Building Construction I

(Foundations)

Department of Architectural Engineering/2nd stage

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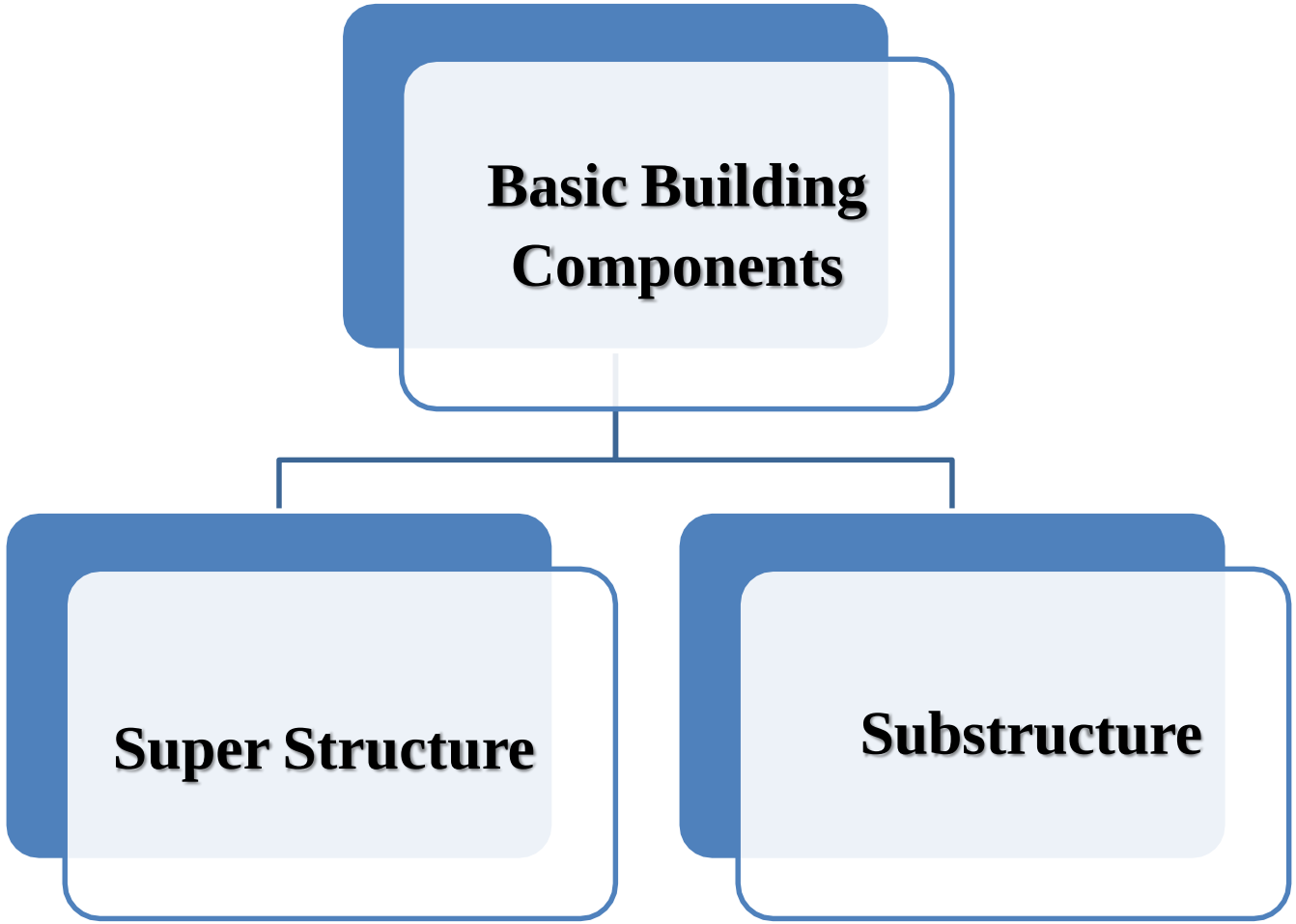
Common Building Components

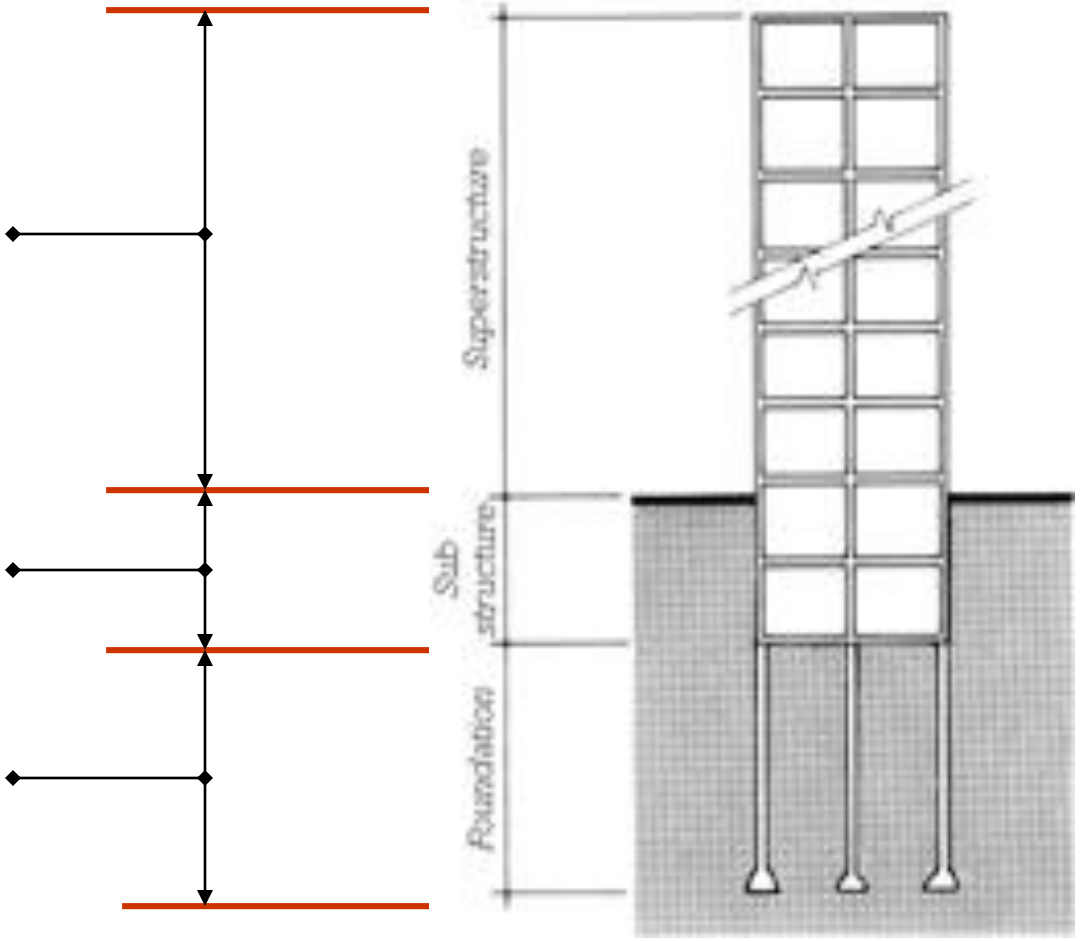


Major Building Parts

Superstructure

Substructure

Foundation



Super Structure

The superstructure is that part of the building which is above the ground and which serves the purpose of building's intended use. It includes:

