FOUNDATION ENGINEERING I

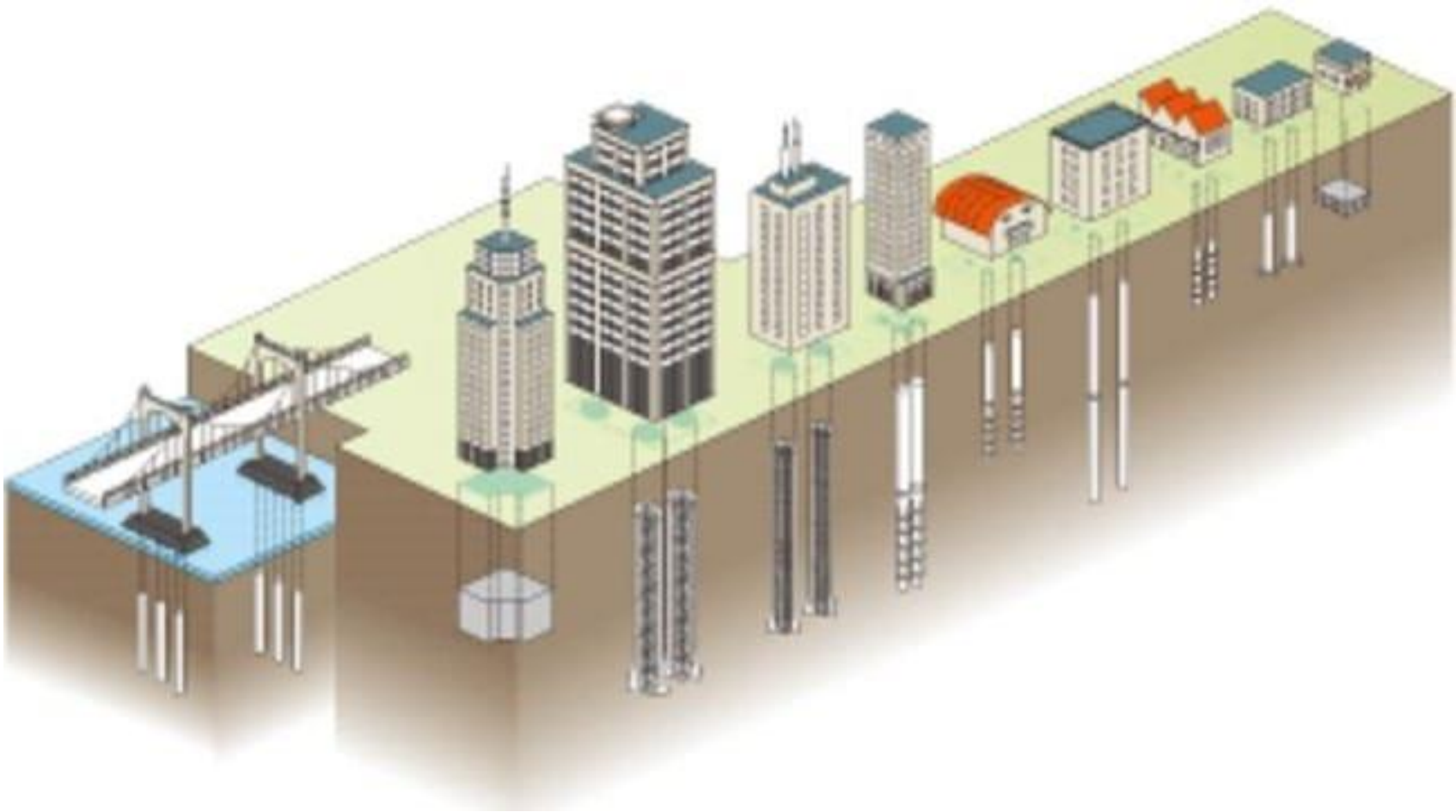
CEng 3204

Chapter 2: **Types of Foundation & their Selection**

Introduction

- Lowest artificial built part of a structure which transmits the load of the structure to the ground is called foundation.
- Always constructed below ground level so to increase the stability of the structure.
- Can be in the form of concrete block, grillage, raft, piles, etc…at it base as to provide a firm and level surface for transmitting the load of the structure on a large area of the soil lying underneath.

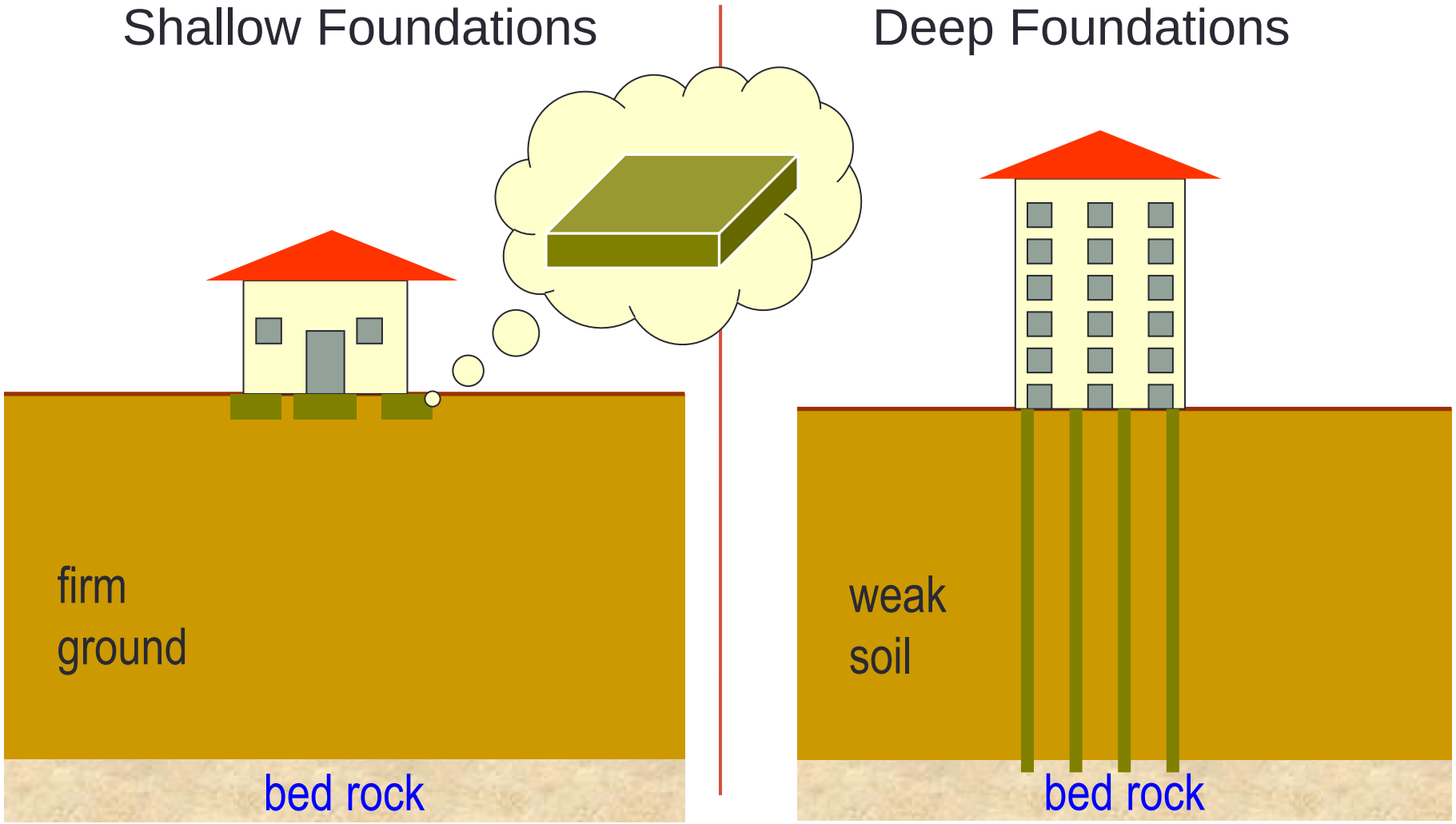
Introduction



Purpose of Foundation

- Distribute load from structure over a large area.
- Load the bearing surface at a uniform rate.
- Prevent the lateral movement of the supporting material.
- Secure level and firm bed for building operations.
- Increase the stability of the structure.

