

TYPES OF FOUNDATION AND THEIR SELECTION

- Every building consists of two basic Components
 - o The super structure
 - o The sub structure (Foundation)
- The basic function of foundation is to transmit
 - o The dead load (weight of walls, partitions, floors, roofs, and other permanent structures
 - o Super imposed load (Live loads) people, furniture, machines etc.
 - o Wind load

From a building to the soil on which the building rests in such a way that

- a) Settlements are within permissible limits, without causing cracks in the super structure
- b) The soil doesn't fail
 - *Generally foundation is therefore, that part of the structure which is in direct contact with the ground to which the loads are transmitted.*
 - *The foundation should be sufficiently strong to prevent excessive settlement as well as differential settlement.*

Foundations serve the following purposes

1. Reduction of load intensity
 - by increasing the area of contact, so that the total load divided by the total area (intensity of load) doesn't exceed the bearing capacity of the soil.
2. Even distribution of loads
 - Foundations distribute the non-uniform load of the superstructure evenly to the sub soil.
3. Provision of level surface
4. Lateral stability
 - It anchors the super structure to the ground, thus imparting lateral stability to the super structure.

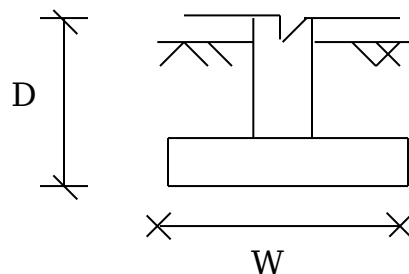
5. Safety against undermining
 - provides structural safety against undermining (scouring) due to burrowing animals and floodwater.
6. Protection against soil movements
 - minimizes cracks in the super structure due to expansion or contraction of sub soil because of moisture movement in some problematic soils.

Essential Requirements of a good foundation

- Sustain the dead and imposed loads
- It should be rigid
- Good location.

TYPES OF FOUNDATION (as per Terzaghi)

1. Shallow Foundation- Depth is equal to or less than its width
2. Deep Foundation - Depth is greater than its width



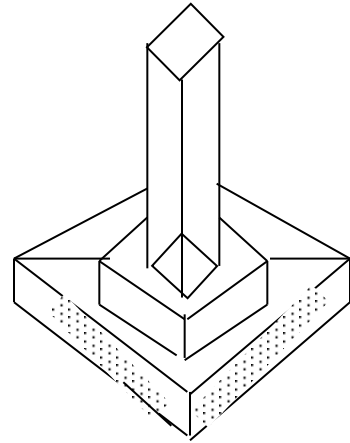
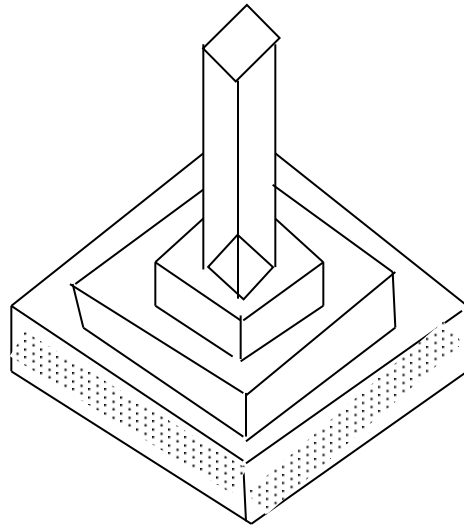
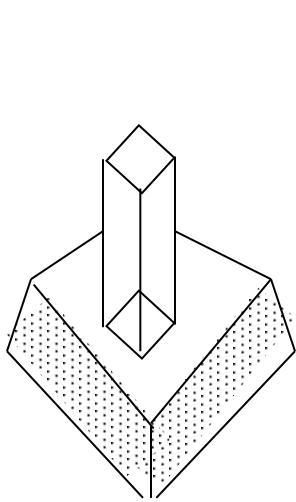
1. SHALLOW FOUNDATIONS

1.1. Spread footing

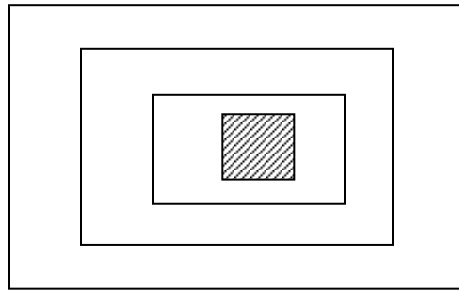
This footing spreads the super-imposed load of column or wall over a larger area.

