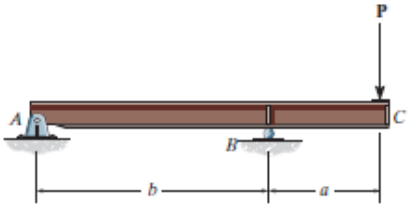
CHAPTER VII

INTERNAL FORCES

7–45.

Draw the shear and moment diagrams for the overhang beam.



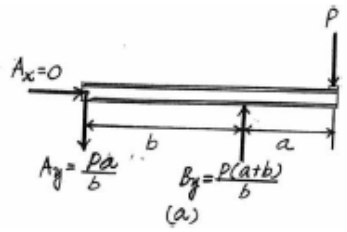
SOLUTION

Since the loading discontinues at B, the shear stress and moment equation must be written for regions $0 \le x < b$ and $b < x \le a + b$ of the beam. The free-body diagram of the beam's segment sectioned through an arbitrary point in these two regions are shown in Figs. b and c.

Region $0 \le x < b$, Fig. b

$$+\uparrow \Sigma F_y = 0; \qquad -\frac{Pa}{b} - V = 0 \qquad V = -\frac{Pa}{b} \qquad \textbf{(1)}$$

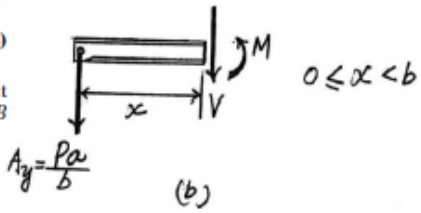
$$\zeta + \Sigma M = 0; \qquad M + \frac{Pa}{b}x = 0 \qquad M = -\frac{Pa}{b}x \qquad \textbf{(2)}$$



Region $b < x \le a + b$, Fig. c

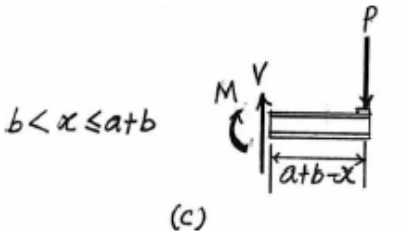
$$\Sigma F_y = 0; \qquad V - P = 0 \qquad V = P \qquad \textbf{(3)}$$

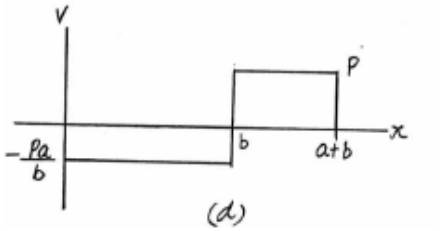
$$\zeta + \Sigma M = 0; \qquad -M - P(a + b - x) = 0 \qquad M = -P(a + b - x) \qquad \textbf{(4)}$$

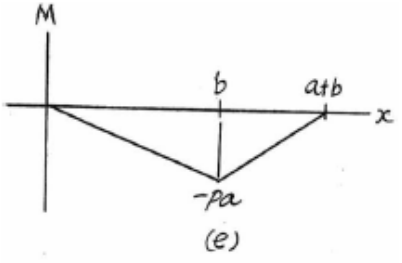


The shear diagram in Fig. d is plotted using Eqs. (1) and (3), while the moment diagram shown in Fig. e is plotted using Eqs. (2) and (4). The value of moment at B is evaluated using either Eqs. (2) or (4) by substituting $x = b$; i.e.,

$$M|_{x=b} = -\frac{Pa}{b}(b) = -Pa \text{ or } M|_{x=b} = -P(a + b - b) = -Pa$$

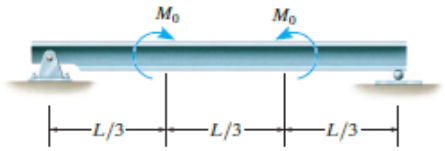






7–48.

Draw the shear and moment diagrams for the beam (a) in terms of the parameters shown; (b) set $M_0 = 500\ \text{N}\cdot\text{m}$, $L = 8\ \text{m}$.



