

Flexural Analysis of T-Sections

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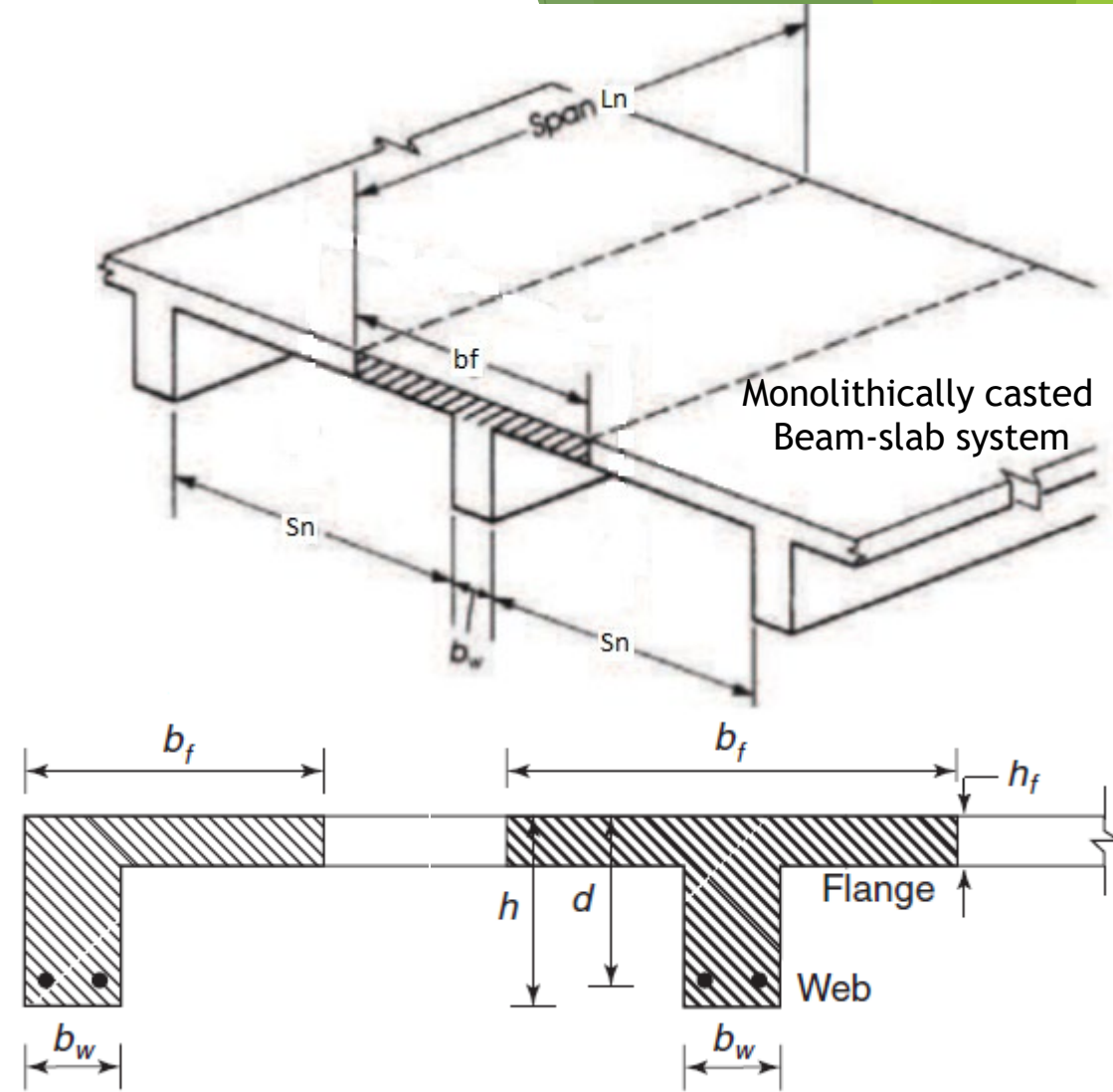
Flange Effective Width Limitations:

$$(T - Section): b_f \leq \begin{cases} bw + 2(8hf) \\ bw + 2\left(\frac{Ln}{8}\right) \\ bw + 2\left(\frac{Sn}{2}\right) \end{cases}$$

$$(L - Section): b_f \leq \begin{cases} bw + (6hf) \\ bw + \left(\frac{Ln}{12}\right) \\ bw + \left(\frac{Sn}{2}\right) \end{cases}$$



$$\text{Isolated T beam} \begin{cases} b_f \leq 4 b_w \\ hf \geq 0.5 b_w \end{cases}$$



If flange located in Tension zone (Negative Moment), the section will be Rectangular with $b=b_w$

If flange located in Compression zone, There will be two possibilities, depending on the concrete compression area required to satisfy the equilibrium:

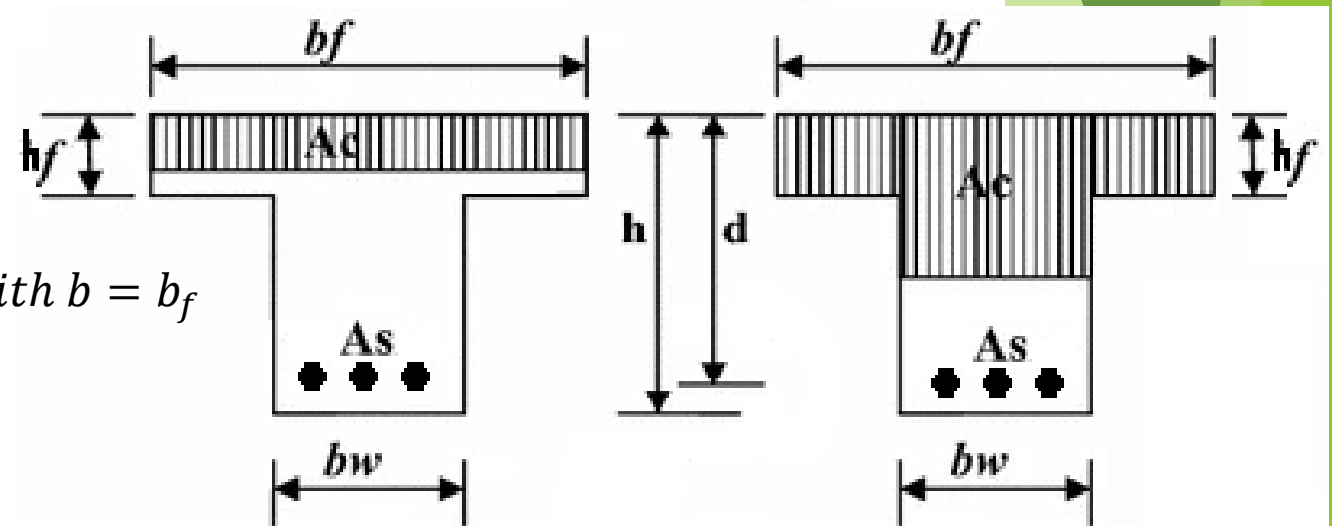
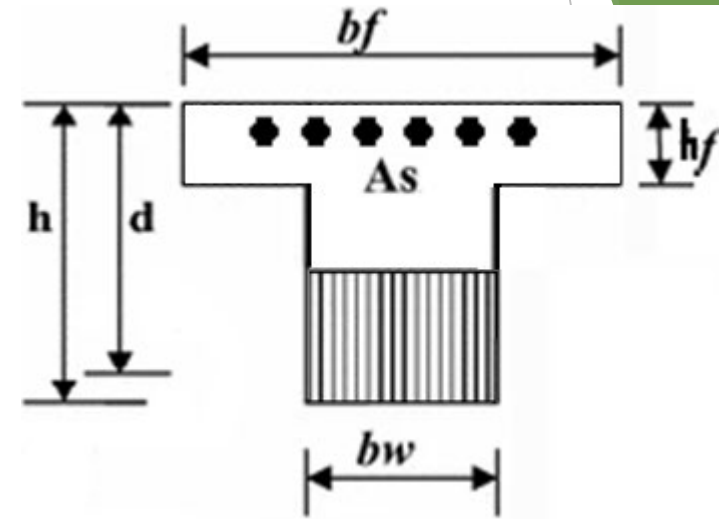
$$a \leq h_f \quad (\text{Rectangular Section with } b = b_f)$$