- Floors
- Walls and columns
- Beams
- Arches
- Roofs and slabs
- Lintel and arches
- Steps and stairs

Substructure

The substructure is the lower portion of the building, which is located below ground level which transmits the load of the superstructure to the sub soil. it includes:

- Foundations

Definition of Foundation

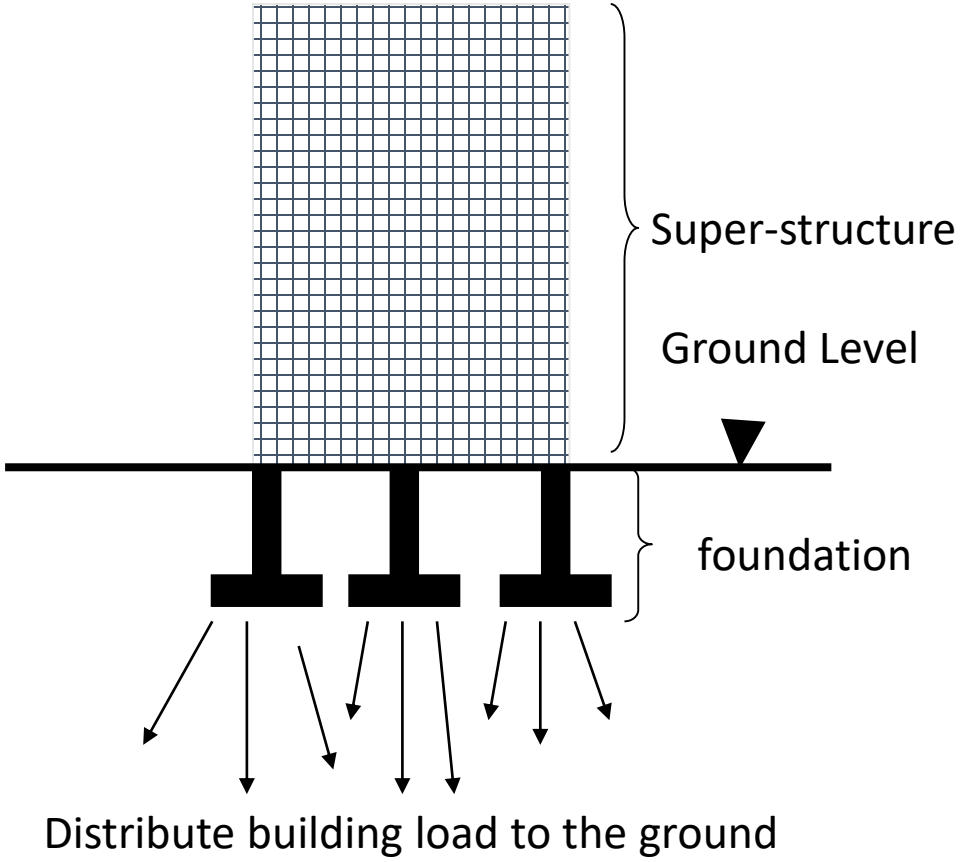
Foundations are structural members used to support columns and walls and to transmit and distribute their loads to the soil in such a way that the load bearing capacity of the soil is not exceeded, excessive settlement, differential settlement, or rotation are prevented and adequate safety against overturning or sliding is maintained.

Foundations must be design to:

- Prevent excessive settlement
- Minimize differential settlement
- Provide adequate safety against overturning and sliding

Purpose of Foundation

- To distribute the load of the structure over a large bearing area so as to bring the intensity of load within the safe bearing capacity of soil.
- To load the bearing surface at a uniform rate to avoid differential settlement.
- To prevent the lateral movement of supporting material.
- To attain a level and firm bed for building operations.
- To increase the stability of the structure as a whole.



- The size and depth of a foundation is determined by the **structure and size of a building** it supports and the **nature and bearing capacity of the ground** supporting it.

The importance of foundations in building constructions

- Buildings are built for a purpose: schools for education, offices for work, theatres for culture. Each is constructed for a specific purpose behind with a specific provision of foundation.
- to be aesthetically pleasing as well as to fulfill the purpose for which it was created.
- Foundations do not typically contribute to the architectural aesthetics of a building. Yet, without suitable foundations, a building will not function effectively, will be unsafe and its architectural merits will rapidly fade.

