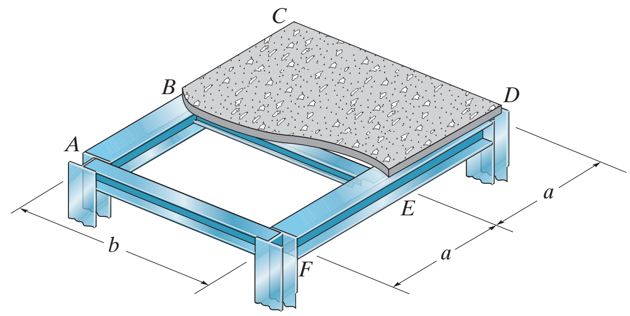
2–1. The steel framework is used to support the reinforced stone concrete slab that is used for an office. The slab is 200 mm thick. Sketch the loading that acts along members *BE* and *FED*. Take $a = 2$ m, $b = 5$ m. *Hint*: See Tables 1–2 and 1–4.



Beam *BE*. Since $\frac{b}{a} = \frac{5\text{ m}}{2\text{ m}} = 2.5$, the concrete slab will behave as a one way slab.

Thus, the tributary area for this beam is rectangular shown in Fig. *a* and the intensity of the uniform distributed load is

200 mm thick reinforced stone concrete slab:
$(23.6\text{ kN/m}^3)(0.2\text{ m})(2\text{ m}) = 9.44\text{ kN/m}$

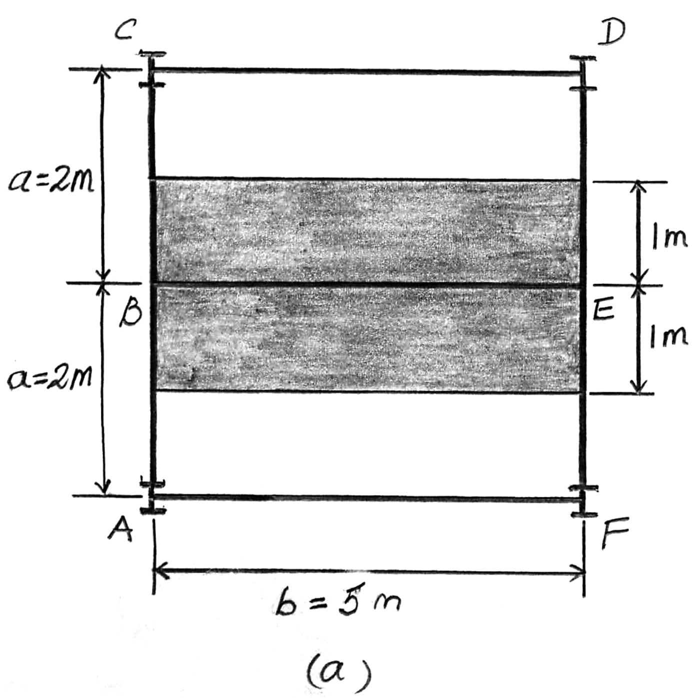
Live load for office: $(2.40\text{ kN/m}^2)(2\text{ m}) = \frac{480\text{ kN/m}}{14.24\text{ kN/m}}$ **Ans.**

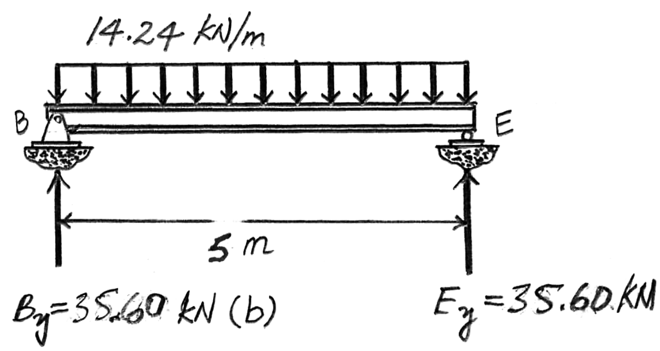
Due to symmetry the vertical reaction at *B* and *E* are

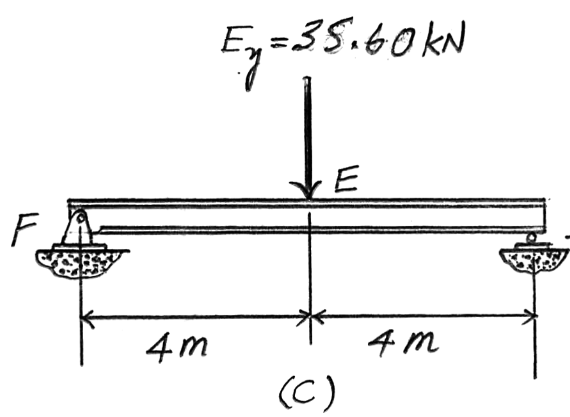
$$B_y = E_y = (14.24\text{ kN/m})(5)/2 = 35.6\text{ kN}$$

The loading diagram for beam *BE* is shown in Fig. *b*.

