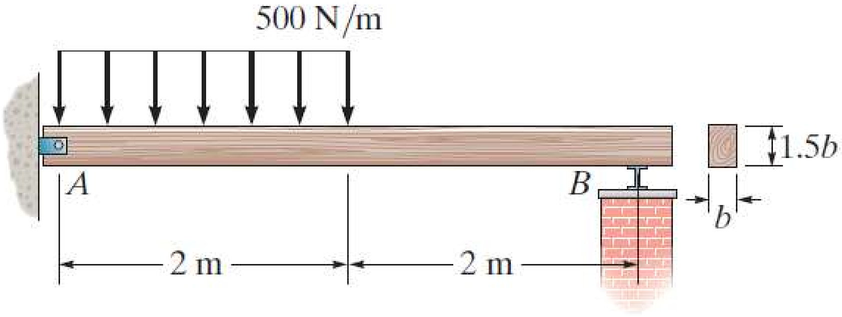
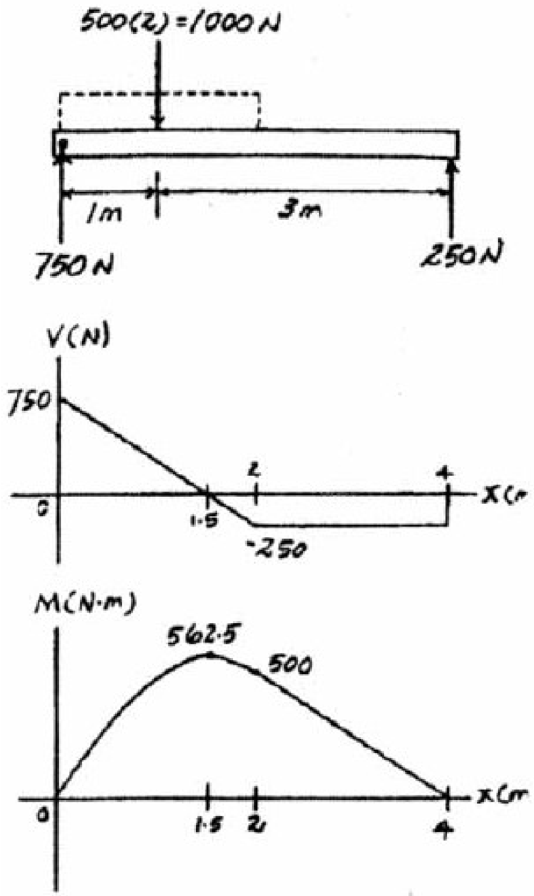
The wood beam has a rectangular cross section in the proportion shown. Determine its required dimension b if the allowable bending stress is $\sigma_{allow} = 10$ MPa.



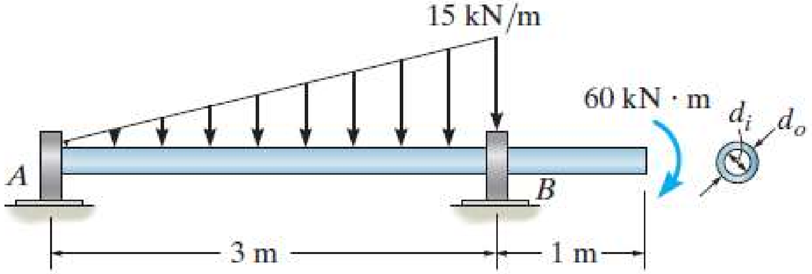
$$\sigma_{max} = \sigma_{allow} = \frac{M_{max}\, c}{I}$$