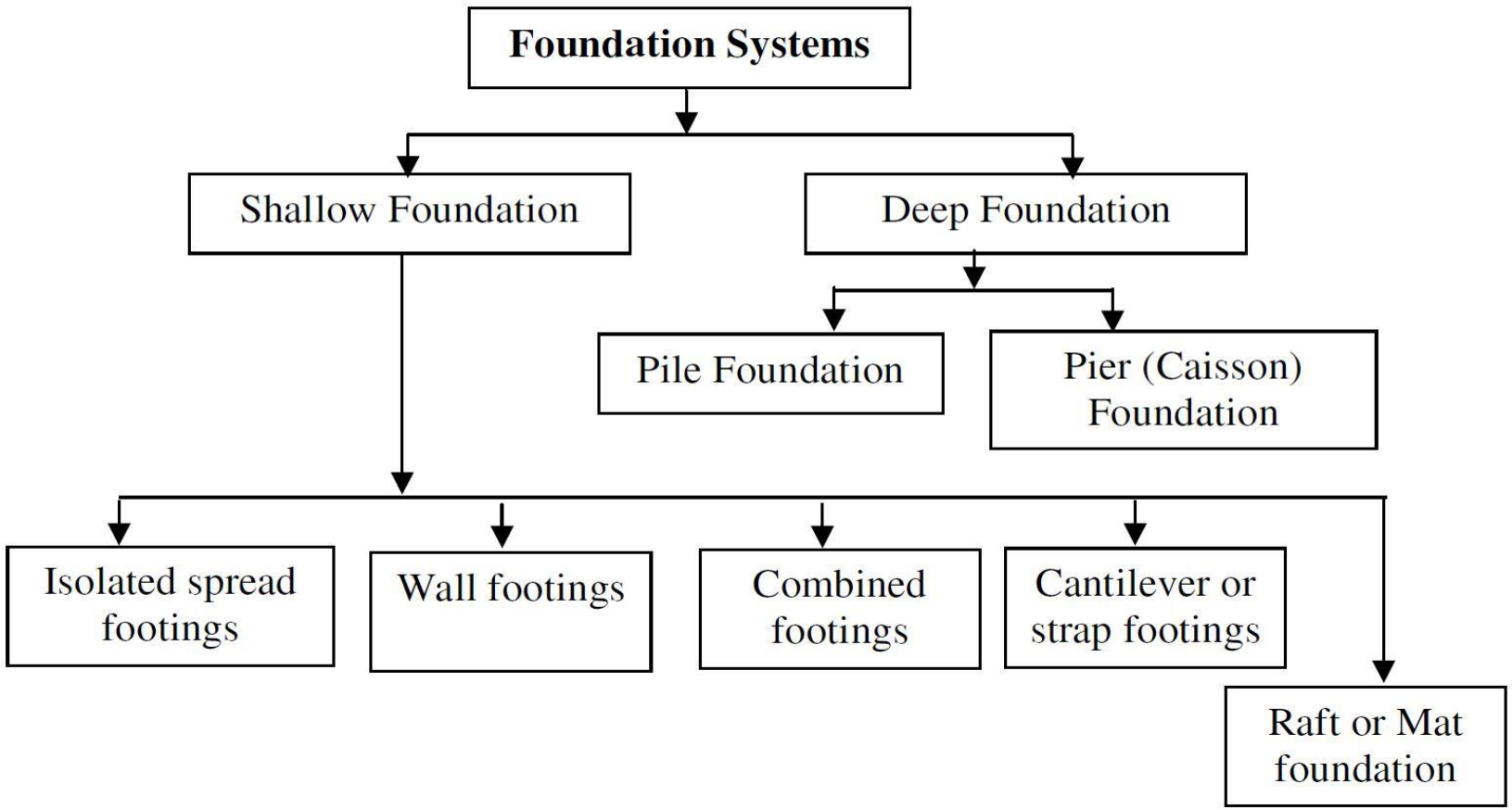
Requirements of foundation

- Structural stability
- Not impairing function of the building
- Durability
- Economy

Factors affecting design of foundation

- Soil types and ground water table conditions.
- Structural requirements and foundations.
- Construction requirements .
- Site condition and environmental factor.
- Economy etc.

TYPES OF FOUNDATIONS

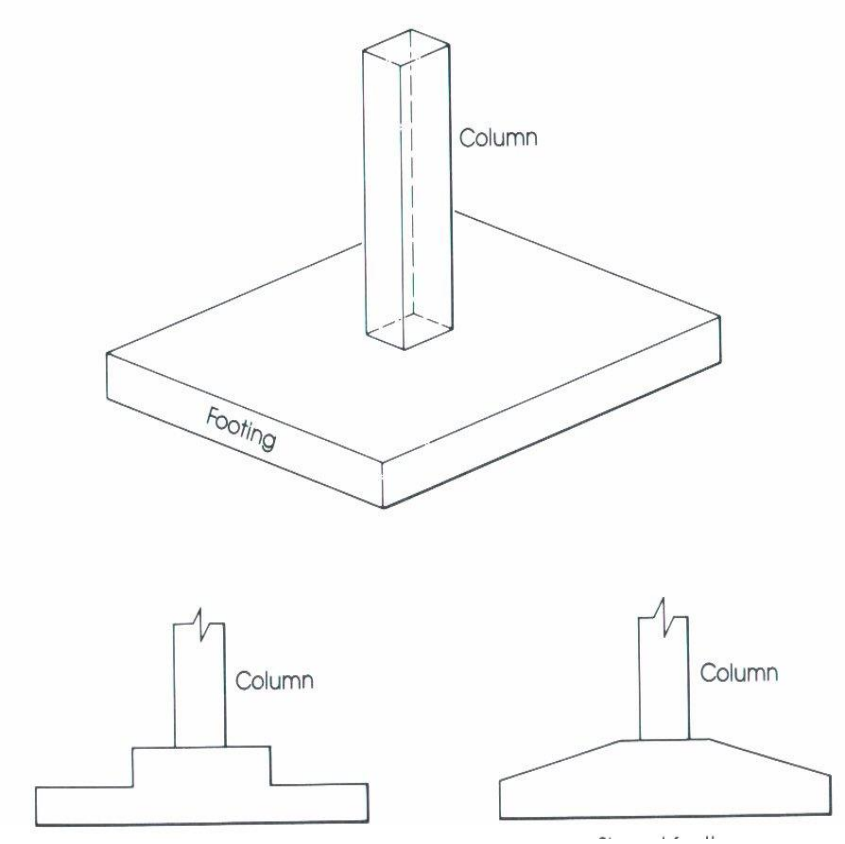


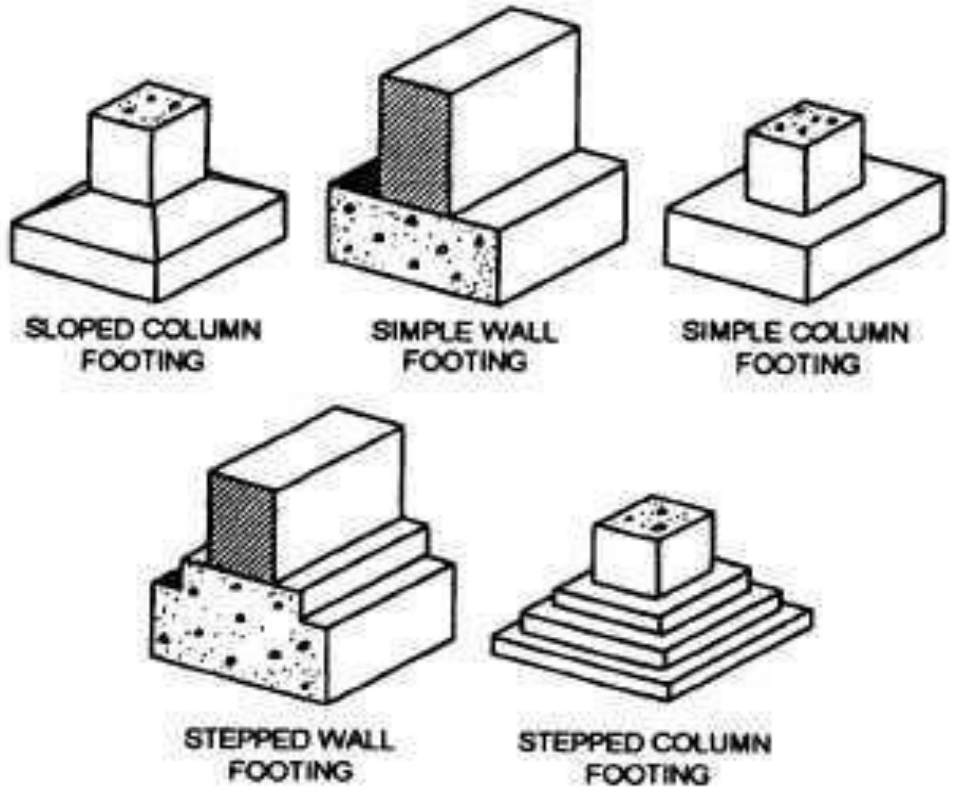
Shallow foundations are usually located no more than 2 m below the lowest finished floor. A shallow foundation system generally used when:

- the soil close the ground surface has sufficient bearing capacity.
- underlying weaker strata do not result in undue settlement.

