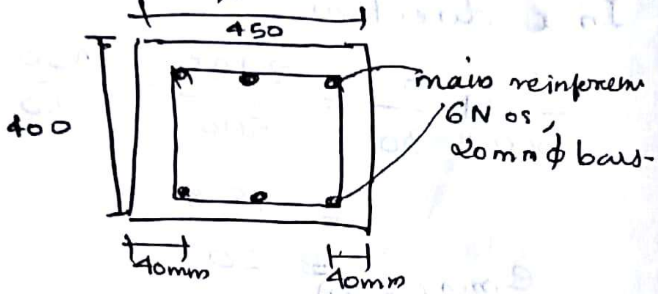
cl. 26.5.3.2

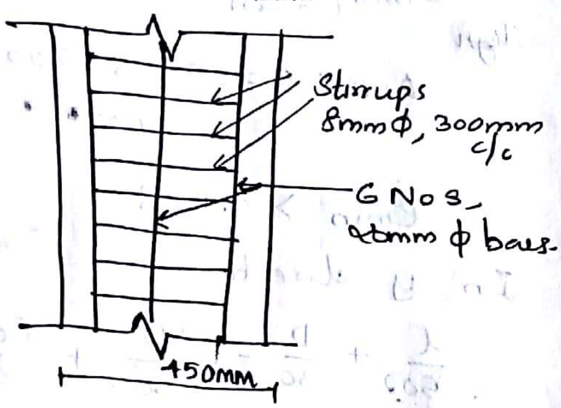
(i) least lateral dimension = 400

(ii) $16\phi = 16 \times 20 = 320$

(iii) 300mm

provide 8mm $\phi$ bars @ 300mm c/c




## MODULE. 4

### ISOLATED FOOTING

ISOLATED FOOTING FOR AXIALLY LOADED COLUMNS

ISOLATED FOOTING FOR UNIFORM DEPTH FOR RCC COLUMN

Design a isolated footing of uniform thickness for a RCC column having a vertical load of 600kN and having a base of size foot 300mm. The safe bearing capacity of soil is 120 kN/m². Use $M_{20}$ concrete & Fe 415 steel.

b = 500mm, d = 500mm } column.

$f_{ck} = 20 N/mm^2$   $f_y = 415 N/mm^2$

Step 1: Dimension of the section

Let w' be the selfweight of the column 10% of Super imposed load.

$W' = 10\% \, W$

$= 600 \times \frac{10}{100} = 60kN$

Total load $= 600 + 60 = 660kN$

$$\text{Area} = \frac{\text{Load}}{\text{Pressure}}$$

$$= \frac{660}{120}$$

$$= 5.5 m^2$$

So provide a square column of size $B^2 = 5.5$

$B = 2.34 \approx$

$B = 2.4m$

Provide a square footing of $2.4 \times 2.4m$

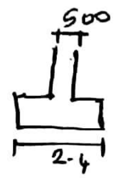
Net upward pressure $= \frac{\text{Actual load}}{\text{Area}} = \frac{600}{2.4 \times 2.4}$

$= 104.17 \, kN/m^2$

Design

1. Depth on the basis of bending compression. ⇒ Momentum

The max bending moment (load × distance) act at the face of the column


$$\frac{B-b}{2} \times \frac{\frac{B-b}{2}}{2}$$

$$w \times l \times \frac{l}{2}$$

$$P_oB \quad \frac{B-b}{2} \quad \frac{\frac{B-b}{2}}{2}$$

$$1 \times \frac{1}{2}$$

Moment

$$M = \underbrace{P_oB\,\frac{(B-b)}{2}}_{\text{load}} \times \frac{\frac{B-b}{2}}{2}$$

$$\boxed{M = \frac{P_oB}{8}(B-b)^2}$$

$$M = \frac{104.17 \times 2.4}{8}(2.4-0.5)^2$$

$$= 112.8016 \text{ kNm}$$

$$M_u = M \times 1.5$$

$$= 169.20 \text{ kNm}$$

$$= 169.2 \times 10^6 \text{ Nmm}$$

Calculate 'd'

