Ollscoil na hÉireann, Gaillimh

National University of Ireland, Galway

SECOND SEMESTER EXAMINATIONS, 1999

Third Environmental Engineering Examination

Solids and Structures

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Time allowed: Three hours

Attempt 5 Questions

1. a) Two concentric tubes made of different linear elastic materials are welded to end blocks as shown. The end blocks may be assumed to be infinitely stiff. The length, cross-sectional area, Young's Modulus and coefficient of linear expansion for each tube are: L_1, A_1, E_1, α_1 and L_2, A_2, E_2, α_2 respectively. If a tensile force T is applied axially as shown and the whole assembly is subject to a temperature increase of θ^0 find the force in each tube.

   b) If T =500kN and θ^0 =60°C find the forces in each tube given the following:

   L_1 = 1500mm, A_1 = 6570mm^2, E_1 = 207x10^{3}MPa and α_1 = 11x10^{-6} per °C

   L_2 = 1000mm, A_2 = 1720mm^2, E_2 = 70x10^{3}MPa and α_2 = 25x10^{-6} per °C

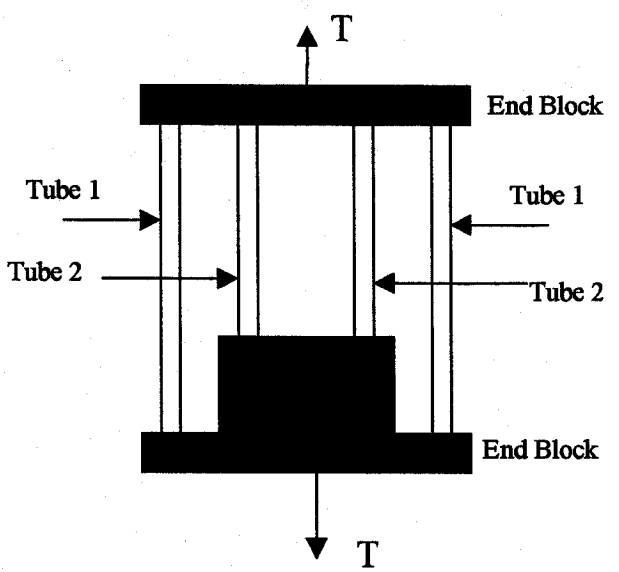

Fig. Q1

2. A rectangular-section steel member, 50mm wide and 20mm deep, is used as a simply supported beam over a span of 2m as shown. The steel behaves in an ideal elastic-plastic manner with a yield stress of 300Mpa. The self-weight of the beam may be neglected.

   a) Determine the value of the load W to produce yielding of the outer fibres of the beam.

   b) If the load W is increased by 15%, determine the depth to which yielding takes place at the centre of the span.

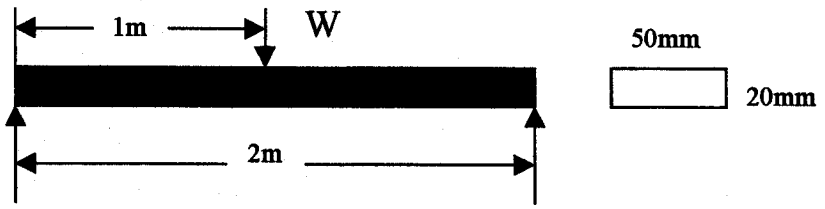

Fig. Q2

3. The stresses at a point in the wall of a thin cylinder are shown in Fig. Q3.

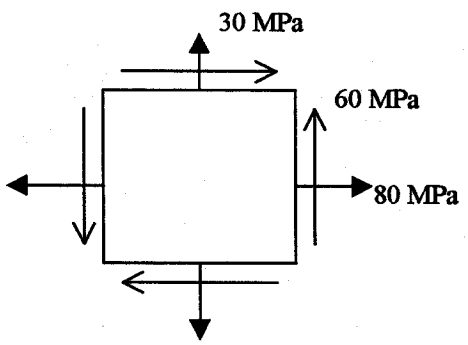

Fig. Q3

a) Evaluate the principal stresses at the point. (If using a graphical solution then plot the solution on graph paper).

b) Find the planes on which these principal stresses act.

c) Draw a diagram showing the principal planes and the principal stresses.

