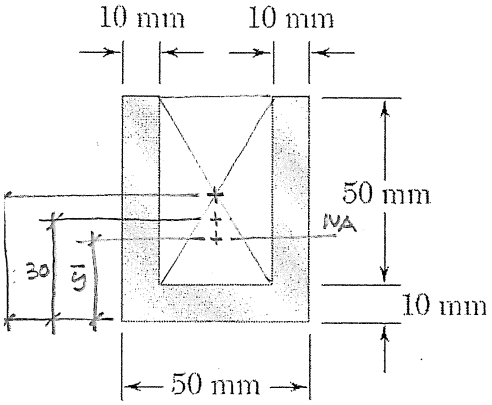
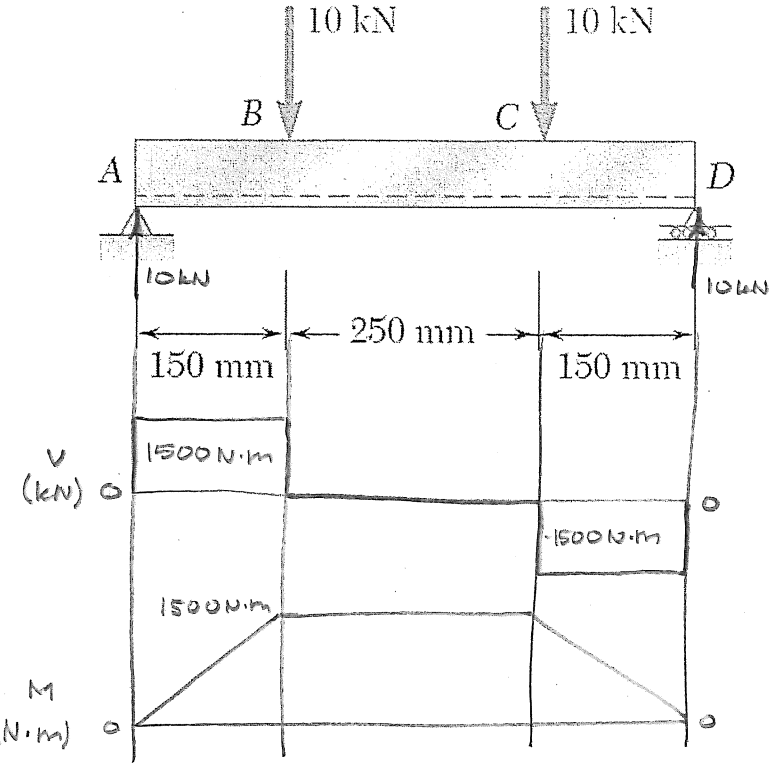
1) GIVEN: Two vertical forces are applied to a beam of the cross section shown. (B11.97)




REQ'D: A) $V_{max}$ and $M_{max}$

$V_{max} = 1000\ N$

$M_{max} = 1500\ N \cdot m$

B) Centroid location, $\bar{y}$

$$\bar{y} = \frac{\Sigma Ad}{\Sigma A} = \frac{.05(.06)(.03) - (.05)(.03)(.035)}{.05(.06) - (.05)(.03)}$$

$$= .025\ m$$

C) Moment of inertia about neutral axis, $I_{NA}$

$$I_{NA} = \bar{I} + Ad^2$$

$$= \left[\frac{.05(.06)^3}{12} + .05(.06)(.005)^2\right] - \left[\frac{.03(.05)^3}{12} + .03(.05)(.01)^2\right]$$

$$= 975 \times 10^{-9} - 462.5 \times 10^{-9}\ m^4$$

$$= 512.5 \times 10^{-9}\ m^4$$

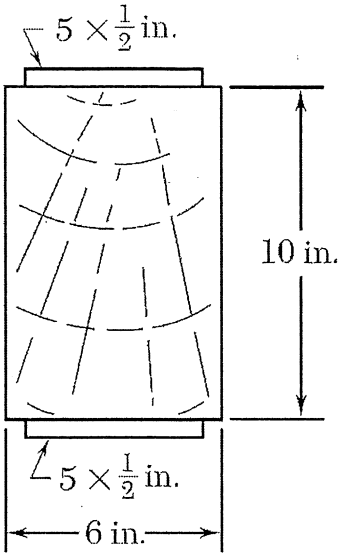
D) Maximum compressive and tensile bending stress

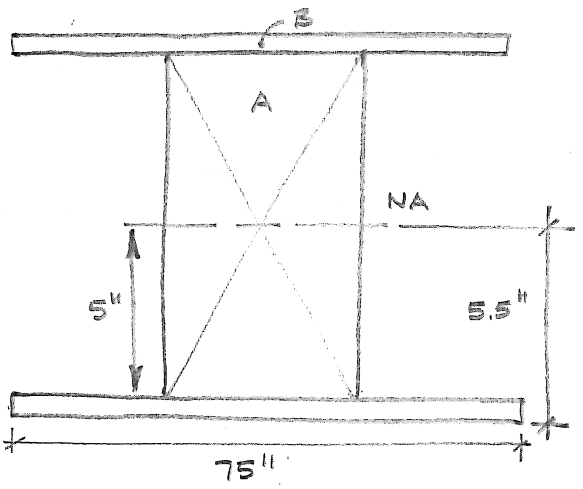
$$\sigma_c = \frac{Mc}{I} = \frac{(1500\ N \cdot m)(.06 - .025\ m)}{512.5 \times 10^{-9}\ m^4} = 102.4 \times 10^6\ Pa\ (C)$$

$$\sigma_T = \frac{Mc}{I} = \frac{(1500\ N \cdot m)(.025\ m)}{512.5 \times 10^{-9}\ m^4} = 73.17 \times 10^6\ Pa\ (T)$$

**2)** GIVEN: The composite beam shown.

| | Wood | Steel |
|---|---|---|
| Modulus of elasticity | $2 \times 10^6$ psi | $30 \times 10^6$ psi |
| Allowable stress | 2000 psi | 22 ksi |




REQ'D: A) Transformation factor, n (draw transformed section)

$$n = \frac{E_s}{E_w} = \frac{30 \times 10^6 \text{ psi}}{2 \times 10^6 \text{ psi}} = 15$$

B) Locate $\bar{y}$ and calculate $I_t$ about the NA for the transformed section

$$I_T = I_A + I_B$$

$$= \left[\frac{6''(10'')^3}{12}\right]_A + 2\left[\frac{75''(.5'')^3}{12} + 75''(.5'')(5.25'')^2\right]$$

$$= 500 \text{ in}^4 + 1034.4 \text{ in}^4 = 1534.4 \text{ in}^4$$

C) Maximum allowable bending moment

FOR WOOD:

$$\sigma = \frac{Mc}{I} \Rightarrow M_{allow} = \frac{\sigma_{allow} I}{c}$$

$$= \frac{2000 \text{ psi}\,(1534.4 \text{ in}^4)}{5 \text{ in - TO OUTER FIBER OF WOOD}}$$

$$= 614 \times 10^3 \text{ in·lb} \Rightarrow 614 \text{ kip·in}$$

FOR STEEL:

$$\sigma = \frac{Mc_n}{I} \Rightarrow M_{allow} = \frac{\sigma_{allow} I}{c_n}$$

$$= \frac{(22 \times 10^3 \text{ psi})(1534.4 \text{ in}^4)}{(5.5 \text{ in})(15)}$$

$$= 409 \times 10^3 \text{ in·lb} \Rightarrow 409 \text{ kip·in}$$