DEPARTMENT OF CIVIL ENGINEERING, IIT BOMBAY

CE 201 Solid Mechanics

Tutorial Sheet = 5 Instructor : Siddhartha Ghosh

1. The sections of the beam shown in Fig. 1 are subjected to a positive bending moment of 20 kN.m. Determine (i) the neutral axis and the moment of inertia of the cross-section, (ii) the stresses in extreme fibers, (iii) the resultant compressive force above neutral axis, (iv) the resultant tensile force below neutral axis, and (v) the lever arm of the couple.

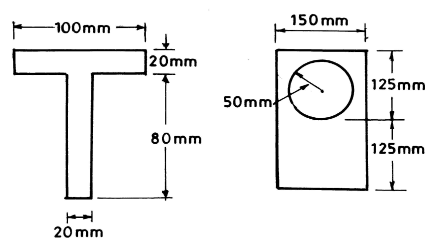

Fig. 1

2. A solid steel beam (Fig. 2) was loaded in laboratory in pure bending about a horizontal neutral axis. Strain measurements showed that the top fibers contracted 0.0003 m/m longitudinally, the bottom fibers elongated 0.0006 m/m longitudinally. Determine the total normal force which acted on the shaded area indicated in the figure. E = 200 GPa.

3. A portion of the square bar is removed by milling as shown in Fig. 3. Determine the ratio h/h_0 for which the section has the maximum moment carrying capacity about its horizontal neutral axis.

4. A trapezoidal beam section has depth **d,** the top width **b** and bottom width as α**b**. Determine the value of α if the ratio of maximum stress at top to bottom is 1.5.

5. A steel beam in the shape of T has been strengthened by securing bolting to it the two oak timbers shown in Fig. 4. The modulus of elasticity is 12.5 GPa for the wood and 200 GPa for the steel. Draw the bending stress diagram of the beam due to positive bending moment 50 kNm.

6. A rectangular beam (b = 60 mm, d = 120 mm) is made of a plastic for which the modulus of elasticity in tension is one-half of its value in compression. Determine the maximum tensile and compressive stress due to moment of 5 kN.m.

7. A rectangular beam (b = 100 mm, d = 180 mm) is made of an alloy for which the stress-strain relationship, in both tension and compression may be represented by the relation $\varepsilon = k\sigma^3$. Determine the maximum stress due to moment of 60 kN.m.

8. Determine the plastic moment of the member with the cross-section shown in Fig. 1, assuming the material to be elasto-plastic with yield strength of 250 MPa.

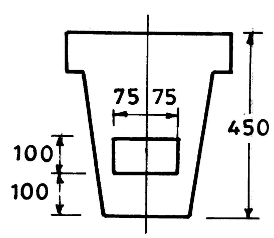

Fig. 2

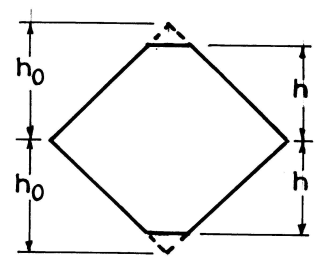

Fig. 3

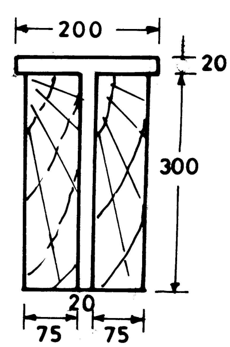

Fig. 4