Department of Civil Engineering
Katihar Engineering College, Katihar

Subject: Design of Concrete Structure-I
Topic: Footing
Lecture: 04
Course Instructor: Prof. Rashid Mustafa

Q-2. Design a uniform thickness footing for a column of size 400 mm square having an axial load of 1100 kN. Safe Bearing Capacity = 150 kN/m². Use M20 & Fe 415. Use LSM. Take 20% weight of footing.

Step 1. Load = 1100 kN

footing load = $0.20 \times 1100 = 220$ kN

Total load (P_T) = 1320 kN

Area of footing (A) = $\frac{P_T}{S.B.C} = \frac{1320}{150}$

= 8.8 m²

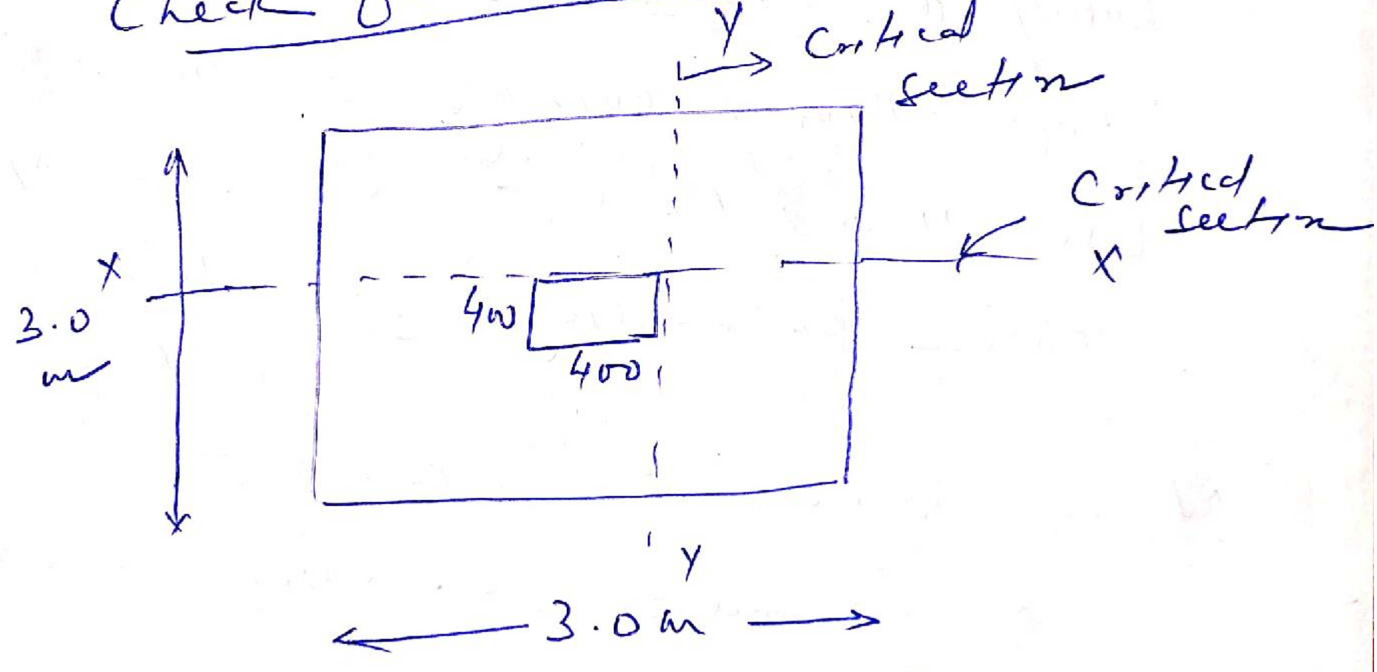
Let us assume footing is in Square shape having dimension B.

$$\text{Size of footing } (B) = \sqrt{8.8}$$
$$= 2.97 \text{ m}$$

Provide $B = 3.0$ m.

$$W_{uo} = 1.5\frac{P}{A} = \frac{1.5 \times 1100}{3 \times 3}$$
$$= 183.33 \text{ kN/m}^2$$
$$\simeq 185 \text{ kN/m}^2$$

(2) Check for B.M



$$M_{ux} = \frac{W_{uo} \times 1 \times (B-b)^2}{8}$$
$$= \frac{185 \times 1 \times (3-0.4)^2}{8}$$
$$= 156.33 \text{ kN-m}$$

