May 1988

1. (8 marks)

The structure ABCDEF shown in Fig. 1 is supported on pinned bases at A and E. The vertical segment ABD has a pin at B and is rigidly attached to the horizontal member CDEF. The loading consists of a 10 kN horizontal force applied at pin B, a vertical 5 kN force at C and a uniformly distributed load of intensity 2 kN/m over DEF.

(a) Determine the reaction force components acting at A and E,

(b) Draw the bending moment diagram for the horizontal member CDEF, showing all critical values.

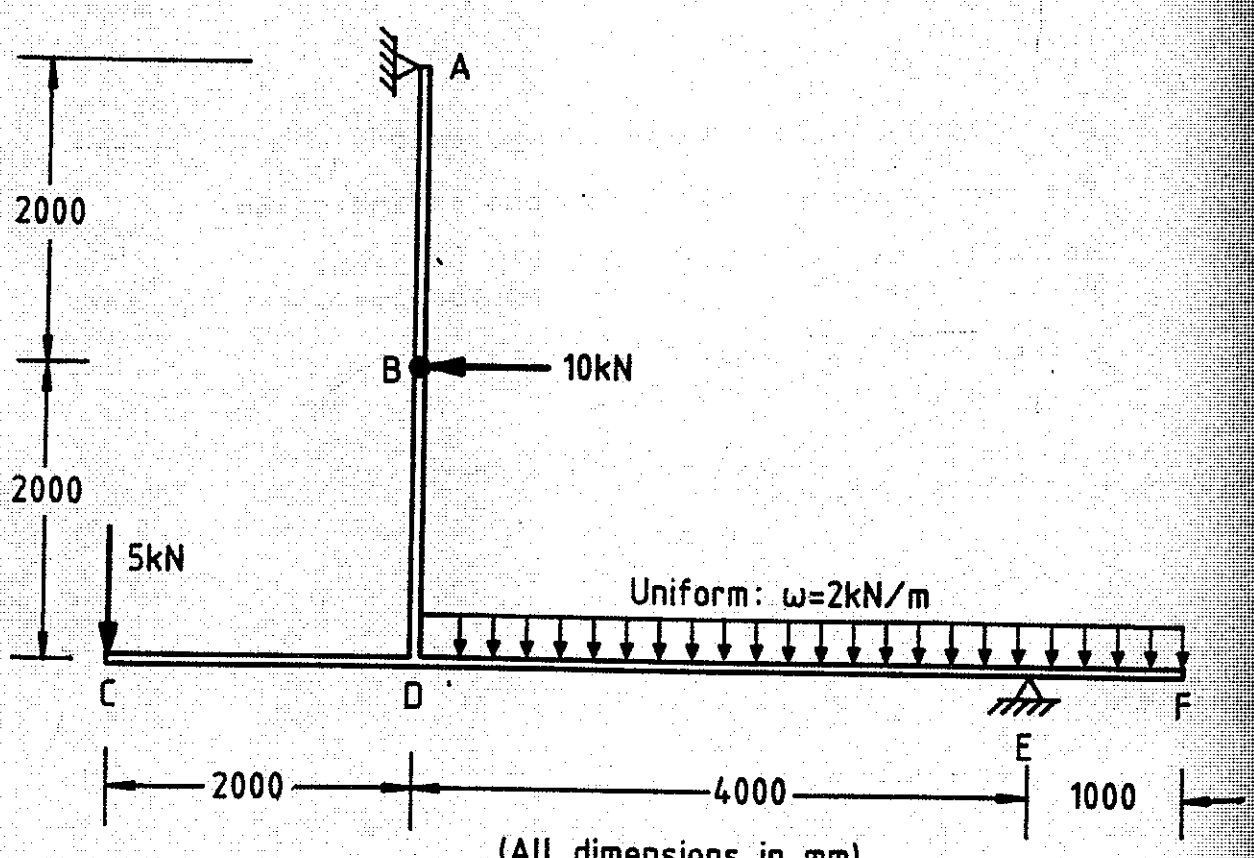

FIG.1

2. (8 marks)

