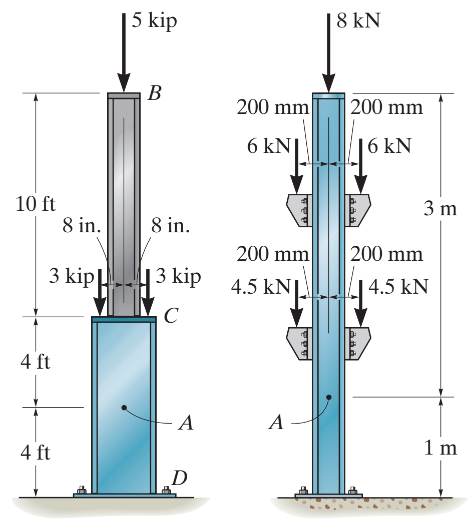
**1–1.** Determine the resultant internal normal force acting on the cross section through point $A$ in each column. In (a), segment $BC$ weighs 180 lb/ft and segment $CD$ weighs 250 lb/ft. In (b), the column has a mass of 200 kg/m.



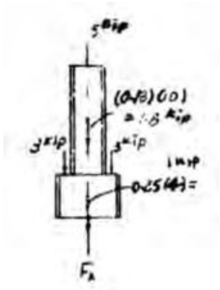

(a) (b)

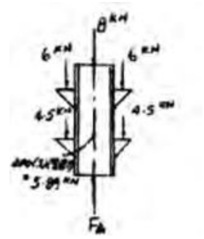
(a) $+\uparrow\ \Sigma F_y = 0;\qquad F_A - 1.0 - 3 - 3 - 1.8 - 5 = 0$

$$F_A = 13.8\text{ kip}\qquad\textbf{Ans.}$$

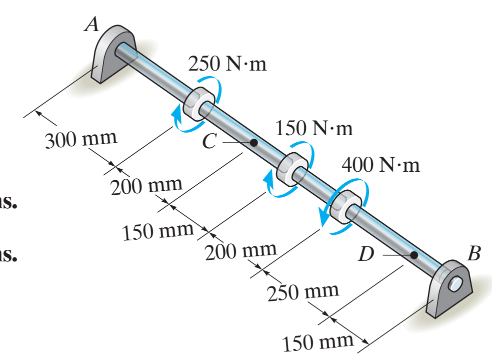
(b) $+\uparrow\ \Sigma F_y = 0;\qquad F_A - 4.5 - 4.5 - 5.89 - 6 - 6 - 8 = 0$

$$F_A = 34.9\text{ kN}\qquad\textbf{Ans.}$$





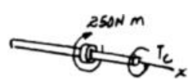
**1–2.** Determine the resultant internal torque acting on the cross sections through points $C$ and $D$. The support bearings at $A$ and $B$ allow free turning of the shaft.



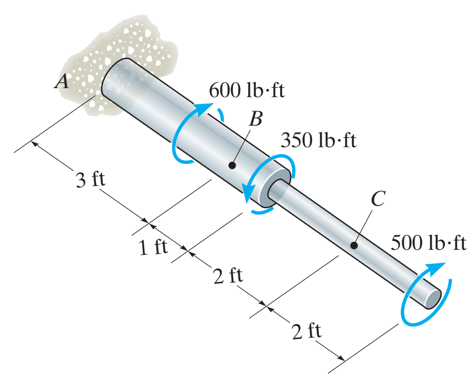

$\Sigma M_x = 0;\qquad T_C - 250 = 0$

$$T_C = 250\text{ N}\cdot\text{m}\qquad\textbf{Ans.}$$

$\Sigma M_x = 0;\qquad T_D = 0\qquad$ **Ans.**



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

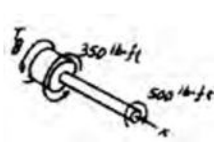



$\Sigma M_x = 0;\qquad T_B + 350 - 500 = 0$

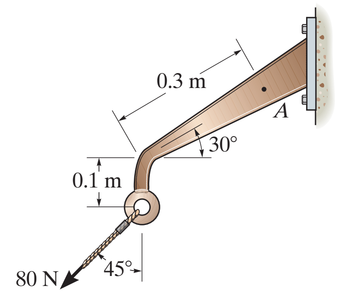
$$T_B = 150\text{ lb}\cdot\text{ft}\qquad\textbf{Ans.}$$

