Homework problems 32-35
Due in class, Friday, 6 November 2020

32. If the beam is subjected to a shear of V = 30 kN, determine the web's shear stress at A and B. Indicate the shear-stress components on a volume element located at these points. (a) Set w = 300 mm; (b) Set w = 200 mm.

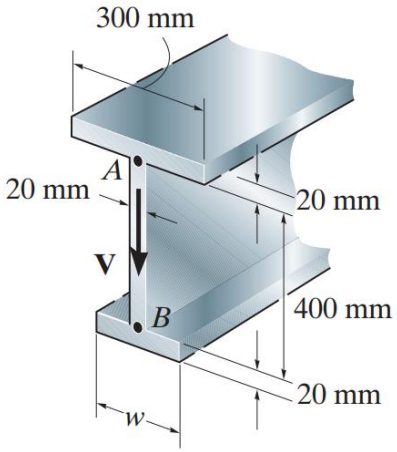


Figure 32

33. The composite beam is constructed from wood and reinforced with a steel strap. Determine the maximum shear stress in the beam when it is subjected to a shear of V = 50 kN. Take E_{st} = 200 GPa, E_w = 15 GPa.

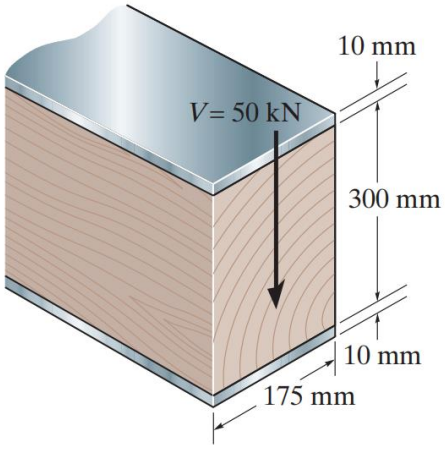
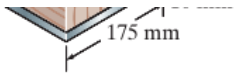


Figure 33

SOLUTION



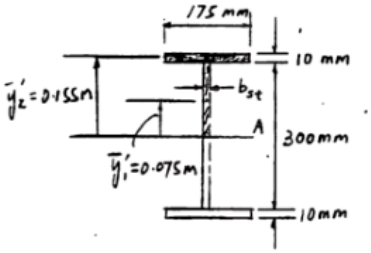
$$b_{st} = nb_w = \frac{15}{200}(0.175) = 0.013125 \text{ m}$$

$$I = \frac{1}{12}(0.175)(0.32^3) - \frac{1}{12}(0.175 - 0.013125)(0.3^3) = 0.113648(10^{-3}) \text{ m}^4$$

$$Q_{\max} = \Sigma \bar{y}' A' = 0.075(0.013125)(0.15) + 0.155(0.175)(0.01) = 0.4189(10^{-3}) \text{ m}^3$$

$$\tau_{\max} = n\frac{VQ_{\max}}{It} = \left(\frac{15}{200}\right)\frac{50(10^3)(0.4189)(10^{-3})}{0.113648(10^{-3})(0.013125)}$$

$$= 1.05 \text{ MPa} \quad \textbf{Ans.}$$



34. A beam is constructed from three boards bolted together as shown. Determine the shear force in each bolt if the bolts are spaced s = 250 mm apart and the shear is V = 35 kN.

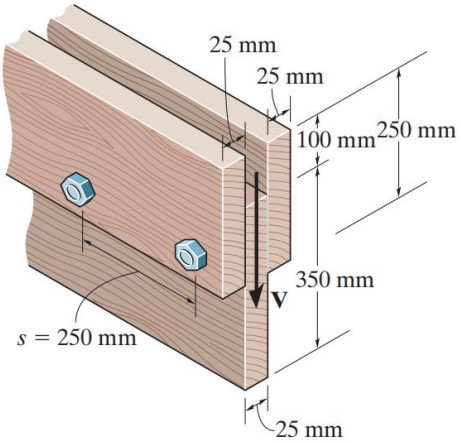
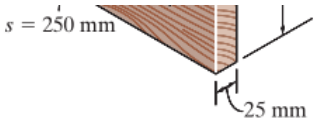
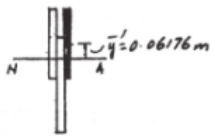


Figure 34

SOLUTION



$$\bar{y} = \frac{2\,(0.125)(0.25)(0.025) + 0.275\,(0.35)(0.025)}{2\,(0.25)(0.025) + 0.35\,(0.025)} = 0.18676\ \text{m}$$



$$I = (2)\left(\frac{1}{12}\right)(0.025)(0.25^3) + 2\,(0.025)(0.25)(0.18676 - 0.125)^2$$

$$+ \frac{1}{12}\,(0.025)(0.35)^3 + (0.025)(0.35)(0.275 - 0.18676)^2$$

$$= 0.270236\,(10^{-3})\ \text{m}^4$$

$$Q = \bar{y}'A' = 0.06176(0.025)(0.25) = 0.386(10^{-3})\ \text{m}^3$$

$$q = \frac{VQ}{I} = \frac{35(0.386)(10^{-3})}{0.270236(10^{-3})} = 49.997\ \text{kN/m}$$

$$F = q(s) = 49.997\,(0.25) = 12.5\ \text{kN}$$ **Ans.**

35. The H-beam is subjected to a shear of V = 80 kN. Determine the shear flow at point A.

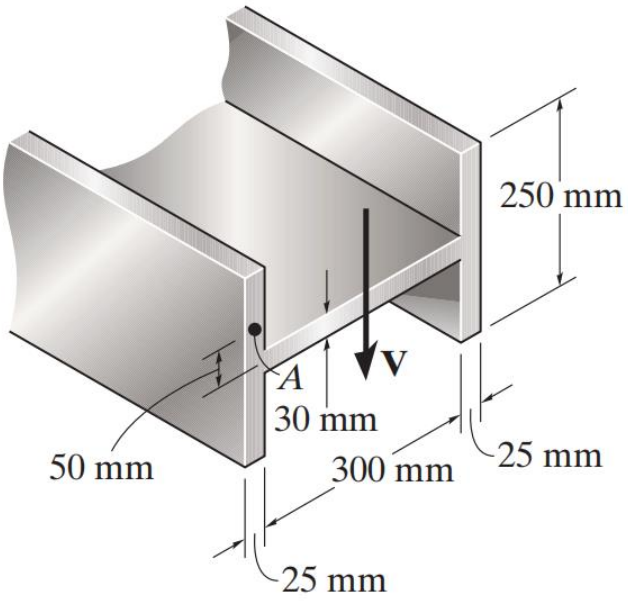
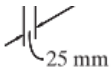


Figure 35

SOLUTION



$$I = 2\left[\frac{1}{12}(0.025)(0.25^3) + \frac{1}{12}(0.3)(0.03^3)\right] = 65.7792(10^{-6})\ \text{m}^4$$

$$Q_A = \bar{y}'A' = 0.0875(0.075)(0.025) = 0.1641(10^{-3})\ \text{m}^3$$

$$q_A = \frac{VQ_A}{I} = \frac{80(10^3)(0.1641)(10^{-3})}{65.7792(10^{-6})} = 200\ \text{kN/m}$$ **Ans.**