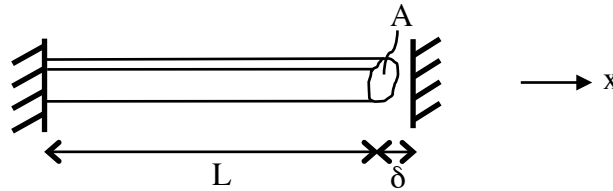


Department of Aeronautics & Astronautics  
MIT  
Field Exam, Jan. 2013

**Question – Materials & Structures**



A slender member, of length  $L$ , shown above has a constant cross section of area  $A$ . The member is fixed on one side, and on the other it is separated by a distance  $\delta$  from a wall (illustrated as a rigid constraint above). Unless otherwise specified, the member will be isotropic in all material properties and linearly elastic.

(1) The member will be uniformly heated to elevated temperature  $\Delta T$ . Develop analyses to evaluate *at least* two modes of failure (and associated  $\Delta T$  for each).

(2) Describe (but do not solve) how your answer to (1) would or would not change if the member was heated at the fixed end, and  $\Delta T$  was linear along the length.

(3) Consider deformation of the member for a constant temperature change  $\Delta T$ , for the case of a square cross section (area  $A$ ) of two equal thickness materials having different coefficients of thermal expansion (CTE), but equal modulus. Ignore the wall on the right hand side and develop equations to calculate deflection at the end of the member (at  $x = L$ ). Discuss a solution for the case where one of the materials has  $\text{CTE} = 0$ .