

UNIT V DESIGN OF FOOTINGS

Design of wall footing

Problem

Design a footing for 250mm thick has masonry wall with supports to carry a design load of 200kN/m at service state. Consider unit weight of soil 20kN/m³. Angle of repose = 30°. Allowable bearing capacity 150kN/m², M₂₀, Fe₄₁₅.

Given Data:

$$\begin{aligned} q_0 &= 150 \text{ kN/m}^2 \\ \gamma &= 20 \text{ kN/m}^3 \\ B &= 250 \text{ mm} \\ p_u &= 200 \text{ kNm} \\ \phi &= 30^\circ \\ f_{ck} &= 20 \text{ N/mm}^2 \\ f_y &= 415 \text{ N/mm}^2 \end{aligned}$$

Step 2:

Determination of depth of foundation

$$\begin{aligned} h &= \frac{q_0}{\gamma} \times [1 - \sin\phi / 1 + \sin\phi]^2 \\ &= \frac{150}{20} \times [1 - \sin 30 / 1 + \sin 30]^2 \\ &= 0.83 \cong 1 \text{ m} \end{aligned}$$

Step 3:

Find width of footing

$$\begin{aligned} B &= \frac{\text{Load}}{\text{S.B.C}} \\ &= \frac{200}{150} = 1.35 \text{ m} \end{aligned}$$

Step 4:

Find total load

$$\begin{aligned} \text{Self weight of footing} &= (L \times B \times D) \gamma \\ &= (1 \times 1.35 \times 1) 25 \end{aligned}$$

$$= 33.75 \cong 34$$

$$\begin{aligned}\text{Total Load} &= p_u + \text{self weight} \\ &= 200 + 34 \\ &= 234 \text{ KN/m}^2\end{aligned}$$

Step 5:

Actual width of footing

$$\text{Actual width} = \frac{234}{150} = 1.56 \cong 1.6 \text{ m}$$

Step 6:

Net upward pressure

$$\begin{aligned}P_o &= \frac{\text{Load(given)}}{\text{Width} \times 1(\text{m given})} \\ &= \frac{200}{1.6} = 125 \text{ KN/m}^2 / \text{m length}\end{aligned}$$

Step 7:

a) Depth of Basis of Bending Compression

$$\begin{aligned}M &= \frac{P_o}{8} \times (B - b) \times (B - \frac{b}{4}) \\ &= \frac{125}{8} \times (1.6 - 250 \times 10^{-3}) \times (1.6 - \frac{250 \times 10^{-3}}{4})\end{aligned}$$

$$M = 32.43 \text{ KNm}$$

$$\begin{aligned}\text{Factored Moment} &= 1.5 \times M \\ &= 1.5 \times 32.43\end{aligned}$$

$$M_u = 48.645 \text{ KNm}$$

$$\begin{aligned}M_u \text{ lim} &= \frac{0.36 x_{u \text{ max}}}{d} f_{ck} \left[1 - \frac{0.42 x_{u \text{ max}}}{d} \right] b d^2 \\ &= 0.36 \times 0.48 \times 20 \left[1 - 0.42 \times 0.48 \right] b d^2 \\ &= 2.759 b d^2\end{aligned}$$

$$M_u \text{ lim} = M_u$$

$$2.759 b d^2 = 48.645 \times 10^3$$

$$2.759 \times 10^{-3} \times 10^3 \times d^2 = 48.645 \times 10^3$$

$$d = 132.78 \text{ mm}$$

$$D = d + \text{cover}$$

$$= 132.78 + 60$$

$$= 192.78 \text{ mm}$$

$$D = 200 \text{ mm}$$

b) Depth on basis of one way shear

$$\text{Assume, } p_t = 0.3\%$$

$$\tau_v = \tau_c \times K$$

$$\tau_c \text{ ref IS456 Pg No: 73}$$

$$0.25 \rightarrow 0.36$$

$$0.50 \rightarrow 0.48$$

$$\tau_c = 0.38$$

$$\text{Permissible shear stress, } \tau_v = 0.38 K$$

$$K \text{ ref IS 456 Pg No : 73}$$

$$K = 1.20$$

$$\tau_v = 0.38 \times 1.20$$

$$\tau_v = 0.456$$

c) Critical section lies 'd' distances from face of wall

$$V_u = 1.5 P_o a$$

$$a = \frac{B}{2} - \frac{b}{2}$$

$$= \frac{1.35}{2} - \frac{250}{2}$$

$$a = 675 \text{ mm}$$

$$a = 0.675 \text{ m}$$

$$V_u = 1.5 \times P_o \times a$$

$$= 1.5 \times 125 \times 0.675 = 126.56 \text{ N/m}^2$$

$$\tau_v = \frac{V_u}{bd}$$

$$0.456 = \frac{126.56 \times 10^3}{1000 \times d}$$

$$d = 277.54 \text{ mm} \cong 280 \text{ mm.}$$

$$D = d + d_c$$

$$= 280 + 60 = 340 \text{ mm}$$

Design Reinforcement

$$M_u = 0.87 f_y A_{st} d \left[1 - \frac{f_y A_{st}}{bd f_{ck}} \right]$$

$$48.65 \times 10^6 = 0.87 \times 415 \times A_{st} \times 270 \left[1 - \frac{415 A_{st}}{1000 \times 270 \times 20} \right]$$

$$A_{st} = 519.83$$

Provide 12mm ϕ at 200mm C/C.

Distribution Reinforcement

$$= \frac{0.12}{100} \times 1000 \times 250$$

$$= 300\text{mm}$$