$$M_{u\,limit} = 0.36\,\frac{x_{umax}}{d}\left[1 - 0.042\,\frac{x_{umax}}{d}\right] bd^2 f_{ck}$$

$$169.2 \times 10^6 = 0.36 \times 0.48\,[1 - 0.042 \times 0.48]\; 2400 \times d^2 \times 20$$

$$d = 159.85 \text{ mm} \approx 160 \text{mm}$$

20mm ϕ bars.

$$D = 160 + 50 + \frac{20}{2}$$

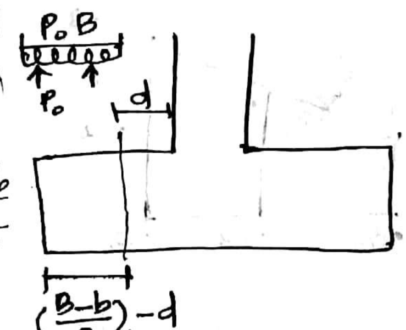
$$= \underline{\underline{220 \text{mm}}}$$

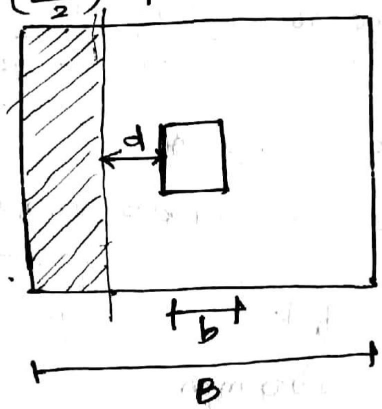
2. Depth on the basis of one way shear. ⇒ force load

For one way shear the critical section is located at a distance d from the face of the column.

$$P = \frac{\text{Load}}{\text{Area}}$$

$$120 = \frac{\cdot}{\text{Area}}$$




$$\text{Shear force, } V = P_oB\left[\left(\frac{B-b}{2}\right)-d\right]$$

$$= 104.17 \times 2.4 \times \left[\left(\frac{2.4-0.5}{2}\right) - d \times 10^{-3}\right]$$

$$= 237.5076 - 0.25008\,d$$

$$V_u = (237.5076 - 0.25008\,d) \times 1.5$$

$$= 356.2614 - 0.375012\,d$$

...ominal shear stress is equated to the permissible shear stress.

$$\tau_v = k\tau_c$$

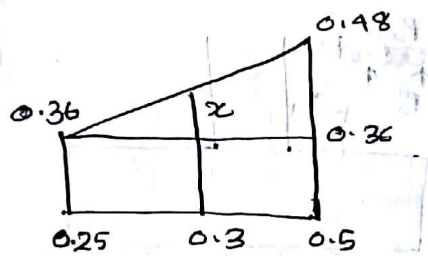
$$\frac{V_u}{Bd} = k\tau_c \rightarrow$$

Pg: 73

Assume 0.3% of %tensile reinforcement.

0.25

$$\frac{100 A_s}{bd} = P_t = 0.3\%$$



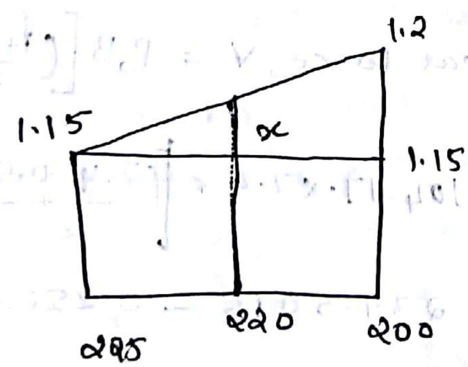

$$\frac{0.48 - 0.36}{x} = \frac{0.5 - 0.25}{0.3 - 0.25}$$

$$x = 0.024$$

$$\tau_c = 0.36 + x = 0.384$$

<u>value of k</u>

D = 220 mm




$$\frac{1.2 - 1.15}{x} = \frac{225 - 200}{225 - 220}$$

$$x = 0.01$$

$$k = 1.15 + x = 1.16 \text{ mm}$$

(350...) = 1.16×0.3...

