported steel beams.

For a list of the proper weights for different building materials, the designer should consult ASCE 7-95 or other specified or recognized sources.

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shoring, and reshoring are not required for its support, the concrete becomes a dead load.

4.2.2 Materials Contained in Equipment

Materials being lifted by or contained in equipment are part of the equipment load, not a material load. Once such materials have been discharged from the equipment, they become a material load.

4.3 Personnel and Equipment Load, C_P

4.3.1 General

Personnel and equipment loads shall be considered in the analysis or design of a partially completed or temporary structure. The design or analysis of the structure shall be governed by either a uniformly distributed or a concentrated personnel and equipment load, whichever creates the most severe strength and/or serviceability condition. The governing load shall be assumed to be placed in the pattern or location that creates the most severe strength and/or serviceability condition.

The personnel and equipment loads used in the design or analysis of a partially completed or temporary structure shall be the maximum loads that are likely to be created during the sequence of construction.

4.3.2 Uniformly Distributed Loads

Uniform loads shall be selected to result in forces and moments that envelope the forces and moments that would result from the application of concentrated loads that could occur and are not separately considered.

4.3.3 Concentrated Loads

The personnel and equipment concentrated loads shall be the actual maximum loads expected in the construction process but shall be no less than those given in Table 1. The concentrated load shall be located to produce the maximum strength and/or serviceability conditions in the structural members. The designer shall consider each category of minimum concentrated personnel and equipment load that is likely to occur during the construction process.

Concentrated loads from equipment shall be determined in accordance with Section 4.6.

For temporary structures that are used for public traffic, the structure shall be designed in accordance

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C4.2.2 Materials Contained in Equipment

The equipment reactions should include the effects of the material being lifted or contained therein (see Section 4.6).

C4.3.2 Uniformly Distributed Loads

Construction loads, except for material loads, will rarely be distributed uniformly. However, design for equivalent uniformly distributed loads is a long-standing practice that has stood the test of time. The designer must select a uniform load that will adequately capture the effects of real construction loads. Section 4.8.1.1 presents a tabulation of traditional minimum uniformly distributed loads that include personnel, equipment, and material in transit or staging.

C4.3.3 Concentrated Loads

The designer must make an important decision in choosing the concentrated load category that properly fits the construction process for the project.

Concentrated loads from equipment are a serious concern. The type of equipment to be used for each construction operation, its location (on or off the structure), and its loading must be considered. Loads for different types of construction equipment have been tabulated (Caterpillar 1987; Jahren 1996). See also Sections C4.6.1 and C4.6.2 for precautions in using tabulated data.

Individual personnel load, defined in Section 4.1.1, is defined differently in ANSI's A10.8 (1989) as

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Table 1 Minimum Concentrated Personnel and Equipment Loads

Action	Minimum Load[a] *lb(kN)*	Area of Load Application *in. × in.* (*mm × mm*)
Each person	250 (1.11)	12 × 12 (300 × 300) [b]
Wheel of manually powered vehicle	500 (2.22)	Load divided by tire pressure[c]
Wheel of powered equipment	2000 (8.90)	Load divided by tire pressure [c]

[a] Use actual loads when they are larger than tabulated here.
[b] Need not be less than 18 in. (457 mm) c. to c.
[c] For hard rubber tires, distribute load over an area 1 in. (25 mm) by the width of the tire.

with the AASHTO bridge design specifications (AASHTO 1996, AASHTO 1998) or designed for the construction equipment which will use the structure in accordance with the requirements of Section 4.6, whichever gives the more critical effects.

4.3.4 Impact Loads

The concentrated loads specified in Table 1 include adequate allowance for ordinary impact conditions. Provision shall be made in the structural design

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200 lb (0.89 kN) per person plus 50 lb (0.22 kN) of equipment per person; however the totals of the loads are the same.

Wheeled vehicles, both manually operated and powered, may require a more rigorous analysis similar to AASHTO. The factors that may have to be investigated include the following:

- Pneumatic tire pressure,
- Spacing of adjacent tires,
- Axle load,
- Number of axles,
- Spacing of axles, and
- Gross vehicle weight.

In some instances, the authority with jurisdiction may require that provisions be made for specified concentrated load. Examples of materials that might be covered are piles of unspecified debris and pallets of material. When these materials can be specified or identified, the design should be based on the specific materials.

Many specifications require that temporary or permanent structures be designed for a uniform load and/or a concentrated load. If the source of the concentrated load can be clearly identified, such as wheel loads, axle loads, pallet loads, or equipment reactions, that specific load should be distributed as determined by its source.

Problems arise in determining the distribution areas of unidentified, but specified, loads. To determine the distribution area for an unidentified concentrated load, assume that the load will be generated by the densest material normally available on a construction site. That material is arbitrarily chosen to be concrete at 150 pcf (23.6 kN), and of a cubic shape. This should provide the smallest distribution area for a pallet load or a pile of material generating the concentrated load.

The specified concentrated load in Table 1 is assumed to be the total load, including dynamic forces.

The concentrated loads required herein are not intended for protection against an accident involving falling objects, such as when a beam, a length of reinforcing steel, or a piece of equipment falls several stories.

C4.3.4 Impact Loads

The designer is not expected to anticipate the effects of poor workmanship such as concrete being discharged from a bucket from excessive heights above

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for loads that involve predictable unusual vibration and impact forces.

4.4 Horizontal Construction Load, C_H

One of the following horizontal load criteria, where appropriate, shall be applied to temporary or partially complete structures as a minimum horizontal loading, whichever gives the greatest structural effects in the direction under consideration.

1. For wheeled vehicles transporting materials, 20% for a single vehicle or 10% for two or more vehicles of the fully loaded vehicle weight. Said force shall be applied in any direction of possible travel, at the running surface.
2. For equipment reactions as described in Section 4.6, the calculated or rated horizontal loads, whichever are the greater.
3. 50 lb per person (0.22 kN/person), applied at the level of the platform in any direction.
4. 2% of the total vertical load. This load shall be applied in any direction and shall be spatially distributed in proportion to the mass. This load need not be applied concurrently with wind or seismic load.

This provision shall not be considered a substitute for the analysis of environmental loads.

