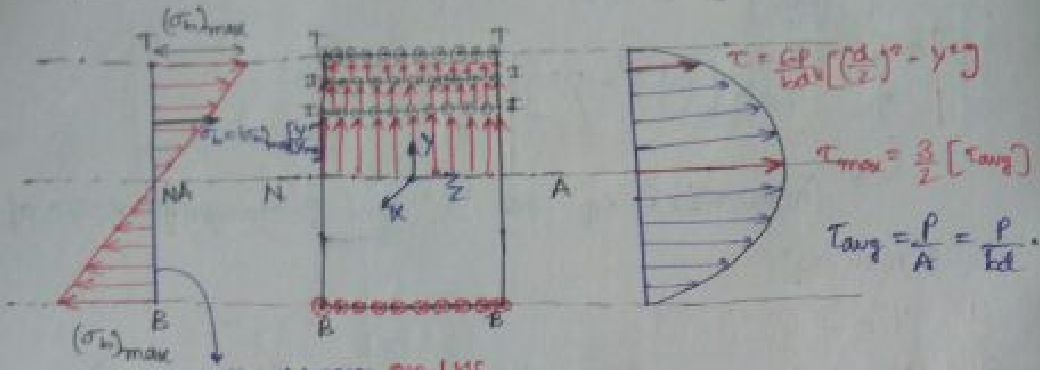
Comparison b/w S.S & B.S-



x-S/c of beam on LHS

Bending stress variation on the rectangular x-S/c

x-S/c of beam (or) x-face (or) YZ plane

Shear stress variation on the Rectangular x-S/c.

~~Effects~~
→ Left hand side cutting surface.
(Just by looking the variation we can't tell it's either sagging or hogging. It should be given that which cutting surface we are considering :)
→ Hogging

→ Direction ✓
~~→ Mag~~
→ Magnitude ✓
→ Variation ✗

→ Mag. ✓
→ Direction ✓
→ Variation ✓

Bending Stress	Shear Stress
1- Bending stress is ⊥ to the x-S/c of the beam.	1- Shear stress is ∥ to the x-S/c of the beam.
2- σ_b varies linearly over the depth of the beam	2- τ_s varies parabolically over the depth of the beam
3- σ_b max. at extreme fibres.	3- τ_s is zero at the extreme fibres.
4- At N.A. σ_b is zero.	4- At NA, τ_s is non-zero but it becomes max. at neutral axis in case circular, square, rect. I-S/c & T-S/c (ie. except triangular & S.D).

5- $\sigma_b = \frac{MY}{I_{NA}}$ (or) $\frac{EY}{R}$ (or) $(\sigma_b)_{max}\left[\frac{Y}{Y_{max}}\right]$

6- $(\sigma_b)_{max} = \frac{M}{Z_{NA}}$ (or) $\frac{EY_{max}}{R}$

7- For every x-s/c, σ_b variation consists of two similar Δs.

5- $\tau_s = \frac{PA\bar{Y}}{I_{NA}\,b}$.

6- $\tau_{max} = K\,\tau_{avg}$.

where $\tau_{avg} = P/A$.

$K = \frac{3}{2} \Rightarrow$

$= \frac{4}{3} \Rightarrow$

$= \frac{9}{8} \Rightarrow$

$\frac{big}{small} = \frac{3}{2} < \frac{9}{3} > \frac{9}{8}$

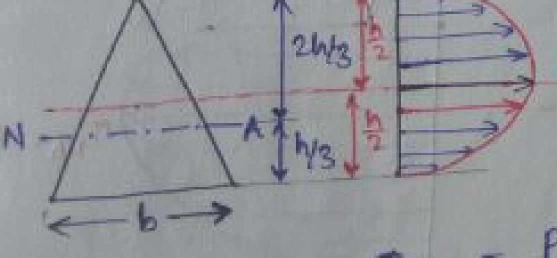
7- Shape of τ_s variations depends on shape of the x-s/c:

→ Uni-axial state of stress is developed (ie. $\sigma_x = (\sigma_b)_{max}$; $\sigma_y = \tau_{xy} = 0$] at any point on the extreme fibres of the beam.

