Department of Civil Engineering
Katihar Engineering College, Katihar

Subject: Design of Concrete Structure-I
Topic: Footing
Lecture: 03
Course Instructor: Prof. Rashid Mustafa

Q-1 Design a rectangular footing for a column of size 300 x 600 mm subjected to a load of 1400 kN. Safe Bearing Capacity = 120 kN/m². Use M25 Concrete / Fe 415 steel. Use LSM. Size of foundation width = 3 m.

Solⁿ.

Load from column = 1400 kN

Weight of footing (10% of P) = 140 kN

Total Load (P_T) = 1540 kN

$$\text{Area of footing} = \frac{P_T}{S.B.C} = \frac{1540}{120}$$

$$= 12.83 \text{ m}^2$$

Scanned with CamScanner

Width of footing (B) = 3 m

Length of footing (L) = $\frac{12.83}{3}$

= 4.3 m

Provided Rectangular footing 4.3 m x 3 m

Design soil Pressure = $\frac{P}{A}$ = $\frac{1400}{4.3 \times 3}$

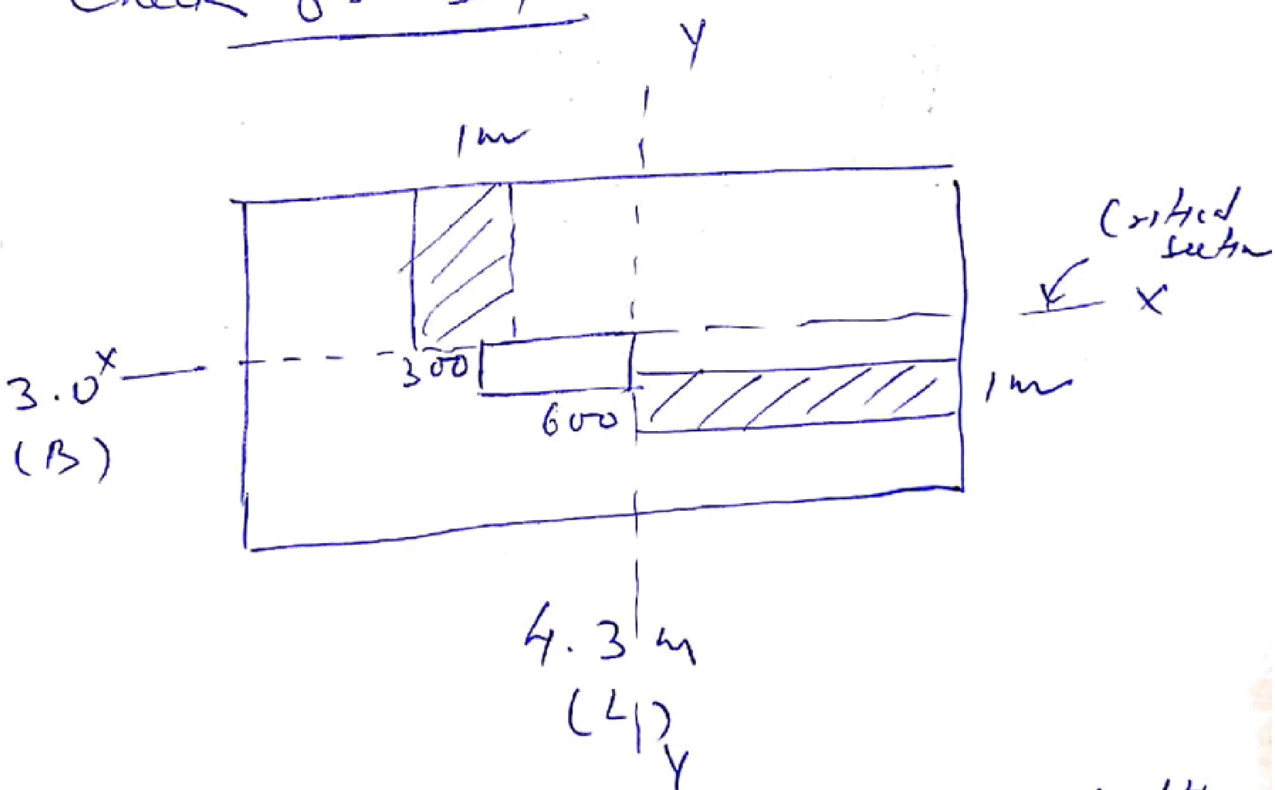
= 108.53 kN/m²

W_{uo} = 1.5 x 108.53

= 162.80 kN/m²

≃ 163 kN/m²

(2) <u>Check for BM</u>



(1) Moment about X–X (For 1 m width)

