Total No. of Questions—**12**] [Total No. of Printed Pages—8

[3362]-103

S.E. (Civil) EXAMINATION, 2008

STRENGTH OF MATERIALS

(2003 COURSE)

Time : Three Hours **Maximum Marks : 100**

N.B. :— (*i*) Answer Q. No. **1** *or* Q. No. **2**, Q. No. **3** *or* Q. No. **4**, Q. No. **5** *or* Q. No. **6** from Section I and Answer Q. No. **7** *or* Q. No. **8**, Q. No. **9** *or* Q. No. **10**, Q. No. **11** *or* Q. No. **12** from Section II.

(*ii*) Answers to the two Sections should be written in separate answer-books.

(*iii*) Neat diagrams must be drawn wherever necessary.

(*iv*) Figures to the right indicate full marks.

(*v*) Use of electronic pocket calculator is allowed.

(*vi*) Assume suitable data, if necessary and clearly state them.

(*vii*) Assessment will be based on complete solutions but not on final answer.

(*viii*) Use of cell phone is prohibited in the examination hall.

SECTION I

1. (*a*) A standard steel specimen of 12 mm diameter elongated 0.22 mm in a 200 mm gauge length when it was subjected to a tensile force of 30 kN. Determine three elastic constant if the Poisson's ratio $\upsilon = 0.25$. [8]

P.T.O.

(*b*) The steel bar shown in Fig. 1 (*b*) is axially loaded at its third points and fixed at its ends. The cross-sectional area of bar is A. Calculate the axial force in each of the sections AB, BC and CD if the bar was free from initial stresses. [8]

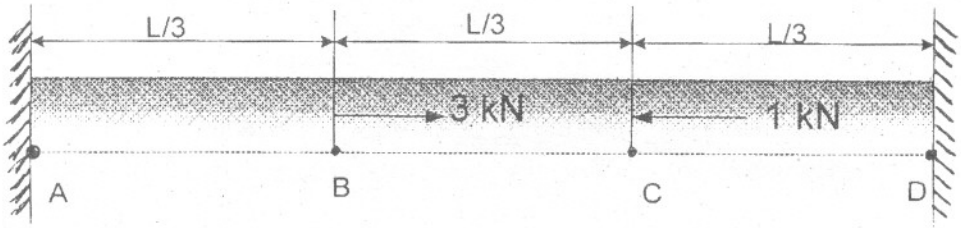

Fig. 1 (*b*)

Or

2. (*a*) A rigid bar AB is hinged to a vertical wall and supported horizontally by a tie-bar CD as shown in Fig. 2 (*a*). The tie-bar has cross-sectional area of 50 mm^2 and its allowable stress in tension is 150 N/mm^2. Find the magnitude of the load P and the corresponding vertical deflection δ_B of point B. [8]

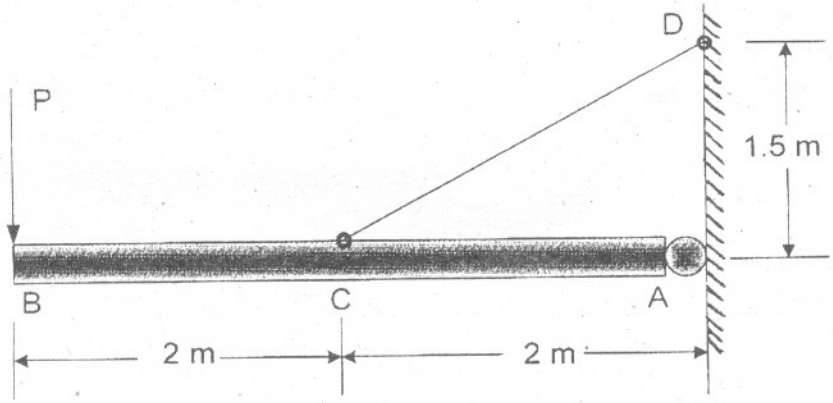

Fig. 2 (*a*)

(*b*) A reinforced concrete column 200 mm in diameter is designed to carry an axial compressive load of 300 kN. Determine the required area of the reinforcing steel if the allowable stresses are 6 MPa and 120 MPa for the concrete and steel respectively. Use E_{co} = 14 GPa and E_{st} = 200 GPa. [8]

