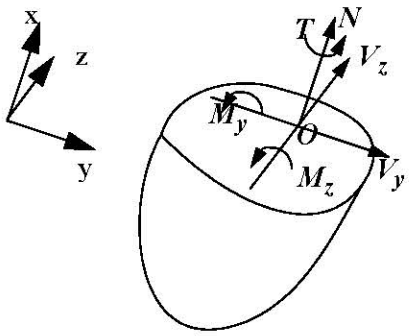
Internal Forces and Moments

Definition 1 The normal force acting in the direction of the axis of the body is called the *axial force*.
Definition 2 Forces which are tangent to the imaginary cut surface are called *shear forces*.
Definition 3 Internal moment about an axis normal to the imaginary cut surface is called torsional moment or torque.
Definition 4 Internal moments about axis tangent to the imaginary cut are called *bending moments*.

At a cross-section with outward normal defined as the x -direction, the internal forces and moments are as shown below.



N= Axial force

V_y = Shear Force

V_z = Shear Force

T = Torque

M_y = Bending Moment

M_z = Bending Moment

All internal forces in the book are shown in ***bold italics***.

Static Review Problems

In the problems below using the above notation determine the zero and non-zero internal forces and moments. You will see these problems again in Chapter 10 homework.

SR.1 Determine the internal forces and moments on the section passing through point A in the bent pipe shown in Fig. SR.1

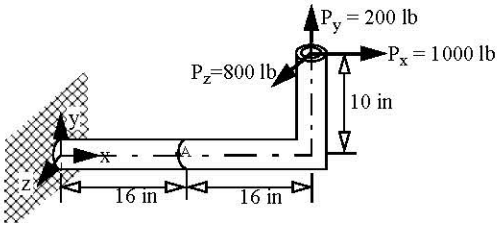


Fig. SR.1

SR.2 A hollow steel shaft shown in Fig. SR.2 has an outside diameter of 4 inches and an inside diameter of 3 inches. Two pulleys of 24 inch diameter carry belts that have the given tensions. The shaft is supported at the walls using flexible bearings permitting rotation in all directions. Determine the internal forces and moments at a section passing through point A.

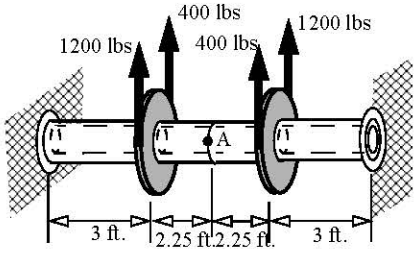


Fig. SR.2

SR.3 Determine the internal forces and moments in the middle of the bar BC.

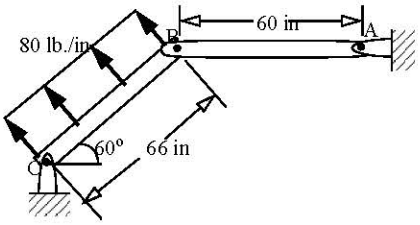


Fig. SR.3

SR.4 A distributed force of intensity w N/m acts on the structure shown in Fig. SR.4, determine (a) the forces at all pin joints. (b) the internal forces and moments in terms of w at a section just above pin D on member CDE. Assume the surface at E is smooth.

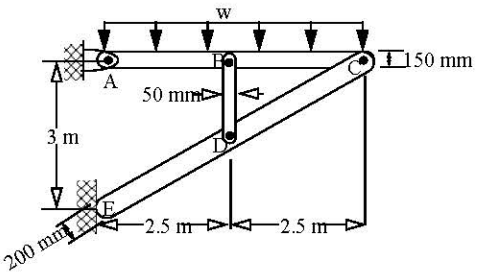


Fig. SR.4

SR.5 The hoist shown in Fig. SR.5 lifts a weight of W = 300 lb. Determine (a) the forces at all pin joints (b) the internal forces and moment on a section just below pin E on member CEF.

