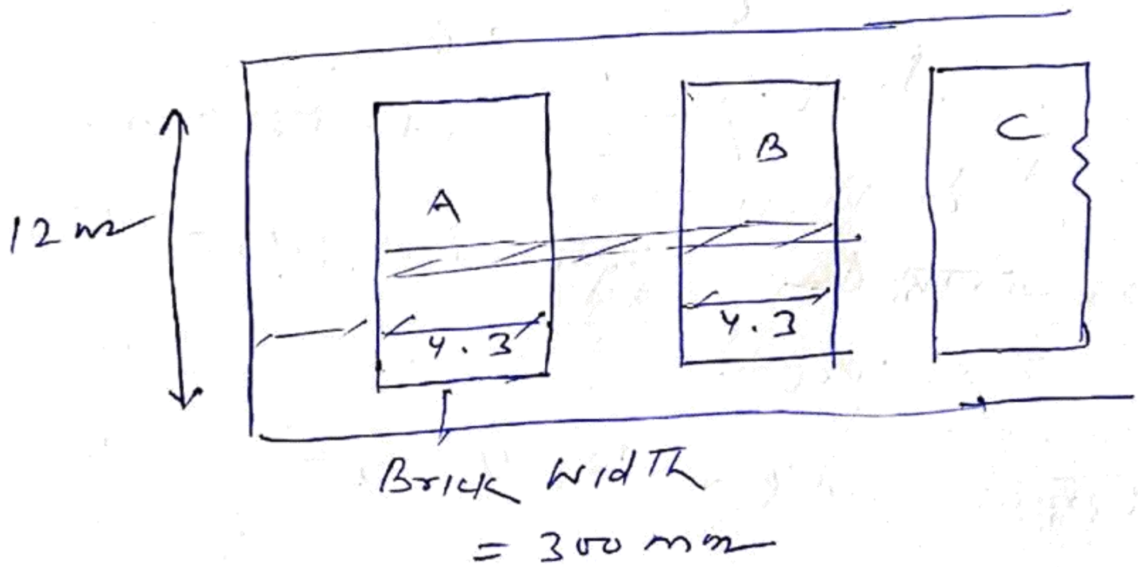
Department of Civil Engineering
Katihar Engineering College, Katihar

Subject : Design of Concrete Structure-I
Topic : Design of Slab
Lecture : 04
Course Instructor : Prof. Rashid Mustafa

Q-1. A Continuous slab is supported over 300 mm wide supports as shown in figure.



Live load = 8 kN/m²
Floor finishing = 60 mm thick flooring (Marble flooring)

Design slab A using M25 grade of concrete & Fe415 steel. Use LSM

Soln $\frac{L_y}{L_x} = \frac{12}{4.3} = 2.79 > 2$
(One way slab)

If $\frac{L_y}{L_x} > 2 \longrightarrow$ One way slab

Step 1. Load Calculation

Effective depth of slab required
(For deflection criteria)

For Continuous slab $\frac{L}{d} = 26$, $(L_x = 4.3)$

$$d = \frac{span}{26} = \frac{4300}{26}$$

$$d = 165.38 \text{ mm}$$

Provide, Effective depth $(d) = 170$ mm

Cover $= 30$ mm

Gross depth or Overall depth $= 170 + 30$
$= 200$ mm.

(i) Live load (LL) $= W_L \times 1 \times 1$
$= 8 \times 1 \times 1$
$= 8 \text{ kN/m}^2$

(ii) Floor finishing $= t_f \times 1 \times 1 \times 24$
$= 0.60 \times 1 \times 1 \times 24$
$= 1.44 \text{ kN/m}^2$

(iii) Self weight = $0.20 \times 1 \times 1 \times 25$

= $5\ kN/m^2$

Total load = $LL + W_f + W_s$

= $8 + 1.44 + 5$

= $14.44\ kN/m^2$

Design load (W_u) = 1.5×14.44

= $21.66\ kN/m^2$

(2) Effective span (L_{eff})

$W = 300\ mm$

$\frac{L_o}{12} = \frac{4300}{12} = 358.33$

$W < \frac{L_o}{12}$

$L_{eff} = \left.\begin{array}{l} L_c + d \\ L_c + W \end{array}\right\}$ whichever is less

$L_{eff} = \left.\begin{array}{l} 4.30 + 0.30 \\ 4.30 + 0.17 \end{array}\right\}$ whichever is less

$L_{eff} = 4.47\ m$

$L_{eff} = \left.\begin{matrix} L_y + W \\ L_y + d \end{matrix}\right\}$ Whichever is less

$L_y = 12.17$ m

Now $\frac{L_{eff\,y}}{L_{eff\,x}} = \frac{12.17}{4.47} = 2.92 > 2$

(one way slab)

(3) Max^m Bending moment.

