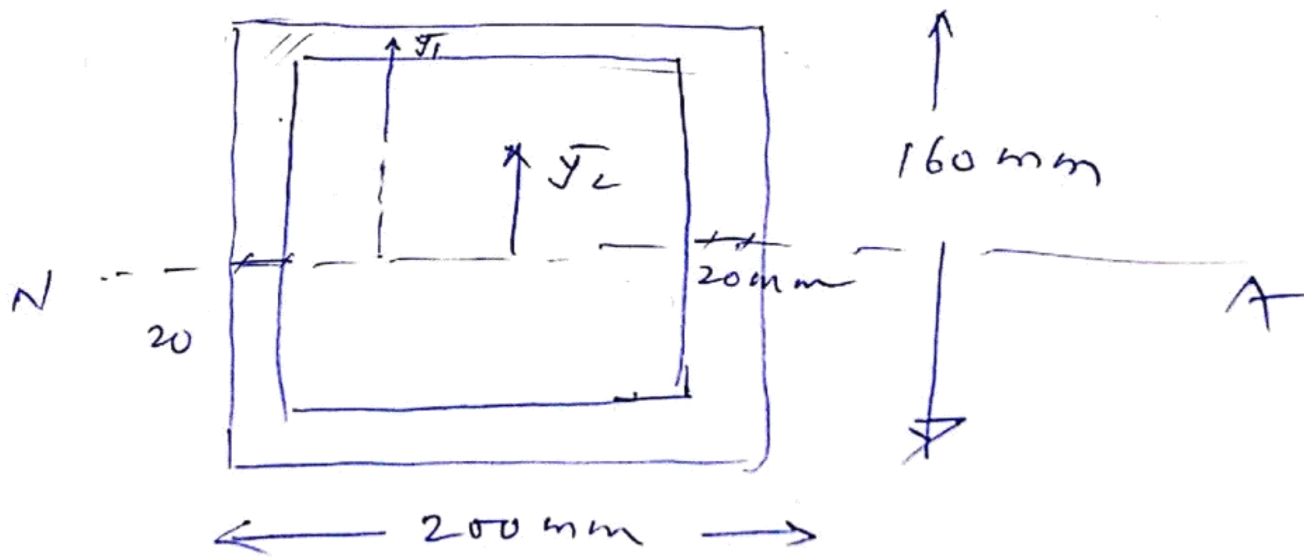
Department of Civil Engineering
Katihar Engineering College, Katihar

Subject : Introduction to Solid Mechanics
Topic : Shear Stress in Beam
Lecture : 03
Course Instructor : Prof. Rashid Mustafa

P-1. A simply supported hollow rectangular beam of outside width 200 mm, outside depth 160 mm and material thickness 20 mm is subjected to udl of 10 kN/m for entire span of 10 m. Find maximum shear stress induced in the beam



$$\text{Shear stress}(\tau) = \frac{V}{I \cdot B} \cdot (A \cdot \bar{y})$$

$$V_{max} = \frac{wL}{2} = \frac{10 \times 10}{2} = 50 \text{ kN}$$

$$I = \frac{200 \times 160^3}{12} - \frac{(200 - 2\times 20) \times (160 - 2\times 20)^3}{12}$$

$$= \frac{13568 \times 10^4}{3} \text{ mm}^4.$$

B at NA $= 2 \times 20 = 40$ mm.

