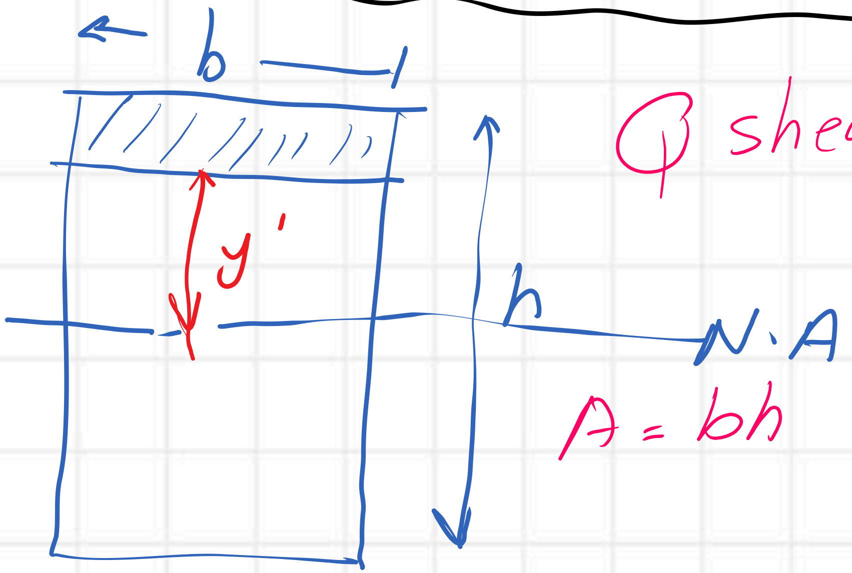
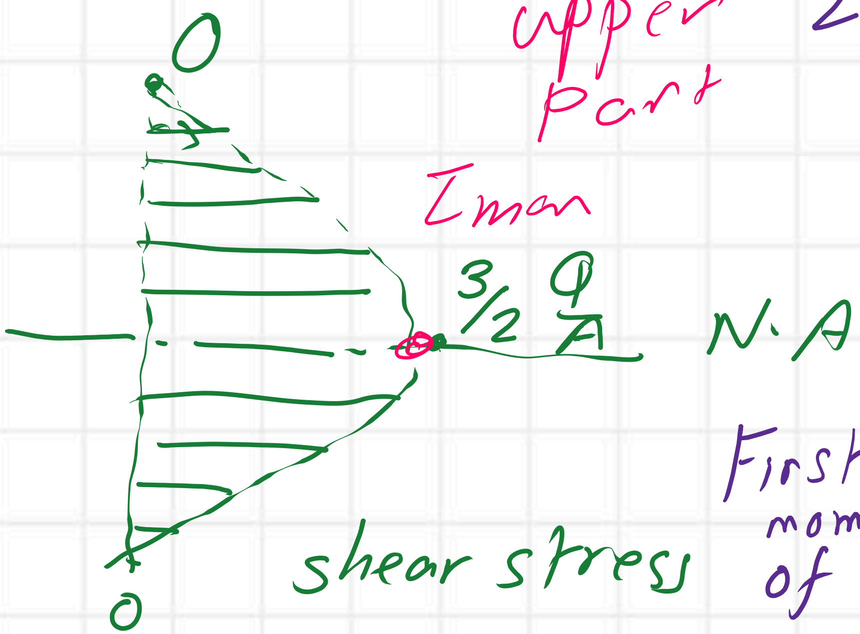
shear stress for a rectangle

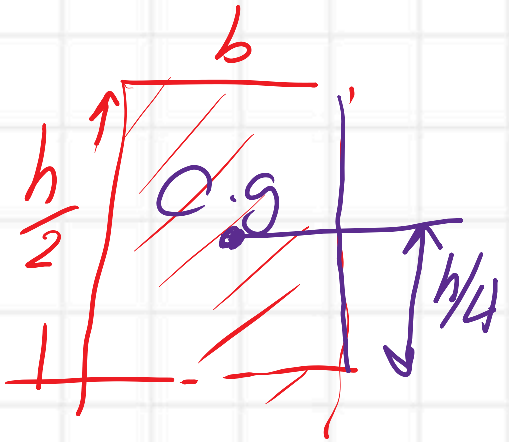


Q shear

$A = bh$



Area $= \frac{bh}{2}$ upper part



First moment of area $= \frac{bh}{2} \cdot \frac{h}{4} = \frac{bh^2}{8}$

$I_x = \frac{bh^3}{12}$

$$\tau_{N.A} = \frac{(V)Q}{I_x b} = \frac{\frac{bh^2}{8}}{\left(\frac{bh^3}{12}\right)} \cdot \frac{Q}{(b)} = \frac{bh^2}{8} \, \frac{12}{bh^3} \, \frac{Q}{b}$$

