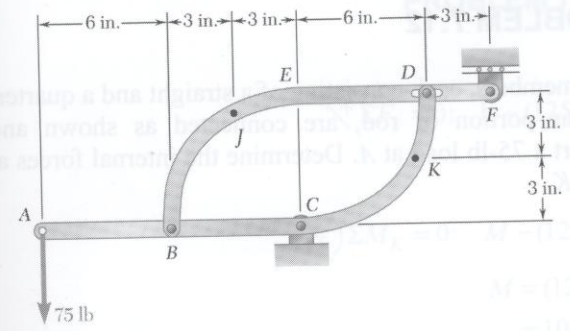
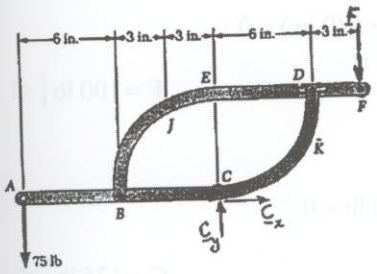


PROBLEM 7.11

Two members, each consisting of a straight and a quarter-circular portion of rod, are connected as shown and support a 75-lb load at A. Determine the internal forces at Point J.

SOLUTION

Free body: Entire frame



$$+\circlearrowleft \Sigma M_C = 0: \quad (75\text{ lb})(12\text{ in.}) - F(9\text{ in.}) = 0$$

$$\mathbf{F} = 100\text{ lb} \downarrow \blacktriangleleft$$

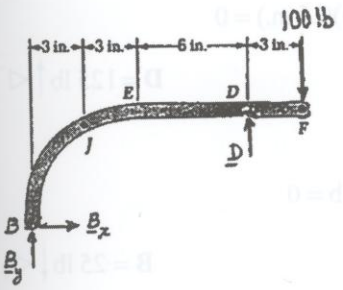
$$\pm \Sigma F_x = 0: \quad C_x = 0$$

$$+\uparrow \Sigma F_y = 0: \quad C_y - 75\text{ lb} - 100\text{ lb} = 0$$

$$C_y = +175\text{ lb}$$

$$\mathbf{C} = 175\text{ lb} \uparrow \blacktriangleleft$$

Free body: Member *BEDF*



$$+\circlearrowleft \Sigma M_B = 0: \quad D(12\text{ in.}) - (100\text{ lb})(15\text{ in.}) = 0$$

$$\mathbf{D} = 125\text{ lb} \uparrow \blacktriangleleft$$

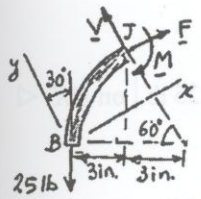
$$\pm \Sigma F_x = 0: \quad B_x = 0$$

$$+\uparrow \Sigma F_y = 0: \quad B_y + 125\text{ lb} - 100\text{ lb} = 0$$

$$B_y = -25\text{ lb}$$

$$\mathbf{B} = 25\text{ lb} \downarrow \blacktriangleleft$$

Free body: *BJ*



$$+\nearrow \Sigma F_x = 0: \quad F - (25\text{ lb})\sin 30° = 0$$

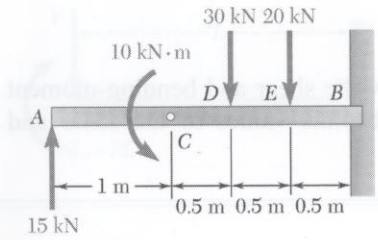
$$\mathbf{F} = 12.50\text{ lb} \angle 30.0° \blacktriangleleft$$

$$+\nwarrow \Sigma F_y = 0: \quad V - (25\text{ lb})\cos 30° = 0$$

$$\mathbf{V} = 21.7\text{ lb} \angle 60.0° \blacktriangleleft$$

$$+\circlearrowleft \Sigma M_J = 0: \quad -M + (25\text{ lb})(3\text{ in.}) = 0$$

$$\mathbf{M} = 75.0\text{ lb}\cdot\text{in.} \circlearrowleft \blacktriangleleft$$



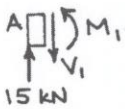
PROBLEM 7.35

For the beam and loading shown, (*a*) draw the shear and bending-moment diagrams, (*b*) determine the maximum absolute values of the shear and bending moment.