Types of Foundations



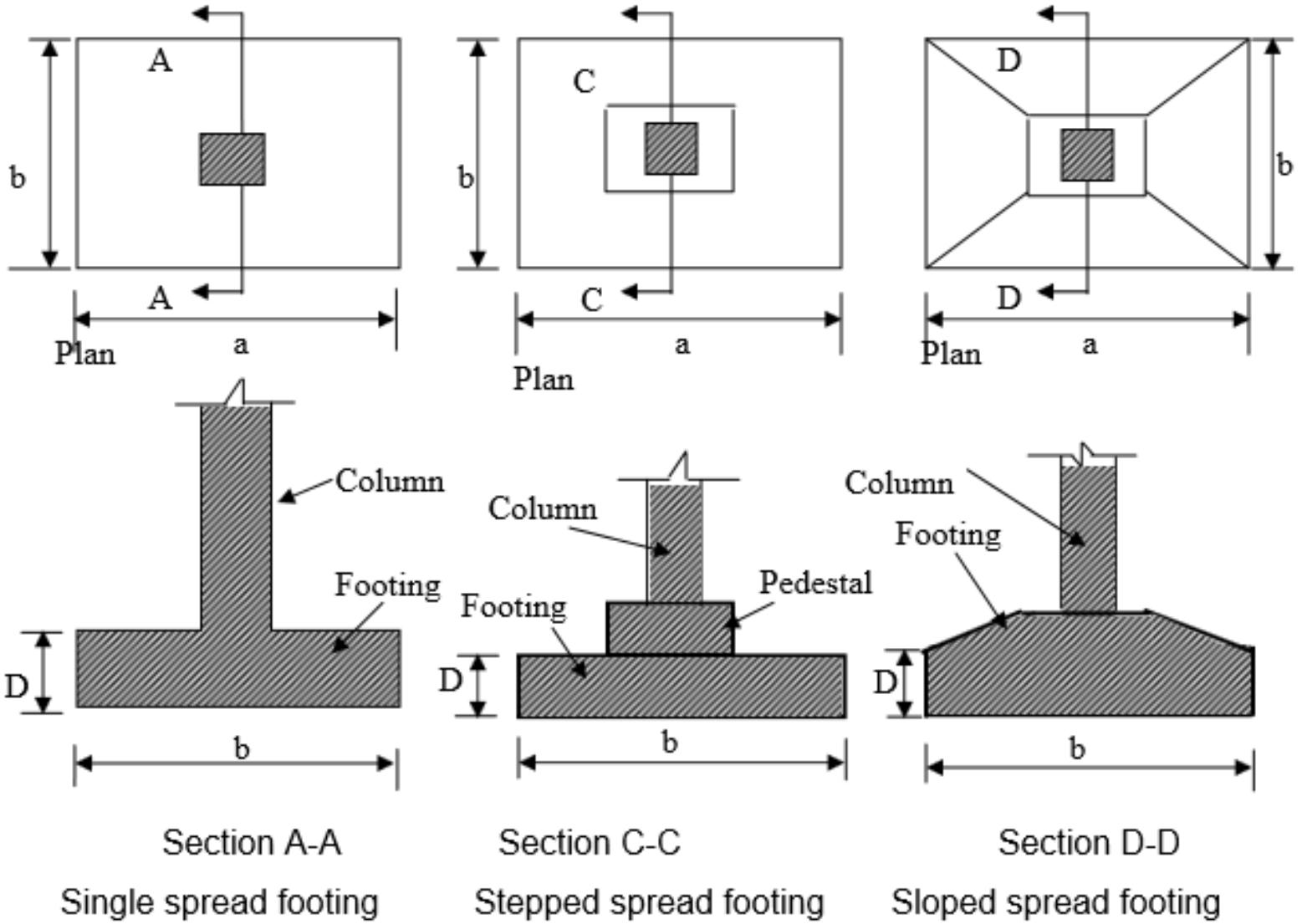
Shallow Foundations

- Foundation placed immediately below the lowest part of the super-structure.
- Used to distribute structural load over a wide area at shallow depth.
- Also called ***Open Foundation.***
- Various types available.
  - Spread / isolated footing
  - Combined footing
  - Cantilever / strap footing
  - Continuous / wall / strip footing
  - Raft / mat foundation

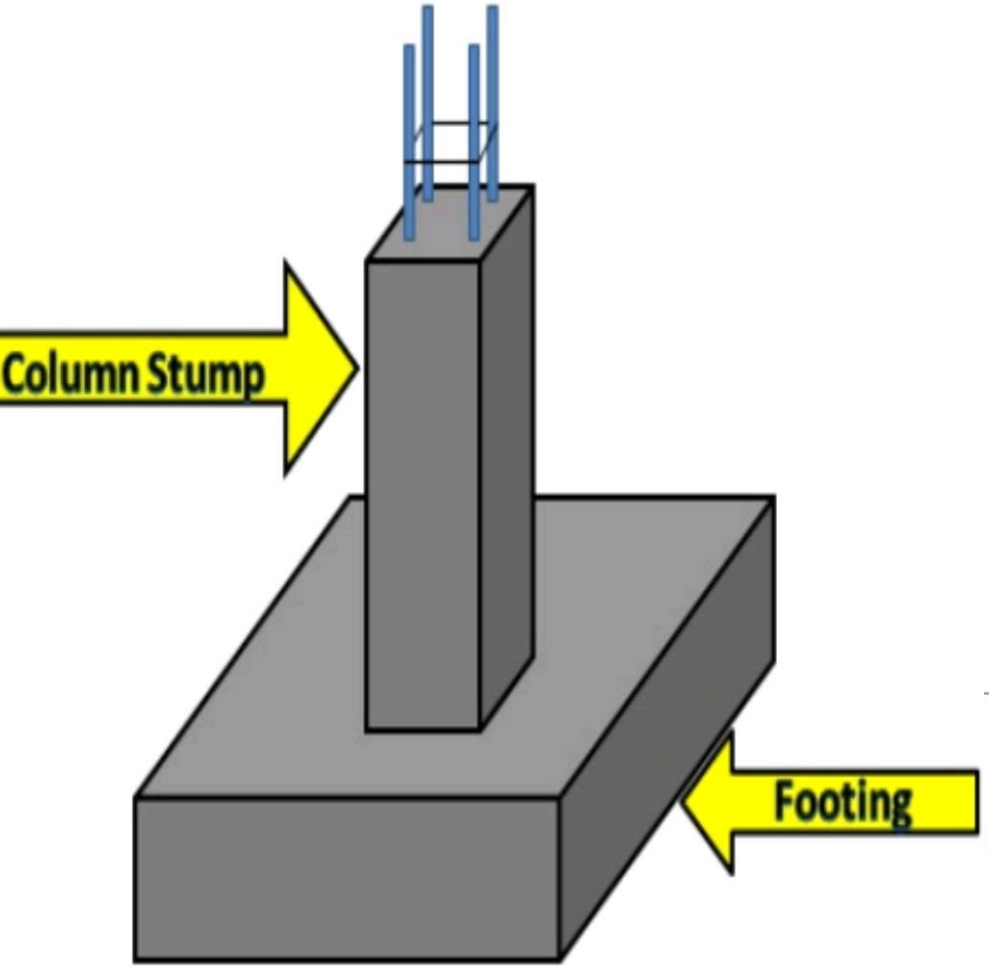
Spread / Isolated Footings

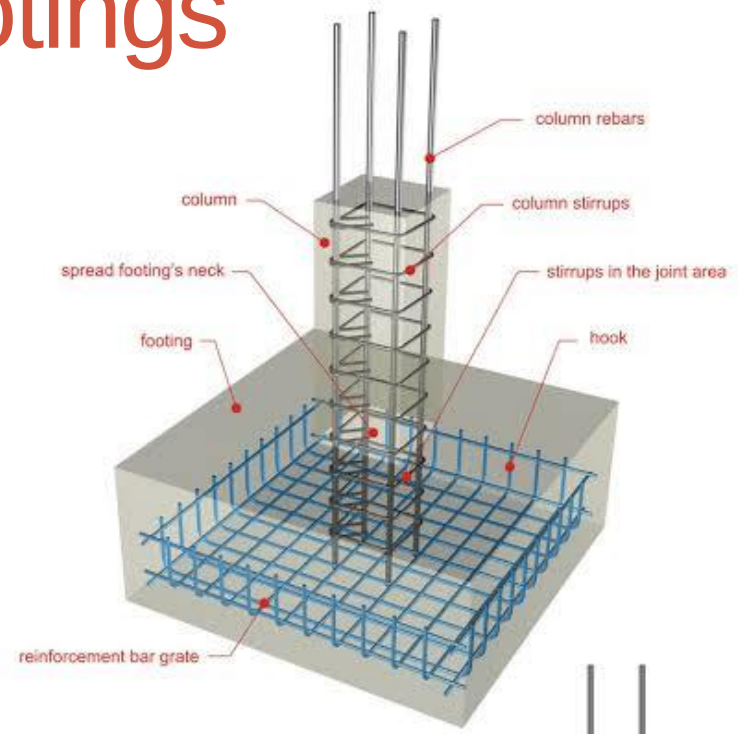
- Used to support individual column and spread the load over a large area.
- Most common type of foundation.
- Economical and easier to construct.
- Most often used:
  - In small to medium sized structures
  - Moderate to good soil conditions.
  - On large structures constructed on exceptionally good soil or shallow bedrock.
- Can be ***stepped type***, ***simple type*** or ***sloped type*** in the base concrete.