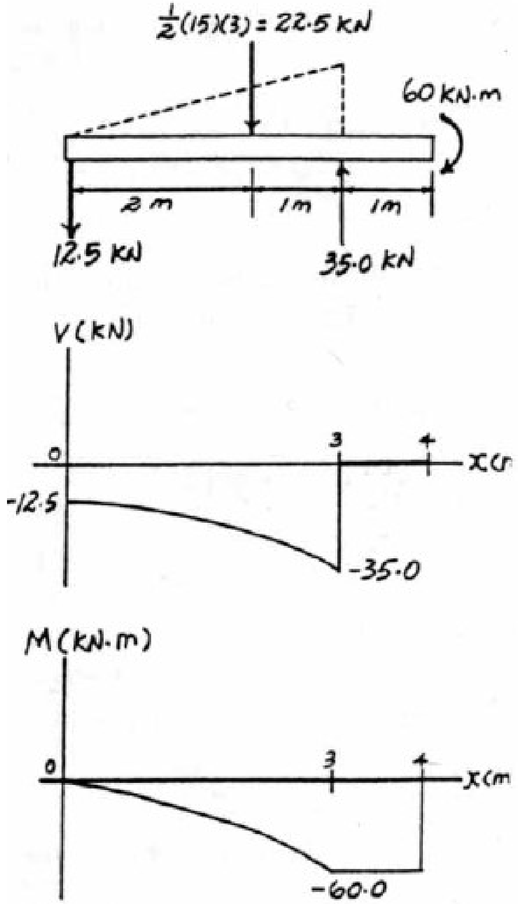
$$10\left(10^6\right) = \frac{562.5(0.75b)}{\frac{1}{12}(b)(1.5b)^3}$$

$$b = 0.05313 \text{ m} = 53.1 \text{ mm}$$



The tubular shaft is to have a cross section such that its inner diameter and outer diameter are related by $d_i = 0.8d_o$. Determine these required dimensions if the allowable bending stress is $\sigma_{\text{allow}} = 155$ MPa.





$$I = \frac{\pi}{4}\left[\left(\frac{d_o}{2}\right)^4 - \left(\frac{d_i}{2}\right)^4\right] = \frac{\pi}{4}\left[\frac{d_o{}^4}{16} - \left(\frac{0.8d_o}{2}\right)^4\right] = 0.009225\pi d_o^4$$

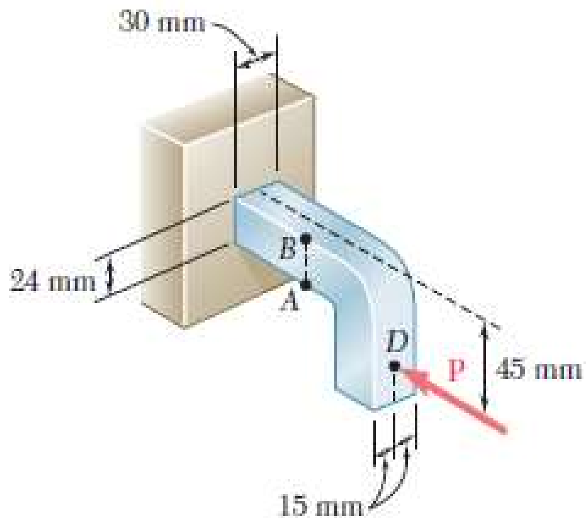
$$\sigma_{\max} = \sigma_{\text{allow}} = \frac{M_{\max}c}{I}$$

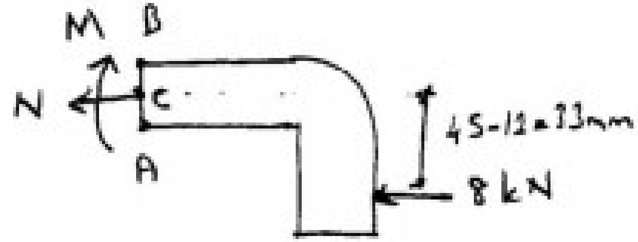
$$155\left(10^6\right) = \frac{60.0(10^3)\left(\frac{d_o}{2}\right)}{0.009225\pi d_o^4}$$

$$d_o = 0.1883 \text{ m} = 188 \text{ mm}$$

$$d_i = 0.8d_o = 151 \text{ mm}$$

Knowing that the magnitude of the horizontal force **P** is 8 kN, determine the bending stress at (*a*) point *A*, (*b*) point *B*.

