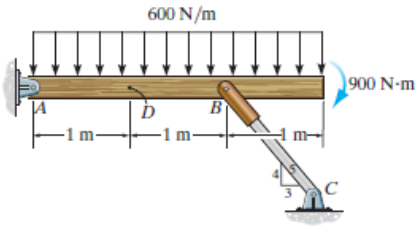
CHAPTER VII (SELECTED PROBLEMS)

Determine the internal normal force, shear force, and moment at point D in the beam.



SOLUTION

Writing the equations of equilibrium with reference to Fig. *a*, we have

$$\zeta + \Sigma M_A = 0; \quad F_{BC}\left(\frac{4}{5}\right)(2) - 600(3)(1.5) - 900 = 0 \quad F_{BC} = 2250\ \text{N}$$

$$\zeta + \Sigma M_B = 0; \quad 600(3)(0.5) - 900 - A_y(2) = 0 \quad A_y = 0$$

$$\pm \Sigma F_x = 0; \quad A_x - 2250\left(\frac{2}{5}\right) = 0 \quad A_x = 1350\ \text{N}$$

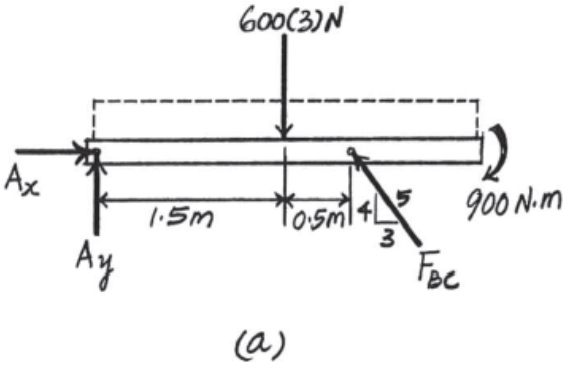
Using these results and referring to Fig. *b*, we have

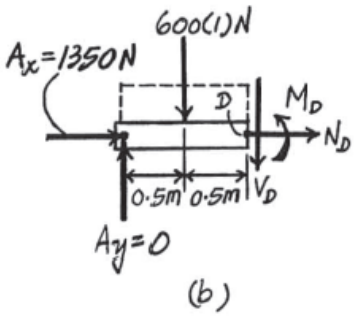
$$\pm \Sigma F_x = 0; \quad N_D + 1350 = 0 \quad N_D = -1350\ \text{N} = -1.35\ \text{kN} \quad \textbf{Ans.}$$

$$+\uparrow \Sigma F_y = 0; \quad -V_D - 600(1) = 0 \quad V_D = -600\ \text{N} \quad \textbf{Ans.}$$

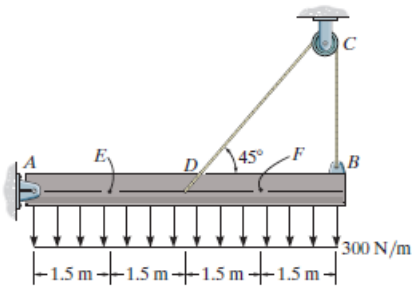
$$\zeta + \Sigma M_D = 0; \quad M_D + 600(1)(0.5) = 0 \quad M_D = -300\ \text{N}\cdot\text{m} \quad \textbf{Ans.}$$

The negative sign indicates that $\mathbf{N}_D$, $\mathbf{V}_D$, and $\mathbf{M}_D$ act in the opposite sense to that shown on the free-body diagram.





Determine the internal normal force, shear force, and moment at points E and F in the beam.



SOLUTION

With reference to Fig. *a*,

$\zeta + \Sigma M_A = 0;$ $\quad T(6) + T \sin 45°(3) - 300(6)(3) = 0$ $\quad T = 664.92$ N

$\pm \Sigma F_x = 0;$ $\quad 664.92 \cos 45° - A_x = 0$ $\quad A_x = 470.17$ N

$+\uparrow \Sigma F_y = 0;$ $\quad A_y + 664.92 \sin 45° + 664.92 - 300(6) = 0$ $\quad A_y = 664.92$ N