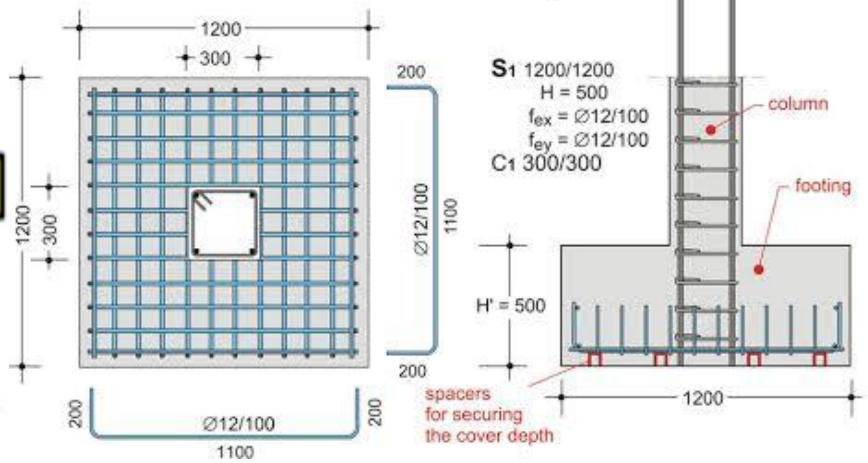
Spread / Isolated Footings



Spread / Isolated Footings



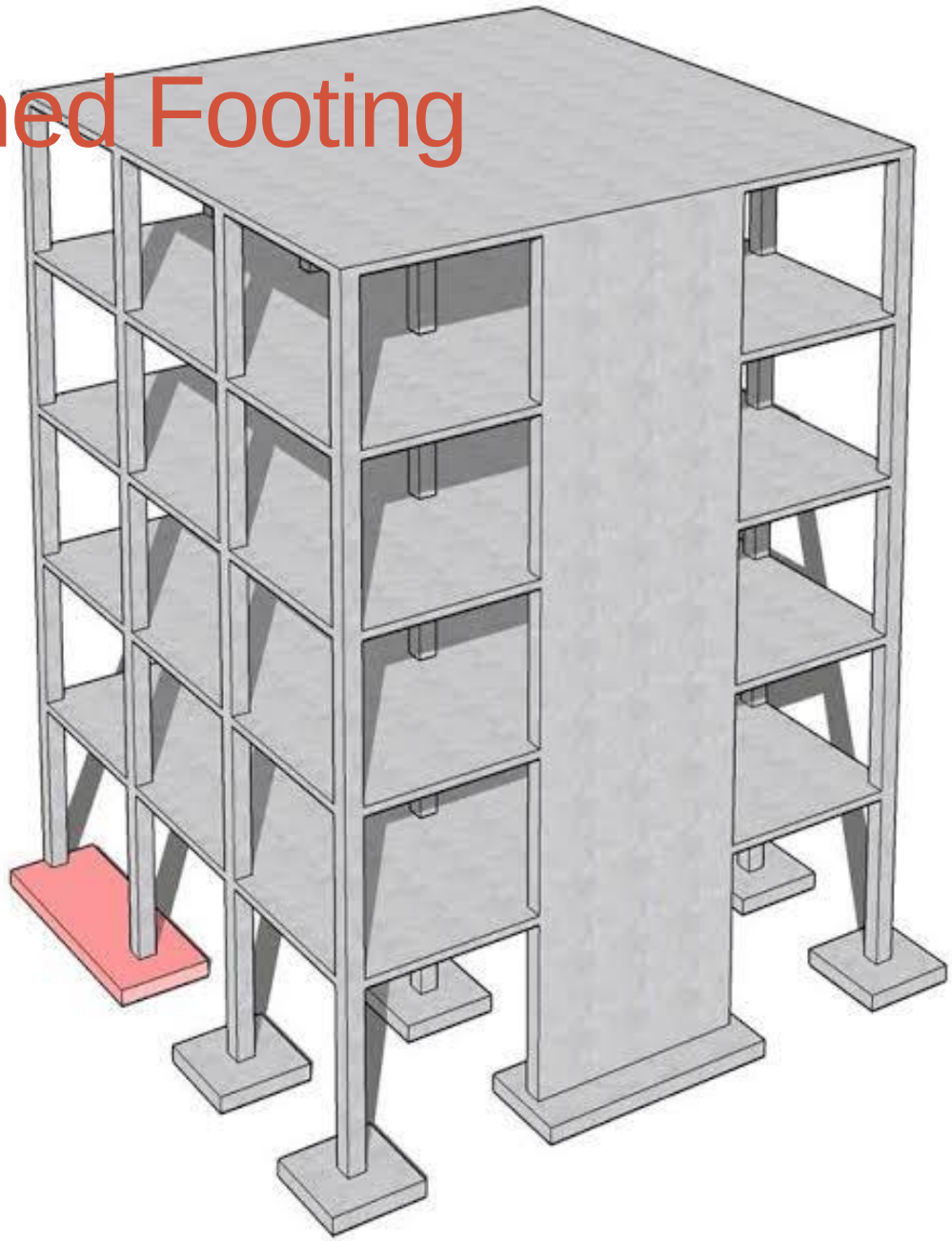




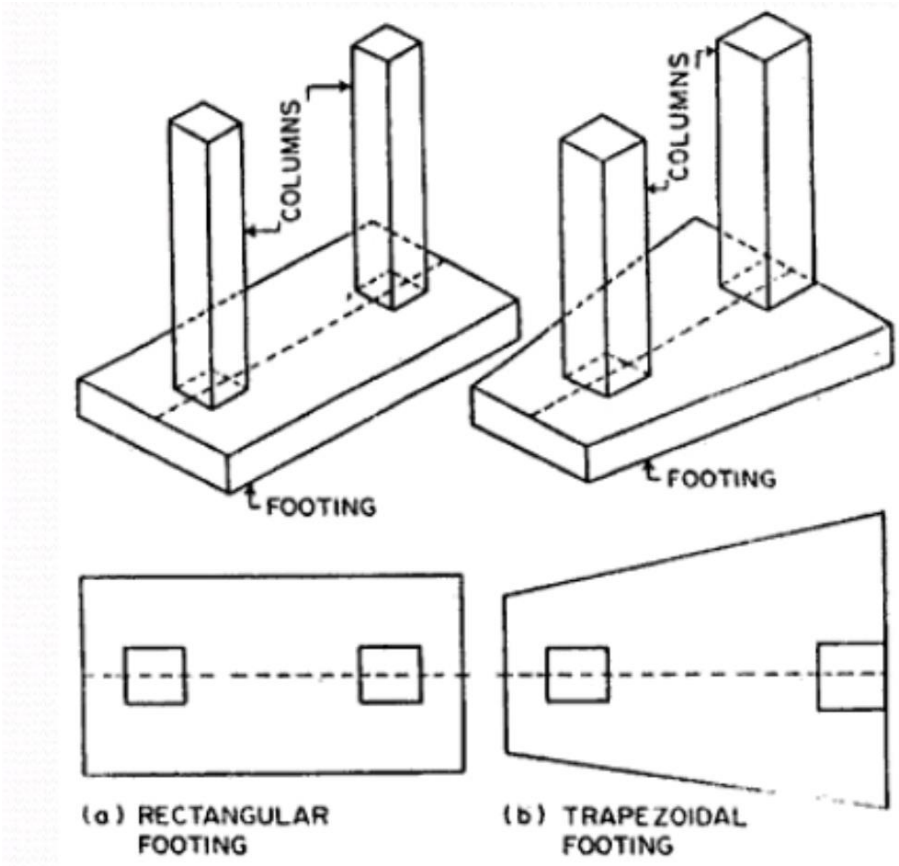
Combined Footing

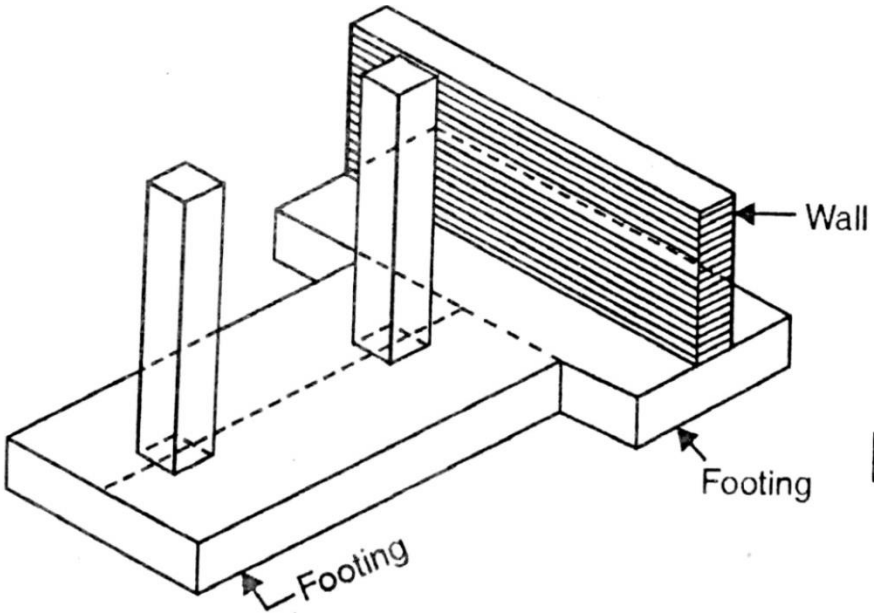
- Supports two or sometimes three columns in a row.
- Used when property lines, equipment locations, column spacing or other considerations limit the footing clearance at the column locations.
- Can be:
  - ***Rectangular combined footing*** if both columns carry equal loads
  - ***Trapezoidal combined* footing** if there is a place limitation or columns have unequal load.
  - ***Combined column-wall footing***