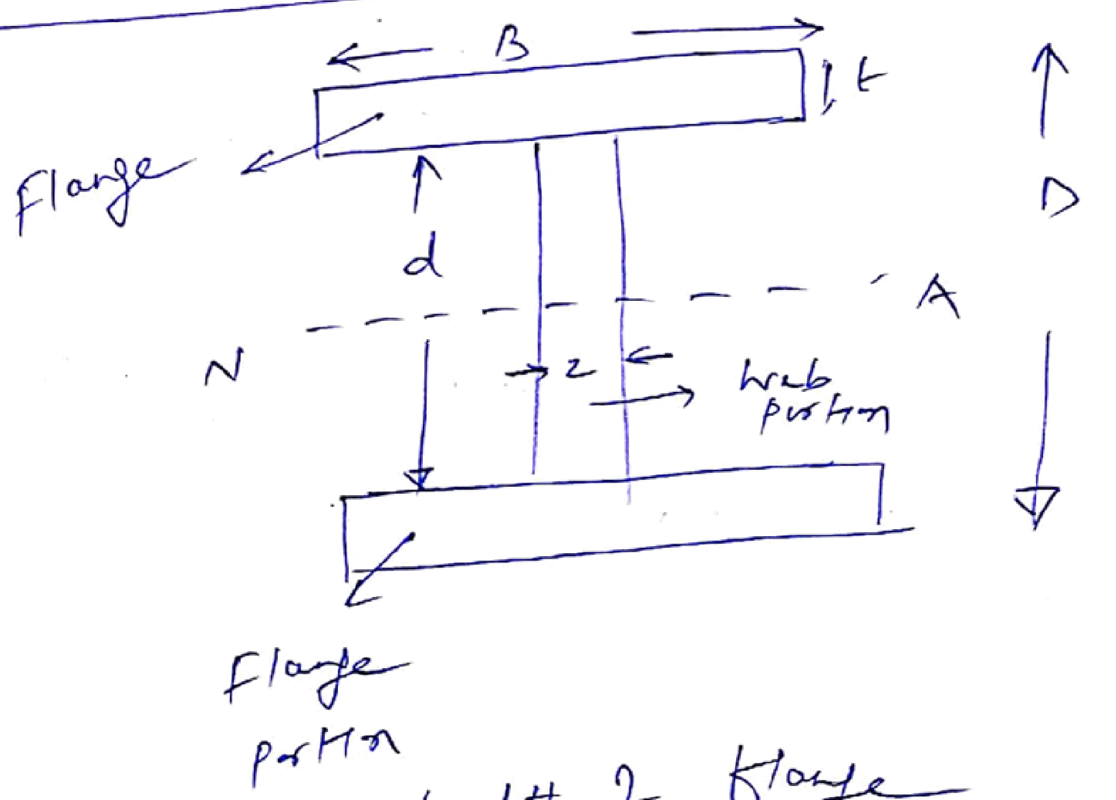
$$A\bar{y} = (200 \times 20) \times 70 + 2 \times [60 \times 20 \times 30]$$

$$= 352000 \text{ mm}^3.$$

$$\tau = \frac{V}{IB} \cdot A\bar{y} = \frac{(50 \times 1000) \times 352000}{\frac{13568 \times 10^4}{3} \times 40}$$

$$\tau = 9.73 \text{ N/mm}^2$$

Shear stress in I- Section :



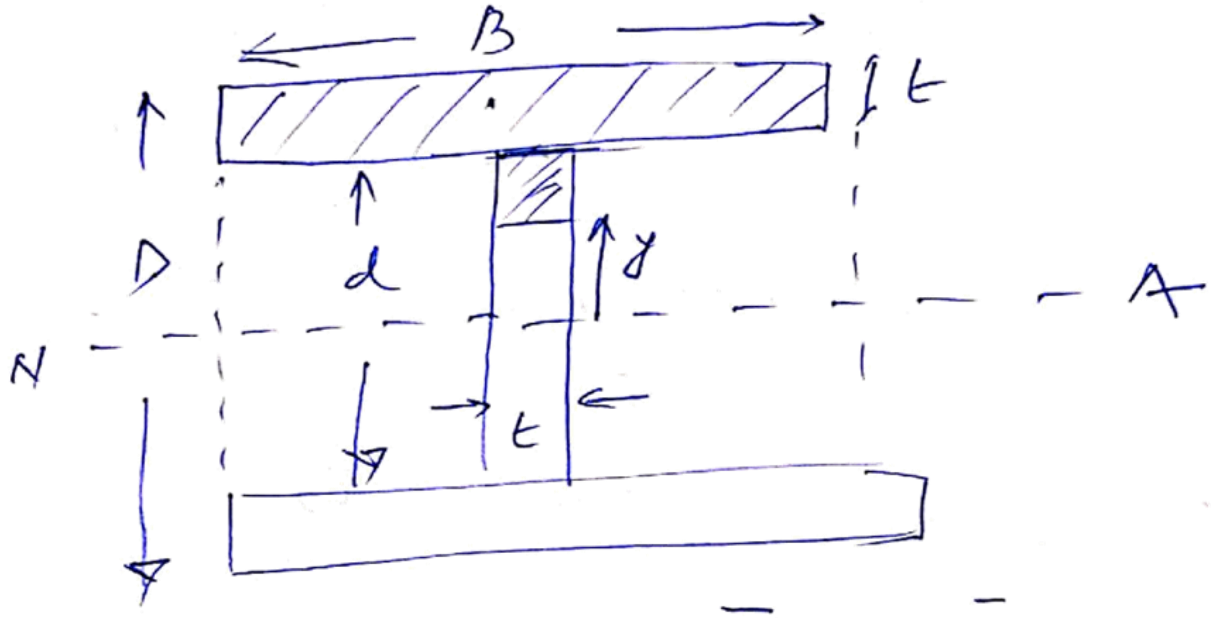
B → width of flange

t → thickness of flange

$z \rightarrow$ thickness of web

$D \rightarrow$ Overall depth of I-section

$d \rightarrow$ depth of web section.