4.5 Erection and Fitting Forces, C_F

Forces caused by erection (alignment, fitting, bolting, bracing, guying,and so on) shall be considered.

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the formwork. A concrete bucket that hits the forms is an impact load that would be considered accidental and not fall within the scope of this provision.

C4.4 Horizontal Construction Load, C_H

Forces necessary for member stability are determined during analysis of the structure, and as such are not specified by this standard.

The intent of this provision is to provide a minimum lateral load resistance mechanism and a minimum lateral stiffness in all temporary or partially complete structures. Due to unavoidable eccentricities, vertical superimposed loads may produce some horizontal loading. Also, horizontal loads can be created from personnel and equipment operations.

The designer should be aware that the actual horizontal loads may exceed the minimum specified in this section, particularly if more than one construction activity is being conducted at the same time.

The 50 lb/person (0.22 kN/person) load in criterion 3 represents a conservative estimate of the lateral force that could be generated from the activities of personnel.

Criterion 4 is intended to provide a minimum lateral load resistance and to assure lateral stability for the structure as a whole during construction. Generally, it is not expected that this criterion will result in forces during construction that exceed the capacity of the permanent lateral load resisting system of a structure below the level where the permanent lateral load resisting system has been completed; however, the permanent lateral load resisting system needs to be checked for this criterion.

Wind and other phenomena that produce horizontal loads must be considered separately from the requirements of this section, except as permitted for criterion 4.

C4.5 Erection and Fitting Forces, C_F

This provision applies to all types of structures but more specifically to the erection of components typical of steel, metal, timber, and precast structures (see this section's Bibliography)

On May 15, 1994, the State of California issued an amendment to the "Falsework Manual" (Office of Structure Construction 1988) (Memo No. C-10: Internal Cable Bracing Systems). This revision to their previously issued document appears to address many of the erection forces normally encountered, such as fitting, aligning, and bracing operations, that are normally performed with the help of guys.

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4.6 Equipment Reactions, C_R

The reactions from equipment, with due consideration to all loading conditions, shall be used in the design of the temporary or partially completed structure. The equipment reactions shall include the full weight of the equipment operating at its maximum rated load in conjunction with any applicable environmental loads, unless the use is restricted and revised reactions are developed.

4.6.1 General

The structure shall be designed to safely support the full weight of the equipment and associated worst-case load effects caused by its operation. The design shall include the consideration of support deflections or movements, out-of-level supports, vertical misalignment, and environmental loads on the equipment.

4.6.2 Rated Equipment

The minimum equipment loads for design shall be those provided by the equipment manufacturer or supplier.

Unless loaders, such as front end loaders or forklifts, are intentionally restricted from tipping on one axle, the loader selfweight plus tipping load shall be applied to the front axle.

The designer shall verify the basis of the rating and the rated reactions given by the equipment supplier. If the basis of the rating is different than the conditions under which the equipment will be used, the more severe reactions shall be used in design.

4.6.3 Nonrated Equipment

The equipment loads for nonrated equipment shall be determined by analysis.

COMMENTARY

C4.6 Equipment Reactions, C_R

Rated equipment is that for which reactions are given by the equipment manufacturer or supplier. For nonrated equipment, the designer is to determine the reactions by analysis. Examples of calculations for reactions from lifting or hoisting equipment that include assessments of environmental loads are provided in Shapiro et al. (1991).

C4.6.1 General

In addition to using a piece of equipment at less than its maximum operating capacity, there may be hybrid situations such as the use of a crane with rear outriggers placed over a major support member of the structure. At this point, the crane may reach out to its maximum operating radius to make a pick and then boom in, thus substantially reducing the outrigger reactions when the crane swings to a new position to deposit or pick up the load. In this case, maximum outrigger loads are apparently developed over the rear of the crane and lesser loads are developed over the other outrigger pads, which could be placed on lighter structural members. This is a common practice when the outrigger support members are not adequate to sustain the full or maximum rated capacity outrigger reactions.

Because of a shift of the center of gravity, vehicle axle loads and crane outrigger or support reactions may be greatest in the absence of payload or pick. The worst case condition controls (loaded or unloaded).

C4.6.2 Rated Equipment

Care should be exercised when the tabulated values for equipment, such as loaders, from references or from any manufacturer's data are used. Axle load distributions at maximum load do assume that all of the axles are touching the ground and with a certain load distribution. Unless special precautions are taken, such as limiting bucket size and floor or deck obstacles, it is a quite frequent occurrence that the loaders, in attempting to pick materials for transport, will either catch an element of the deck or try to pick more than their rated load. In this instance, the entire vehicle picks up and pivots about its front axle. This load could create axle and wheel loads more than 30% greater than the manufacturer's rated wheel load.

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4.6.4 Impact

The reaction of equipment shall be increased by 30% to allow for impact, unless other values (either larger or smaller) are recommended by the manufacturer, are required by the authority having jurisdiction, or are justified by analysis.

4.7 Form Pressure

4.7.1 Form Pressure

Unless the conditions of Section 4.7.1.1 or 4.7.1.2 are met, formwork shall be designed for the lateral pressure of the newly placed concrete given by Equation 4-1. Maximum and minimum values given for other pressure formulas do not apply to Equation 4-1.

$$C_C = w \times h \qquad (4\text{-}1)$$

$$C_{C\,SI} = 23.5\, h_{SI} \qquad (4\text{-}1\ SI)$$

where C_C (C_{CSI}) is lateral pressure, psf (kPa); w is the unit weight of fresh concrete, pcf; and h (h_{SI}) is the depth of fluid or plastic concrete, ft (m).

For columns or other forms that may be filled rapidly before any stiffening of the concrete takes place, h shall be taken as the full height of the form or the distance between horizontal construction joints when more than one placement of concrete is to be made.

4.7.1.1 For concrete made with Type I cement, weighing 150 pcf (23.6 kN/m^3), containing no pozzolans or admixtures, having a slump of 4 in. (100 mm) or less, and normal internal vibration to a depth of 4 ft (1.22 m) or less, formwork may be designed for a lateral pressure as follows.