$$M_{uy} = W_{uo} \times 1 \times \left(\frac{L-a}{8}\right)^2$$

$$= 185 \times 1 \times \left(\frac{3-0.4}{8}\right)^2$$

$$= 156.33 \text{ kN-m}$$

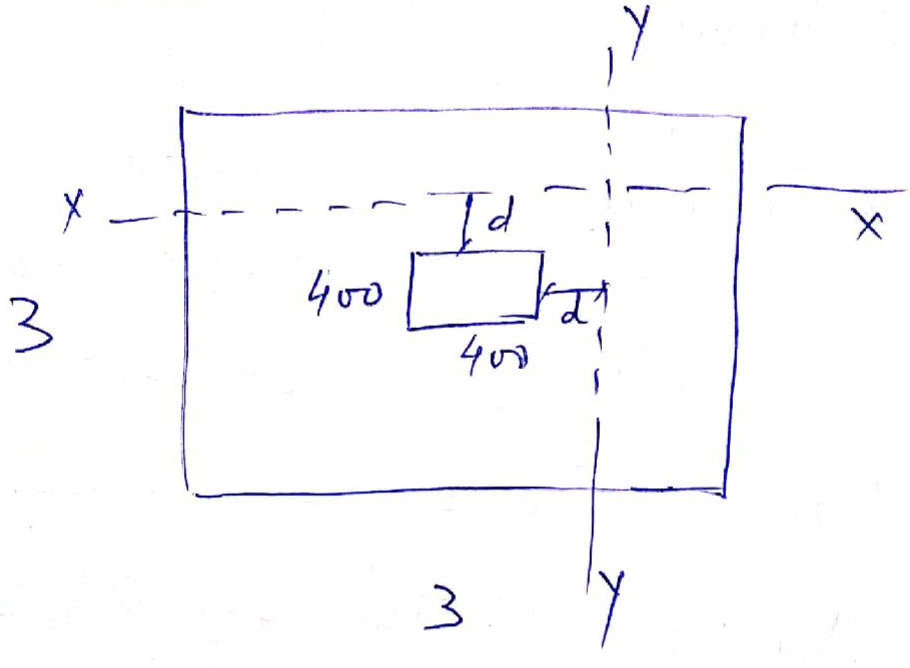
$$\text{depth required } (d) = \sqrt{\frac{BM_{max}}{Q_r \cdot B_1}}$$

$$= \sqrt{\frac{156.33 \times 10^6}{0.138 \times 20 \times 1000}}$$

$$= 238 \text{ mm}$$

Provide 250 mm

(3) Check for one way shear



$$V_{uy} = W_{uo} \times 1 \left(\frac{L-a}{2} - d\right)$$

$= 185 \times 1 \times \left[\frac{3-0.4}{2} - 0.25\right]$

$= 194.25\ kN$

Nominal Shear Stress $(\tau_{vu}) = \frac{V_u}{B.d}$

$= \frac{194.25 \times 10^3}{1000 \times 250}$

$= 0.77\ N/mm^2$

For M20 grade of ~~gra~~ Concrete & $p_t \leq 0.15\%$ $\tau_c = 0.28\ N/mm^2$

$K = 1.10$

$\tau_{vu} \not< K.\tau_c$

depth required $= \frac{194.25 \times 10^3}{1000 \times 0.28}$

$= 693.75\ mm$

Take $d = 500\ mm$

$V_u = 185 \times \left(\frac{3-0.4}{2} - 0.50\right)$

$= 148\ kN$

$\tau_{vu} = \frac{148 \times 10^3}{1000 \times 500} = 0.29\ N/mm^2$

$K \cdot \tau_c = 1.0 \times 0.28 = 0.28$

$\tau_{vu} \nless K \cdot \tau_c$ Not ok.

Check at $d = 520$ mm

$V_{uy} = 185 \times \left(\frac{3 - 0.4}{2} - 0.520 \right)$

$= 144.3$ kN

$\tau_{vu} = \frac{144.3 \times 10^3}{1000 \times 520}$

$= 0.27$ N/mm²

$\tau_{vu} \leq K \cdot \tau_c$

Provide $d = 520$ mm

$D = 600$ mm

(4) Check for Two way shear (Punching shear)

τ_{vp} (developed) $= \frac{P_u - w_{uo} \times (b+d)^2}{4(b+d) \times d}$

$= \frac{1.5 \times 1100 \times 10^3 - 185 \times (0.4 + 0.52)^2}{4 \times (400 + 520) \times 520}$

$= 0.78$ N/mm²

$K\beta = 0.5 + \frac{b}{a}$

$= 0.5 + \frac{400}{400} = 1.5$

$K\beta \ngtr 1.0$

Take $k\beta = 1$.

τ_{vp} (Permissible) $= k\beta \times 0.25\sqrt{fck}$

$= 1 \times 0.25 \times \sqrt{20}$

$= 1.12\ N/mm^2$

τ_{vp} (developed) $<$ τ_{vp} (Permissible)

OK.

(5) Area of steel (Ast)

Here Moment in x-direction as well y-direction are same.

$Ast\ (1\,m\ width) = \frac{0.5 \times 20}{415} \times \left[1 - \sqrt{1 - \frac{4.6 \times 155.4 \times 10^6}{20 \times 1000 \times 520^2}}\right] \times 500^2 \times 1000$

$= 857.9\ mm^2$

$Ast\ (min) = \frac{0.12}{100} \times 1000 \times 520$

$= 624\ mm^2$

$Ast_{min} \ngtr Ast$ Provided ~~Not~~ ok

Provide Ast = 857.7 mm²

For 3m width

$$A_{st} = 3 \times 857.9$$

$$= 2573.7 \text{ mm}^2$$

$$\text{No of bar } (n) = \frac{2573.7}{\frac{\pi}{4} \times 16^2}$$

$$\simeq 13 \text{ Nos.}$$