3. (*a*) Derive an expression for shear force and bending moment for the beam loaded and supported as shown in Fig. 3 (*a*). Also draw shear force and bending moment diagram. [8]

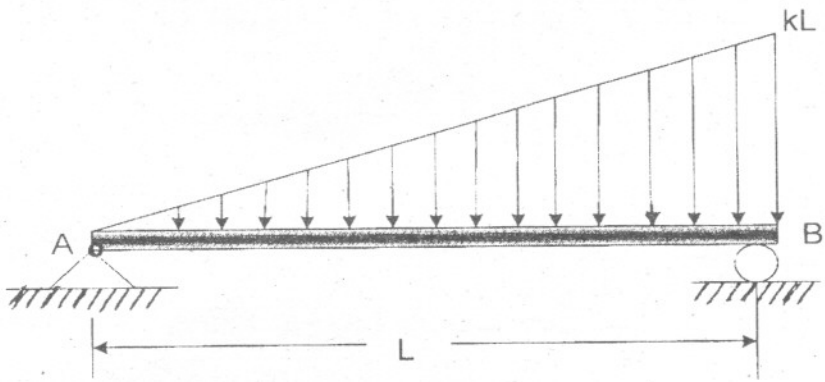

Fig. 3 (*a*)

(*b*) Find the maximum flexural stress at a section 250 mm from the support for the cantilever shown in Fig. 3 (*b*). [8]

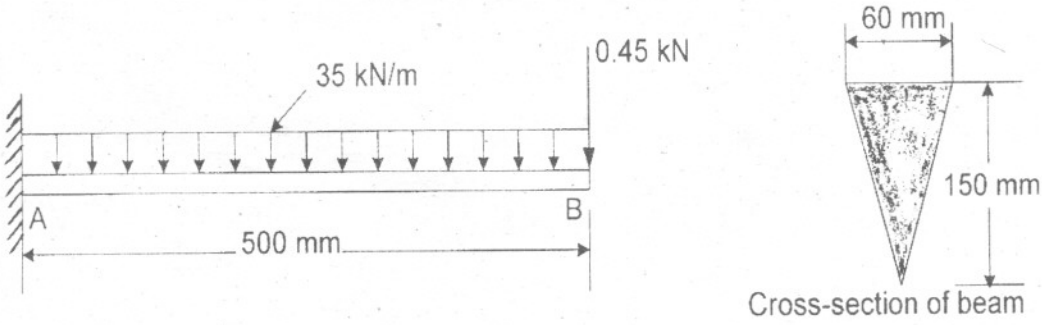

Fig. 3 (*b*)

Or

4. (*a*) A simply supported beam AB is acted upon by two externally applied couples of moment M and 2M as shown in Fig. 4 (*a*). Neglecting the self weight of the beam, draw S.F. and B.M. diagrams. [8]

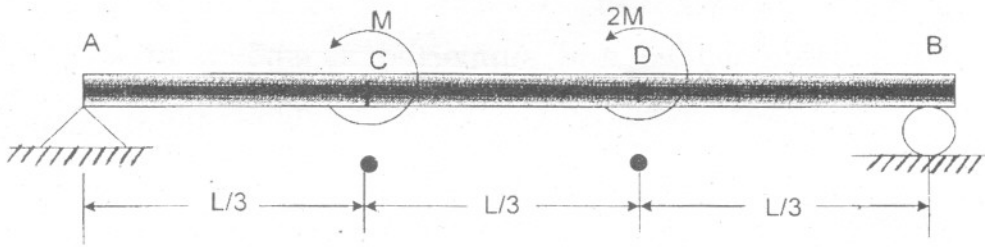

Fig. 4 (*a*)

(*b*) A simply supported beam with overhang is loaded as shown in Fig. 4 (*b*). The beam has a heavy T-section, the flange is 225 mm wide and the web of 150 mm deep. Flange and web are each 100 mm thick. Calculate the maximum flexural stresses at top and bottom. [8]

