Unit - III

Foundations:- A structure is generally considered to have two main portions

i) Super structure

ii) Sub structure

The substructure transmits the loads of super-structure to the supporting soil and is generally termed as the foundation. Footing is that portion of the foundation which ultimately delivers the load to the soil and is thus in contact with it.

Types:-

i) Shallow Foundation

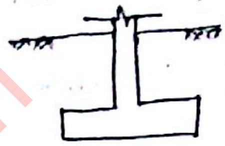
ii) Deep Foundation

→ If the depth of foundation is equal to or less than its width then that foundation is called shallow foundation.

→ If the depth of foundation is greater than the width of foundation then that foundation is called deep foundation.

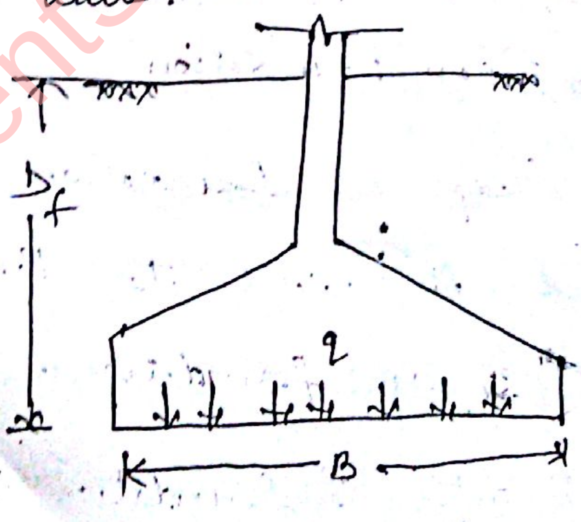
Types of Shallow foundation :-

i) Spread footing :- A spread footing or simply footing is a type of sallow foundation used to transmit the load of an isolated column, or that of a wall, on the subsoil. In the case of wall, the footing is continuous while in the case of column, it is isolated.



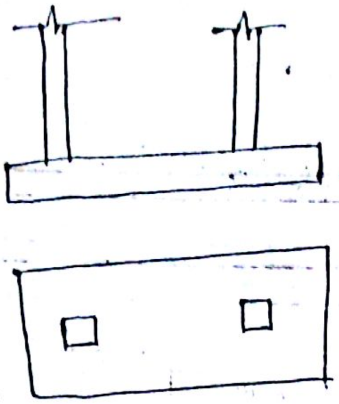
(ii) Strip footing or continuous footing :-

When the length of footing is much greater than its width (L>>>B), that type of footing is called strip footing or continuous footing commonly used below walls.

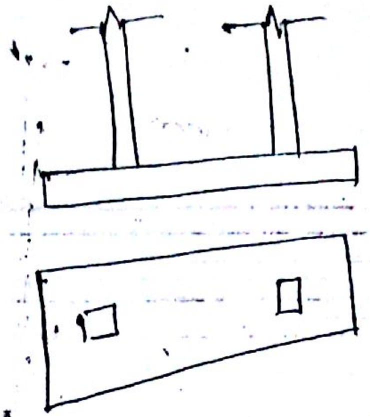


(iii) Combined footing :-

A spread footing which supports two or more columns is termed as combined footing. This type of footing is provided when the individual footings are either very near to each other, or overlap. Combined footings may either be rectangular or trapezoidal.



Rectangular combined footing



Trapezoidal combined footing

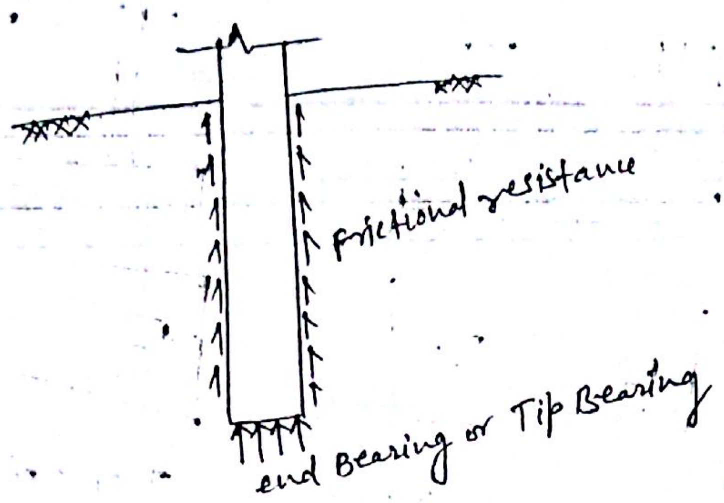
V) Mat or Raft foundation :-

A mat or raft is a combined footing that covers the entire area beneath a structure and supports all the walls and columns. When the available soil pressure is low or the building loads are heavy, the mat or raft foundation is more economical.

