DESIGN OF TWO WAY SLAB

Design a two way slab for a room of size 4M x 5M with discontinuous and simply supported edges on all the sides with corners prevented from lifting to support a live load of $4 KN/m^2$. Adopt M20 grade concrete and Fe 415 HYSD bars.

GIVEN:

$L_x = 4M$, $L_y = 5M$, $f_{ck} = 20 N/mm^2$, $f_y = 415 N/mm^2$

$$\frac{L_y}{L_x} = \frac{5}{4} = 1.25 < 2 \Rightarrow \text{Two way slab.}$$

DEPTH OF THE SLAB:

Span is more than 3.5M.

$$\frac{\text{Span}}{\text{Depth}} = 25 \Rightarrow \text{Depth} = \frac{\text{Span}}{25}$$

$$\text{Depth} = \frac{4000}{25} = 160 MM$$

Effective depth, $d = 145 mm$

Overall depth, $D = 170 mm$.

EFFECTIVE SPAN:

Effective span = Clear span + effective depth

$= 4 + 0.145 = 4.145 m$.

LOADS:

Self-weight of the slab $= 0.17 \times 25 = 4.25 KN/m^2$

Live load $= 4 KN/m^2$

Floor finish $= 0.60 KN/m^2$.

Total load $= 8.85 KN/m^2$

Design ultimate load $= 1.5 \times 8.85 = 13.275 KN/m^2$

ULTIMATE DESIGN MOMENTS & SHEAR FORCE :

Pg.no - 90, 91. Table 26.

$\frac{l_y}{l_x} = 1.25 \Rightarrow$ Three edges discontinuous,

$\alpha_x = 0.076$, $\alpha_y = 0.057$.

$M_x = \alpha_x w L^2 = 0.076 \times 13.275 \times 4.145 = 17.37 \text{ kNm}$

$M_y = \alpha_y w L^2 = 0.057 \times 13.275 \times 4.145 = 12.80 \text{ kNm}$

$V_u = \frac{wL}{2} = 13.275 \times 4.145 / 2 = 27.6 \text{ kN}.$

CHECK FOR DEPTH :

$$M_{max} = 0.138 f_{ck} b d^2$$

$$d = \sqrt{\frac{M_{max}}{0.138 f_{ck} b d}} = \sqrt{\frac{17.37 \times 10^6}{0.138 \times 20 \times 10^3}}$$

$= 79.33 \text{ mm} < 145 \text{ mm}.$

∴ The effective depth selected is sufficient to resist the design ultimate moment.

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

$= 0.0012 \times 1000 \times 170 = 204 \text{mm}^2$

REINFORCEMENTS [SHORT AND LONG SPAN] :

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

$$17.37 \times 10^6 = 0.87 A_{st} \times 415 \times 145 \left[1 - \frac{A_{st} \times 415}{1000 \times 145 \times 20}\right]$$

$A_{st} = 302 \text{mm}^2$

Adopt 10mm dia bars @ 255 mm c/c in short span.

Using 10mm dia bars in long span.

Effective depth = 145 − 10 = 135mm.

$$12.8\times10^6 = 0.87\times415\,A_{st}\times135\left[1-\frac{415\,A_{st}}{10^3\times135\times20}\right]$$

$$A_{st} = 237\,mm^2.$$

Provide 10mm dia bars @ 300 mm c/c in long span.

CHECK FOR SHEAR STRESS:

$$\tau_v = \frac{V_u}{bd} = \frac{27.6\times10^3}{1000\times145} = 0.18$$

$$P_t = \frac{100\,A_{st}}{bd} = \frac{100\times\pi/4\times10^2}{1000\times145} = 0.20$$

Pg. no - 73 , interpolate.

$$\tau_c = 0.32$$

$$k\,\tau_c = 1.26\times0.32 = 0.40\ N/mm^2 > \tau_v$$

Hence, the slab is safe against the shear force.

CHECK FOR DEFLECTION:

$$(l/d)_{provi} = \frac{4150}{145} = 28.6$$

$k_t = 1.7$

$$(l/d)_{max} = 20\times1.7$$

$$= 34$$

$$(l/d)_{provided} < (l/d)_{max}.$$

Hence, the deflection control is satisfied

CHECK FOR CRACKING:

1) Steel provided is more than the minimum percentage of 0.12 %

2) Spacing of main steel $< 3d < (3 \times 145) = 435$ mm

3) Diameter of reinforcement $< D/8 = 175/8 = 21.8$ mm.