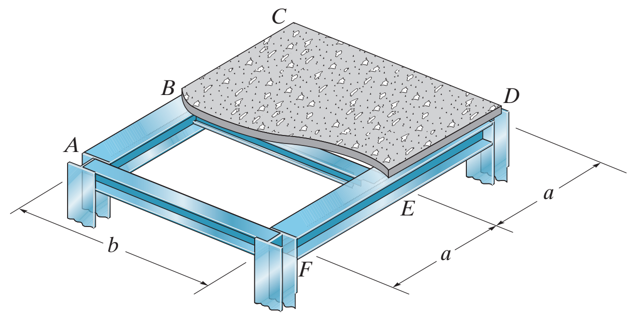
Beam *FED*. The only load this beam supports is the vertical reaction of beam *BE* at *E* which is $E_y = 35.6$ kN. The loading diagram for this beam is shown in Fig. *c*.







2–2. Solve Prob. 2–1 with $a = 3$ m, $b = 4$ m.



Beam *BE*. Since $\frac{b}{a} = \frac{4}{3} < 2$, the concrete slab will behave as a two way slab. Thus, the tributary area for this beam is the hexagonal area shown in Fig. *a* and the maximum intensity of the distributed load is

200 mm thick reinforced stone concrete slab: $(23.6\ \text{kN/m}^3)(0.2\ \text{m})(3\ \text{m})$
$= 14.16\ \text{kN/m}$

Live load for office: $(2.40\ \text{kN/m}^2)(3\ \text{m})$ $= \underline{\ 7.20\ \text{kN/m}\ }$
$21.36\ \text{kN/m}$ **Ans.**

Due to symmetry, the vertical reactions at B and E are

$$B_y = E_y = \frac{2\left[\frac{1}{2}(21.36\ \text{kN/m})(1.5\ \text{m})\right] + (21.36\ \text{kN/m})(1\ \text{m})}{2}$$
$$= 26.70\ \text{kN}$$

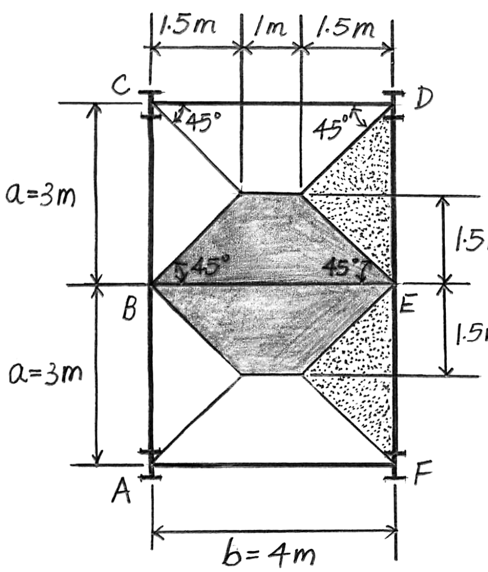
The loading diagram for Beam *BE* is shown in Fig. *b*.

Beam *FED*. The loadings that are supported by this beam are the vertical reaction of beam *BE* at *E* which is $E_y = 26.70$ kN and the triangular distributed load of which its tributary area is the triangular area shown in Fig. *a*. Its maximum intensity is

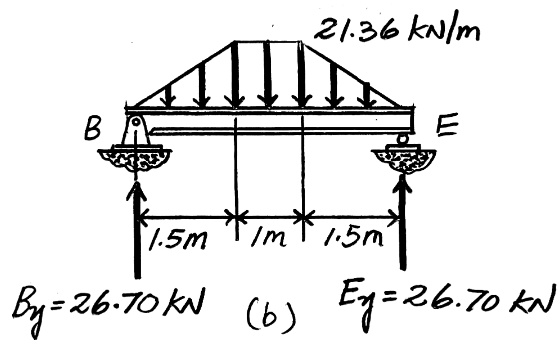
200 mm thick reinforced stone concrete slab: $(23.6\ \text{kN/m}^3)(0.2\ \text{m})(1.5\ \text{m})$
$= 7.08\ \text{kN/m}$

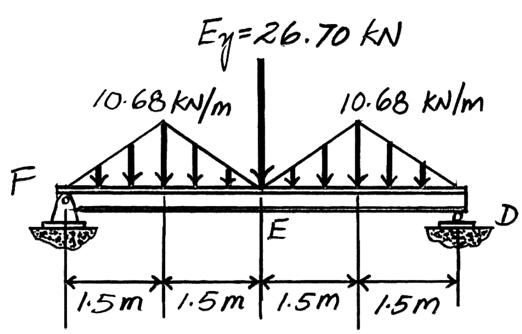
Live load for office: $(2.40\ \text{kN/m}^2)(1.5\ \text{m})$ $= \underline{\ 3.60\ \text{kN/m}\ }$
$10.68\ \text{kN/m}$ **Ans.**

The loading diagram for Beam *FED* is shown in Fig. *c*.



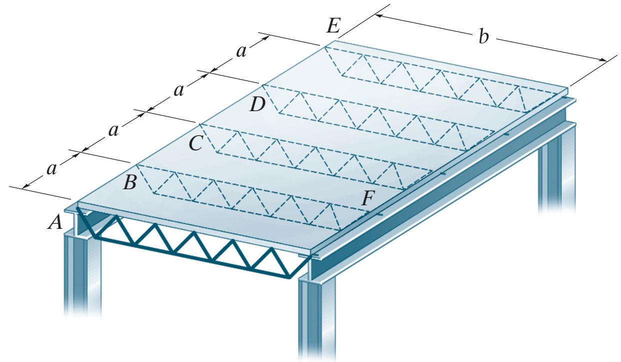
(a)





(c)

2–3. The floor system used in a school classroom consists of a 4-in. reinforced stone concrete slab. Sketch the loading that acts along the joist *BF* and side girder *ABCDE*. Set $a = 10$ ft, $b = 30$ ft. *Hint*: See Tables 1–2 and 1–4.