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

$$T_C = 500\text{ lb}\cdot\text{ft}\qquad\textbf{Ans.}$$



***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:***

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

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

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

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

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

$- 80 \sin 45°(0.1 + 0.3 \sin 30°) = 0$

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

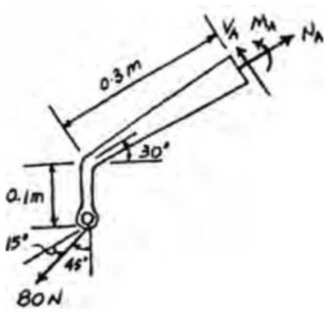
or

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

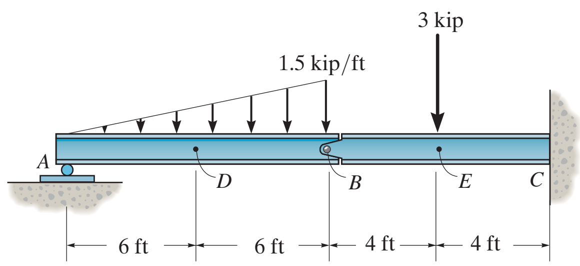
$-80 \cos 15°(0.1 \cos 30°) = 0$

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

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



**•1–5.** Determine the resultant internal loadings in the beam at cross sections through points $D$ and $E$. Point $E$ is just to the right of the 3-kip load.




***Support Reactions:*** For member $AB$

$\circlearrowleft + \Sigma M_B = 0; \quad 9.00(4) - A_y(12) = 0 \quad A_y = 3.00 \text{ kip}$

$\overset{+}{\rightarrow} \Sigma F_x = 0; \quad B_x = 0$

$+\uparrow \Sigma F_y = 0; \quad B_y + 3.00 - 9.00 = 0 \quad B_y = 6.00 \text{ kip}$

***Equations of Equilibrium:*** For point $D$

$\overset{+}{\rightarrow} \Sigma F_x = 0; \quad N_D = 0$ **Ans.**

$+\uparrow \Sigma F_y = 0; \quad 3.00 - 2.25 - V_D = 0$

$V_D = 0.750 \text{ kip}$ **Ans.**

$\circlearrowleft + \Sigma M_D = 0; \quad M_D + 2.25(2) - 3.00(6) = 0$

$M_D = 13.5 \text{ kip} \cdot \text{ft}$ **Ans.**

***Equations of Equilibrium:*** For point $E$

$\overset{+}{\rightarrow} \Sigma F_x = 0; \quad N_E = 0$ **Ans.**

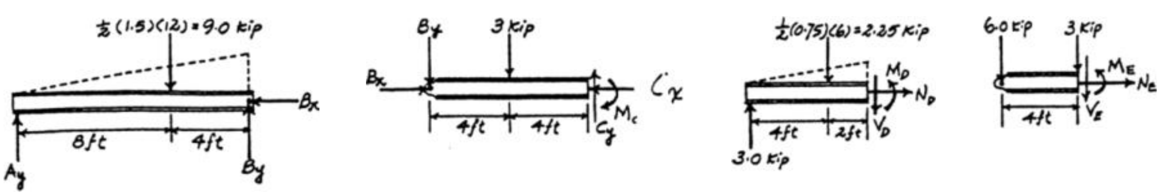
$+\uparrow \Sigma F_y = 0; \quad -6.00 - 3 - V_E = 0$

$V_E = -9.00 \text{ kip}$ **Ans.**

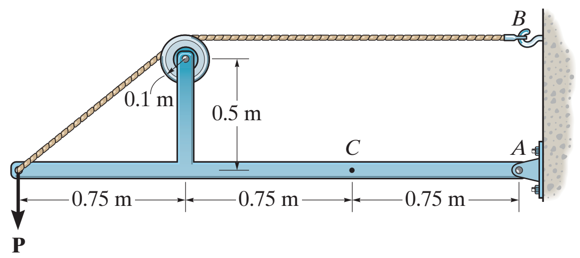
$\circlearrowleft + \Sigma M_E = 0; \quad M_E + 6.00(4) = 0$

$M_E = -24.0 \text{ kip} \cdot \text{ft}$ **Ans.**

Negative signs indicate that $M_E$ and $V_E$ act in the opposite direction to that shown on FBD.