$$A\bar{y} = A_1\bar{y}_1 + A_2\bar{y}_2 + A_3\bar{y}_3 + \cdots$$

$$A\cdot\bar{y} = B \times \left(\frac{D-d}{2}\right) \times \left(\frac{d}{2} + \frac{D-d}{4}\right) + t \times \left(\frac{d}{2} - y\right) \times \left(y + \frac{\frac{d}{2} - y}{2}\right)$$

$$A\bar{y} = B\left(\frac{D^2 - d^2}{8}\right) + \frac{t\left(\frac{d^2}{4} - y^2\right)}{2}$$

$$\text{Moment of Inertia } (I) = \frac{BD^3}{12} - \frac{(B-t) \times (D-2t)^3}{12}$$

$$I = \frac{BD^3}{12} - \frac{(B-t)\,d^3}{12}$$

Shear stress in Web $(\tau_w) = \frac{V}{IB} \cdot A\bar{y}$

$$\tau_w = \frac{V}{I \times t}\left[\frac{B(D^2-d^2)}{8} + \frac{t\left(\frac{d^2}{4}-y^2\right)}{2}\right]$$

$$\tau_w = \frac{V(D^2-d^2)}{8I}\left(\frac{B}{t}\right) + \frac{V}{2I}\left(\frac{d^2}{4}-y^2\right)$$

Shear stress in flange (τ_f)

$$A\bar{y} = B\left(\frac{D}{2}-y\right)\left(y + \frac{\frac{D}{2}-y}{2}\right)$$

$$= \frac{B\left(\frac{D^2}{4}-y^2\right)}{2}.$$

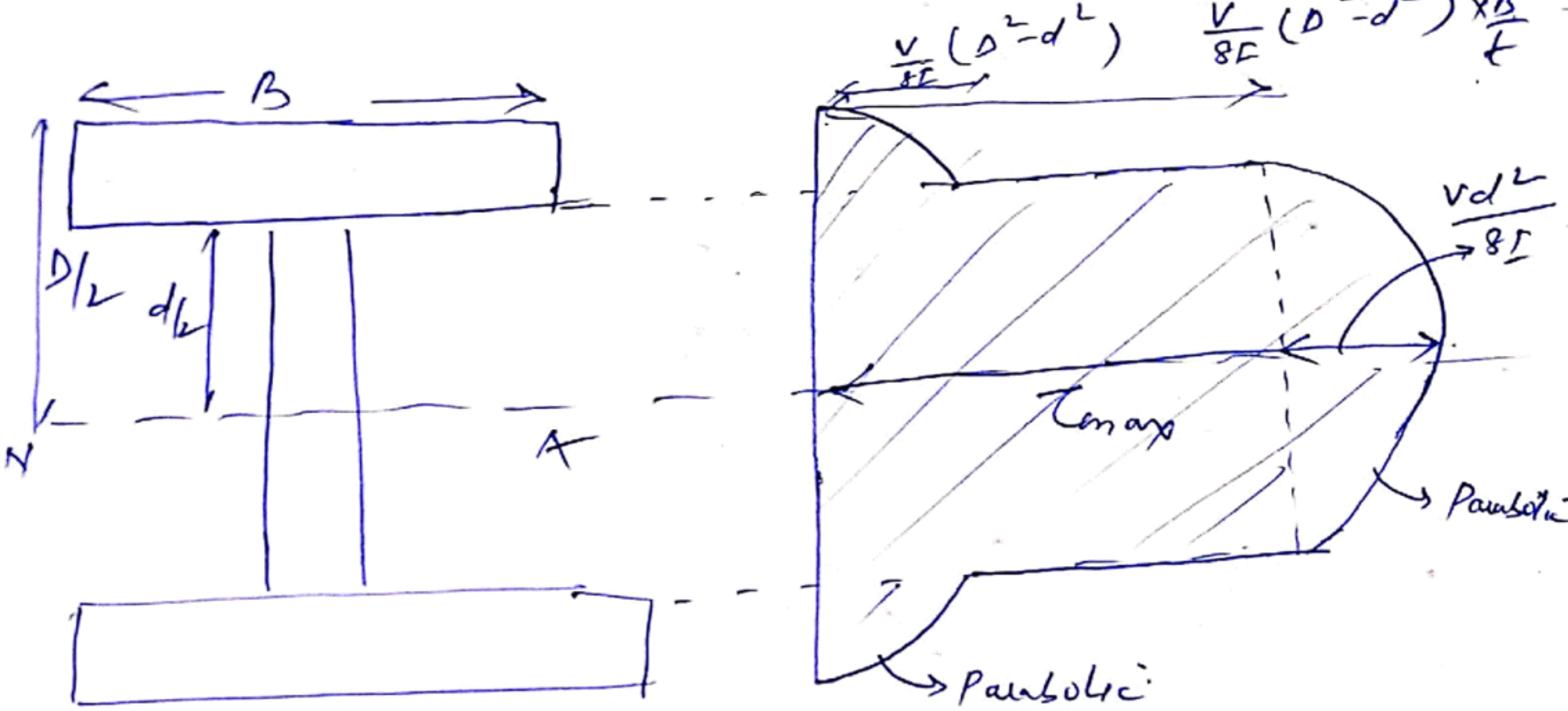
Shear stress in flange $(\tau_f) = \frac{V \cdot B\left(\frac{D^2}{4}-y^2\right)}{2 \times I \times B}$

