MASSACHUSETTS INSTITUTE OF TECHNOLOGY
13.10J/1.573J Structural Mechanics
13.014 Materials and Structures
1.052 Mechanics of Structures
Problem Set 5

Assigned : October 4, 2000
Due : October 11, 2000

1. Undergraduate students (1.052) : 6.27, 7.14, 7.27

2. For undergraduate students (13.014) : 6.27, 7.14, 7.27

3. For graduate students (13.10J/1.573J) : 6.27, 7.14, 7.27, 8.14

4. A problem for all students (13.10J/1.573J, 13.014, 1.052)

   Figure 1 shows a bar of aluminum with a steel sleeve. The aluminum is rigidly joined to the steel along its entire length. The cross sectional area A of the steel sleeve is the same as the cross sectional area of the aluminum rod. The stress strain diagrams for the steel and the aluminum are also shown in Figure 1.

   (a) Derive an expression for the elongation of the assembly as a function of F. Assume that both materials remain elastic.

   (b) Derive an expression for the elongation assuming the loading is great enough to cause the aluminum to yield.

   (c) What is the maximum loading F the assembly can withstand before the aluminum yields?

   (d) What is the maximum loading F the assembly can withstand before the steel yields?

5. A problem for graduate students (13.10J/1.573J)

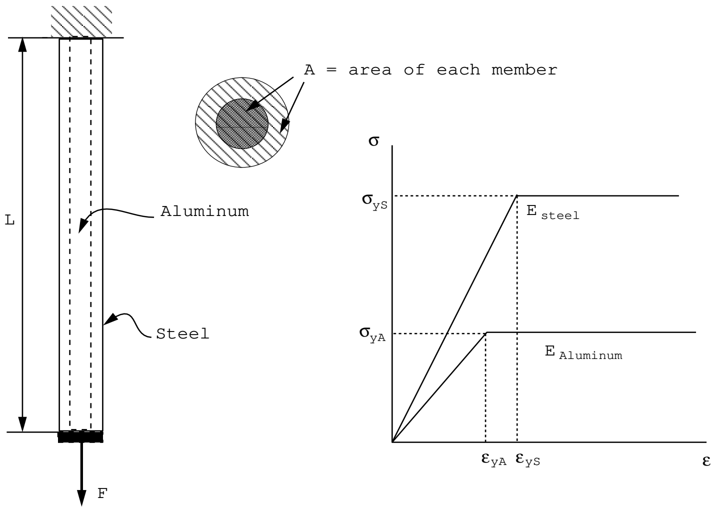

Figure 1: Diagrams for problem 4

A bimetallic bar consisting of a copper core securely bonded to two steel stripes is heated uniformly by an amount ΔT. Assuming that the width of the bar is b, the length is L, and the thickness of each layer is t, determine the stress σ_s and σ_c in the steel and copper, respectively. Also, draw free-body diagrams of each of the three strips. (Note: Coefficients of thermal expansion for steel and copper are $\alpha_c > \alpha_s$. Moduli of elasticity are E_s and E_c.)

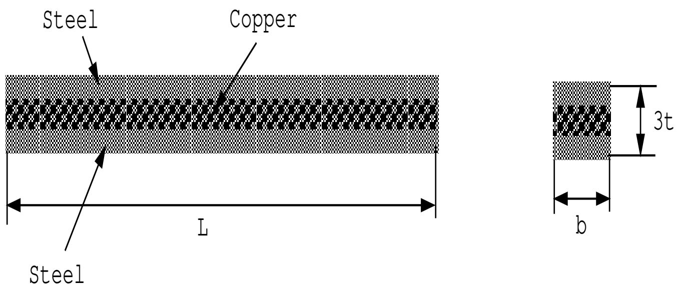

Figure 2: Diagrams for problem 5

Problem sets are available also in the course homepage.