$$\frac{2400}{2.4} \times d$$

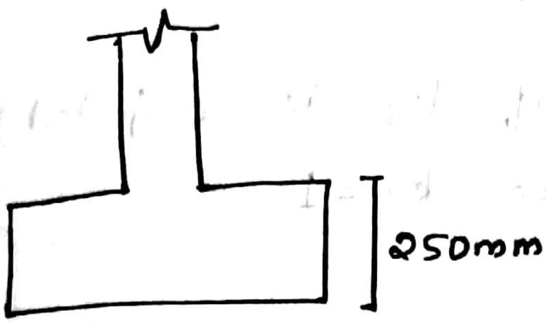
$$= \cancel{1.069d}$$
$$= 1063.48d$$

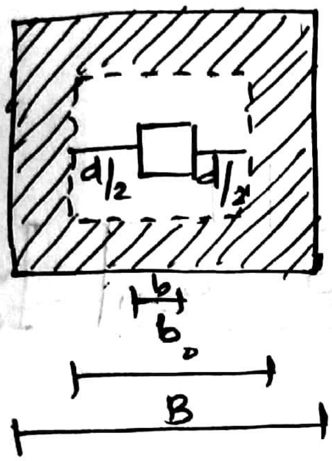
$$356.2614 \times 10^3 = \cancel{376.08d}$$
$$= 1438.5d$$

$$\cancel{d = 947.29}$$

$$d = \cancel{246.4}\ 247.6$$
$$\approx 250 \text{mm}$$

## CHECK FOR TWO-WAY SHEAR / PUNCHING SHEAR




S/n lies @ d/2 distance from the column face all around

$$b_o = b + \frac{d}{2} + \frac{d}{2}$$

$$= 500 + \frac{250}{2} + \frac{250}{2}$$

$$= 750 \text{ mm}$$

$$\text{Area} = B^2 - b_o^2$$

Stress = load / Area

$$= 2.4^2 - 0.75^2$$

$$= 5.1975 \text{ mm}^2$$

Shear force around the s/n

= Pressure x Area.

$$V = 104.17 \times (2.4^2 - 0.75^2).$$

$$= 541.424 \text{ kN}$$

$$V_u = 812.136 \text{ kN}$$

Shear stress $\tau_v = \frac{V_u}{4 b_o d} = \frac{812.136 \times 10^3}{4 \times 750 \times 250}$

4 side

$$= 1.08$$

from cl 31.6.3.1 of IS 456:2000 pg:59

Permissible shear stress = $k_s \tau_c$

where $k_s = 0.5 + \beta_c$

$\beta_c$ = ratio of longer side to shorter side.

$= \frac{500}{500} = 1$

$\therefore k_s = 0.5 + 1 = 1.5$

Since the value of $k_s$ is subjected to a max of 1. Take $k_s = 1$

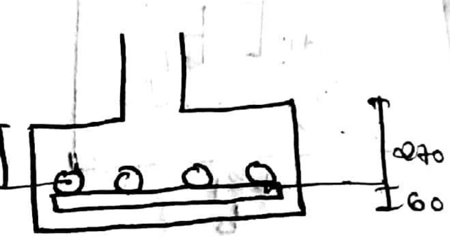
$\tau_c = 0.25\sqrt{f_{ck}}$

$= 0.25\sqrt{20} = 1.118$

$k_s \tau_c = 1.118$

$\boxed{\tau_v < k_s \tau_c}$

∴ footing is safe



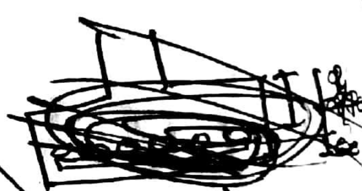

∴ Provide a footing of size 2.4m × 2.4m with effective depth = 250mm

Assume effective cover of 60mm

Overall depth = 250 + 60 = 310 mm

≈ 330 mm

$d = 330 - 60 = 270$



Design of steel reinforcement

effective depth in other direction

$270 - 12 = 258$

Since the actual depth provided is greater than depth required for bending compression it is an under reinforced section

Annex G.