SOLUTION

(a)

For $0 \le x \le \frac{L}{3}$

$+\uparrow \Sigma F_y = 0;$ $\quad V = 0$

$\zeta + \Sigma M = 0;$ $\quad M = 0$

For $\frac{L}{3} < x < \frac{2L}{3}$

$+\uparrow \Sigma F_y = 0;$ $\quad V = 0$

$\zeta + \Sigma M = 0;$ $\quad M = M_0$

For $\frac{2L}{3} < x \le L$

$+\uparrow \Sigma F_y = 0;$ $\quad V = 0$

$\zeta + \Sigma M = 0;$ $\quad M = 0$

(b)

Set $M_0 = 500\ \text{N}\cdot\text{m}$, $L = 8\ \text{m}$

For $0 \le x < \frac{8}{3}\ \text{m}$

$+\uparrow \Sigma F_y = 0;$ $\quad V = 0$

$\curvearrowleft + \Sigma M = 0;$ $\quad M = 0$

For $\frac{8}{3}\ \text{m} < x < \frac{16}{3}\ \text{m}$

$+\uparrow \Sigma F_y = 0;$ $\quad V = 0$

$\curvearrowleft + \Sigma M = 0;$ $\quad M = 500\ \text{N}\cdot\text{m}$

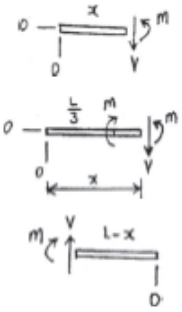
For $\frac{16}{3}\ \text{m} < x \le 8\ \text{m}$

$+\uparrow \Sigma F_y = 0;$ $\quad V = 0$

$\curvearrowleft + \Sigma M = 0;$ $\quad M = 0$

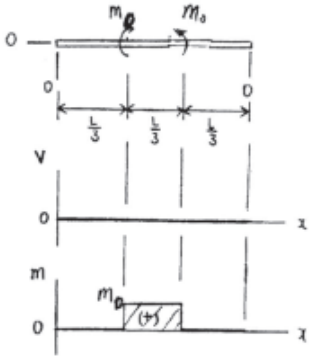
Ans.

Ans.



Ans.

Ans.

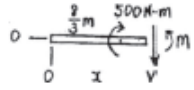


Ans.

Ans.

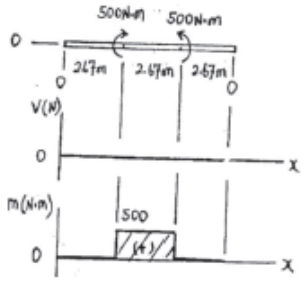
Ans.

Ans.

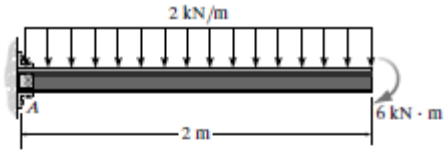


Ans.

Ans.



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.

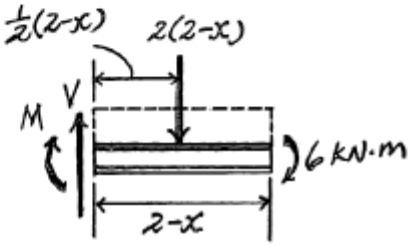
$$+\uparrow \Sigma F_y = 0; \qquad V - 2(2-x) = 0 \qquad V = \{4 - 2x\}\ \text{kN} \qquad (1)$$

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

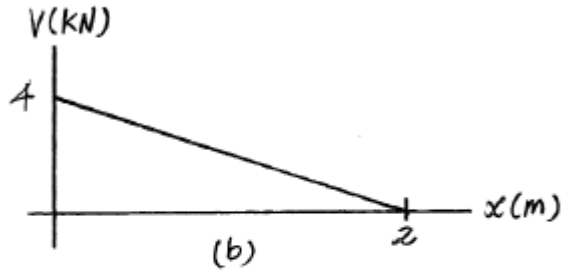
The shear and moment diagrams shown in Figs. *b* and *c* are plotted using Eqs. (1) and (2), respectively. The value of the shear and moment at $x = 0$ is evaluated using Eqs. (1) and (2).