Joist *BF*. Since $\frac{b}{a} = \frac{30 \text{ ft}}{10 \text{ ft}} = 3$, the concrete slab will behave as a one way slab. Thus, the tributary area for this joist is the rectangular area shown in Fig. *a* and the intensity of the uniform distributed load is

4 in thick reinforced stone concrete slab: $(0.15 \text{ k/ft}^3)\left(\frac{4}{12} \text{ ft}\right)(10 \text{ ft}) = 0.5 \text{ k/ft}$

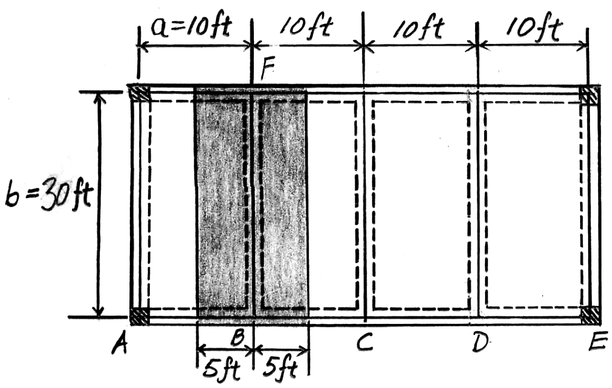
Live load for classroom: $(0.04 \text{ k/ft}^2)(10 \text{ ft}) = \frac{0.4 \text{ k/ft}}{0.9 \text{ k/ft}}$ **Ans.**

Due to symmetry, the vertical reactions at *B* and *F* are

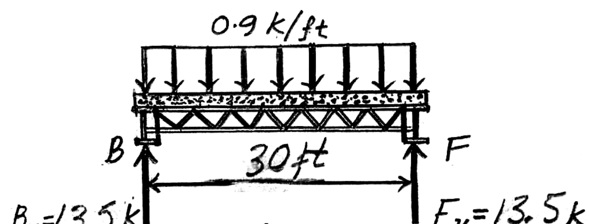
$$B_y = F_y = (0.9 \text{ k/ft})(30 \text{ ft})/2 = 13.5 \text{ k}$$ **Ans.**

The loading diagram for joist *BF* is shown in Fig. *b*.

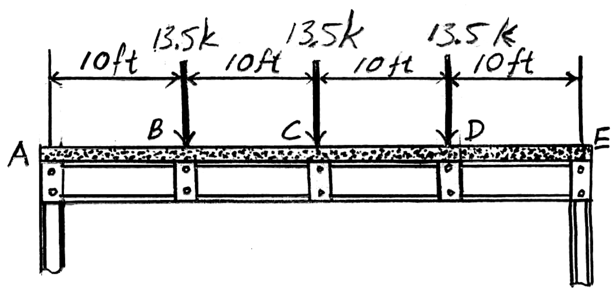
Girder *ABCDE*. The loads that act on this girder are the vertical reactions of the joists at *B*, *C*, and *D*, which are $B_y = C_y = D_y = 13.5$ k. The loading diagram for this girder is shown in Fig. *c*.



(a)

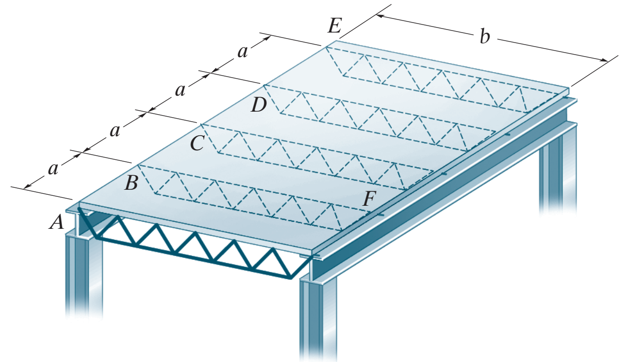


(b)



(c)

***2–4.** Solve Prob. 2–3 with $a = 10$ ft, $b = 15$ ft.



Joist *BF*. Since $\frac{b}{a} = \frac{15\text{ ft}}{10\text{ ft}} = 1.5 < 2$, the concrete slab will behave as a two way slab. Thus, the tributary area for the joist is the hexagonal area as shown in Fig. *a* and the maximum intensity of the distributed load is

4 in thick reinforced stone concrete slab: $(0.15\text{ k/ft}^3)\left(\frac{4}{12}\text{ ft}\right)(10\text{ ft}) = 0.5\text{ k/ft}$

Live load for classroom: $(0.04\text{ k/ft}^2)(10\text{ ft}) = \frac{0.4\text{ k/ft}}{0.9\text{ k/ft}}$ **Ans.**

Due to symmetry, the vertical reactions at B and G are

$$B_y = F_y = \frac{2\left[\frac{1}{2}(0.9\text{ k/ft})(5\text{ ft})\right] + (0.9\text{ k/ft})(5\text{ ft})}{2} = 4.50\text{ k} \qquad \textbf{Ans.}$$

The loading diagram for beam BF is shown in Fig. *b*.