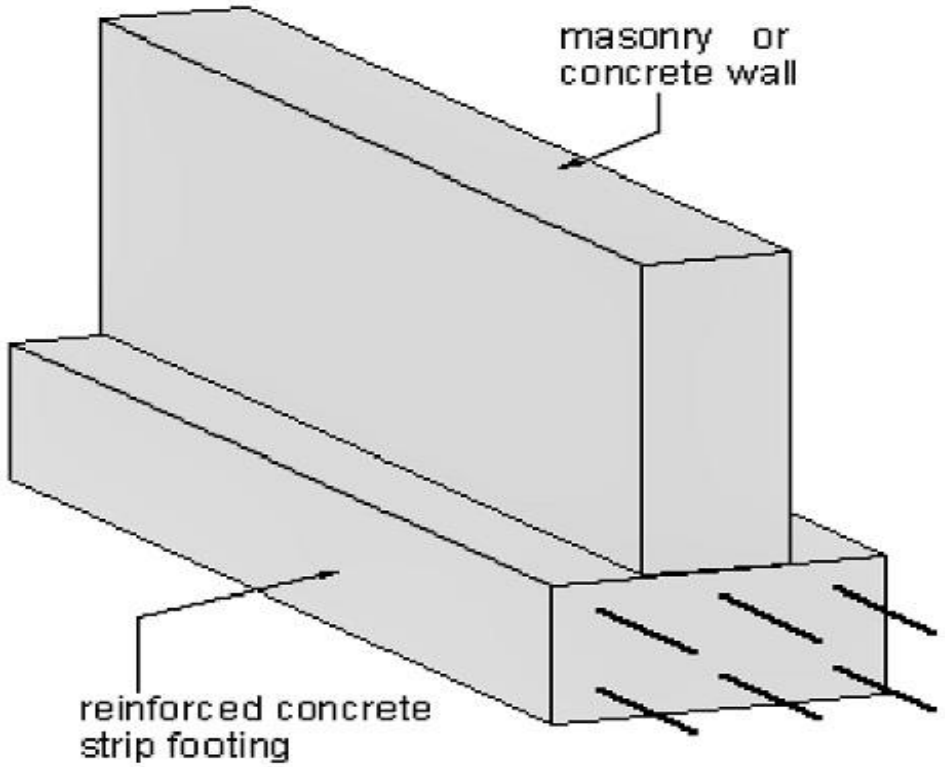
The shallow foundations are commonly used most economical foundation systems.

Isolated foundations are used to support single columns. This is one of the most economical types of foundations and is used when columns are spaced at relatively long distances.

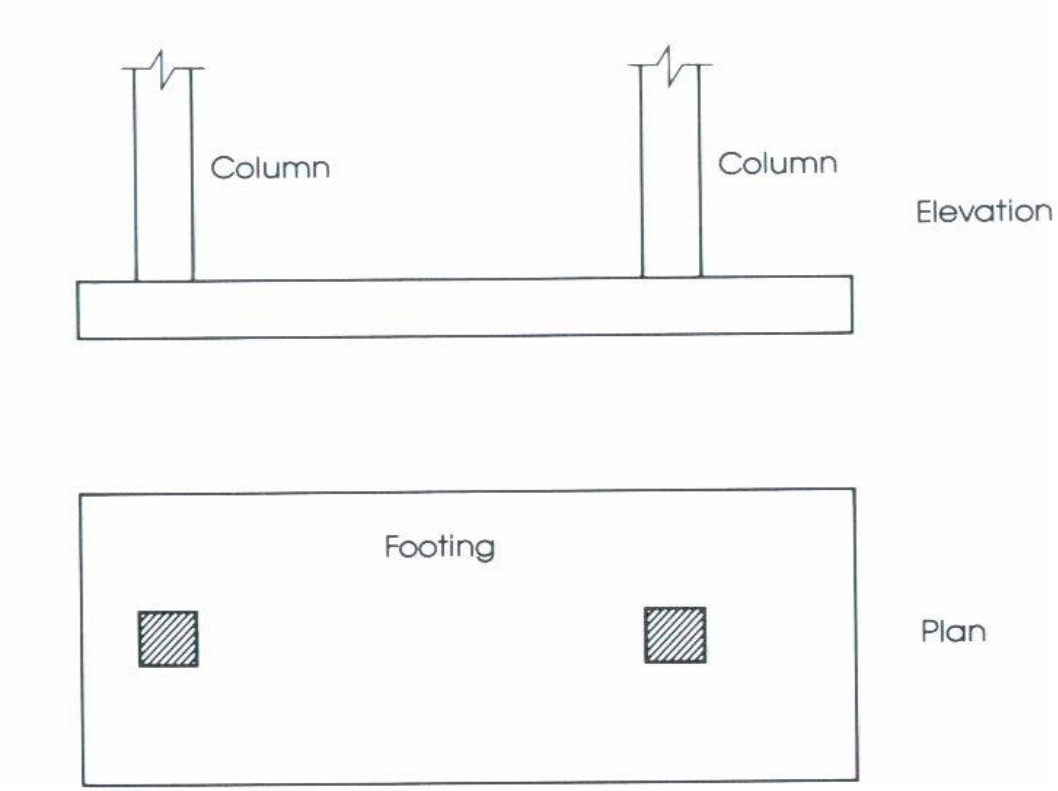




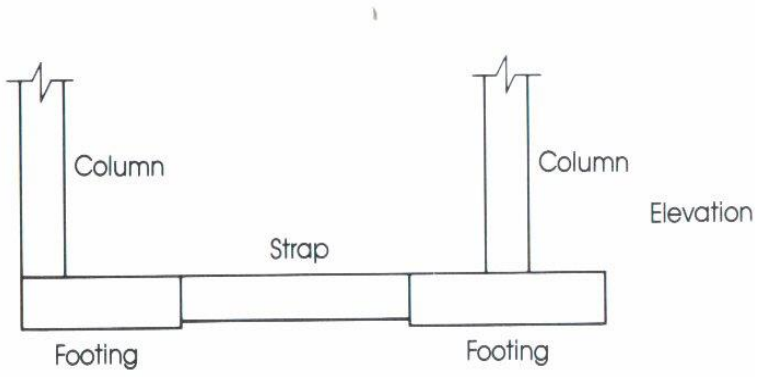
Wall foundations is a continuous slab strip along the length of wall.

