33+33+32

T0923 / T1473 STRENGTH OF MATERIALS

24.5.17

O. P. Code : 18284

SE Civil III CBSGS

(3 Hours) [Total Marks: 80

N. B.: 1) Question No. 1 is **Compulsory.**
2) Answer any **three** from the remaining.
3) Each **full** question carries **equal** marks.
4) **Assume** suitable data, if needed & **state** it clearly.

Q. 1) (a) Choose & write the correct option: **(02 M)**
A solid circular shaft of diameter (d) is subjected to to a bending moment (M). The same shaft is then subjected to a pure torque (T), such that T = M/2. The ratio of Maximum Bending Stress to Maximum Shear Stress is:
(i) 2 (ii) 4 (iii) 3 (iv) 1.5

(b) Choose & write the correct option: **(02 M)**
If a simply supported beam of circular cross-section with diameter (D) & length (l) carries a point load (W) at the centre of the beam, then the strength of the beam is proportional to:
(i) $1/D^3$ (ii) $1/D^2$ (iii) D^3 (iv) D^2

(c) What are the assumptions of Euler's column buckling theory? **(04 M)**

(d) Locate core (i.e. Kernel) of the solid rectangular section of width 400 mm & depth 600 mm. **(04 M)**

(e) Choose & write the correct option: **(04M)**
A mild steel bar is in three parts, each 200 mm long (**fig. 1**). The diameters of the parts are indicated on the diagram. The bar is subjected to axial pull of (P) N. If E = 2 X 10^5 MPa & the elongations in the three parts AB, BC & CD are Δ1, Δ2 & Δ3 respectively, then the ratio of the greatest elongation to the least elongation will be:

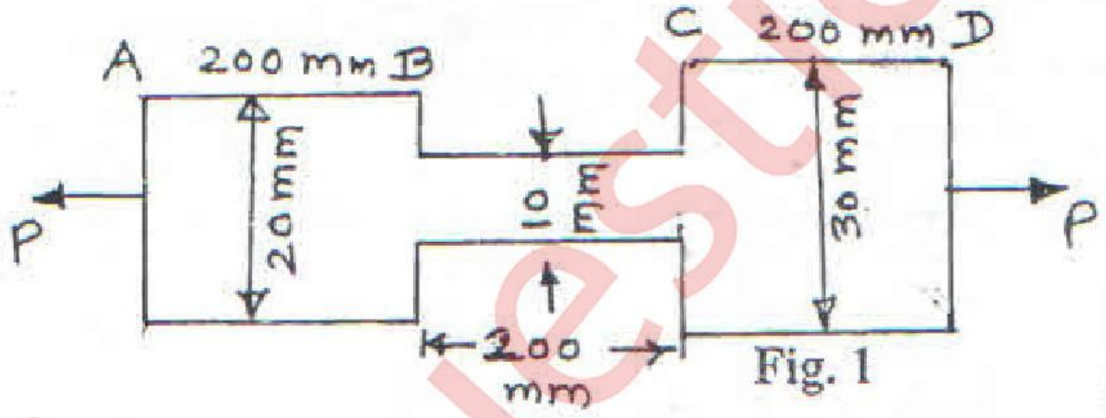

Fig. 1

(i) 9 (ii) 4
(iii) 3 (iv) 2

(f) Derive the relationship between the loading (w), Shear Force (F) & Bending Moment (M). **(04 M)**

Q. 2) (a) The beam **(fig. 2)** is bolted (pinned or hinged) at A & rests on a bearing pad at B that exerts an upward UDL on the beam over its 0.6 m length. Draw the Shear Force Diagram & Bending Moment Diagram for the beam. Show the SF & BM values at all the important points. **(08 M)**