$M_{ux} = W_{uo} \times 1 \times \left(\frac{B-b}{2}\right)\left(\frac{B-b}{4}\right)$

$$M_{ux} = W_{uu} \times 1 \times \frac{(B-b)^2}{8}$$

$$= 163 \times 1 \times \frac{(3-0.3)^2}{8}$$

$$= 148.53 \text{ kN-m}$$

(11) Moment about Y-Y (For 1m width)

$$M_{uy} = W_{uu} \times L \times \frac{(L-a)^2}{8}$$

$$= 163 \times 1 \times \frac{(4.3-0.6)^2}{8}$$

$$= 278.93 \text{ kN-m}$$

Depth required (Depth of footing)

$$d = \sqrt{\frac{M_{umax}}{Q \cdot B_1}}$$

$$= \sqrt{\frac{278.93 \times 10^6}{0.138 \times 25 \times 1000}}$$

$$= 284.34 \text{ mm}$$

Provided depth = 300 mm.

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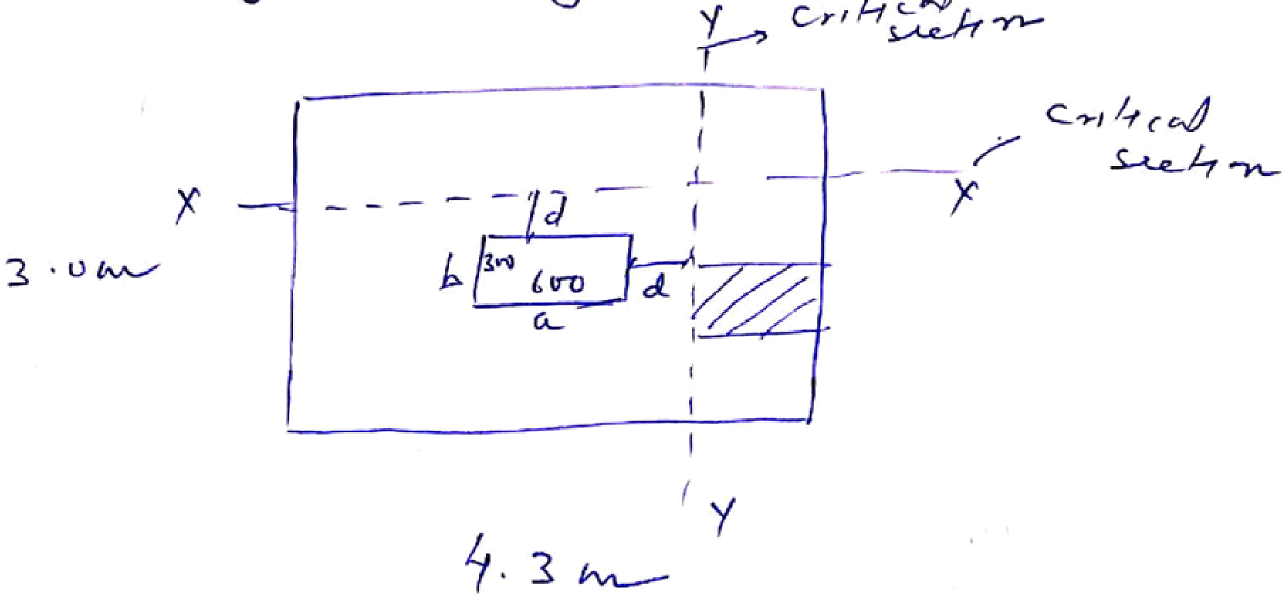
(3) Check for One way shear



Critical Section is at Y-Y at a distance d from face of the Column.