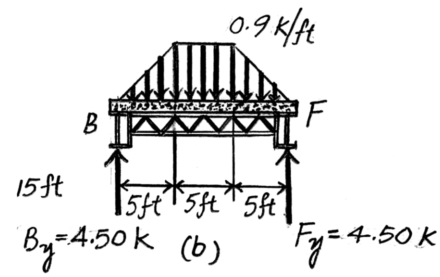
Girder *ABCDE*. The loadings that are supported by this girder are the vertical reactions of the joist at B, C and D which are $B_y = C_y = D_y = 4.50$ k and the triangular distributed load shown in Fig. *a*. Its maximum intensity is

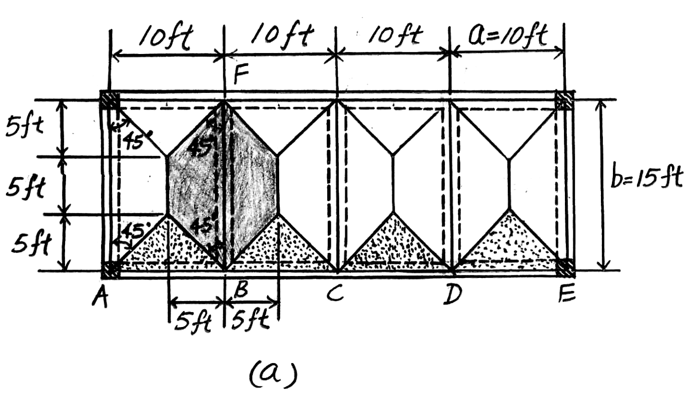
4 in thick reinforced stone concrete slab:

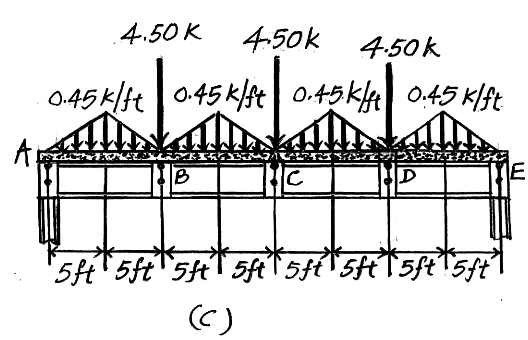
$$(0.15\text{ k/ft}^3)\left(\frac{4}{12}\text{ ft}\right)(5\text{ ft}) = 0.25\text{ k/ft}$$

Live load for classroom: $(0.04\text{ k/ft}^2)(5\text{ ft}) = \frac{0.20\text{ k/ft}}{0.45\text{ k/ft}}$ **Ans.**

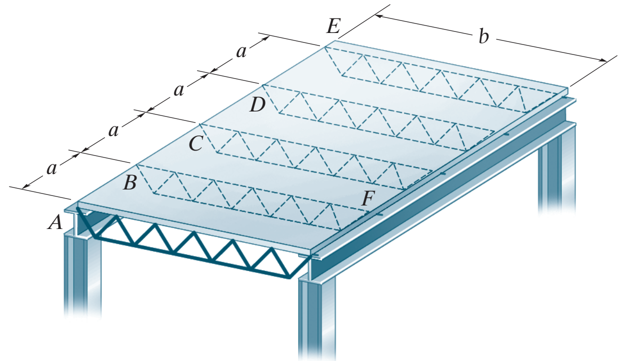
The loading diagram for the girder $ABCDE$ is shown in Fig. *c*.







2–5. Solve Prob. 2–3 with $a = 7.5$ ft, $b = 20$ ft.



Beam *BF*. Since $\frac{b}{a} = \frac{20\text{ ft}}{7.5\text{ ft}} = 2.7 > 2$, the concrete slab will behave as a one way slab. Thus, the tributary area for this beam is a rectangle shown in Fig. *a* and the intensity of the distributed load is

4 in thick reinforced stone concrete slab: $(0.15\text{ k/ft}^3)\left(\frac{4}{12}\text{ ft}\right)(7.5\text{ ft}) = 0.375\text{ k/ft}$

Live load from classroom: $(0.04\text{ k/ft}^2)(7.5\text{ ft}) = \underline{0.300\text{ k/ft}}$

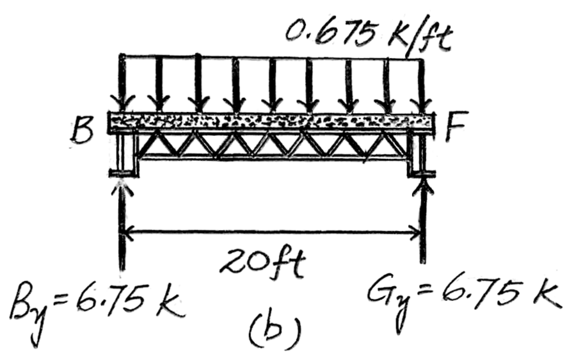
0.675 k/ft **Ans.**

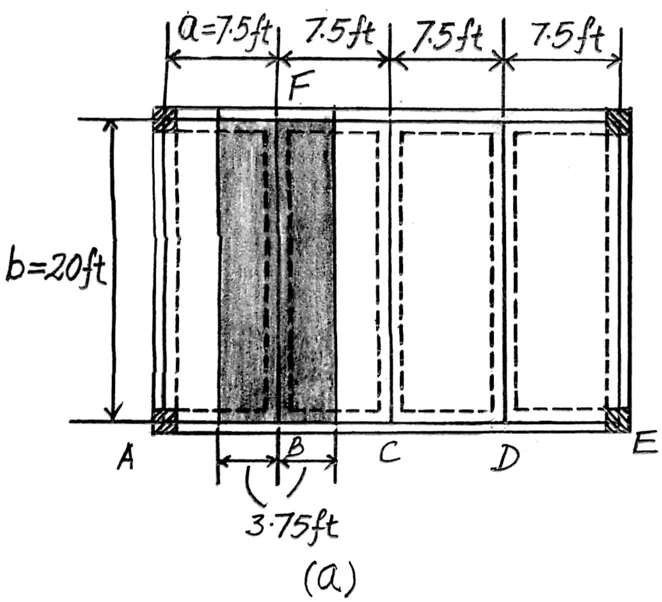
Due to symmetry, the vertical reactions at *B* and *F* are

