COE-C2001 - Foundations of Solid Mechanics

Mid-term report questions

(1) Deadline: 12:00 noon, Thursday, 25 November 2021.
(2) Free format submission.

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1. Determine the maximum normal and minimum normal stress in the bracket (**Fig. 1**) at section *a-a* when the load is applied at *x*=250mm. (Note: *Maximum* and *minimum* denote "maximum positive value" and "maximum negative value", respectively). (6 points)

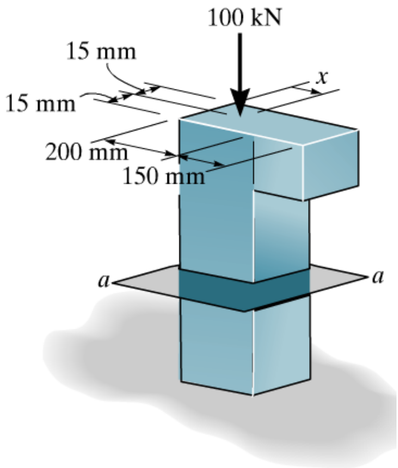

Fig. 1. for Q1

2. The assembly shown in **Fig. 2** consists of two 10-mm diameter red brass C83400 copper rods *AB* and *CD*, a 15-mm diameter 304 stainless steel rod *EF*, and a rigid bar *G*. (a) If *P* = 5 kN, determine the horizontal displacement of end *F* of rod *EF*, (b) If the horizontal displacement of end *F* of rod *EF* is 0.45 mm, determine the magnitude of *P*. (6 points)

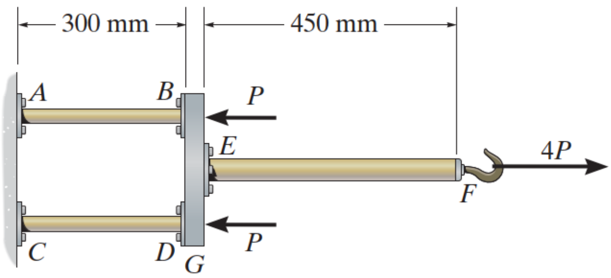

Fig. 2. for Q2

3. The assembly is made of stainless steel and consists of a solid rod 25 mm in diameter fixed to the inside of a tube using a rigid disk at B, as shown in **Fig. 3**. The shear modulus of stainless

steel is 77 GPa. The tube has an outer diameter of 45 mm and wall thickness of 5 mm. Determine the angle of twist at *D*. (6 points)

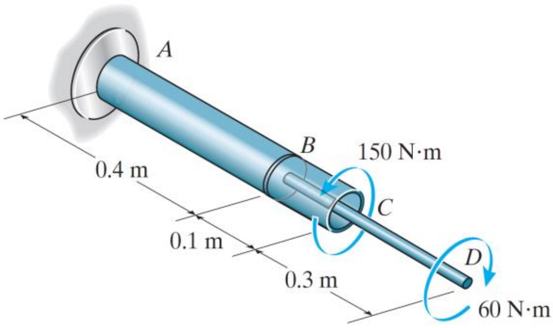

Fig. 3. for Q3

4. Two cylindrical rods are joined at B and restrained by rigid supports at A and D. Two loads are applied at B and C respectively, as shown in **Fig. 4**. The Young's modulus and cross-sectional area of two rods are shown in the figure. Determine (10 points)

Fig. 3. for Q3

(a) the reactions at A and D;

(b) the deflection of point B.

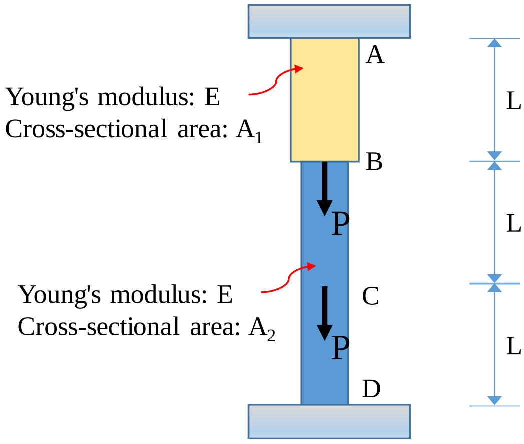

Fig. 4. for Q4

5. The three suspender bars are made of steel and have equal cross-sectional areas of 450 mm^2. Determine the average normal stress in each bar if the rigid beam is subjected to the loading shown in **Fig. 5**. (8 points)

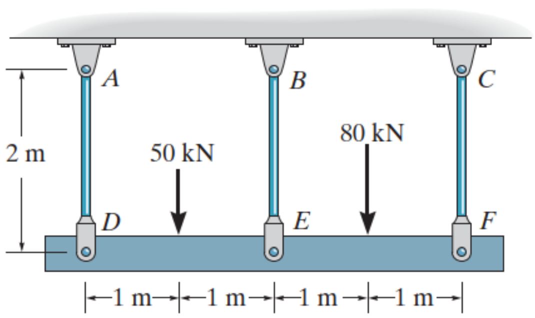

Fig. 5. for Q5

6. As shown in **Fig. 6**, The magnesium tube is bonded to a steel rod. If the allowable shear stresses for the magnesium and steel are $(\tau_{all})_{mg}$ = 45 MPa and $(\tau_{all})_{st}$ = 75 MPa, respectively, determine the maximum allowable torque that can be applied at *A*. Also, find the corresponding angle of twist of end *A*. (6 points)

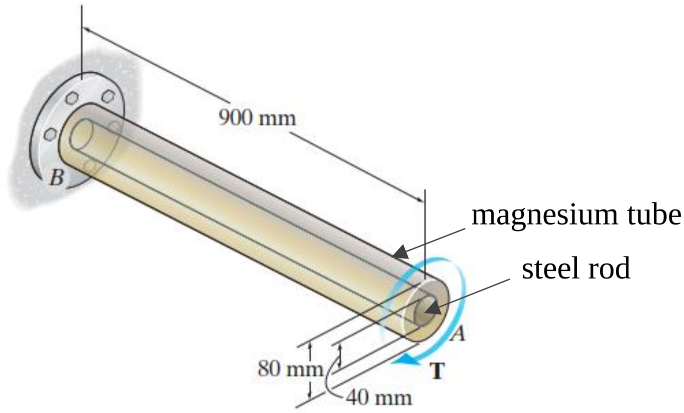

Fig. 6. for Q6

7. As shown in **Fig. 7**, the built-up beam is subjected to an internal moment of *M* = 75 kN·m. Determine the amount of this internal moment resisted by plate *A*. (10 points)

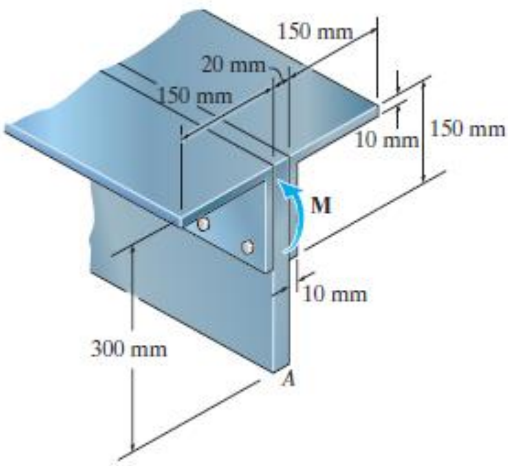

Fig. 7. for Q7

8. Determine the maximum normal stress and shear stress developed in the beam shown in **Fig. 8**. *E* = 100 GPa. (12 points)

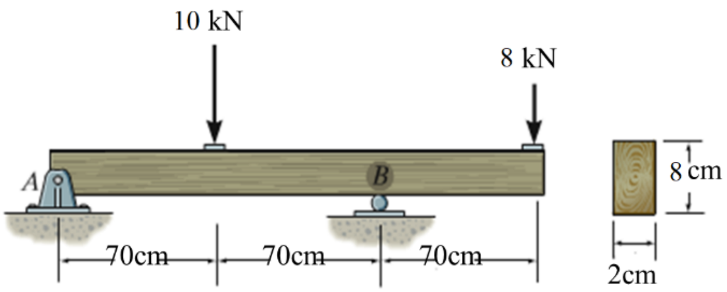

Fig. 8. for Q8

9. A timber beam *AB* of length *L* and rectangular cross section carries a uniformly distributed load w and is supported as shown in the **Fig. 9**. (a) Show that the ratio τ_m/σ_m of the maximum values of the shearing and normal stresses in the beam is equal to $2h/L$, where h and L are the depth and the length of the beam, respectively, (b) Determine the depth h and the width b of the beam, knowing that $L = 4$ m, $w = 10$ kN/m, $\tau_m = 1.28$ MPa, and $\sigma_m = 9.8$ MPa. (15 points)

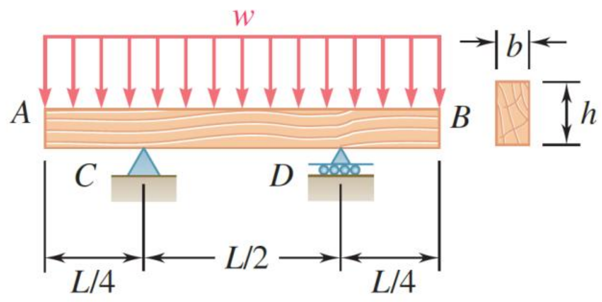

Fig. 9. for Q9

10. The beam shown in **Fig. 10** is made of a nylon for which the allowable stress is 24 MPa in tension and 30 MPa in compression. Determine the largest couple *M* that can be applied to the beam. (6 points)

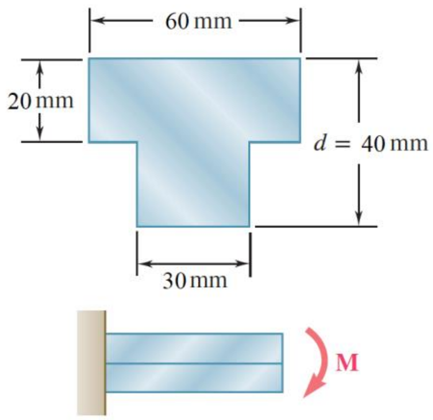

Fig. 10. for Q10

11. For the simply supported beam shown in **Fig. 11**, determine the greatest magnitude of P that can be applied to the beam, where $\sigma_{allow} = 25$ MPa, $\tau_{allow} = 2.5$ MPa. (15 points)

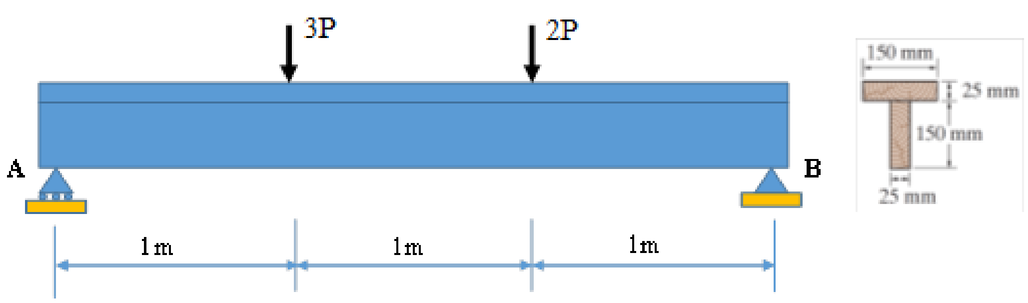

Fig. 11. for Q11