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

$$= 163 \times 1 \times \left(\frac{4.3-0.6}{2} - 0.3\right)$$

$$= 163 \times (1.85 - 0.3)$$

$$= 252.65 \text{ kN}$$

Nominal shear stress $(\tau_{vu}) = \frac{V_{uy}}{B_1 d} = \frac{252.65 \times 10^3}{1000 \times 300}$

$$= 0.84 \text{ N/mm}^2$$

$$\tau_c = 0.28 \text{ N/mm}^2$$

$$K = 1$$

$\tau_{vu} > K\tau_c$ (Not ok)

depth reqd (d) = $\frac{252.65 \times 10^3}{1000 \times 0.28}$

= 902 mm

Check for d = 650 mm

$V_{uy} = 163 \left[1.85 - 0.65 \right]$

= 195.6 kN-m

$\tau_{vu} = \frac{195.6 \times 10^3}{1000 \times 650} = 0.3$

$\tau_{vu} > k \tau_c$ (Not ok)

Check for d = 700 mm

$V_{uy} = 163 \times 1 (1.85 - 0.70)$

= 187.45 kN

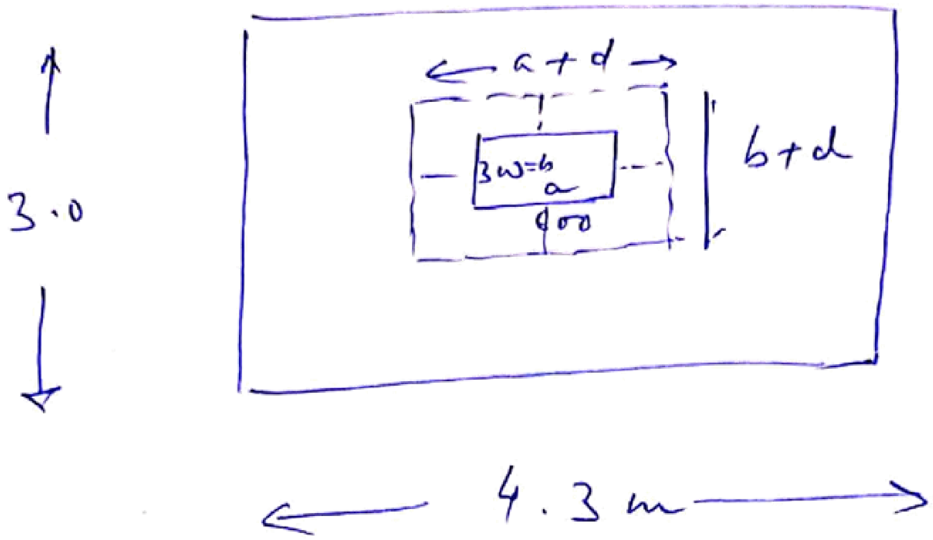
$\tau_{vu} = \frac{187.45 \times 10^3}{1000 \times 700}$

= 0.27 N/mm²

$\tau_{vu} < k \tau_c$ OK.

Provide d = 700 mm

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



τ_{up} (developed) = $\frac{\text{Net Punching force}}{\text{Resisting Area}}$

$= \frac{P_u - W_u (a+d)(b+d)}{2[(a+d)+(b+d)] \times d}$

$= \frac{1.5 \times 1400 - 163 \times (0.6+0.7) \times (0.3+0.7)}{2[(600+700)(300+700)] \times 700}$

$= 0.586 \ N/mm^2$

τ_{vp} (Permissible) = $k_\beta \times 0.25\sqrt{f_{ck}}$

$k_\beta = \left(0.5 + \frac{b}{a}\right) = 0.5 + \frac{300}{600}$

$= 1.$

$= 1 \times 0.25 \times \sqrt{25}$

$= 1.25 \ N/mm^2$

τ_{vp} (developed) $< k_\beta \times 0.25\sqrt{f_{ck}}$

ok.