$$= \frac{3}{2}\frac{Q}{hb} = \frac{3}{2}\frac{Q}{A}$$

First moment of area

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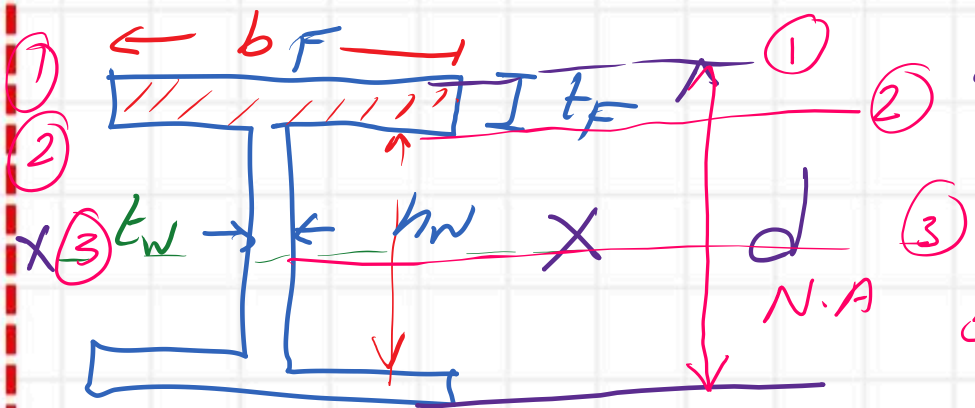


Derive an Expression For shear stress for I beam

b_f: width of upper Flange

d: overall depth

h_w = Web height

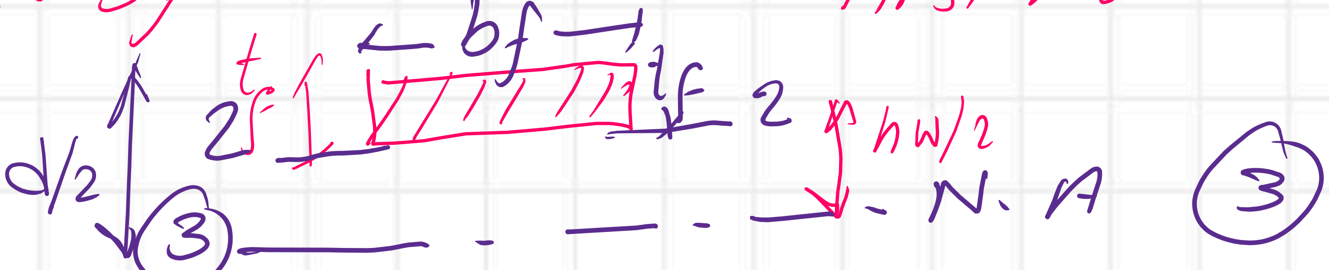
t_w = web thickness

Q: Shear Force

$$\tau_{x\,max} = \frac{\text{First moment of area } (Q)}{I_x \cdot b_f}$$

⇒ For Line 1-1
First moment of area = 0

For Line 2-2



First moment of area $= b_f t_f \left(\frac{d}{2} - \frac{t_f}{2}\right)$

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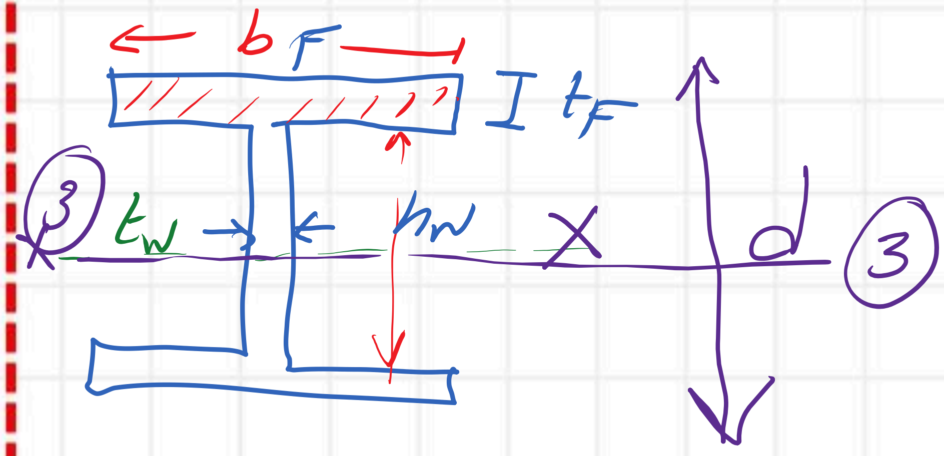
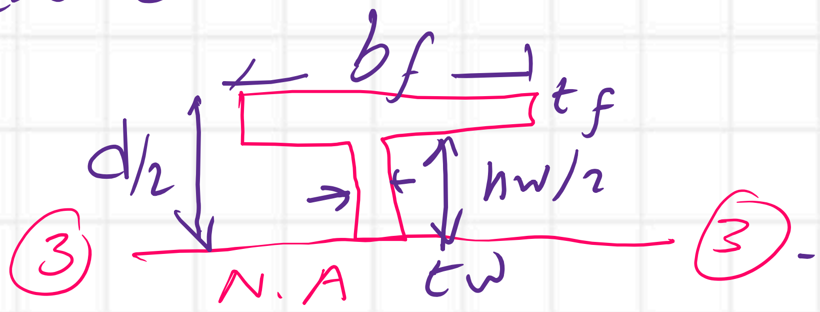
Derive an Expression For shear stress for I beam



