



## Chapter 2

- 2.4** An 18-m-long steel wire of 5-mm diameter is to be used in the manufacture of a prestressed concrete beam. It is observed that the wire stretches 45 mm when a tensile force  $\mathbf{P}$  is applied. Knowing that  $E = 200$  GPa, determine (a) the magnitude of the force  $\mathbf{P}$ , (b) the corresponding normal stress in the wire.

- 2.14** The aluminum rod  $ABC$  ( $E = 10.1 \times 10^6$  psi), which consists of two cylindrical portions  $AB$  and  $BC$ , is to be replaced with a cylindrical steel rod  $DE$  ( $E = 29 \times 10^6$  psi) of the same overall length. Determine the minimum required diameter  $d$  of the steel rod if its vertical deformation is not to exceed the deformation of the aluminum rod under the same load and if the allowable stress in the steel rod is not to exceed 24 ksi.

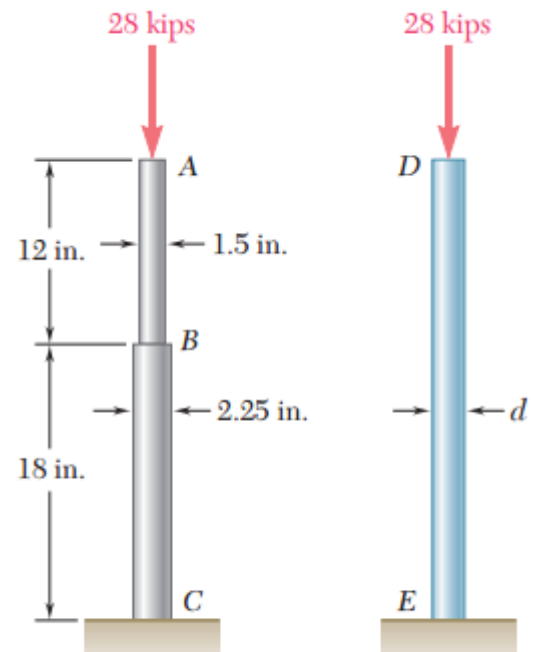
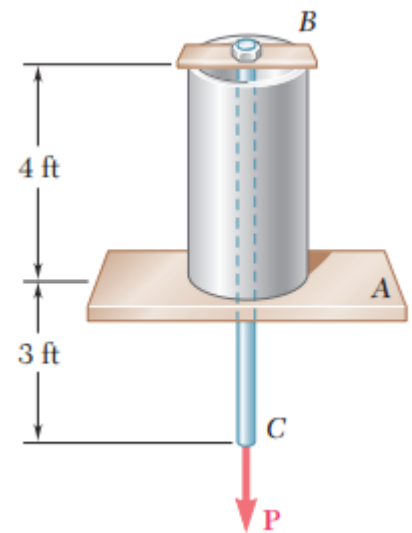
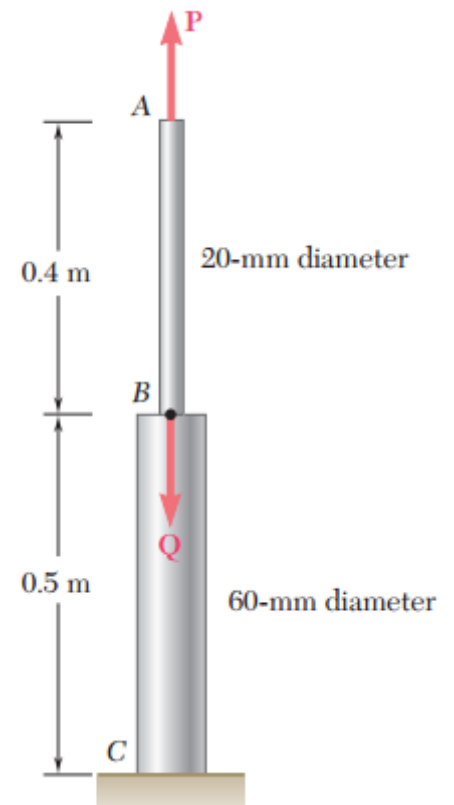