TORSION REINFORCEMENT AT CORNERS:

Area of reinforcement in each of the four layers $= 0.75 \times 302 = 226.5\ mm^2$

Distance over which torsion reinforcement is provided $= 1/5$ short span

$= 1/5 \times 4000 = 800$ mm.

Provide 6mm diameter bars @ 100mm centres for a length of 800mm at all four corners in 4 layers.

REINFORCEMENT IN EDGE STRIPS:

$A_{st} = 0.12\ \% \cdot bd$

$= 0.0012 \times 10^3 \times 170$

$= 204\ mm^2/m$

Provide 10mm diameter bars at 300mm centres ($A_{st} = 262\ mm^2$) in all edge strips.

(Diagram as image)

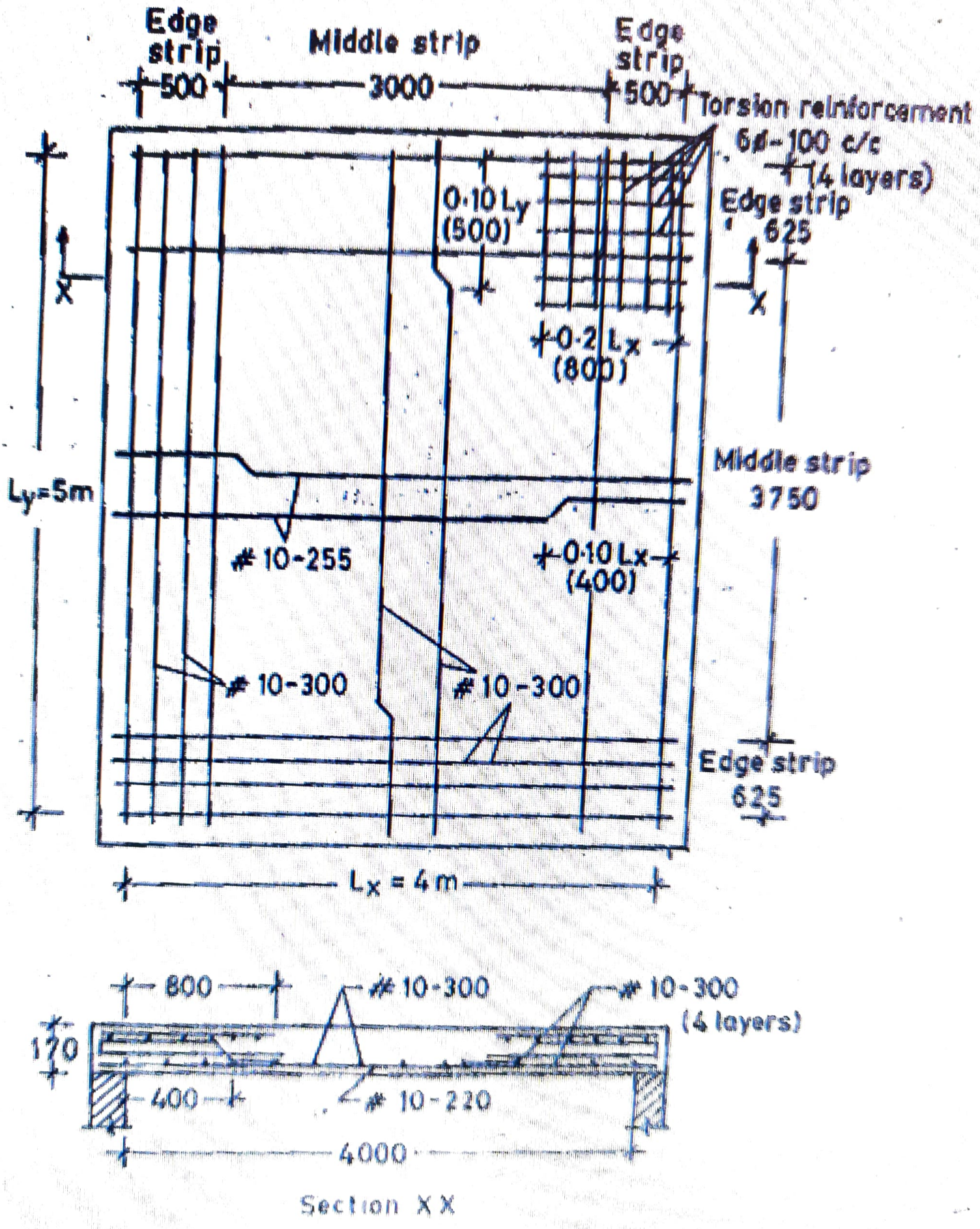

Fig. 9.5 Reinforcement Details in Two Way Slabs
(with provision for torsion at corners)