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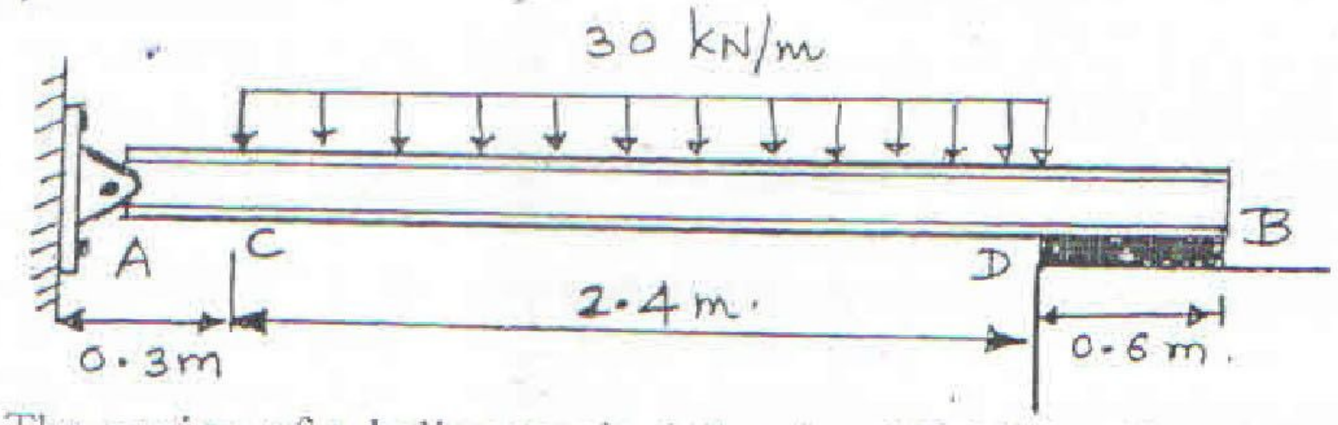


Fig. 2

(b) The engine of a helicopter is delivering 450 kW to the rotor shaft AB when the blades are rotating at 1200 Revolutions/Minute. Determine the diameter of the shaft AB, if the allowable shear stress in shaft AB is 74 MPa & the vibrations limit the angle of twist of shaft AB to 0.05 radians. The shaft is 0.6 m long & modulus of rigidity for the shaft material = 75 GPa. Refer fig. 3. **(08 M)**

