Design of Sections Subjected to M,T

Bending Moment & Tension Force

Steps of Design :

1 – Get Dimensions of the section. (b×t)

2 – Get Reinforcement A_{s1}, A_{s2}

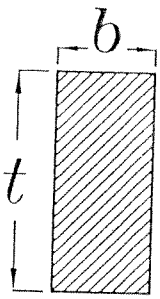
نسألكم الدعاء

Solution:

1 – Get Dimensions of the section. (b×t)

Take $b = (25\ cm \longrightarrow 40\ cm)$

Get $d_o = C_1\sqrt{\frac{M_{U.L.}}{F_{cu}\,b}}$ take $C_1 = 3.5$, $J = 0.78$



Then take $d = (0.9 \rightarrow 1.0)\, d_o$

$t = d + 5.0\ cm$ IF $t \leqslant 100\ cm$

$t = d + 10\ cm$ IF $t > 100\ cm$

2 – Get Reinforcement A_{s1}, A_{s2}

Then get $e = \frac{M_{U.L.}}{T_{U.L.}}$ Then get $\frac{e}{t}$

– IF $\frac{e}{t} \leqslant 0.05 \longrightarrow$ neglect $M_{U.L.}$

and Design the Sec. on N.F. only as Tie.

IF $\frac{e}{t}$

$\frac{e}{t} \geqslant 0.5$ Big Eccentricity

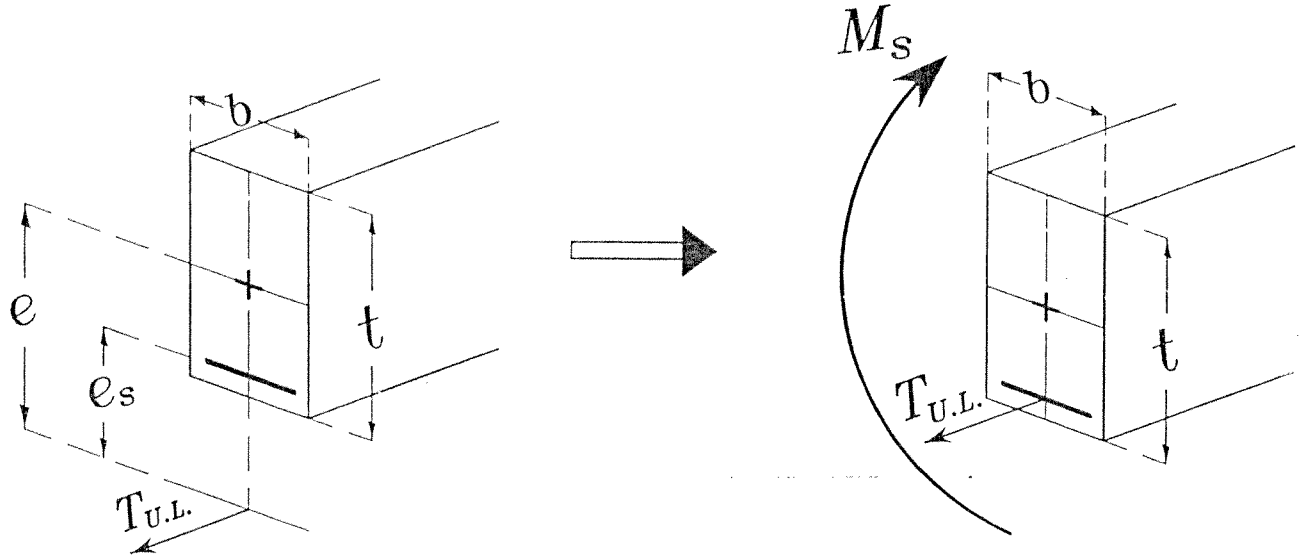
$\frac{e}{t} < 0.5$ Small Eccentricity

① $\frac{e}{t} \geq 0.5$ *Big Eccentricity.*

∴ محصلة القوى العمودية تكون خارج القطاع.

القطاع أقرب لقطاع الكمره منة لقطاع الـ *Tie* .

جهة من الخرسانة عليها *Compression* و جهة عليها *Tension* .



