44/16

THE UNIVERSITY OF SYDNEY

FACULTY OF ENGINEERING

(School of Civil and Mining Engineering)

Intermediate Year Examination

COURSE U2.220 STRUCTURES 1 - PAPER 1 AND
CIVIL ENGINEERING SCIENCE - PAPER 1

June 1989 Time allowed: Three hours

Answers are expected to ALL questions.

The mark value of all questions is shown.

Lecture notes may be used.

Text books may not be used.

Battery powered calculators may be used.

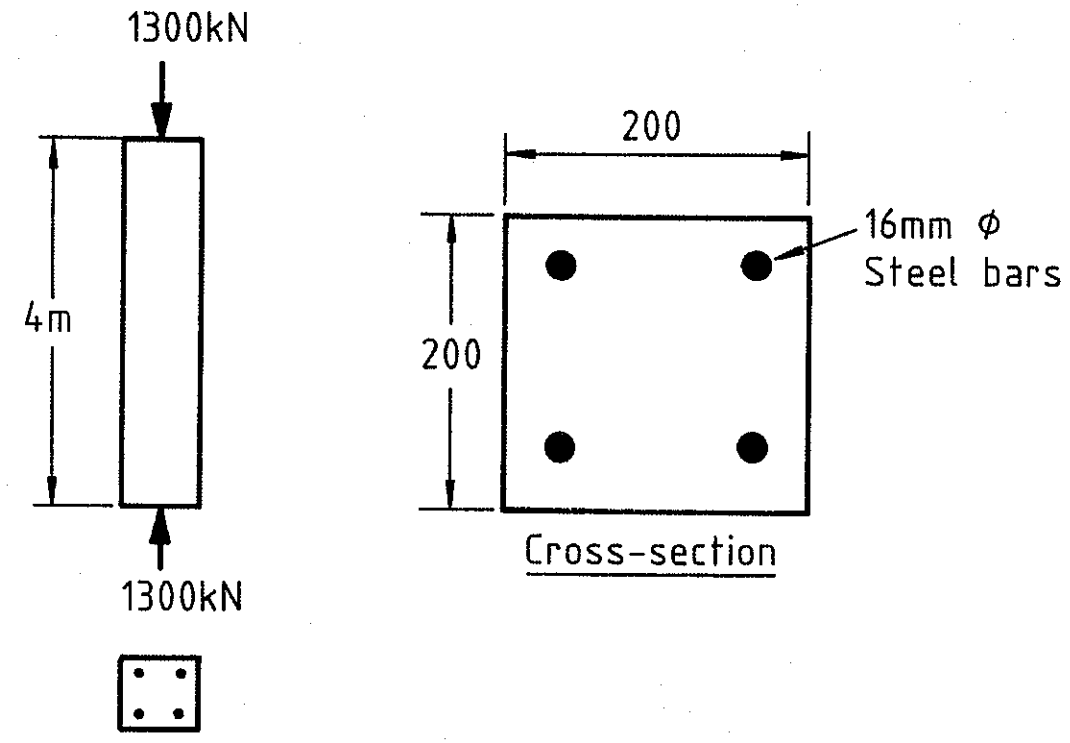
All working should be shown.

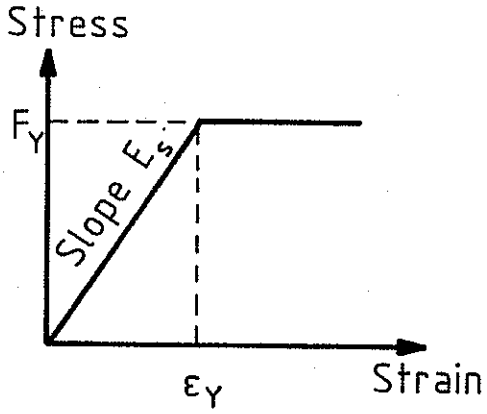
..../2

1. (12 marks)

