ONE WAY SLAB DESIGN

Design a simply supported one–way slab over a clear span of 3.5 m. It carries a live load of 4kN/m^2 and floor finish of 1.5kN/m^2. The width of supporting wall is 230 mm. Adopt M-20 concrete & Fe-415 steel.

Step: 1 Depth of slab

Assume approximate depth d = L/26

3500/26 = 134 mm

Assume overall depth D = 160 mm

& clear cover 15mm for mild exposured = 160 – 25 = 140mm

Effective span is lesser of the two

i. l = 3.5 + 0.23 (width of support) = 3.73 m

ii. l = 3.5 + 0.14 (effective depth) = 3.64 m

Effective span = 3.64 m

Step: 2 Load on slab

Self-weight of slab = 0.16 x 25 = 4.00

Live load = 4.00

Floor finish = 1.50

Total Load W = 9.5 kN/m^2

Ultimate load Wu = 9.5 x 1.5 = 14.25 kN/m^2

Step 3: Design bending moment and check for depth

$$M_u = \frac{W_u\, l^2}{8}$$

$$= \frac{14.25 \text{ x } 3.64^2}{8}$$

$$M_u = 23.60 \text{ kN/m}$$

Minimum depth required from BM consideration

$$d = \sqrt{\frac{M_u}{0.138\, f_{ck} b}}$$

$$= \sqrt{\frac{23.60 \times 10^6}{0.138 \times 20 \times 1000}}$$

$$d = 92.4 > 140 \quad \text{(OK)}$$

Step: 4 Area of Reinforcement

Area of steel is obtained using the following equation

$$M_u = 0.87 f_y \, Ast \, d \left(1 - \frac{f_y Ast}{f_{ck} bd}\right)$$

$$23.60 \times 10^6 = 0.87 \times 415 \times Ast \times 140 \left(1 - \frac{415\ Ast}{20 \times 1000 \times 140}\right)$$

$$23.60 \times 10^6 = 50547\ Ast - 7.49\ Ast^2$$

$$\text{Solving } Ast = 504\ mm^2$$

OR

$$Ast = \frac{0.5 f_{ck}}{f_y}\left[1 - \sqrt{1 - \frac{4.6\, M_u}{f_{ck}\ bd^2}}\right] bd$$

$$Ast = \frac{0.5 \times 20}{415}\left[1 - \sqrt{1 - \frac{4.6 \times 23.60 \times 10^6}{20 \times 1000 \times 140^2}}\right] 1000 \times 140$$

$$= 505\ mm^2$$

$$\text{Spacing of 10mm } S_v = \frac{ast}{Ast} \times 1000$$

$$S_v = \frac{78}{505} \times 1000 = 154mm$$

Provide 10mm @ 150C/C.

Distribution steel@ 0.12% of the Gross area

$$\frac{0.12}{100} \times 1000 \times 160 = 192\ mm^2$$

$$\text{Spacing of 10mm } S_v = \frac{50}{192} \times 1000 = 260\ mm$$

Provide 8mm @ 260mm

Step: 5 Check for shear

$$\text{Design shear } V_u = \frac{W_u\, l}{2}$$

$$= \frac{14.25 \times 3.64}{2}$$

$$= 25.93\ kN$$

$$\tau_v = \frac{25.93 \times 10^3}{1000 \times 140}$$

$$= 0.18 \text{ N/mm}^2 \qquad (<\tau_{c\,max} = 28 \text{ N/mm}^2)$$

Shear resisted by concrete $\boldsymbol{\tau_c}$ = 0.42 for $\mathbf{p_t}$ = 0.37 (Table 19, IS 456-2000)

$$\boldsymbol{\tau_c} > \boldsymbol{\tau_v}$$

Step: 6 Check for Deflection

$$\left(\frac{l}{d}\right)_{Actual} < \left(\frac{l}{d}\right)_{Allowable}$$

$$\left(\frac{l}{d}\right)_{Allowable} = \left(\frac{l}{d}\right)_{Basic} \text{ x } k_1 \text{ x } k_2 \text{ x } k_3 \text{ x } k_4$$

k_1 - Modification factor for tension steel

k_2 - Modification factor for compression steel

k_3 - Modification factor for T-sections

if span exceeds 10 m (10/span)

$\mathbf{k_1}$ = 1.38 for $\mathbf{p_t}$ = 0.37 (Fig. 4, cl.32.2.1)

$$\left(\frac{l}{d}\right)_{Allowable} = 20 \text{ x } 1.38 = 27.6$$

$$\left(\frac{l}{d}\right)_{Actual} = 3630/140 = 25.92$$

$$\left(\frac{l}{d}\right)_{Actual} < \left(\frac{l}{d}\right)_{Allowable} \quad \text{(OK)}$$