SOLUTION

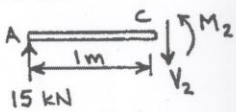
(*a*) Just to the right of *A*:

$$+\uparrow \Sigma F_y = 0 \quad V_1 = +15 \text{ kN} \quad M_1 = 0$$



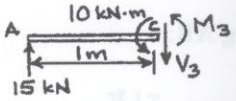
Just to the left of *C*:

$$V_2 = +15 \text{ kN} \quad M_2 = +15 \text{ kN} \cdot \text{m}$$



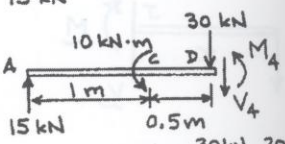
Just to the right of *C*:

$$V_3 = +15 \text{ kN} \quad M_3 = +5 \text{ kN} \cdot \text{m}$$



Just to the right of *D*:

$$V_4 = -15 \text{ kN} \quad M_4 = +12.5 \text{ kN} \cdot \text{m}$$

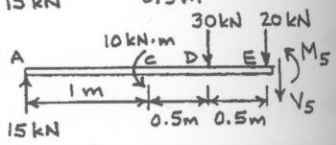


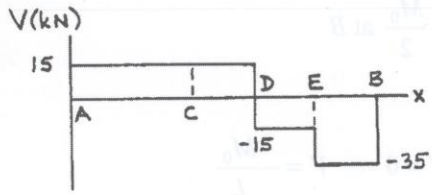
Just to the right of *E*:

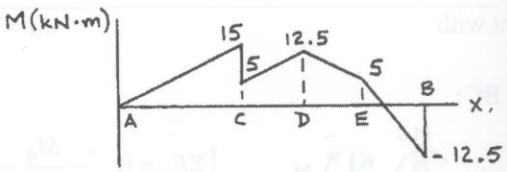
$$V_5 = -35 \text{ kN} \quad M_5 = +5 \text{ kN} \cdot \text{m}$$

At *B*:

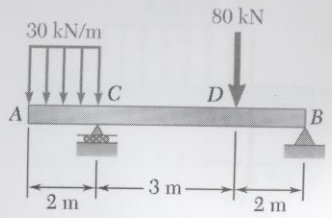
$$M_B = -12.5 \text{ kN} \cdot \text{m}$$







(*b*) $|V|_{\max} = 35.0 \text{ kN}$ $|M|_{\max} = 12.50 \text{ kN} \cdot \text{m}$ ◀

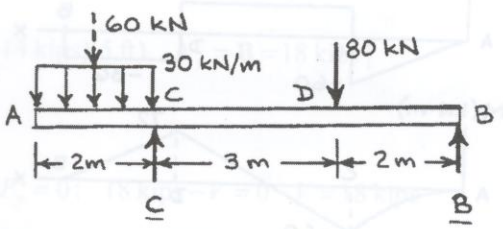


PROBLEM 7.40

For the beam and loading shown, (*a*) draw the shear and bending-moment diagrams, (*b*) determine the maximum absolute values of the shear and bending moment.

SOLUTION

Free body: Entire beam



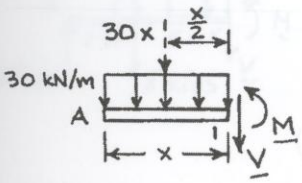
$$+\circlearrowleft \Sigma M_B = 0: \quad (60\text{ kN})(6\text{ m}) - C(5\text{ m}) + (80\text{ kN})(2\text{ m}) = 0$$

$$C = +104\text{ kN} \qquad \mathbf{C} = 104\text{ kN}\uparrow$$

$$+\uparrow \Sigma F_y = 0: \quad 104 - 60 - 80 + B = 0 \qquad \mathbf{B} = 36\text{ kN}\uparrow$$