Raft foundation

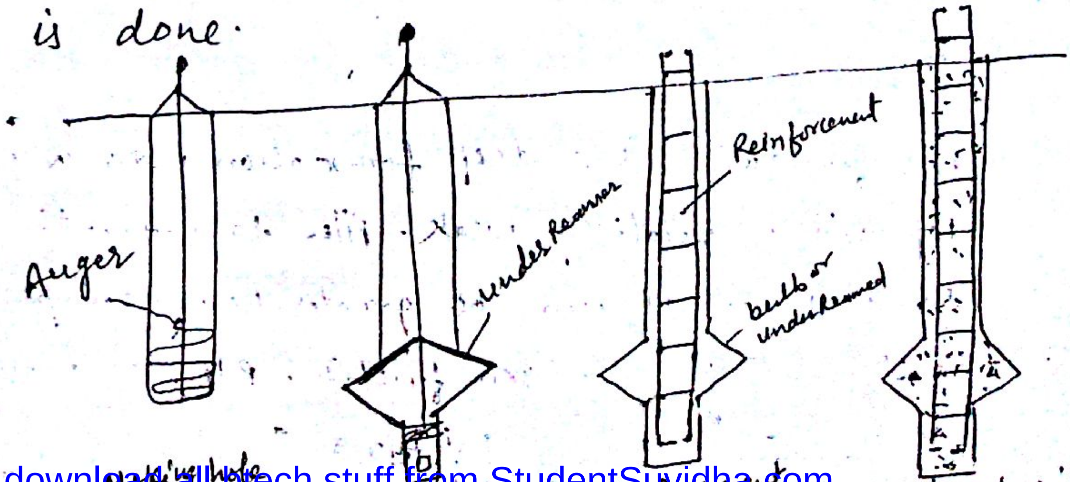
Pile foundation :-

Pile foundation is a deep foundation used where the top soil is relatively weak. Piles transfer the load to a lower stratum of greater bearing capacity, by end bearing and skin friction. Piles are usally provided in groups for most structures. The piles may be subjected to vertical loads, horizontal loads or both.



under-reamed piles:-

An under reamed pile is a special type of bored pile which is provided with a bulb at the end. The under reamed pile is constructed by making a hole in the ground by hand operated auger. An under reamer is then lowered in the cleaned hole. The under reamer is pressed down and rotated. Under pressure the blades open up and due to rotary action, the soil is cut and falls in the bucket. When the bucket is full, the under reamer is pulled out and cleaned. The under reamer is lower again and the process repeated. After the enlarged end is formed, the reinforced cage is lowered and concreting is done.



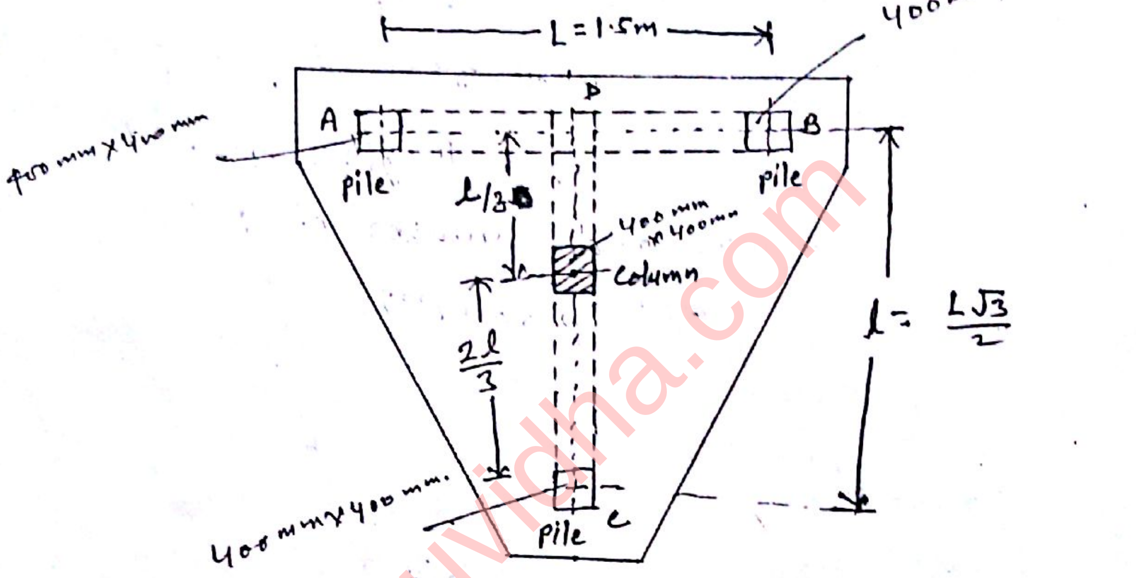
The usual size of such piles are 150 mm to 200 mm shaft diameter, 3m to 4m long. The diameter of the under reamed portion is usually 2 to 3 times the shaft diameter.