**Fig. P2.14**

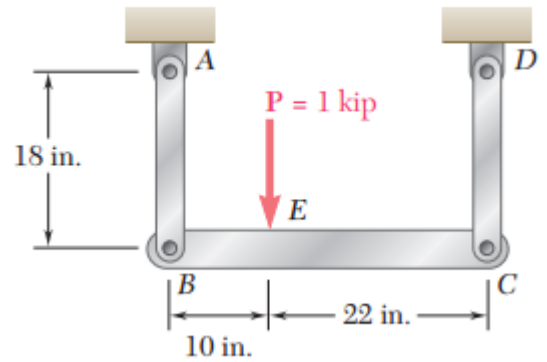
- 2.15** A 4-ft section of aluminum pipe of cross-sectional area  $1.75 \text{ in}^2$  rests on a fixed support at *A*. The  $\frac{5}{8}$ -in.-diameter steel rod *BC* hangs from a rigid bar that rests on the top of the pipe at *B*. Knowing that the modulus of elasticity is  $29 \times 10^6 \text{ psi}$  for steel and  $10.4 \times 10^6 \text{ psi}$  for aluminum, determine the deflection of point *C* when a 15-kip force is applied at *C*.



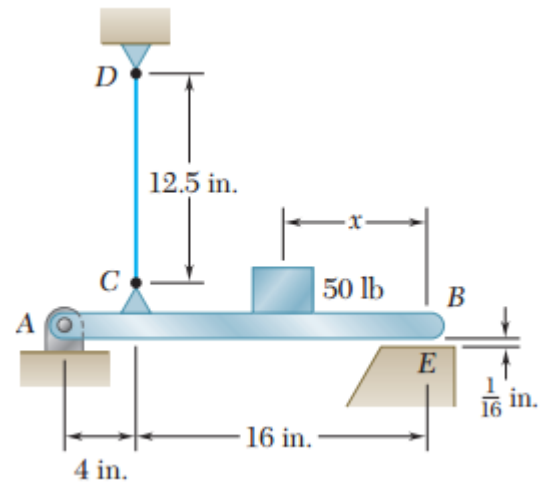
- 2.20** The rod  $ABC$  is made of an aluminum for which  $E = 70$  GPa. Knowing that  $P = 6$  kN and  $Q = 42$  kN, determine the deflection of (a) point A, (b) point B.



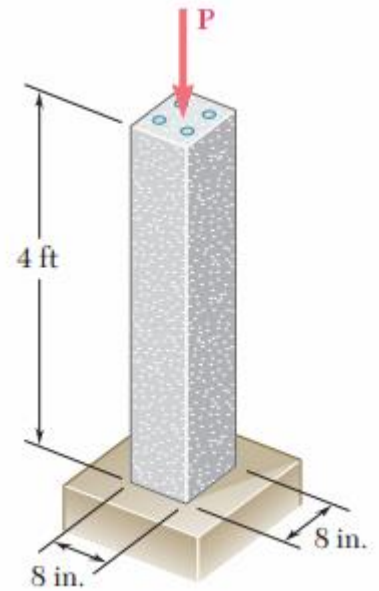
- 2.25** Each of the links  $AB$  and  $CD$  is made of aluminum ( $E = 10.9 \times 10^6$  psi) and has a cross-sectional area of  $0.2 \text{ in}^2$ . Knowing that they support the rigid member  $BC$ , determine the deflection of point  $E$ .



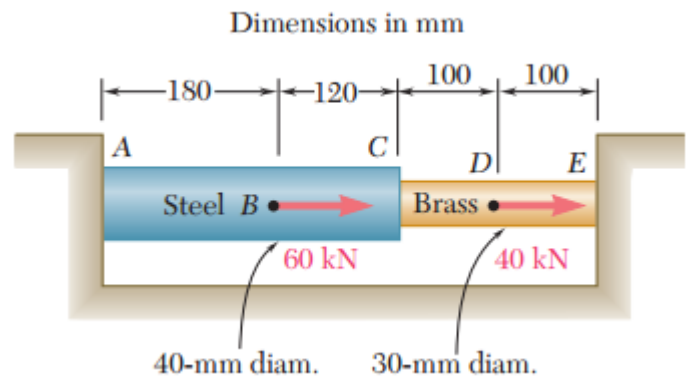
- 2.26** The length of the  $\frac{3}{32}$ -in.-diameter steel wire  $CD$  has been adjusted so that with no load applied, a gap of  $\frac{1}{16}$  in. exists between the end  $B$  of the rigid beam  $ACB$  and a contact point  $E$ . Knowing that  $E = 29 \times 10^6$  psi, determine where a 50-lb block should be placed on the beam in order to cause contact between  $B$  and  $E$ .