Area of steel

(a) For Moment about X–X (M_{UX})

$M_{UX} = 148.53$ kN-m

$$A_{st} = 0.5 \frac{f_{ck}}{f_y} \left[1 - \sqrt{1 - \frac{4.6 M_U}{f_{ck} B_1 d^2}}\right] \times B_1 d$$

$$= \frac{0.5 \times 25}{415} \left[1 - \sqrt{1 - \frac{4.6 \times 148.53 \times 10^6}{25 \times 1000 \times 700^2}}\right] \times 1000 \times 700$$

$= 596.42 \ mm^2$

$$A_{st\,min} = \frac{0.12}{100} \times B \times D$$

$$= \frac{0.12}{100} \times 1000 \times [700 + 75]$$

$= 936 \ mm^2$

Provide Minm Area of steel $= 936 \ mm^2$

For total width L (4.3 m)

$$A_{st} = 4.3 \times 936 = 4025 \text{ mm}^2$$

Total No of bars reqd using 12 mm ϕ

$$n_T = \frac{4025}{\frac{\pi}{4} \times 12^2} = 36$$

No of bars in Central band

$$n_c = n_T \times \frac{2}{\left(1 + \frac{L}{B}\right)}$$

$$= 36 \times \frac{2}{1 + \frac{4.3}{3}} = 30 \text{ Nos}$$

No of bars in side band (n_s)

$$n_s = \frac{36 - 30}{2} = 3 \text{ Nos.}$$

(b) For Moment about Y–Y (M_{uy})

$$M_{uy} = 278.9 \text{ kN-m}$$

$$A_{st} = \frac{0.5 \times 25}{415} \times \left[1 - \sqrt{1 - \frac{4.6 \times 278.9 \times 10^6}{25 \times 1000 \times 700^2}}\right] \times 1000 \times 700$$

$$= 1134.6 \text{ mm}^2 \quad (\text{For } 1 \text{ m width})$$

$A_{st} > A_{st\,min}$ (ok)

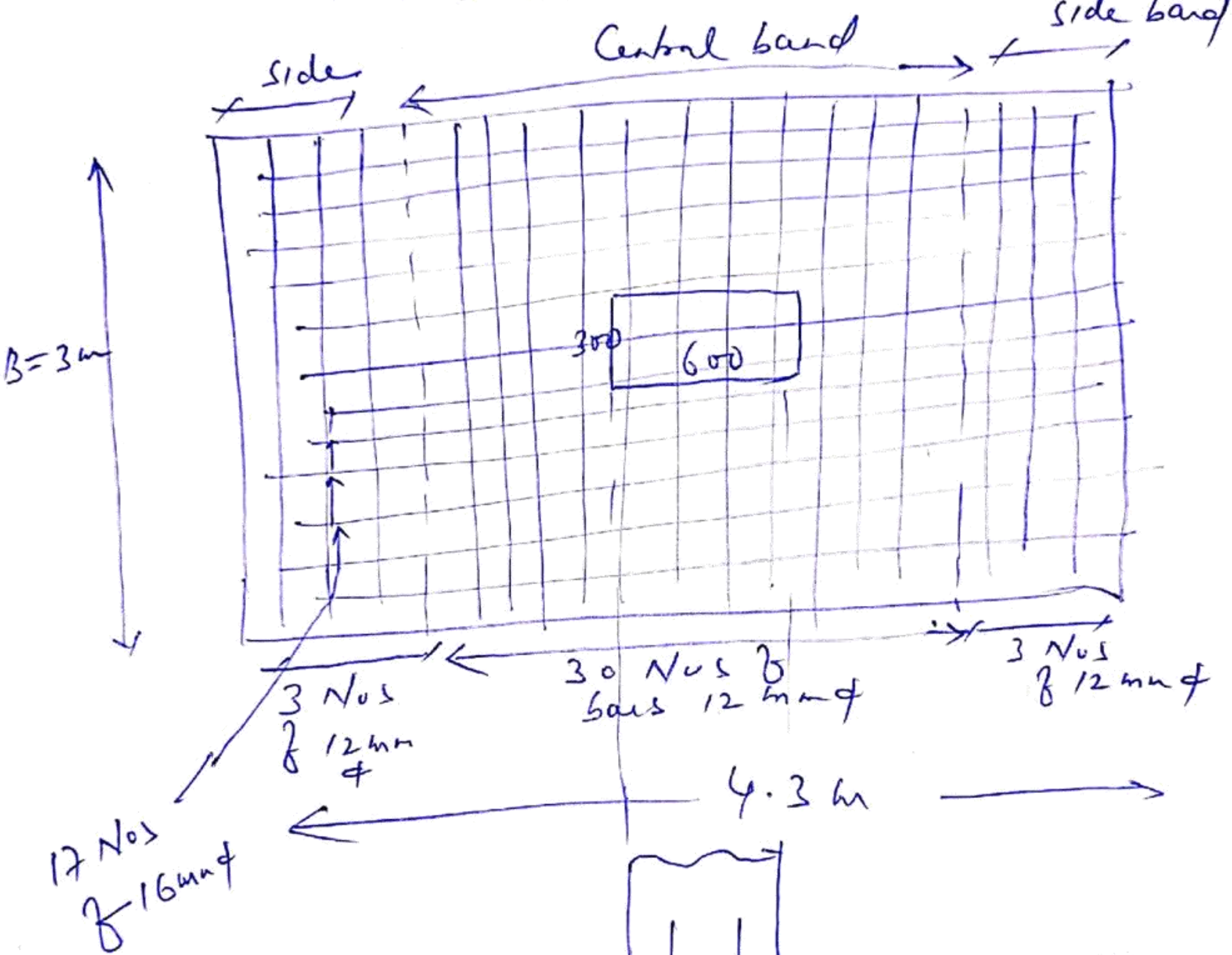
For total width B (3.0 m)