$q_F = b t_f \cdot (d - \frac{f}{2})$

b_f : width of upper Flange
d : overall depth
h_w = Web height
t_w = web thickness

Q : Shear Force



$$\tau_{x\,max} = \frac{\text{First moment of area } (Q)}{I_x \cdot b_f}$$

A

$$\text{First moment of area} = b_f(t_f)\left(\frac{d}{2} - \frac{t_f}{2}\right) + \frac{h_w}{2}(t_w)\frac{h_w}{4}$$

$$\hookrightarrow = b_f t_f \frac{1}{2}(d - t_f) + \frac{h_w t_w h_w}{8}$$

Max Value

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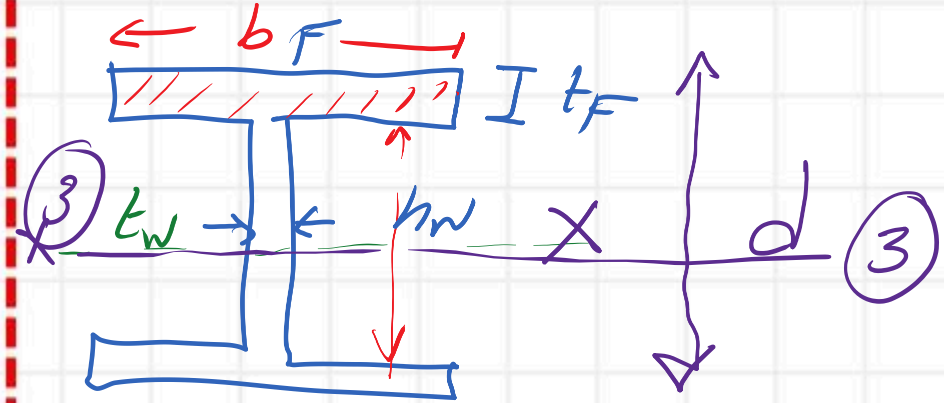


Derive an Expression For shear stress for I beam

b_f: width of upper Flange

d: Overall depth

h_w = Web height

t_w = web thicknes

Q: Shear Force

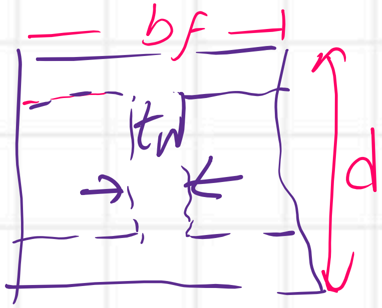
→ Two Methods

$(b_f - t_w)/2$

$d - 2t_f$

$I_x = I_x$ big Rect − I_x 2 rectangles

$$\frac{b_f (d)^3}{12} - 2\left(\frac{b_f - t_w}{2}\right) - \frac{(b_f - t_w)(d - 2t_f)^3}{12}$$