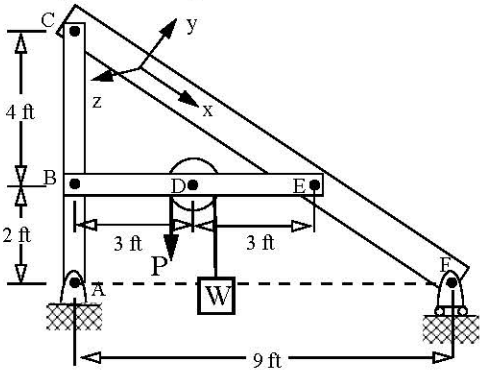


Fig. SR.5

SR.6 A park structure is modeled with pin joints as shown in Fig. SR.6. Determine (a) the forces at all pin joints. (b) the internal forces and moments at mid section of AB.

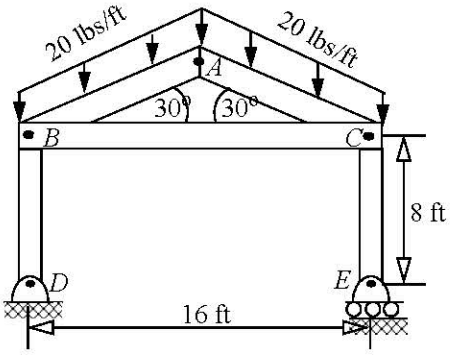


Fig. SR.6

SR.7 A highway sign uses a 16 inch hollow pipe as a vertical post and 12 inch hollow pipe for horizontal arms. The pipes are one inch thick. A uniform wind pressure of 20 lbs/ft^2 acts on the sign boards and the pipes. Note the pressure on the pipes acts on the projected area of $L\ d$, where L is the length of pipe and d is the diameter of the pipe. Neglect the weight of the pipe and determine the internal forces and moments acting on the section containing points A and B.

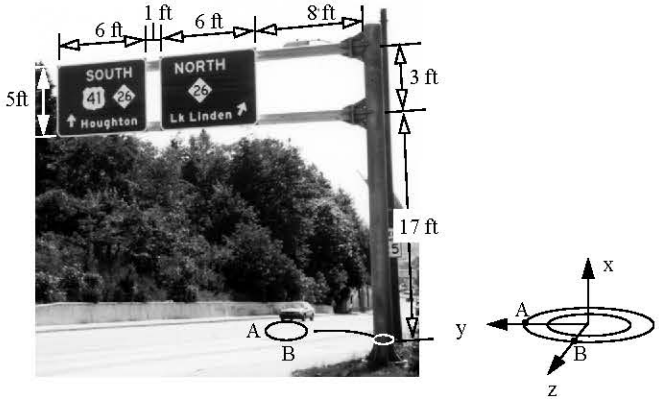


Fig. SR.7

Answers (Your answers may differ by a sign)

SR1: N=1000 lb (T); V_y = 200 lb; V_z = 800 lb; T = 8000 in-lb; M_y = 12,800 in-lb; Mz = 6800 in-lb

SR2 : N = 0; V_y = 0; V_z = 0; T = 800 ft-lb ; M_y = 0 ; M_z= 4800 ft–lb

SR3: N = 1524 lb (T); V_y = 0; V_z=0; T= 0; M_y = 0; M_z = 43560 in–lb

SR4: N = 6.14w (C); V_y= 2.14w; V_z = 0; T = 0; M_y= 0; M_z = 6.25w

SR.6: A_x = 159.78 lb ; A_y = 0 ; B_x = 159.78 lb ; B_y = 184.75 lb ; C_x = 159.78 lb ; C_y = –184.75 lb ; D_x = 0 ; D_y = 184.75 lb ; E_y = 184.75 lb ; N = 184.7 lb (C); V_y= 0; V_z = 0; T = 0; M_y= 0; M_z = 184.7 ft-lb

SR.7: N = 0 (C); V_y= 0; V_z =-2093.3 lb; T = -20,300 ft-lb; M_y= 34,193 ft-lb; M_z = 0