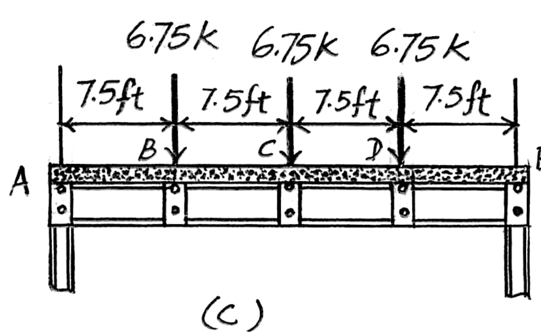
$$B_y = F_y = \frac{(0.675\text{ k/ft})(20\text{ ft})}{2} = 6.75\text{ k}$$ **Ans.**

The loading diagram for beam *BF* is shown in Fig. *b*.

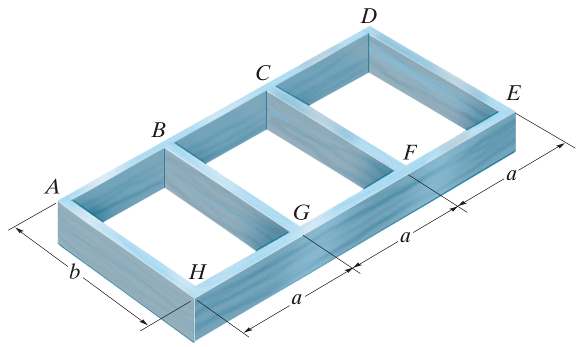
Beam *ABCD*. The loading diagram for this beam is shown in Fig. *c*.







2–6. The frame is used to support a 2-in.-thick plywood floor of a residential dwelling. Sketch the loading that acts along members *BG* and *ABCD*. Set $a = 5$ ft, $b = 15$ ft. *Hint*: See Tables 1–2 and 1–4.



Beam *BG*. Since $\frac{b}{a} = \frac{15\text{ ft}}{5\text{ ft}} = 3$, the plywood platform will behave as a one way slab. Thus, the tributary area for this beam is rectangular as shown in Fig. *a* and the intensity of the uniform distributed load is

2 in thick plywood platform: $\left(36\,\frac{\text{lb}}{\text{ft}^2}\right)\left(\frac{2}{12}\text{ ft}\right)(5\text{ft}) = 30\text{ lb/ft}$

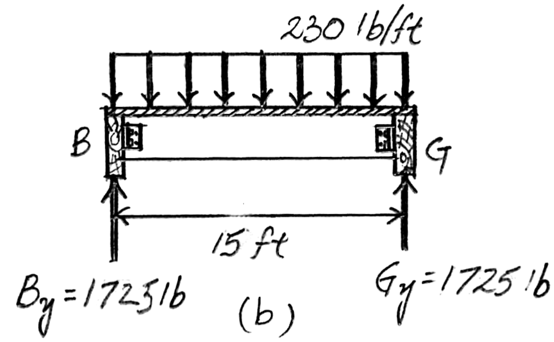
Line load for residential dweller: $\left(40\,\frac{\text{lb}}{\text{ft}^2}\right)(5\text{ ft}) = \dfrac{200\text{ lb/ft}}{230\text{ lb/ft}}$ **Ans.**

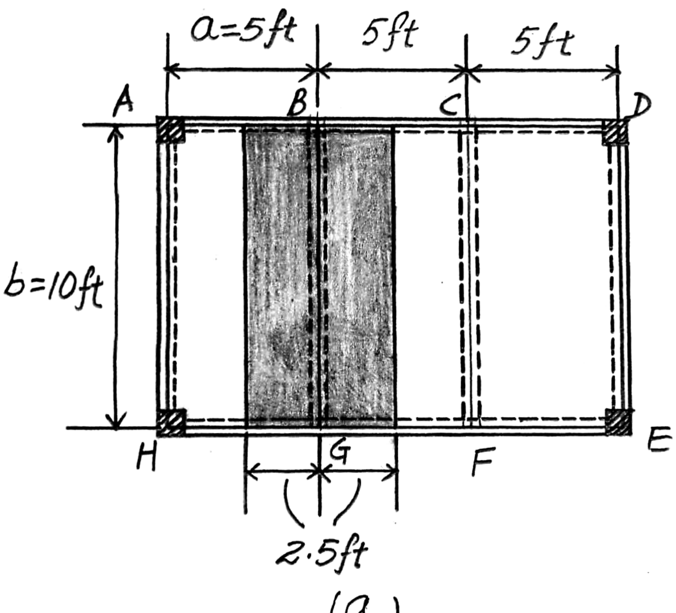
Due to symmetry, the vertical reactions at *B* and *G* are