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

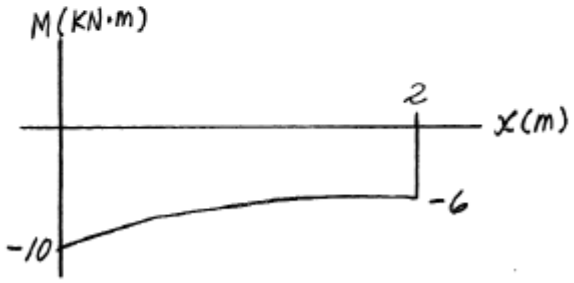
$$M|_{x=0} = [-0 + 4(0) - 10] = -10\,\text{kN} \cdot \text{m}$$



(a)



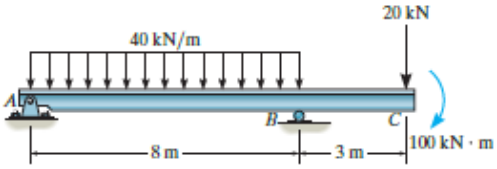
(b)



(c)

7–53.

Draw the shear and moment diagrams for the beam.



SOLUTION

$0 \le x < 8$

$+\uparrow \Sigma F_y = 0; \quad 140 - 40x - V = 0$

$V = 140 - 40x$

$\zeta + \Sigma M = 0; \quad M + 40x\left(\frac{x}{2}\right) - 140x = 0$

$M = 140x - 20x^2$

$8 < x \le 11$

$+\uparrow \Sigma F_y = 0; \quad V - 20 = 0$

$V = 20$

$\zeta + \Sigma M = 0; \quad M + 20(11 - x) + 100 = 0$

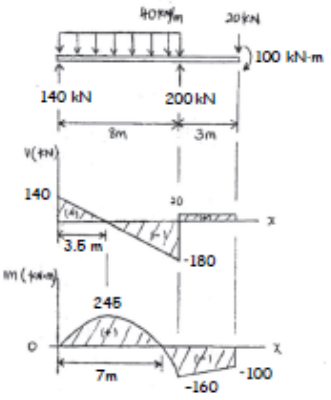
$M = 20x - 320$

Ans.

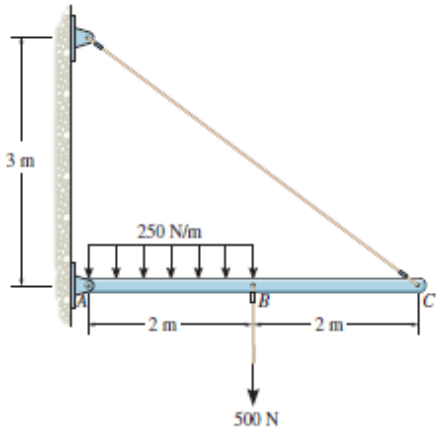
Ans.

Ans.

Ans.



Draw the shear and moment diagrams for the beam.

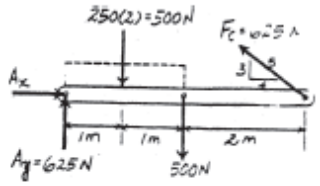


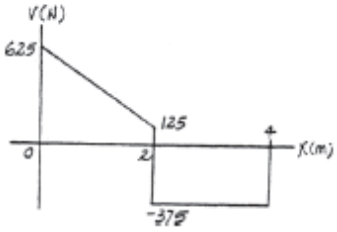
SOLUTION

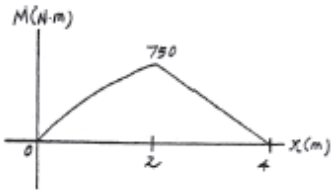
Support Reactions:

$$\zeta + \Sigma M_A = 0; \qquad F_C\left(\frac{3}{5}\right)(4) - 500(2) - 500(1) = 0 \qquad F_C = 625 \text{ N}$$

$$+\uparrow \Sigma F_y = 0; \qquad A_y + 625\left(\frac{3}{5}\right) - 500 - 500 = 0 \qquad A_y = 625 \text{ N}$$

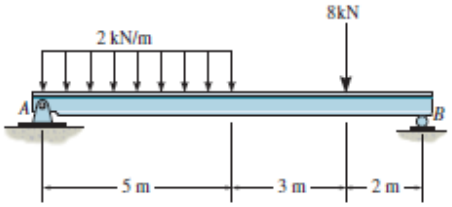






7–76.