→ Bi-axial combined state of stress is developed at any point on the ~~inne~~ inner fibre of the beam. [$\sigma_x = \sigma_b$, $\sigma_y = 0$, $\tau_{xy} = \tau$].

→ Pure shear state of stress is developed at any pt. on the N.A of the beam ($\sigma_x = \sigma_y = 0$; $\tau_{xy} = \tau_{max}$ (or) τ)

For triangular x-s/c -



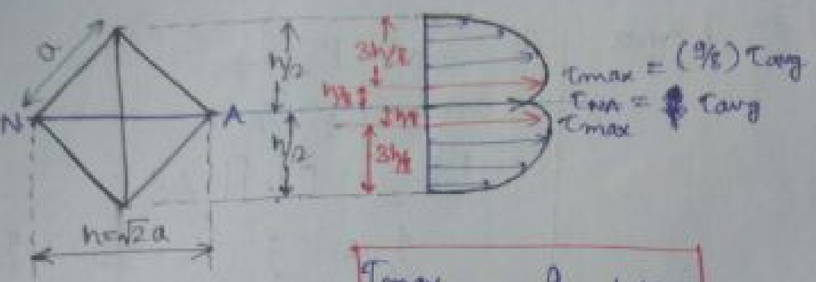
$\tau_{max} = \frac{3}{2}[\tau_{avg}]$

$\tau_{NA} = \frac{4}{3}\tau_{avg}$ (or) $\frac{8}{9}\tau_{max}$

$$\tau_{avg} = \frac{P}{A} = \frac{2P}{bh}.$$

$$\boxed{\frac{\tau_{max}}{\tau_{NA}} = \frac{9}{8} = 1.125}$$

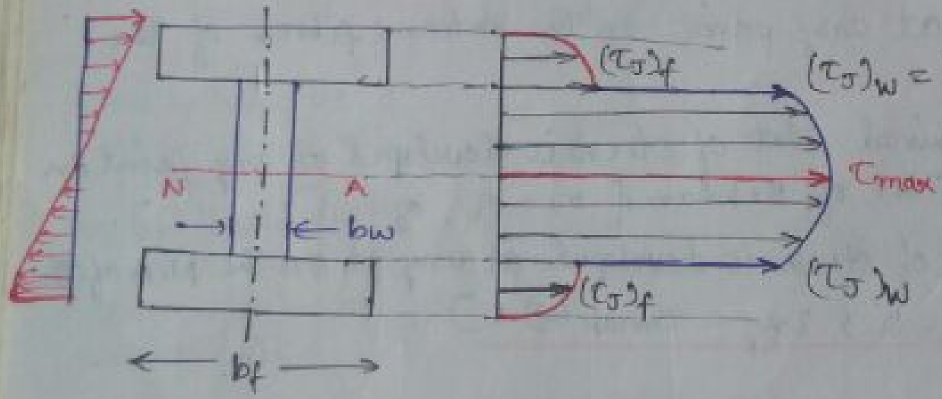
For S.D



$$\boxed{\frac{\tau_{max}}{\tau_{NA}} = \frac{9}{8} = 1.125}$$

$$\boxed{\tau_{avg} = \frac{P}{A} = \frac{P}{a^2} \text{ (or) } \frac{2P}{h^2}}$$