$\frac{b_f - t_f}{2}$ $(b_f - t_w)/2$

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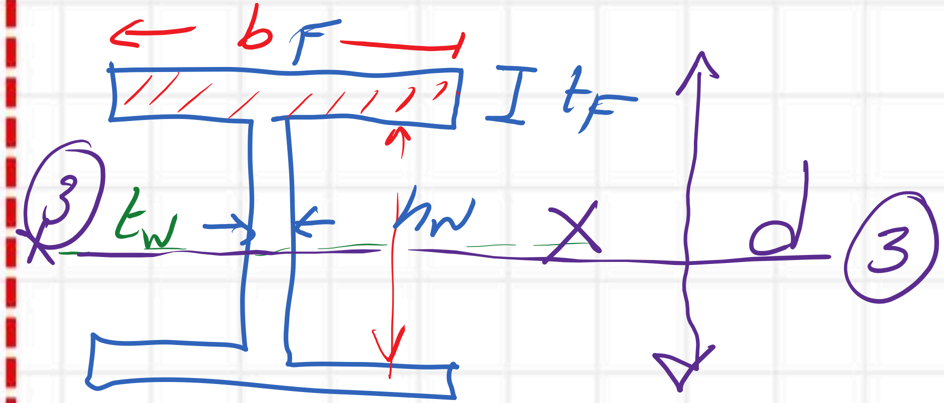
Derive an Expression For shear stress for I beam



b_f: width of upper Flange

d: overall depth

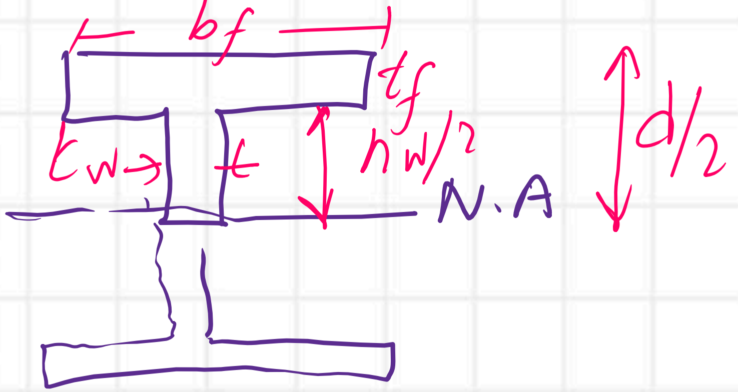
h_w = Web height

t_w = web thickness

Q: Shear Force

2nd method

$$I_x = 2\left[b_f\frac{t_f^3}{12} + (b_f t_f)\left(\frac{d}{2}-\frac{t_f}{2}\right)^2 + \frac{t_w}{12}\left(\frac{h_w}{2}\right)^3 + \frac{t_w h_w}{2}\left(\frac{h_w}{4}\right)^2 \right]$$



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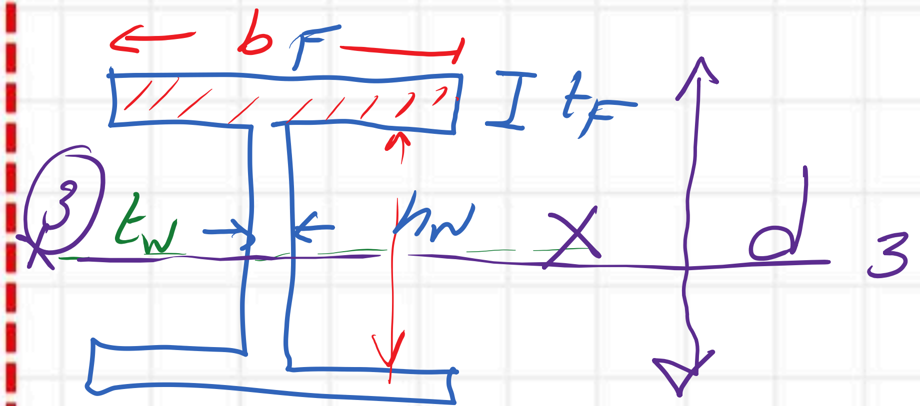
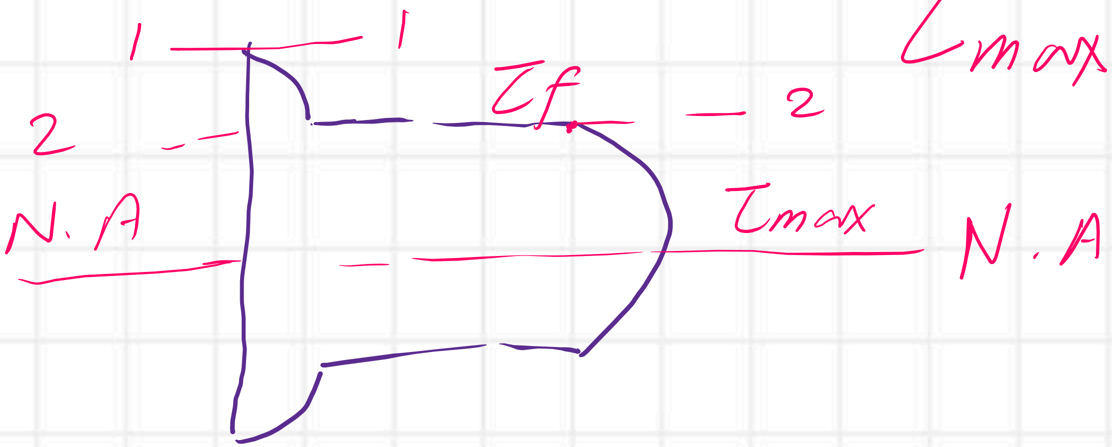
Derive an Expresion For shear stress for I beam