Combined Footing



Combined Footing

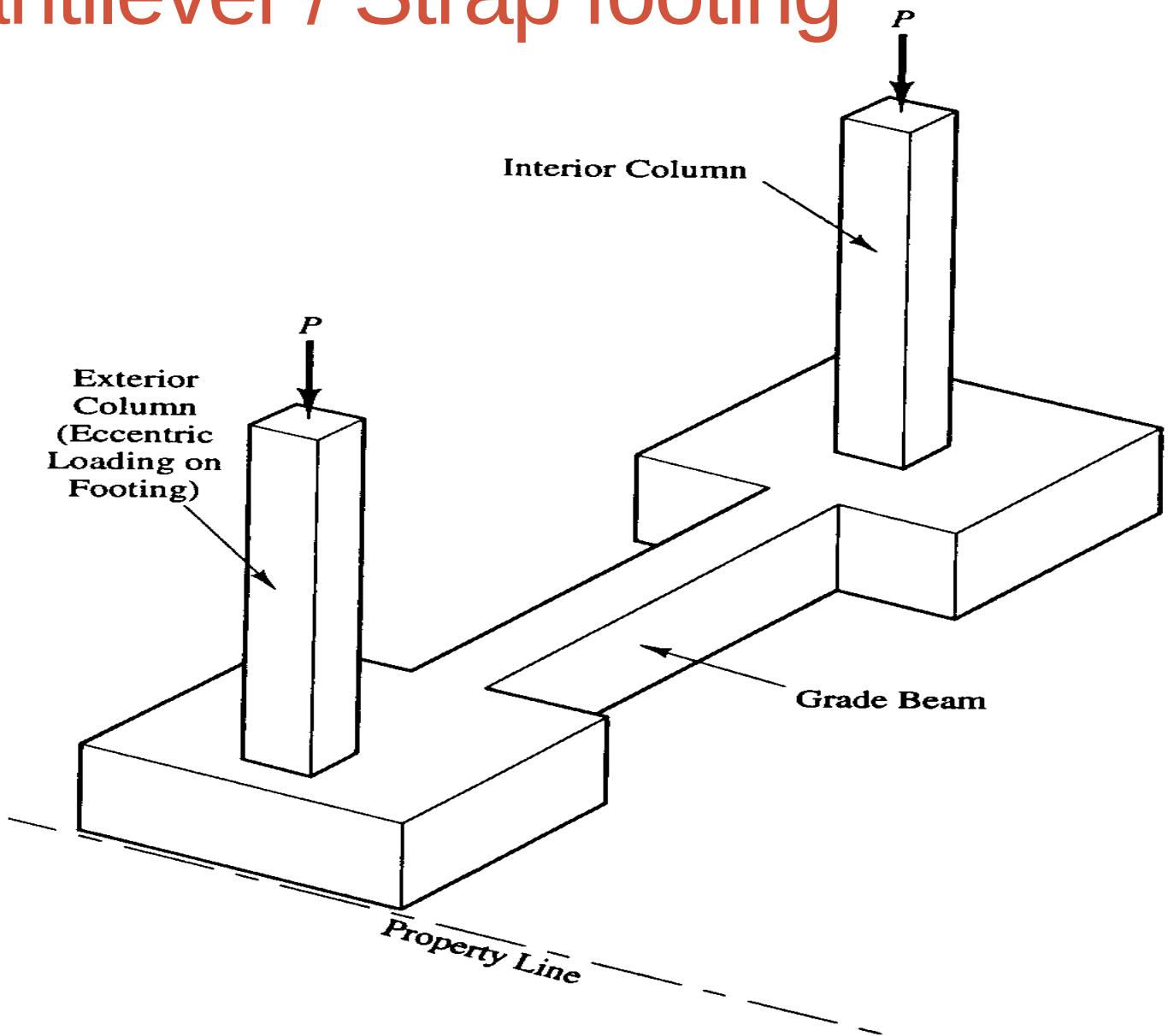




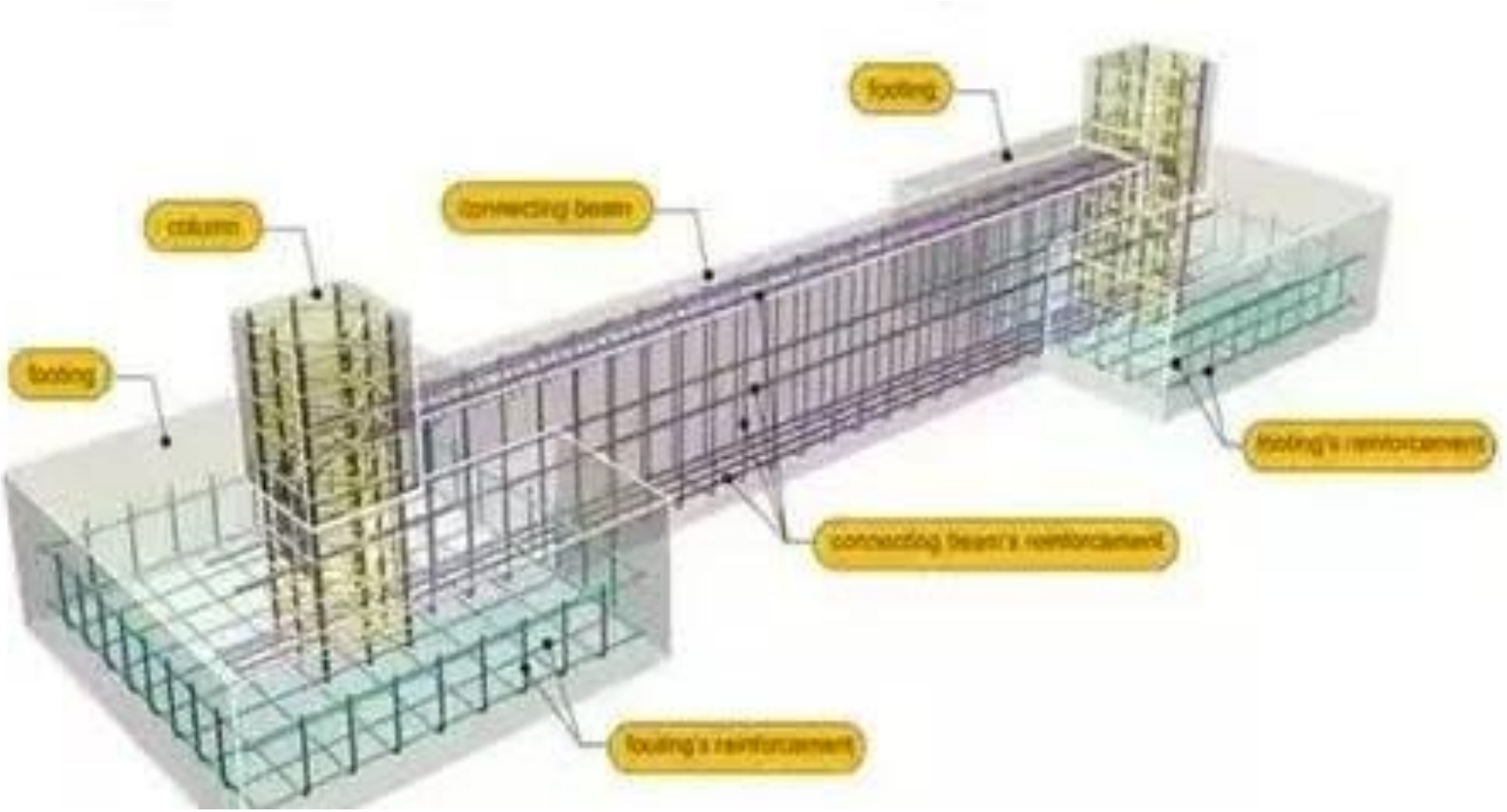
Cantilever / Strap footing

- Consists of two individual footing connected by a beam called ***strap***.
- Cantilever footing may be used:
    - where the distance between the columns is so great that a trapezoidal combined footing becomes quite narrow, resulting high bending moments.
- The strap beam does not remain in contact with soil so a strap doesn’t transfer any pressure to the soil.