The element in Fig. 2 consists of a steel shaft with diameters 100 and 150 mm. An aluminium tube of length 200 mm, external diameter 150 mm and wall thickness 5 mm is applied over one end of the element as shown. When set up at room temperature of 20°C, there is an end clearance of 0.2 mm. When the temperature of the system is increased to 100°C and an axial load of 400 kN is applied, determine the stresses in both the aluminium tube and the 100 mm diameter portion of the steel shaft.

Data: E (steel) = 200,000 MPa, E (aluminium) = 70,000 MPa.
α (steel) = 12 x 10^{-6}/°C, α (aluminium) = 24 x 10^{-6}/°C.

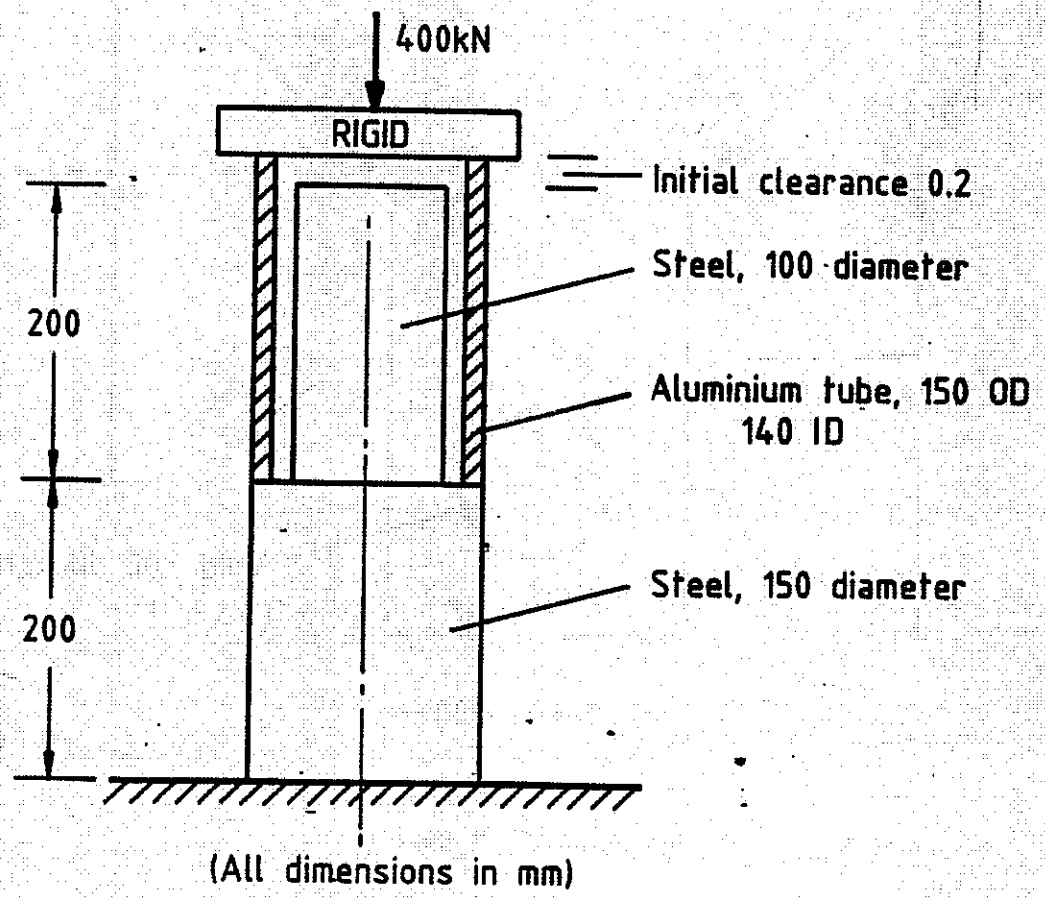

FIG.2

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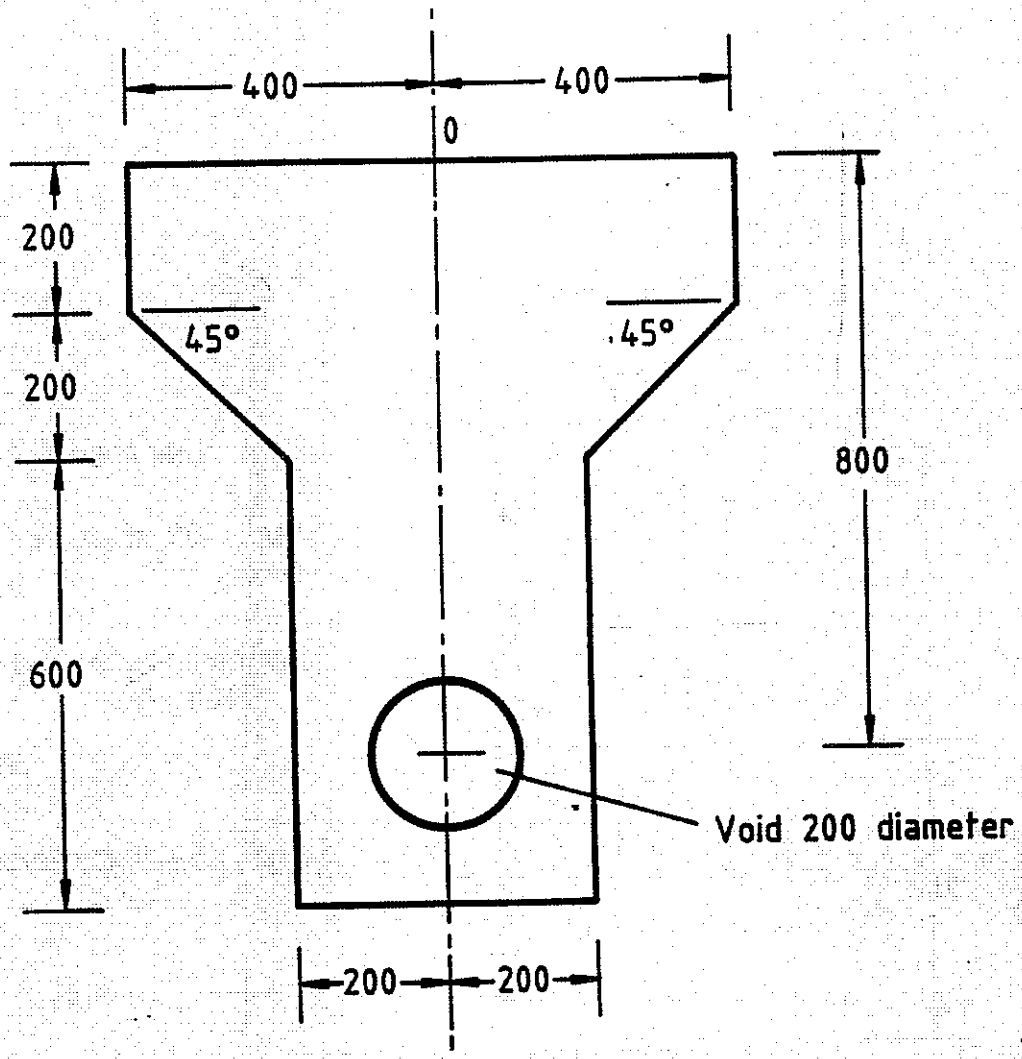
3. (4 marks)

The concrete beam shown in cross-section in Fig. 3 has a vertical axis of symmetry. Determine the location of the section centroid, G, on the vertical axis relative to an assumed origin 0 and calculate the second moment of area of the section about a horizontal (x) axis through the centroid.



(All dimensions in mm)

FIG.3