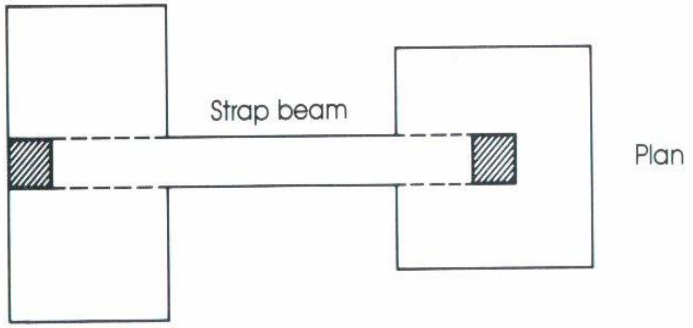


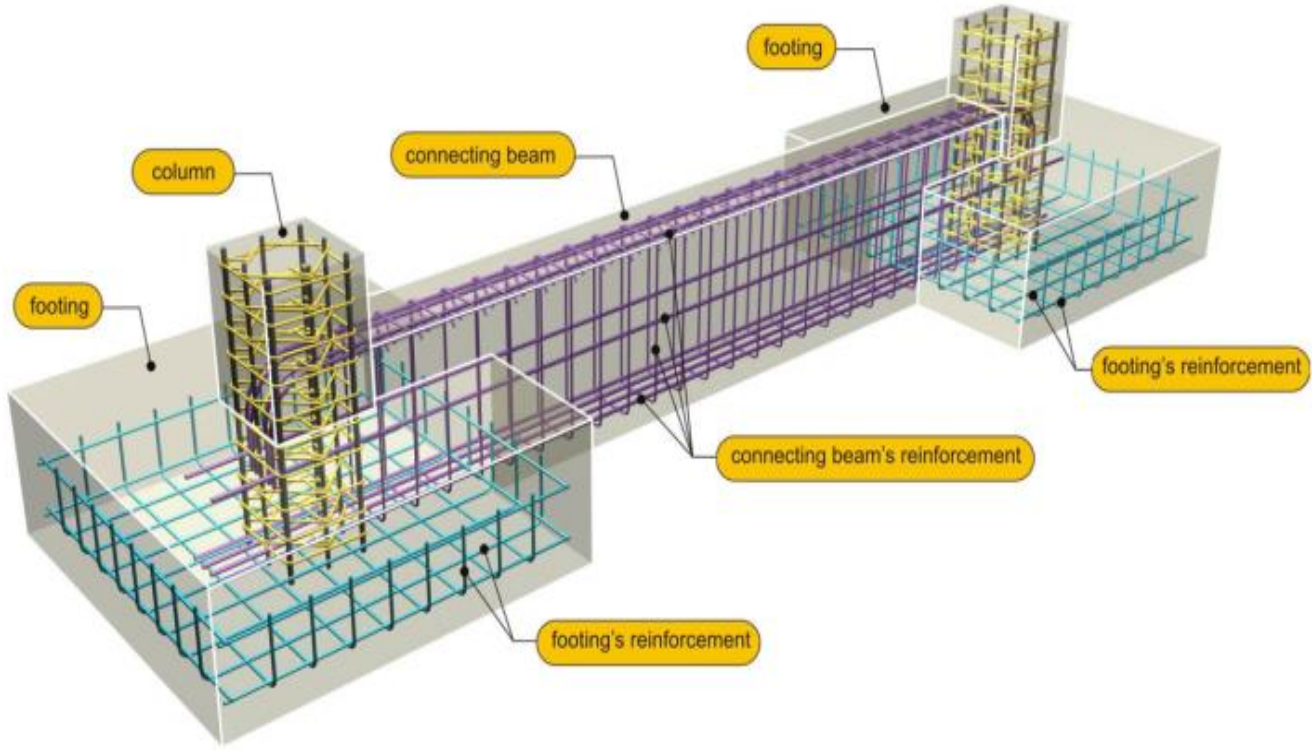
Combined foundations usually support two columns, or three columns not in a row. Combined footings are used when tow columns are so close that single footings cannot be used or when one column is located at or near a property line.



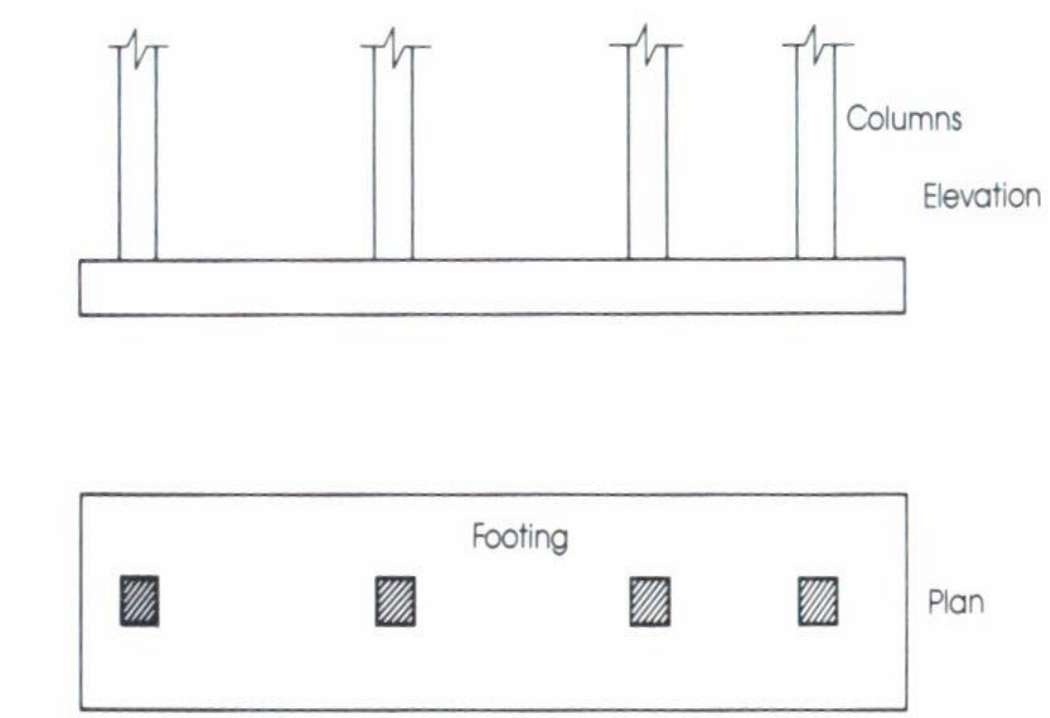
Cantilever or strap foundations consist of two single footings connected with a beam or a strap and support two single columns. This type replaces a combined footing and is more economical.



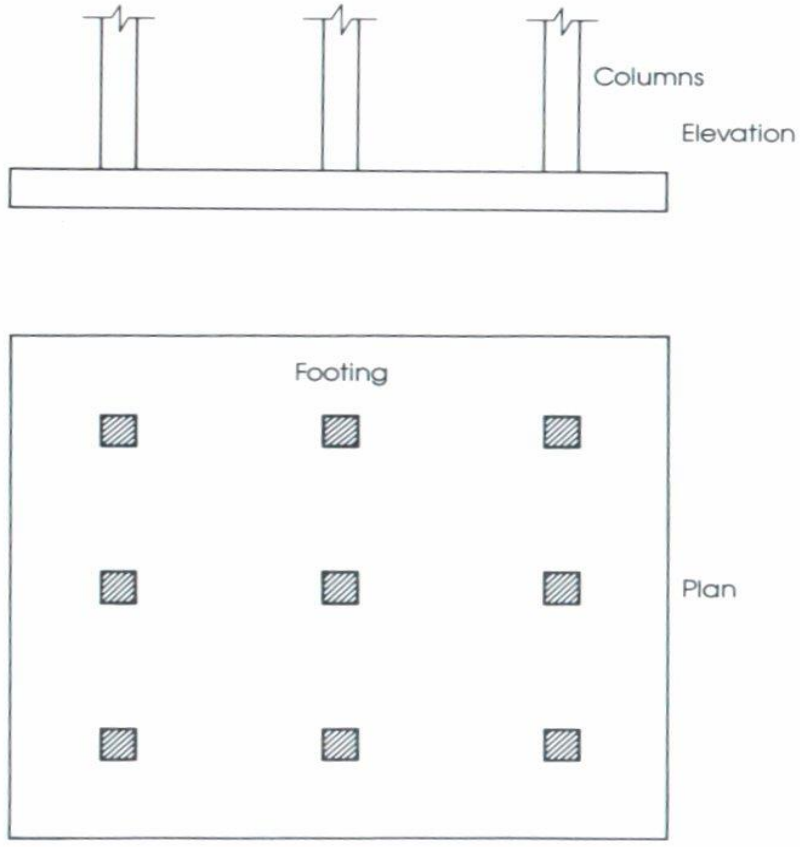




Continuous foundations support a row of three or more columns. They have limited width and continue under all columns.