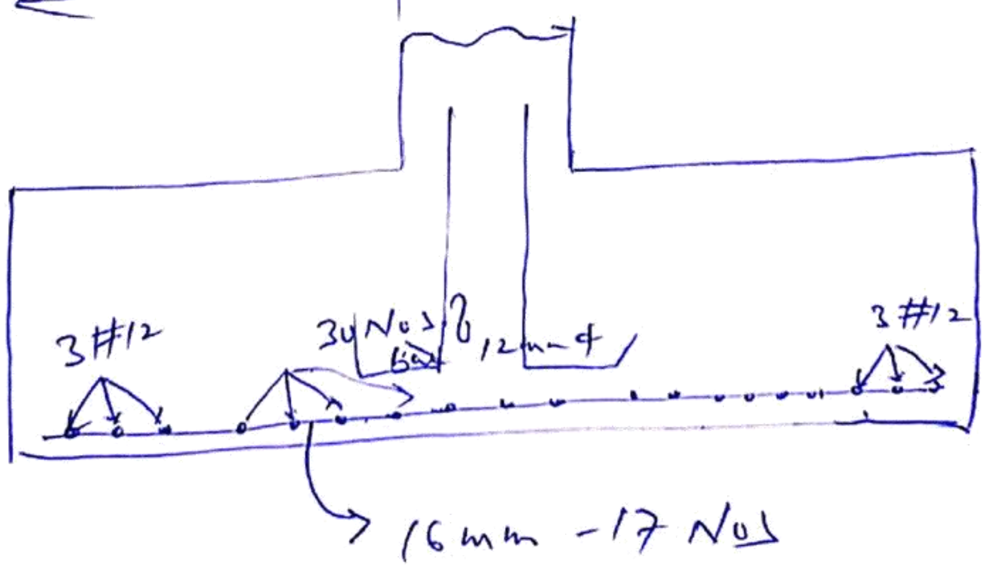
$$A_{st} = 3 \times 1134.6$$
$$= 3403.82 \text{ mm}^2$$

Provide 16 mm ϕ

$$\text{No of bars} = \frac{3403.82}{\frac{\pi}{4} \times 16^2} = 17$$

Provide 17 Nos 16 mm ϕ equally distributed for full width





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