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

$$169.224\times10^{6} = 0.87 \times 415 \times A_{st} \times 258 \left[1 - \frac{A_{st}\times 415}{2400\times 258\times 20}\right]$$

$$16.665 = A_{st} - 3.35\times10^{-5} A_{st}^{2}$$

$$A_{st} = 1943.156$$

No. of bars $= \dfrac{A_{st}}{\text{Area of 1 bar}}$

$$= \frac{1943.156}{\frac{\pi}{4}\times 12^{2}} = 17.19 \approx 18\ \text{No.s}$$

<u>Check for development length</u>

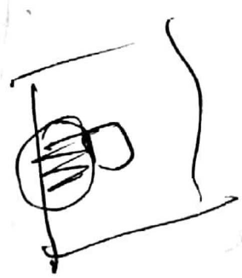
bikeet

Min development length, $L_d = 47\times\phi$

$= 47\times12$

$= 564\ mm$

length of the bar $= \dfrac{B-b}{2} - 60$



$$= \frac{2400-500}{2} - 60$$

$$= 890 > L_d$$

footing is safe

<u>Transfer of load at the column base</u>

cl. 34.4    pg: 65

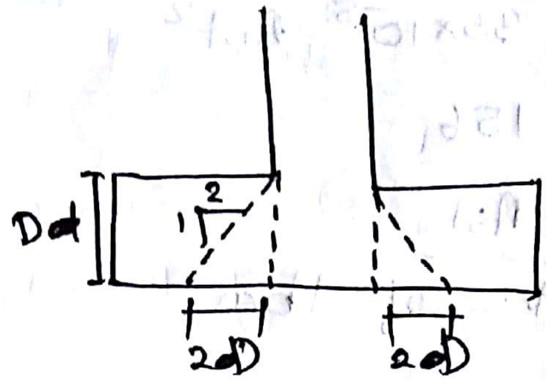