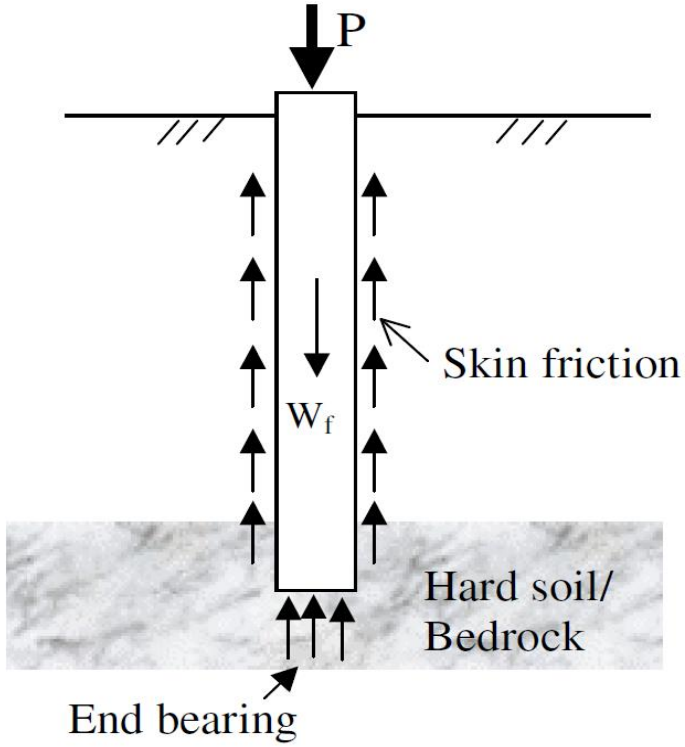


Rafted or mat foundation consists of one footing usually placed under the entire building area. They are used, when soil bearing capacity is low, column loads are heavy single footings cannot be used, piles are not used and differential settlement must be reduced.

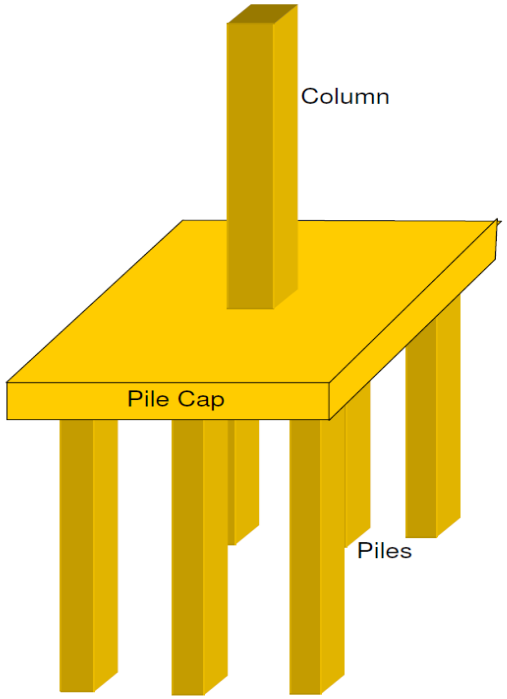


Deep foundations

The shallow foundations may not be economical or even possible when the soil bearing capacity near the surface is too low. In those cases deep foundations are used to transfer loads to a stronger layer, which may be located at a significant depth below the ground surface. The load is transferred through skin friction and end bearing.



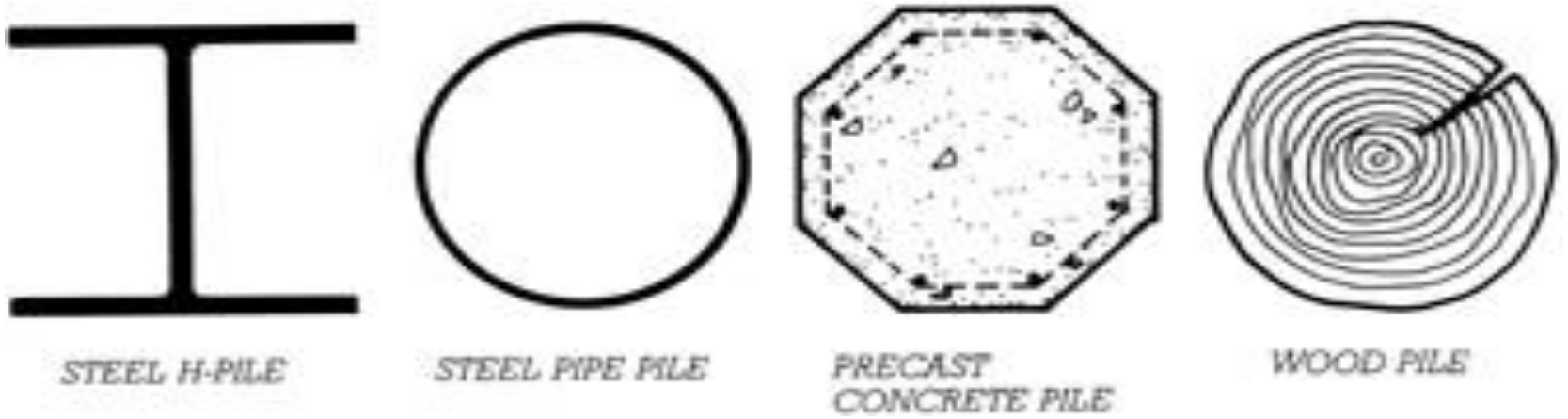
Pile Foundation: Pile Foundation is that type of foundation in which the loads are taken to a low level by means of vertical members which may be timber, concrete or steel. Pile foundation may be adopted when no firm bearing strata is available and the loading is uneven.