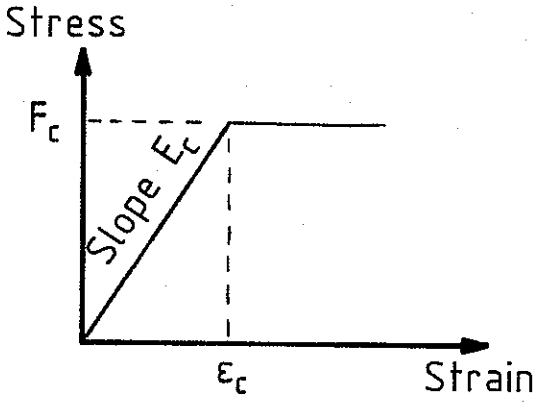
A reinforced concrete column, 4 m in length and of 200 mm square cross-section, contains four 16 mm diameter steel reinforcing bars. It is subjected to an axial load of 1300 kN as shown in Fig. 1. The steel bars may be assumed to be perfectly bonded to the concrete so that there is no slip between the concrete and steel. The stress - strain relationships for both materials are shown in Fig. 1.

Determine the stresses in both steel and concrete and the amount of column shortening due to the axial compressive force of 1300 kN.





Steel:
$F_Y = 250MPa$
$E_s = 2 \times 10^5 MPa$



Concrete:
$F_c = 30MPa$
$E_c = 2 \times 10^4 MPa$

FIG.1

2. (14 marks)

The beam ABC shown in Fig. 2 is uniform in cross-section and is simply supported at A and B. A concentrated vertical force W can act at any position in ABC. The maximum permissible stress in the beam due to bending is 110 MPa in tension and 170 MPa in compression. The beam self-weight may be assumed as 0.3 kN/m.
Determine the maximum permissible value of W, in kN.

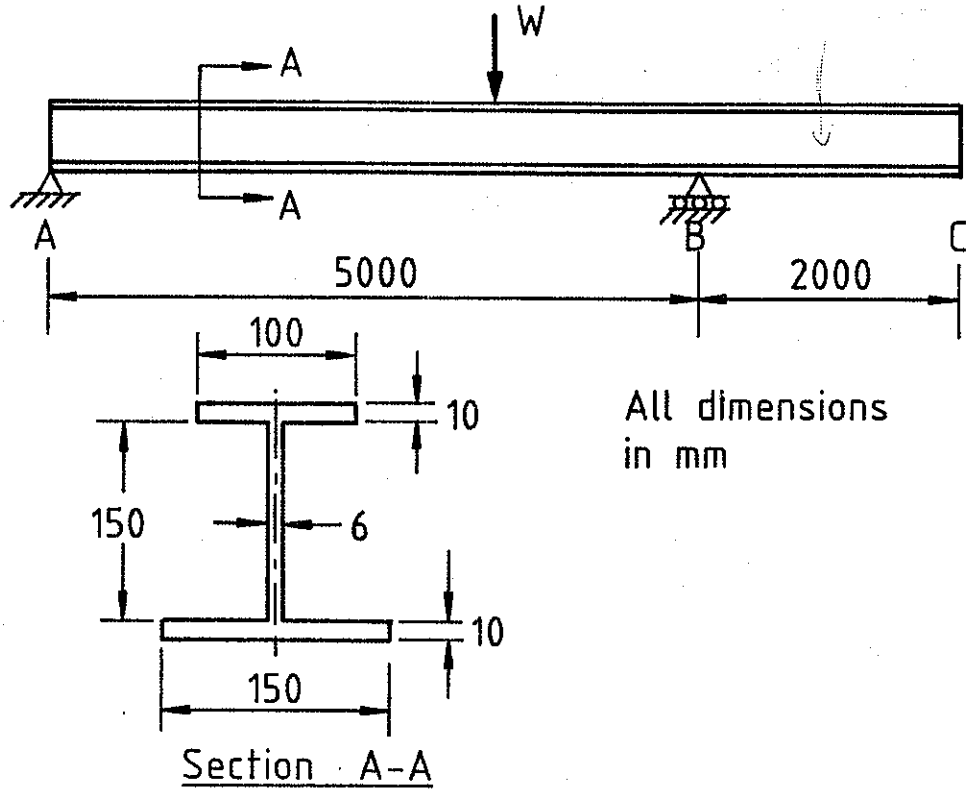


FIG.2

3. (12 marks)