- The strap beam transfers the load of heavily loaded outer column to the inner one. The strap is subjected to bending moment and shear force and should be designed accordingly.

Cantilever / Strap footing

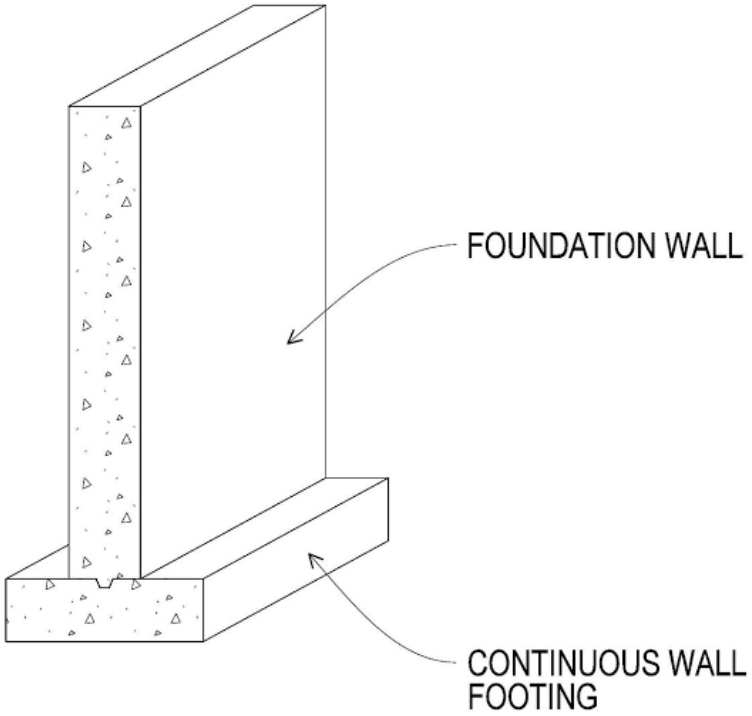


Cantilever / Strap footing

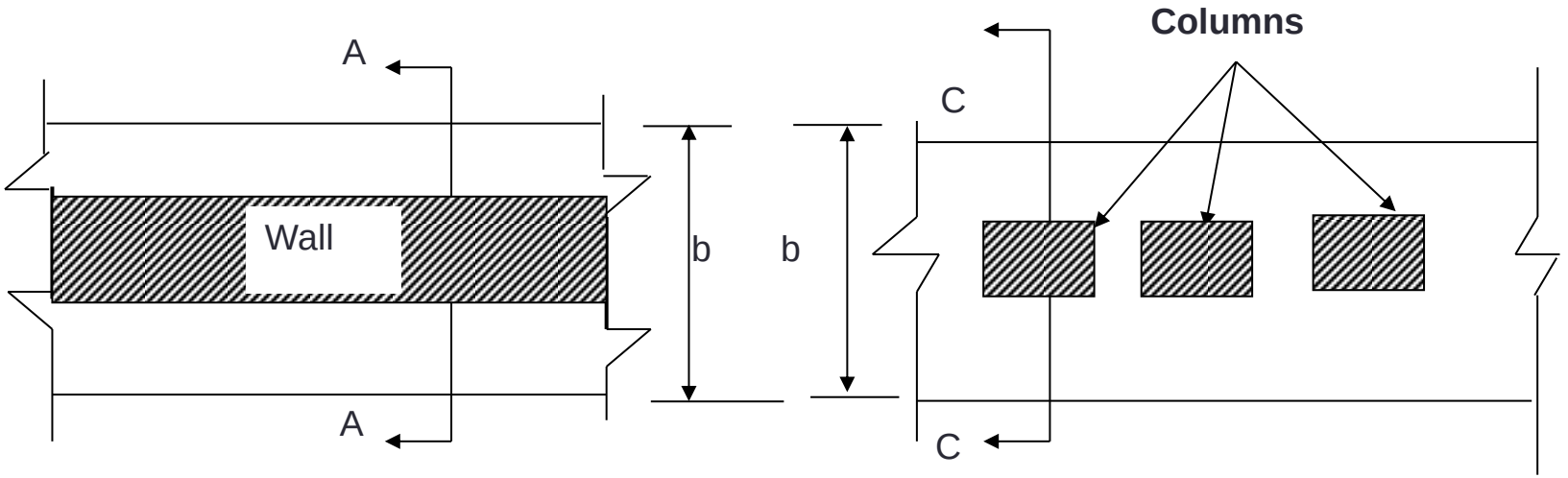


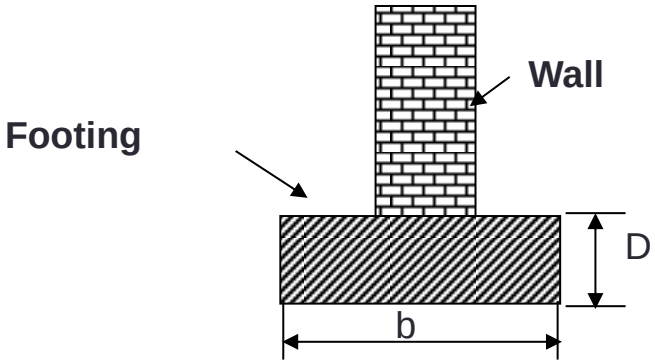
Continuous / Wall / Strip footing

- Provides a continuous longitudinal bearing for a continuous wall.
- A strip footing is also provided for a row of columns which are so closely spaced that their spread footings overlap or nearly touch each other.



