INDIAN INSTITUTE OF TECHNOLOGY

27.9.12 (A.N) | 2 Hrs. | F.M: 100 | No. of Students: 50

Autumn Sem, 2012 | Aerospace Engg. | AE-31009

3rd Yr. B. Tech (H) | Aerospace Structural Analysis

Instruction: Answer to any Q. should be at one place only

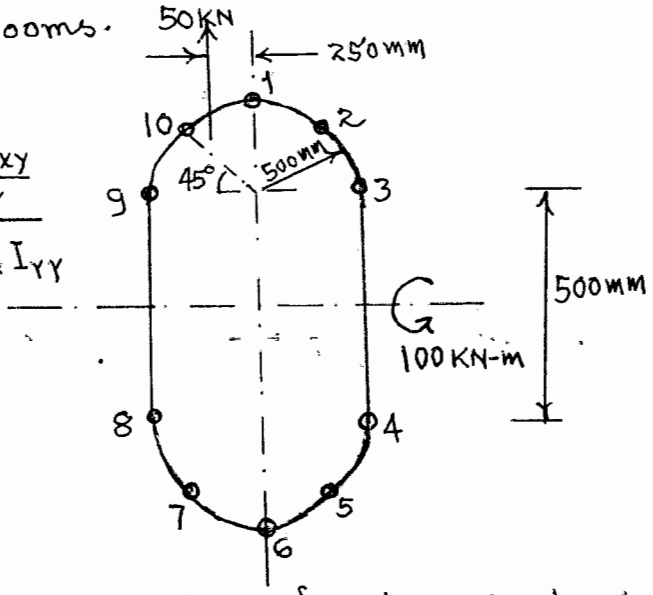
1.

(a) Explain the concept of symmetric and unsymmetric bending using neat sketches. (5)

(b) The doubly symmetrical fuselage section shown has been idealized into an arrangement of direct stress carrying booms and shear stress carrying skin panels; the boom areas are all 150 mm^2. Calculate the direct stresses in the booms. (20)

Given:

$$\bar{M}_x = \frac{M_x - \frac{M_y I_{xy}}{I_{yy}}}{1 - I_{xy}^2/I_{xx} I_{yy}}$$

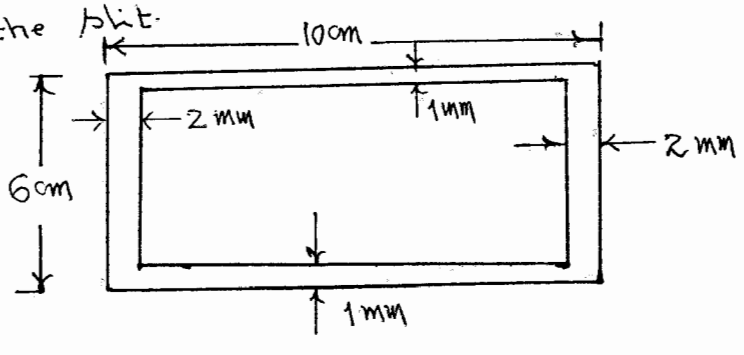


2.

(a) Define Prandtl stress function in torsional problem, hence prove that the resultant forces acting on the ends of the bar vanish. Prove that $T = 2\iint \phi(x,y)\,dx\,dy$ (8)

(b) For the elasticity problem involving torsion, write down the mathematical relationships between St. Venant warping function, $\psi(x,y)$ and the Prandtl stress function, $\phi(x,y)$. (7)

(c) A thin-walled rectangular tube shown, is subjected to torsion T. A slit is now made to the wall of the tube. Calculate the ratio of the torsional stiffness between the closed tube and the tube with the slit. (10)



3. A solid bar of elliptic cross-section is subjected to uniform torsion T. Using the Prandtl stress function solution technique, obtain the following:

(a) the stress function $\phi(x,y)$ for the problem.

(b) the relationship between the applied torque and the rate of twist.

(c) hence, prove that $J_{eff}/I_p = (4a^2b^2)/(a^2+b^2)^2$
where, I_p = Polar M.I. for an ellipse

(d) the value of the shear stresses at $x = \pm a$, $y = \pm b$

(e) Obtain the expression for the warping displacement, $w(x,y)$ and sketch the distribution.

5 X 5

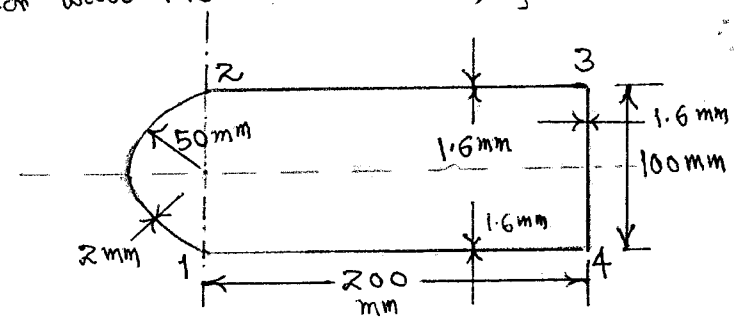
4.

(a) For the single cell box section shown, assuming that the stresses are given by Bredth-Batho theory of torsion,

(i) find the allowable torque on the tube so that the maximum shear stress on the cell wall does not exceed 140 MPa. Find the torsional rigidity of the tube. G = 26 GPa for all walls

(ii) find the torsional rigidity of the above section if G for wall 1-2 is 22 GPa, for all other walls G = 26 GPa

(20)



(b) Explain: Neuber Tube with appropriate example.

(5)