Types of spread footings

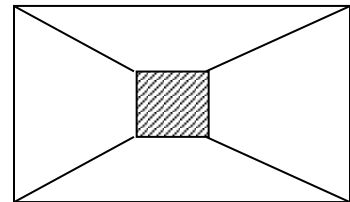
- Single footing
- Stepped footing
- Sloped footing
- Wall footing without steps
- Stepped footing for walls



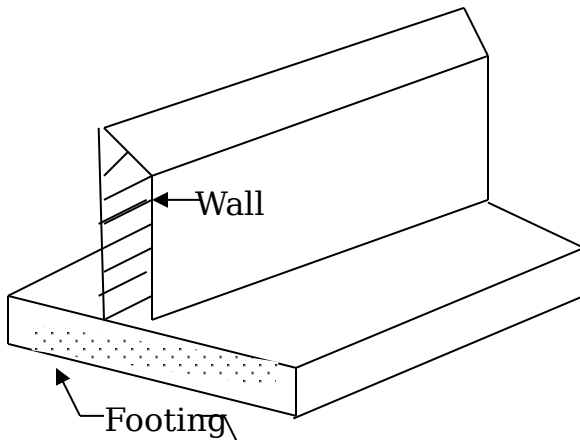
A)
Single
footing



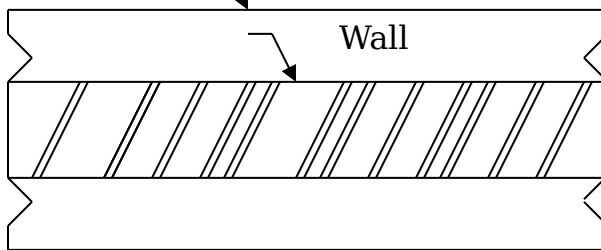
b) Stepped
footing

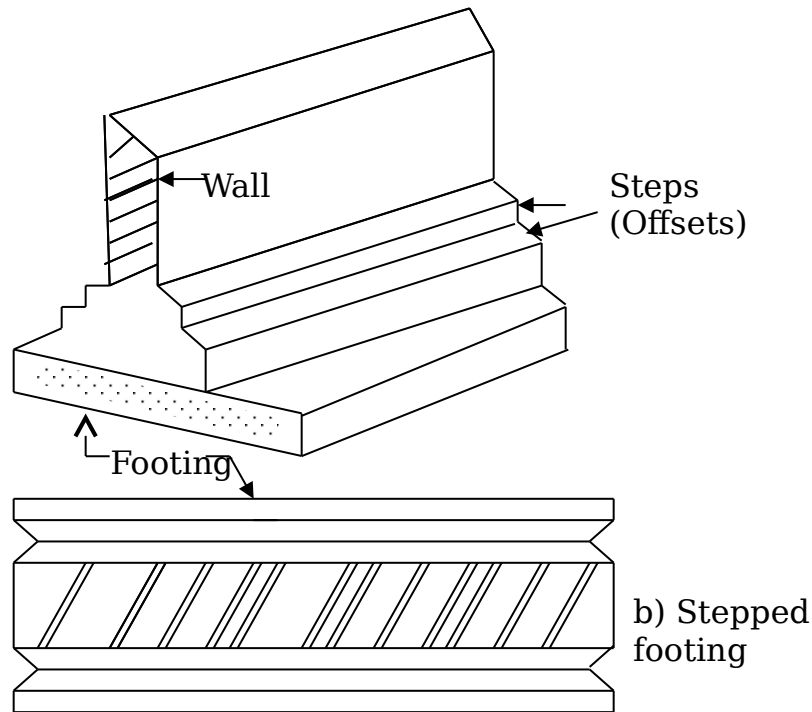


c) Slopped
Footing



a) Simple Footing

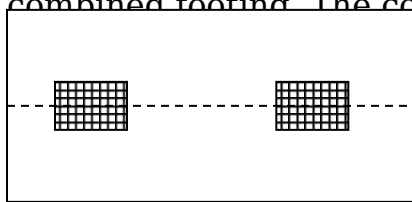




1.2 Combined footing

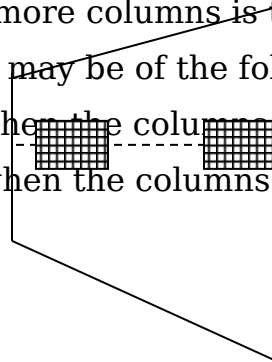
A spread footing which supports two or more columns is termed as