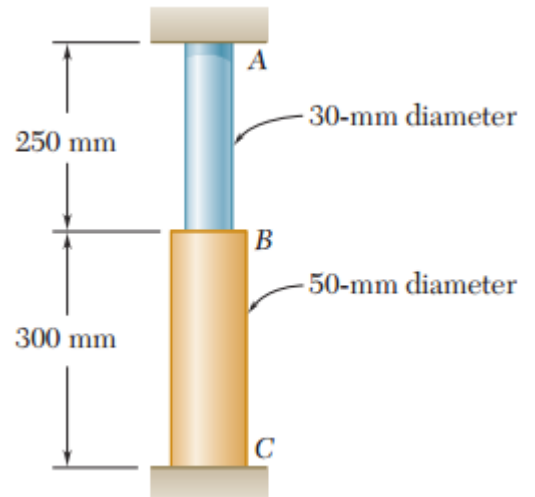
- 2.35** A 4-ft concrete post is reinforced with four steel bars, each with a  $\frac{3}{4}$ -in. diameter. Knowing that  $E_s = 29 \times 10^6$  psi and  $E_c = 3.6 \times 10^6$  psi, determine the normal stresses in the steel and in the concrete when a 150-kip axial centric force  $\mathbf{P}$  is applied to the post.



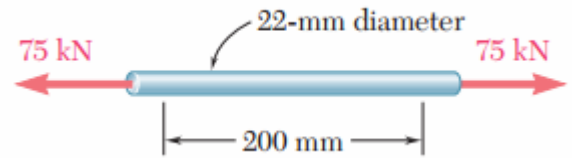
- 2.41** Two cylindrical rods, one of steel and the other of brass, are joined at  $C$  and restrained by rigid supports at  $A$  and  $E$ . For the loading shown and knowing that  $E_s = 200$  GPa and  $E_b = 105$  GPa, determine (a) the reactions at  $A$  and  $E$ , (b) the deflection of point  $C$ .



- 2.51** A rod consisting of two cylindrical portions  $AB$  and  $BC$  is restrained at both ends. Portion  $AB$  is made of steel ( $E_s = 200 \text{ GPa}$ ,  $\alpha_s = 11.7 \times 10^{-6}/^\circ\text{C}$ ) and portion  $BC$  is made of brass ( $E_b = 105 \text{ GPa}$ ,  $\alpha_b = 20.9 \times 10^{-6}/^\circ\text{C}$ ). Knowing that the rod is initially unstressed, determine the compressive force induced in  $ABC$  when there is a temperature rise of  $50^\circ\text{C}$ .



**2.62** In a standard tensile test a steel rod of 22-mm diameter is subjected to a tension force of 75 kN. Knowing that  $\nu = 0.3$  and  $E = 200$  GPa, determine (a) the elongation of the rod in a 200-mm gage length, (b) the change in diameter of the rod.



**2.63** A 20-mm-diameter rod made of an experimental plastic is subjected to a tensile force of magnitude  $P = 6$  kN. Knowing that an elongation of 14 mm and a decrease in diameter of 0.85 mm are observed in a 150-mm length, determine the modulus of elasticity, the modulus of rigidity, and Poisson's ratio for the material.

**2.75** A vibration isolation unit consists of two blocks of hard rubber bonded to a plate  $AB$  and to rigid supports as shown. Knowing that a force of magnitude  $P = 25$  kN causes a deflection  $\delta = 1.5$  mm of plate  $AB$ , determine the modulus of rigidity of the rubber used.

