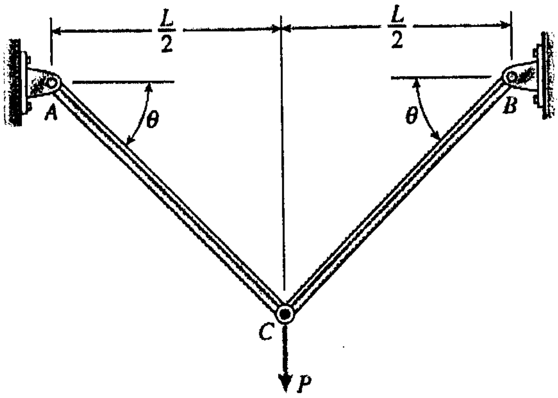
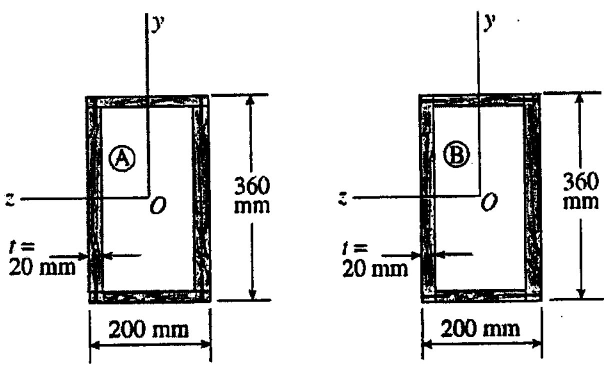
1. (25%) Two identical bars AC and BC support a vertical load P. The distance L between the supports is fixed, but the angle θ can be varied by changing the length of the bars. Determine the angle θ so that the structure has minimum weight without exceeding the allowable tensile stress in the bars. (Note: The weights of the bars can be neglected.)



2. (25%) Two wood box beams (beams A and B) have the same outside dimensions and the same thickness throughout. Both beams are formed by nailing, with each nail having an allowable shear load of 250 N. The beams are designed for a shear force $V = 3.2$ kN. (a) What is the maximum longitudinal spacing s_A for the nails in beam A? (b) What is the maximum longitudinal spacing s_B for the nails in beam B? (c) Which beam is more efficient in resisting the shear force?



(3) (25%) An element of aluminum (Assume E = 10,400 ksi and ν = 0.33) in the form of a rectangular parallelepiped (see Fig. 3) of dimensions a = 5 in., b = 4 in., and c = 3 in. is subjected to triaxial stresses σ_x=11,000 psi, σ_y = -5,000 psi, and σ_z = -1,500 psi acting on the x, y, and z faces, respectively. Determine the following quantities: (a) the maximum shear stress $\tau_{\max}$ in the material; (b) the changes Δa, Δb, and Δc in the dimensions of the element; (c) the change ΔV in the volume; and (d) the strain energy U stored in the element.

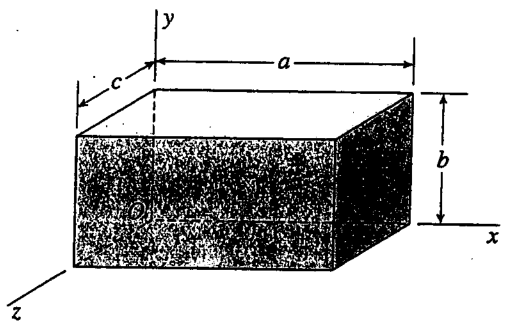


Figure 3

(4) (25%) A cantilever beam AB is subjected to a parabolically varying load of intensity $q = q_0\left(L^2 - x^2\right)/L^2$, where q_0 is the maximum intensity of the load (see Fig. 4). Derive the equation of the deflection curve, and then determine the deflection δ_B and angle of rotation θ_B at the free end. Use the fourth-order differential equation of the deflection curve (the load equation).

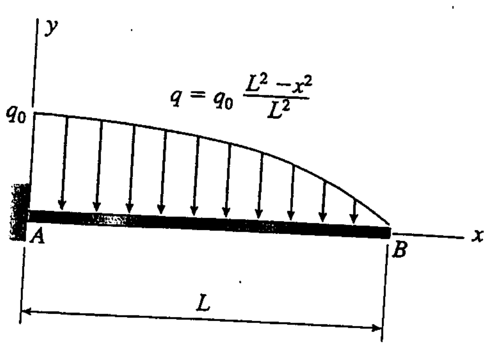


Figure 4