combined footing. The combined footing may be of the following types.

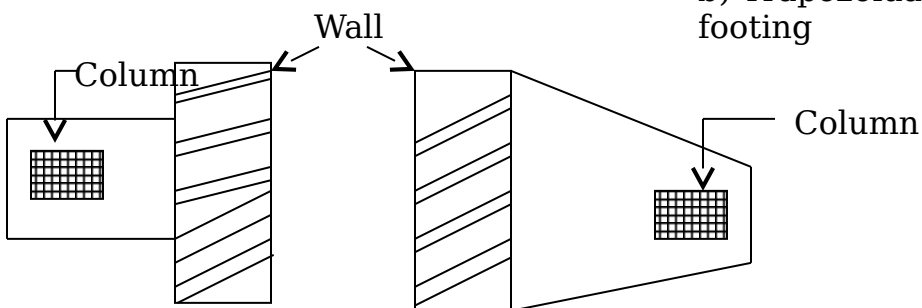


a) Rectangular combined footing - wall footings

footing- used when the columns have equal load
 footing- used when the columns have unequal



b) Trapezoidal footing

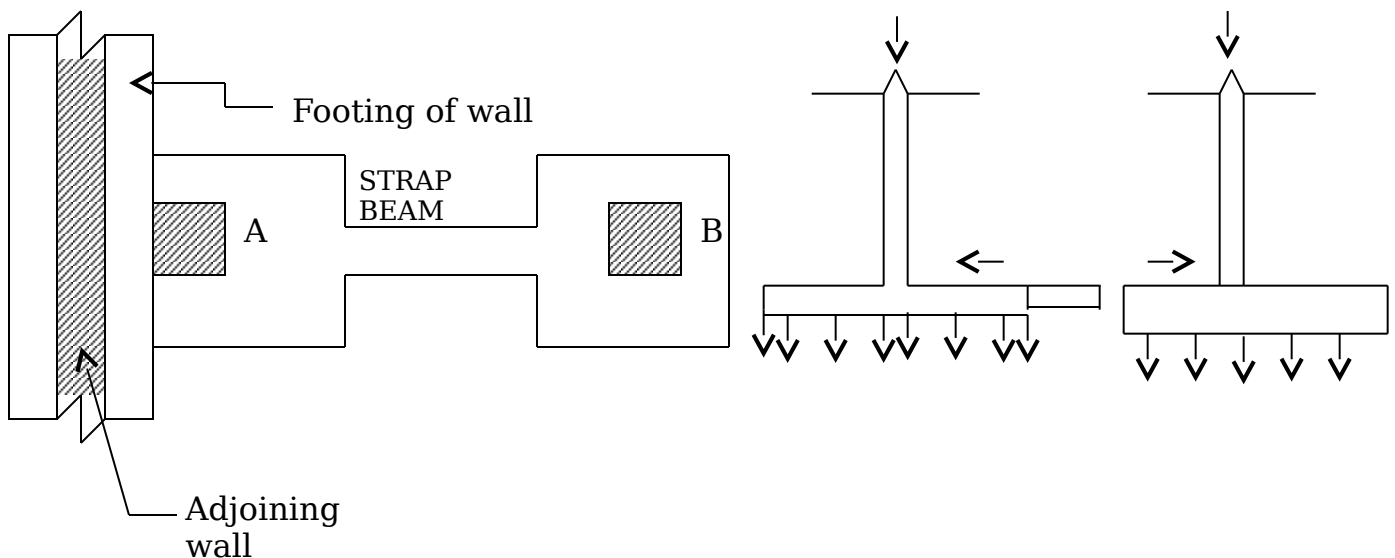


c) Combined column wall footing

The design of combined footing must be such that the centroid of the footing area coincides with the center of gravity of the column load.