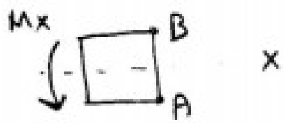




$$\Sigma M_C = 0$$

$$-M - (8\times10^3)(0.033) = 0$$

$$M = -264 \text{ N.m}$$

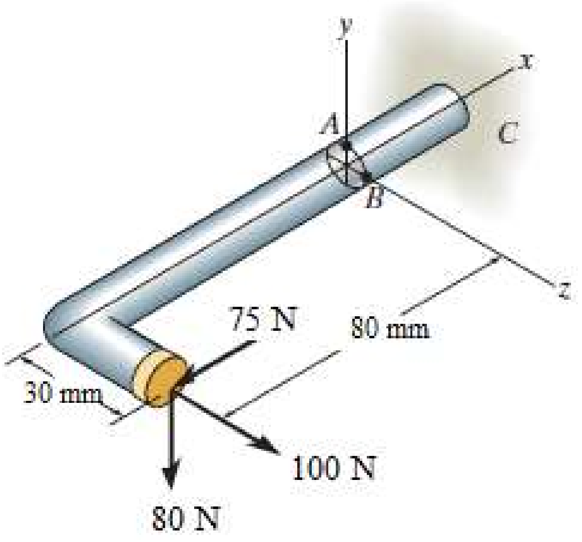


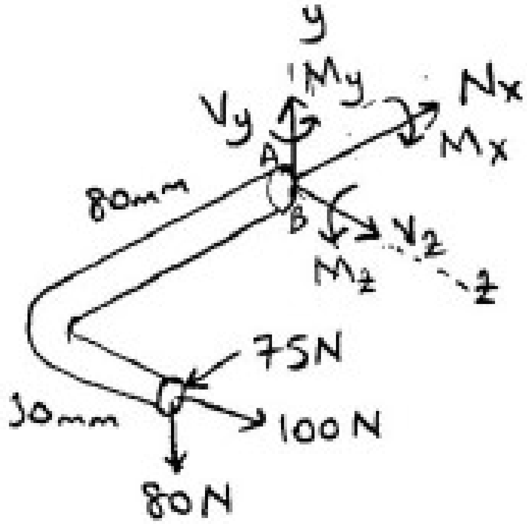
$$I = \frac{1}{12}bh^3 = \frac{1}{12}(30)(24)^3 = 34.56\times10^3 \text{ mm}^4 = 34.56\times10^{-9} \text{ m}^4$$

$$\sigma_A = -\frac{Mc}{I} = -\frac{(264)(0.012)}{34.56\times10^{-9}} = -916.67 \text{ MPa}$$

$$\sigma_B = +\frac{Mc}{I} = \frac{(264)(0.012)}{34.56\times10^{-9}} = 916.67 \text{ MPa}$$

The 10-mm-diameter rod is subjected to the loads shown
Determine the bending stress at point A.





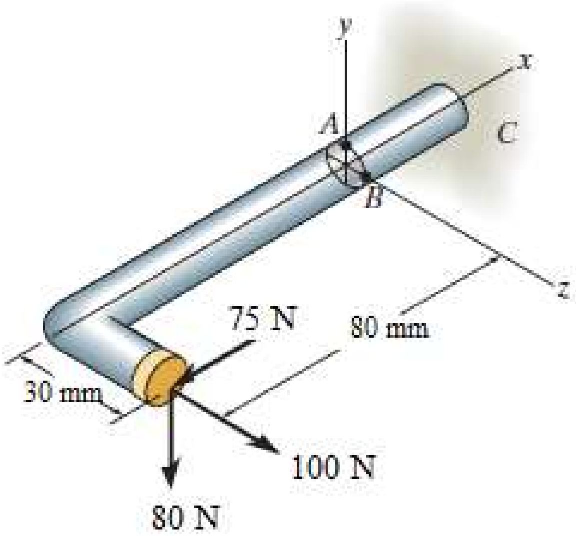
$\Sigma M_z = 0: \ M_z + (80)(0.08) = 0 \qquad M_z = -6.4 \text{ N.m}$

$\Sigma M_x = 0: \ M_x + (80)(0.03) = 0 \qquad M_x = T = -2.4 \text{ N.m}$

$\Sigma M_y = 0: \ M_y - (75)(0.03) + (100)(0.08) = 0$

$M_y = -5{,}75 \text{ N.m}$

The 10-mm-diameter rod is subjected to the loads shown. Determine the bending stress at point *A*.

