MODULE 3

# TWO WAY SLAB

depth can be reduced

Q) Design a RC slab for a room measuring 4m x 5m from inside. the slab carries a live load of 2000 N/m² & it is finished with 20mm thick topping of self wt 24 kN/m³ Use $M_{20}$ Concrete & Fe 415 steel. The slab is simply supported @ all edges with corners free to lift.

Given:

$L = 5m$

$l = 4m$

F.L = 200mm thick with 24 kN/m³

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

$f_y = 415 N/mm^2$

L.L = 2000 N/m² kN/m

multiply with breadth ||ly in beam

LL = 2000 x 1 x N/m

= 2 kN/m

Step 1: Check for 2 way slab

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

∴ It is 2 way slab

Step 2: Computation of slab dimension

$\frac{l}{d} = 20 \times M.F$

Assume percentage tension reinforcement = 0.35

Modification factor = 1.4 from fig 4

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

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

$d = 142.85$

Assume a clear cover of 20 mm / Better or take 30mm

$\phi$ of bars = 10mm

$D = d + c + \phi/2$

$= 142.85 + 20 + 5$

$= 167.85$

$\approx 170 mm$

$d = 170 - 20 - 5$

$d = 145 mm$

Assume width of slab b = 1m

c/c → support ~~to~~ length not given
& take only
$l + d$.

effective span in one direction = 4 + 0.145

= 4.145 m

effective span in other dr$^n$

= 5 + 0.145

= 5.145 m

Step 3 : Computation of bending moment & Load.

L.L = 2 KN/m

D.L = c/s Area × unit wt

= D× b× unit wt

= 0.17 × 25

= 4.25 KN/m

F.L = 0.02 × 1 × 24

= 0.48

T.L = 6.73 KN/m

Moment = ?

Pg: 90 Annex D

cl. D-1.1

$l_x$ = 4.145 m (Smallest)

$l_y$ = 5.145 m

$M_x = \alpha_x w l_x^2$

$M_y = \alpha_y w l_x^2$

for $\alpha_x$ & $\alpha_y$.

Table 27

$$\frac{l_y}{l_x} = \frac{5.145}{4.145} = 1.24 \approx 1.25$$

interpolate

$$\alpha_x = \frac{0.084 + 0.093}{2}$$

$= 0.0885$

$$\alpha_y = \frac{0.059 + 0.055}{2}$$

$= 0.057$

$M_x = \alpha_x w l_x^2$

$= 0.0885 \times 6.73 \times 4.145^2$

= 10.233 KNm

$M_{ux}$ = 15.345 KNm

$M_y = \alpha_y w l_x^2$

$= 0.057 \times 6.73 \times 4.1452^2$

= 6.59 KNm

$M_{uy}$ = 9.885 KNm

Step 4 : Effective depth required =

should be less than 140

$$M_u = 0.36 \frac{x_{umax}}{d}\left(1 - 0.42 \frac{x_{umax}}{d}\right) bd^2 f_{ck}$$

$15.349 \times 10^6 = 0.36 \times 0.48 (1 - 0.42 \times 0.48) \times 1000 \times d^2 \times 20$

d = 74.5 mm

$d_{provided} > d_{required}$

$145 > 74.5$

Hence Safe

$$d = 145 - \frac{10}{2} - \frac{10}{2} = 135 \text{ mm}$$

Step 5: Computation of steel

(i) Shorter Direction (main bar)

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

$$15.349 \times 10^6 = 0.87 \times 415 \times A_{st} \times 145 \left[1 - \frac{A_{st}\ 415}{1000 \times 145 \times 20}\right]$$

$A_{st} = \cancel{293.48}\ 306.63 \text{ mm}^2$

$$\text{Spacing} = \frac{1000 \times \text{Area of 1 bar}}{A_{st}}$$

$$= \frac{1000 \times \pi/4 \times 10^2}{306.63}$$

$= 256.13 \text{ mm} \approx 250 \text{ mm}$

Provide 10mm $\phi$ bar @ 250mm Shorter direction.

$A_{st\,min} = 0.12\%\ bD$

$$= \frac{0.12}{100} \times 1000 \times 170$$

$= 204 \text{ mm}^2.$

(ii) Longer direction (main bar)

Both direction $\Rightarrow$ Main bar.

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

$$9.885 \times 10^6 = 0.87 \times 415 \times A_{st} \times 135 \left(1 - \frac{A_{st} \times 415}{1000 \times 135 \times 20}\right)$$

$A_{st} = 209.5 \text{ mm}^2$

$$\text{Spacing} = 1000 \times \pi/4 \times 10^2 / 209.5$$

$= 374 \approx 300 \text{ mm}$

Provide 10mm $\phi$ bar 300 c/c (Check of spa longer)

Step 6: Check for Shear

Cl. 40.1

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

$$V_u = \frac{w l_x}{2} \times 1.5$$

$$= \frac{6.73 \times 4.145}{2}$$

$= 13.947 \times 1.5$

$= 20.9205$

$$\tau_v = \frac{20.92 \times 10^3}{1000 \times 145}$$

$= 0.144 \text{ N/mm}^2$

$\tau_c = \frac{\quad}{bd}$

$A_s = \frac{1000 \times \text{Area of 1 bar}}{\text{Spacing}}$

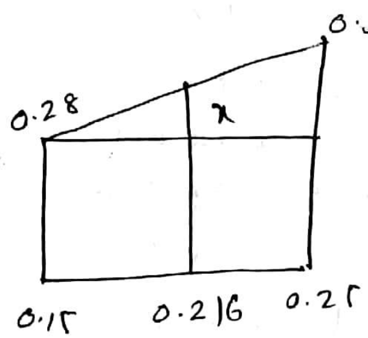
Spacing of shorter dirⁿ

$= \frac{1000 \times \pi/4 \times 10^2}{250}$

$= 314.159 \text{ mm}^2$

$\frac{100 A_s}{bd} = \frac{100 \times 314.159}{1000 \times 145}$

$= 0.216$




$\frac{0.25 - 0.15}{\cancel{0.36 - 0.28}\; 0.216 - 0.15} = \frac{0.36 - 0.28}{x}$

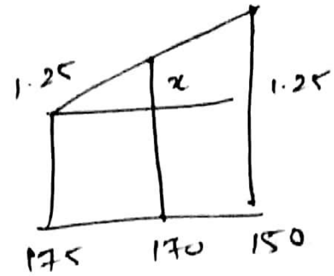
$x = 0.0528$

$\tau_c = 0.28 + 0.0528$

$\tau_c = 0.3328$

From cl. 40.2.1.1 of

D = 170




$\frac{175 - 150}{175 - 170} = \frac{1.3 - 1.25}{x}$

$x = 0.01$

$k = 1.26$

$k\tau_c = 0.4193$

$\tau_v < k\tau_c$

Slab is safe in shear.

Step 7 : Check for development length.

[cl. 26.2]

$L_d = \frac{\phi \sigma_s}{4 \tau_{bd}}$

$= \frac{10 \times 0.87 \times 415}{4 \times 1.2}$

$= 752.187 \text{ mm}$

Q: Design a RCC roofing slab over a room 4m x 5m the slab is simply supported on all 4 edges with corners held down. the super imposed load is 2kN/m² and floor finish is