Section B

3. Draw the shear force and bending moment diagrams for the beam shown in Fig. 3. Also indicate the location and magnitude of maximum bending moment. Is there any contraflexure ? **10**

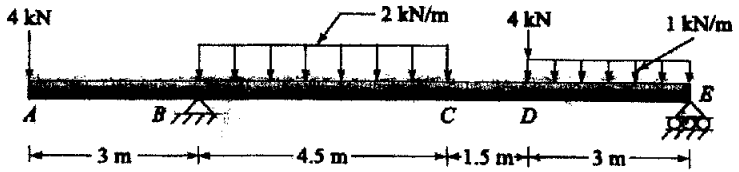

Fig. 3

4. A simple beam of length 5 m carries two types of loads : a uniformly distributed load of 6 kN/m is acting over the entire span and a point load of 2 kN at a distance 2 m from the left support as shown in Fig. 4a. The cross-section of the beam is shown in Fig. 4b. Calculate the maximum bending stress at a distance 3.5 m from the left support. **10**

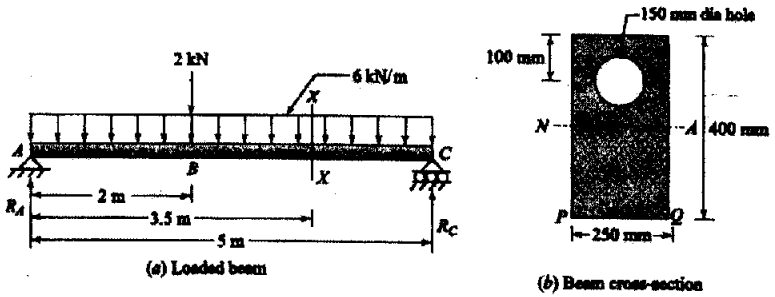

Fig. 4

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July-22-00221

B.Tech. EXAMINATION, 2022

Semester III

MECHANICS OF SOLIDS-I

CE-301

Time : 3 Hours *Maximum Marks : 60*

The candidates shall limit their answers precisely within the answer-book (40 pages) issued to them and no supplementary/continuation sheet will be issued.

Note : Attempt *Five* questions in all, selecting *one* question from each Sections A, B, C and D. Q. No. **9** is compulsory. Assume any suitable missing data if any. Use of non-programmable calculator is allowed.

Section A

1. (a) How is shear strain different from direct strain ? What is the effect shear strain on the volume of a body ? **3**

(b) An assembly of a steel bar enclosed in an aluminium tube is compressed between two rigid parallel plates by a force of 600 kN (Fig. 1). The diameter of steel bar is 60 mm, length of both steel bar and aluminium tube is 1 m. The inside and outside diameters of the aluminium tube are 70 cm and 110 mm respectively. Find the stresses in the bar and tube. E_s = 200 GPa, E_{al} = 70 GPa. 7

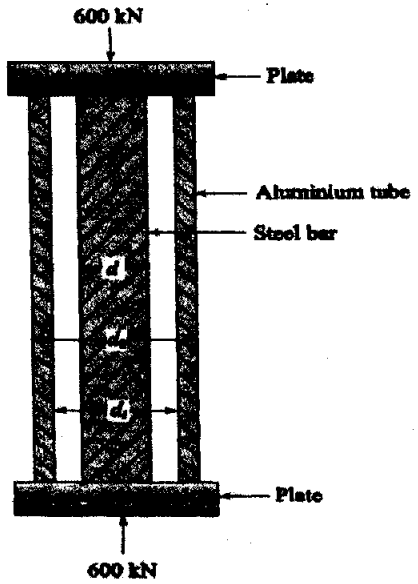

Fig. 1

2. (a) Drw Mohr's circle for a two-dimensional stress field subjected to : 4

(i) Pure shear

(ii) Pure biaxial tension

(iii) Pure uniaxial tension

(iv) Pure uniaxial compression.

(b) For a plane stress condition shown in Fig. 2, find the following parameters : 6

(i) Principlal stresses

(ii) Maximum shear stress

(iii) Corresponding normal stress

(iv) Position of the principal planes

(v) Plane of maximum shear stress.

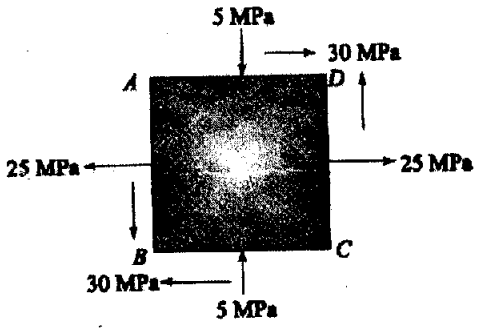

Fig. 2

Section D

7. (a) A cylindrical steel pressure vessel 400 mm in diameter with a wall thickness of 20 mm, is subjcted to an internal pressure of 4.5 MN/m^2.

   (i) Calculate the tangential and longitudinal stresses in the steel.

   (ii) To what value may the internal pressure be increased if the stress in the steel is limited to 120 MN/m^2 ?

   (iii) If the internal pressure were increased until the vessel burst, sketch the type of fracture that would occur. **6**

   (b) A steel storage tank of wall thickness 5 mm, diameter 8 m and height 25 m is filled with water to a certain height h. Assuming a factor of safety of 3.5 and ultimate strength of steel in tension to be 390 MPa, find the value of h. **4**

8. A T section column of length 2 m is subjected to an axial load as shown in Fig. 5. Find the crippling load using Euler's formula, assuming that the column is hinged at both ends. Take E = 200 GPa. **10**

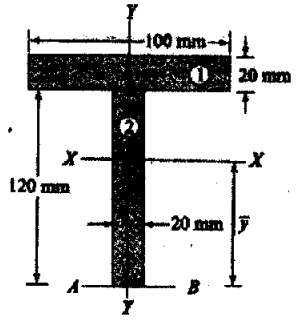

Fig. 5

(Compulsory Question)

9. (a) What is working stress ? How does it differ from ultimate stress ?

   (b) Why is it difficult to predict the failure of an intermediate column ?

   (c) What is polar moment of inertia ? How does it differ from second moment of area ?

   (d) What are pressure vessels ? Name a few pressure vessels.

   (e) What are the limitations of differential equation of beams ?

   (f) Why is mild steel the most important material for engineering applications ?

(g) How is the plane of maximum shear stress located ?

(h) What are the advantages of an I section beam ?

(i) The equation for the deflected shape of a beam carrying a uniformly distributed load and simple supported at the ends is given by :

$$y = \frac{1}{EI}\left(2x^3 - \frac{x^4}{6} - 36x\right).$$

Determine the load carried by the beam. The unit of EI is kN/m^2.

(j) Write the expressions for Euler's formula and Rankine Gordon's formula. **10×2=20**

Section C

5. (a) A 3 m long hollow steel shaft of outside diameter 75 mm is transmitting a power of 150 kW at 1000 rpm. Find thickness of the shaft, if the maximum shear stress in shaft is limited to 40 MPa. Take Modulus of Rigidity (G) = 80 GPa. **4**

(b) 3 m long solid steel shaft transmits a power of 20 kW at 2000 rpm. Find the smallest permissible diameter of the shaft, if the maximum shear stress is not to exceed 50 MPa. Also, find the corresponding angle of twist. Modulus of Rigidity (G) = 80 GPa. **6**

6. A cantilever beam of uniform section and of length *l* carries two concentrated load : W at free end and 2W at a distance '*a*' from the free end. Determine the deflection under the load 2W. If the cantilever is made from steel tube of circular section of 100 mm external diameter and 6 mm thickness and length 1.5 mm, '*a*' = 0.6 m, determine the value of W so that the maximum bending stress is 140 MPa. Calculate the maximum deflection for the loading. Young's modulus of elasticity (E) = 200 GPa. **10**