For columns:

$$C_C = (150 + 9{,}000\ R/T) \qquad (4\text{-}2)$$

$$C_{C\,SI} = 7.2 + \frac{785\, R_{SI}}{T_{SI} + 17.8} \qquad (4\text{-}2\ SI)$$

with a maximum of 3,000 psf (144 kPa), a minimum of 600 psf (28.8 kPa), but in no case greater than 150 h (23.5 h_{SI}).

For walls:

rate of placement less than 7 ft (2 m) per h

$$C_C = (150 + 9{,}000\ R/T) \qquad (4\text{-}3)$$

$$C_{C\,SI} = 7.2 + \frac{785\, R_{SI}}{T_{SI} + 17.8} \qquad (4\text{-}3\ SI)$$

with a maximum of 2,000 psf (95.8 kPa), a minimum of 600 psf (28.8 kPa), but in no case greater than 150 h (23.5 h_{SI}).

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C4.7.1 Form Pressure

The lateral pressure formulas are adopted from ACI (ACI 1994; Hurd 1995). Equation 4-1 assumes a fully liquid head and normally can be applied without restriction. However, there are exceptions. Caution must be taken when using external vibration or concrete made with shrinkage-compensating cement. In these situations, pressures in excess of equivalent hydrostatic may occur.

The designer must consider the uplift caused by the vertical component of the normal pressure of freshly placed concrete on inward sloping forms.

The SI version of the lateral pressure formula is adopted from ACI 347R-94 (ACI 1994; Hurd 1995) and from the Appendix of ACI 347R-94. An alternate presentation of these formulas is in FHWA's 93-032 (1993).

C4.7.1.1 Under the limitations listed, the formwork may be designed for a maximum lateral pressure, as provided in Equations 4-2, 4-3, and 4-4, that is less than the full hydrostatic head.

Where any of the limitations are not met, the lateral pressure must be taken as provided in Equation 4-1. Equations 4-2, 4-3, and 4-4 are applicable for concrete with unit weights up to 150 pcf (23.5 kN/m^3).

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For walls: rate of placement of 7 to 10 ft (2 to 3 m) per hour

$$C_C = 150 + 43{,}400/T + 2{,}800\,R/T \qquad (4\text{-}4)$$

$$C_{C\,SI} = 7.2 + \frac{244\,R_{SI}}{T_{SI} + 17.8} + \frac{1156}{T_{SI} + 17.8} \qquad (4\text{-}4\ SI)$$

where R (R_{SI}) is the rate of placement, ft/h (m/h); and T (T_{SI}) is the temperature of concrete in the form, °F (°C).

4.7.1.2 Alternatively, a method based on appropriate experimental data may be used to determine the lateral pressure used for form design.

4.7.1.3 If concrete is pumped from the base of the form, the form shall be designed for full hydrostatic head of concrete, $C_C = w \times h$, plus a minimum allowance of 25% for pump surge pressure. In certain instances, pressures may be as high as the face pressure of the pump piston.

4.7.2 Slipform Pressure

For a slipform concreting operation, the lateral pressure of fresh concrete to be used in designing the forms, bracing, and wales shall be calculated as

$$C_C = c + 6{,}000\,R/T \qquad (4\text{-}5)$$

$$C_{C\,SI} = c_{SI} + \frac{524\,R_{SI}}{T_{SI} + 17.8} \qquad (4\text{-}5\ SI)$$

where c (c_{SI}) is 100 psf (4.79 kPa) for concrete placed in 6 to 10-in. (150 to 250-mm) lifts with slight vibration or no revibration and 150 psf (7.19 kPa) for concrete that requires additional vibration, such as gastight or containment structures; C_C ($C_{C\,SI}$) is lateral pressure, psf (kPa); R (R_{SI}) is the rate of concrete placement, ft/h (m/h); and T (T_{SI}) is the temperature of concrete in the forms, °F (°C).

4.7.3 Shoring Loads

When shores are required to support the load of newly placed concrete, these shores shall be maintained until the concrete has gained enough strength to be self-supporting. When shoring is continuous over several floors, the calculated loads on these shores shall be cumulative unless and until the shores have been released and reset to allow the slab in question to carry its own dead weight. Such release should not occur until the concrete is capable of carrying its own dead load.

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4.8 Application of Loads

4.8.1 Combined Loads

The design construction load shall include the critical combination of personnel, equipment, and material loads.

4.8.1.1 Working Surfaces. Structures supporting working surfaces as defined in Section 4.1 shall be designed for the combined material, personnel, equipment, and other applicable construction loads.

When the construction operation fits the definition in Table 2, the designer is permitted to design for the tabulated uniform loads as the vertical load from the combination of personnel, equipment, and material in transit or staging. When the construction operation does not fit the definitions in Table 2, the design shall be for the actual loads. Concentrated loads shall be considered separately.

Table 2 Classes of Working Surfaces for Combined Uniformly Distributed Loads

Operational Class	Uniform Load[a] *psf (kN/m²)*
Very light duty: sparsely populated with personnel; hand tools; *very small amounts of construction materials*	20 (0.96)
Light duty: sparsely populated with personnel; hand operated equipment; staging of materials for lightweight *construction*	25 (1.20)
Medium duty: concentrations of personnel; staging of materials *for average construction*	50 (2.40)
Heavy duty: material placement by motorized buggies; staging of materials for heavy construction	75 (3.59)

[a] Loads do not include dead load, D; construction dead load, C_D; or fixed material loads, C_{FML}.

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C4.8 Application of Loads

Construction loads depend very much on the specific planning and processes of construction. This section includes rules for applying and combining the various loads, as well as traditional minimums for several common construction processes.

C4.8.1 Combined Loads

The combination of the various forms of construction loads, materials, personnel, and equipment is an important step in engineering for construction, requiring careful application of professional judgment.

C4.8.1.1 Working Surfaces. It is traditional to design many working surfaces for a uniformly distributed load that is meant to include all construction loads, except for materials in their final position.

Temporary structures have often been designed, advertised, and specified by the light, medium, and heavy duty ratings given in Table 2. This standard also applies to partially completed structures, and the same terminology is adopted. Different styles of construction and different segments of the construction industry have different traditions for design loads on partially completed structures during construction, and this section of the standard is an attempt to unify the industry on a common basis.

Examples of construction operations that have traditionally been designed for the loads given in the table are

Very light duty:
Roofing, reroofing, excepting situations with stockpiles of ballast
Access catwalks
Painting, caulking
Maintenance using hand tools

Light duty:
Light frame construction
Concrete transport and placement by hose and concrete finishing with hand tools

Medium duty:
Concrete transport and placement by buckets, chutes, or handcarts
Concrete finishing using motorized screeds
Masonry construction with tile or hollow lightweight concrete units
Structural steel erection or concrete reinforcing steel placement

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Heavy duty:
Concrete transport and placement using motorized buggies
Masonry of brick or heavy-weight concrete units
Material storage

Conflicts between provisions of this section and those in ASCE 3-91 and ASCE 9-91 are acknowledged.

Following are examples of working surfaces that do not fall under Table 2:

Roofs for which design is controlled by building code live load or snow loads that are less than values in Table 2.

Attics or hung ceilings that provide access for maintenance, installation of utilities, and emergency services such as firefighters.

These working surfaces must be addressed in accordance with Sections 4.8.1.1 and 4.8.4.

4.8.1.2 Specification of Temporary Structures. When temporary structures are specified by load name, the names of the load class and the magnitude of design loads shall be as given in Table 2.

C4.8.1.2 Specification of Temporary Structures. This requirement will encourage uniformity in terminology for capacity of scaffolds and similar structures.

4.8.2 Partial Loading

The full intensity of the construction load applied only to a portion of the length of a structure or member shall be considered if it produces a more unfavorable effect than the same intensity applied over the full length of the structure or member.

C4.8.2 Partial Loading

Partial-length loads on a beam or truss may produce higher shear on a portion of the span than a full-length load. Checkerboard loadings on floors and multistory frames produce the highest positive and negative moments. Cantilevers cannot rely on a possible construction load on the anchor span for equilibrium. ASCE 7-95 describes other possible conditions of designing members or floors for partial loading.

4.8.3 Reduction in Construction Loads

4.8.3.1 Material Loads. No reduction is allowed for fixed or variable material loads, except to the extent that small amounts of material in transit or staging are included in uniformly distributed personnel, equipment, and material loads, such as those in Table 2.

4.8.3.2 Personnel and Equipment Loads. When justified by an analysis of the construction operations, members having an influence area of 400 ft^2 (37.16 m^2) or more may be designed for a reduced uniformly distributed personnel and equipment load determined by applying the following formula:

$$C_P = L_o\,(0.25 + 15/\sqrt{A_I}) \qquad (4\text{-}6)$$

$$C_{P\,SI} = L_o\,(0.25 + 4.57/\sqrt{A_I}) \qquad (4\text{-}6\ SI)$$

C4.8.3.2 Personnel and Equipment Loads. Uniformly distributed loads are a convenient substitute for computing the combined effect of several concentrated loads. As such they are generally calibrated to a particular area. For smaller areas, the concentrated loads control structural design. The nature of transient concentrated loads, such as personnel and equipment, is that their spacing is not uniform, thus, for areas larger than the calibration area, the uniform load may be unnecessarily conservative.

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where C_P ($C_{P\,SI}$)is the reduced design uniformly distributed personnel and equipment load per ft^2 (m^2) of area supported by the member; L_o is the unreduced uniformly distributed personnel and equipment design load per ft^2 (m^2) of area supported by the member; and A_I is the influence area, ft^2 (m^2). The influence area A_I is normally four times the tributary area for a column, two times the tributary area for a beam, and equal to the panel area for a two-way slab.

The reduced uniformly distributed personnel and equipment design load, regardless of influence area, shall not be less than 50% of the unreduced design load for members supporting one level or 40% of the unreduced design load for members supporting more than one level, except that where the uniformly distributed personnel and equipment load is 25 psf (1.2 kN/m^2)or less, the reduced load shall not be less than 60% of the unreduced design load, unless justified by an analysis of the construction operations.

4.8.3.3 Personnel and Equipment Loads on Sloping Roofs. A reduction in gravity construction loads for personnel and equipment on a roof is also permitted based upon the slope of the roof. The reduction factor *R* is:

$$R = 1.2 - 0.05F$$

where *F* is the slope of the roof expressed in inches per foot *(in SI system, $F = 0.12 \times$ slope of the roof expressed in percentage points)*. R need not exceed 1.0 and shall not be less than 0.6. This reduction may be combined by multiplication with the reduction based on area, but the reduced load shall not be less than 60% of the basic unreduced load.

4.8.4 Restriction of Loads

The following working surfaces shall have their use and access restricted by posting of the permitted loads and load conditions or by operational control by the entity that has jurisdiction over their use.

1. Scaffolds with working surfaces of 40 ft^2 (3.72 m^2) or less shall be rated for the number of individual personnel loads that they can support, and the working surfaces shall be restricted accordingly. When designing, the individual personnel loads shall be placed in such locations as to maximize their effects on the structural members of the scaffold; however, they need not be spaced closer than 2 ft (0.61 m) on center.

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A construction load reduction based on influence is reasonable. There is a lack of data from construction projects. Without specific information, the derivation of a new reduction equation was not warranted. Therefore, a commonly used live load reduction procedure (ASCE 1995) has been used for this document.

Care shall be exercised, since many construction loads are actual not statistical loads. If actual loads are anticipated over the entire area, no reduction should be taken.

For load restrictions see commentary in Section 4.8.4.

ASCE 7-95 allows for reduced live loads of 12 lb/ft^2 (0.57 kN/m^2). Model building codes have the same roof loading. On the surface, this is a violation of OSHA (1977) minimum loading of 25 psf (1.2 kN/m^2); however, the OSHA requirement is for temporary platforms and traditionally has not been applied to completed or partially completed roof structures (see Section 4.8.4).

C4.8.3.3 Personnel and Equipment Loads on Sloping Roofs. For consistency, the reduction in roof personnel and equipment loads also follows ASCE 7-95. The detail of application is somewhat different, but the limits are essentially the same.