1.3 STRAP FOOTING.

- If the independent footings of two columns are connected by a beam, it is called a strap footing.
- It is used when the distance between the columns is so great that a combined trapezoidal footing becomes quite narrow, with high bending moments. In this case the column is provided with its independent footings and a beam is used to connect the two footings
- The strap beam doesn't remain in contact with soil, and thus doesn't transfer any pressure to the soil.
- The strap, assumed to be infinitely stiff, serves to transfer the column loads on the soil with equal and uniform soil pressure under both footings.



1.4 MAT (RAFT) FOUNDATION

-A raft or mat is a combined footing that cover the entire area beneath a structure and support all the walls and columns

- Mat foundation will be used when:
 - o the allowable soil pressure is low
 - o the building loads are heavy
 - o use of spread footing covers more than the one half the area
- Based on design and construction Rafts may be
 - o solid slab
 - o Beam slab
 - o cellular system

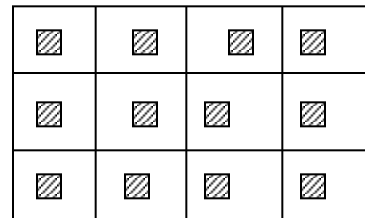


Fig. MAT
Foundation

1.5 DEEP FOUNDATION

- Deep foundations are those in which the depth of the foundation is greater than its width. Deep foundations are of the following types.
 1. Pile foundations- more commonly used.
 2. pier foundation
 3. caisson or well foundation

1.5.1 Pile foundations

Pile foundations are preferable under the following situation

- When the load of the super structure is heavy and its distribution is uneven.
- the top soil has poor bearing capacity
- The sub soil water level is high so that pumping of water from the open trenches for the shallow foundations is difficult and uneconomical.
- when there is large fluctuations in sub soil water level
- when the structure is situated on the sea shore or river bed
- Canal or deep drainage lines exist near the foundations.

Types of piles

- Piles used for building foundation may be of four types; based on the function they serve.

i) End bearing pile

- Used to transfer load through water or soft soil to a suitable bearing stratum. Such piles are used to carry heavy loads safely to hard strata. Multi-storeyed buildings are invariably founded on end bearing piles, so that the settlements are minimized.

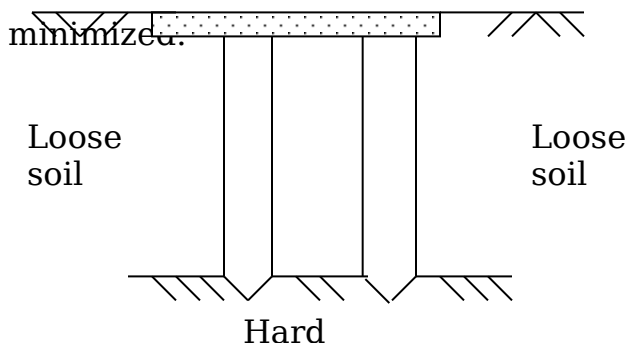


Fig End bearing pile

ii) Friction piles

- used to transfer load to a depth of a friction - load- carrying material by means of skin friction along the length of the pile

- Generally used in granular soil where the depth of hard stratum is very great.
- iii) Combined end bearing
- Some times the super imposed load is transferred both through and friction side friction as well as end bearing.