**1–6.** Determine the normal force, shear force, and moment at a section through point $C$. Take $P = 8$ kN.

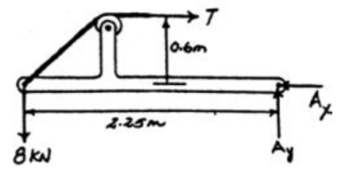



***Support Reactions:***

$\circlearrowleft + \Sigma M_A = 0; \quad 8(2.25) - T(0.6) = 0 \qquad T = 30.0 \text{ kN}$

$\xrightarrow{+} \Sigma F_x = 0; \quad 30.0 - A_x = 0 \qquad A_x = 30.0 \text{ kN}$

$+\uparrow \Sigma F_y = 0; \quad A_y - 8 = 0 \qquad A_y = 8.00 \text{ kN}$



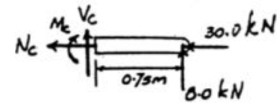

***Equations of Equilibrium:*** For point $C$

$\xrightarrow{+} \Sigma F_x = 0; \quad -N_C - 30.0 = 0$

$N_C = -30.0 \text{ kN}$ **Ans.**

$+\uparrow \Sigma F_y = 0; \quad V_C + 8.00 = 0$

$V_C = -8.00 \text{ kN}$ **Ans.**




$\circlearrowleft + \Sigma M_C = 0; \quad 8.00(0.75) - M_C = 0$

$M_C = 6.00 \text{ kN} \cdot \text{m}$ **Ans.**

Negative signs indicate that $N_C$ and $V_C$ act in the opposite direction to that shown on FBD.

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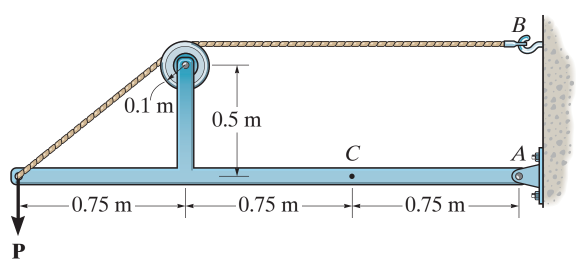
**1–7.** The cable will fail when subjected to a tension of 2 kN. Determine the largest vertical load $P$ the frame will support and calculate the internal normal force, shear force, and moment at the cross section through point $C$ for this loading.



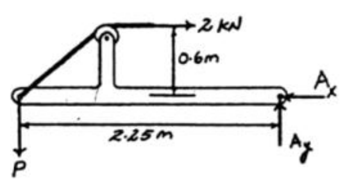

***Support Reactions:***

$\circlearrowleft + \Sigma M_A = 0; \quad P(2.25) - 2(0.6) = 0$

$P = 0.5333 \text{ kN} = 0.533 \text{ kN}$ **Ans.**

$\xrightarrow{+} \Sigma F_x = 0; \quad 2 - A_x = 0 \qquad A_x = 2.00 \text{ kN}$

$+\uparrow \Sigma F_y = 0; \quad A_y - 0.5333 = 0 \qquad A_y = 0.5333 \text{ kN}$



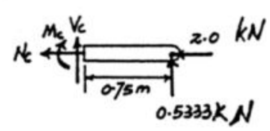

***Equations of Equilibrium:*** For point $C$

$\xrightarrow{+} \Sigma F_x = 0; \quad -N_C - 2.00 = 0$

$N_C = -2.00 \text{ kN}$ **Ans.**

$+\uparrow \Sigma F_y = 0; \quad V_C + 0.5333 = 0$

$V_C = -0.533 \text{ kN}$ **Ans.**

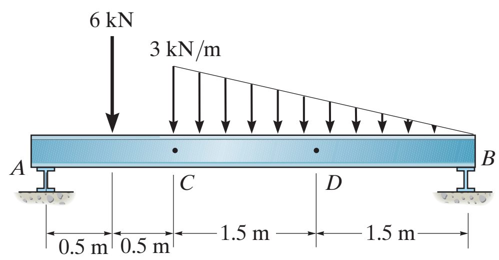



$\circlearrowleft + \Sigma M_C = 0; \quad 0.5333(0.75) - M_C = 0$

$M_C = 0.400 \text{ kN} \cdot \text{m}$ **Ans.**

Negative signs indicate that $N_C$ and $V_C$ act in the opposite direction to that shown on FBD.

***1–8.** Determine the resultant internal loadings on the cross section through point $C$. Assume the reactions at the supports $A$ and $B$ are vertical.