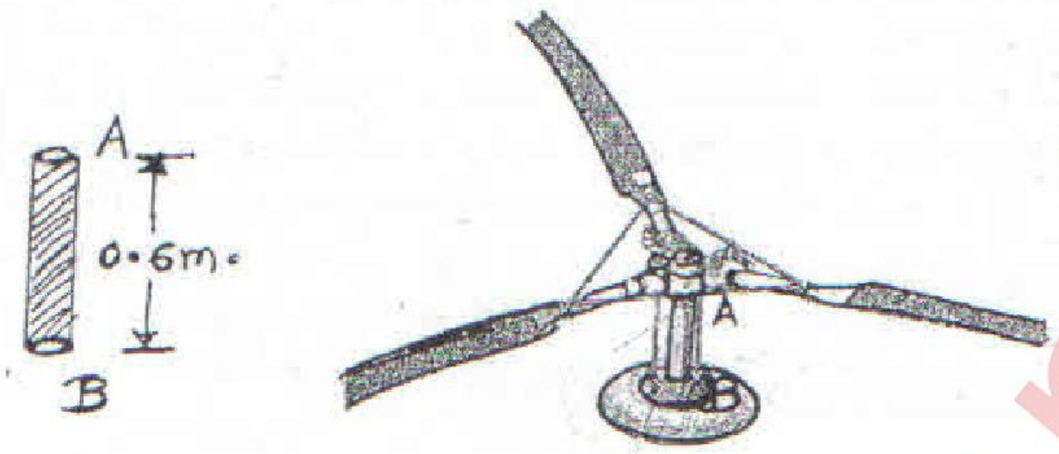
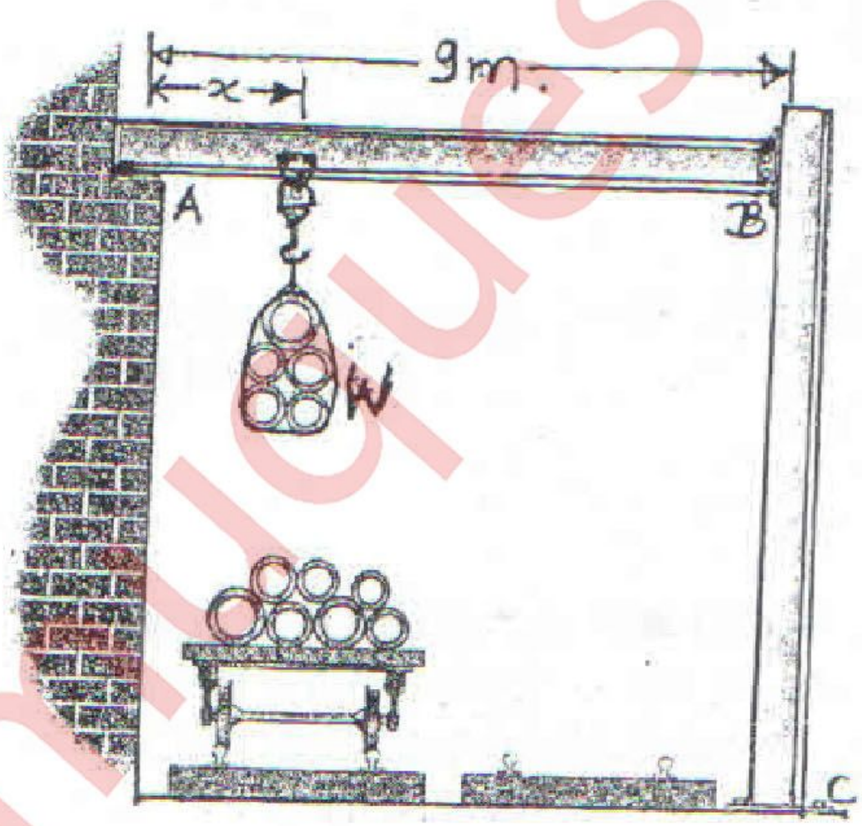


Fig. 3

(c) Write a note on flitched beams, with neat sketches. **(04 M)**

Q. 3) (a) The beam AB is used in a railroad yard for loading & unloading cars. The hoist travels along the bottom flange of the I section beam AB (**fig. 4**). Assume the beam AB is pinned to the column at B & roller supported at A. At what position of the hoist load, the Bending Moment in beam AB will be maximum? The C/S details of beam AB are shown. If the allowable bending stress in the beam material is 170 MPa, what will be maximum value of hoist load, that can be allowed to be lifted? Calculate maximum Bending Moment corresponding to maximum hoist load. **(08 M)**