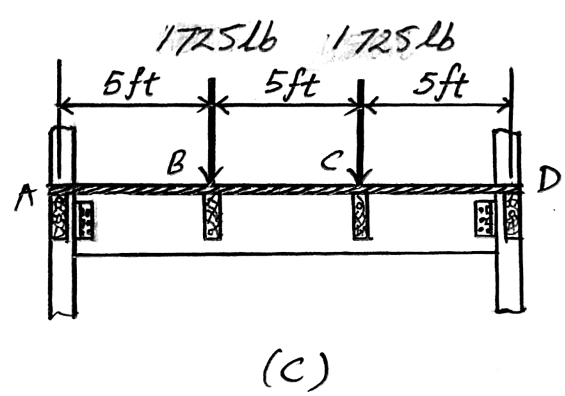
$B_y = G_y = \dfrac{(230\text{ lb/ft})(15\text{ ft})}{2} = 1725$ **Ans.**

The loading diagram for beam *BG* is shown in Fig. *a*.

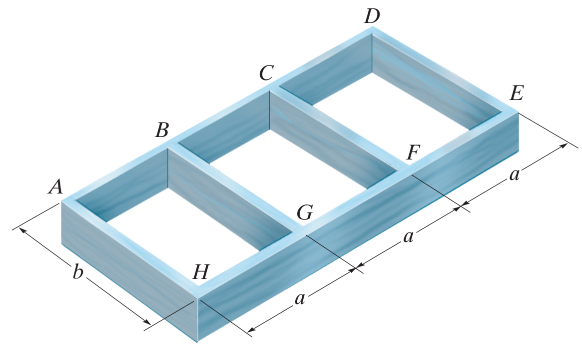
Beam *ABCD*. The loads that act on this beam are the vertical reactions of beams *BG* and *CF* at *B* and *C* which are $B_y = C_y = 1725$ lb. The loading diagram is shown in Fig. *c*.







2–7. Solve Prob. 2–6, with $a = 8$ ft, $b = 8$ ft.



Beam *BG*. Since $\frac{b}{a} = \frac{8\text{ ft}}{8\text{ ft}} = 1 < 2$, the plywood platform will behave as a two way slab. Thus, the tributary area for this beam is the shaded square area shown in Fig. *a* and the maximum intensity of the distributed load is

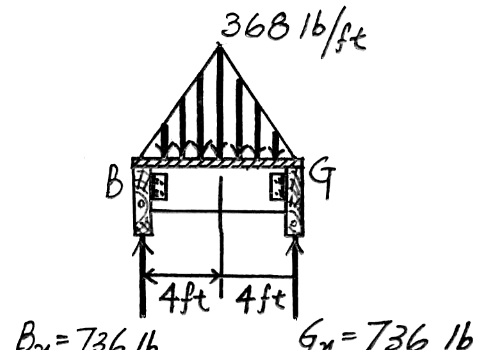
$$\text{2 in thick plywood platform: } (36\text{ lb/ft}^3)\left(\frac{2}{12}\text{ in}\right)(8\text{ ft}) = 48\text{ lb/ft}$$

$$\text{Live load for residential dwelling: } (40\text{ lb/ft})(8\text{ ft}) = \frac{320\text{ lb/ft}}{368\text{ lb/ft}}$$ **Ans.**

Due to symmetry, the vertical reactions at *B* and *G* are

$$B_y = G_y = \frac{\frac{1}{2}(368\text{ lb/ft})\,(8\text{ ft})}{2} = 736\text{ lb}$$ **Ans.**

The loading diagram for the beam *BG* is shown in Fig. *b*



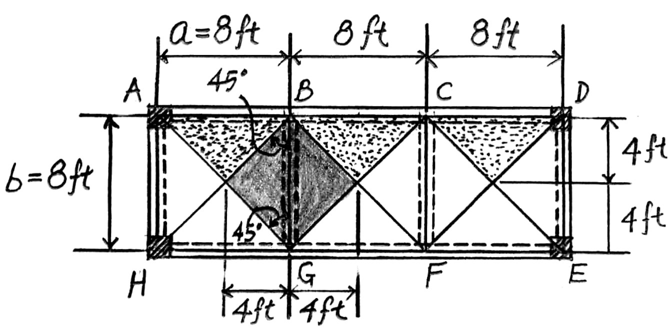
(b)

Beam *ABCD*. The loadings that are supported by this beam are the vertical reactions of beams *BG* and *CF* at *B* and *C* which are $B_y = C_y = 736$ lb and the distributed load which is the triangular area shown in Fig. *a*. Its maximum intensity is

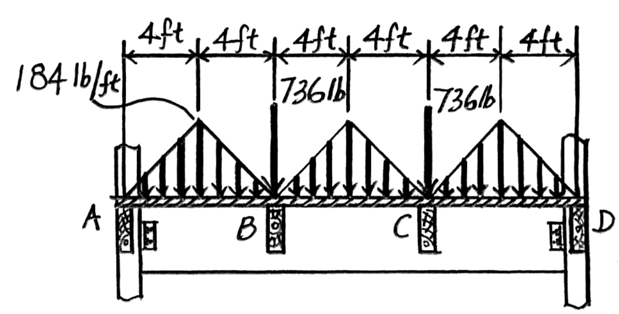
$$\text{2 in thick plywood platform: } (36\text{ lb/ft}^3)\left(\frac{2}{12\text{ ft}}\right)(4\text{ ft}) = 24\text{ lb/ft}$$

$$\text{Live load for residential dwelling: } (40\text{ lb/ft}^2)(4\text{ lb/ft}) = \frac{160\text{ lb/ft}}{184\text{ lb/ft}}$$ **Ans.**

The loading diagram for beam *ABCD* is shown in Fig. *c*.

