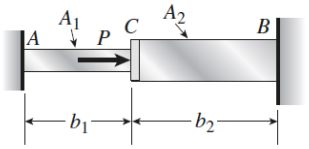
Mechanics of Solids

Home Work No.3

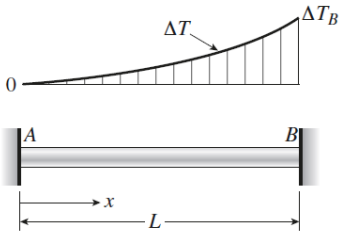
Problem 2.4-4 A bar ACB having two different cross-sectional areas A_1 and A_2 is held between rigid supports at A and B (see figure). A load P acts at point C, which is distance b_1 from end A and distance b_2 from end B.

(a) Obtain formulas for the reactions R_A and R_B at supports A and B, respectively, due to the load P.
(b) Obtain a formula for the displacement δ_C of point C.
(c) What is the ratio of the stress σ_1 in region AC to the stress σ_2 in region CB?



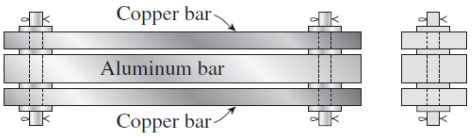
Problem 2.5-5 A bar AB of length L is held between rigid supports and heated nonuniformly in such a manner that the temperature increase ΔT at distance x from end A is given by the expression $\Delta T = \Delta T_B x^3/L^3$, where ΔT_B is the increase in temperature at end B of the bar (see figure).

Derive a formula for the compressive stress σ_c in the bar. (Assume that the material has modulus of elasticity E and coefficient of thermal expansion α.)



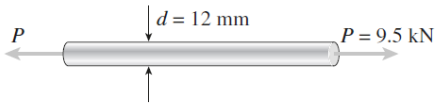
Problem 2.5-9 Rectangular bars of copper and aluminum are held by pins at their ends, as shown in the figure. Thin spacers provide a separation between the bars. The copper bars have cross-sectional dimensions 0.5 in. × 2.0 in., and the aluminum bar has dimensions 1.0 in. × 2.0 in.

Determine the shear stress in the 7/16 in. diameter pins if the temperature is raised by 100°F. (For copper, $E_c = 18{,}000$ ksi and $\alpha_c = 9.5 \times 10^{-6}$/°F; for aluminum, $E_a = 10{,}000$ ksi and $\alpha_a = 13 \times 10^{-6}$/°F.) *Suggestion:* Use the results of Example 2-8.



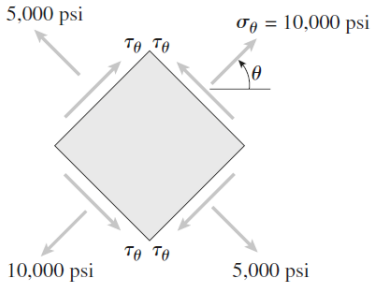
Problem 2.6-6 A steel bar with diameter $d = 12$ mm is subjected to a tensile load $P = 9.5$ kN (see figure).

(a) What is the maximum normal stress σ_{max} in the bar?
(b) What is the maximum shear stress τ_{max}?
(c) Draw a stress element oriented at 45° to the axis of the bar and show all stresses acting on the faces of this element.



Problem 2.6-15 Acting on the sides of a stress element cut from a bar in uniaxial stress are tensile stresses of 10,000 psi and 5,000 psi, as shown in the figure.

(a) Determine the angle θ and the shear stress τ_θ and show all stresses on a sketch of the element.
(b) Determine the maximum normal stress σ_{max} and the maximum shear stress τ_{max} in the material.



Problem 2.6-9 A compression member in a bridge truss is fabricated from a wide-flange steel section (see figure). The cross-sectional area $A = 7.5$ in.^{2} and the axial load $P = 90$ k.

Determine the normal and shear stresses acting on all faces of stress elements located in the web of the beam and oriented at (a) an angle $\theta = 0°$, (b) an angle $\theta = 30°$, and (c) an angle $\theta = 45°$. In each case, show the stresses on a sketch of a properly oriented element.