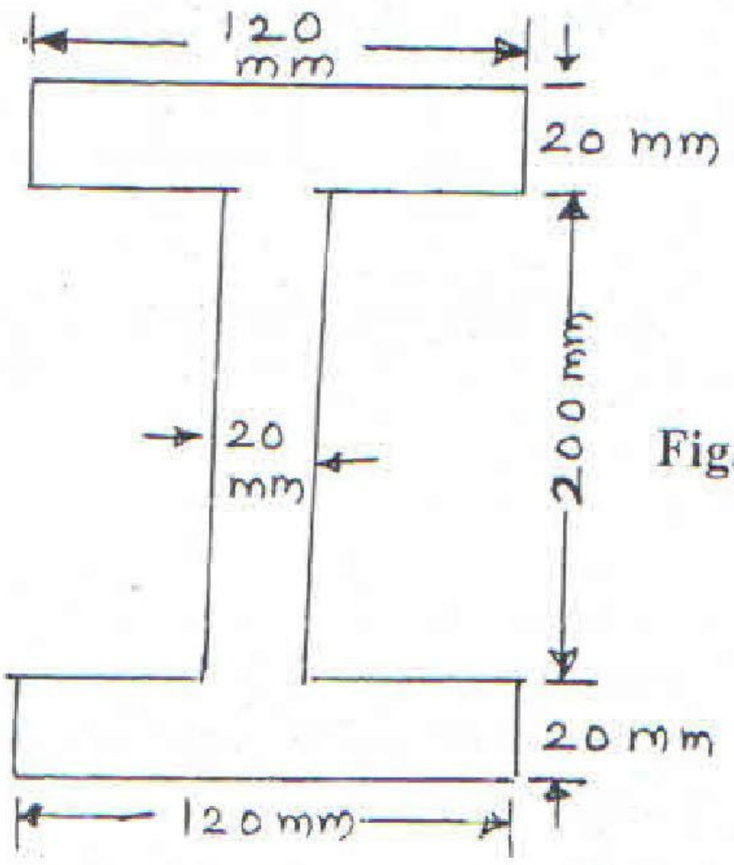


Fig. 4

(b) A 30mm dia. solid circular aluminium rod 3 m long, is subjected to an axial pull of 100 kN. Taking E = 70 GN/m² & Poisson's Ratio = (1/3), determine the elongation, change in diameter & change in volume of the rod. Also, find the bulk modulus. **(08 M)**

(c) Draw typical Shear Stress Distribution diagrams for the symmetrical I section (symmetrical about both the axes), T section, solid rectangular section & circular section. **(04 M)**

Q. 4) (a) A thin cylindrical shell, 3.25 m long & 1 m internal diameter, is subjected to an internal fluid pressure of 1.2 MPa. The shell thickness is 10 mm. Find the circumferential & longitudinal stresses. Find also the maximum shear stress & change in dimensions. Also, determine the change in volume. Take E = 200 GN/m² & Poisson's ratio = 0.3. **(08 M)**

(b) For a solid rectangular section, show that the maximum shear stress = (1.5 X Average shear stress). A symmetrical I section beam has flange width 220 mm, flange thickness = 20 mm, web thickness = 15 mm & web depth = 300 mm. It carries a shear force of 110 kN. Sketch Shear Stress Distribution across the section. **(08 M)**

(c) Derive an expression for the strain energy due to suddenly applied loads. **(04 M)**

Q. 5) (a) The following results were obtained in a tension test on a Mild Steel specimen of Gauge Length 50 mm & diameter 14 mm (observations are given only up to yield point). Yield Load = 35.5 kN, Ultimate Load = 58 kN, Breaking Load = 46 kN, Final Gauge Length = 73 mm, Final Gauge Diameter at Neck = 8.4 mm. Determine Young's Modulus, Ultimate Stress, Breaking Stress, Percentage Elongation, Percentage Reduction in Area & True Stress at fracture. **(08 M)**

Load (kN)	0	1.5	7	10	14	18.5	22	25	28.5	34	35.5
Extension (mm)	0	0.005	0.01	0.015	0.02	0.025	0.03	0.035	0.04	0.045	0.05

(b) A concrete dam has the cross-section shown in **fig. 5**. Determine the maximum & minimum stresses at the base of the dam (section m-n). The concrete density = 24 kN/m³ & Unit weight of water γ_w = 9.81 kN/m³. Consider the length of the dam as 1 m. Draw the Stress Distribution Diagram at the Dam base. **(08 M)**