Use these result and referring to Fig. *b*,

$\pm \Sigma F_x = 0;$ $\quad N_E - 470.17 = 0$

$N_E = 470$ N **Ans.**

$+\uparrow \Sigma F_y = 0;$ $\quad 664.92 - 300(1.5) - V_E = 0$

$V_E = 215$ N **Ans.**

$\zeta + \Sigma M_E = 0;$ $\quad M_E + 300(1.5)(0.75) - 664.92(1.5) = 0$

$M_E = 660$ N · m **Ans.**

Also, by referring to Fig. *c*,

$\pm \Sigma F_x = 0;$ $\quad N_F = 0$ **Ans.**

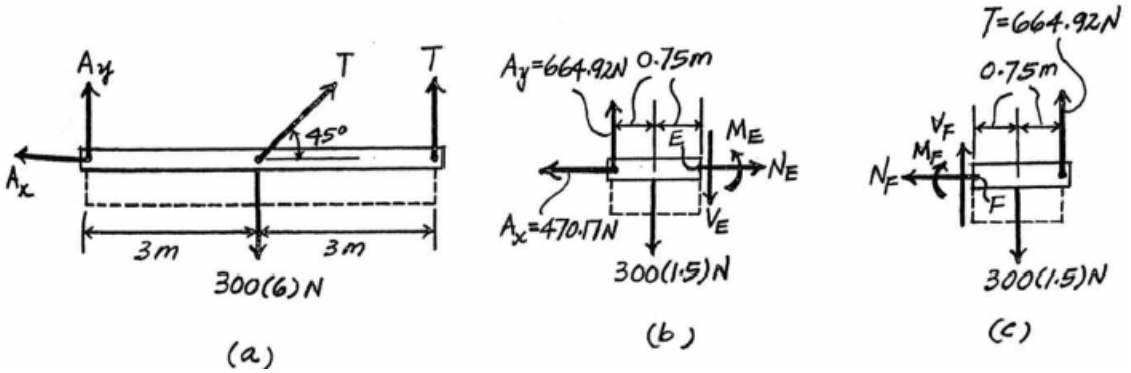
$+\uparrow \Sigma F_y = 0;$ $\quad V_F + 664.92 - 300 = 0$

$V_F = -215$ N **Ans.**

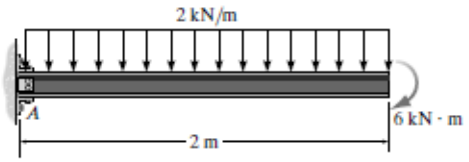
$\zeta + \Sigma M_F = 0;$ $\quad 664.92(1.5) - 300(1.5)(0.75) - M_F = 0$

$M_F = 660$ N · m **Ans.**

The negative sign indicates that $\mathbf{V}_F$ acts in the opposite sense to that shown on the free-body diagram.



7–50. Draw the shear and moment diagrams for the cantilever beam.



The free - body diagram of the beam's right segment sectioned through an arbitrary point shown in Fig. *a* will be used to write the shear and moment equations of the beam.

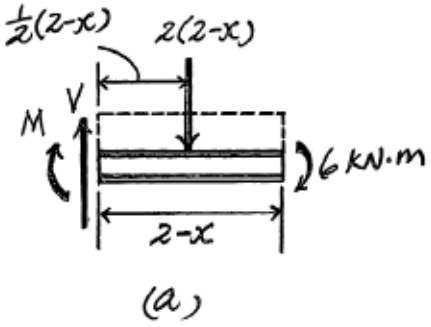
$+\uparrow \Sigma F_y = 0;$ $\quad V - 2(2-x) = 0$ $\quad V = \{4-2x\}\ \text{kN}$ (1)

$+\Sigma M = 0;\ -M - 2(2-x)\left[\frac{1}{2}(2-x)\right] - 6 = 0$ $\quad M = \{-x^2 + 4x - 10\}\ \text{kN}\cdot\text{m}$ (2)

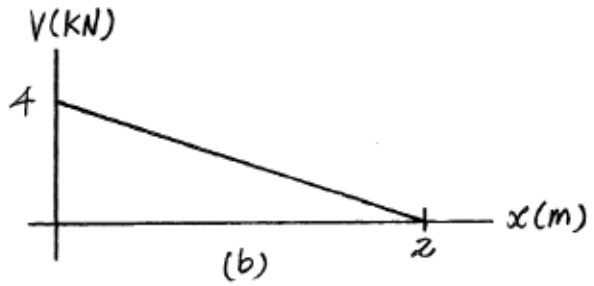
The shear and moment diagrams shown in Figs. *b* and *c* are plotted using Eqs. (1) and (2), respectively. The value of the shear and moment at $x = 0$ is evaluated using Eqs. (1) and (2).

