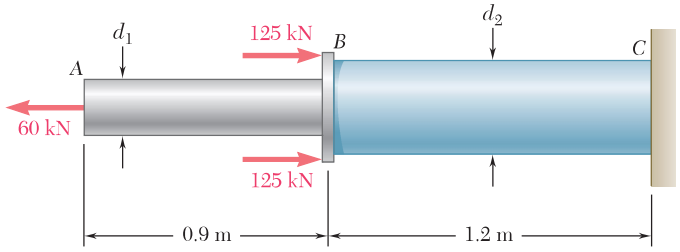


PROBLEM 1.1

Two solid cylindrical rods AB and BC are welded together at B and loaded as shown. Knowing that $d_1 = 30$ mm and $d_2 = 50$ mm, find the average normal stress at the midsection of (*a*) rod AB, (*b*) rod BC.

SOLUTION

(*a*) Rod AB:

Force: $P = 60 \times 10^3$ N tension

Area: $A = \dfrac{\pi}{4} d_1^2 = \dfrac{\pi}{4}(30 \times 10^{-3})^2 = 706.86 \times 10^{-6}\ \text{m}^2$

Normal stress: $\sigma_{AB} = \dfrac{P}{A} = \dfrac{60 \times 10^3}{706.86 \times 10^{-6}} = 84.882 \times 10^6\ \text{Pa}$

$\sigma_{AB} = 84.9$ MPa ◀

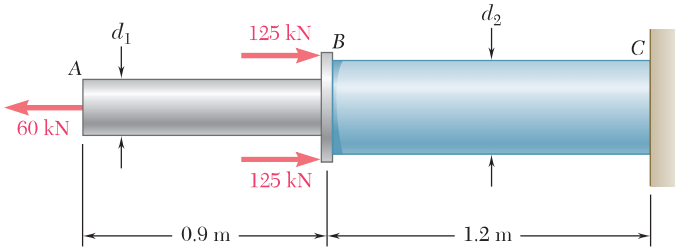
(*b*) Rod BC:

Force: $P = 60 \times 10^3 - (2)(125 \times 10^3) = -190 \times 10^3$ N

Area: $A = \dfrac{\pi}{4} d_2^2 = \dfrac{\pi}{4}(50 \times 10^{-3})^2 = 1.96350 \times 10^{-3}\ \text{m}^2$

Normal stress: $\sigma_{BC} = \dfrac{P}{A} = \dfrac{-190 \times 10^3}{1.96350 \times 10^{-3}} = -96.766 \times 10^6\ \text{Pa}$

$\sigma_{BC} = -96.8$ MPa ◀



PROBLEM 1.2

Two solid cylindrical rods *AB* and *BC* are welded together at *B* and loaded as shown. Knowing that the average normal stress must not exceed 150 MPa in either rod, determine the smallest allowable values of the diameters d_1 and d_2.

SOLUTION

(*a*) Rod *AB*:

Force: $P = 60 \times 10^3 \text{ N}$

Stress: $\sigma_{AB} = 150 \times 10^6 \text{ Pa}$

Area: $A = \dfrac{\pi}{4} d_1^2$

$$\sigma_{AB} = \frac{P}{A} \quad \therefore \quad A = \frac{P}{\sigma_{AB}}$$

$$\frac{\pi}{4} d_1^2 = \frac{P}{\sigma_{AB}}$$

$$d_1^2 = \frac{4P}{\pi \sigma_{AB}} = \frac{(4)(60 \times 10^3)}{\pi (150 \times 10^6)} = 509.30 \times 10^{-6} \text{ m}^2$$

$$d_1 = 22.568 \times 10^{-3} \text{ m} \qquad d_1 = 22.6 \text{ mm} \blacktriangleleft$$

(*b*) Rod *BC*:

Force: $P = 60 \times 10^3 - (2)(125 \times 10^3) = -190 \times 10^3 \text{ N}$

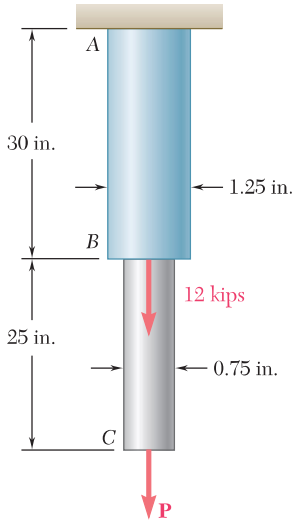
Stress: $\sigma_{BC} = -150 \times 10^6 \text{ Pa}$

Area: $A = \dfrac{\pi}{4} d_2^2$

$$\sigma_{BC} = \frac{P}{A} = \frac{4P}{\pi d_2^2}$$

$$d_2^2 = \frac{4P}{\pi \sigma_{BC}} = \frac{(4)(-190 \times 10^3)}{\pi (-150 \times 10^6)} = 1.61277 \times 10^{-3} \text{ m}^2$$

$$d_2 = 40.159 \times 10^{-3} \text{ m} \qquad d_2 = 40.2 \text{ mm} \blacktriangleleft$$



PROBLEM 1.3

Two solid cylindrical rods AB and BC are welded together at B and loaded as shown. Knowing that $P = 10$ kips, find the average normal stress at the midsection of (a) rod AB, (b) rod BC.

SOLUTION

(a) Rod AB:

$$P = 12 + 10 = 22 \text{ kips}$$

$$A = \frac{\pi}{4} d_1^2 = \frac{\pi}{4}(1.25)^2 = 1.22718 \text{ in}^2$$

$$\sigma_{AB} = \frac{P}{A} = \frac{22}{1.22718} = 17.927 \text{ ksi} \qquad \sigma_{AB} = 17.93 \text{ ksi} \blacktriangleleft$$

(b) Rod BC:

$$P = 10 \text{ kips}$$

$$A = \frac{\pi}{4} d_2^2 = \frac{\pi}{4}(0.75)^2 = 0.44179 \text{ in}^2$$

$$\sigma_{AB} = \frac{P}{A} = \frac{10}{0.44179} = 22.635 \text{ ksi} \qquad \sigma_{AB} = 22.6 \text{ ksi} \blacktriangleleft$$