$$a > h_f \quad (\text{True T Beam})$$

$$0.85 f'_c a b_f = A_s f_y$$

$$a = \frac{A_s f_y}{0.85 f'_c b_f}$$

Check: $a \begin{cases} \leq h_f & \rightarrow \rightarrow \rightarrow \text{Rectangular Sec. with } b = b_f \\ > h_f & \rightarrow \rightarrow \rightarrow \text{True T Section} \end{cases}$



For True T Section:

$$M_n = M_{n1} + M_{nov}$$

$$M_{nov} = 0.85 f'_c h_f (b_f - b_w) \left(d - \frac{h_f}{2} \right)$$

$$A_{sov} = \frac{0.85 f'_c h_f (b_f - b_w)}{f_y}$$

$$A_{s1} = A_s - A_{sov}$$

$$A_{s1} f_y = 0.85 f'_c a b_w$$

$$a = \frac{A_{s1} f_y}{0.85 f'_c b_w}$$

$$M_{n1} = 0.85 f'_c a b_w \left(d - \frac{a}{2} \right)$$

$$M_n = M_{n1} + M_{nov}$$

$$c = \frac{a}{\beta_1}$$

$$\epsilon_t = 0.003 \left(\frac{d_t - c}{c} \right)$$

$$M_u = \phi M_n$$

$$\rho_1 = \frac{A_{s1}}{b_w d}$$

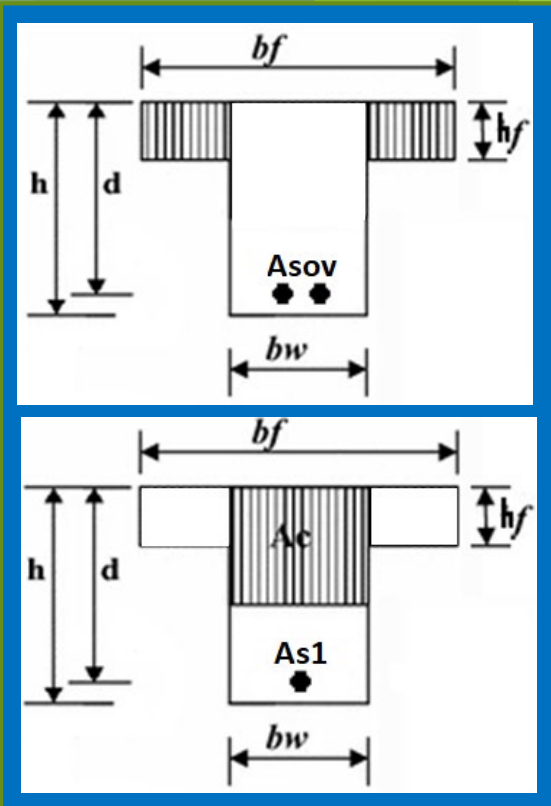
$$m = \frac{f_y}{0.85 f'_c}$$

$$M_{n1} = \rho_1 f_y b_w d^2 \left(1 - \frac{1}{2} \rho_1 m \right)$$

$$M_n = M_{n1} + M_{nov}$$

$$\rho_1 \leq \rho_{max} = \frac{3}{8} \frac{\beta_1}{m} \left(\frac{d_t}{d} \right) \quad (\text{for tension control})$$

$$M_u = \phi M_n$$



Ex1: Calculate the design moment strength of the T-section shown below, using $f'_c=24$ MPa, $f_y=420$ MPa