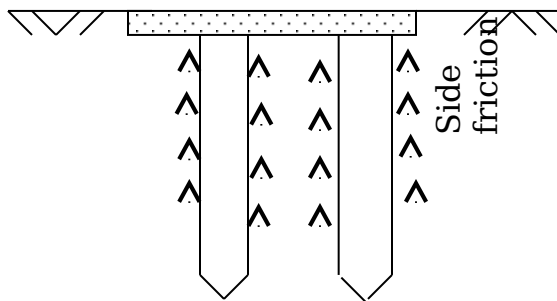


Fig Friction pile

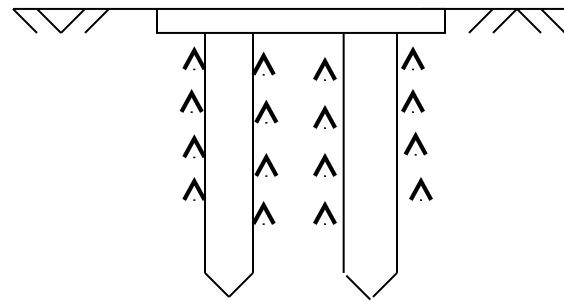


Fig Combined End bearing and friction pile

iv) Compaction piles

- Used to compact loose granular soils, thus increasing their bearing capacity. The compaction piles themselves do not carry a load. Hence they may be of weaker material (e.g. timber, bamboo, etc)
- The pile tube, driven to compact the soil, is gradually taken out and sand is filled in its place thus forming a 'sand pile'

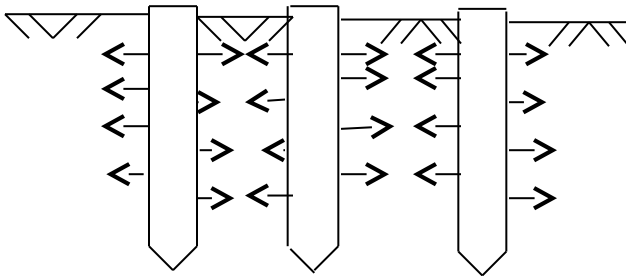


Fig compaction pile

* Classification of piles base on materials and composition

1. Concrete piles

a) pre- cast

- b) cast in – situ
 - Driven piles (cased or uncased)
 - Bored piles (pressure piles, under- reamed piles, bored compaction piles)
- 2. Timber piles
- 3. Steel piles
 - a) H- pile
 - b) Pipe pile
 - c) Sheet pile
- 4. Composite pile
 - a) concrete and timber
 - b) concrete and steel.

1.5.2 Pier Foundations (drilled caisson foundation)

- transfer large superimposed loads to the firm strata below
- The difference between pile foundation and pier foundation lies in the method of construction.
- Pile foundations transfer the load through friction and or bearing, pier foundations transfer the load only through bearing.
- pier foundation is shallower in depth than pile foundation
- Pier foundation is preferred in a location where the top strata consists of decomposed rock over lying a strata of sound rock. In such cases it is difficult to drive the bearing piles through decomposed rock.

1.5.3 Well Foundations (Caissons)

- These are box like structures circular or rectangular which are sunk from the surface of either land or water to the desired depth.
- Much large in diameter than the pier foundations.
- These are used for major foundation works, such as.
 - o bridge piers and abutments in rivers, lakes, etc

- o wharves, quay, walls, docks (related to ships)
- o Break waters and other structures for shore protection.
- o large water front structures such as pump houses
- Well foundations are not used for building.

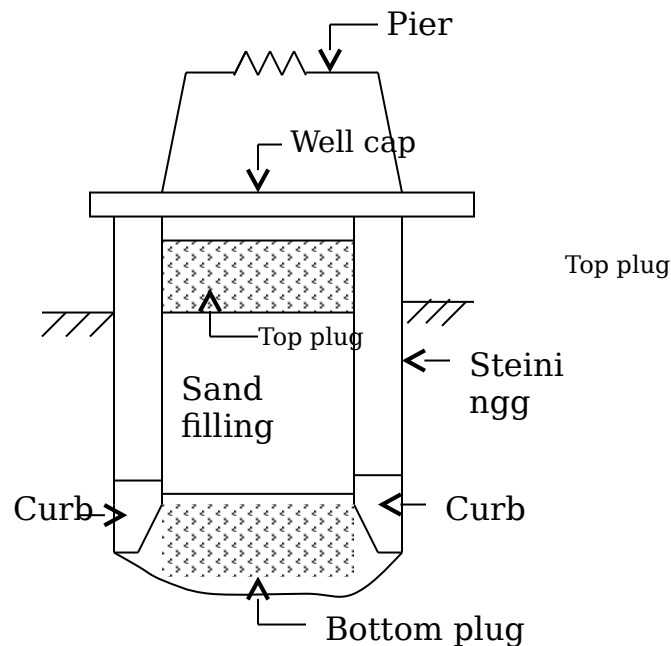


Fig. Well foundation

- wharves = landing stage where ships may moor for loading/unloading
- dock= artificially enclosed body of water where ships are admitted for loading, unloading or repair

Foundations for Black Cotton soils

- In black cotton soil and other expansive type of soils, building often cracks due to relative ground movements. This is caused by alternate swelling and shrinkage of the soil due to changes in its moisture content.

