Ex/BESUS/AM-301/07

B.E. (CE) Part-II 3rd Semester Examination, 2007

Solid Mechanics-I

(AM-301)

Time : 3 hours **Full Marks : 70**

Use separate answerscript for each half.

FIRST HALF

(Answer Q.No. 1 and any THREE from the rest.)

1. Choose the best response : [1×5]

   i) Shear stress may occur due to (a) bending, (b) torsion, (c) bending and torsion, (d) none of the above.

   ii) In a triangular prismatic bar subjected to simple bending, shear stress will show the maximum value at (a) apex of triangle, (b) base of triangle, (c) N.A. of the triangle, (d) none of these.

   iii) $\frac{T}{J} = \frac{\tau}{\rho} = G\frac{\phi}{l}$ relationship is valid for shaft of (a) circular c/s, (b) any c/s, (c) triangular c/s, (d) rectangular c/s.

   iv) $\tau = \frac{VQ}{Ib}$ relationship fails to analyse the shear stress distribution in bending in (a) web, (b) flange, (c) web and flange both, (d) none of these.

   v) The unit of applied torque in S.I. is (a) kgm, (b) Ncm, (c) kgcm, (d) Nm.

2. A water main of 500 mm internal diameter and 20 mm thick is running full. The water main is of cast iron and is supported at two points 10 m apart. Find the maximum bending stress in the pipe cross section. The cast iron and water weight 72 kN/m^3 and 10 kN/m^3 respectively. [10]

3. A timber beam 150 mm wide and 200 mm deep is to be reinforced by bolting on two steel flitches each 150 mm x 12.5 mm in section. Calculate the moment of resistance in the following cases : i) flitches attached symmetrically at top and bottom, ii) flitches attached symmetrically at the sides. Allowable stress in timber is 6 MPa. What is the maximum stress in steel in each case? Take $E_s = 2 \times 10^5$ MPa, $E_t = 1 \times 10^4$ MPa. [10]

4. The shear force acting on a beam at an I-section with unequal flanges is 50 kN. The section is : top flange 200 x 50, bottom flange 130 x 50, web 200 x 50. Calculate the shear stress at N.A. and also draw the shear stress distribution over the depth of the section. [10]

5. a) State the assumptions considered in Euler-Bernoulli beam theory.

   b) Prove the relationship : $\frac{T}{J} = \frac{\tau}{\rho} = G\frac{\phi}{l}$ where the symbol carry usual meaning.

[5+5]

6. A hollow shaft of diameter ratio $\frac{3}{8}$ is to transmit 375 kW power @ 100 r.p.m. The maximum torque being 20% greater than the mean. The shear stress is not to exceed 60 MPa and twist in a length of 4 m not to exceed 2°. Calculate its external and internal diameters which would satisfy both the above conditions. Assume modulus of rigidity 0.85×10^5 MPa. [10]

SECOND HALF

(Answer Q.No.7 and any THREE from the rest.)

7. Choose the correct alternative : [5×1]

   a) If G, E & μ are shear modulus, modulus of elasticity and Poisson's ratio, respectively, then

   (i) $E = \frac{G}{2(1+\mu)}$, (ii) $G = \frac{\mu}{2(1+E)}$, (iii) $\mu = \frac{G}{2(1+E)}$ and (iv) $G = \frac{E}{2(1+\mu)}$

   b) Strain energy stored in a bar with length *l*, cross sectional area A subjected to an uni-axial tension P is given by

   (i) $U = \frac{l^2 AE}{2P}$, (ii) $U = \frac{A^2 El}{P^2}$, (iii) $U = \frac{P^2 l}{2AE}$, (iv) $U = \frac{E^2 A}{2Pl^2}$

   c) The distance between the centres of adjacent rivets in the same row is called
   (i) pitch, (ii) lap, (iii) gauge and (iv) staggered pitch.

   d) A flat ended thin cylindrical tank with radius r and wall thickness t contains internal gas pressure p. the principal membrane stresses σ_1 and σ_2 are

   (i) $\frac{pr}{4t}$ and $\frac{pr}{2t}$, (ii) $\frac{pt}{2r}$ and $\frac{pt}{4r}$, (iii) $\frac{pr}{2t}$ and $\frac{pr}{t}$, (iv) $\frac{pr}{3t}$ and $\frac{pt}{3r}$

   e) In a transversely loaded beam the point of contraflexure is a point where
   (i) bending moment is maximum, (ii) bending moment is minimum,
   (iii) shear force changes its sign, (iv) bending moment changes its sign.

8. A composite structural member made up of steel and brass has total length of 75 cm which is fixed between two supports at two ends. The steel portion of the bar has a length of 50 cm with a cross sectional area of $2\,cm^2$. The remaining portion of the member is made up of brass and having a cross sectional area of $4\,cm^2$. Find the stress developed in each material if the temperature of the assembly drops by 50°C. Take $E_s = 2 \times 10^6$ kN/cm², $\alpha_s = 12 \times 10^{-6}$/°C, $E_b = 1 \times 10^6$ kN/cm² and $\alpha_b = 19 \times 10^{-6}$/°C. [10]

9. A two dimensional element of rectangular shape is subjected to bi-axial tensile stresses of 20 N/mm^2 and 50 N/mm^2 in its lateral and longitudinal direction, respectively. Find out the normal and shear stress in a plane which makes an angle of 30° with the longitudinal direction. Also find the value of maximum shear stress and orientation of the plane on which it occure. [10]

10. Design a suitable fillet weld to connect a tie bar 60 x 8 mm to a 12 mm thick gusset plate. The permissible stresses in the tie bar and fillet weld are 145 MPa and 109 MPa respectively. [10]

11. A flat ended cylindrical tank has radius of 300 cm and wall thickness of 3 mm. It is subjected to an internal gas pressure of 150 kN/cm^2. Find out the value of principal membrane stresses σ_1 and σ_2. Derive the formula which you have to use for the problem. [6+4]

12. Draw BMD and SFD for the beam loaded as shown in Fig.Q.12. Indicate also the position of point of contraflexure, point of maximum bending moment (+ve), point of maximum bending moment (–ve). [10]

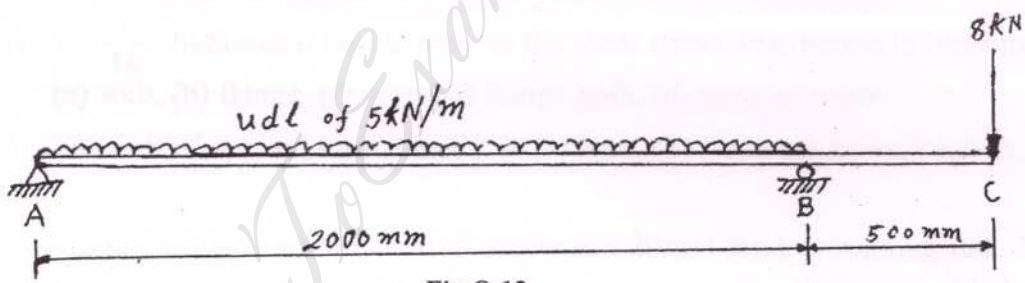

Fig.Q.12

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