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Group 9

M20

Fe415

For S8 :

step 1: length of slab = 15 ft = 4.575 m

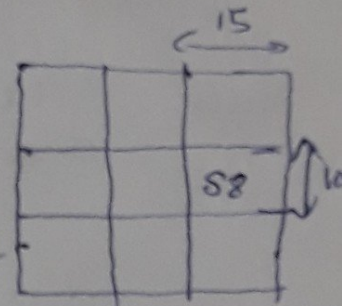
height of slab = 10 ft = 3.05 m.

outer wall thickness = 10 inch = 0.254 m

inner wall thickness = 5 inch = 0.127 m

$L_y = 4.575\ m - \frac{0.252}{2} \times 2 = 4.321\ m$

$L_x = 3.05\ m - \frac{0.254}{2} - \frac{0.127}{2} = 2.86\ m$



$\frac{L_y}{L_x} > 2$ one way

≤ 2 two way

$\frac{L_y}{L_x} = \frac{4.321}{2.86} = 1.51 < 2$ (Two way slab)

Step 2: For high strength deformed bars.

continuous slab $= 40 \times 0.8 = 32$

Now, $\frac{L_x}{D_x} \ngtr 32$

$\Rightarrow \frac{2.86}{D_x} \ngtr 32 \Rightarrow D_x \nless 0.089\ m$

$\frac{L_y}{D_y} < 32$

$\Rightarrow \frac{4.321}{D_y} < 32 \Rightarrow D_y > 0.135\ m$

Taking the larger one :-

$D_y > 0.135$ m

$D_y = 140$ mm

Taking $\phi_x = \phi_y = 10$ mm

clear cover = 15 mm

Thus, $d_x = D - CC - \phi/2$

$d_x = 140 - 15 - \frac{10}{2} = 120$ mm

~~$d_y = 140 - [15 +$~~

$d_y = D - \left[15 + \phi_x + \frac{\phi_y}{2}\right]$

$= 140 - \left[15 + 10 + \frac{10}{2}\right]$

$= 110$ mm

Step 3 :- Load Calculation

Unit weight of concrete = 25 kN/m³

Self wt. of the slab = $25 \times 1 \times 1 \times \frac{140}{1000}$

$= 3.5$ kN/m²

Total Dead load = Self wt. + Superimposed DL

$= 3.5 + 3.5 = 7$ kN/m²

$W_{LL} = 2.75$ kN/m²

$W = W_{DL} + W_{LL} = 7 + 2.75 = 9.75$ kN/m²

Total factored load = $1.5 \times W = 1.5 \times 9.75$

$= 14.625$ kN/m²

P 4 : BM & SF calculation.

Short edge continuous.

$\frac{l_y}{l_x} = \frac{\cancel{110}}{\cancel{120}} = \cancel{0.98} = \frac{4.321}{2.86} = 1.5$

Short edge coefficients.

For negative moment at continuous edge

$\alpha_x = \cancel{0.030}\ 0.057$

~~For positive moment at mid span = 0.028~~

$\alpha_y = 0.037$

$M_x = \alpha_x w l_x^2 = 0.057 \times 14.625 \times \left(2.86\right)^2$

$\cancel{= 7.7922 \times 10^{-3}\ KNm}$

$= 6.8187\ KNm$

$M_y = \alpha_y w l_y^2 = 0.037 \times 14.625 \times \left(4.321\right)^2$

$\cancel{= 6.5476 \times 10^{-3}\ KNm}$

$= 10.1034\ KNm$

For positive moment at mid span.

$\alpha_x = \cancel{0.028}\ 0.044$, $\alpha_y = 0.028$

$M_x = \alpha_x w l_x^2 = \cancel{0.028}\ 0.044 \times 14.625 \times \left(2.86\right)^2$

$\cancel{= 5.8969 \times 10^{-3}\ KNm}$

$= 5.2636\ KNm$

$M_y = \alpha_y w l_y^2 = 0.028 \times 14.625 \times (4.321)^2$

$\cancel{= 4.9550 \times 10^{-3}\ KNm}$

$= 7.6458\ KNm$

Taking the larger of above:

$M_x = \cancel{7.7922 \times 10^{-3}\ kNm}\ 6.8187$

$M_y = \cancel{6.5478 \times 10^{-3}}\ kNm\ 10.1034$

Shear force $= \dfrac{wl}{2}$

<u>Step 5</u>: Reinforcement Calculation:

$$P_t = \frac{A_{st}}{bd}$$

For x-dir,

$$P_t^2 - \frac{f_{ck}}{f_y} P_t + \frac{M_u f_{ck}}{0.87 f_y^2 bd^2} = 0$$

$$\Rightarrow P_t^2 - \frac{20}{415} P_t + \frac{6.8187 \times 10^6 \times 20}{0.87 \times (415)^2 \times 1000 \times (120)^2}$$

$$P_t = 0.0466,\ 0.00135 = 0$$

For y-dir, $$P_t^2 - \frac{20}{415} P_t + \frac{10.1034 \times 10^6 \times 20}{0.87 \times (415)^2 \times 1000 \times (110)^2}$$