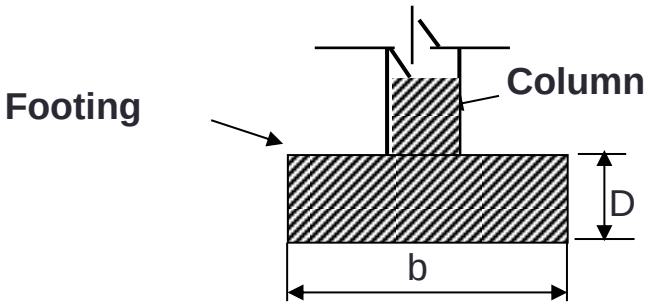
Continuous / Wall / Strip footing





Section A.A

Wall on footing



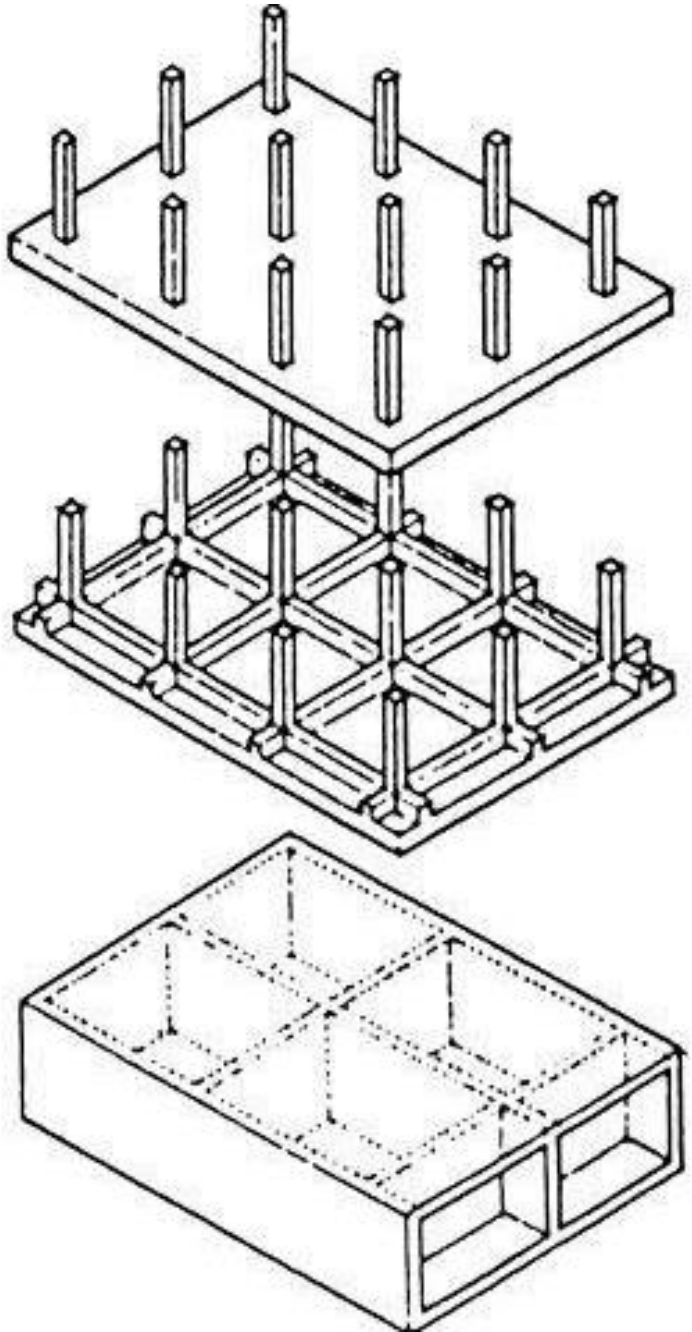
Section C-C

Columns on footing

Raft / Mat Foundation

- Foundation which consists of thick reinforced concrete slab covering the entire area beneath a structure.
- Mat foundation is considered when dealing with any one of the following conditions:
  - When the allowable soil pressure is low, or the building loads are heavy.
  - As a general rule of thumb, if spread footings would cover more than 50 percent of the building footprint area, a mat or some type or deep foundation will usually be more economical.
  - The soil is very erratic and prone to excessive differential settlement.
  - The structural loads are erratic, and thus increase the likelihood of excessive differential settlement.
  - The lateral loads are not uniformly distributed through the structure and thus may cause differential horizontal movement in spread footings.
  - The uplift loads are larger than spread footings can accommodate.
  - The bottom of the structure is located below ground water table, so waterproofing is an important concern. Because mats are monolithic, they are easier to waterproof.

Raft or Mat Foundation



mat
A thick, slablike footing of reinforced concrete supporting a number of columns o an entire building.

ribbed mat
A mat foundation reinforced by a grid of ribs above or below the slab.

cellular mat
A composite structure of reinforced concrete slabs and basement walls servin as a mat foundation.

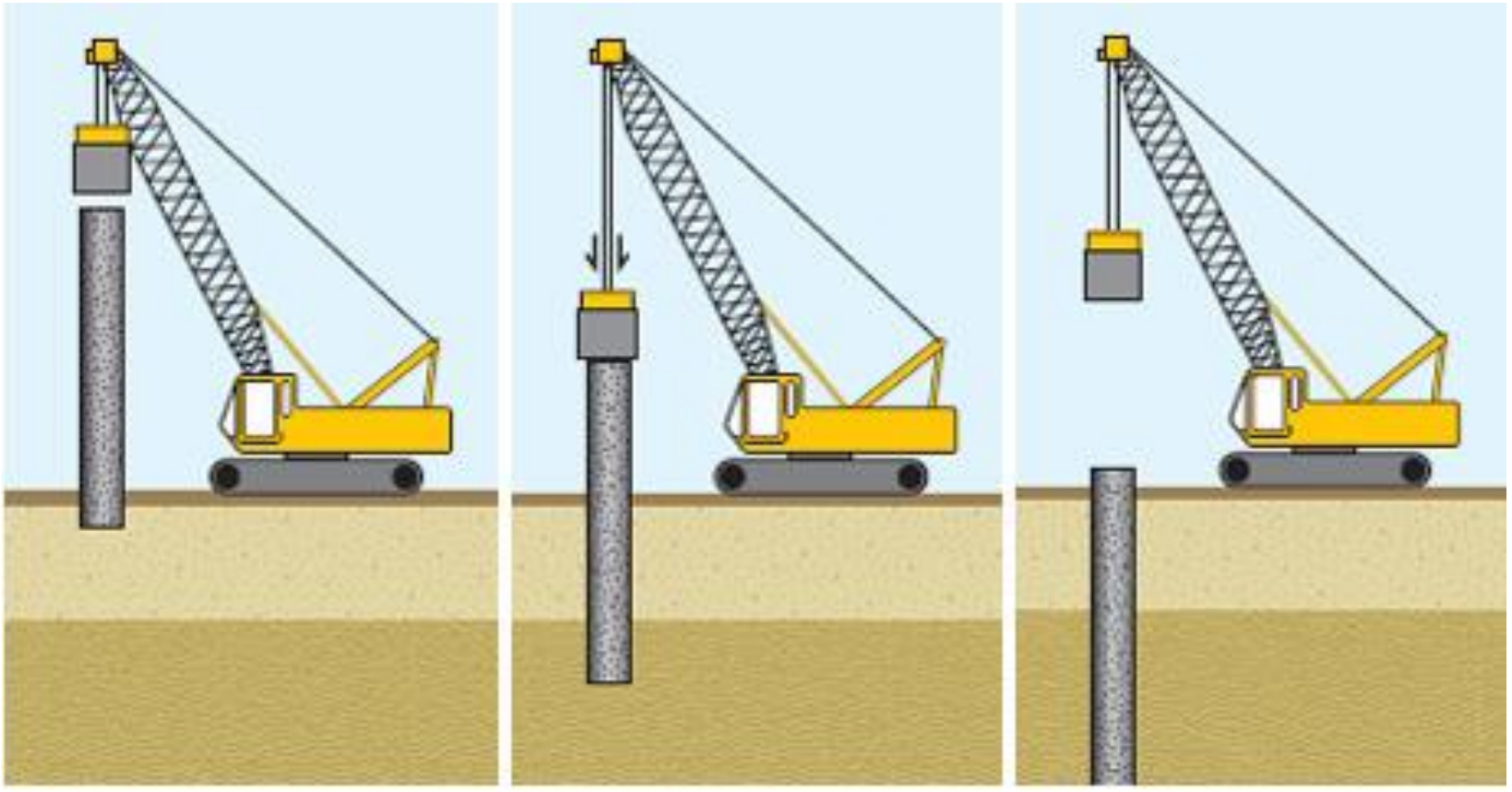
Deep Foundations

- Used when the soil at or near the ground surface is week and unable to carry the load from the structure.
- Used when the surface soil is unsuitable for shallow foundation, and a firm stratum is so deep that it cannot be reached economically by a shallow foundation.
- The most common type of deep foundations are:
  - ***Piles***
  - ***Piers***
  - ***Cassions***

Piles

- A slender structural member used to transmit structural load to deeper soil layers capable of supporting the loads.
- Can be made of steel, concrete or wood.
- According to there construction method, there are three types of piles.
  - ***Driven piles***
  - ***Cast in-situ piles***
  - ***Driven and cast in-situ piles***
- On the basis of load transfer, there are three types of piles.
  - ***End-bearing piles***
  - ***Friction piles***
  - ***Friction and end-bearing piles***

