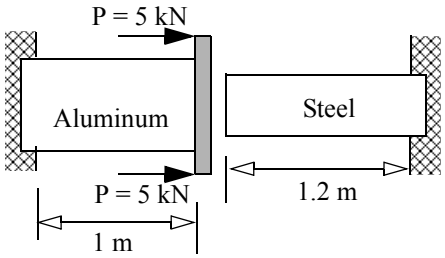
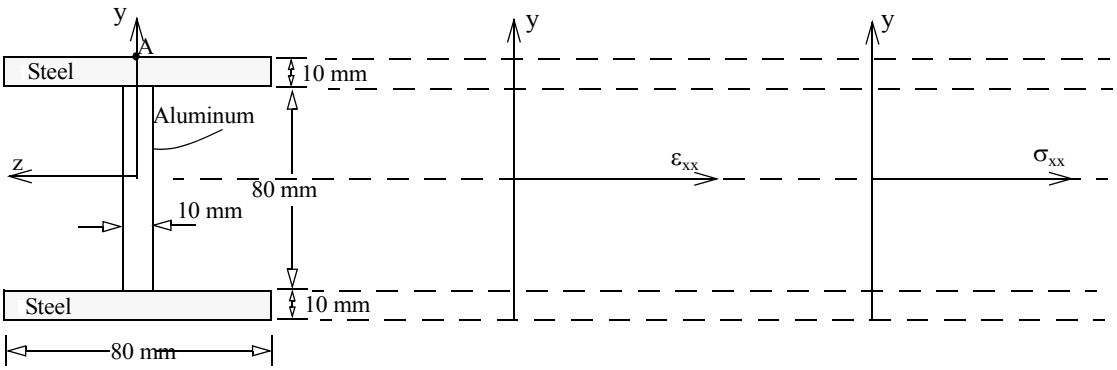
EXAM 2 MEEM 4150 Nov. 8th, 2011

1. An aluminum rod is securely fastened to a rigid plate that does not rotate during deformation. A gap of 0.5 mm exists between the rigid plate and the steel rod in the undeformed state. The properties of the two rods are given in the table below. In addition to the applied load the temperature of both rods is raised by 50^{o}. (a) Determine the movement of the rigid plate (b) The axial stress in steel.

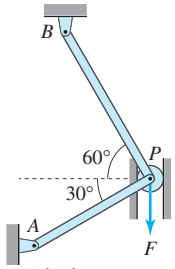
	diameter mm	E GPa	α $\mu/^{o}C$
Aluminum	20	70	22.5
Steel	10	210	12



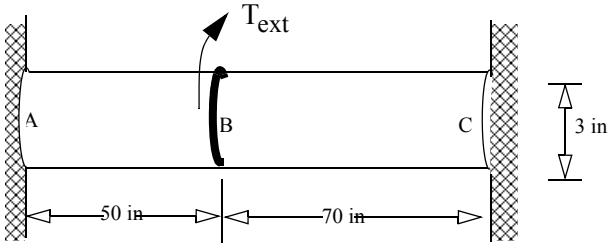
2. (a) A steel $E_{steel} = 200\ GPa$ strip is attached to a aluminum $E_{Al} = 70\ GPa$ beam to form a composite beam cross-section as shown. The bending normal strain at point A was found to be 500 μ. On the axis shown draw the variation of the bending normal strain and stress as a function of y. **Report numerical values** on each of the horizontal dashed lines.



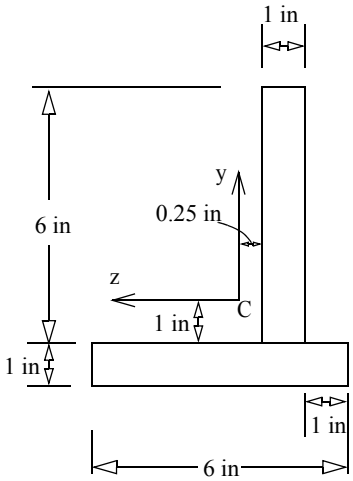
(b) The lengths of the bars are $L_A = 2$ m ans $L_B = 2.5$ m. Bothe bars have a yield stress of 200 MPa and a cross sectional area of 100 mm^2. Determine the collapse load for the two bar structure.



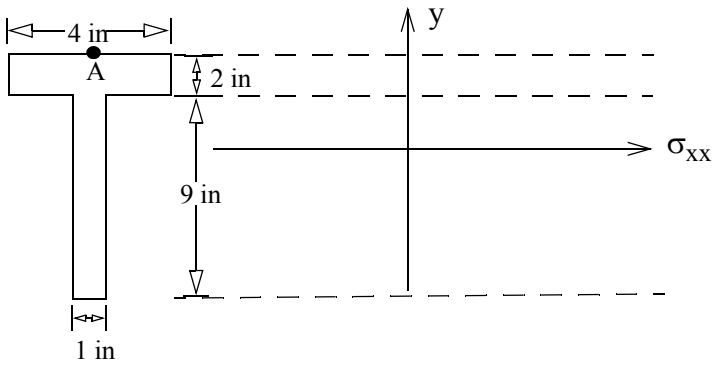
(c) A shaft made from elastic-perfectly plastic has a shear yield stress of 15 ksi and a shear modulus of 12,000 ksi. Due to the action of the torque the section at B was seen to rotate by 0.15 radians. Determine the depth of plastic zone in AB



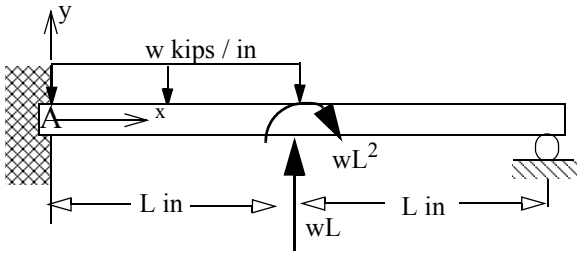
(d) Determine I_{yz} for the cross-section shown.



(e) A beam of elastic-perfectly plastic material has a yield stress of 30 ksi. Point A on the cross-section shown just reaches yield stress in *compression* at a given load. (i) Sketch the stress distribution as a function of y. (ii) Write the expressions for bending normal stress σ_{xx} , dA and the intervals you would use to evaluate $\boldsymbol{N} = \int_A \sigma_{xx} dA$. Use coordinate y and parameter 'a' representing the distance of elastic-plastic boundary from neutral axis in writing your stress expressions. DO NOT EVALUATE THE INTEGRAL.



3. (a) Determine the equation of the elastic curve for the beam and loading shown in terms of w, x, L, E, and I. (b) Determine the reaction force and reaction moment at the wall. BE METHODICAL



ANSWERS

1. δ_{plate} = 0.832 mm**;** σ_{steel} = 193.8 MPa(C)

2 (b) $F_{collapse}$=27.32 kN; (c) depth = 1.083 in.; (d) I_{yz} = -15.74 in^4 ;

3. R_A= 23wL/64 Down; M_A= $7wL^2/32$ CW