Referring to the FBD of the entire beam, Fig. *a*,

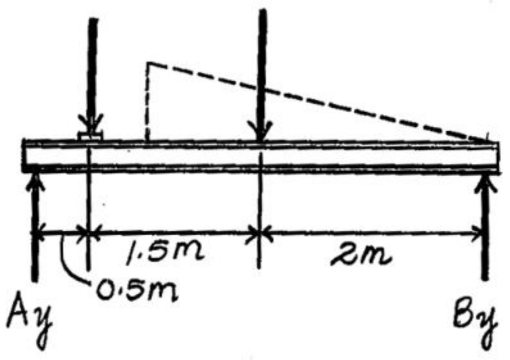
$\circlearrowleft + \Sigma M_B = 0; \quad -A_y(4) + 6(3.5) + \frac{1}{2}(3)(3)(2) = 0 \quad A_y = 7.50 \text{ kN}$

Referring to the FBD of this segment, Fig. *b*,

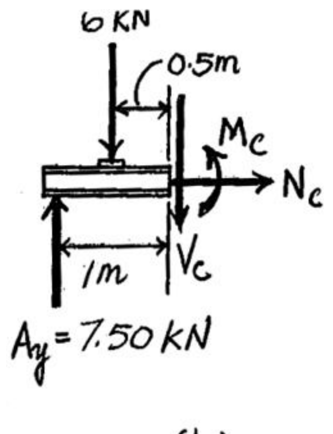
$\overset{+}{\rightarrow} \Sigma F_x = 0; \quad N_C = 0$ **Ans.**

$+\uparrow \Sigma F_y = 0; \quad 7.50 - 6 - V_C = 0 \quad V_C = 1.50 \text{ kN}$ **Ans.**

$\circlearrowleft + \Sigma M_C = 0; \quad M_C + 6(0.5) - 7.5(1) = 0 \quad M_C = 4.50 \text{ kN} \cdot \text{m}$ **Ans.**

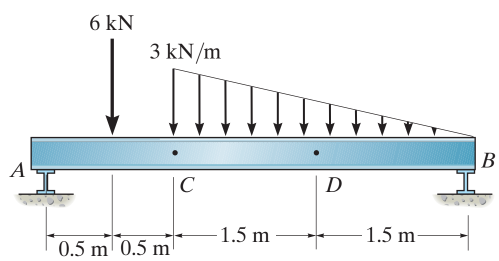



(a)




(b)

**•1–9.** Determine the resultant internal loadings on the cross section through point $D$. Assume the reactions at the supports $A$ and $B$ are vertical.




Referring to the FBD of the entire beam, Fig. *a*,

$\circlearrowleft + \Sigma M_A = 0; \quad B_y(4) - 6(0.5) - \frac{1}{2}(3)(3)(2) = 0 \quad B_y = 3.00 \text{ kN}$

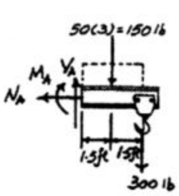
Referring to the FBD of this segment, Fig. *b*,

$\overset{+}{\rightarrow} \Sigma F_x = 0; \quad N_D = 0$ **Ans.**

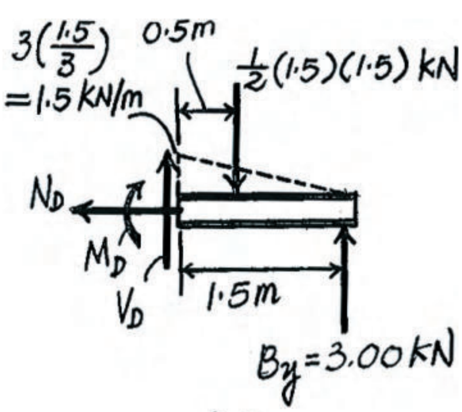
$+\uparrow \Sigma F_y = 0; \quad V_D - \frac{1}{2}(1.5)(1.5) + 3.00 = 0 \quad V_D = -1.875 \text{ kN}$ **Ans.**

$\circlearrowleft + \Sigma M_D = 0; \quad 3.00(1.5) - \frac{1}{2}(1.5)(1.5)(0.5) - M_D = 0 \quad M_D = 3.9375 \text{ kN} \cdot \text{m}$

$= 3.94 \text{ kN} \cdot \text{m}$ **Ans.**




(a)




(b)