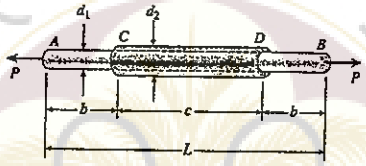
(20%) 1. A plastic rod AB of length $L = 0.5$ m has a diameter $d_1 = 30$ mm. A plastic sleeve CD of length $c = 0.3$ m and outer diameter $d_2 = 45$ mm is securely bonded to the rod so that no slippage can occur between the rod and the sleeve. The rod is made of an acrylic with modulus of elasticity $E_1 = 3.1$ GPa and the sleeve is made of a polyamide with $E_2 = 2.5$ GPa.

(a) Calculate the elongation d of the rod when it is pulled by axial forces $P = 12$ kN. (8%)

(b) If the sleeve is extended for the full length of the rod, what is the elongation? (6%)

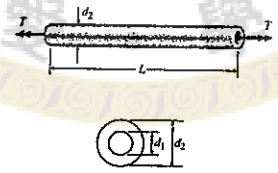
(c) If the sleeve is removed, what is the elongation? (6%)



(15%) 2. A hollow aluminum shaft has outside diameter $d_2 = 100$ mm and inside diameter $d_1 = 50$ mm. When twisted by torques T, the shaft has an angle of twist per unit distance equal to 2°/m. The shear modulus of elasticity of the aluminum is $G = 27.5$ GPa.

(a) Determine the maximum tensile stress σ_{max} in the shaft. (8%)

(b) Determine the magnitude of the applied torques T. (7%)



(15%) 3. The compound beam $ABCDE$ consists of two beams (AD and DE) joined by a hinged connection at D. The hinge can transmit a shear force but not a bending moment. The loads on the beam consist of a 4-kN force at the end of a bracket attached at point B and a 2-kN force at the midpoint of beam DE. Draw the shear-force and bending-moment diagrams for this compound beam.

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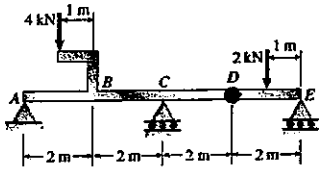
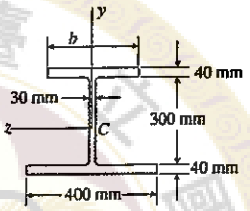
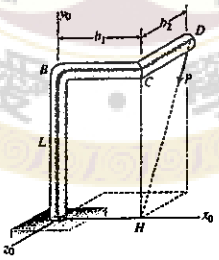


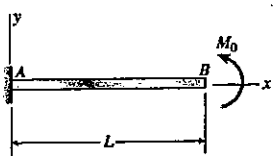
(15%) 4. A beam having a cross section in the form of an unsymmetric wide-flange shape is subjected to a negative bending moment acting about the z axis. Determine the width b of the top flange in order that the stresses at the top and bottom of the beam will be in the ration 4:3, respectively.



(20%) 5. A bracket $ABCD$ having a hollow circular cross section consists of a vertical arm AB (L = 1.85 m), a horizontal arm BC parallel to the x_0 axis, and a horizontal arm CD parallel to the z_0 axis. The arms BC and CD have lengths b_1 = 1.1 m and b_2 = 0.67 m, respectively. The outer and inner diameters of the bracket are d_2 = 190 mm and d_1 = 170 mm. An inclined load P = 10 kN acts at point D along line DH. Determine the maximum tensile, compressive, and shear stresses in the vertical arm.



(15%) 6. Derive the equation of the deflection curve for a cantilever beam AB when a couple M_0 acts counterclockwise at the free end. Also, determine the deflection δ_B and slope θ_B at the free end. (The beam described above has constant flexural rigidity EI and the origin of coordinate is at the left-hand end of the beam.)



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