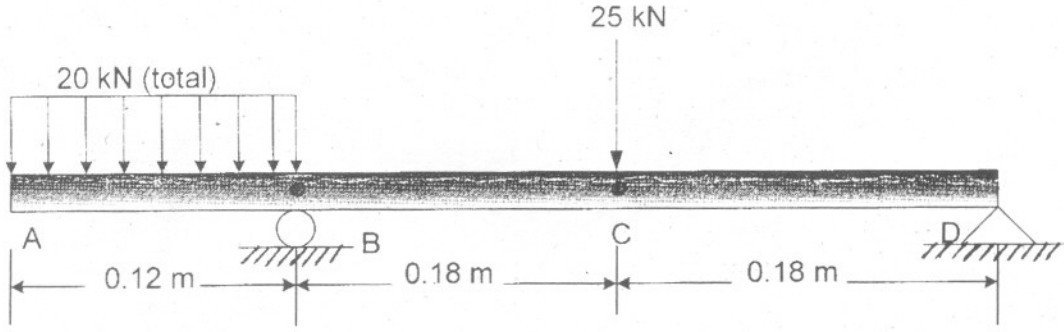

Fig. 4 (*b*)

5. (*a*) A simply supported beam of span 3 m carries uniformly distributed load w per unit length. The cross-section of a beam is a rectangle 200 mm wide and 300 mm deep. The maximum flexure stress due to bending is 8.4 N/mm^2. Calculate the maximum shear stress. [10]

(*b*) Determine the proper diameter d for a solid steel shaft to transmit 300 hP at 105 r.p.m. if the permissible shear stress is 40 N/mm^2. [8]

Or

6. (*a*) A simply supported beam of span L = 2.7 m has the T-section, the flange is 75 mm wide and the web of 75 mm deep. Flange and web are each 25 mm thick shown in. The beam carries a load P = 5 kN at a point 900 mm from the right support. Calculate the maximum shear stress in the beam. [8]

(*b*) A solid aluminum shaft 1.0 m long and 50 mm diameter is to be replaced by a hollow steel shaft of the same length and the same outside diameter of that aluminum shaft so that either shaft could carry the same torque and have the same angle of twist over the total length. Determine the inner diameter of the steel shaft. G_{St} = 84 kN/mm^2 and G_{Al} = 28 kN/mm^2. [10]

SECTION II

7. (*a*) Determine the normal and tangential components of stresses on the plane which makes an angle $\theta = 22.5°$ with x plane, if $\sigma_x = 35$ N/mm^2 and $\sigma_y = 56$ N/mm^2. Also find angle of obliquity ϕ. [8]

(*b*) A 60 mm diameter shaft supported a 750 mm diameter pulley weighing 2.5 kN at an overhanging end of the shaft as shown in Fig. 7 (*b*). Determine the principal stresses at the section 150 mm from overhanging end if the horizontal belt tensions are as shown. [10]

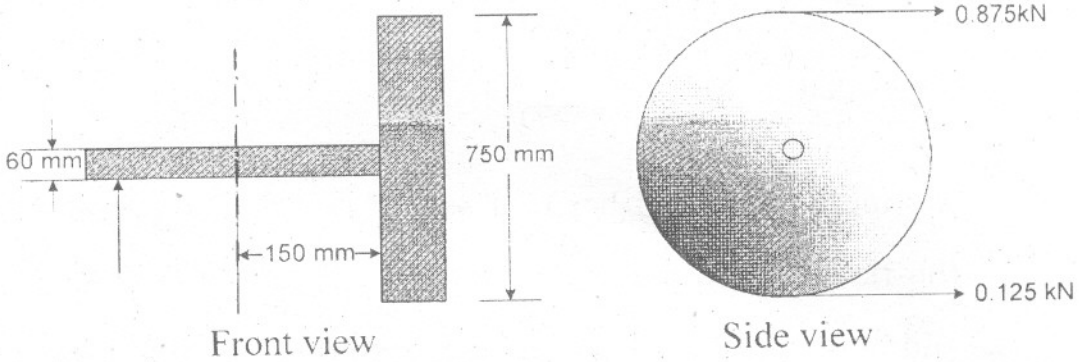

Fig. 7 (*b*)

Or

8. (*a*) Construct the Mohr's circle for the case of complex state of stresses and determine the principal stresses and maximum shear stress if $\sigma_x = 150$ N/mm^2, $\sigma_y = 50$ N/mm^2 and $\tau = 50$ N/mm^2. [8]

(*b*) A solid shaft 100 mm in diameter is subjected simultaneously to an axial compressive force of 600 kN and to a torque that twist the shaft through an angle of 1.5° in a length of 8 m. If modulus of rigidity G = 80 GPa, determine the principal stresses and max. shear stress in the shaft. [10]

9. (*a*) State and explain concept effective length of column and draw the buckling pattern for different end conditions of columns. [8]

(*b*) Bars AB, AC and AD are slender steel rods of circular cross-section which all have the same flexural rigidity EI. They have pinned ends at A, B and D and a fixed end at C. Calculate the critical value of the vertical load P applied at A. Assume buckling of the bars to take place in the plane of the Fig. 9 (*b*). [8]

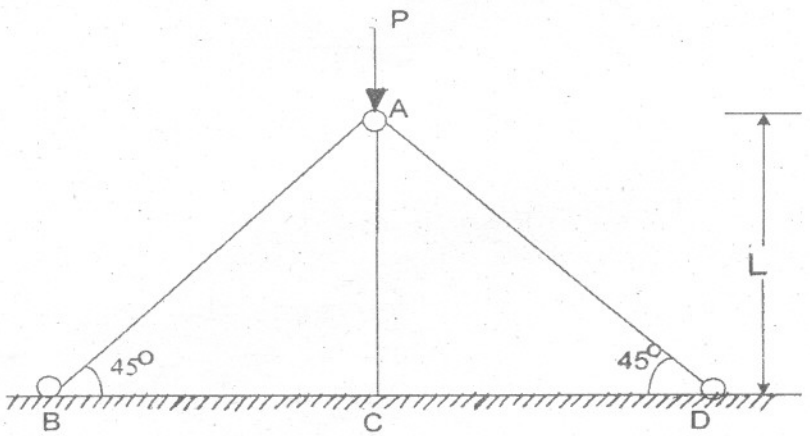

Fig. 9 (*b*)

Or

10. (*a*) Determine the slenderness ratio of a 5 m column with fixed ends if its cross-section is :

(*i*) circular with radius of 40 mm and

(*ii*) 50 mm square.

Also find Euler's buckling load for both cases in terms of EI. [8]

(*b*) Find total stresses at corner A, B, C and D due to force P as shown in Fig. 10 (*b*). [8]

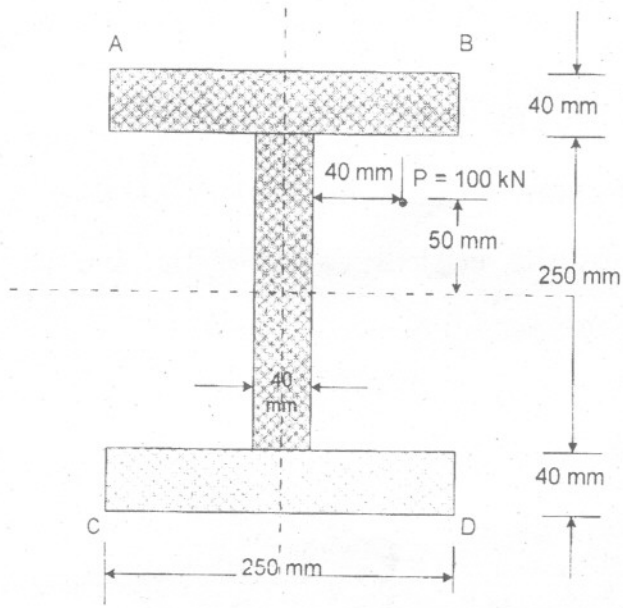

Fig. 10 (*b*)

11. (*a*) Using Macaulay's method determine the slope and deflection of a simply supported beam of span '4*a*' in terms of EI if clockwise couple is act at a distance of '*a*' from left support. [8]

(*b*) Find the slope and deflection at the free end of cantilever loaded with uniformly distributed load of 5 kN/m on entire span of 4 m. The flexural rigidity for 2 m from fixed end is 2 EI and for remaining length is EI. [8]

Or

12. (*a*) A cantilever beam of span 2 m is loaded with uniformly distributed load of 4 kN/m upward over entire span. Determine clockwise moment to be applied at the free end so as to have no deflection at the free end. Assume EI is constant. [8]

(*b*) Find slope at the ends and maximum deflection for a simply supported beam of span L loaded with uniformly distributed load *w* per unit length over entire span by conjugate beam method. [8]