$\frac{l}{d} = 20 \times MF$

Assume % tensile reinforcement = 0.85%

∴ From fig 4 of IS 456 2000

$MF = 1.4$

$\frac{l}{d} = 20 \times 1.4$

$\frac{4000}{d} = 20 \times 1.4$

$\therefore d = \underline{142.85}$

Assume a clear cover of 20 mm & (ϕ) of diam bar 10 mm

$D = d + c + \frac{10}{2}$

$= 142.85 + 20 + 5$

$= \underline{167.85} \text{ mm} \simeq \underline{170 \text{ mm}}$

$\therefore d = \underline{145}$

Assume $b = 1 m$

Eff. span of slab $= l + b$

Eff. span in one dirn $= 4000 + 145$

$= \underline{4145} \text{ mm}$

Eff. span in other dirn $= 5000 + 145$

$= \underline{5145} \text{ mm}$

<u>Step 3</u>: Computatn of loads & B.M.

$\tau_v < \tau_c$

Hence safe

Development length $= \dfrac{\phi \sigma_s}{4 \tau_{bd}} = \dfrac{10 \times 0.87 \times 415}{4 \times 1.2}$

$= 752.187\ mm$

Q Design RCC roofing slab over a room 4m×5m. The slab is simply supported on all four edges with corners held-down. The super imposed load is 2 kN/m² & floor finish is 0.5 kN/m². Use M15 concrete & Fe 415 steel.

A. Given

$L = 5m$

$l = 4m$

$f_{ck} = 15 N/mm^2$

$f_y = 415 N/mm^2$

$LL = 2 kN/m^2$

w — load area

Step 1 Check for one way or 2 way slab

$\frac{L}{l} = \frac{5}{4} = 1.25 < 2$

∴ It is a 2-way slab

Step 2 Computatn of slab dimension

$L.L = 2 KN/m$

$D.L = 0.17 \times 1 \times 25$

$= 4.25 \ KN/m$

$F.L = 0.5 KN/m^2$

$= 0.5 \ KN/m$

Total load = $6.75 \ KN/m$

$\frac{l_y}{l_x} = \frac{5.145}{4.145} = 1.241$

From table 26, for all edges discontinuous

$\alpha_x = \frac{0.072 + 0.079}{2}$

$= 0.0755$

$\alpha_y = 0.056$

$M_x = \alpha_x w l_x^2$

$= 0.0755 \times 6.75 \times 4.145^2$

$= 8.7558 \ KNm$

$M_{ux} = 8.7558 \times 1.5 = 13.134 \ KNm$

$M_y = \alpha_y w l_x^2$

$= 0.056 \times 6.75 \times 4.145^2$

$= 6.4944 \ KNm$

$M_{uy} = 6.4944 \times 1.5$

$= \underline{9.741 \ KNm}$

Eff. depth required = 0.36 × [illegible]

$13.134 \times 10^6 = 0.36 \times 0.48 \left(1 - 0.42 \times 0.48\right) \times 1000 \times d^2 \times 15$

$d_{req} = 79.6$ mm (min)

$d_{req} < d_{provided}$, hence safe

Step 4. Computatⁿ of reinforcement

i) Shorter dirⁿ

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

$13.134 \times 10^6 = 0.87 \times 415 \times A_{st} \times 145 \left(1 - \frac{A_{st} \times 415}{1000 \times 145 \times 15}\right)$

$250.877 = A_{st} - 1.908 A_{st}^2$

$1.909 A_{st}^2 - A_{st} + 250.877 = 0$

$A_{st} = 264.124$

$\text{Spacing} = \frac{1000 \times \text{Area of one bar}}{A_{st}}$

$= \frac{1000 \times \frac{\pi}{4} \times 10^2}{264.124} = 297 \simeq 290$ mm

ii) longer dirⁿ

Eff. depth $= 145 - 10$

$= 135$ mm

$M_{uy} = 0.87 f_y A_{st} d \left(1 - \frac{A_{st} f_y}{b d f_{ck}}\right)$

$9.74 \times 10^6 = 0.87 \times 415 \times A_{st} \times 135 \left(1 - \frac{A_{st} \times 415}{1000 \times 135 \times 15}\right)$

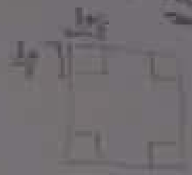
$199.828 = A_{st} - 2.049 \times 10^{-4} A_{st}^2$

$8.049 \times 10^{-4} A_{st}^2 - A_{st} + 199.828 = 0$

$A_{st} = 208.757 mm$

$$\text{Spacing} = \frac{1000 \times \text{Area of one bar}}{A_{st}}$$

$$= \frac{1000 \times \frac{\pi}{4} \times 10^2}{208.757} = 376.22 \simeq 300 mm$$



Step 5 Torsional reinforcement

As the corners are held down, all the four corners are ~~held down~~ provided with torsional reinforcement

$$\text{Size of torsional mesh} = \frac{l_x}{5} \times \frac{l_x}{5}$$

$$= \frac{4.145}{5} \times \frac{4.145}{5}$$

$$= 0.829 m \times 0.829 m$$

At each corner two meshes one at top & one at bottom are provided

$$\text{Area of torsional steel} = \frac{3}{4} A_{stx}$$

$$= \frac{3}{4} \times 264.124$$

$$= 198.09 mm^2$$

Provide 10mm ϕ bars at spacing

$$= \frac{1000 \times \text{Area of one bar}}{A_{st}}$$

$$= \frac{1000 \times \frac{\pi}{4} \times 10^2}{198.09} = 396.48 \simeq 300 mm$$

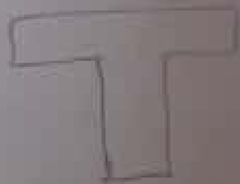
Scanned by CamScanner

Check for Shear

Q. Determine the mom. of resistance of a T-beam with following data

$b_f = 740$ mm, $d = 400$ mm, $b_w = 240$ mm,

A_{st} 5, 20 mm ϕ Fe 250, $D_f = 100$ mm, M15 concrete is used.



Sol $D_f = 100$ mm

$$\frac{x_u}{d} = \frac{0.87 f_y A_{st}}{0.36 f_{ck} b_f \times d}$$

$$= \frac{0.87 \times 250 \times 5 \times \frac{\pi}{4} \times 20^2}{0.36 \times 15 \times 740 \times 400}$$

$$= 0.2137$$

$$x_u = 0.2137 \times 400$$

$$= 85.49 \simeq 85.5 \text{ mm}$$

$85.5 < 100$

$x_u < D_f$

N.A lies inside flange. It behaves as rectangular section.

$$\frac{x_{u.max}}{d} = 0.53$$

$$\frac{x_u}{d} < \frac{x_{u.max}}{d}$$

It is under reinforced secⁿ

From G.1.1.b of IS 456: 2000

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

$$= 0.87 \times 250 \times 5 \times 20^2 \times \frac{\pi}{4} \times 400 \left[1 - \frac{1570 \times 250}{740 \times 400 \times 15}\right]$$

$$= 1245 \text{ KNm}$$