DESIGN OF FLANGED BEAMS

A T-beam slab floor of Reinforced concrete has a slab 150mm thick spanning between the T-beams which are spaced 3m apart. The beams have a clear span of 10m and the end bearings are 450mm thick walls. The live load on the floor is 4 kN/m². Using M-20 grade concrete and Fe-415 HYSD bars. Design one of the intermediate T-beams.

1. DATA:

Clear span = 10m

Bearing thickness = 450mm

Working live load = 4 kN/m²

Spacing of T-beams = 3m

f_{ck} = 20 N/mm²

f_y = 415 N/mm²

D_f = 150mm.

2. CROSS-SECTIONAL DIMENSIONS:

Assuming Effective depth = $\frac{\text{Span}}{15} = \frac{10 \times 10^3}{15} = 666.67\text{mm}$

Adopt $d = 700\text{mm}$, $D = 750\text{mm}$, $b_w = 300\text{mm}$

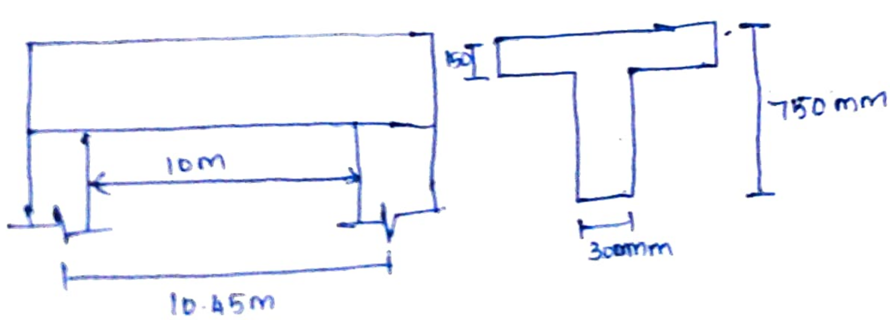
3. EFFECTIVE SPAN:

The least value of

i) Centre to centre of bearings = 10 + 0.45 = 10.45m

ii) Clear span + Effective depth = 10 + 0.7 = 10.70m.

∴ Effective span = L = 10.45m.



4. **LOADS :**

Self weight of slab = 0.15 x 3 x 25 = 11.25 kN/m.

Floor finish = 0.6 x 3 = 1.80 kN/m.

Self-weight of rib = 0.3 x 0.6 x 25 = 4.5 kN/m.

Plaster finishes = 0.45 kN/m

Total Dead load, g = 18 kN/m

Live load, q = 4 x 3 = 12.00 kN/m

⇒ Total load = 30 kN/m

Design Ultimate Load, W_u = 1.5 x 30 = 45 kN/m

5. **Ultimate Moments and Shear Forces :**

$$M_u = \frac{W_u L^2}{8} = \frac{45 \times 10.45^2}{8} = 614.26 \text{ kNm}$$

$$V_u = \frac{WL}{2} = \frac{45 \times 10.45}{2} = 235.125 \text{ kN}$$

6. **Effective width of Flange (b_f) :**

Pg.no = 37 ⇒ $b_f = \frac{l_0}{6} + b_w + 6D_f$

$$= \frac{10.45}{6} + 0.3 + (6 \times 0.15) = 2.94 \text{ m} < 3 \text{ m}$$

b_f = 2940 mm

7. **Moment Capacity of Flange Section :**

Pg. no. 96 (modified)

$$M_{uf} = 0.36 f_{ck} b_f D_f (d - 0.42 D_f)$$

$$= 0.36 \times 20 \times 2940 \times 150 [(700 - 0.42 \times 150)]$$

$$= 2022 \times 10^6 \text{ Nmm}$$

$$= 2022 \text{ kNm}.$$

7. Tension Reinforcements:

Pg.no-96 ⇒ $M_u = 0.87 f_y A_{st} d \left[1 - \frac{A_{st} f_y}{bd f_{ck}}\right]$

$614 \times 10^6 = 0.87 \times 415 \times A_{st} \times 700 \left[1 - \frac{A_{st} \times 415}{2940 \times 700 \times 20}\right]$

$614 \times 10^6 = 252735 A_{st} \left[1 - 1.008 \times 10^{-5} A_{st}\right]$

$2429.4 = A_{st} - 1.008 \times 10^{-5} A_{st}^2$

$1.008 \times 10^{-5} A_{st}^2 - A_{st} + 2429.4 = 0$ ⇒ $A_{st\,(req)} = 2492\, mm^2$

Provide 2 bars of 32mm diameter and 2 bars of 25mm diameter.

$A_{st\,(provided)} = 2 \times \pi/4 \times 32^2 + 2 \times \pi/4 \times 25^2 = 2590\, mm^2$

Ast required < Ast provided ∴ Hence, safe.

8. Shear Reinforcements:

P.g.no-72 ⇒ $\tau_v = \frac{V_u}{bd} = \frac{235 \times 10^3}{300 \times 700} = 1.19\, N/mm^2$

$P_t = \frac{100 A_{st}}{bd} = \frac{100 \times 2590}{300 \times 700} = 1.23$

pg.no-73 ⇒ $\tau_c = 0.67\, N/mm^2$

$\tau_v > \tau_c$ ⇒ shear reinforcements are required.

Balance shear, $V_{us} = [V_u - \tau_c bd]$ ⇒ Pg.no-73

$= 235 \times 10^3 - (0.67 \times 300 \times 700)$

$= 94300\, N = 94.3\, kN.$

Using 8mm dia 2 legged stirrups, spacing is

pg.no 73 ⇒ $S_v = \frac{0.87 \times A_{sv} f_y d}{V_{us}} = \frac{0.87 \times 415 \times 700 \times 2 \times \pi/4 \times 8^2}{94.3 \times 10^3}$

$= 269.4\, mm.$

$S_v \not> 0.75d$

$S_v \not> 300\, mm.$

Provide 250mm spacing and gradually increase to 300mm towards the centre.

9. CHECK FOR DEFLECTION CONTROL :

$$(L/d)_{max} = (L/d)_{basic} \times K_t \times K_c \times K_f$$

Pg.no-38 $\Rightarrow$ $P_t = \frac{100 A_{st}}{bd} = \frac{100 \times 2590}{2940 \times 700} = 0.126.$

$$b_w/b_f = \frac{300}{2940} = 0.102.$$

$K_t = 2.0$, $K_c = 1.0$, $K_f = 0.8$.

$$(L/d)_{max} = 20 \times 2 \times 1 \times 0.8 = 32$$

$$(L/d)_{provided} = \frac{10450}{700} = 14.92 < 32$$

$\therefore$ Hence, check for Deflection control is satisfactory

10. Details of Reinforcement ;