Driven Piles

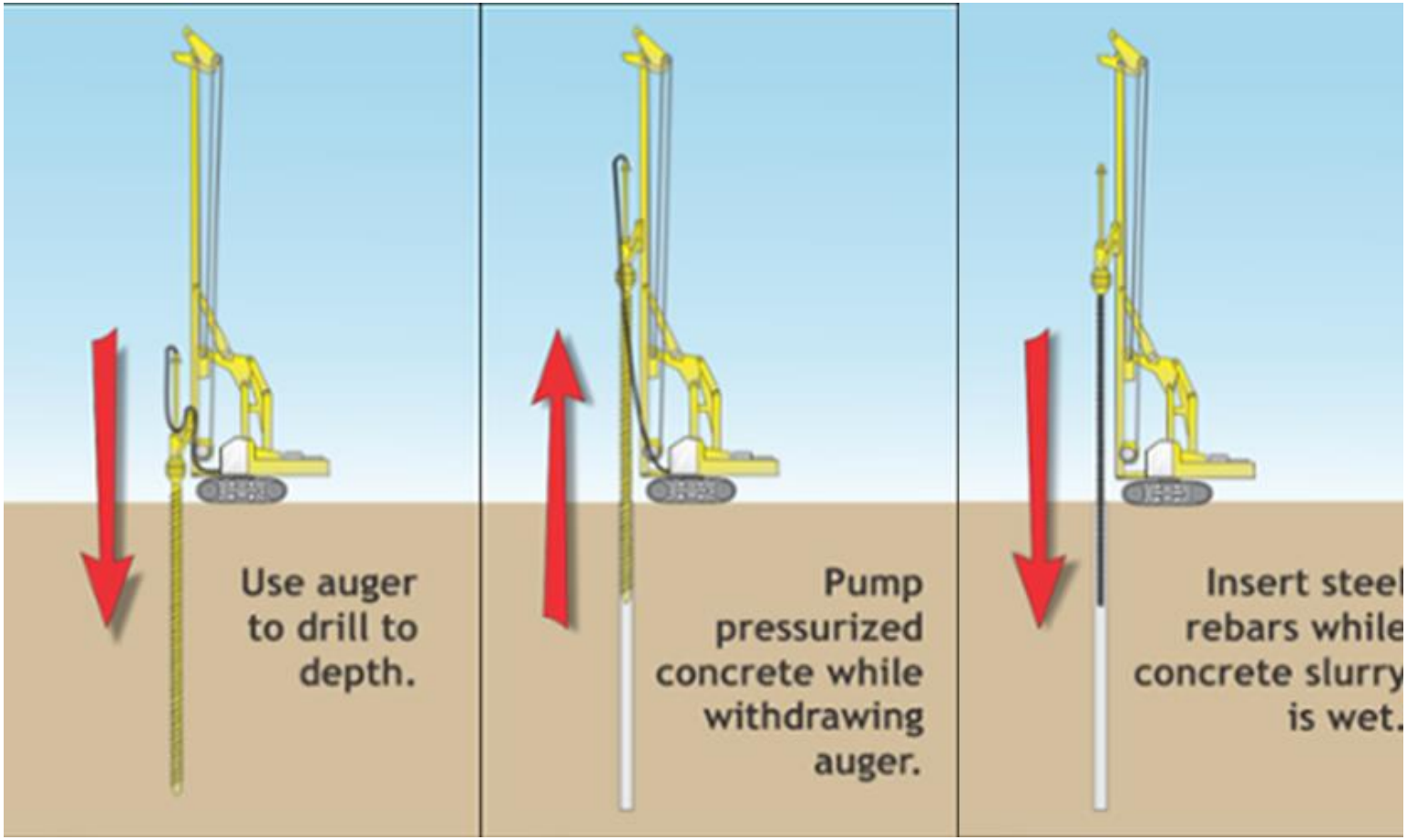


PLACEMENT OF PILE

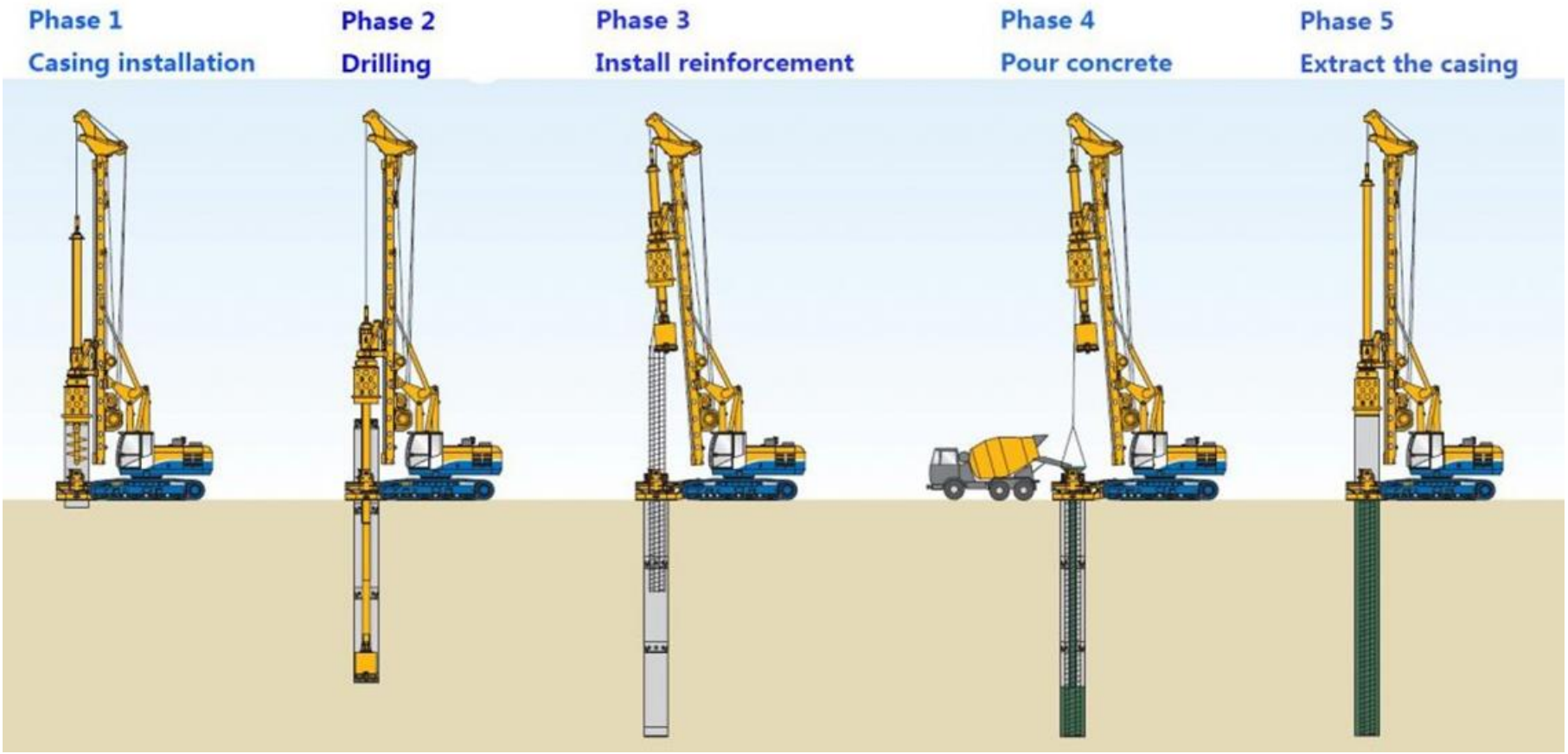
INSTALLATION OF PILE

REPETITION OF PROCESS

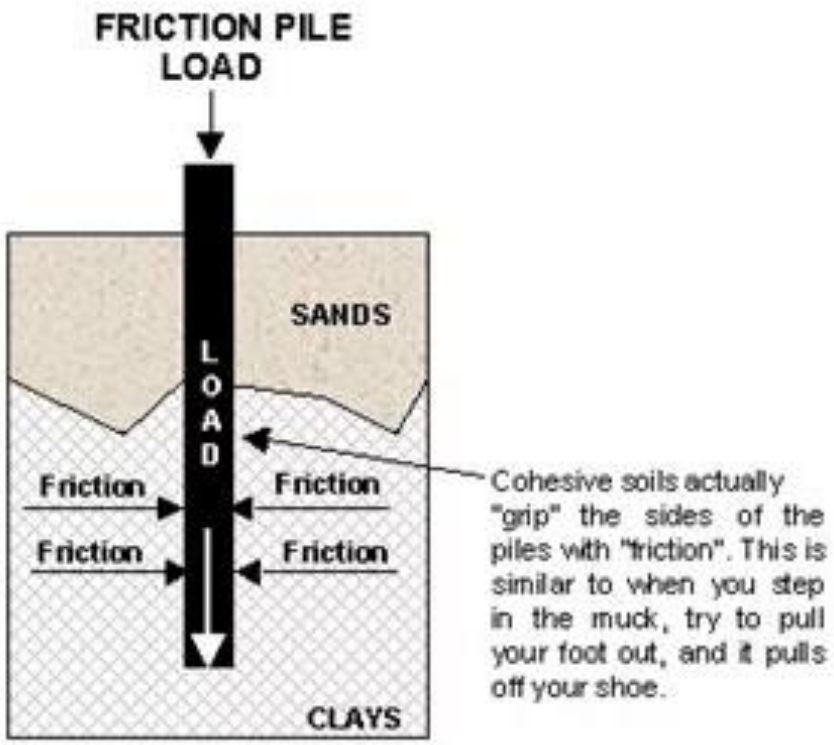
Cast In-situ Piles

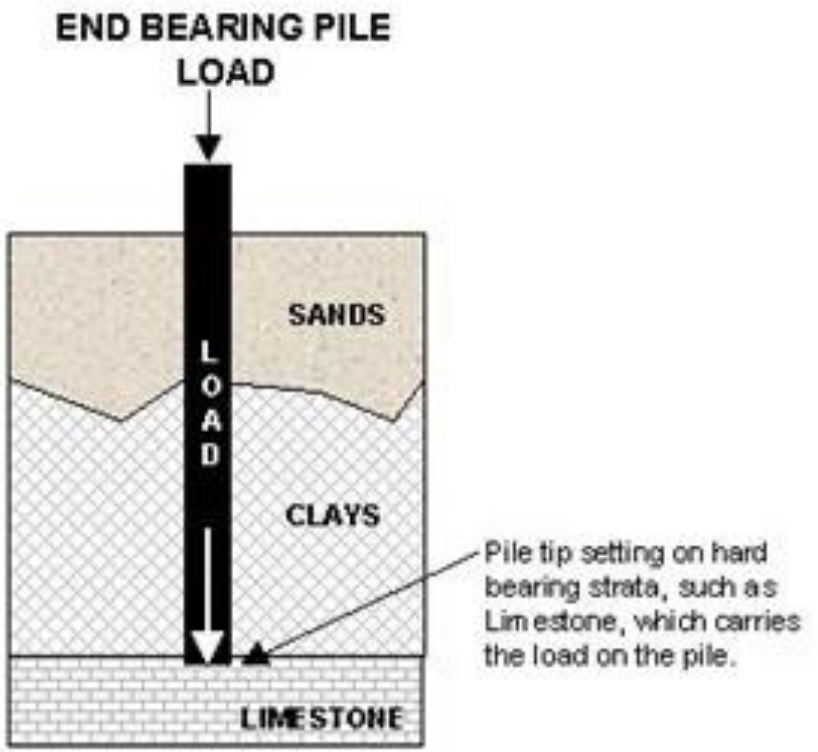


Driven and Cast In-situ Piles



Friction and End-bearing piles





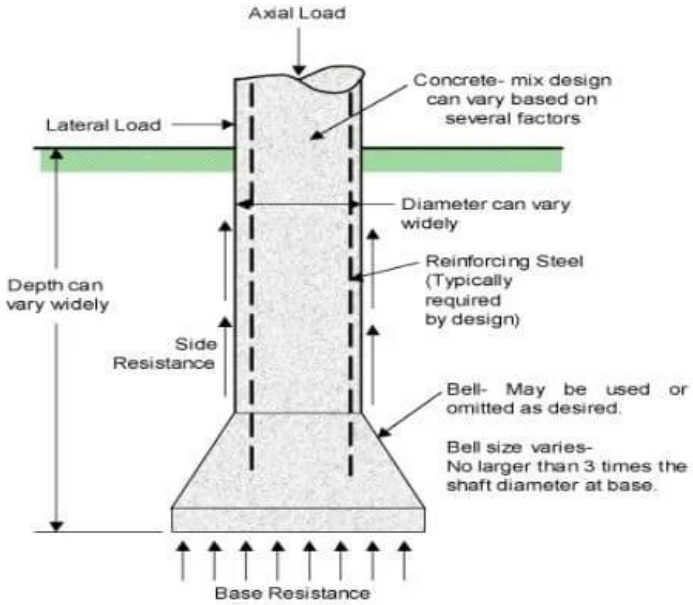
Piers and Cassions

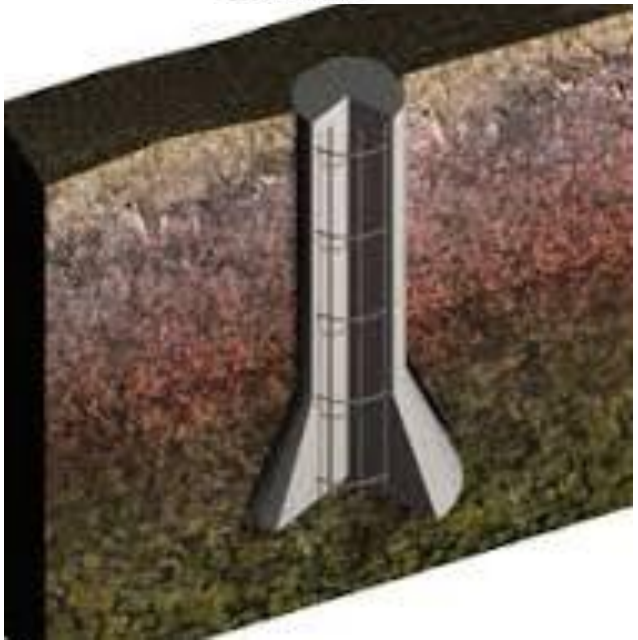
Piers

- A vertical column of relatively large cross-section than a pile.
- Installed in a dry area excavating a cylindrical hole of large diameter to the desired depth and backfilling with concrete.

Cassions

- A watertight foundation used for laying foundation under water. It is a watertight box or chamber used for laying foundation under water.
- ***A pier and caisson differ basically only in the method of construction***





Pier Foundation	Caisson	Pile Foundation
Pier foundation is a type of deep foundation, which consists of a cylindrical column of large diameter to support and transfer large superimposed loads to firm strata below.	Caissons are watertight structures made up of wood, steel or reinforced concrete built above the ground level and then sunken into the ground.	Pile foundation is a type of deep foundation, in which the loads are taken to a low level by means of vertical timber, concrete or steel.
The types of pier foundations are masonry or concrete piers and drilled caissons.	The types of caissons are box, open, pneumatic, monolithic, floating, excavated etc.	The types of pile foundation are end-bearing piles, friction piles, compaction piles, anchor piles, tension or uplift piles, sheet and batter piles etc.