These piles are suitable for expansion soils such as black cotton soil or filled up grounds and loose or soft soil strata. The load carrying capacity of an under reamed pile foundation depends upon the pile length, stem diameter, bulb diameter and number of bulbs besides the usual soil parameters.

Pile Cap :-

When a column is supported on the pile only, the column should rest centrally on the pile. However, when the column is supported on more than one pile, the piles should be connected through a rigid pile cap, to distribute the load to the individual piles. The pile cap consists of a rigid, deep reinforced concrete slab which acts monolithically with the group of piles. The pile cap slab is provided in uniform thickness. The pile cap should be extended beyond exterior piles by 10 to 15 cm. The pile should be placed at least 15 cm in the pile cap, and the reinforcement in the cap should be placed at least 10 cm above the pile head.

Prob - ① A R.C. column, 400 mm x 400 mm carrying a load of 600 kN is supported on three piles 400 mm x 400 mm in section. The centre to centre distance between piles is 1.5 m. Design a suitable pile cap. Use M20 concrete and Fe 415 steel.



Step-I : Dimension of pile cap

$L = 1.5\,m$

Keeping 200 mm clear projection of the cap beyond pile face.

∴ overall length of the cap along the direction AB

$= 1.5 + 0.4 + 0.4 = 2.3\,m$

Length of beam $CD = l = \frac{L\sqrt{3}}{2} = \frac{1.5 \times \sqrt{3}}{2} = 1.3\,m$

∴ Length of cap in the direction of DC

$= 1.3 + 0.4 + 0.4 = 2.1\,m$

Step II :- Design of beam DC.

Load on each pile $= \frac{W}{3} = \frac{600}{3} = 200\ KN$

Let width of beam = width of column = 400 mm

$\therefore$ B.M. due to load $= \frac{W}{3} \times \frac{2l}{3}$

$= \frac{W}{3} \times \frac{2}{3} \times \frac{L\sqrt{3}}{2}$

$= \frac{WL}{3\sqrt{3}}$

$= \frac{600 \times 1.5}{3\sqrt{3}} = 173\ KN\text{-}m$

Let thickness of slab = 800 mm

width of slab = 2 × width of the beam

$\therefore$ Self wt $= 3 \times (1.3 \times 0.400 \times 0.800) \times 25$

(wt of column + slab) $= 31.200\ KN$ $\qquad w = \frac{31.2}{1.3} = 24\ KN/m$

Reaction at c $= \frac{31.2}{2} = 15.6\ KN$

B.M. due to Self wt $= 15.6 \times \frac{2l}{3} - 24 \times \left(\frac{2l}{3}\right) \times \frac{\left(\frac{2l}{3}\right)}{2}$

$= \frac{15.6 \times 2 \times 1.3}{3} - \frac{24 \times 0.87 \times 0.87}{2}$

$= 4.489\ KN\text{-}m$

$\therefore$ Total B.M $= 173 + 4.489 = 177.5\ KN\text{-}m$

$M = Q b d^2$

$\therefore d = \sqrt{\frac{M}{Qb}} = \sqrt{\frac{177 \times 10^6}{0.914 \times 400}} = 697\ mm$

Keep $d = 700\ mm$

Now, Area of Steel Required

$$A_{st} = \frac{M}{\sigma_{st}\, jd} = \frac{177.5 \times 10^6}{230 \times 0.904 \times 700}$$

$$= 1206\ mm^2$$

provide 25 mm diameter steel bar

$\therefore$ Area of one bar $A_{s\phi} = \frac{\pi}{4} \times 25^2 = 490.6\ mm^2$

$\therefore$ No of bar required $= \frac{A_{st}}{A_{s\phi}} = \frac{1206}{490.6} \simeq 3$ bars

provide 4 bar of 25 mm ϕ

Step III Design of beam AB :-

B.M due to load from beam CD

$$= \frac{2W}{3} \times \frac{L}{2} = \frac{WL}{6} = \frac{600 \times 1.5}{6} = 150\ KN\text{-}m$$

B.M. due to self wt $= \frac{24 \times 1.5^2}{8} = 6.75\ KN\text{-}m$

$\therefore$ Total B.M = 150 + 6.75 = 156.75 KN-m

$$\therefore A_{st} = \frac{M}{\sigma_{st}\, jd} = \frac{156.75 \times 10^6}{230 \times 0.904 \times 700} = 1077\ mm^2$$

provide 25 mm ϕ bar.