I. Strip or pad foundation:

- For medium loads, strip foundation (for walls) and pad foundation (for columns) may be provided with care.

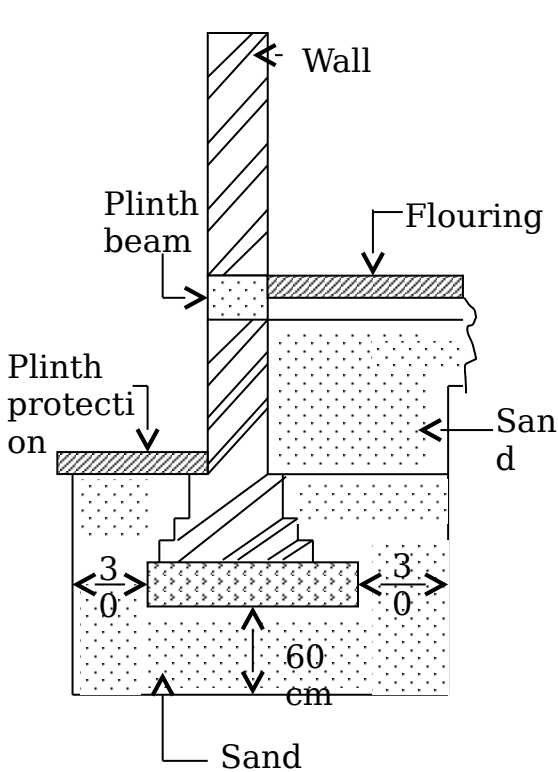


Fig Simple sand fill

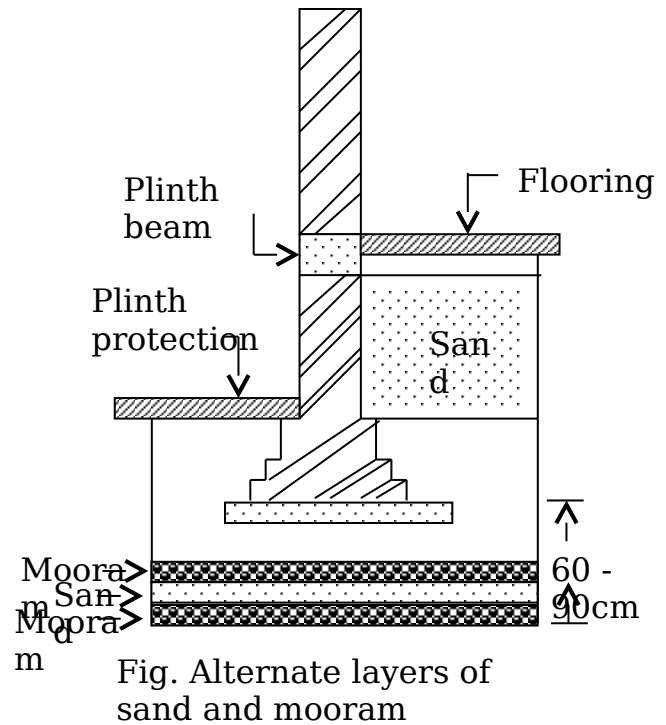


Fig. Alternate layers of sand and mooram

II. Pier foundation with arches.

- o Piers are dug at regular interval and filled with cement concrete. The piers may rest on good bearing strata. These piers are connected by concrete or masonry arch, over which the wall is constructed.