$V|_{x=0} = 4 - 2(0) = 4\,\text{kN}$

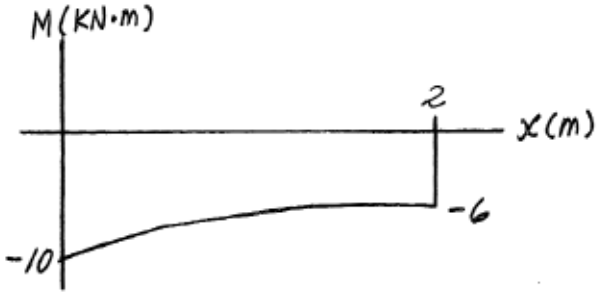
$M|_{x=0} = [-0 + 4(0) - 10] = -10\,\text{kN}\cdot\text{m}$



(a)

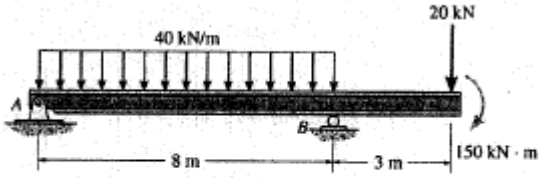


(b)



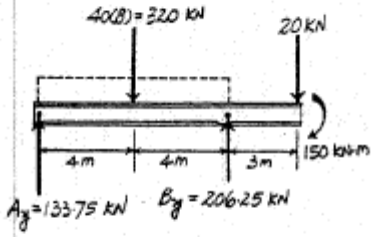
(c)

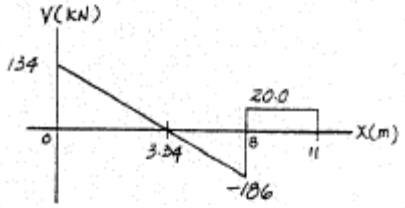
7-73. Draw the shear and moment diagrams for the beam.

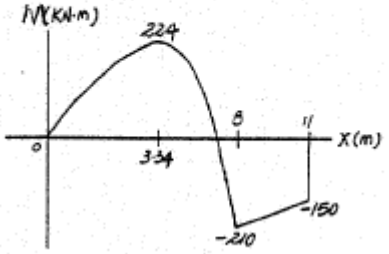


Support Reactions :

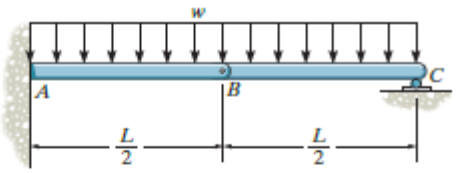
$$\zeta + \Sigma M_A = 0; \quad B_y(8) - 320(4) - 20(11) - 150 = 0$$
$$B_y = 206.25 \text{ kN}$$
$$+\uparrow \Sigma F_y = 0; \quad A_y + 206.25 - 320 - 20 = 0 \quad A_y = 133.75 \text{ kN}$$







Draw the shear and bending-moment diagrams for beam ABC. Note that there is a pin at B.



SOLUTION

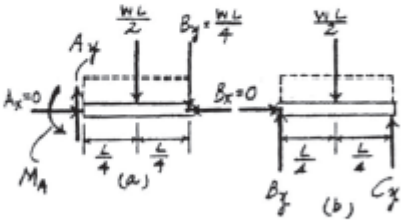
Support Reactions: From FBD (a),

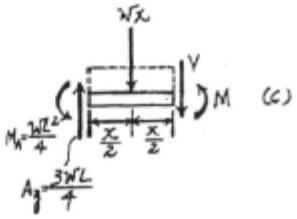
$$\zeta + \Sigma M_C = 0; \quad \frac{wL}{2}\left(\frac{L}{4}\right) - B_y\left(\frac{L}{2}\right) = 0 \qquad B_y = \frac{wL}{4}$$

From FBD (b),

$$+\uparrow \Sigma F_y = 0; \quad A_y - \frac{wL}{2} - \frac{wL}{4} = 0 \qquad A_y = \frac{3wL}{4}$$

$$\zeta + \Sigma M_A = 0; \quad M_A - \frac{wL}{2}\left(\frac{L}{4}\right) - \frac{wL}{4}\left(\frac{L}{2}\right) = 0 \qquad M_A = \frac{wL^2}{4}$$



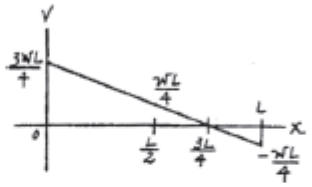


Shear and Moment Functions: For $0 \le x \le L$ [FBD (c)],

$$+\uparrow \Sigma F_y = 0; \quad \frac{3wL}{4} - wx - V = 0$$

$$V = \frac{w}{4}(3L - 4x)$$

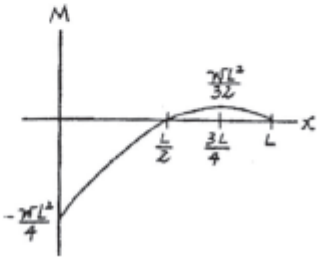
Ans.



