Indian Institute of Science

UE 204: Midsemester Test

Date: 28/3/14.
Duration: 10.00 a.m.–11.00 a.m.
Maximum Marks: 100

1. A two-bar truss has pin joints at A, B and C, and both members are subjected to thermal loading ΔT as shown in Fig. 1. Let the length, area of cross section etc. for member AB be L_{AB}, A_{AB} etc., and for member BC be L_{BC}, A_{BC} etc. Find the vertical deflection at point B in terms of L_{BC} and θ, and the stresses developed in the members. The expressions for the potential energy and complementary energy, and the stress (1D approximation under axial loading) are (40)

$$\Pi = \frac{EAu^2}{2L} - EAu\alpha\Delta T - Pu,$$
$$\Pi^* = \frac{P^2L}{2EA} + \alpha PL\Delta T - Pu,$$
$$\tau = E(\epsilon - \alpha\Delta T).$$

2. A bar with circular cross section with material properties E_1, ν_1, G_1, and geometrical properties A, J, L_1 is given an initial twist ϕ_0 at the end L_1. It is then brought into contact with a second bar of circular cross section with material properties E_2, ν_2, G_2 and geometrical properties A, J and L_2, and bonded with it (see Fig. 2). The system is then allowed to come to equilibrium. (The first bar tries to go back to 'zero twist' from its initial twist of ϕ_0, but the second bar being bonded to it prevents it from doing so). (60)

   (a) Find the equilibrium angles of twist of the two bars at the bonded interface.

   (b) Assuming the radius of the bars to be a, find the stresses on an element on the outer surface of the first bar, and on an element on the outer surface of the second bar. Is there a jump in stresses across the bonded interface?

   (c) Draw the Mohr circle corresponding to the state of stress on the surface of the first bar, and find the principal stresses using this Mohr circle.

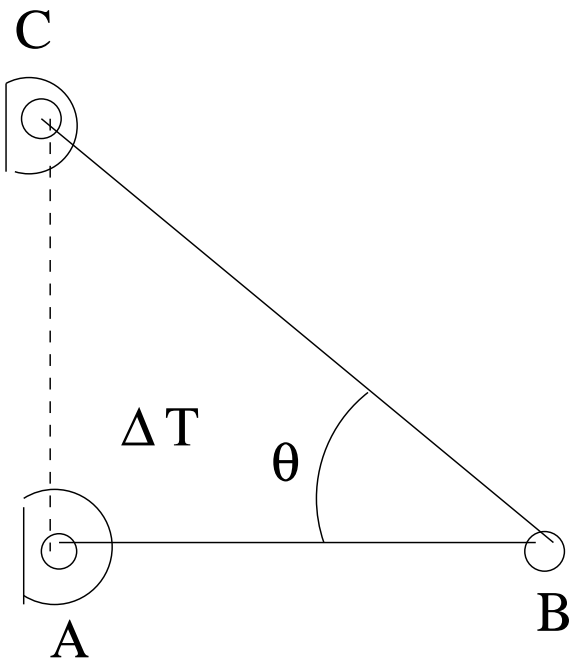

Figure 1:

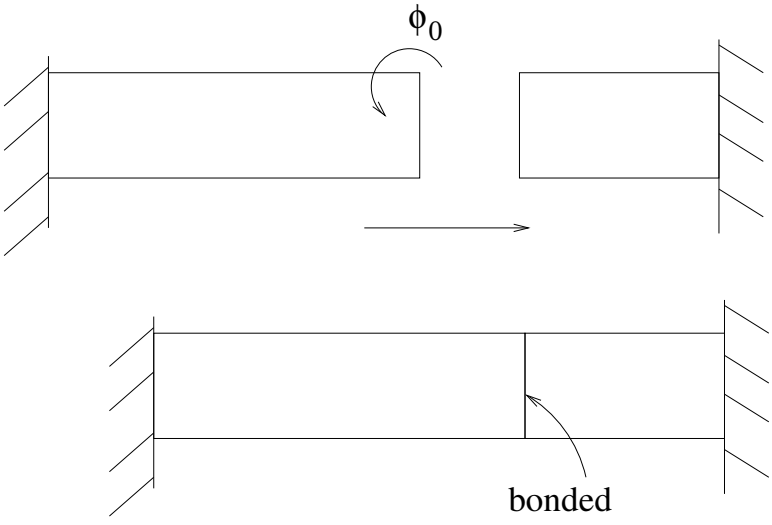

Figure 2: