

2011

University of Asia Pacific
Department of Civil Engineering
Final Examination Spring 2013
Program: B.Sc. Engineering (Civil)

Course Code: CE 211
 Full Marks: 100 (=10×10)

Course Title: Mechanics of Solids I
 Time: 3 Hours

There are fourteen (14) questions. Answer any ten (10)

1. Using section method, draw axial force, shear force and bending moment diagrams for the beam as loaded in Fig. 1.

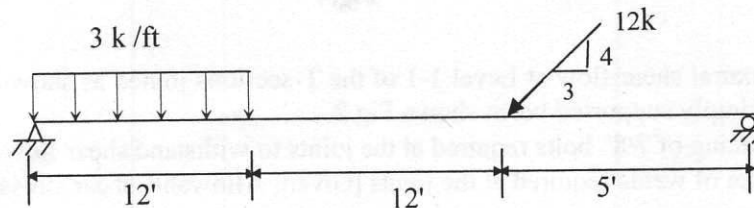


Fig :1

2. Using summation procedure, construct shear force and bending moment diagram for the beam with loads as shown in Fig. 2. Provide brief calculation.

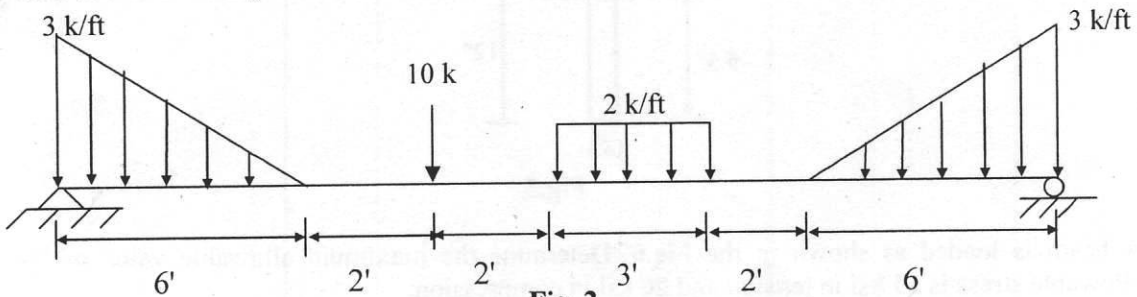


Fig. 2

3. Using singularity function, determine the expressions of shear force and bending moment for the beam loaded as shown in Fig.3. Hence draw shear force and bending moment diagram for the beam.

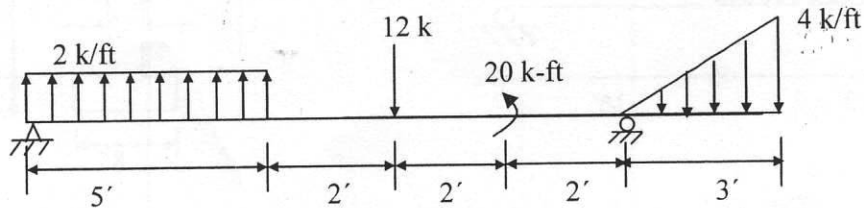


Fig.3

4. Calculate the reactions at supports in the following frame structure shown in Fig.4 and also find out the Axial Force, Shear Force and Bending Moment at section a-a.

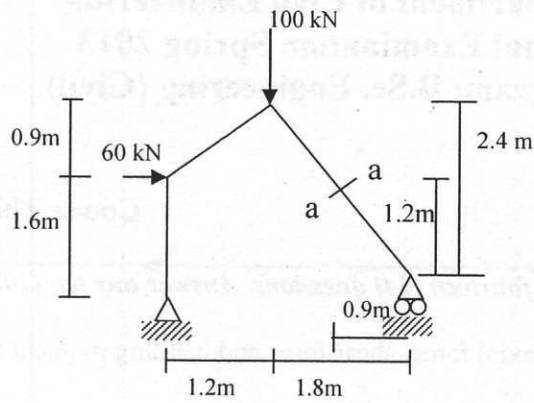


Fig.4

5. (i) Calculate the flexural shear flow at Level 1-1 of the T-sections joined as shown below in Fig 5 if loaded as the simply supported beam shown Fig 2.
 (ii) Calculate the spacing of 7/8" bolts required at the joints to withstand shear flow.
 (iii) Calculate the size of welds required at the joints [Given: Allowable shear stress = 20 ksi].

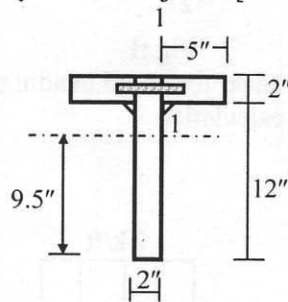


Fig.5

6. A beam is loaded as shown in the Fig.6. Determine the maximum allowable value of "w" if allowable stress is 15 ksi in tension and 20 ksi in compression.

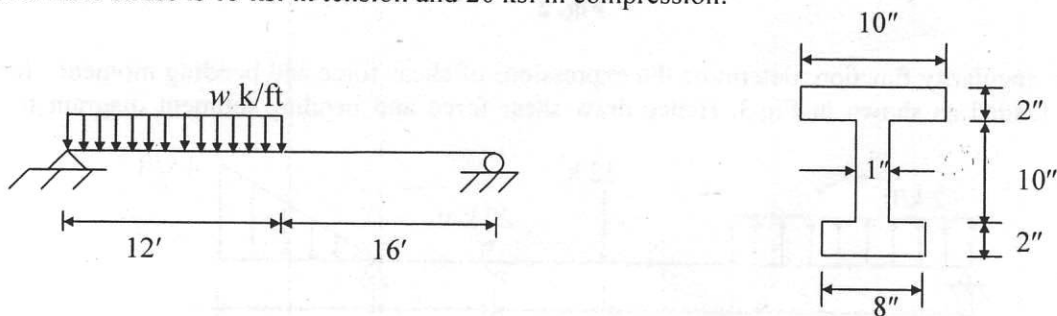


Fig.6

7. A steel beam with load is shown in Fig.7. Calculate shearing stress at levels indicated at section A-A. Also draw the shear stress distribution diagram.

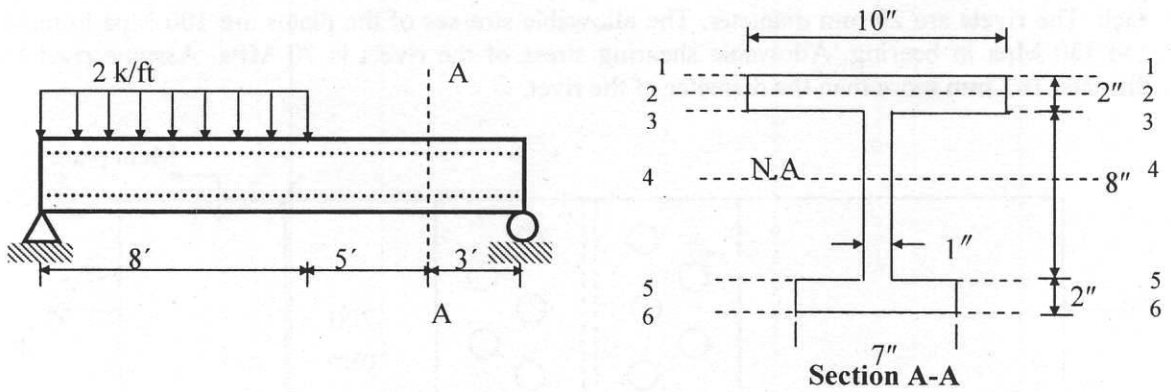


Fig.7

8. For a simply supported beam loaded as shown below in Fig 8, draw the flexural stress and strain diagrams over the composite cross-sectional area at section B.

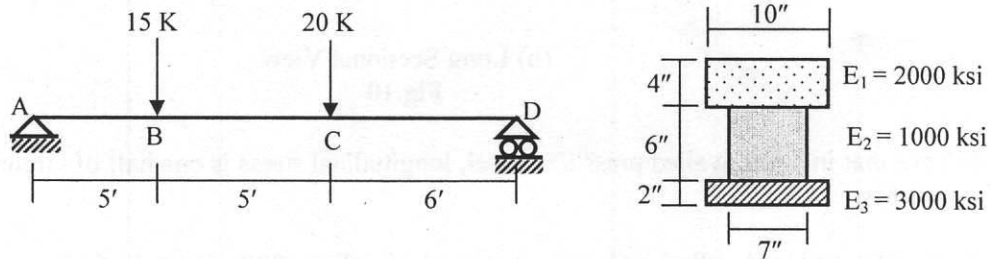


Fig. 8

9. A composite bar consists of an Aluminum section rigidly fastened between Bronze section and Steel section as shown in Fig. 9. Axial loads are applied as indicated. Determine the stress in each section. Also calculate the total change in length of the composite bar.
Given: $E_{\text{Steel}} = 29,000 \text{ ksi}$, $E_{\text{Bronze}} = 12,000 \text{ ksi}$ and $E_{\text{Al}} = 10,000 \text{ ksi}$.

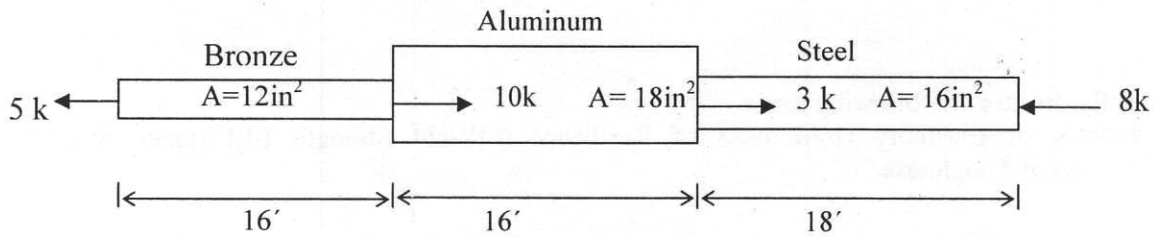
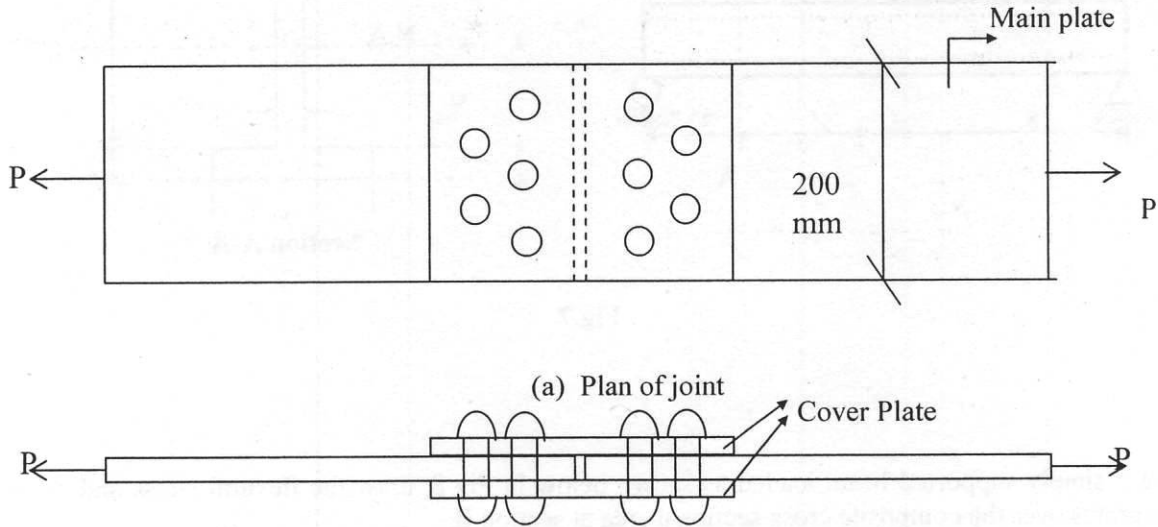


Fig. 9

10. Determine the safe capacity of the double-riveted butt joint shown in Fig.10 and hence the efficiency of the joint. The thickness of the main plate is 16 mm and that of cover plate is 10 mm each. The rivets are 20 mm diameter. The allowable stresses of the plates are 100 Mpa in tension and 130 Mpa in bearing. Allowable shearing stress of the rivets is 70 MPa. Assume rivet hole diameter is 3 mm more than the diameter of the rivet.



(b) Long Sectional View

Fig.10

11. a) Prove that in a thin walled pressure vessel, longitudinal stress is one half of circumferential or hoop stress.

b) Consider a closed cylindrical pressure vessel of radius 1000 mm and of 10 mm wall thickness. Determine the longitudinal and hoop stresses in the cylindrical wall caused by an internal pressure of 0.80 MPa. Also calculate the change in diameter of the cylinder caused by pressurization. Let $E = 200 \text{ GPa}$ and $\nu = 0.25$. Assume that $r_i = r_o = r$

12. 6. Briefly discuss the following terms
 (a) Modulus of Elasticity (b) Modulus of Resilience (c) Yield Strength (d) Ultimate Strength
 (e) Modulus of Toughness

- 13 A L-3"×3"×0.5" angle, which is to be welded to a gusset plate carries a load of 150 kips to a gusset plate along its centroidal axis.
- Determine the lengths of a side fillet welds required at the heel and toe of the angle for a non-eccentric connection. Assume that the allowable shearing stress through the throat of each weld is 21 ksi
 - Resolve part (a) assuming that a fillet weld of maximum permissible size is added along the entire length of the end of the angle. (Use 5/16" fillet weld for both calculation.)

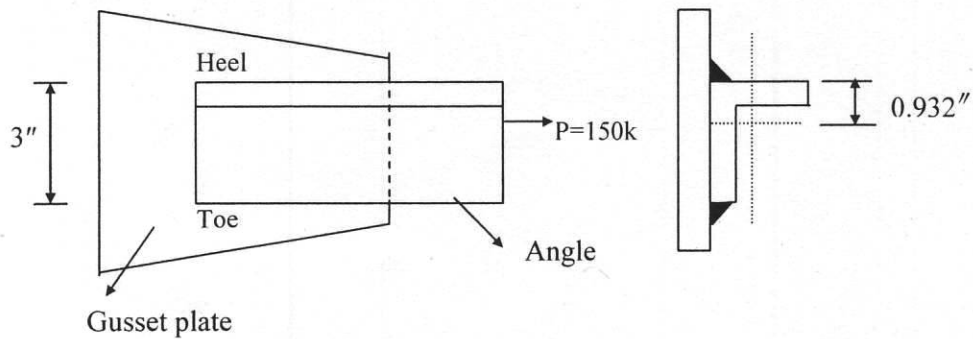


Fig: 11

14. Locate the Shear Center for the following beam. The thickness, t is constant throughout the section.

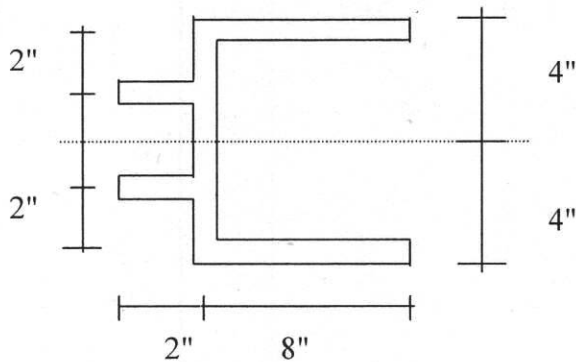


Fig: 12

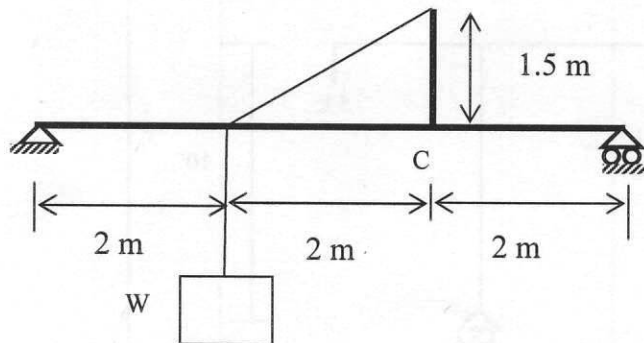
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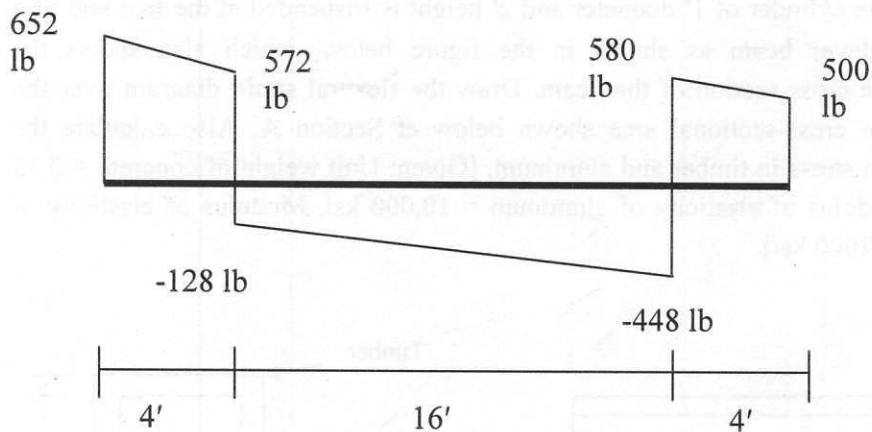
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There are seven questions. Question #1 is compulsory. Answer **Q.1 and any four**. The figures in the right margin indicate the marks of the questions.

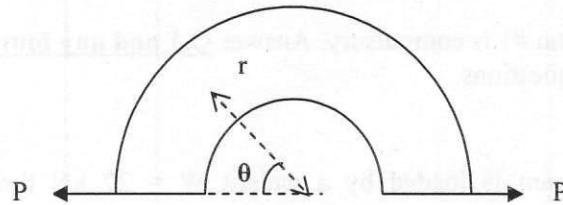
- 1.(a) The simply-supported beam is loaded by a weight $W = 27 \text{ kN}$ through the arrangement shown in the figure. The cable passes over a small frictionless pulley and is attached to the end of the vertical arm. Calculate the axial force, shear force, and bending moment at section C. (5)



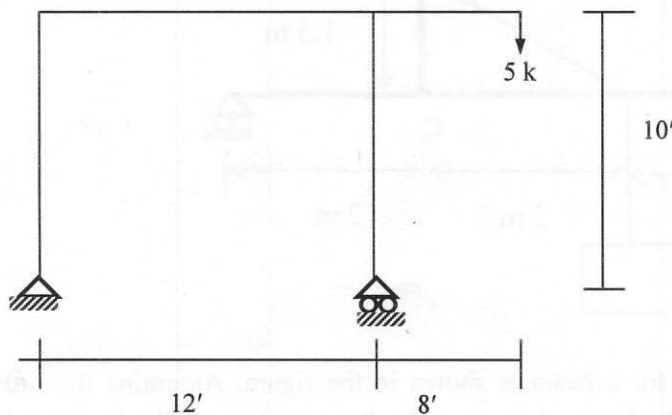
- (b) The shear-force diagram for a beam is shown in the figure. Assuming that no couples act as loads on the beam, determine the forces acting on the beam and draw the bending moment diagram. (5)



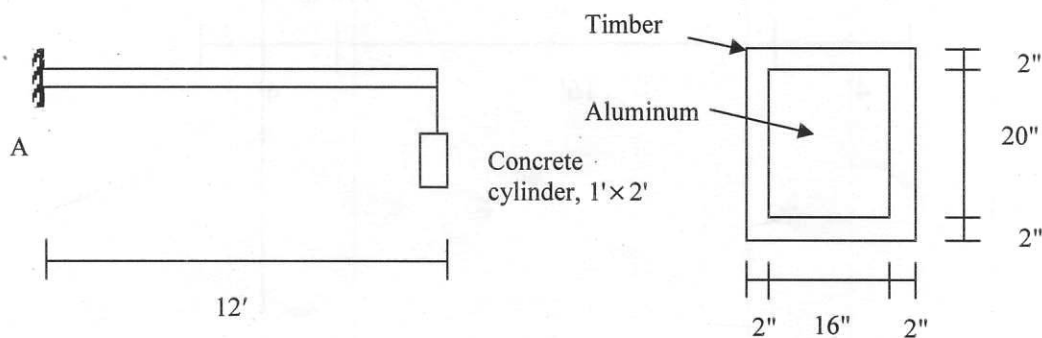
- (c) A curved bar is subjected to loads in the form of two equal and opposite forces P , as shown in the figure. The axis of the bar forms a semicircle of radius r . Determine the axial force, shear force, and bending moment acting at a cross section defined by the angle θ . (5)



- (d) Draw the SFD and BMD of the frame shown below. (5)

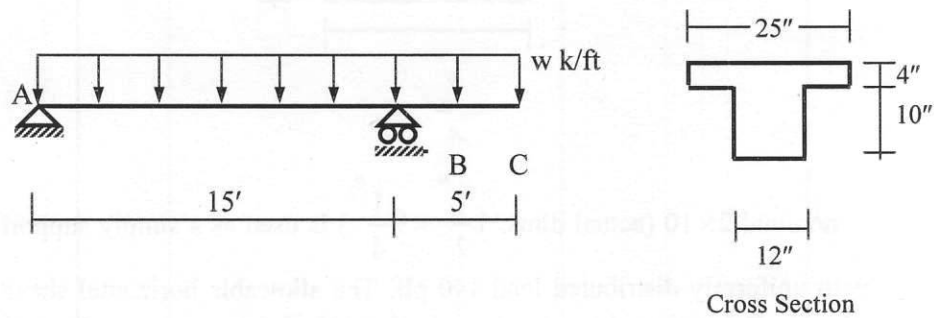


- 2.(a) A concrete cylinder of 1' diameter and 2' height is suspended at the free end of a 12' cantilever beam as shown in the figure below, which also shows the composite cross-section of the beam. Draw the flexural strain diagram over the composite cross-sectional area shown below at Section A. Also calculate the maximum stress in timber and aluminum. [Given: Unit weight of concrete = 0.15 k/ft³, Modulus of elasticity of aluminum = 10,000 ksi, Modulus of elasticity of timber = 2000 ksi]. (12)



- (b) A cylindrical steel pressure vessel 500 mm in diameter with a wall thickness of 25 mm is subjected to an internal pressure of 6 MPa. Calculate the circumferential and longitudinal stresses and strains in the wall of the cylinder. Assume, Modulus of elasticity of steel = 30×10^3 ksi, Poisson's ratio = 0.25. (8)

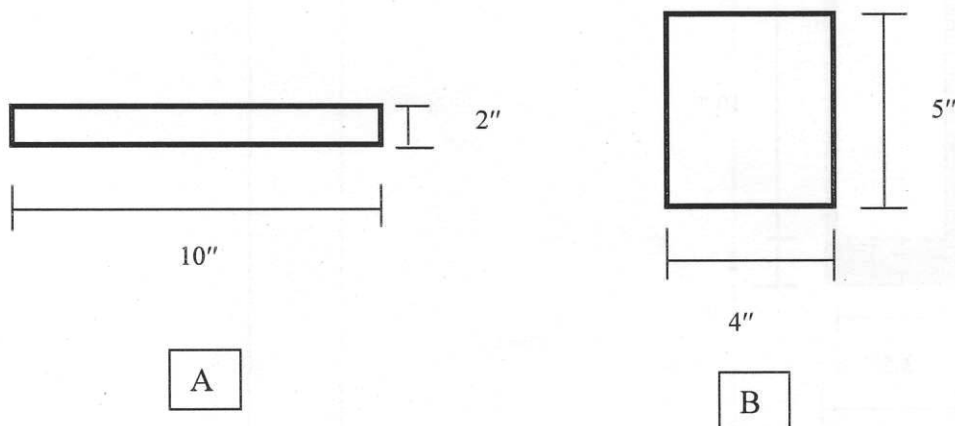
- 3.(a) Calculate the maximum allowable value of w (k/ft) if the flexural shear stress over the cross-section is not to exceed 100 psi. Using the value of w , draw the shear stress diagram over the cross-section where the shear force in the beam is the maximum. Also calculate the section modulus, plastic section modulus and shape factor of the T-section [Given: Modulus of elasticity $E = 30,000$ ksi]. (12)

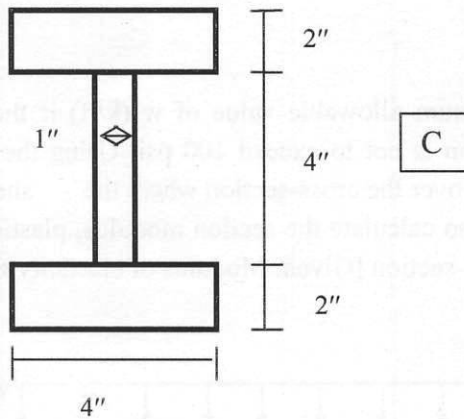


- (b) What are the assumptions for thin walled pressure vessels? Explain generalized Hooke's law for isotropic material. (8)

- 4.(a) Derive a relationship for bending stress in a beam. (8)

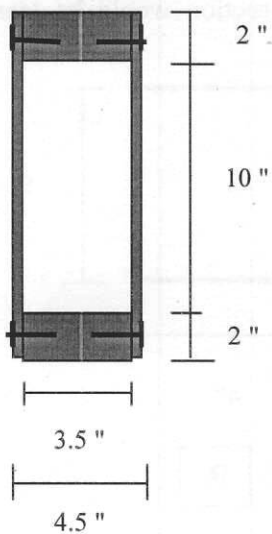
- (b) A simply supported beam spans a distance of 12' and carries a uniformly distributed load of 120 lb/ ft. Determine which cross section would be least stressed: A, B, or C. (12)



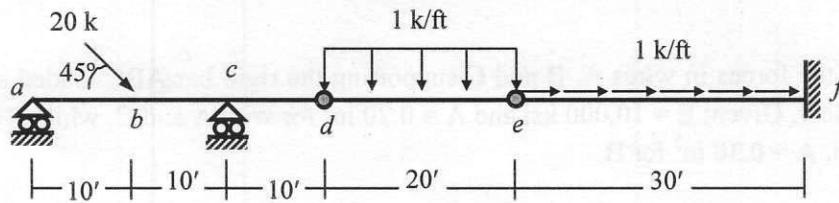


- 5(a) A nominal 2×10 (actual dims. $1\frac{1}{2} \times 9\frac{1}{4}$) is used as a simply supported beam with uniformly distributed load 140 plf. The allowable horizontal shear stress is 95 psi. Determine the maximum horizontal shear stress on the beam. Also determine if the beam is acceptable based upon allowable horizontal shear stress. (10)

- (b) A built-up plywood box beam shown in figure is held together by nails. Determine the spacing of the nails if the beam supports a uniform load of 200 #/ft along the 26-foot span. Assume the nails have a shear capacity of 80# each. (10)

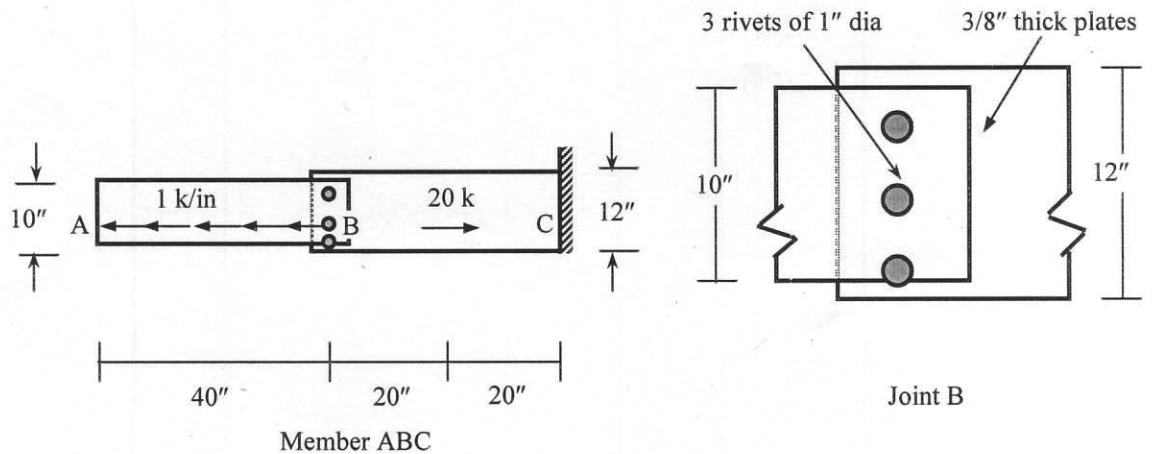


- 6.(a) Draw the AFD, SFD and BMD of the beam loaded as shown below. (14)



- b) A beam with section modulus 40 in^3 experiences a moment of 95 kip-feet. The allowable bending stress for the steel beam is 24 ksi. Determine the maximum allowable moment. Also determine if the beam is acceptable or not based upon allowable bending moment. (6)

- 7.(a) Calculate the shearing stress in the rivets and maximum tearing and bearing stresses in the plates at joint B of the structural member ABC loaded as shown below. (10)



- (b) Calculate the forces in wires A, B and C supporting the rigid bar ABC loaded as shown below. Given: $E = 10,000$ ksi and $A = 0.20$ in² for wire A and C, while $E = 30,000$ ksi, $A = 0.30$ in² for B. (10)