C4.8.4 Restriction of Loads

Posting, restricting, or otherwise limiting construction loads is consistent with building codes, AASHTO, OSHA, scaffolding industry, and ANSI requirements. This issue should not be confused with reduction of design live load based on contributory area. Load reduction, based on influence area, is addressed in Section 4.8.3.2.

The posting or load restriction can be accomplished by physical barriers that direct the traffic on a bridge deck or parking structure, or barriers on a floor system to restrict access to wheeled vehicles, storage of materials, or personnel.

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2. Working surfaces designed for superimposed uniform loads of 25 psf (1.20 kN/m^2) or less shall be rated for both their superimposed uniform load capacity and the number and location of the individual personnel loads that they can support. These working surfaces shall be restricted accordingly.
3. Working surfaces designed for loads less than what could reasonably be expected to be placed thereon shall be restricted to the design loads.

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It is not uncommon to have relatively large work platforms or scaffolds, for example 100 × 100 ft (30.48 × 30.48 m) work platform for renovation of the structural steel roof of a building or members of a bridge. As a platform for personnel and equipment, the heavy duty 75 lb/ft^2 (3.59 kN/m^2) rating is appropriate to design the deck system. However, recognizing that the work crew may consist of several personnel working in a localized area using the 75 lb/ft^2 (3.59 kN/m^2) is inappropriate simultaneously on the entire platform and does not reflect the true operating use of the scaffold or platform. The hanger or support system for the platform could be designed for the maximum load developed by the limited number of personnel on the platform clustering around one support to create the greatest load at that support point. The platform would be clearly posted or rated, as with scaffolds in accordance with the ANSI maximum number of occupants. Failure to do this could result in a loading on the structure from which the scaffold is hanging or supported, substantially exceeding the design load of that structure.

There are many lightweight platforms and scaffolds that are intended to support only one to three persons, their small tools, and incidental materials. An example is small hanging platforms below steel beams ("floats") used extensively in structural steel erection. The capacities of these scaffolds are controlled by the number of individual personnel loads for which they are designed. Restriction of use is necessary to prevent overloading.

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5.0 LATERAL EARTH PRESSURE

5.1 Definition

For the purpose of this standard, lateral earth pressure, $C_{EH,}$ is defined as the horizontal or nearly horizontal resultant of forces per unit area created by soil and water on a vertical or nearly vertical plane of a structure.

5.2 Determination of Lateral Earth Pressure

Design values of lateral earth pressures and their distribution shall be determined by the use of credible and reliable methods in accordance with accepted engineering practice. One test of credibility of a method of earth pressure determination shall be its publication in one or more generally accepted references on geotechnical engineering.

Site-specific conditions shall be considered in the selection of method(s) of calculation, and site-specific data shall be used for the critical factors in the calculations.

Distinction shall be made among active, at-rest, and passive earth pressures as influenced by the direction and magnitude of movement or deformation of the structure under load.

Laboratory or field instrumentation, observations, and measurements shall be permissible bases for determination of earth pressures.

C5.0 LATERAL EARTH PRESSURE

C5.2 Determination of Lateral Earth Pressure

The magnitude and distribution of soil pressures on both permanent and temporary structures during construction depend on a multitude of factors. Their determination for design should be performed by an engineer with adequate knowledge of soil mechanics, understanding of structural behavior, and familiarity with the construction procedures at hand.

Innovative methods of temporary excavation supports are continually developing. The application of existing methods of earth pressure analyses should be done with caution and should, when possible, rely on recorded field performance.

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6.0 ENVIRONMENTAL LOADS

The basic reference for computation of environmental loads is the 1995 edition of ASCE 7. The requirements of ASCE 7-95 shall be applied except as modified herein.

When an environmental loading is contained in another document acceptable to the authority having jurisdiction, written to address a specific material or method of construction, the more applicable document shall be permitted to be followed.

6.1 Importance Factor

During construction, the importance factor, I, shall be 1.0 for all environmental loads, regardless of what the importance factor is for the completed structure.

6.2 Wind

Except as modified herein, wind loads shall be calculated in accordance with procedures in ASCE 7-95.

Design wind pressures shall be based on design velocities calculated in accordance with Section 6.2.1, without increases to meet minimum design wind loading requirements of ASCE 7-95.

6.2.1 Design Velocity

The design wind speed shall be taken as the following factor multiplied by the basic wind speed in ASCE 7-95:

Construction Period	Factor
less than 6 weeks	0.75
6 weeks to 1 year	0.8
1 to 2 years	0.85
2 to 5 years	0.9

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C6.0 ENVIRONMENTAL LOADS

This section deals with special issues of construction and temporary structures for which the basic procedures of ASCE 7-95 are to be modified.

The objective of this standard is to provide a level of safety during construction that is comparable to that of the completed structure. To achieve this, the probability of a load exceeding the factored nominal construction load during the construction period should be roughly the same as that of a load exceeding the factored nominal design load during the projected life of the completed structure.

Standards and other documents applicable to specific materials or methods of construction have been developed and are recognized and used extensively (e.g., AASHTO 1996; CALTRANS 1989; MCAA 2001).

C6.1 Importance Factor

The importance factor is 1.0 for all environmental loads during construction, regardless of the occupancy after construction. During construction, the primary occupancy of a building is by construction personnel. As such, the risk to loss of human life is comparable to that for Category II buildings as defined in ASCE 7-95.

C6.2 Wind

Structures shall be stabilized during construction to resist the wind loads specified in this section with full regard to all intermediate stages of construction.

Information and guidance have been lacking in the United States on the selection of wind speeds and force coefficients on structures during construction (Ratay 1987). Limited research and development have been performed for the purpose of this standard (Boggs and Peterka 1992; Rosowsky 1995).

If local conditions so dictate, and for certain hazardous construction operations, it might be appropriate to apply a minimum wind pressure, such as 10 psf (0.48 kN/m^2), to design.

C6.2.1 Design Velocity

Wind provisions are established such that $(1.4)^{0.5}$ $\times$ the construction design wind velocity should have the same likelihood of being exceeded in the construction period (say 1 to 2 years) as $(1.4)^{0.5}$ $\times$ the 50-year mean recurrence interval design wind does in a 50-year period. The reduced construction period velocity factors have been developed to achieve this objective (Boggs and Peterka 1992; Rosowsky 1995).