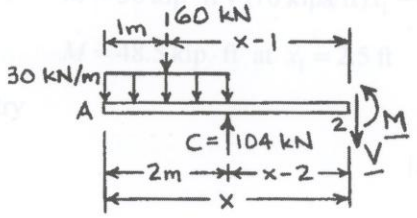
From *A* to *C*:

$$+\uparrow \Sigma F_y = 0: \quad -30x - V = 0 \qquad V = -30x$$



$$+\circlearrowleft \Sigma M_1 = 0: \quad (30x)\left(\frac{x}{2}\right) + M = 0 \qquad M = -15x^2$$

From *C* to *D*:

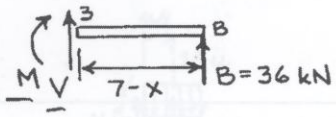


$$+\uparrow \Sigma F_y = 0: \quad 104 - 60 - V = 0 \qquad V = +44\text{ kN}$$

$$+\circlearrowleft \Sigma M_2 = 0: \quad (60)(x-1) - (104)(x-2) + M = 0 \qquad M = 44x - 148$$

PROBLEM 7.40 (Continued)

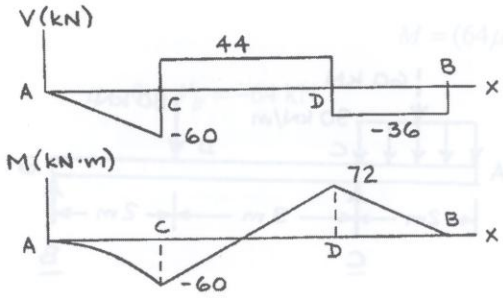
From D to B:



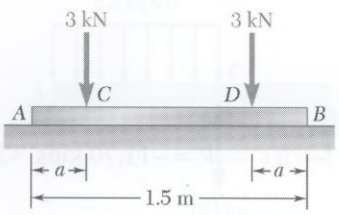
$$+\uparrow \Sigma F_y = 0: \quad V = -36 \text{ kN}$$

$$+\circlearrowleft \Sigma M_3 = 0: \quad (36)(7-x) - M = 0$$

$$M = -36x + 252$$



(*b*) $|V|_{\max} = 60.0 \text{ kN}$ $|M|_{\max} = 72.0 \text{ kN} \cdot \text{m}.$ ◀



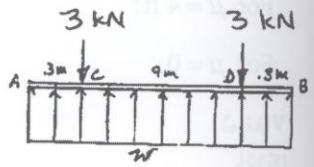
PROBLEM 7.43

Assuming the upward reaction of the ground on beam AB to be uniformly distributed and knowing that $a = 0.3$ m, (*a*) draw the shear and bending-moment diagrams, (*b*) determine the maximum absolute values of the shear and bending moment.

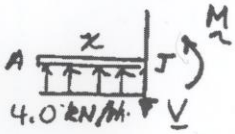
SOLUTION

(*a*) **FBD Beam:** $\uparrow \Sigma F_y = 0$: $w(1.5\text{ m}) - 2(3.0\text{ kN}) = 0$

$$w = 4.0\text{ kN/m}$$



Along AC:

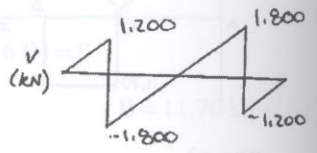


$\uparrow \Sigma F_y = 0$: $(4.0\text{ kN/m})x - V = 0$

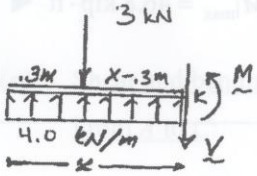
$$V = (4.0\text{ kN/m})x$$

$\circlearrowleft \Sigma M_J = 0$: $M - \frac{x}{2}(4.0\text{ kN/m})x = 0$

$$M = (2.0\text{ kN/m})x^2$$



Along CD:

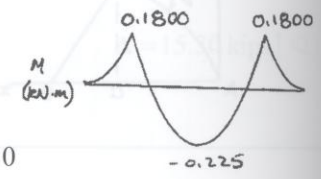


$\uparrow \Sigma F_y = 0$: $(4.0\text{ kN/m})x - 3.0\text{ kN} - V = 0$

$$V = (4.0\text{ kN/m})x - 3.0\text{ kN}$$

$\circlearrowleft \Sigma M_K = 0$: $M + (x - 0.3\text{ m})(3.0\text{ kN}) - \frac{x}{2}(4.0\text{ kN/m})x = 0$

$$M = 0.9\text{ kN}\cdot\text{m} - (3.0\text{ kN})x + (2.0\text{ kN/m})x^2$$

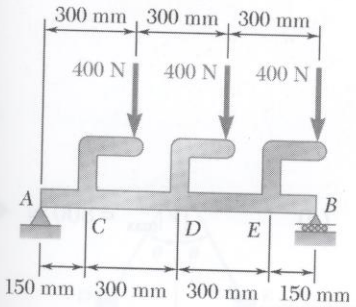


Note: $V = 0$ at $x = 0.75$ m, where $M = -0.225\text{ kN}\cdot\text{m}$

Complete diagrams using symmetry.

(*b*) $|V|_{\max} = 1.800$ kN at C and D ◀

$|M|_{\max} = 0.225\text{ kN}\cdot\text{m}$ at center ◀

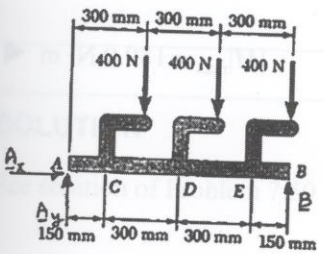


PROBLEM 7.54

Draw the shear and bending-moment diagrams for the beam AB, and determine the maximum absolute values of the shear and bending moment.

SOLUTION

Free body: Entire beam



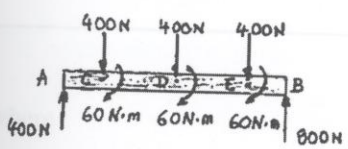
$$+\circlearrowleft \Sigma M_A = 0: \quad B(0.9\text{ m}) - (400\text{ N})(0.3\text{ m}) - (400\text{ N})(0.6\text{ m}) - (400\text{ N})(0.9\text{ m}) = 0$$

$$B = +800\text{ N} \qquad \mathbf{B} = 800\text{ N} \uparrow \triangleleft$$

$$\Sigma F_x = 0: \quad A_x = 0$$

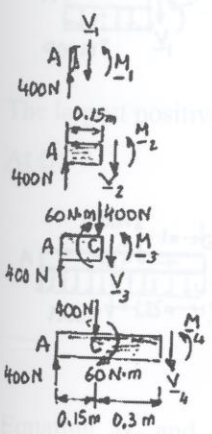
$$+\uparrow \Sigma F_y = 0: \quad A_y + 800\text{ N} - 3(400\text{ N}) = 0$$

$$A_y = +400\text{ N} \qquad \mathbf{A} = 400\text{ N} \uparrow \triangleleft$$



We replace the loads by equivalent force-couple systems at C, D, and E.

We consider successively the following F-B diagrams.



$$V_1 = +400\text{ N} \qquad M_1 = 0$$

$$V_2 = +400\text{ N} \qquad M_2 = +60\text{ N}\cdot\text{m}$$

$$V_3 = 0 \qquad M_3 = +120\text{ N}\cdot\text{m}$$

$$V_4 = 0 \qquad M_4 = +120\text{ N}\cdot\text{m}$$

$$V_5 = -400\text{ N} \qquad M_5 = +180\text{ N}\cdot\text{m}$$

$$V_6 = -400\text{ N} \qquad M_6 = +60\text{ N}\cdot\text{m}$$

$$V_7 = -800\text{ N} \qquad M_7 = +120\text{ N}\cdot\text{m}$$

$$V_8 = -800\text{ N} \qquad M_8 = 0$$