$$\tau_f = \frac{V}{2I}\left(\frac{D^2}{4}-y^2\right)$$

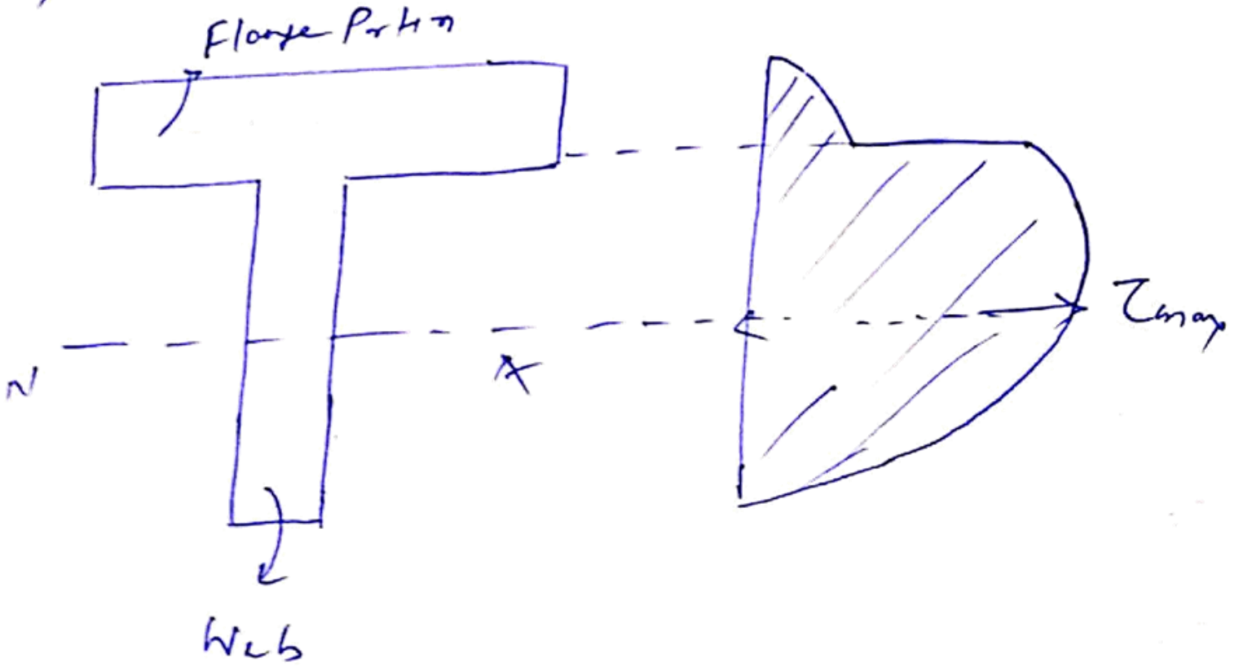
At $y = d/2$

Shear stress in flange $(\tau_f) = \frac{V}{8I}(D^2-d^2)$

Shear stress in web $(\tau_w) = \frac{V}{8I}(D^2 - d^2) \times \frac{B}{t}$



⇒ T-Section



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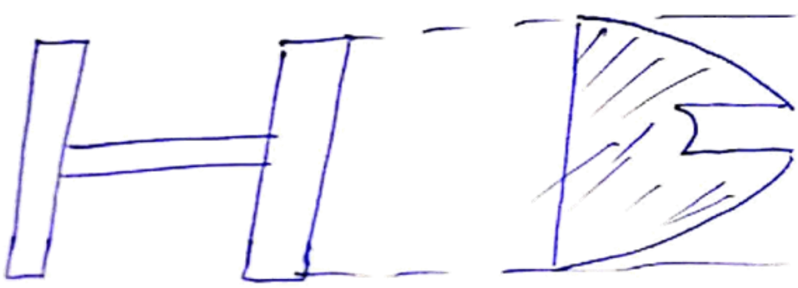
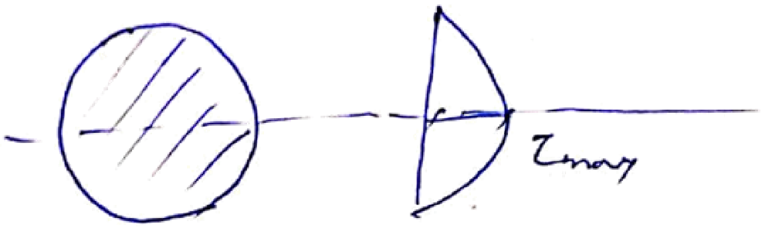
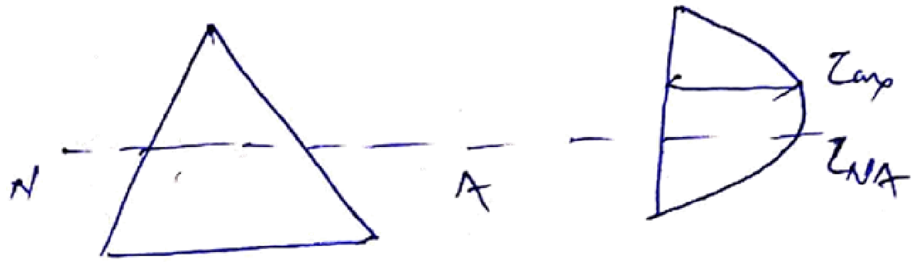
