1. A rigid bar AB of length L = 1600 mm 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 = 16 mm^2) and are made of the same material (modulus E = 200 GPa, yield stress f_y = 80 Mpa). The material behavior is elastic-perfectly plastic. The wire at C has length h = 0.4 m and the wire at D has length twice that amount. The horizontal distances are c = 0.5 m and d = 1.2 m. (30%)

   (a) Determine the load P and the vertical displacements at C and D (δ_C and δ_D) when one of the wires reach the yielding stress.

   (b) Determine the ultimate load P and the vertical displacements at C and D when both wires reach their yielding stresses.
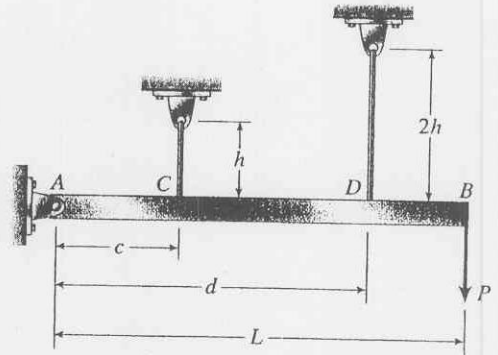
2. A thin-walled circular tube and a solid circular bar of the same material (see figure) are subjected to torsion. The tube and the bar have the same cross sectional area and the same length.

   What is the ratio of the strain energy U_1 in the tube to the strain energy U_2 in the solid bar if the maximum shear stresses are the same in both cases? (For the tube, use the approximate theory for thin-walled bars.) (20%)
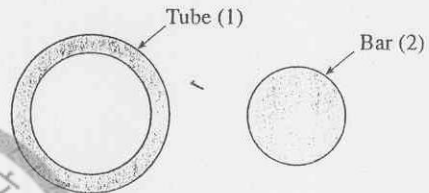
3. A cantilever beam of T-section is loaded by an inclined force of magnitude 10 kN (see figure). The line of action of the force is inclined at an angle of 60° to the horizontal and intersects the top of the beam at the end cross section. The beam is 1.5 m long and the cross section has the dimensions shown.

   Determine the principle stresses σ_1 and σ_2 and the maximum shear stresses at points A and B in the web of the beam. (30%)
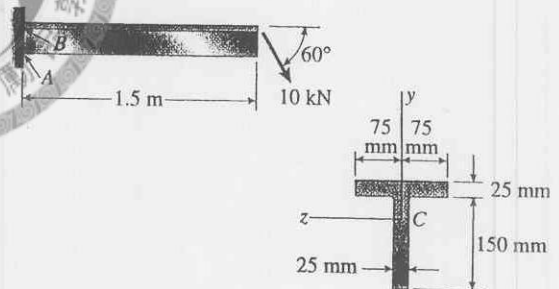
4. A slender bar AB with pinned ends and length L is held between immovable supports (see figure). What increase ΔT in the temperature of the bar will produce buckling at the Euler load? (20%)

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