$$\Rightarrow P_t = 0.04556,\ 0.002486$$

~~P4 BM & SF calculation.~~
~~One short edge continuous.~~

$$\cancel{\frac{l_y}{l_x} = \frac{4.321}{2.86} = 1.5}$$

~~Now, for x-dir.~~

$$\cancel{\frac{A_{st}}{bd} = 0.0466}$$

$$\cancel{\Rightarrow A_{st} = 0.00135 \times 1000 \times 120}$$

$$\cancel{= 162}$$

$$\cancel{\Rightarrow A_{st} = 0.0466 \times 1000 \times 120}$$

$$\cancel{= 5592 \text{ mm}^2}$$

Now,

For x-dir

$$\frac{A_{st}}{bd} = 0.00135$$

$$\Rightarrow A_{st} = 0.00135 \times 1000 \times 120$$

$$= 162 \text{ mm}^2$$

For y-dir

$$\frac{A_{st}}{bd} = 0.002436$$

$$\Rightarrow A_{st} = 0.002436 \times 1000 \times 110$$

$$= \cancel{292.32 \text{ mm}^2}$$

$$= 267.96 \text{ mm}^2$$

For x-dir, no. of bars,

$$n \times \pi \times \frac{d^2}{4} = 162$$

$$\Rightarrow n \times 3.14 \times \frac{10^2}{4} = 162$$

$$\Rightarrow n \simeq 2$$

For y- dir, no. of bars

$n \times \pi \times \left(\frac{d^2}{4}\right) = 267.96$

$\Rightarrow n \times 3.14 \times \left(\frac{100}{4}\right) = 267.96$

$\Rightarrow n \simeq 3$

For spacing :- $1000 \frac{A_\phi}{A_{st}}$

For x- direction, i) Spacing $= \frac{1000 \times \pi \times \frac{10^2}{4}}{162}$

$= 484.57$ mm.

ii) $3d = 3 \times 120 = 360$ mm

~~For y- direction spacing~~ $= \cancel{\frac{100 \times \pi \times \frac{10^2}{4}}{267.96}}$

$= \cancel{292.95}$ mm.

iii) 300 mm.

Hence spacing = 300 mm.

For y- direction, i) Spacing $= \frac{1000 \times \pi \times \frac{10^2}{4}}{267.96}$

$= 292.95$ mm

ii) $3d = 3 \times 110 = 330$ mm

iii) 300 mm.

Hence spacing = 300 mm

Step 6 :- Depth checking for bending.

$M_u = 0.138 f_{ck} bd^2$

check for de

$$\frac{P_{t,x}}{100} = \frac{(A_{st})_{pro}}{bd_x} = \frac{180}{1000 \times 120}$$

$$\Rightarrow P_{t,x} = 0.15$$

$$f_s = 0.58 f_y \frac{(A_{st})_{req}}{(A_{st})_{prov.}}$$

$$= 0.58 \times 415 \times \frac{162}{180}$$

$$= 216.63$$

Modification factor (K) = 1.9

Cl. 23.2.1,

$$\left(\frac{l}{d}\right)_{max} < K \times 26$$

$$\Rightarrow \frac{2860}{120} < 1.9 \times 26$$

$$\Rightarrow 23.86 < 49.4 \quad \text{OK}.$$

Check for shear :-

clause 40.1

Normal shear stress $\tau_v = \frac{V_u}{bd}$

$$d = \frac{d_x + d_y}{2} = \frac{120 + 110}{2} = 115 \text{ mm}$$

$$V_u = \frac{W_u l_x}{2} = \frac{14.625 \times 0.86}{2} = 20.91 \text{ kN/m}$$

$$\tau_v = \frac{20.91 \times 10^3}{1000 \times 115} = 0.18 \text{ MPa}$$

For $P_{tx} = \cancel{0.0135}\ 0.15$

$\tau_c = 0.28$

$K\tau_c > \tau_v$

$\Rightarrow 2 \times 0.28 > 0.18$

$\Rightarrow 0.56 > 0.18$ OK.

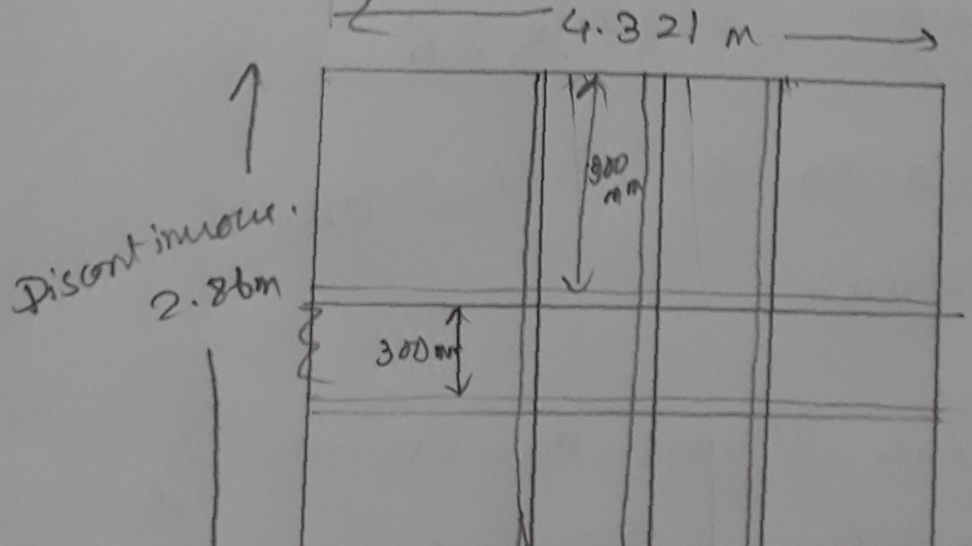
Check for development length : Cl. 26.2.1.

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

$\tau_{bd}(M20) = 1.2 \text{ N/mm}^2$

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

$= 752.18$ mm



$$S = \frac{1000 A_\phi}{(A_{st})_T}$$

$$= \frac{1000 \times \pi \times \left(\frac{10}{2}\right)^2}{135.}$$

$= 581.48$ mm

For torsion $A_{st} = \frac{3}{4} A_{st} = \frac{3}{4} \times 180 = 135$ mm