Solution: $A_b = 706 \text{ mm}^2$

$$A_s = 6 \times 706 = 4236 \text{ mm}^2$$

$$0.85 f'_c a b_f = A_s f_y$$

$$a = \frac{A_s f_y}{0.85 f'_c b_f} = \frac{4236 \times 420}{0.85 \times 24 \times 915} = 95.31 > 80 \text{ (T.T.S)}$$

$$M_n = M_{n1} + M_{nov}$$

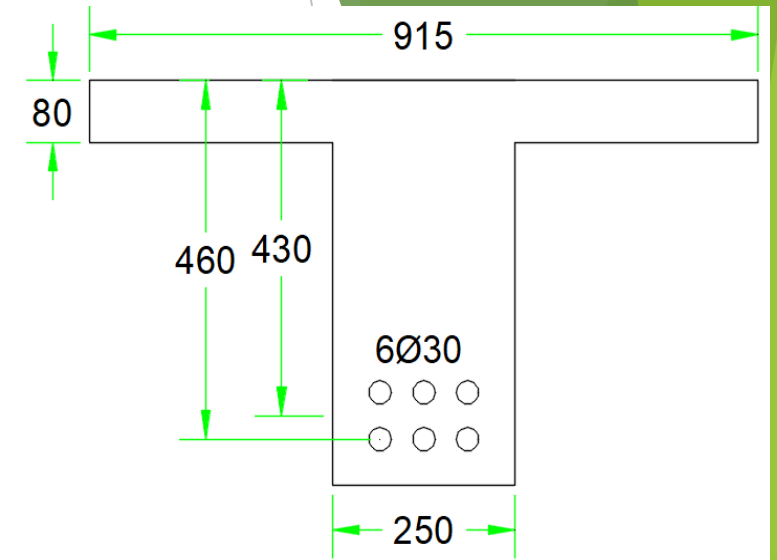
$$M_{nov} = 0.85 f'_c h_f (b_f - b_w) \left(d - \frac{h_f}{2} \right)$$

$$M_{nov} = 0.85 \times 24 \times 80 (915 - 250) \left(430 - \frac{80}{2} \right)$$

$$M_{nov} = 423.26 \text{ kN.m}$$

$$A_{sov} = \frac{0.85 f'_c h_f (b_f - b_w)}{f_y}$$

$$A_{sov} = \frac{0.85 \times 24 \times 80 (915 - 250)}{420} = 2584 \text{ mm}^2$$



$$A_{s1} = A_s - A_{sov}$$

$$A_{s1} = 4236 - 2584 = 1652 \text{ mm}^2$$

$$A_{s1} f_y = 0.85 f'_c a b_w$$

$$a = \frac{A_{s1} f_y}{0.85 f'_c b_w}$$

$$a = \frac{1652 \times 420}{0.85 \times 24 \times 250} = 136.04 \text{ mm}$$

$$M_{n1} = 0.85 f'_c a b_w \left(d - \frac{a}{2} \right)$$

$$M_{n1} = 0.85 \times 24 \times 136.04 \times 250 \left(430 - \frac{136.04}{2} \right)$$

$$M_{n1} = 251.14 \text{ kN.m}$$

$$M_n = M_{n1} + M_{nov}$$

$$M_n = 251.14 + 423.26 = 674.4 \text{ kN.m}$$

$$c = \frac{a}{\beta_1} = \frac{136.04}{0.85} = 160.04$$

$$\varepsilon_t = 0.003 \left(\frac{d_t - c}{c} \right)$$

$$\varepsilon_t = 0.003 \left(\frac{460 - 160.04}{160.04} \right) = 0.0056 > 0.005 \text{ (Tension Control)}$$

$$M_u = \phi M_n$$

$$M_u = 0.9 \times 674.4 = 606.96 \text{ kN.m}$$

Thank you...