For I-S/C-

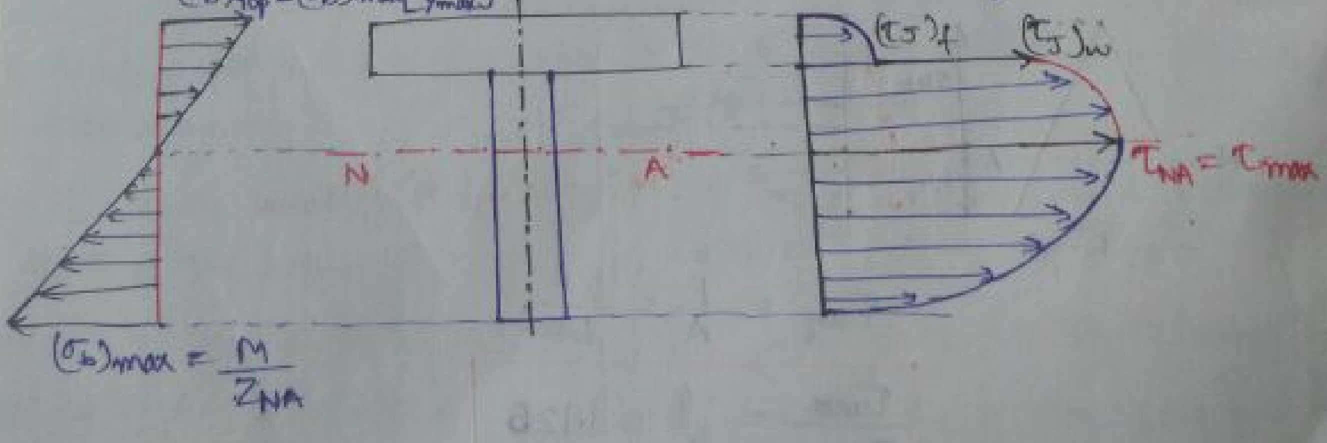


$$(\tau_s)_w = (\tau_s)_f \left[\frac{b_f}{b_w}\right].$$

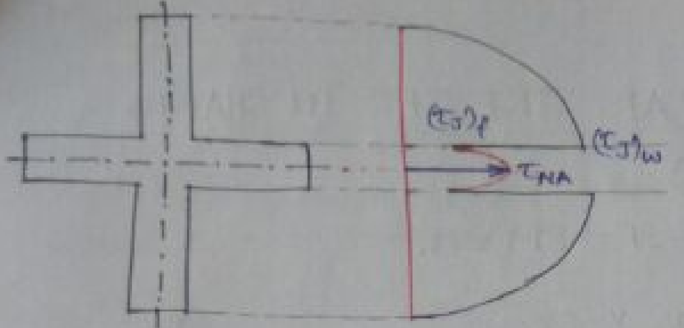
For T-X-S/C-

$$(\sigma_b)_{top} = (\sigma_b)_{max}\left[\frac{y_t}{y_{max}}\right]$$

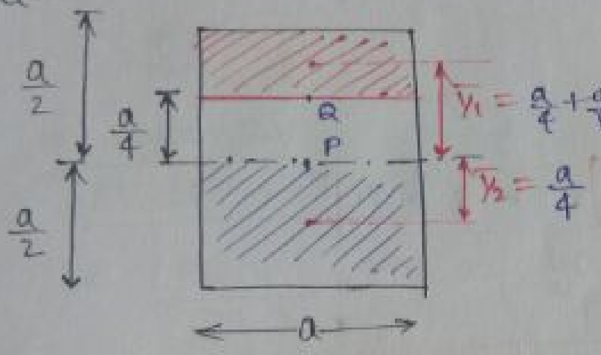
Remember



$$(\sigma_b)_{max} = \frac{M}{Z_{NA}}$$



Q-



Det.
(i) $\tau_P / \tau_Q = ?$.
(ii) τ_Q in terms of shear force (P).

$$\frac{\tau_P}{\tau_Q} = \frac{A_2 \bar{y}_2}{A_1 \bar{y}_1} = \frac{a(a/2)(a/4)}{a(a/4)(3a/8)} = \frac{(1/8)}{(3/32)} = \frac{4}{3},$$

$$\tau_Q = \frac{3}{4}(\tau_P \text{ or } \tau_{max})$$

$$= \left(\frac{3}{4}\right)\left(\frac{3}{2}\tau_{avg}\right)$$

$$\tau_Q = \left(\frac{9}{8}\right)\left(\frac{P}{a^2}\right)$$