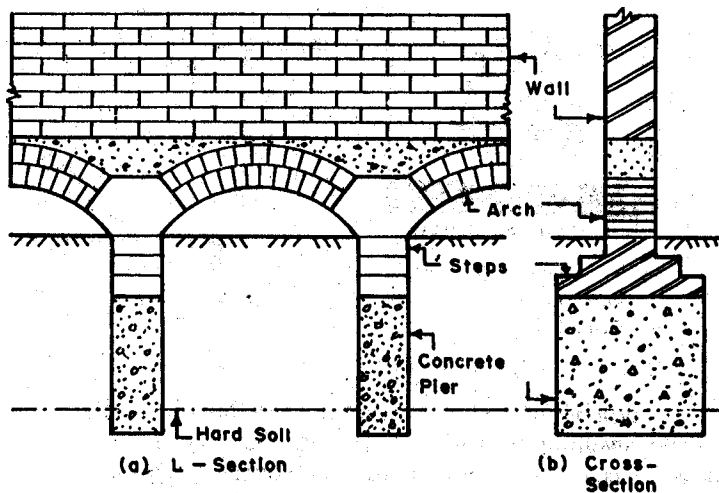


FIG. Pier Foundation with Arch

III. Under-reamed pile foundation

- o An under - reamed pile is a pile of shallow depth (1 to 6m) having one bulb at its lower end. If the bulb is provided at a level lower than the critical depth of moisture movement in expansive soils, the foundation will be anchored to the ground and it would not move with the swelling and shrinkage of the soil. The diameters of the piles vary from 15cm-50cm and are reinforced.
- o Spacing of the piles may vary between 2-4m.
- o The piles are connected by a rigid capping beam, suitably reinforced over which the wall is constructed.
- o The capping beam is kept 8 to 12 cm above the ground level, so as to provide air gap to accommodate the soil movement.

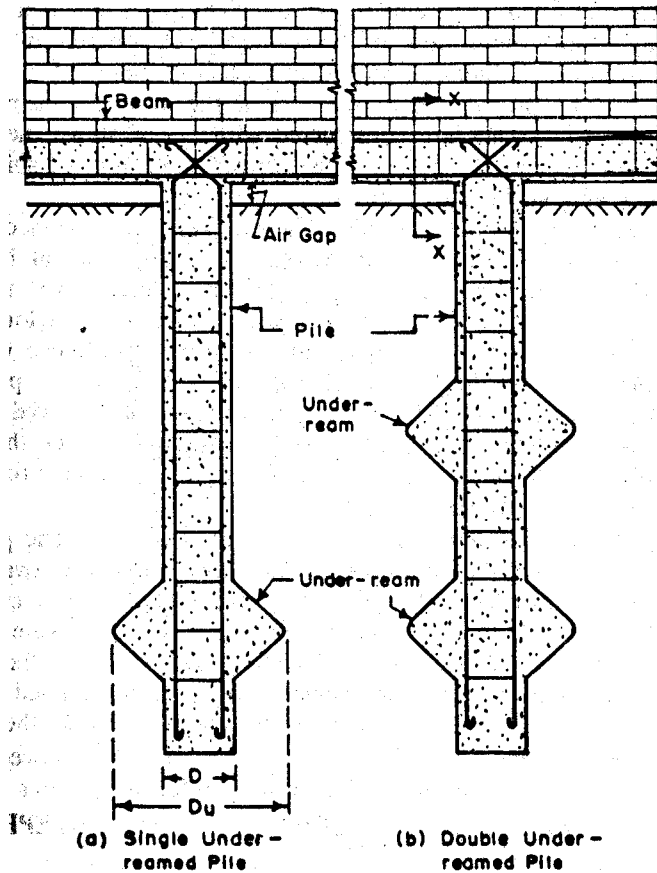


Fig. Under - Reamed Pile Foundation

Selection of Foundation Type

In selecting the foundation type the following points must be considered:

- a) Function of the superstructure
- b) Loads it must carry
- c) Sub structure conditions
- d) 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:

- 1) Obtain at least approximate information concerning the nature of superstructure and the loads to be transmitted to the foundation.
- 2) Determine the subsurface conditions in a general way

- 3) Consider each of the usual types of foundations in order to judge whether or not
 - a) they could be constructed under existing conditions
 - b) they are capable of carrying the required load,
 - c) they experience serious differential settlements
- 4) Undertake a detailed study of the most promising types. Such a study may require additional information on loads and subsurface conditions. Determine the approximate size of footings, piers or caissons or the approximate length and number of piles required
- 5) Propose an estimate for the cost of each promising type of foundation
- 6) Select the type that represents the most acceptable compromise between performance and cost.