Get $\boxed{e_s = e - \frac{t}{2} + c}$

C is the Cover $\begin{cases} = 5.0\ cm & IF\ t \leq 100\ cm \\ = 10\ cm & IF\ t > 100\ cm \end{cases}$

Get $M_s = T_{U.L.} * e_s$

From $d = c_1 \sqrt{\frac{M_s}{F_{cu}\, b}}$ *Get* $c_1 = \checkmark \xrightarrow{get} J = \checkmark$

$$\boxed{A_s = \frac{M_s}{J\, F_y\, d} + \frac{T_{U.L.}}{(F_y/\gamma_s)}}$$

Check $A_{s_{min.}} = \frac{11}{F_y}\, b\, d$

Example.

$F_{cu} = 250\ kg\backslash cm^2$ st. 360/520

$M_{U.L.} = 30\ m.t.$, $T_{U.L.} = 30\ t$, $b = 30\ cm$

Req. Design the Sec.

Solution.

Take $d_\circ = C_1 \sqrt{\frac{M_{U.L.}}{F_{cu}\, b}}$ $C_1 = 3.5$, $J = 0.78$

$\therefore\ d_\circ = 3.5 \sqrt{\frac{30 * 10^5}{250 * 30}} = 70\ cm$

$d = (0.9 \rightarrow 1.0)\, d_\circ = (0.9 \rightarrow 1.0)\ (70\ ) = (63.0 \rightarrow 70.0)\ cm$

Take $d = 65.0\ cm$, $t = 65.0 + 5 = 70\ cm$

$e = \frac{M}{T} = \frac{30}{30} = 1.0\ m$ $\therefore\ \frac{e}{t} = \frac{1.0}{0.7} = 1.428 > 0.5$ Use e_s

$e_s = e - \frac{t}{2} + c = 1.0 - \frac{0.70}{2} + 0.05 = 0.70\ m$

$M_S = N * e_s = 30 * 0.70 = 21.0\ m.t.$

$\therefore\ d = C_1 \sqrt{\frac{M_S}{F_{cu}\, b}}$ $\therefore\ 65 = C_1 \sqrt{\frac{21.0 * 10^5}{250 * 30}} \rightarrow C_1 = 3.884 \rightarrow J = 0.798$

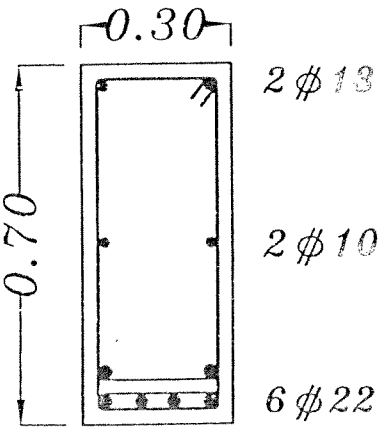
$\therefore\ A_S = \frac{M_S}{J\, F_y\, d} + \frac{T_{U.L.}}{(F_y \backslash \gamma_s)} = \frac{21.0 * 10^5}{0.798 * 3600 * 65} + \frac{30 * 10^3}{(3600 \backslash 1.15)} = 20.83\ cm^2$

$6\ \phi\ 22$

- Check $A_{S_{min.}} = \frac{11}{F_y}\, b\, d = \frac{11}{360}\ (30)\ (65) = 5.95\ cm^2$

$\therefore\ A_S > A_{S_{min.}}$ $\therefore$ o.k.

$\therefore\ n = \frac{b - 2.5}{\phi + 2.5} = \frac{30 - 2.5}{2.2 + 2.5} = 5.85 = 5.0$



