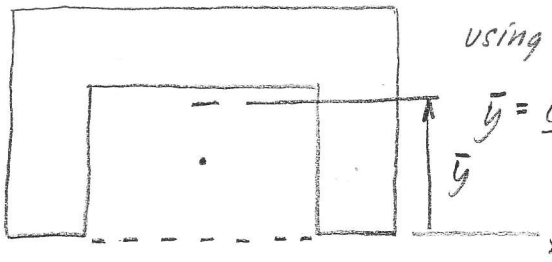
K. Dennehy Ch. 7, Pgs 382-385: 7-9, 7-19, 7-26

(7-9)



using outer (5in × 3in) & inner (3in × 2in) rectangles

$$\bar{y} = \frac{(1.5\text{in})(5\text{in})(3\text{in}) - (1\text{in})(3\text{in})(2\text{in})}{(5\text{in})(3\text{in}) - (3\text{in})(2\text{in})} = 1.833\text{ in}$$

$$\tau_{max} = \frac{VQ}{It}$$

$$V_{max} = \frac{\tau_{max} I t}{Q}$$

$$V_{max} = \frac{\left(8\ \frac{\text{kip}}{\text{in}^2}\right)(6.750\ \text{in}^4)(2(1\text{in}))}{3.360\ \text{in}^3} = \boxed{32.1\ \text{kip}}$$

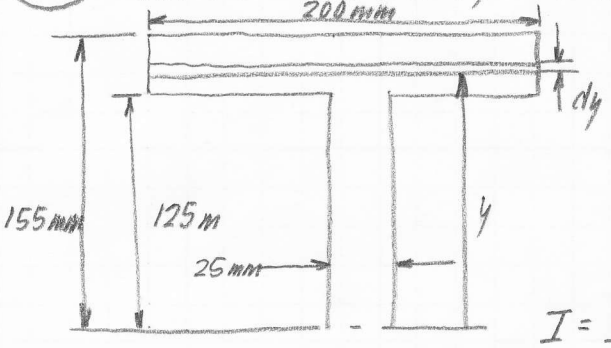
$$I = \frac{1}{12}(5\text{in})(3\text{in})^3 + (5\text{in})(3\text{in})(1.833\text{in} - 1.5\text{in})^2 - \left(\frac{1}{12}(3\text{in})(2\text{in})^3 + (3\text{in})(2\text{in})(1.833\text{in} - 1\text{in})^2\right)$$

$$= 6.750\ \text{in}^4$$

$Q = \bar{y}' A'$ (working with bottom)

$$= \left(\frac{1.833\text{ in}}{2}\right) 2\left((1.833\text{in})(1\text{in})\right) = 3.360\ \text{in}^3$$

(7-19) shear force resisted by the web = 20 kN − (2)(shear force resisted by a flange)



$$Q = \bar{y}' A'$$

$$\bar{y}' = \frac{(0.155\text{m} - y)}{2} + y = 0.0775\text{m} + 0.5y$$

$$A' = (0.155\text{m} - y)(0.200\text{m}) = 0.031\text{m}^2 - 0.200\text{m}\,y$$

$$Q = (0.0775 + 0.5y)(0.031 - 0.200y)\ (\text{m}^3) = -0.100y^2 + 0.00240\ (\text{m}^3)$$

$$I = \frac{1}{12}(0.200\text{m})(0.310\text{m})^3 - \frac{1}{12}(0.200\text{m} - 0.025\text{m})(0.250\text{m})^3$$

$$= 2.6865 \times 10^{-4}\ \text{m}^4$$

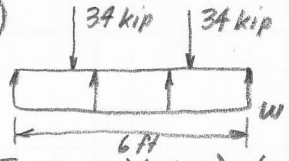
$$\tau = \frac{VQ}{It} = \frac{(30\text{kN})(-0.100y^2 + 0.00240)(\text{m}^3)}{(2.6865 \times 10^{-4}\ \text{m}^4)(0.200\text{m})} = -55,834.3y^2 + 1,340.0\ (\text{kPa})$$

$$V_{flange} = \int_{A_{flange}} \tau\, dA = \int_{0.125\text{m}}^{0.155\text{m}} (-55,834.3y^2 + 1,340.0)\left(\frac{\text{kN}}{\text{m}^2}\right)(0.200\text{m})\,dy$$

$$= -3,722.3y^3 + 268.0y \Big|_{0.125}^{0.155}\ (\text{kN}) = 27.679 - 26.230\ (\text{kN}) = 1.449\ \text{kN}$$

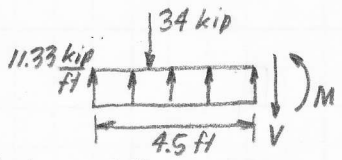
$$V_{web} = 30\text{ kN} - (2)(1.449\text{ kN}) = \boxed{27.1\ \text{kN}}$$

(7-26)



$\Sigma F_y = 0$, $(2)(34\text{kip}) - (6\text{ft})(w) = 0$

$$\boxed{w = 11.33\ \frac{\text{kip}}{\text{ft}}}$$



$\Sigma F_y = 0$,

$34\text{ kip} - (4.5\text{ft})\left(11.33\ \frac{\text{kip}}{\text{ft}}\right) + V = 0$

$V = 17.0\text{ kip}$

$$\tau_{max} = \frac{VQ}{It}$$

for rectangular x-section

$$\tau_{max} = \frac{3}{2}\frac{V}{A} = \frac{3}{2}\frac{(17.0\text{ kip})}{(8\text{in})(6\text{in})} = 0.53125\ \text{ksi}$$

or $\boxed{531\ \text{psi}}$