Pile Foundation

Piles materials

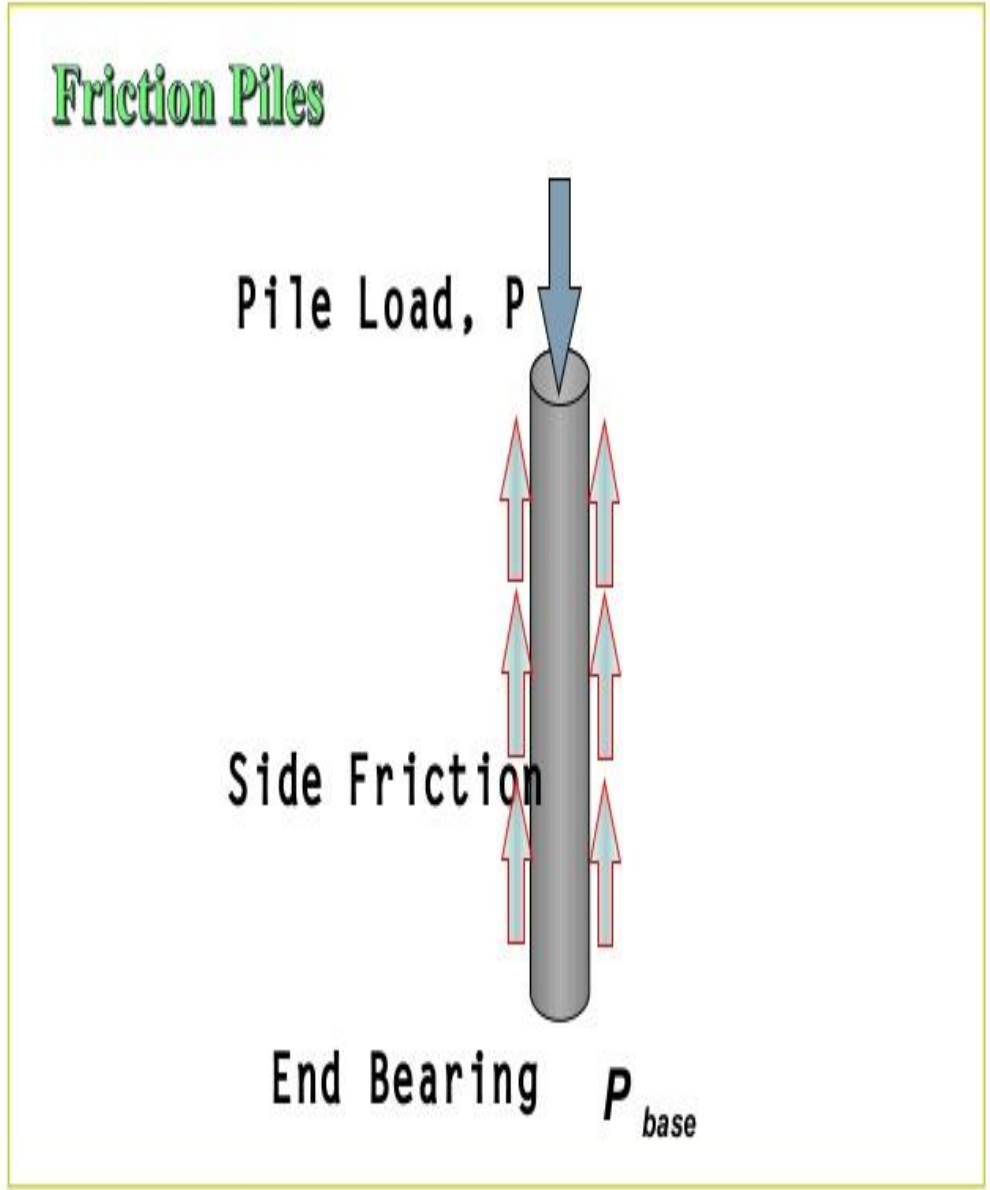
- Steel; H- piles, Steel pipe
- Concrete; Site cast or Precast
- Wood; Timber
- Composite



FRICTION PILES

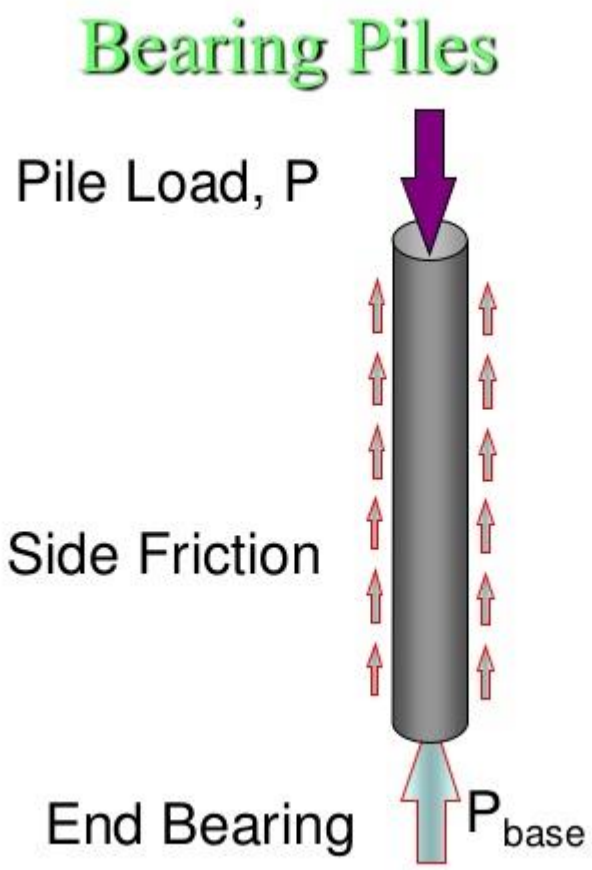
Piles are driven at a site where soil is weak or soft to a considerable depth and it is not economical or rather possible to rest the bottom end of the pile on the hard stratum

- Load is carried by the friction developed between the sides of the pile and the surrounding ground (skin friction).
- The piles are driven up to such a depth that skin friction developed at the sides of the piles equals the load coming on the piles.



End bearing piles:

In end bearing piles, the **bottom end of the pile rests on a layer of especially strong soil or rock**. The load of the building is transferred through the pile onto the strong layer. In a sense, this pile acts like a column. The key principle is that the bottom end rests on the surface which is the intersection of a weak and strong layer. The load therefore bypasses the weak layer and is safely transferred to the strong layer.



Factors affecting choice of foundation

- The type of construction.
- The magnitude of load.
- Drainage conditions.
- Feasibility in terms of available skilled labors and cost.
- The type and bearing capacity of soil.
- The seismic hazard and vulnerability of site to earthquake.

