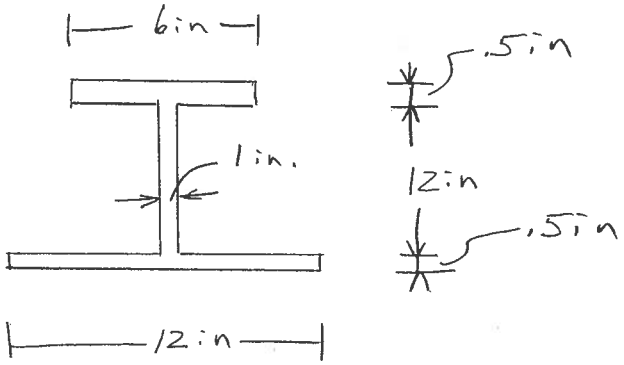
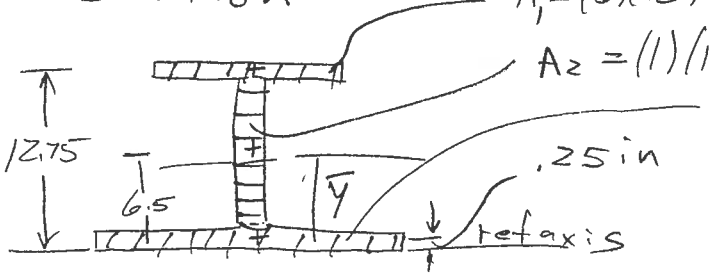
A beam of the cross-section is subjected to a shear force of 4,000 lb. Calculate the maximum shearing stress in the beam and give its location.



98 % of the time the maximum shearing stress will be at the centroid. In this case, this is true because the thickness is constant through the web.

First we locate the centroid of the section



$$\bar{y} = \frac{\sum A_i y_i}{\sum A_i}$$

(11)

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(2) $\bar{y} = \dfrac{(3)(12.75)+(12)(6.5)+(6)(.25)}{3+12+6}$

(3) $\bar{y} = 5.607$ in

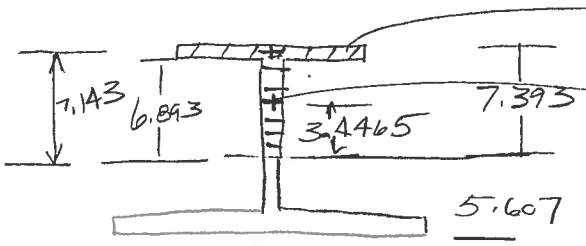
Next we calculate the moment of inertia about the centroidal axis.

(4) $I = \frac{1}{12}(6)(.5)^3 + (6)(.5)(12.75-5.607)^2 + \frac{1}{12}(1)(12)^3 + (1)(12)(6.5-5.607)^2 + \frac{1}{12}(12)(.5)^3 + (12)(.5)(.25-5.607)^2$

(5) $I = .0625 + 153.1 + 144 + 9.569 + .125 + 172.2$

(6) $I = 479.1$ in^4

Next we calculate Q_{max} at the centroid



$A_1 = (6)(.5) = 3$ in^2

$A_2 = (1)(6.893) = 6.893$ in^2

(7) $Q_{max} = \sum A_i y_i$

(8) $Q_{max} = (3)(7.143) + (6.893)(3.4465)$

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(9) $Q_{max} = 21.429 + 23.757$

(10) $Q_{max} = 45.186 \text{ in}^3$

Finally, calculate the maximum shear stress is calculated as follows:

(11) $$\tau = \frac{VQ}{Ib}$$

(12) $$\tau = \frac{(4000)(45.186)}{1479.1\,(1)}$$

(13) $\tau = 377.3 \text{ psi}$

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