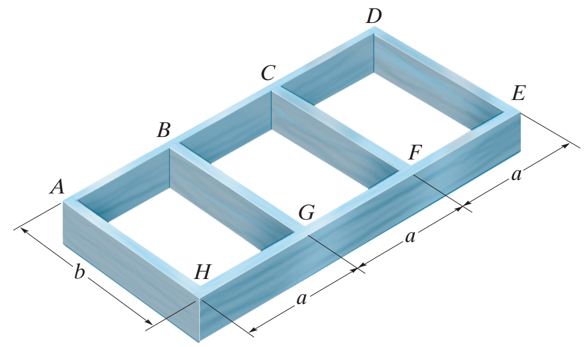


(a)



(c)

***2–8.** Solve Prob. 2–6, with $a = 9$ ft, $b = 15$ ft.



Beam *BG*. Since $\frac{b}{a} = \frac{15 \text{ ft}}{9 \text{ ft}} = 1.67 < 2$, the plywood platform will behave as a two way slab. Thus, the tributary area for this beam is the octagonal area shown in Fig. *a* and the maximum intensity of the distributed load is

$$\text{2 in thick plywood platform: } (36 \text{ lb/ft}^3)\left(\frac{2}{12} \text{ in}\right)(9 \text{ ft}) = 54 \text{ lb/ft}$$

$$\text{Live load for residential dwelling: } (40 \text{ lb/ft}^2)(9 \text{ ft}) = \frac{360 \text{ lb/ft}}{414 \text{ lb/ft}}$$ **Ans.**

Due to symmetry, the vertical reactions at B and G are

$$B_y = G_y = \frac{2\left[\frac{1}{2}(414 \text{ lb/ft})(4.5 \text{ ft})\right] + (414 \text{ lb/ft})(6 \text{ ft})}{2} = 2173.5 \text{ lb}$$

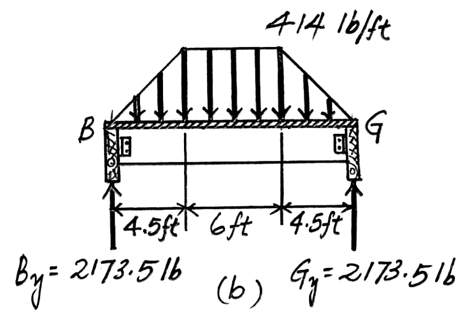
The loading diagram for beam BG is shown in Fig. *b*.

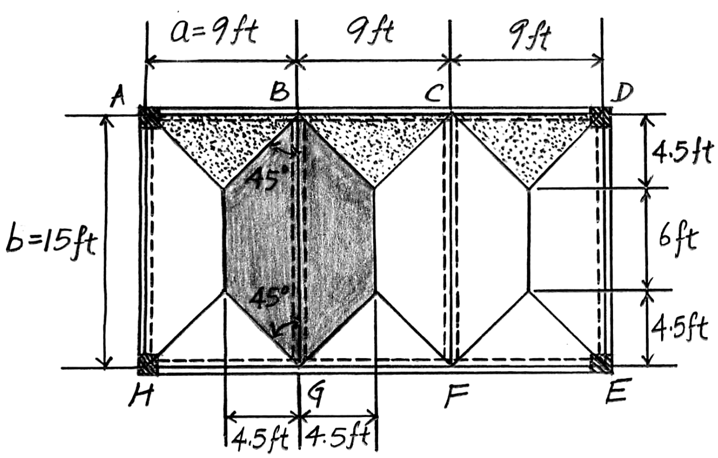
Beam *ABCD*. The loading that is supported by this beam are the vertical reactions of beams BG and CF at B and C which is $B_y = C_y = 2173.5$ lb and the triangular distributed load shown in Fig. *a*. Its maximum intensity is

$$\text{2 in thick plywood platform: } (36 \text{ lb/ft}^3)\left(\frac{2}{12} \text{ ft}\right)(4.5 \text{ ft}) = 27 \text{ lb/ft}$$

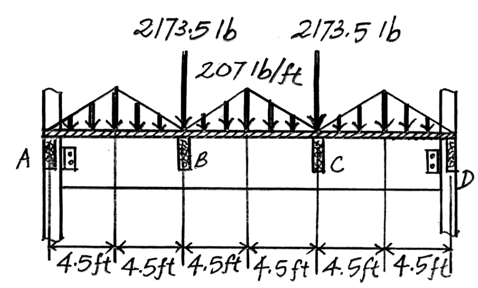
$$\text{Live load for residential dwelling: } (40 \text{ lb/ft}^2)(4.5 \text{ ft}) = \frac{180 \text{ lb/ft}}{207 \text{ lb/ft}}$$ **Ans.**

The loading diagram for beam $ABCD$ is shown in Fig. *c*.



