Pile Foundation

It is required to provide pile foundation consisting of three piles under a column carrying a load of 1350 kN. The piles are to be driven to hard strata which is available at a depth of 7 m. Design one of the piles. Assume suitable working stress and other data not given.

M15 and mild steel.

Step-I : Design constant.

Grade M15 — $\sigma_{cbc} = 5 N/mm^2$
Mild steel = $\sigma_{st} = 140 N/mm^2$

Weight of RCC = $25000 N/m^3$

Length of pile = 7m + 0.7 (size of pile cap)
= 7.7 m.

Total load on 3 piles = 1350 kN.

Load on 1 pile = $\frac{1350}{3}$ = 450 kN

Step-II

Dimensions of pile.

Assume the size of pile = 350 mm × 350 mm

(Note :- size will be not less than 300×300 mm and more than 450 mm×450.)

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$$\frac{l}{b} = \frac{7700}{350} = 22.$$

Since the ratio of l/b is greater than 12.

∴ pile behaves as long column.

Reduction factor

$$C_r = 1.25 - \frac{l}{48b}.$$

$$= 1.25 - \frac{7.7}{48 \times 3.5} = 0.79$$

Design load for a short pile with same dimension

$$\frac{\text{Load on 1 pile}}{C_r}$$

$$= \frac{450}{0.79} = 570 \text{ kN}$$

$$= 570 \text{ kN}$$

m20 → σ_{cc} = 5 N/mm²

III Design of Reinforcement :-

Load carrying capacity (P) =

$= \sigma_{sc} \cdot A_{sc} + \sigma_{cc} \cdot A_{cc}$

$570 \times 10^3 = 130 \times A_{sc} + ~~10~~ \times (490000 - 4A_{sc})$

$= 130 A_{sc} + 490000 - 4A_{sc}$

$= 126 A_{sc} + 490000$

$126 A_{sc} = 8000$

$= 634.92 \text{ mm}^2$

→ $A_{sc} = 634.92 \text{ mm}^2$.

IV ~~minim~~ ~~8~~. minimum Reinforcement

If $l/b < 30$

then

Provide min. reinforcement a

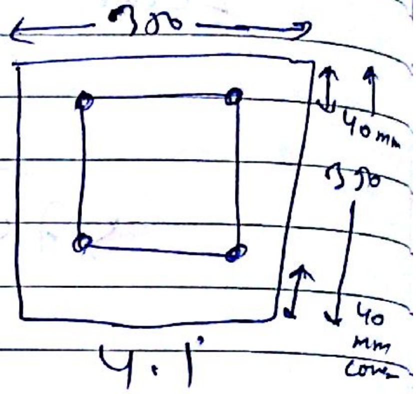
1.25% of gross area

$= \frac{1.25}{100} \times 350 \times 350$

$= 1531 \text{ mm}^2$

Use 22 mm ϕ bars.

$$A_\phi = \frac{\pi}{4} (22)^2 = 380 \text{ mm}^2.$$



∴ No. of bar required =

$$\frac{1531}{380} = 4.1$$ say 4 bars

Provide a 40 mm clear cover.

(V) Design of lateral reinforcement in the body of pile. —

Use 8 mm ϕ for ties.

Total length of one ties.

$$= \overline{350 - 2 \times 40 + 8 \times 1} \, 4$$

$$= (350 - 2 \times 40 + 8) \times 4$$

$$= 1112 \text{ mm}^2$$

Area of 8 mm ϕ bars. (A_ϕ)

$$= \frac{\pi}{4} \times (8)^2 = 50 \text{ mm}^2$$

volume of each tie = area × total length

= 50 × 1112

= ~~556000~~

= 55600 mm^3.

~~pitch of ties = volume~~

volume of lateral ties needed per ~~metre~~ mm length of pile

= 0.2% of gross area × ~~1mm~~ 1mm

$= \frac{0.2}{100} \times 350 \times 350 \times 1$

$= 245\ mm^3$

pitch of ties = $\frac{\text{volume of each ties}}{\text{volume of lateral ties}}$

$= \frac{55600}{245} = 226.9$

<u>227 mm</u>

Max. Permissible pitch of the ties as per rule

$\frac{1}{2} \times 350 = 170$ mm.

Provide 8 mm ϕ lateral ties @ 170 mm c/c

VI

Design of lateral Reinforcement near the bottom end of pile :-

As per IS rule the magnitude of lateral reinforcement near the end pile =

0.6% of gross volume

volume of ties per mm length of pile

$= \frac{0.6}{100} \times 350 \times 350 \times 1 = 735 \text{ mm}^3$

volume of 18 mm ϕ ties $= 55600 \text{ mm}^3$

pitch of ties $= \frac{55600}{735} = 75.6$ mm

Say 70 mm

Provide 8 mm ϕ bar of lateral ties @ 70 mm c/c