Pier is inserted down to the bedrock.	Caisson is putting a box into underwater and pouring it with concrete.	Pile is a column of material driven by a piledriver. It can also be cast in place.
Pier has a footing.	Caisson doesn't have a footing.	Pile doesn't have a footing.
Pier is typically dug out and cast in place using forms.	Caissons are driven into surface condition.	Piles are driven into surface condition.

Selection of Foundation Types

- In selecting the foundation type the following points must be considered:
  - **Function of the structure**
  - **Loads it must carry**
  - **Subsurface conditions**
  - **Cost of foundation in comparison with the cost of the superstructure.**
- Having these points in mind one should apply the following steps in order to arrive at a decision.

Selection of Foundation Types

1. Obtain at least approximate information concerning the nature of the superstructure and the loads to be transmitted to the foundation.
2. Determine the subsurface condition in a general way.
3. Consider each of the usual types of foundations in order to judge whether or not;
    i. They could be constructed under existing conditions.
    ii. They are capable of carrying the required load.
    iii. They experience serious differential settlements.
        - The types that are found to be unsuitable should then be eliminated.

Selection of Foundation Types

4. Undertake a detailed study of the most promising types. Such a study may require additional information on loads and subsurface conditions.
5. Determine the approximate size of footing or the approximate length and number of piles required.
6. Prepare an estimate for the cost of each promising type of foundation.
7. Select the type that represents the most acceptable compromise between performance and cost.