A beam has the cross-section shown in Fig.3 . The distribution of strain over the depth of section, when the beam is subjected only to a uniform bending moment, is linear. Given that the stress/strain behaviour of the beam material is as shown, calculate the bending moment which is acting on the beam. Note: the stress distribution is NOT linear.

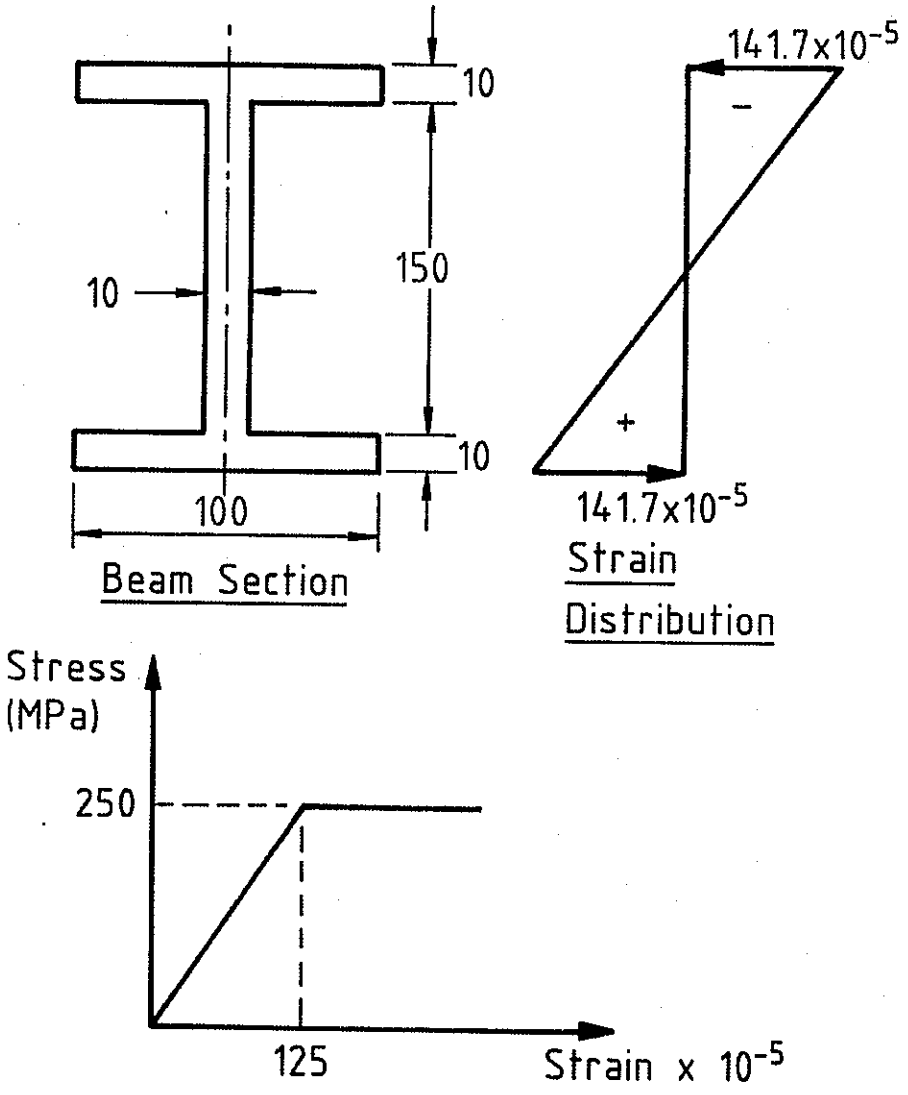


FIG.3

4. (12 marks)

The aluminium beam shown in Fig. 4 is simply supported at B and is fixed at C. It carries a load which varies linearly from zero at B to w at C. The following data are provided: span L = 3500 mm, E = 70,000 MPa, I_x = 3.0 x 10^7 mm^4 , w = 30 N/mm. Determine the reaction force at B.

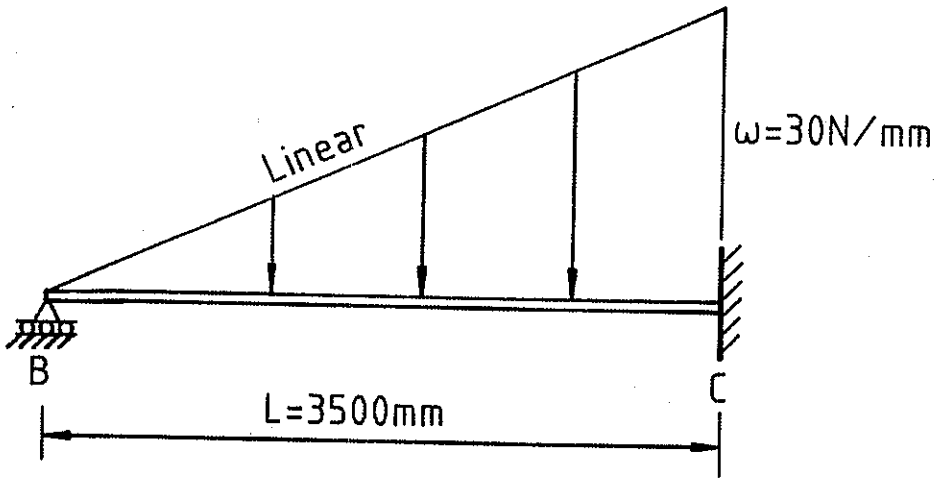


FIG.4

5. (15 marks)

Three forces are applied to bar ADB, which is rigidly attached to a vertical circular cross-section bar of 40 mm diameter. The bar is rigidly fixed at its base, O. Estimate the normal and shearing stresses at (a) point H, (b) point K. Use these stress values to calculate the principal stresses at H and K and draw a correctly oriented element showing the principal stresses acting at K.
Given: the centroid of a semicircle of radius r lies at a distance of 0.4244r from the base diameter.