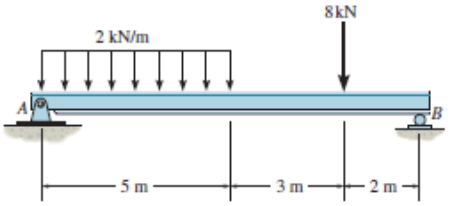
$$\zeta + \Sigma M = 0; \quad \frac{3wL}{4}(x) - wx\left(\frac{x}{2}\right) - \frac{wL^2}{4} - M = 0$$

$$M = \frac{w}{4}\left(3Lx - 2x^2 - L^2\right)$$

Ans.



Draw the shear and moment diagrams for the beam.

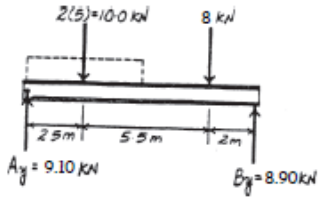


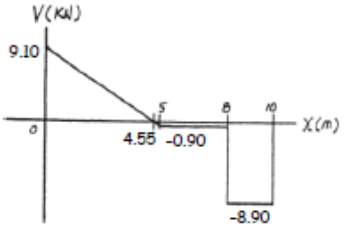
SOLUTION

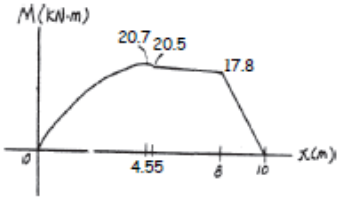
Support Reactions:

$\zeta + \Sigma M_A = 0; \quad B_y\,(10) - 10.0(2.5) - 8(8) = 0 \qquad B_y = 8.90\ \text{kN}$

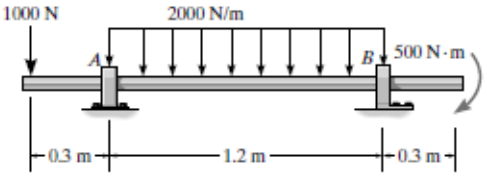
$+\uparrow \Sigma F_y = 0; \qquad A_y + 8.90 - 10.0 - 8 = 0 \qquad A_y = 9.10\ \text{kN}$

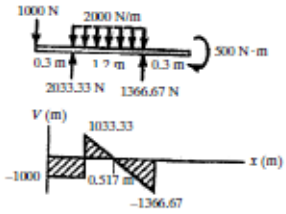


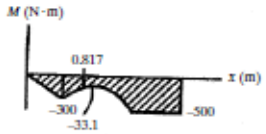




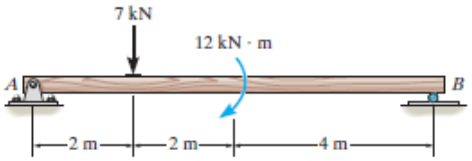
7–83. Draw the shear and moment diagrams for the shaft. The support at A is a journal bearing and at B it is a thrust bearing.



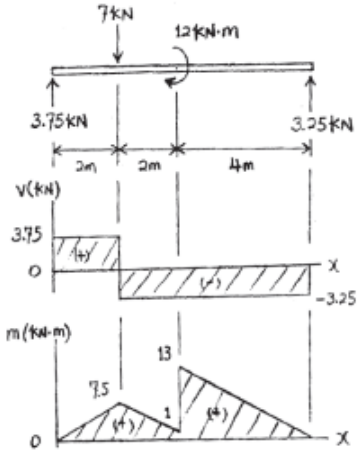




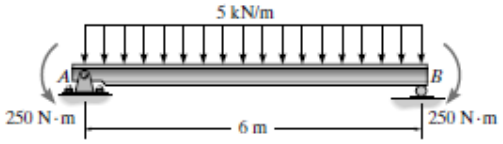
Draw the shear and moment diagrams for the beam.



SOLUTION



7–57. Draw the shear and moment diagrams for the beam.



$(+\Sigma M_A = 0;\quad -30\,(3) + B_y\,(6) = 0$

$B_y = 15\ \text{kN}$

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

$+\uparrow\Sigma F_y = 0;\quad A_y - 30 + 15 = 0$

$A_y = 15\ \text{kN}$

For $0 \le x \le 3\ \text{m}$

$\overset{+}{\rightarrow}\Sigma F_x = 0;\quad 15 - 5x - V = 0$

$V = 5\,(3 - x)$ **Ans.**

$(+\Sigma M = 0;\quad -15\,(x) + 0.250 + 5\left(\frac{x}{2}\right) + M = 0$

$M = \frac{1}{2}\,(30x - 5x^2 - 0.5)$

$M = 15x - 2.5x^2 - 0.25$ **Ans.**