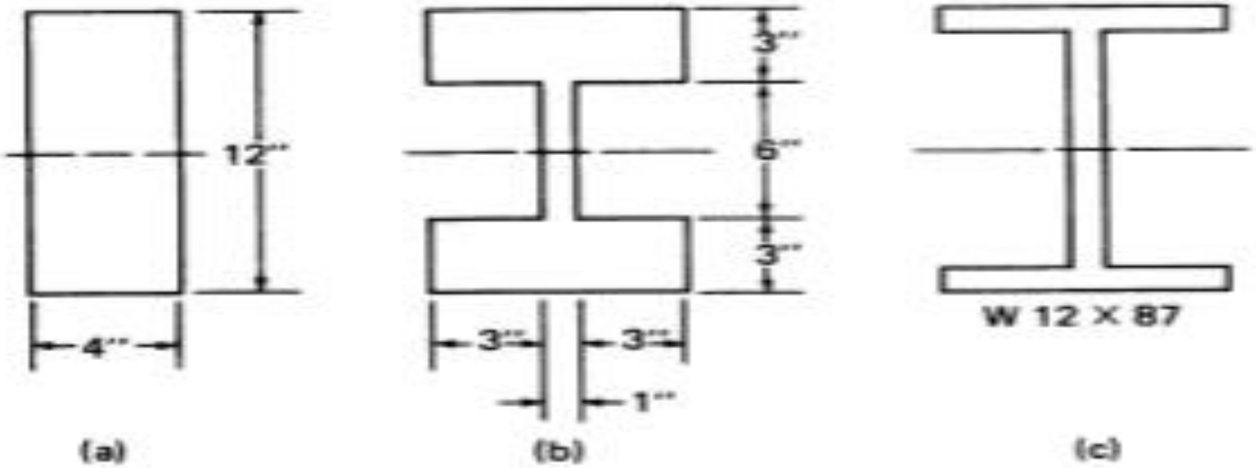


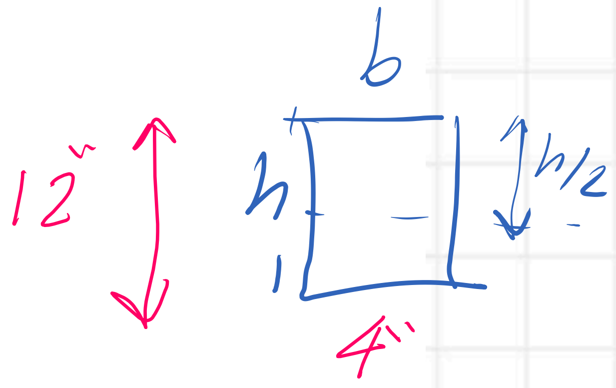
τ_f : stress at flange

τ_{max} = max stress value



Example 2.22. Determine the maximum shearing stress for the following sections when the external shear force $V = 75$ kips.



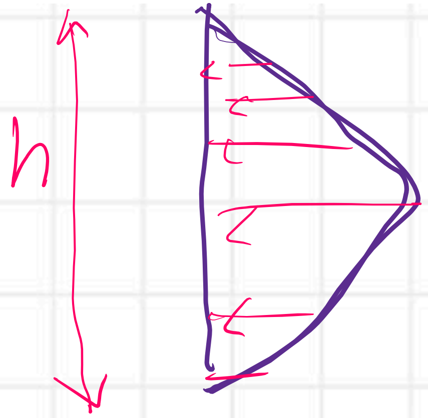


shear $V = 75$ kips

$A = 4(12) = 48 \text{ inch}^2$

(a) $\tau = \dfrac{VQ}{I_x b} \Rightarrow$

shear stress $= \dfrac{3}{2}\dfrac{V}{A}$



$\dfrac{3}{2}\dfrac{V}{A} = \dfrac{3}{2}\dfrac{(75)}{48}$

$\tau = 2.344 \dfrac{\text{kips}}{\text{inch}^2} = 2.344$ ksi

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