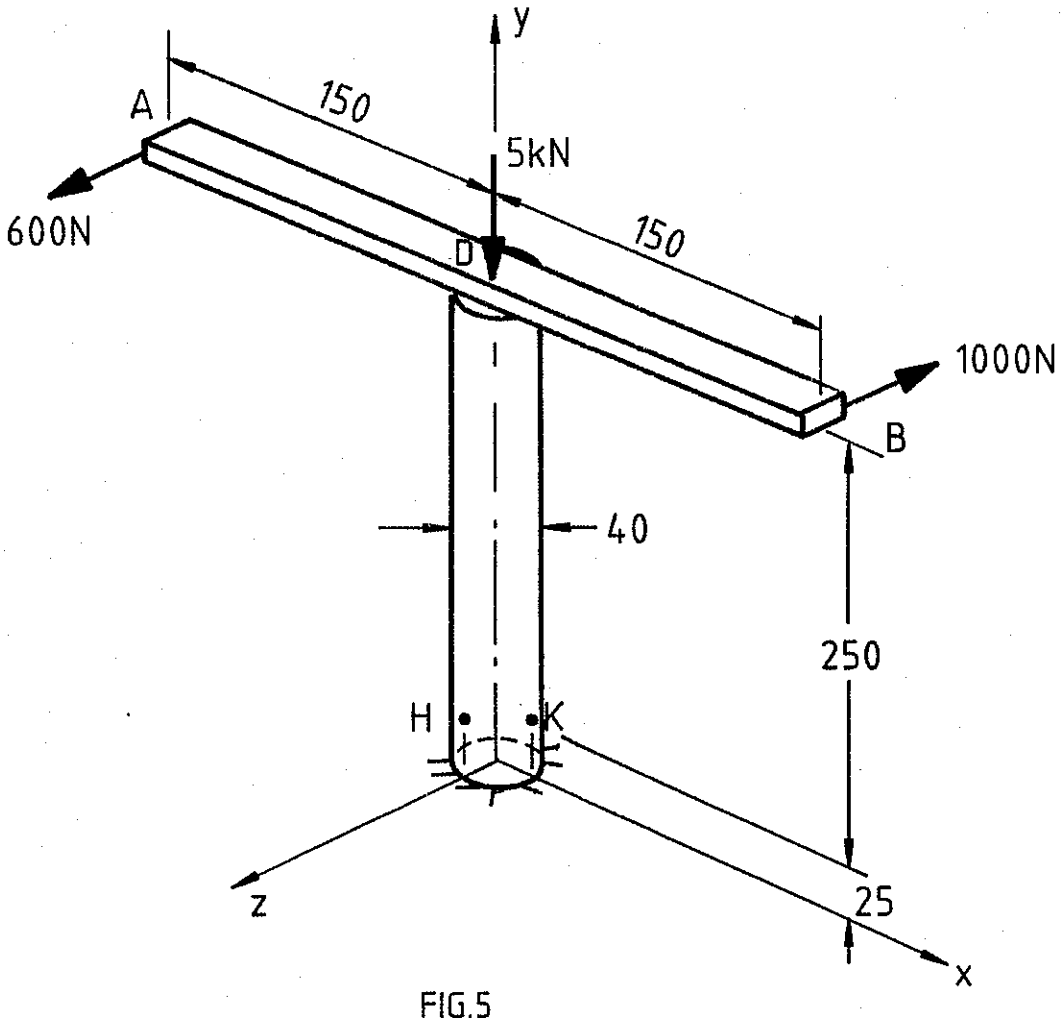


FIG.5

6. (10 marks)

The pin-jointed truss shown in Fig. 6 is simply supported and is loaded by three forces of equal magnitude P at the lower panel points. Each member of the frame is of circular section and diameter 20 mm. If the permissible tensile stress is not to exceed 120 Mpa and there is to be a factor of safety of 1.5 against elastic compressive buckling, calculate the permissible value of P (in kN) for the truss. Given: E = 200,000 Mpa for the truss material.

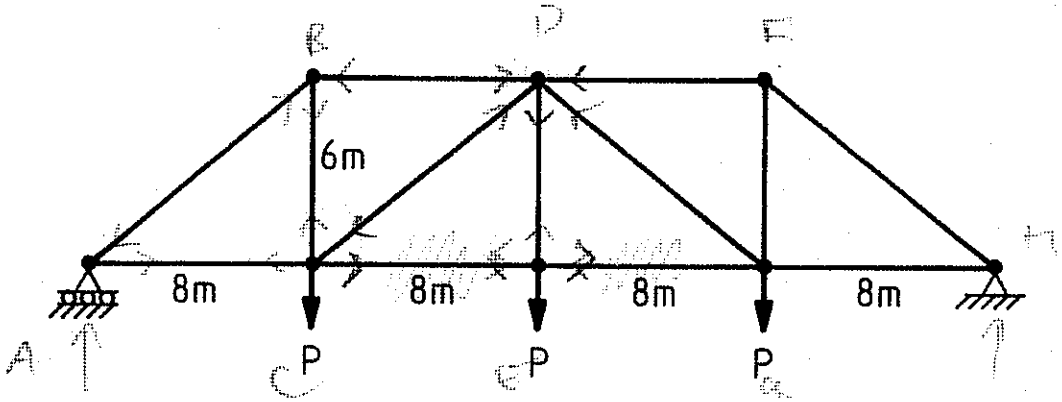


FIG.6