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Factors for construction periods less than 1 year are developed based on judgment because statistical analyses of seasonal wind variations have not been performed for all regions. Local wind speed data should be consulted when using these factors.

6.2.1.1 Construction Period. The construction period shall be taken as the time interval from first erection to structural completion of each independent structural system, including installation of cladding.

For construction periods less than 6 weeks, factors of less than 0.75 shall be permitted if justified by a statistical analysis of local wind data for the season during which the subject construction conditions will exist.

For construction between November 1 and July 31 (outside of the hurricane season), the unfactored basic wind speed of 90 mph (40 m/s) shall be permitted for structures near the Gulf Coast and Eastern Seaboard where ASCE 7-95–specified basic wind speed exceeds 90 mph (40 m/s) (3-second gust).

Between August 1 and October 31, basic wind speed of 90 mph (40 m/s) shall be permitted provided additional bracing is prepared in advance and applied in time before the onset of an announced hurricane.

C6.2.1.1 Construction Period. The dates selected to represent the hurricane season are not intended to include all times when hurricanes are possible. The dates are intended to include the period when the most severe hurricanes are probable.

6.2.1.2 Continuous Work Period. For continuous work periods, it shall be permissible to use wind speeds lower than those specified in Section 6.2. For continuous work periods, the basic wind speed shall be not less than the predicted speed, adjusted to the 3-second gust speed, as reported by the National Weather Service or another reliable source acceptable to the authority having jurisdiction, for the day of construction.

Continuous work periods shall be those periods of continuous rigging, erection, or demolition that last for 1 work day or less. Continuous work periods end at the end of the work day, at which time the structure shall be made inherently stable, or appropriately secured, to meet the requirements for the construction period as defined in Section 6.2.1.1.

C6.2.1.2 Continuous Work Period. During erection, many structural components, including columns, girders, trusses, formwork, and facade panels cannot be made to meet the requirements for the construction period because they are being lifted or they have not been fully incorporated into braced and secured structures. Under such circumstances that last for 1 work day or less, it is permissible to use reduced wind speeds that are based on weather conditions predicted for the site. Temporary guys, struts, minimum number of fasteners, and so on should be employed as necessary for continuous work periods. At no time should wind speeds used for continuous work periods exceed those recommended by manufacturers of equipment used in the erection or demolition operation.

Weather forecasters sometimes publish predicted wind speeds based on different sampling periods. The sampling period must be known, and the predicted wind speed must be adjusted to be consistent with provisions of ASCE 7-95. For the purposes of this Standard, to obtain 3-second gust speeds multiply fastest-mile or 1-minute average speeds by 1.25 and mean-hourly speeds by 1.55.

At the end of continuous work periods, when the duration of the operation exceeds the time period

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within which the wind speed can be reasonably predicted, or when wind speeds exceed those used for the continuous work period, the structure or element should be stabilized to resist the design speeds specified in Section 6.2.1.1.

Certain rigging operations may, by their very nature, pose hazards, and may require more restrictive measures to conform to ordinance of the authority having jurisdiction, or to good practice. An example is to provide free-fall areas for the materials being handled, which may result in closure of streets or sidewalks, or evacuation of buildings.

6.2.2 Frameworks without Cladding

Structures shall resist the effect of wind acting upon successive unenclosed components.

Treatment of staging, shoring, and falsework with regular rectangular plan as trussed towers in accordance with ASCE 7-95 shall be permissible. Unless detailed analyses are performed to show that lower loads may be used, no allowance shall be given for shielding of successive rows or towers.

For unenclosed frames and structural elements, wind loads shall be calculated for each element. Unless detailed analyses are performed, load reductions caused by shielding of elements in such structures with repetitive patterns of elements shall be as follows:

1. The loads on the first three rows of elements along the direction parallel to the wind shall not be reduced for shielding.
2. The loads on the fourth and subsequent rows shall be permitted to be reduced by 15%. Wind load allowances shall be calculated for all exposed interior partitions, walls, temporary enclosures, signs, construction materials, and equipment on or supported by the structure. These loads shall be added to the loads on structural elements.

Calculations shall be performed for each primary axis of the structure. For each calculation, 50% of the wind load calculated for the perpendicular direction shall be assumed to act simultaneously.

C6.2.2 Frameworks without Cladding

Although the design wind speed during construction may be lower than that for the completed structure, the total wind load may actually be higher because of the cumulative effect of wind acting on many more surfaces and often with higher drag coefficients than in the fully enclosed structure. For common arrangements of elements in typical open frames and temporary structures, shielding effects are small. Considering the changing nature of the building silhouette and the arrangement of construction materials on the structure, it is prudent to assume that loads will **not** be reduced because of shielding, except in certain specific cases.

For open structures with regular patterns of elements, the direction of maximum force on the structure usually is not parallel to the principal axis of the structure. Shielding effects are minimized, and therefore loads are at their highest, when the direction of the wind is not parallel to the column lines. For this reason, the most severe loads on an open structure include components of load in both principal directions of the structure.

Shapiro et al. (1980), Nix et al. (1975), Vickery et al. (1981), and MBMA (1986) provide guidance on shielding effects and loads on open structures.

6.2.3 Accelerated Wind Region

Structures placed in regions of accelerated wind speed (near building edges and corners) shall resist the higher pressures and suctions that will exist in such regions. The design velocity shall be factored upward from the basic velocity by the square root of the suction coefficient for cladding as given in ASCE 7-95. The calculated wind velocity shall be used with appro-

C6.2.3 Accelerated Wind Region

Near building corners, at edges of completed building enclosures, and at other discontinuities in building geometry, the prevailing wind speeds are increased and wind directions are altered. In general, pressure and suction coefficients will be higher than at locations away from discontinuities. Also, there may be substantial side and uplift loads on nearby adjacent

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priate drag factors to calculate loads on structures. At building corners, the resulting pressures shall be assumed to act on adjacent staging structures in horizontal directions parallel to and perpendicular to the enclosure surface. At top edges of enclosures, pressures shall be assumed to act upward as well as horizontally.

