D-31 Determine the angle of tilt of the rigid beam when it is subjected to the load of 5 kips. Before the load is applied, the beam is horizontal. Each rod has a diameter of 0.5 in., and $E = 29(10^6)$ ksi.

D-32 The uniform bar is subjected to the load of 6 kips. Determine the horizontal reactions at the supports $A$ and $B$.

D-33 The cylinder is made of steel and has an aluminum core. If its ends are subjected to the axial force of 300 kN, determine the average normal stress in the steel. The cylinder has an outer diameter of 100 mm and an inner diameter of 80 mm. $E_s = 200$ GPa, $E_a = 73.1$ GPa.

D-34 The column is constructed from concrete and six steel reinforcing rods. If it is subjected to an axial force of 20 kips, determine the force supported by the concrete. Each rod has a diameter of 0.75 in. $E_{con} = 4.20(10^6)$ ksi, $E_s = 29(10^6)$ ksi.

D-35 Two bars, each made of a different material, are connected and placed between two walls when the temperature is $T_1 = 15^\circ$C. Determine the force exerted on the (rigid) supports when the temperature becomes $T_2 = 25^\circ$C. The material properties and cross-sectional area of each bar are given in the figure.

D-36 The aluminum rod has a diameter of 0.5 in. and is attached to the rigid supports at $A$ and $B$ when $T_1 = 80^\circ$F. If the temperature becomes $T_2 = 100^\circ$F, and an axial force of $P = 1200$ lb is applied to the rigid collar as shown, determine the reactions at $A$ and $B$. $\alpha_w = 12.8(10^{-6})/^\circ$F; $E_w = 10.6(10^6)$ psi.

D-37 The aluminum rod has a diameter of 0.5 in. and is attached to the rigid supports at $A$ and $B$ when $T_1 = 80^\circ$F. Determine the force $P$ that must be applied to the rigid collar so that, when $T_2 = 50^\circ$F, the reaction at $B$ is zero. $\alpha_w = 12.8(10^{-6})/^\circ$F; $E_w = 10.6(10^6)$ ksi.

D-38 Can the torsion formula, $\tau = T/d$, be used if the cross section is noncircular?

D-39 The solid 0.75-in.-diameter shaft is used to transmit the torques shown. Determine the absolute maximum shear stress developed in the shaft.

D-40 The solid 1.5-in.-diameter shaft is used to transmit the torques shown. Determine the shear stress developed in the shaft at point $B$.

D-41 The solid shaft is used to transmit the torques shown. Determine the shear stress developed in the shaft.

D-42 The shaft is subjected to the torques shown. Determine the angle of twist of end $A$ with respect to end $B$. The shaft has a diameter of 1.5 in. $G = 11(10^3)$ ksi.
D-58 Determine the moment M that should be applied to the beam in order to create a compressive stress at point D of 10 kip.

Chapter 7—Review Sections 7.1-7.4

D-60 Determine the maximum load \( P \) that can be applied to the beam that is made from a material having an allowable bending stress of \( \sigma_{\text{allow}} = 12 \text{ kPa} \).

D-61 Determine the maximum stress in the beam’s cross section.

D-62 Determine the maximum shear stress in the beam.

D-63 The beam has a rectangular cross section and is subjected to a shear of \( V = 2 \text{ kN} \). Determine the maximum shear stress in the beam.

D-64 Determine the absolute maximum shear stress in the shaft having a diameter of 60 mm.

D-65 Determine the shear stress in the beam at point A, which is located at the top of the web.

D-66 The beam is made from two boards fastened together at the top and bottom with nails spaced every 2 in. If an internal shear force of \( V = 150 \text{ lb} \) is applied to the beam, determine the shear force resisted by each nail.

D-67 The beam is made from four boards fastened together at the top and bottom with two rows of nails spaced every 4 in. If an internal shear force of \( V = 400 \text{ lb} \) is applied to the boards, determine the shear force resisted by each nail.

Chapter 8—Review Section 8.1

D-68 A cylindrical tank is subjected to an internal pressure of 80 psi. If the internal diameter of the tank is 30 in. and the wall thickness is 0.3 in., determine the maximum normal stress in the material.

D-69 A pressurized spherical tank is to be made of 0.25-in. thick steel. If it is subjected to an internal pressure of \( p = 150 \text{ psi} \), determine its inner diameter if the maximum normal stress is not to exceed 10 kips.

D-70 Determine the magnitude of the load \( P \) that will cause a maximum normal stress of \( \sigma_{\text{max}} = 30 \text{ kPa} \) in the tank along section a-a.
D-83 Determine the displacement at point C of the beam shown. Use the method of superposition. $EI$ is constant.

D-84 Determine the slope at point A of the beam shown. Use the method of superposition. $EI$ is constant.

D-87 A 12-ft wooden rectangular column has the dimensions shown. Determine the critical load if the ends are assumed to be pin-connected. $E = 1.6(10^4)$ kti. Yielding does not occur.

D-88 A steel pipe is fixed-supported at its ends. If it is 5 m long and has an outer diameter of 50 mm and a thickness of 10 mm, determine the maximum axial load $P$ that it can carry without buckling. $E = 200$ GPa, $\sigma_y = 250$ MPa.

D-89 A steel pipe is pin-supported at its ends. If it is 6 ft long and has an outer diameter of 2 in., determine its smallest thickness so that it can support an axial load of $P = 40$ kip without buckling. $E = 29(10^6)$ kti, $\sigma_y = 36$ kti.

D-90 Determine the smallest diameter of a solid 43-in. long steel rod, to the nearest 1/8 in., that will support an axial load of $P = 3$ kip without buckling. The ends are pin connected. $E = 29(10^6)$ kti, $\sigma_y = 36$ kti.
### Practice Problems

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**Stress and Strain**

- **Equation:**
  \[ \sigma = \frac{F}{A} \]
  
  - Where:
    - \( \sigma \) is the stress (in MPa)
    - \( F \) is the force (in N)
    - \( A \) is the cross-sectional area (in m²)

- **Example Problem:**
  - A beam is subjected to a force of 200 kN. If the cross-sectional area is 100 m², calculate the stress.
  
  \[ \sigma = \frac{200 \times 10^3 \text{ N}}{100 \text{ m}^2} = 2 \times 10^3 \text{ MPa} \]

- **Note:** Always ensure that units are consistent in calculations.