$W_{du} = 1.5 \times 6.44 = 9.66$ kN/m

$W_{LU} = 1.5 \times 8 = 12$ kN/m

Max^m +ve B.M $= \frac{1}{12} W_{du} L_x^2 + \frac{1}{10} W_{LU} \times L_x^2$

$= \frac{1}{12} \times 9.66 \times 4.47^2 + \frac{1}{10} \times 12 \times 4.47^2$

$= 40.06$ kN-m

Max^m -ve BM $= -\left[\frac{1}{10} W_{du} L_x^2 + \frac{1}{9} W_{LU} \cdot L_x^2 \right]$

$= -\left[\frac{1}{10} \times 9.66 \times 4.47^2 + \frac{1}{9} \times 12 \times 4.47^2 \right]$

$= -45.94$ kN-m

Design for 45.94 kN-m

(4) Depth required (A/c to Limit state of Collapse)

$$d = \sqrt{\frac{B.M}{Q.B}}$$

$$= \sqrt{\frac{45.94 \times 10^6}{0.138 \times 25 \times 1000}}$$

$$= 115 \text{ mm} < d \text{ (Considered)}$$

Consider $d = 170$ mm (Max^m value)

$D = 200$ mm ok.

(5) Area of steel (Ast)

$$Ast = \frac{Mu}{0.87 fy (d - 0.42 x_{u\,lim})}$$

$$= \frac{45.94 \times 10^6}{0.87 \times 415 \times (170 - 0.42 \times 0.48 \times 170)}$$

$$= 813 \text{ mm}^2$$

Provide 10 mm bar

$$\text{No of bars} = \frac{813}{\frac{\pi}{4} \times 10^2}$$

$$\text{Spacing} = \frac{1000}{n}$$

Spacing of 12 mm ϕ

$$= \frac{1000}{Ast} \times \frac{\pi}{4} \times \phi^2$$

$$= \frac{1000}{813} \times \frac{\pi}{4} \times 12^2$$

$$= 139 \text{ mm}$$

Provide 12 mm ϕ @ 130 c/c

For Max^m +ve BM

$$Ast(+ve) = \frac{0.5 f_{ck}}{f_y} \times \left[1 - \sqrt{1 - \frac{4.6 \times M_U}{f_{ck} \times B \times d^2}}\right] \times 1000 \times 170$$

$$= \frac{0.5 \times 25}{415} \times \left[1 - \sqrt{1 - \frac{4.6 \times 40.06 \times 10^6}{25 \times 1000 \times 170^2}}\right] \times 1000 \times 170$$

$$= 700.98 \text{ mm}^2$$

Spacing of 10 mm dia

$$= \frac{1000}{700.98} \times \frac{\pi}{4} \times 10^2$$

$$= 112 \text{ mm}$$

Provide 10 mm ϕ @ 110 c/c.

Distribution of bar

$$= \frac{0.12}{100} \times 1000 \times 200$$

$$= 240 \text{ mm}^2$$

Spacing of 8 mm dia

$$= \frac{1000}{n} = \frac{1000}{\frac{240}{\frac{\pi}{4} \times 8^2}}$$

$$= 209 \text{ mm}$$

Provide 8 mm ϕ @ 200 c/c

(7) Maxm shear force.

$$V_u = 0.6\, W_{du} \times l_x + 0.6\, W_{LU} \times l_x$$

$$= 0.6 \times 9.66 \times 4.47 + 0.6 \times 12 \times 4.47$$

$$= 58.09 \text{ kN}$$

Nominal shear stress $= \frac{V_u}{B d} = \frac{58.09 \times 10^3}{1000 \times 170}$

$$= 0.34 \text{ N/mm}^2$$

% of steel (p_t) $= \frac{100 \times A_{st}(\text{true})}{B d}$

$$= \frac{100 \times 710.98}{1000 \times 170}$$

$$= 0.41\ \%$$

$\tau_c / M25$

p_t	τ_c
0.15	0.28
0.25	0.36
0.41	0.48
0.50	

$\tau_c = 0.39\ N/mm^2$

$\tau_{vu} < \tau_c$ safe.

Step 8. Check for bond.

$$\tau_{bd} = \frac{V_u}{\Sigma O . J . d}$$

$$= \frac{41.41 \times 1000}{\left(\frac{1000}{110}\right) \times \pi \times 10 \times 0.80 \times 170}$$

$$= 1.06\ N/mm^2$$

Shear force at support $(V_u) = (0.4 \times 9.66 + 0.45 \times 12) \times 4.47$

$= 41.41\ kN$

$\tau_{bd}(\text{Permissible}) = 1.4 \times 1.6 = 2.24\ N/mm^2$

$\tau_{bd} < \tau_{bd}\ (\text{Permissible})$ safe.

HAPPY LEARNING