6.3 Thermal Loads

Provisions shall be made for thermal distortions of the structure and architectural components when structures are erected during the following conditions:

1. When the product of the following quantities exceeds 7000 ft-°F (1185 m-°C):
   a) the largest horizontal dimension between expansion joints of the erected structures and
   b) the largest of the differences between the following temperatures for the months when the portion of the structure is erected and exposed temporarily to ambient temperatures
      i) the highest mean daily maximum temperature and the lowest mean daily minimum temperature, or
      ii) the expected average temperature of the structure when it is in its end use and the highest mean daily maximum temperature, or
      iii) the expected average temperature of the structure when it is in its end use and the lowest mean daily minimum temperature
2. When portions of the structure that will be shielded when the structure is completed are subjected to direct solar radiation during hot weather, or
3. When temperature changes create distortions that could damage structural or architectural components.

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structures (such as scaffolding) in these locations. Special attention should be given to the loads on staging structures near the edges of enclosed and partially enclosed structures.

Guidance for pressures on edge regions of surfaces of enclosed structures is available (ASCE 1995; MBMA 1986), but there is little information on loads on structures such as staging constructed adjacent to and in the stream of air flowing around enclosed structures.

C6.3 Thermal Loads

Thermal distortions can be significant when frames of structures under construction are exposed to daily or seasonal ambient temperature variations and when frames are erected at temperatures that differ significantly from the temperature of the structure in its end-use condition.

The provisions of this section limit theoretical structural distortion between expansion joints to approximately 0.5 inch (13 mm). Thermal lag of structural elements is considered by specifying that calculations be based on highest mean daily maximum and lowest mean daily minimum temperatures for the months when the structure is exposed to ambient temperatures.

Mean daily maximum and minimum temperatures suitable for use in thermal load evaluations are available (National Climatic Data Center 2002). Additional temperature data are also available (NAS 1974; National Climatic Data Center 2002).

When the attachment of structural elements to foundations and adjacent structures is flexible, thermal distortions can result in movement that causes forces in those components and attachments without serious consequences. However, if the attachments are rigid, extremely large forces may develop because of the restraint of movement. Damage occurs when stressed elements are incapable of supporting the resulting forces.

Although damage is possible in almost any building, buildings that are most susceptible are those that have relatively unrestrained frames supporting rigid elements, such as precast panels or masonry infilling walls, that are not a part of the primary structural system (Martin 1971). Long buildings, in which the cumulative dimensional changes can be large, and buildings erected during the extremes of the construction season, when ambient temperatures can be very different from end-use temperature, are particularly susceptible. Also, structures with braced bays or shear walls in

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line but spaced far apart can generate substantial forces as the intermediate framing attempts to move with temperature changes.

Multistory buildings usually show the most damage in the lowest stories, where the foundation provides the greatest restraint to free movement (ACI 1985).

Solar radiation on a large surface during construction sometimes causes substantial flexural distortion and/or forces (Chrest et al. 1989; Ho and Liu 1989; Martin 1971; PCICPS 1992). This can overstress a component that is designed to be shielded in the finished structure.

Thermal distortions are often impossible to restrain because the forces that are generated exceed the capacities of practical restraining elements. Therefore, it is advisable to accommodate distortions by sequencing the erection so as to avoid making rigid connections between portions of the structure that may undergo differential movement until the temperature of the frame can be stabilized, or by installing structural and architectural details that will tolerate movement.

6.4 Snow Loads

When snowfall is expected during the construction period, as defined in Section 6.2.1.1, snow loads shall be determined for surfaces on which snow could accumulate in accordance with ASCE 7-95, except as modified herein. If construction will not occur during winter months when snow is to be expected, snow loads need not be considered, provided that the design is reviewed and modified, as appropriate, to account for snow loads if the construction period shifts to include winter months.

Design for snow loads that are lower than those described in this section shall be permissible, provided adequate procedures and means are employed to remove snow before it accumulates to levels that exceed the loads used for design.

6.4.1 Ground Snow Loads

The ground snow loads, p_g, given in ASCE 7-95, shall be modified by the following factors:

Construction Period	Factor
5 years or less	0.8
more than 5 years	1.0

C6.4.1 Ground Snow Loads

In recognition of the relatively short duration of most construction projects, the ground snow load is reduced for durations of 5 years or less to reflect the low probability that the 50-year mean recurrence interval value, which forms the basis for ASCE 7-95 loads, will occur during the construction period. However, it should also be realized that loads in excess of statistically determined design loads may occur.

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6.4.2 Thermal, Exposure, and Slope Factors

The thermal factor, C_t, and the exposure factor, C_e, shall be for the conditions that will exist during construction. If a range of conditions will exist during construction, a series of load calculations shall be made to cover the range of thermal and exposure factors to be expected. The slope factor, C_s, shall be determined based on the construction-phase values of C_t and C_e.

6.4.3 Drainage

Where drainage provisions may become blocked during construction (e.g., by freezing), the extra loads created by such blockages shall be included.

6.4.4 Loads in Excess of the Design Value

Surfaces on which snow and ice accumulate shall be monitored and any loads in excess of construction-phase design loads shall be removed before construction proceeds.

6.5 Earthquake

Where required by the governmental authority having jurisdiction, or by the owner, or by the design engineer of record, seismic design of temporary structures and supports shall be performed. If so required, earthquake loads shall be calculated in accordance with procedures in the 1995 edition of ASCE 7-95. All structures shall be treated as Category II, per Table 1-1 of ASCE 7-95, regardless of the group classification of the completed structure.

6.5.1 Applicability

Earthquake loads need not be considered unless the acceleration coefficient, A_a, read from Map 9-1 of ASCE 7-95, exceeds 0.15. If A_a exceeds 0.15, earthquake loads need not be considered if the horizontal design loads from wind or other causes (nominal load

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C6.4.2 Thermal, Exposure, and Slope Factors

The values of the thermal factor, C_t, are determined for the conditions that will exist during construction. These conditions may be quite different from those that will exist once the building is occupied. Since the value of C_t depends on whether heat is provided in a building, and most buildings under construction are unheated, snow loads may be higher during construction than when the building is completed and occupied.

In most circumstances the exposure factor, C_e, for a roof during construction will be the same as the exposure factor for that roof during the life of the building. When the thermal factor changes, the slope factor, C_s, may also change.

