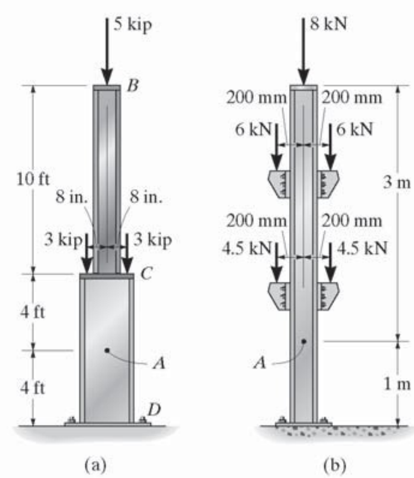
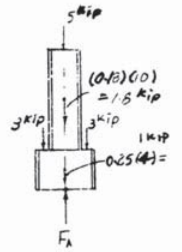
1–1. Determine the resultant internal normal force acting on the cross section through point A in each column. In (a), segment BC weighs 180 lb/ft and segment CD weighs 250 lb/ft. In (b), the column has a mass of 200 kg/m.



(a)

$+\uparrow \Sigma F_y = 0; \quad F_A - 1.0 - 3 - 3 - 1.8 - 5 = 0$

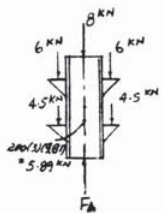
$F_A = 13.8 \text{ kip}$ **Ans**



(b)

$+\uparrow \Sigma F_y = 0; \quad F_A - 4.5 - 4.5 - 5.89 - 6 - 6 - 8 = 0$

$F_A = 34.9 \text{ kN}$ **Ans**

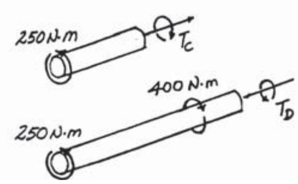


1–2. Determine the resultant internal torque acting on the cross sections through points C and D of the shaft. The shaft is fixed at B.

Equations of Equilibrium :

$\circlearrowleft + \quad 250 - T_C = 0 \qquad T_C = 250 \text{ N}\cdot\text{m}$ **Ans**

$\circlearrowleft + \quad 250 - 400 + T_D = 0 \qquad T_D = 150 \text{ N}\cdot\text{m}$ **Ans**



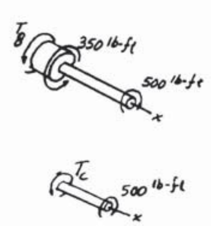
1–3. Determine the resultant internal torque acting on the cross sections through points B and C.

$\Sigma M_x = 0; \quad T_B + 350 - 500 = 0$

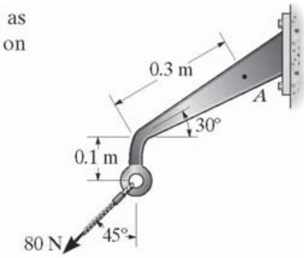
$T_B = 150 \text{ lb}\cdot\text{ft}$ **Ans**

$\Sigma M_x = 0; \quad T_C - 500 = 0$

$T_C = 500 \text{ lb}\cdot\text{ft}$ **Ans**



***1–4.** A force of 80 N is supported by the bracket as shown. Determine the resultant internal loadings acting on the section through point A.



Equations of Equilibrium :

$+\nearrow \Sigma F_{x'} = 0;\quad N_A - 80\cos 15° = 0$

$N_A = 77.3\ \text{N}$ **Ans**

$\nwarrow + \ \Sigma F_{y'} = 0;\quad V_A - 8\ 0\sin 15° = 0$

$V_A = 20.7\ \text{N}$ **Ans**

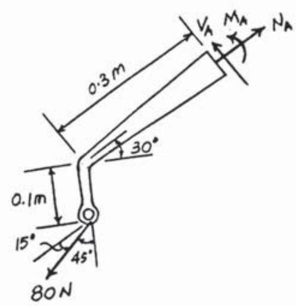
$\circlearrowleft + \ \Sigma M_A = 0;\quad M_A + 80\cos 45°(0.3\cos 30°)$
$- 80\sin 45°(0.1 + 0.3\sin 30°) = 0$

$M_A = -0.555\ \text{N}\cdot\text{m}$ **Ans**

or

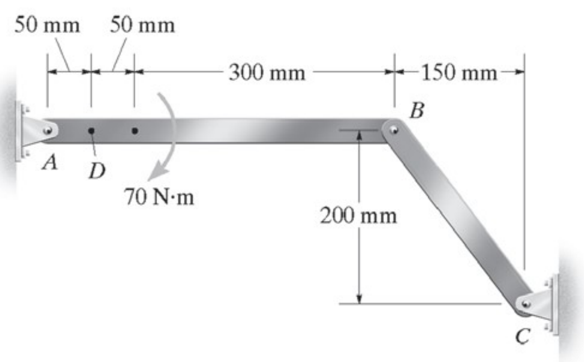
$\circlearrowleft + \ \Sigma M_A = 0;\quad M_A + 80\sin 15°(0.3 + 0.1\sin 30°)$
$- 80\cos 15°(0.1\cos 30°) = 0$

$M_A = -0.555\ \text{N}\cdot\text{m}$ **Ans**



Negative sign indicates that M_A acts in the opposite direction to that shown on FBD.

