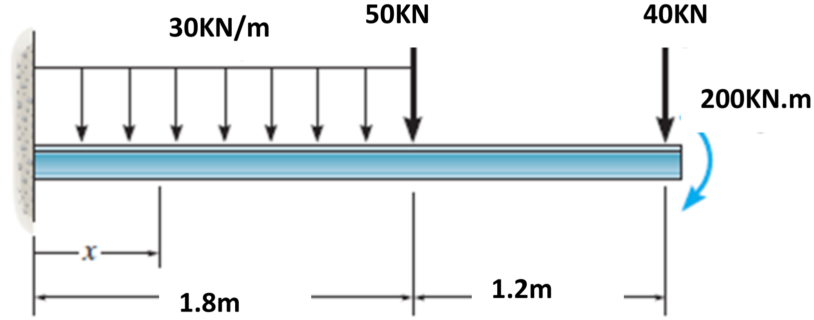
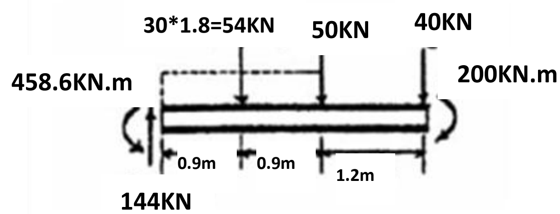
6-18. Draw the shear and moment diagrams for the beam, and determine the shear and moment throughout the beam as functions of *x*.



Support Reactions: As shown on FBD.

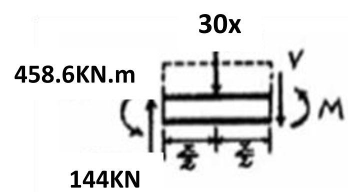
Shear and Moment Function:



For $0 \leq x < 1.8\,m$:

$+\uparrow \Sigma F_y = 0;$ $144 - 30x - V = 0$

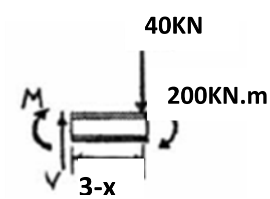
$V = (144 - 30x)KN.$ $Ans.$



$\circlearrowleft + \Sigma M_{NA} = 0;$ $M + 458.6 + 30x\left(\frac{x}{2}\right) - 144x = 0;$

$M = (-15x^2 + 144x - 458.6)KN.m$ $Ans.$

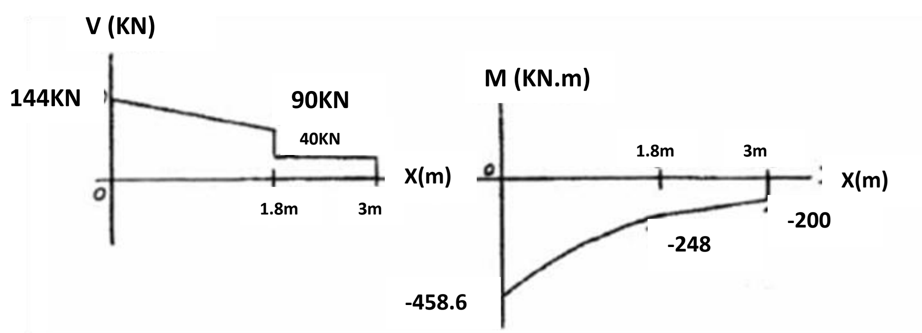
For 6 ft $< x \leq$ 10 ft:



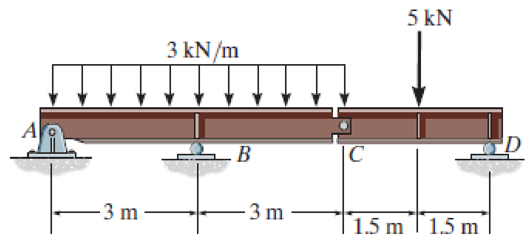
$+\uparrow \Sigma F_y = 0;$ $V - 40 = 0;$ $V = 40\,KN$ $Ans.$

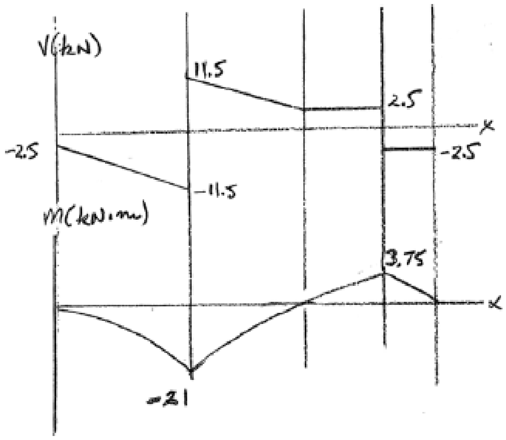
$\circlearrowleft + \Sigma M_{NA} = 0;$ $-M - 40(x - 3) - 200 = 0;$