C6.4.3 Drainage

Drainage provisions, which often rely on building heat to function properly, may become blocked with ice during construction in cold weather if the building is unheated. When this occurs, excess loads may accumulate on roofs. Ponding instability may result. It may be appropriate to install temporary heaters in drains to avoid such problems during construction.

C6.4.4 Loads in Excess of the Design Value

If loads in excess of construction-phase design values are encountered during construction, work within the building should be halted until the overload is eliminated. Snow removal procedures must be planned to avoid overloading the structure with piles of snow or by the use of equipment too heavy for the structure.

C6.5 Earthquake

The earthquake provisions of ASCE 7-95 are modeled on FEMA (1994).

C6.5.1 Applicability

The 0.15 threshold for A_a is derived as follows:

1. The design acceleration for a 6-month duration (A_a^*) is approximately 20% of the A_a mapped as having a 10% chance of being exceeded in a 50-year period

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level) exceed $0.2A_a$ times the weight to be braced by the temporary bracing system.

Construction of detached one- and two-family lightly framed dwellings not exceeding two stories in height is exempt from these earthquake requirements.

This section applies to all construction except those specifically covered in Section 6.5.3.

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(a mean recurrence interval of about 475 years).

2. The inelastic response modification factor, R, for temporary bracing systems common in construction projects is assumed to be 2.5, consistent with a low level of ductility and redundancy. Therefore, the response acceleration for short-period structures (also characteristic of temporary bracing) is

$$Ca = \frac{2.5\ A_a^*}{R} = 1.0 \quad A_a^* = 0.2\ A_a$$

3. The strength required for horizontal construction loads represents a lower bound strength for lateral resistance. It is specified herein to be 2% of the weight at allowable stress, which would be approximately 3% at strength levels.
4. The equivalent threshold acceleration is therefore

$$0.2\ A_a = 0.03$$

$$A_a = 0.15$$

6.5.2 Use of ASCE 7-95

For use of the earthquake load provisions of ASCE 7-95, the following modifications should be made:

1. The mapped values for A_a and A_v may be multiplied by a factor less than one to represent the reduced exposure period, but the factor shall not be less than 0.2. Note: for regions inside the 0.4 contour on the map, the minimum factor should increase to a value of 0.4 along major faults.
2. The restrictions on types of structural systems in seismic performance categories D and E do not apply, as long as the height of the temporary bracing system above the final seismic resisting system does not exceed 100 feet (30 m).
3. The R factor used for temporary bracing systems shall not exceed 2.5 unless the system is detailed in accordance with the provisions of ASCE 7-95.
4. Only the requirements dealing with the strength of the seismic resisting structural system need be satisfied.

C6.5.2 Use of ASCE 7-95

The higher factor with the 0.4 contour is caused by the truncation of the probabilistic maps at the 0.4g acceleration level. It is generally accepted that such truncation results in reasonable design for permanent structures; however, the logic may not be applicable for the much shorter construction periods pertinent during construction.

The drift limitations and the nonstructural provisions are not required for temporary structures and for structures during their construction phases.

Specific provisions for design of masonry structures to resist seismic loads are contained in ASCE 5-92.

6.5.3 Other Standards for Earthquake-Resistant Design

Partially complete structures of a type that are excluded by the earthquake load provisions of ASCE 7-95 and for which specifically applicable standards for earthquake-resistant design exist, such as vehicular bridges, shall be designed and evaluated according to the specifically applicable standard. Earthquake loads

C6.5.3 Other Standards for Earthquake-Resistant Design

ASCE 7-95 excludes certain types of structures for various reasons: unique characteristics of response to ground shaking, exceptionally high risk associated with poor performance, and the existence of other standards for design. The provisions of Section 6.5.2 are intended to make ASCE 7-95 usable for most

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for temporary structures associated with such construction shall be determined in accordance with Section 6.5.2 unless the specifically applicable standard includes provisions for temporary construction.

6.6 Rain

Except as modified herein, rain loads shall be calculated in accordance with procedures in ASCE 7-95.

For temporary conditions that exist for one month or less, rain loads need not be considered for construction during months with historical rainfall averages of less than 1 inch (25 mm) per month.

6.7 Ice

Except as modified herein, ice loads shall be calculated in accordance with procedures in ASCE 7-95.

For construction during seasons when structures are not susceptible to accumulation of ice, ice loads need not be considered.

Structures that will be enclosed when construction is complete and that are designed for live loads of 20 psf (0.96 kN/m^2) or more need not be considered as ice-sensitive structures while open during construction.

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temporary structures; however, it is beyond the scope of this document to repeat complete sets of seismic design provisions for structures already covered by existing standards. For vehicular bridges, the user is referred to Section 3.2 of AASHTO (1996) and CALTRANS (1989). Also, CALTRANS has issued a "Memo to Designers 20-2" recommending acceleration levels, to use for temporary situations involving bridges carrying traffic or positioned over traffic, that are higher than the values specified in Section 6.5.2 for near fault locations (CALTRANS 1989).

C6.6 Rain

In some regions of the country, seasonal rainfall is very low. For construction in these regions during low-rainfall seasons, it is not essential to consider rain loads. Nevertheless, water should be removed when it accumulates in or on structures to a sufficient depth to exceed 25% of the live, rain, or snow loads on any supported structural element as specified in this standard.

Many structures drain better while under construction than when they are finished. However, there are circumstances when drainage potential is reduced. An example is an unfinished parking deck, which relies on a sloped topping slab for drainage. In this case, permanent drains might be above the level of finished construction and the surface of the slab might be essentially level. Also, drainage systems can become blocked with ice during freezing conditions (see Section 6.4.3) and construction debris.

Care must be taken to keep drains clear and to provide for unobstructed paths for rain water to flow from structures. Water that accumulates in unfinished structures should be removed.

C6.7 Ice

Enclosed structures that are designed for significant live loads on floor areas need not be considered for ice loads solely because they have an open configuration during construction. However, should ice accumulate on these structures, it should be removed or the construction and live loads applied to the structure should be reduced by an amount corresponding to the weight of the accumulated ice.

STANDARD

COMMENTARY

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