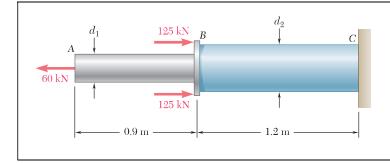


#### PROBLEM 1.1

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*: $P = 60 \times 10^3 \,\mathrm{N}$ tension Force: $A = \frac{\pi}{4}d_1^2 = \frac{\pi}{4}(30 \times 10^{-3})^2 = 706.86 \times 10^{-6} \,\mathrm{m}^2$ Area: $\sigma_{AB} = \frac{P}{A} = \frac{60 \times 10^3}{706.86 \times 10^{-6}} = 84.882 \times 10^6 \,\mathrm{Pa}$ Normal stress: $\sigma_{AB} = 84.9 \text{ MPa} \blacktriangleleft$ *(b)* Rod BC: $P = 60 \times 10^3 - (2)(125 \times 10^3) = -190 \times 10^3 \text{ N}$ Force: $A = \frac{\pi}{4}d_2^2 = \frac{\pi}{4}(50 \times 10^{-3})^2 = 1.96350 \times 10^{-3} \,\mathrm{m}^2$ Area: Normal stress: $\sigma_{BC} = \frac{P}{A} = \frac{-190 \times 10^3}{1.96350 \times 10^{-3}} = -96.766 \times 10^6 \text{ Pa}$ $\sigma_{BC} = -96.8 \text{ MPa} \blacktriangleleft$

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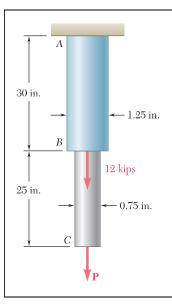


### **PROBLEM 1.2**

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			
( <i>a</i> )	Rod <i>AB</i> :		
	Force:	$P = 60 \times 10^3 \mathrm{N}$	
	Stress:	$\sigma_{AB} = 150 \times 10^6 \mathrm{Pa}$	
	Area:	$A = \frac{\pi}{4}d_1^2$	
		$\sigma_{AB} = \frac{P}{A}  \therefore  A = \frac{P}{\sigma_{AB}}$	
		$\frac{\pi}{4}d_1^2 = \frac{P}{\sigma_{AB}}$	
		$d_1^2 = \frac{4P}{\pi\sigma_{AB}} = \frac{(4)(60 \times 10^3)}{\pi(150 \times 10^6)} = 509.30 \times 10^{-6} \mathrm{m}^2$	
		$d_1 = 22.568 \times 10^{-3} \mathrm{m}$	$d_1 = 22.6 \text{ mm} \blacktriangleleft$
(b)	Rod <i>BC</i> :		
	Force:	$P = 60 \times 10^3 - (2)(125 \times 10^3) = -190 \times 10^3 \mathrm{N}$	
	Stress:	$\sigma_{BC} = -150 \times 10^6 \mathrm{Pa}$	
	Area:	$A = \frac{\pi}{4}d_2^2$	
		$\sigma_{BC} = \frac{P}{A} = \frac{4P}{\pi d_2^2}$	
		$d_2^2 = \frac{4P}{\pi\sigma_{BC}} = \frac{(4)(-190 \times 10^3)}{\pi(-150 \times 10^6)} = 1.61277 \times 10^{-3} \mathrm{m}^2$	
		$d_2 = 40.159 \times 10^{-3} \mathrm{m}$	$d_2 = 40.2 \text{ mm} \blacktriangleleft$

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## **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 kips  $A = \frac{\pi}{4} d_1^2 = \frac{\pi}{4} (1.25)^2 = 1.22718 \text{ in}^2$   $\sigma_{AB} = \frac{P}{A} = \frac{22}{1.22718} = 17.927 \text{ ksi}$ (b) Rod BC: P = 10 kips  $A = \frac{\pi}{4} d_2^2 = \frac{\pi}{4} (0.75)^2 = 0.44179 \text{ in}^2$   $\sigma_{AB} = \frac{P}{A} = \frac{10}{0.44179} = 22.635 \text{ ksi}$   $\sigma_{AB} = 22.6 \text{ ksi} \blacktriangleleft$ 

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