4. Distinguish between:
   (i) Work and Complementary Work
   (ii) Stiffness and Flexibility Coefficients
   (iii) Bending Moment Diagram and Influence Line for Bending Moment

For the beam shown in Fig. Q4, draw the influence lines due to a point load P for (i) the reaction force at A and (ii) the shear force at B.

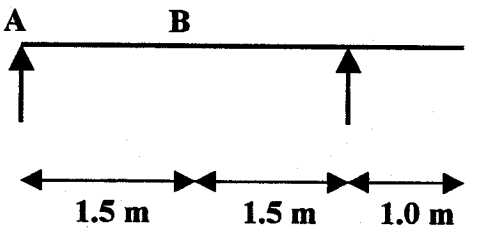

Fig. Q4

5. Determine the horizontal and vertical deflection components at point B of the pin jointed truss shown in Fig. Q5 (E = 200,000 N/mm^2, A = 100 mm^2 for all members).

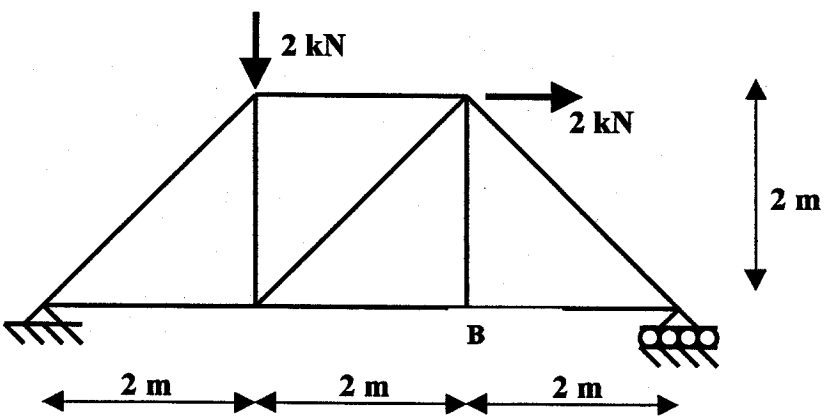

Fig. Q5

6. Using the principal of virtual work, find the reaction forces for the frame shown in Fig. Q6. Draw the bending moment diagram for this structure (EI, a constant). There is a roller support at point A and point B is fixed.

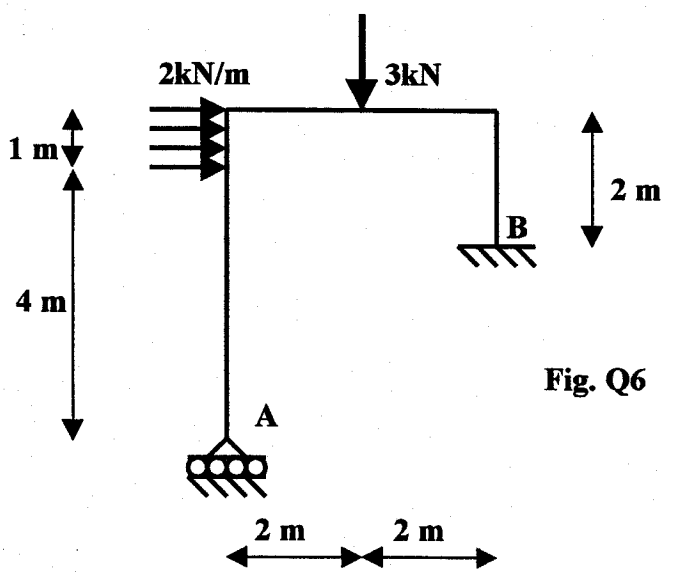

Fig. Q6