1–5. Determine the resultant internal loadings acting on the cross section through point D of member AB.

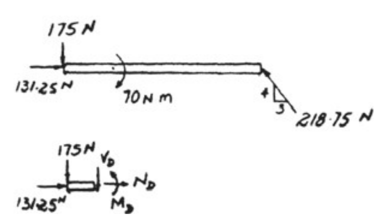


Segment AD :

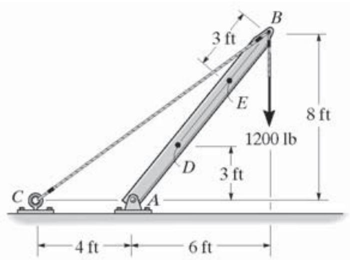
$\overset{+}{\rightarrow} \Sigma F_x = 0;\quad N_D + 131.25 = 0;\quad N_D = -131\ \text{N}$ **Ans**

$+\downarrow \Sigma F_y = 0;\quad V_D + 175 = 0;\quad V_D = -175\ \text{N}$ **Ans**

$\circlearrowleft + \Sigma M_D = 0;\quad M_D + 175(0.05) = 0;\quad M_D = -8.75\ \text{N}\cdot\text{m}$ **Ans**



1–6. The beam AB is pin supported at A and supported by a cable BC. Determine the resultant internal loadings acting on the cross section at point D.



$$\theta = \tan^{-1}\left(\frac{6}{8}\right) = 36.87^\circ$$

$$\phi = \tan^{-1}\left(\frac{10}{8}\right) - 36.87^\circ = 14.47^\circ$$

Member AB :

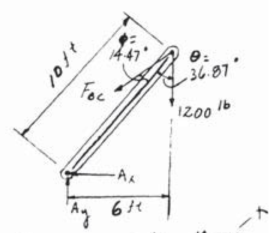
$\circlearrowleft + \Sigma M_A = 0;\quad F_{BC}\sin 14.47^\circ(10) - 1200(6) = 0$

$F_{BC} = 2881.46\text{ lb}$

Segment BD :

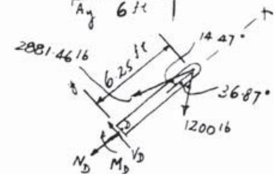
$+\nearrow \Sigma F_x = 0;\quad -N_D - 2881.46\cos 14.47^\circ - 1200\cos 36.87^\circ = 0$

$N_D = -3750\text{ lb} = -3.75\text{ kip}$ **Ans**



$+\nwarrow \Sigma F_y = 0;\quad V_D + 2881.46\sin 14.47^\circ - 1200\sin 36.87^\circ = 0$

$V_D = 0$ **Ans**

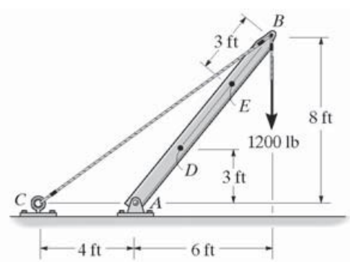


$\circlearrowleft + \Sigma M_D = 0;\quad 2881.46\sin 14.47^\circ(6.25) - 1200\sin 36.87^\circ(6.25) - M_D = 0$

$M_D = 0$ **Ans**

Notice that member AB is the two-force member; therefore the shear force and moment are zero.

1–7. Solve Prob. 1–6 for the resultant internal loadings acting at point E.



$$\theta = \tan^{-1}\left(\frac{6}{8}\right) = 36.87^\circ$$

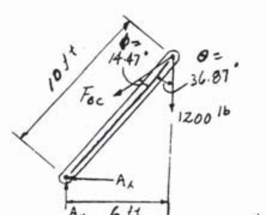
$$\phi = \tan^{-1}\left(\frac{10}{8}\right) - 36.87^\circ = 14.47^\circ$$

Member AB :

$\circlearrowleft + \Sigma M_A = 0;\quad F_{BC}\sin 14.47^\circ(10) - 1200(6) = 0$

$F_{BC} = 2881.46\text{ lb}$

Segment BE :

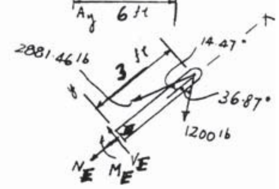


$\overset{+}{\nearrow} \Sigma F_x = 0;\quad -N_E - 2881.46\cos 14.47^\circ - 1200\cos 36.87^\circ = 0$

$N_E = -3750\text{ lb} = -3.75\text{ kip}$ **Ans**

$\nwarrow + \Sigma F_y = 0;\quad V_E + 2881.46\sin 14.47^\circ - 1200\sin 36.87^\circ = 0$