$M = (40x - 320)KN.m$ $Ans.$

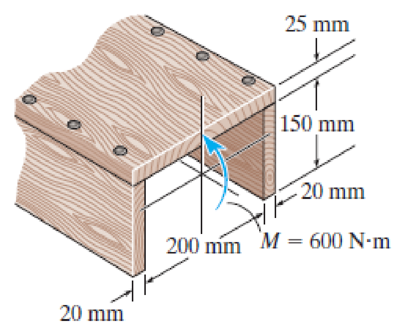


6–34. Draw the shear and moment diagrams for the compound beam.

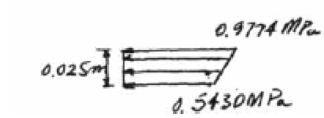




6–55. The beam is made from three boards nailed together as shown. If the moment acting on the cross section is $M = 600\ \text{N}\cdot\text{m}$, determine the resultant force the bending stress produces on the top board.



$$\bar{y} = \frac{(0.0125)(0.24)(0.025) + 2\,(0.15)(0.1)(0.02)}{0.24\,(0.025) + 2\,(0.15)(0.02)} = 0.05625\ \text{m}$$



$$I = \frac{1}{12}(0.24)(0.025^3) + (0.24)(0.025)(0.04375^2)$$

$$+\,2\left(\frac{1}{12}\right)(0.02)(0.15^3) + 2(0.15)(0.02)(0.04375^2)$$

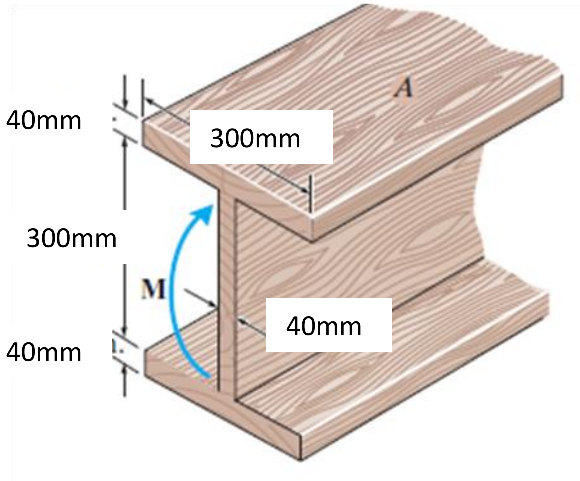
$$= 34.53125\,(10^{-6})\ \text{m}^4$$

$$\sigma_1 = \frac{My}{I} = \frac{600(0.05625)}{34.53125(10^{-6})} = 0.9774\ \text{MPa}$$

$$\sigma_b = \frac{My}{I} = \frac{600(0.05625 - 0.025)}{34.53125(10^{-6})} = 0.5430\ \text{MPa}$$

$$F = \frac{1}{2}(0.025)(0.9774 + 0.5430)(10^6)(0.240) = 4.56\ \text{kN}$$ **Ans.**

6–66. If M= 6 KN.m, determine the resultant force the bending stress produces on the top board *A* of the beam.



The moment of inertia of the cross-section about the neutral axis is

$$I = \frac{1}{12} * 300 * 380^3 - \frac{1}{12} * 260 * 300^3 = 786800000\, mm^4$$

Along the top edge of the flange c = y =190 mm .Thus

$$\sigma_{max} = \frac{Mc}{I} = \frac{6 * 10^6 * 190}{786800000} = \mathbf{1.45\ MPa}.$$

