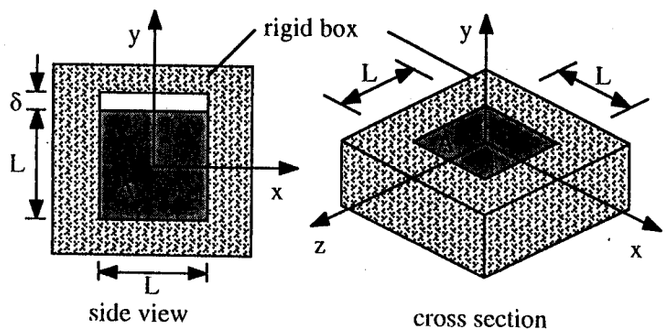
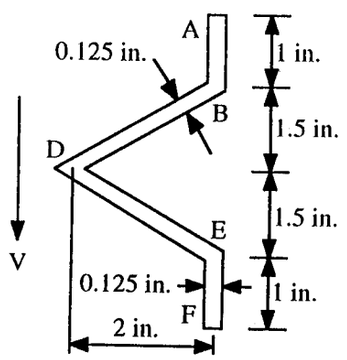
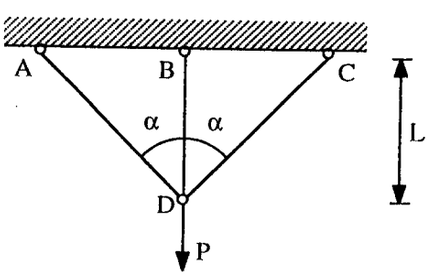
1. A block of material A (with modulus of elasticity E, Poisson's ratio ν, thermal expansion coefficient α) of dimensions L×L×L is confined in a rigid box of inner dimensions L×(L+δ)×L. If the temperature of the material is increased by ΔT, and if αΔTL > δ, calculate σ_x, σ_y, σ_z, ε_x, ε_y, ε_z and maximum shear stress τ_{max} in the material. Assume there is no friction between the material and the rigid box. (20%)



2. Determine the location of the shear center S of a thin-walled beam of uniform thickness having the cross shown. (20%)

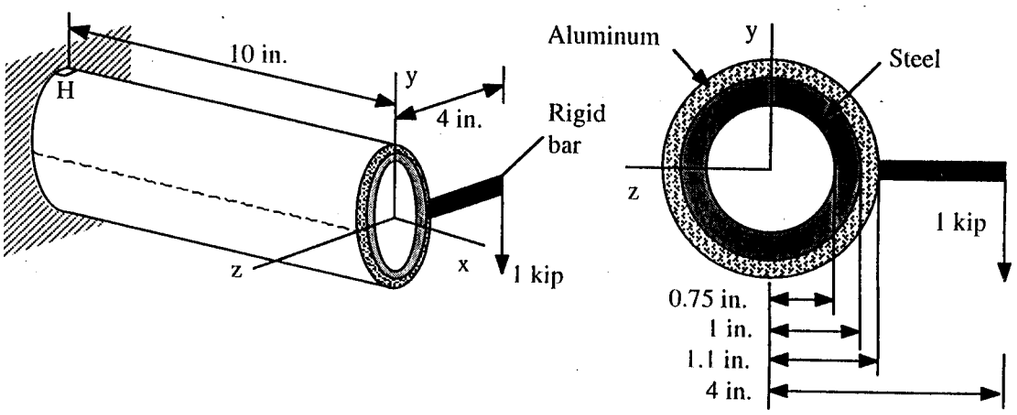


3. A three-bar truss with α = 45° is subjected to a concentrated load P. All bars have the same cross section area A and are made up of the same material with a nonlinear stress-strain relation as $\sigma = K\sqrt{\varepsilon}$. Use the complementary energy theorem (Crotti-Engesser theorem) to calculate: (i) the axial forces in all bars, (ii) the vertical displacement of point D. (20%)



(背面仍有題目,請繼續作答)

4. An outer aluminum pipe and an inner steel pipe are securely bonded to form a composite beam. The modulus of elasticity is 29000 ksi for the steel and 10400 ksi for the aluminum. The shear modulus is 11600 ksi for the steel and 4000 ksi for the aluminum. If an 1 kip downward concentrated load is applied to a rigid bar connecting to the composite beam as shown. Calculate (i) the maximum normal stresses in the aluminum and steel, (ii) the shear stress at point H (top surface of the pipe at the fixed end), (iii) the principal stresses and the maximum shear stress at H. (20%)



5. A simply supported beam is subjected to an axial force P and a lateral concentrated force Q. (i) Derive the differential equation in terms of the deflection curve w(x) for the beam. (ii) Solve the differential equation to obtain the deflection curve w(x). (iii) From the deflection curve w(x), calculate the critical buckling load for P. (20%)