No of bar required $= \frac{1077}{490.6} \simeq 3$ Nos

provide 4 bar of 25 mm diameter

Distribution Reinforcement

Step IV :- Secondary Reinforcement

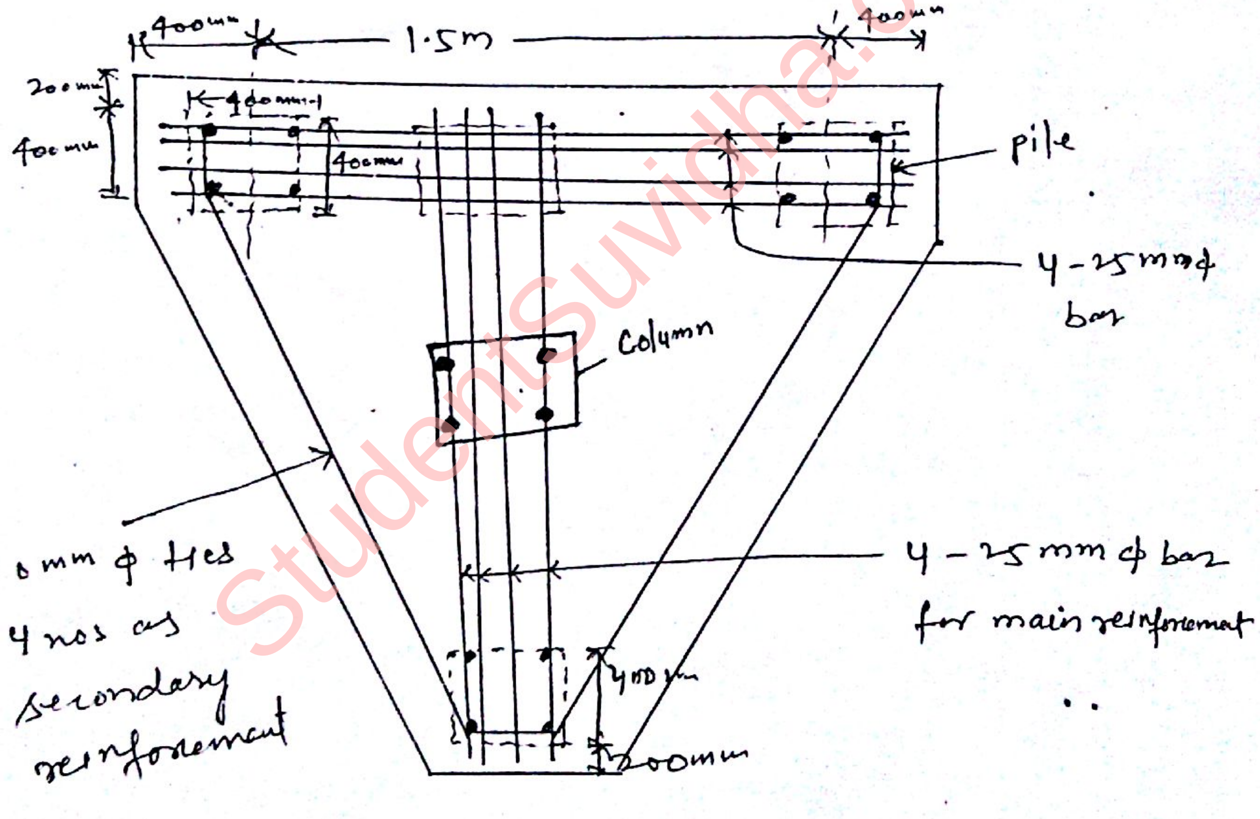
Area of secondary reinforcement

$= 20\%$ of tensile reinforcement

$= \frac{20}{100} \times 1206 = 242\ mm^2$

use 10 mm ϕ bar

No of bar $= \frac{242}{\frac{\pi}{4} \times 10^2} = 3.08 \approx 4$ bars



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