permissible bearing stress $=$

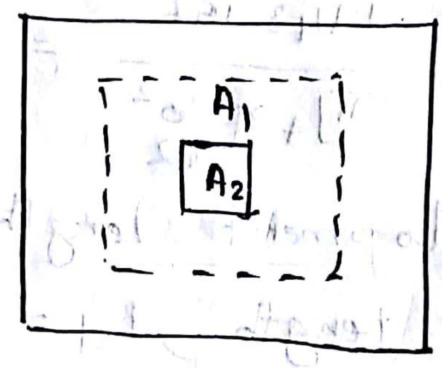
$$0.45\, f_{ck}\sqrt{\frac{A_1}{A_2}}$$

Load area of the column = $A_2$

$= 500 \times 500$

$= 250000$




$A_1 = (2D + 500 + 2D)^2$

$= (2 \times 330 + 500 + 2 \times 330)^2$

$= 3312400 \ mm^2$

$\sqrt{\frac{A_1}{A_2}} = 3.64$

$\therefore$ It is greater than 2 adopt max value 2

$\therefore$ permissible bearing stress

$= 0.45 \, f_{ck} \sqrt{\frac{A_1}{A_2}}$

$= 0.45 \times 20 \times 2$

$= 18 \ N/mm^2$

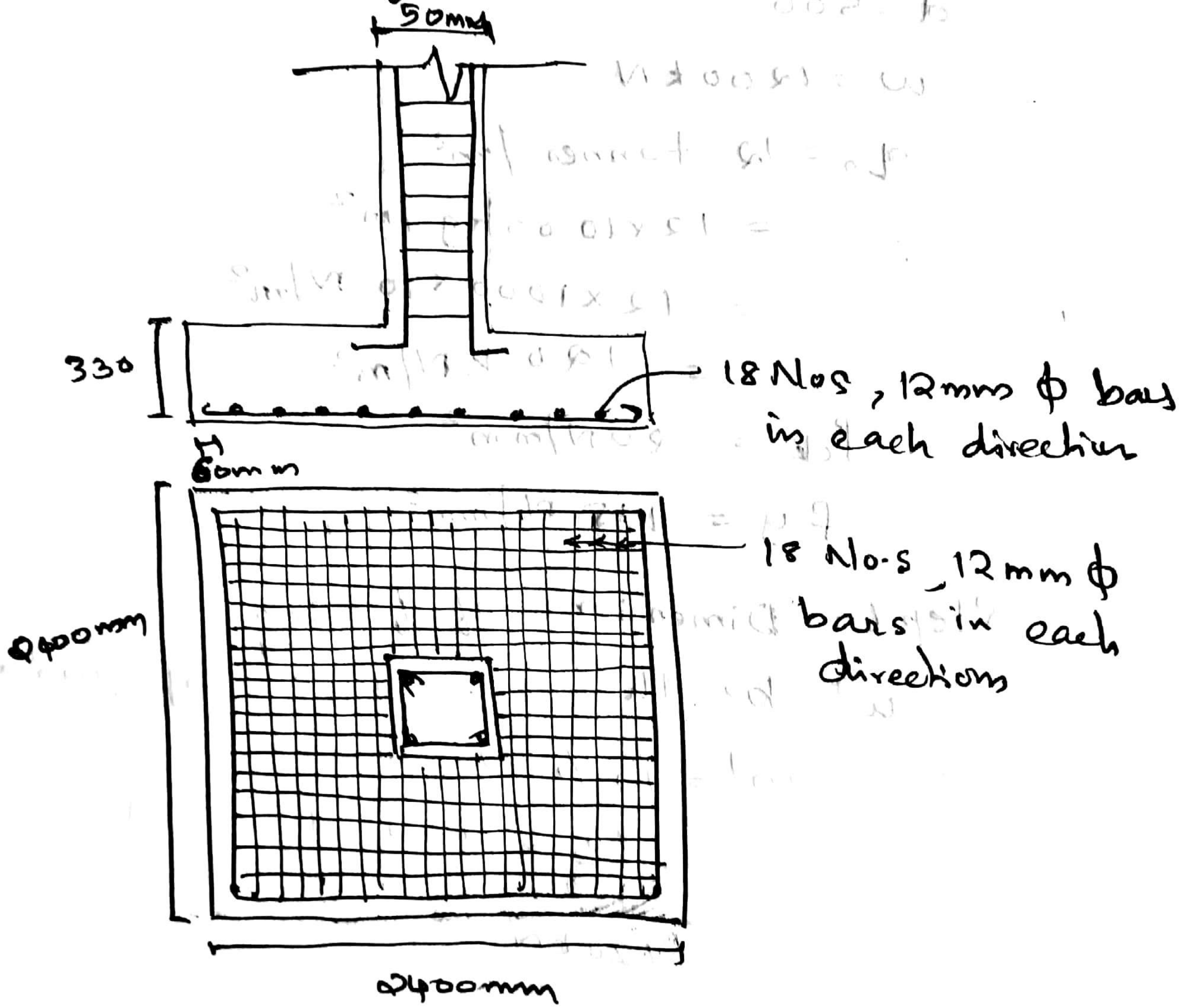
$$\frac{F.O.S \times load}{Area}$$

$$= \frac{1.5 \times 600 \times 10^3}{500 \times 500} = 3.6 N/mm$$

Actual ~~value~~ bearing Stress < Permissible bearing Stress

∴ It is safe

No seperate bars are required to transfer the load.




$= r_{a}b(B-b)$