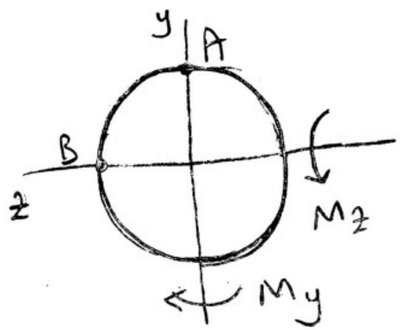


$M_z = -6.4\ N.m$

$M_x = -2.4\ N.m$

$M_y = -5,75\ N.m$

$I_y = I_z = \frac{\pi}{4} r^4 = \frac{\pi}{4} (0.005)^4 = 4.91\times10^{-10}\ m^4$



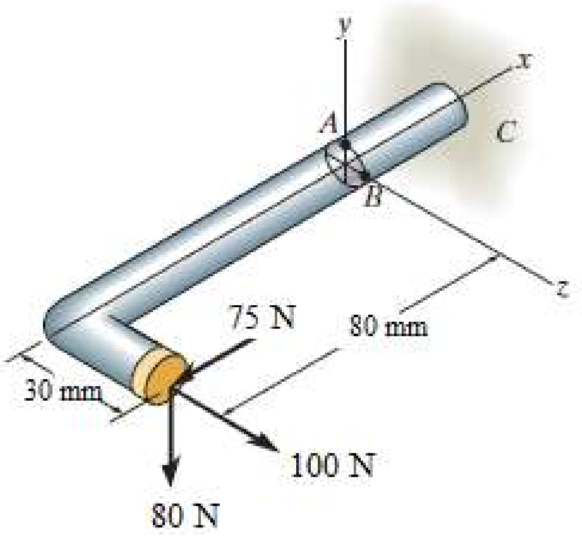
$\sigma_z = -\frac{M_z \cdot y}{I_z} = -\frac{(-6.4)(0.005)}{4.91\times10^{-10}} = 65.19\times10^{6}\ Pa$

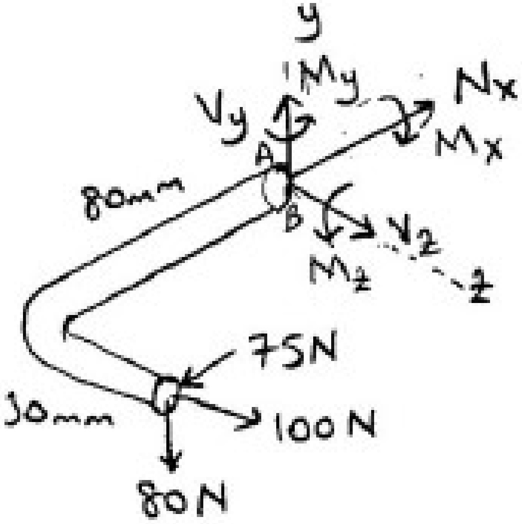
$= 65.19\ MPa$

$\sigma_y = -\frac{M_y \cdot z}{I_y}$ $\quad z = 0$

$\sigma_y = 0$

The 10-mm-diameter rod is subjected to the loads shown. Determine the bending stress at point B.



