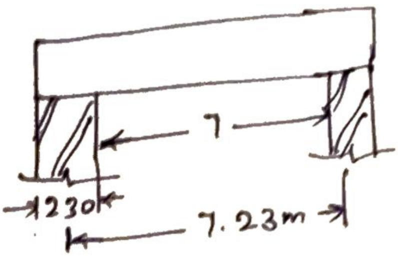
(1)

(1) Design a simply supported at its ends & carry a live load of 25 kN/m over a span of 7m

(1) **Dimensions:**

$\left(\frac{l}{d} \neq 10 \text{ to } 12 \right)$

Take $\frac{l}{d} = 12$



$\frac{7000}{d} = 12$

$d = 583$ say 600mm

Take $b = 300mm$

Assume cover $d' = 50mm$

∴ overall depth $D = 600 + 50$

$= 650mm$

$d = 600mm$, $b = 300mm$, $D = 650mm$

(2) Loads

$D.L = 25 \times b \times D$

$= 25 \times 0.3 \times 0.65$

$= 4.875$ kN/m.

$L.L = 25$ kN/m

$T.L = 29.875$ kN/m

∴ Factored load W_u = 44.81 kN/m.

(3) ~~ultimate B.M & S.F~~

~~$M_u =$~~ A.

(3) Eff. Span

least value of

(i) L_{eff} = clear span + eff. depth

$= 7000 + 600 = 7600mm$

ii) L_{eff} = clear span + width of support

$= 7000 + 230 = 7230mm$.

$\therefore$ Leff = 7.23 mm.

④ Ultimate moment & Shear force:

$$M_u = \frac{W_u \cdot L_{eff}^2}{8} = \frac{44.81 \times 7.23^2}{8}$$

$$= 292.79 \text{ kN.m}$$

$$V_u = \frac{W_u \cdot L_{eff}}{2} = \frac{44.81 \times 7.23}{2}$$

$$= 161.98 \text{ kN}.$$

⑤ Tension Reinforcement

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

$$= 0.138 \times 20 \times 230 \times 600^2$$

$$= 228.53 \times 10^6 \text{ N.mm}.$$

$$= 228.53 \text{ kN.m}.$$

$M_u > M_{ulim}$ — Section shall be designed as doubly reinforced section.

⑥ Check for bending

$$d = \sqrt{\frac{292.79 \times 10^6}{0.138 \times 20 \times 300 \times \cancel{1000}}}$$

$d = 594$ mm

$d < d_{provided}$.

Hence safe.

Tension
ii

Tension Reinforcement: (Ref : 96) ②

(i) Mu - Mulim = 292.79 - 228.53

= 64.21 KN.M

(ii) $f_{sc} = \frac{0.0035(x_{u\,max} - d')}{x_{u\,max}} \times E_s$

$\frac{x_{u\,max}}{d} = 0.48$

$x_{u\,max} = 0.48 \times 600 = 288\,mm$

$E_s = 2 \times 10^5\,N/mm^2$

$= \frac{0.0035(288 - 50)}{288} \times (2 \times 10^5)$

$f_{sc} = 578\,N/mm^2$

iii) Ast = Ast1 + Ast2

ⓐ To calculate Ast1 use formula G.1.1. ⓐ - P.No 96

$\frac{x_{u\,max}}{d} = \frac{0.87\,f_y\,(A_{st1})}{0.36\,f_{ck}\,b\,d}$

$0.48 = \frac{0.87 \times 415 \times (A_{st1})}{0.36 \times 20 \times 230 \times 600}$

$A_{st1} = 1321\,mm^2$

ⓑ To calculate A_{st2} use formula G.1.2.

$A_{st2} = A_{sc}\,f_{sc} / 0.87\,f_y$

but $M_u - M_{ulim} = f_{sc}\,A_{sc}\,(d - d')$

$64.21 \times 10^6 = 578 \times A_{sc}\,(600 - 50)$

$A_{sc} = 201.98\,mm^2$

Provide 2 Nos of 12mm φ rod $\} \Rightarrow 226\,mm^2$

$A_{st2} = \frac{A_{sc}\,f_{sc}}{0.87\,f_y} = \frac{201.98 \times 578}{0.87 \times 415}$

$A_{st2} = 323.35\,mm^2$

$A_{st} = A_{st1} + A_{st2}$

$= 1321 + 323$

$= 1644 \, mm^2$

$A_{st\,req} =$

Adopt 4 Nos of 25mm ϕ rods as a tension reinforcement $\} = 1963 mm$

(8) Step 8

Check for Shear

$\tau_v = \frac{V_u}{bd}$

$= \frac{161.98 \times 10^3}{300 \times 600}$

$= 0.89 \, N/mm^2$

$P_t = \frac{100 A_{st}}{bd} = \frac{100 \times 1963}{300 \times 600} = 0.11.$

$\tau_c = 0.28 \, N/mm^2$

$\tau_v > \tau_c$, Hence provide shear reinforcement.

$V_{us} = V_u - \tau_c bd$

$= (161.98 \times 10^3) - (0.28 \times 300 \times 600)$

$= 111.58 \times 10^3 \, N.$

$V_{us} = \frac{0.87 \, f_y \, A_{sv} \cdot d}{S_v}$

Assume 8mm 2 legged stirrups

$A_{sv} = 2 \times \frac{\pi}{4} \times 8^2 = 100.5 \, mm^2$

$S_v = \frac{0.87 \times 415 \times 100.5 \times 600}{111.58 \times 10^3}$

$= 195 mm. \approx 190 mm$

Sv ... provide

(9) Check

$S_v \not> 0.75d = 0.75 \times 600 = 450mm$

Provide 8mm 2 legged stirrups @ 190mm c/c.

3mm

9 Check for deflection:

$$\left(\frac{l}{d}\right)_{max} = \left(\frac{l}{d}\right)_{basic} \times K_t \times K_c \times K_f$$

$K_t = 1.6$ (Fig. 4 DNO 38)

$$P_c = \frac{100 A_{sc}}{bd} = \frac{100 \times 201}{300 \times 600} = 0.112$$

(Fig 5 - D.NO. 39)

$\therefore K_c = 1.05$

$K_f = 1$

$$\therefore \left(\frac{l}{d}\right)_{max} = 12 \times 1.6 \times 1.05 \times 1$$

$$= 20.16.$$

$$\left(\frac{l}{d}\right)_{act} = \frac{l_{eff}}{d_{eff}} = \frac{7230}{600} = 12.05$$

$$\left(\frac{l}{d}\right)_{act} < \left(\frac{l}{d}\right)_{max}$$

Hence safe.

10 Check for torsion

$$l_d \leq \frac{M_1}{V} + L_o.$$

$$L_d = \frac{0.87 f_y \phi}{4 \tau_{bd}}$$

$$= \frac{0.87 \times 415 \times 25}{4 \times 1.2 \times 1.6}$$

$$= 1175mm$$

$$M_1 = 0.87 f_y A_{st} (d - 0.42 x_{u max})$$

$$= 0.87 \times 415 \times 1963 (600 - 0.42 \times 288)$$

$$= 339.52 \times 10^6 \text{ kN.m}.$$

$l_0 \rightarrow$ greater of $= 12\phi$ (or) d

$= 12 \times 25$ (or) 600

$= 300$ or 600

$\therefore l_0 = 600$ mm

$$\frac{M_1}{V} + l_0 = \frac{339.52 \times 10^6}{161.98 \times 10^3} + 600$$

$= 2696$ mm

$\therefore l_d < \frac{M_1}{V} + l_0$

(1175) (2696)