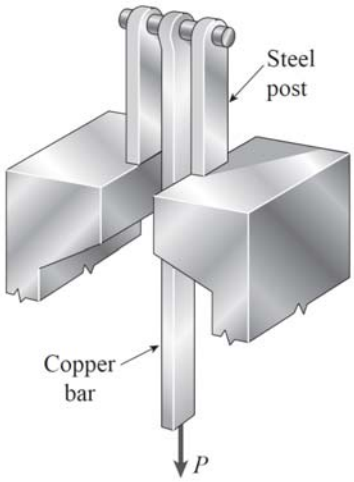
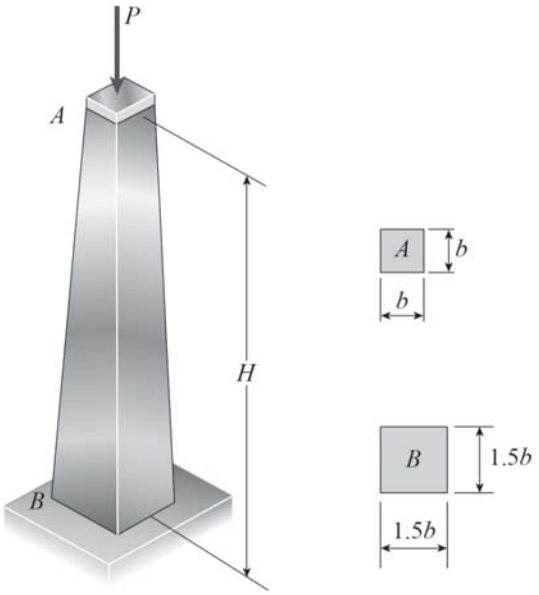
Mechanics of Materials I
Homework assignment # 2

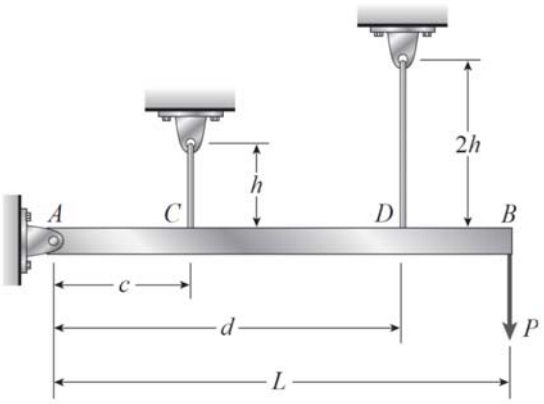
Problem 1. A long, rectangular copper bar under a tensile load P hangs from a pin that is supported by two steel posts (see figure). The copper bar has a length of 2.0 m, a cross-sectional area of 4800 mm^2, and a modulus of elasticity $E_c = 120$ GPa. Each steel post has a height of 0.5 m, a cross-sectional area of 4500 mm^2, and a modulus of elasticity $E_s = 200$ GPa.
(a) Determine the downward displacement δ of the lower end of the copper bar due to a load P=180 kN.
(b) What is the maximum permissible load P_{max} if the displacement δ is limited to 1.0 mm?



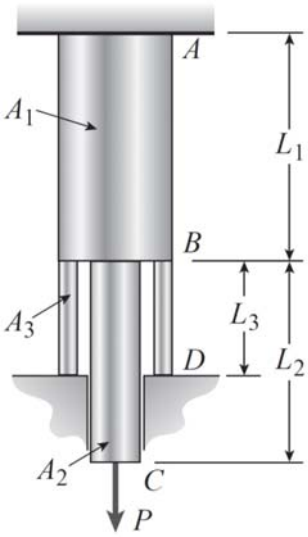
Problem 2. A post AB supporting equipment in a laboratory is tapered uniformly throughout its height H (see figure). The cross sections of the post are square, with dimensions b × b at the top and 1.5b × 1.5b at the base. Derive a formula for the shortening δ of the post due to the compressive load P acting at the top. (Assume that the angle of taper is small and disregard the weight of the post itself.)



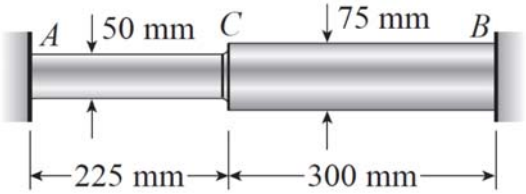
Problem 3. A rigid bar AB of length L=66 in. is hinged to a support at A and supported by two vertical wires attached at points C and D (see figure). Both wires have the same cross-sectional area (A=0.0272 $in.^2$) and are made of the same material (modulus E=30 × 10^6 psi). The wire at C has length h=18 in. and the wire at D has length twice that amount. The horizontal distances are c=20 in. and d=50 in.
(a) Determine the tensile stresses σ_C and σ_D in the wires due to the load P=340 lb acting at end B of the bar.
(b) Find the downward displacement δ_B at end B of the bar.



Problem 4. A circular steel bar ABC (E=200 GPa) has cross-sectional area A_1 from A to B and cross-sectional area A_2 from B to C (see figure). The bar is supported rigidly at end A and is subjected to a load P equal to 40 kN at end C. A circular steel collar BD having cross-sectional area A_3 supports the bar at B. The collar fits snugly at B and D when there is no load. Determine the elongation δ_{AC} of the bar due to the load P. (Assume $L_1 = 2L_3 = 250$ mm, $L_2 = 225$ mm, $A_1 = 2A_3 = 960$ mm^2, and $A_2 = 300$ mm^2.)



Problem 5. A plastic bar ACB having two different solid circular cross sections is held between rigid supports as shown in the figure. The diameters in the left- and right-hand parts are 50 mm and 75 mm, respectively. The corresponding lengths are 225 mm and 300 mm. Also, the modulus of elasticity E is 6.0 GPa, and the coefficient of thermal expansion is 1000×10^{-6} /°C. The bar is subjected to a uniform temperature increase of 30°C.
(a) Calculate the following quantities: (1) the compressive force N in the bar; (2) the maximum compressive stress σ_c; and (3) the displacement δ_C of point C.



Problem 6. A rigid bar of weight W=750 lb hangs from three equally spaced wires, two of steel and one of aluminum (see figure). The diameter of the wires is 0.125 in. Before they were loaded, all three wires had the same length. What temperature increase Δt in all three wires will result in the entire load being carried by the steel wires? (Assume $E_s = 30 \times 10^6$ psi, $\alpha_s = 6.5 \times 10^{-6}$ /°F, and $\alpha_a = 12 \times 10^{-6}$ /°F)