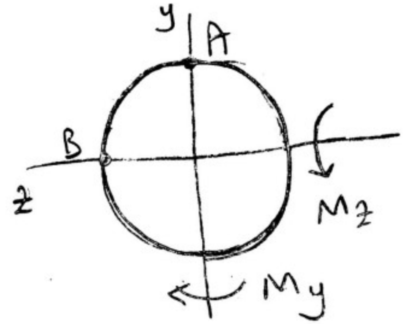


$M_z = -6.4\ \mathrm{N.m}$

$M_x = -2.4\ \mathrm{N.m}$

$M_y = -5.75\ \mathrm{N.m}$

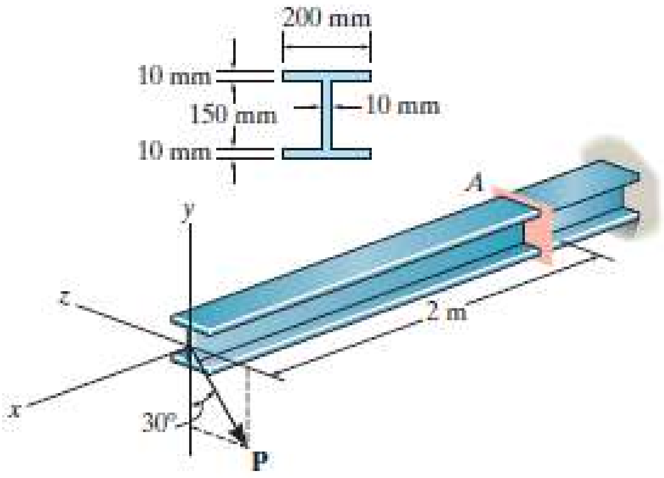
$$I_y = I_z = \frac{\pi}{4} r^4 = \frac{\pi}{4} (0.005)^4 = 4.91 \times 10^{-10}\ \mathrm{m}^4$$

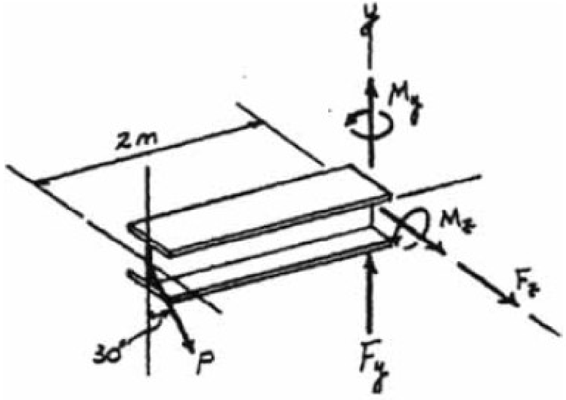


$$\sigma_z = -\frac{M_z \cdot y}{I_z} \qquad y = 0 \qquad \sigma_z = 0$$

$$\sigma_y = \frac{M_y \cdot z}{I_y} = \frac{(-5.75)(0.005)}{4.91 \times 10^{-10}} = -5855 \times 10^6\ \mathrm{Pa} = -58.55\ \mathrm{MPa}$$

The cantilevered wide-flange steel beam is subjected to the concentrated force **P** at its end. Determine the largest magnitude of this force so that the bending stress developed at A does not exceed $\sigma_{allow} = 180$ MPa.



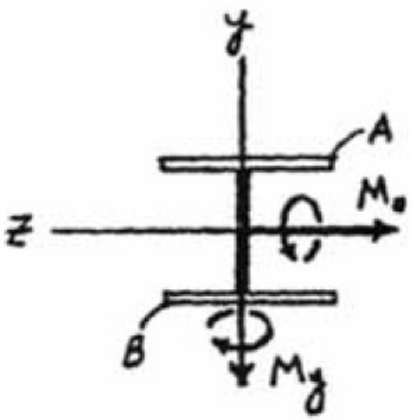


$\Sigma M_z = 0;$

$M_z + P\cos 30°(2) = 0 \quad M_z = -1.732P$

$\Sigma M_y = 0;$

$M_y + P\sin 30°(2) = 0 \quad M_y = -1.00P$



$$I_z = \frac{1}{12}(0.2)(0.17^3) - \frac{1}{12}(0.19)(0.15^3) = 28.44583(10^{-6})\text{ m}^4$$

$$I_y = 2\left[\frac{1}{12}(0.01)(0.2^3)\right] + \frac{1}{12}(0.15)(0.01^3) = 13.34583(10^{-6})\text{ m}^4$$

$$\sigma_A = \sigma_{allow} = -\frac{M_z y}{I_z} + \frac{M_y z}{I_y}$$

$$180(10^6) = -\frac{(-1.732P)(0.085)}{28.44583(10^{-6})} + \frac{-1.00P(-0.1)}{13.34583(10^{-6})}$$

$$P = 14208\text{ N} = 14.2\text{ kN}$$