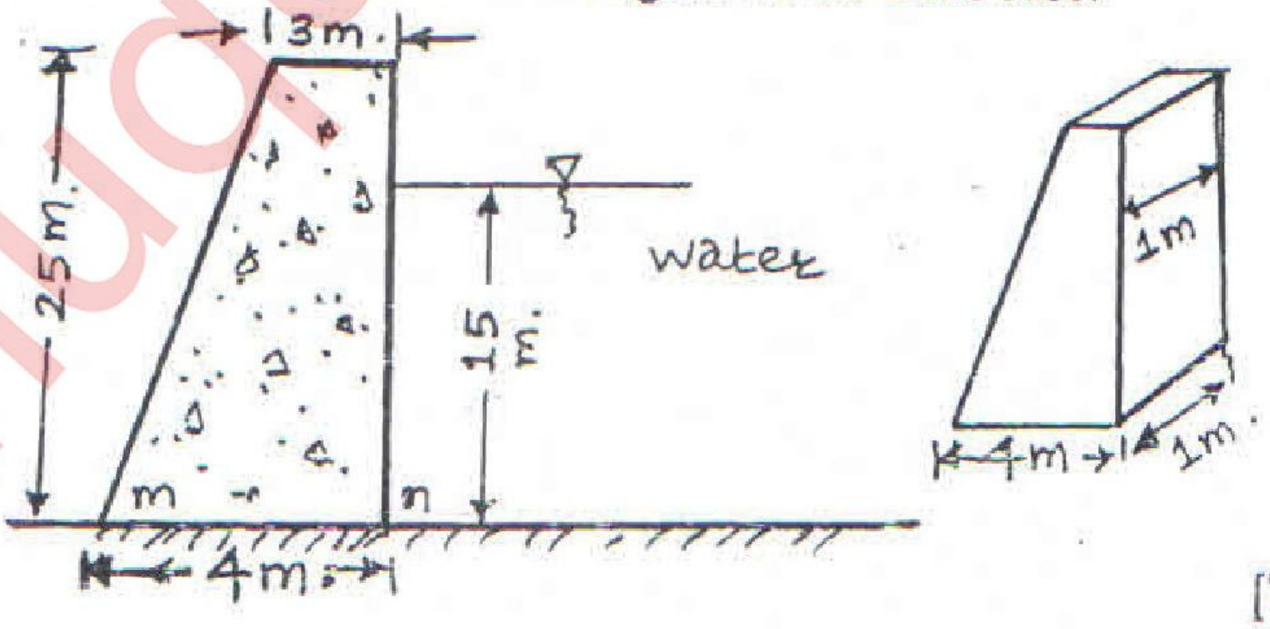


Fig. 5

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(c) Consider the following statements in connection with Euler's Column Buckling theory

I. The elastic critical stress in compression increases with decrease in slenderness ratio.

II. The effective length depends on the boundary conditions at the ends of column.

III. The elastic critical stress in compression is independent of the slenderness ratio.

IV. The ratio of effective length to its least radius of gyration is called as slenderness ratio.

The **TRUE** statements are:

(02 M)

(i) II & III (ii) III & IV (iii) II, III & IV (iv) I, II & IV

(d) What was the shortcoming of the Euler's Column Failure theory? Write Rankine's Column Crippling theory, indicating the meaning of each term. **(02 M)**

Q. 6) (a) The Principal Stresses at a point across two perpendicular planes are 100 MPa (tensile & horizontal) and 60 MPa (tensile & vertical). Determine the normal, shear & resultant stresses in magnitude & direction in a plane, the normal of which makes an angle of 30^0 with the direction of maximum principal stress. Use either analytical method or graphical method. **(08 M)**

(b) A bar of steel is (60 mm X 60 mm) in section & 180 mm long. It is subjected to a tensile load of 320 kN along the longitudinal axis & tensile loads of 760 kN & 600 kN on the lateral faces. Find the change in the dimensions of the bar & the change in volume. Take E = 200 GN/m^2 & Poisson's ratio = 0.3. **(08 M)**

(c) A steel rod 15 m long is at a temperature of 16^0 C. Find the free expansion of the rod when the temperature is raised to 66^0 C. Find the temperature stress produced, when the expansion of the rod is fully prevented. **(04 M)**