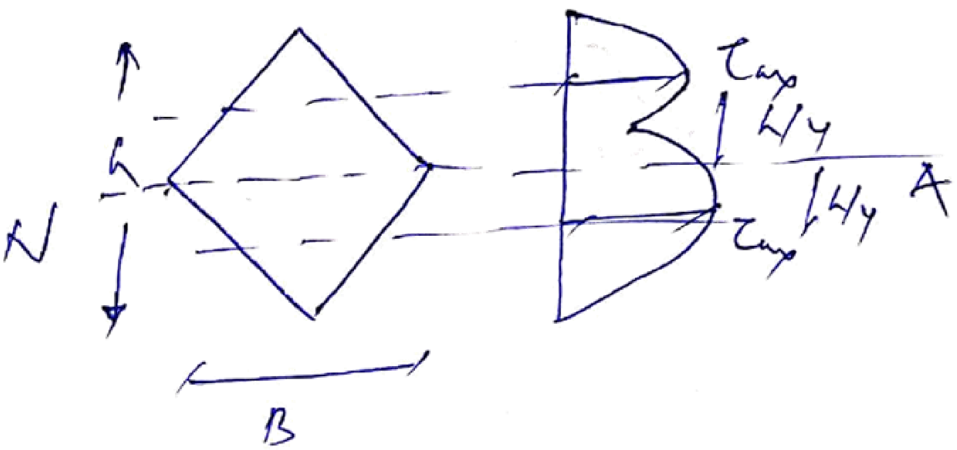






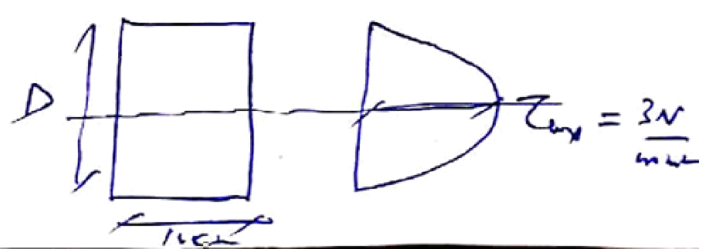


P-2. A rectangular beam 10 cm wide is subjected to a maximum shear force of 50,000 N, the corresponding max^m shear stress being 3 N/mm^2. The depth of the beam is

(a) 25 cm (b) 22 cm (c) 16.67 cm

(d) 30 cm

Sol^n.



$$\tau_{max} = \frac{3}{2}\tau_{avg}$$

$$= \frac{3}{2} \times \frac{V}{BD}$$

$$3 = 1.5 \times \frac{5 \times 10^4}{100 \times D}$$

$$D = 250\ mm = 25\ cm.$$

HAPPY LEARNING