Draw the shear and moment diagrams for the beam.

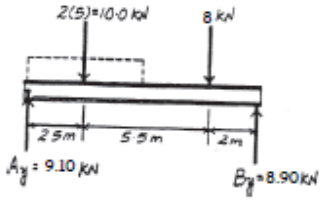


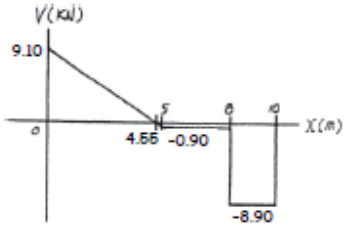
SOLUTION

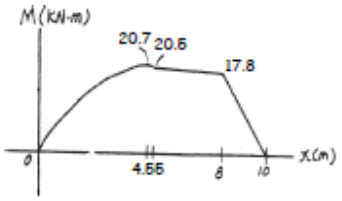
Support Reactions:

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

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

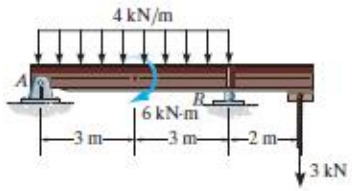




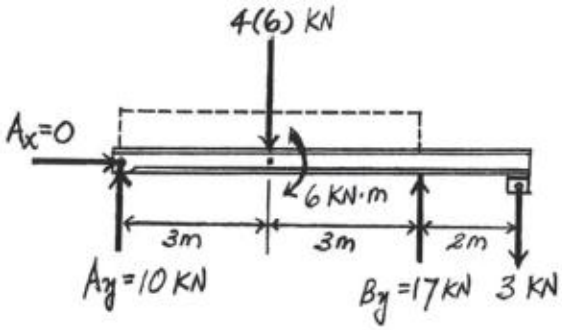


7–82.

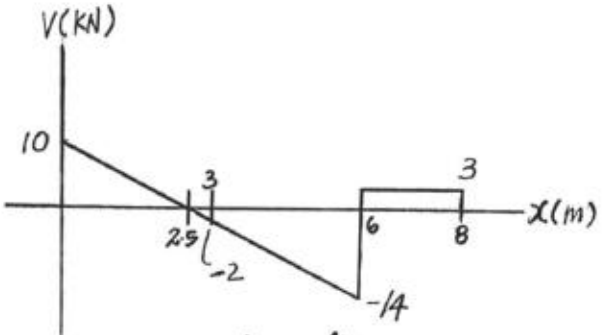
Draw the shear and moment diagrams for the overhang beam.



SOLUTION

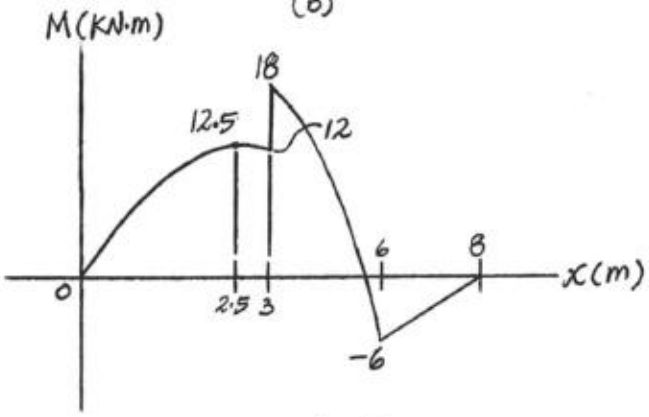


(a)



Shear diagram

(b)



Moment diagram

(c)