Construction of foundation

Construction of foundation consists upon the following activities

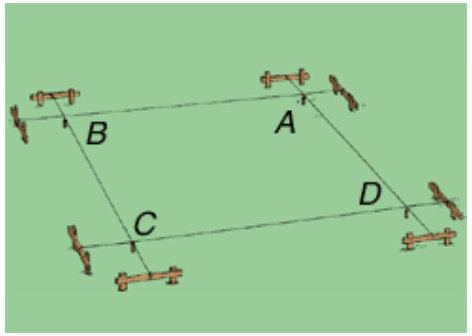
- Site preparation
- Site layout
- Excavation
- Pour footing
- Pour slab on grade
- Pour concrete foundation walls

Site Preparation

- Remove trees and any debris
- Remove top soil (4-6” below surface)

Site Layout

- Define the boundaries by using chalk powder.
- Layout building perimeter, Establish building corners & building perimeter.
- Use surveying instruments



Excavation

- Excavate foundation along line created.
- Excavate remainder of soil inside perimeter
  - *(Don’t excavate inside soil if slab on grade)*
- If deep foundation, taper edges to prevent collapse
- If soil unstable, or very deep - use shoring

Pour Footings

- Construct formwork (if required)
- Install reinforcement (rebar) for footing.
- Pour concrete footings
- Smooth / finish surface

Pour Slab on Grade

- Install gravel base (to keep water off of slab)
- Install moisture barrier (to keep water off of slab)
- Install reinforcement (welded wire fabric)
- Pour concrete slab
- Finish slab surface

Pour Concrete Foundation Walls

- Construct formwork (include sleeves / doors / windows)
- Install reinforcement into formwork
- Pour concrete foundation wall
- Install anchor bolts into semi-cured concrete

Pour Concrete Foundation Walls

- Allow concrete to cure adequately (7-10 days)
- Strip forms
- Apply waterproofing
- Backfill

Protecting foundation against moisture

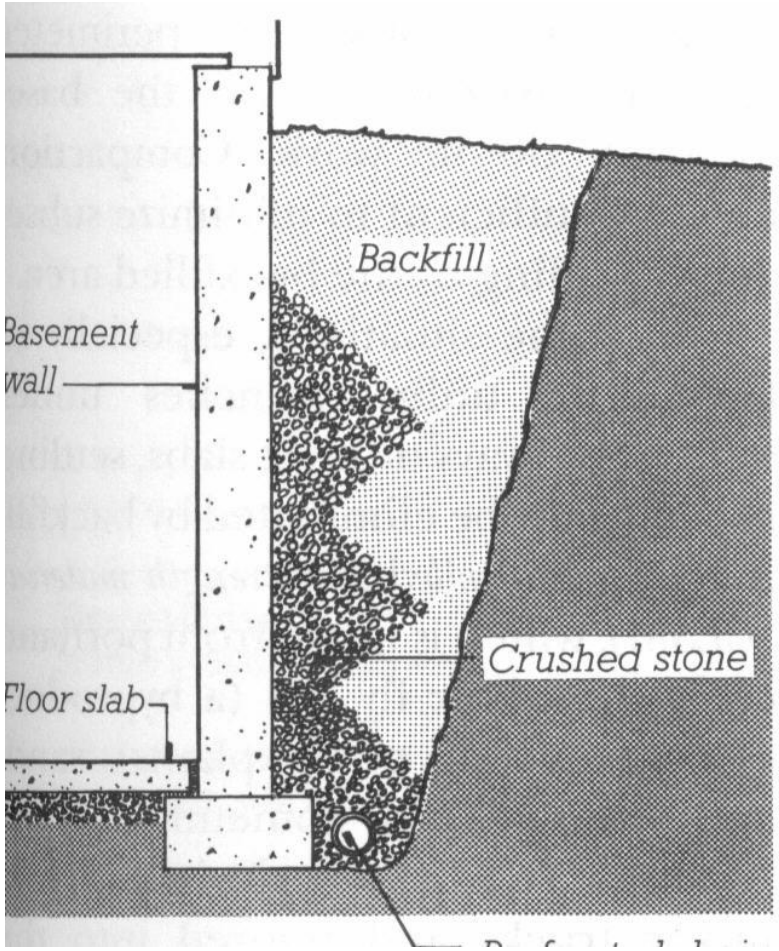
- Structures Below Ground subject to penetration of ground water
- More extreme, if below H_2O table
- Two basic approaches to Waterproofing
  - Waterproof Membranes, or
  - Drainage
  - Generally - both used in tandem

Waterproofing Membranes

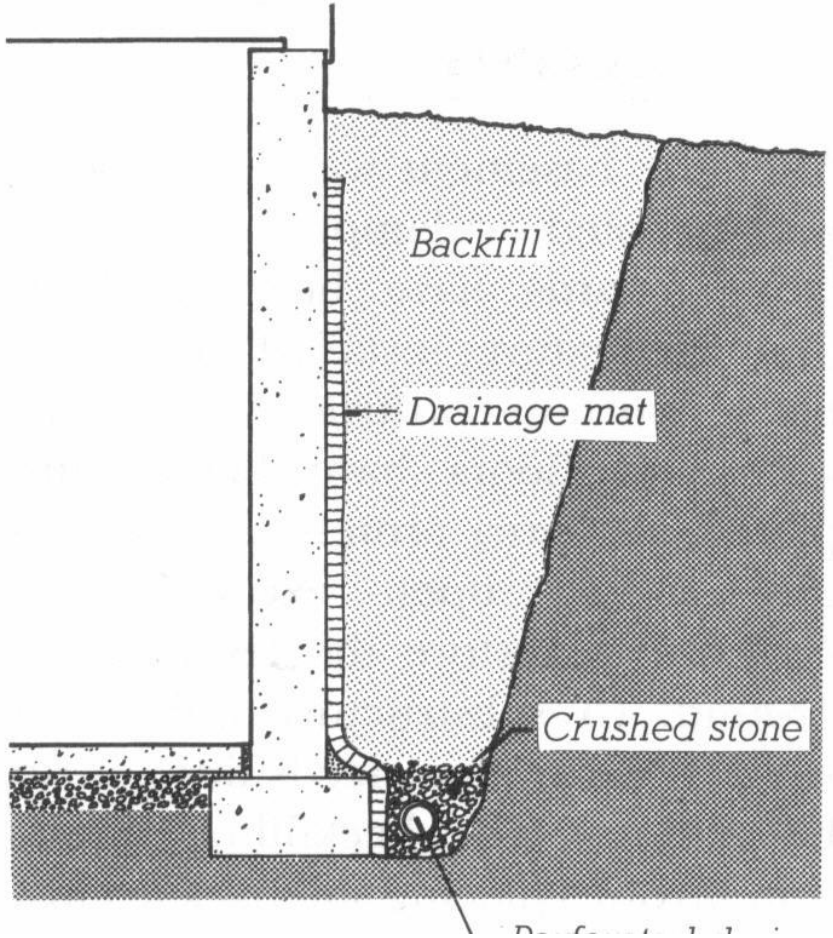
- Materials
  - Liquid or Sheet (Plastic, asphaltic, synthetic rubber)
  - Coatings (asphaltic)
  - Cementitious Plasters & admixtures
  - Bentonite clay
- Protecting boards or panels
  - Protection Board
  - Waterstop
    - Unit of Measure - SF, in (thickness)

Drainage Methods

Stone & Perforated Pipe



Drainage Mat & Perforated Pipe



Design Considerations

Footings must be designed to carry the column loads and transmit them to the soil safely while satisfying code limitations.

* Bearing capacity of columns at their base
* Dowel requirements
* Development length of bars
* Differential settlement

Size of Footing

The area of footing can be determined from the actual external loads such that the allowable soil pressure is not exceeded.

$$\text{Area of footing} = \frac{\text{Total load (including self - weight)}}{\text{allowable soil pressure}}$$

Strength design requirements

$$q_u = \frac{P_u}{\text{area of footing}}$$