Stirrup Hangers $= (0.1 \rightarrow 0.2)\, A_S$

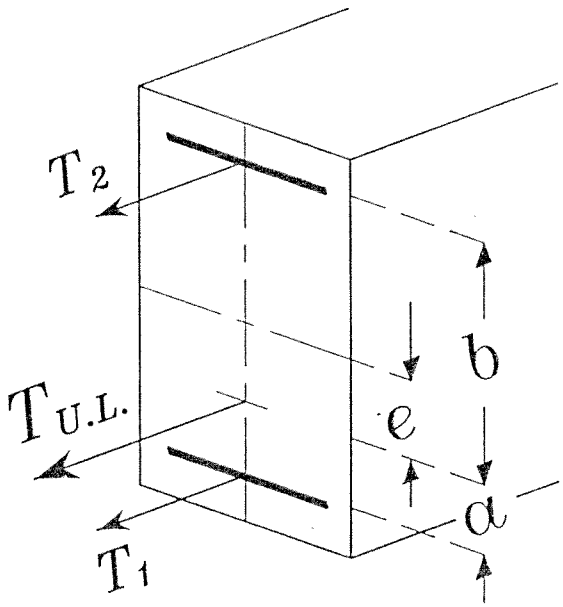
$= (0.1 \rightarrow 0.2)\ 20.83$ $2\ \phi\ 13$

② $\frac{e}{t} < 0.5$ *Small Eccentricity.*

∴ محصلة القوى العمودية تكون داخل القطاع.
القطاع أقرب لقطاع الـ *Tie* منة لقطاع الكمره.
أى أن الخرسانة عليها *Tension* من الجهتين.
و تكون الخرسانة مشرخة من الجهتين و يقاوم الحديد كل إل *Tension*.

$$a = \frac{t}{2} - c - e$$

$$b = \frac{t}{2} - c + e$$



$$T_{U.L.} = T_1 + T_2 \quad \text{----①}$$

$$T_1 * a = T_2 * b \longrightarrow T_2 = T_1 * \left(\frac{a}{b}\right) \quad \text{----②}$$

From ① , ②

$$T_{U.L.} = T_1 + T_2 = T_1 + T_1 * \left(\frac{a}{b}\right) = T_1 \left(\frac{a+b}{b}\right)$$

$$T_1 = T_{U.L.} \left(\frac{b}{a+b}\right) \longrightarrow A_{s1} = \frac{T_1}{(F_y/\gamma_s)}$$

$$T_2 = T_{U.L.} \left(\frac{a}{a+b}\right) \longrightarrow A_{s2} = \frac{T_2}{(F_y/\gamma_s)}$$

دائما الـ T_1 الكبيره جهة الـ *moment*

Example.

$F_{cu} = 250\ kg\backslash cm^2$ st. 360/520

$M_{U.L.} = 10\ m.t.$, $T_{U.L.} = 60\ t$, $b = 30\ cm$, $d = 45\ cm$

Req. Design the Sec.

Solution.

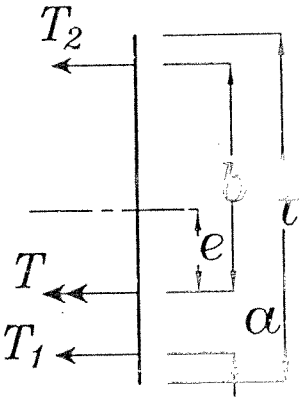
$$e = \frac{M}{T} = \frac{10}{60} = 0.1667\ m$$

$$\therefore \frac{e}{t} = \frac{0.1667}{0.50} = 0.333 < 0.5 \longrightarrow \text{Small Eccentricity.}$$

$$a = \frac{t}{2} - c - e = \frac{0.50}{2} - 0.05 - 0.1667 = 0.033\ m$$

$$b = \frac{t}{2} - c + e = \frac{0.50}{2} - 0.05 + 0.1667 = 0.3667\ m$$

$$T_1 = T_{U.L.}\left(\frac{b}{a+b}\right) = 60\ \left(\frac{0.3667}{0.033+0.3667}\right) = 55.0\ t$$



$$A_{s1} = \frac{T_1}{(F_y/\delta_s)} = \frac{55 * 10^3}{(3600\backslash 1.15)} = 17.57\ cm^2 \quad (5\ \phi 22)$$

$$T_2 = T_{U.L.}\left(\frac{a}{a+b}\right) = 60\ \left(\frac{0.033}{0.033+0.3667}\right) = 5.0\ t$$

$$A_{s2} = \frac{T_2}{(F_y/\delta_s)} = \frac{5.0 * 10^3}{(3600\backslash 1.15)} = 1.59\ cm^2 \quad (2\ \phi 13)$$