$V_E = 0$ **Ans**

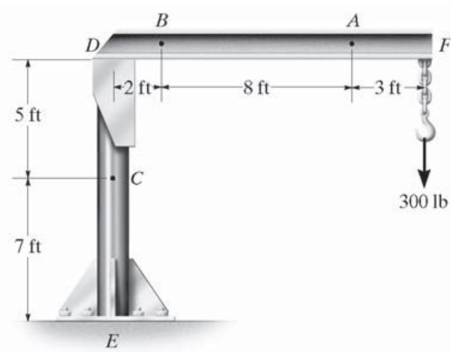


$\circlearrowleft + \Sigma M_E = 0;\quad 2881.46\sin 14.47^\circ(3) - 1200\sin 36.87^\circ(3) - M_E = 0$

$M_E = 0$ **Ans**

Notice that member AB is the two - force member ; therefore the shear force and moment are zero.

*1–8. The boom DF of the jib crane and the column DE have a uniform weight of 50 lb/ft. If the hoist and load weigh 300 lb, determine the resultant internal loadings in the crane on cross sections through points A, B, and C.



Equations of Equilibrium : For point A

$\overset{+}{\leftarrow} \Sigma F_x = 0;$ $N_A = 0$ **Ans**

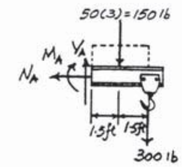
$+\uparrow \Sigma F_y = 0;$ $V_A - 150 - 300 = 0$

$V_A = 450 \text{ lb}$ **Ans**

$\curvearrowleft + \Sigma M_A = 0;$ $-M_A - 150(1.5) - 300(3) = 0$

$M_A = -1125 \text{ lb} \cdot \text{ft} = -1.125 \text{ kip} \cdot \text{ft}$ **Ans**

Negative sign indicates that $\mathbf{M}_A$ acts in the opposite direction to that shown on FBD.



Equations of Equilibrium : For point B

$\overset{+}{\leftarrow} \Sigma F_x = 0;$ $N_B = 0$ **Ans**

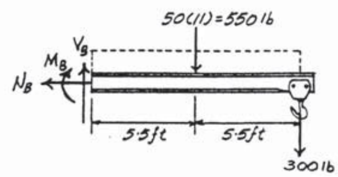
$+\uparrow \Sigma F_y = 0;$ $V_B - 550 - 300 = 0$

$V_B = 850 \text{ lb}$ **Ans**

$\curvearrowleft + \Sigma M_B = 0;$ $-M_B - 550(5.5) - 300(11) = 0$

$M_B = -6325 \text{ lb} \cdot \text{ft} = -6.325 \text{ kip} \cdot \text{ft}$ **Ans**

Negative sign indicates that $\mathbf{M}_B$ acts in the opposite direction to that shown on FBD.



Equations of Equilibrium : For point C

$\overset{+}{\leftarrow} \Sigma F_x = 0;$ $V_C = 0$ **Ans**

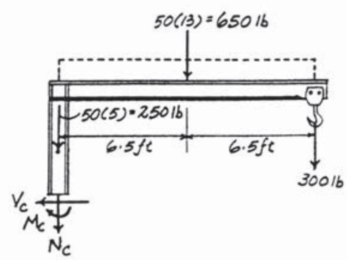
$+\uparrow \Sigma F_y = 0;$ $-N_C - 250 - 650 - 300 = 0$

$N_C = -1200 \text{ lb} = -1.20 \text{ kip}$ **Ans**

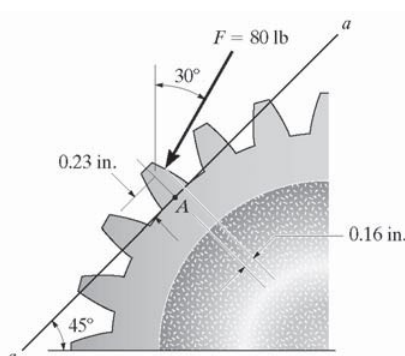
$\curvearrowleft + \Sigma M_C = 0;$ $-M_C - 650(6.5) - 300(13) = 0$

$M_C = -8125 \text{ lb} \cdot \text{ft} = -8.125 \text{ kip} \cdot \text{ft}$ **Ans**

Negative signs indicate that $\mathbf{N}_C$ and $\mathbf{M}_C$ act in the opposite direction to that shown on FBD.



1–9. The force $F = 80$ lb acts on the gear tooth. Determine the resultant internal loadings on the root of the tooth, i.e., at the centroid point A of section a–a.



Equations of Equilibrium : For section $a-a$

$+\nearrow \Sigma F_{x'} = 0;$ $V_A - 80 \cos 15° = 0$

$V_A = 77.3 \text{ lb}$ **Ans**

$\nwarrow + \Sigma F_{y'} = 0;$ $N_A - 80 \sin 15° = 0$

$N_A = 20.7 \text{ lb}$ **Ans**

$\curvearrowleft + \Sigma M_A = 0;$ $-M_A - 80 \sin 15°(0.16) + 80 \cos 15°(0.23) = 0$

$M_A = 14.5 \text{ lb} \cdot \text{in.}$ **Ans**