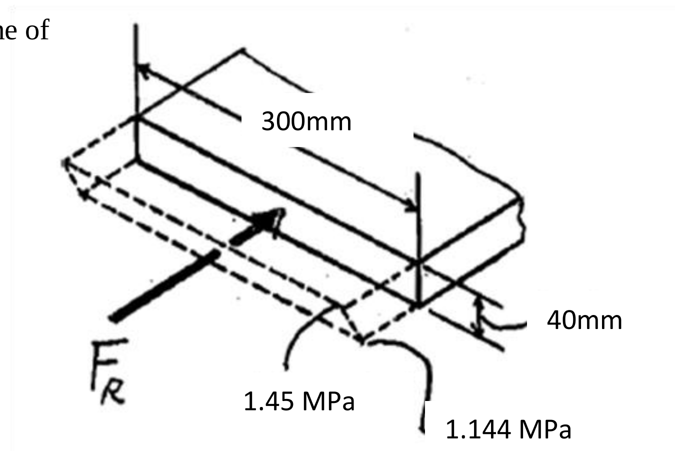
Along the bottom edge of the flange y = 150 mm, .Thus

$$\sigma_{max} = \frac{My}{I} = \frac{6 * 10^6 * 150}{786800000} = \mathbf{1.144\ MPa}.$$

The resultant force acting on board *A* is equal to the volume of the trapezoidal stress block shown in Fig. *a*.

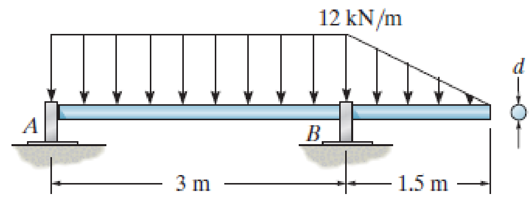
$$F_R = \frac{1}{2}(1.45 + 1.144) * 40 * 300$$

$$F_R = 15563.24\, N.$$



(a)

6–67. The rod is supported by smooth journal bearings at A and B that only exert vertical reactions on the shaft. If $d = 90$ mm, determine the absolute maximum bending stress in the beam, and sketch the stress distribution acting over the cross section.



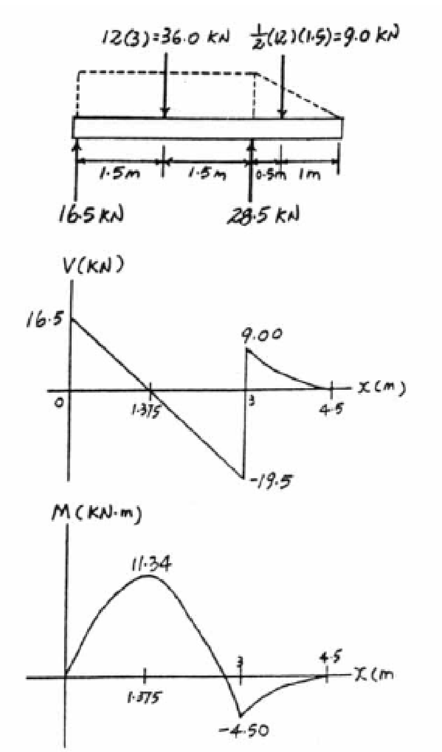
Absolute Maximum Bending Stress: The maximum moment is $M_{max} = 11.34$ kN · m as indicated on the moment diagram. Applying the flexure formula

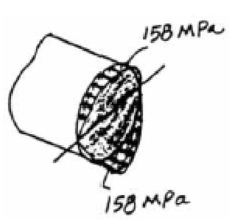
$$\sigma_{max} = \frac{M_{max}\, c}{I}$$

$$= \frac{11.34(10^3)(0.045)}{\frac{\pi}{4}(0.045^4)}$$

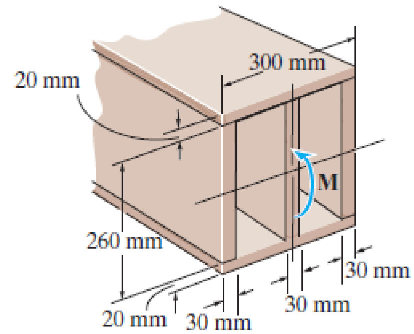
$$= 158 \text{ MPa}$$

Ans.





*6–76. Determine the moment **M** that must be applied to the beam in order to create a maximum stress of 80 MPa. Also sketch the stress distribution acting over the cross section.



The moment of inertia of the cross-section about the neutral axis is

$$I = \frac{1}{12}(0.3)(0.3^3) - \frac{1}{12}(0.21)(0.26^3) = 0.36742(10^{-3})\ \text{m}^4$$

Thus,

$$\sigma_{\max} = \frac{Mc}{I}; \qquad 80(10^6) = \frac{M(0.15)}{0.36742(10^{-3})}$$

$$M = 195.96\ (10^3)\ \text{N}\cdot\text{m} = 196\ \text{kN}\cdot\text{m} \qquad \textbf{Ans.}$$

The bending stress distribution over the cross-section is shown in Fig. *a*.