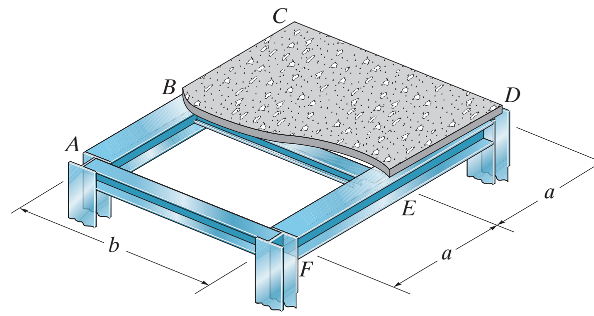


(a)



(c)

2–9. The steel framework is used to support the 4-in. reinforced stone concrete slab that carries a uniform live loading of 500 lb/ft^2. Sketch the loading that acts along members *BE* and *FED*. Set $b = 10$ ft, $a = 7.5$ ft. *Hint*: See Table 1–2.



Beam *BE*. Since $\dfrac{b}{a} = \dfrac{10}{7.5} < 2$, the concrete slab will behave as a two way slab. Thus, the tributary area for this beam is the octagonal area shown in Fig. *a* and the maximum intensity of the distributed load is

$$\text{4 in thick reinforced stone concrete slab: } (0.15 \text{ k/ft}^3)\left(\frac{4}{12}\text{ ft}\right)(7.5 \text{ ft}) = 0.375 \text{ k/ft}$$

$$\text{Floor Live Load: } (0.5 \text{ k/ft}^2)(7.5 \text{ ft}) = \frac{3.75 \text{ k/ft}}{4.125 \text{ k/ft}} \qquad \textbf{Ans.}$$

Due to symmetry, the vertical reactions at *B* and *E* are

$$B_y = E_y = \frac{2\left[\frac{1}{2}(4.125 \text{ k/ft})(3.75 \text{ ft})\right] + (4.125 \text{ k/ft})(2.5 \text{ ft})}{2} = 12.89 \text{ k}$$

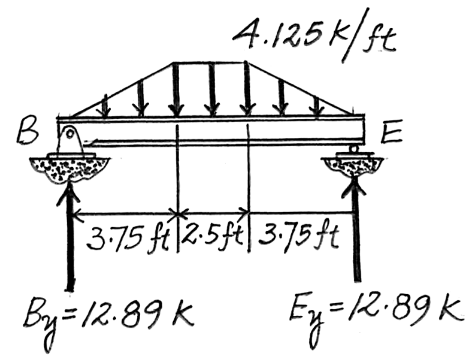
The loading diagram for this beam is shown in Fig. *b*.

Beam *FED*. The loadings that are supported by this beam are the vertical reaction of beam *BE* at *E* which is $E_y = 12.89$ k and the triangular distributed load shown in Fig. *a*. Its maximum intensity is

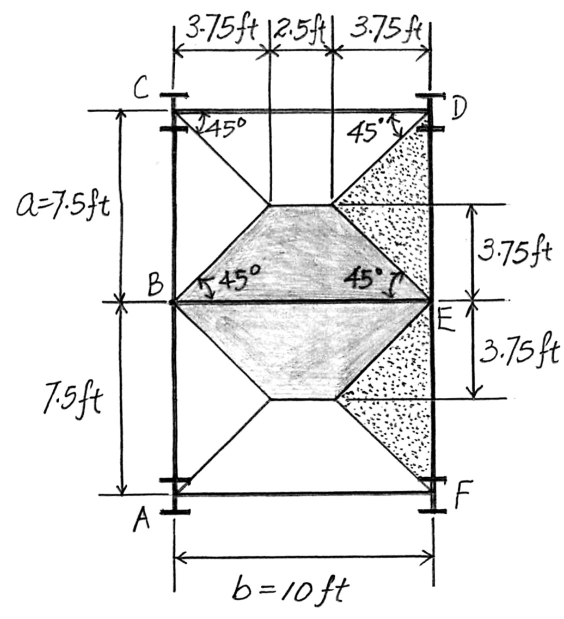
$$\text{4 in thick reinforced stone concrete slab: } (0.15 \text{ k/ft}^3)\left(\frac{4}{12}\text{ ft}\right)(3.75 \text{ ft}) = 0.1875 \text{ k/ft}$$

$$\text{Floor live load: } (0.5 \text{ k/ft}^2)(3.75 \text{ ft}) = \frac{1.875 \text{ k/ft}}{2.06 \text{ k/ft}} \qquad \textbf{Ans.}$$

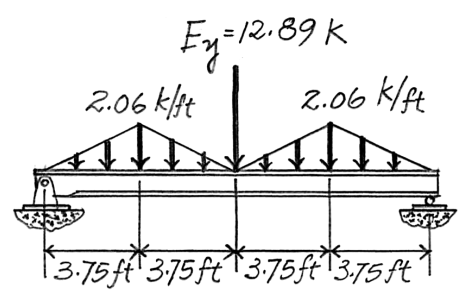
The loading diagram for this beam is shown in Fig. *c*.



(b)

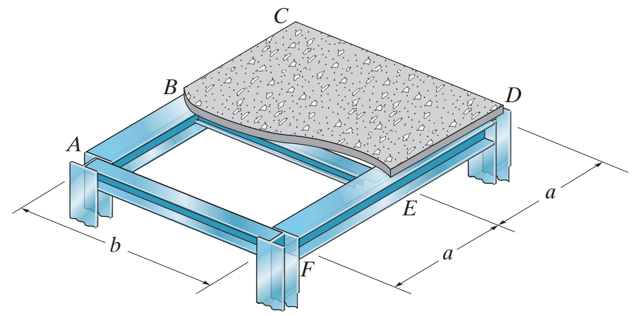


(a)



(c)

2–10. Solve Prob. 2–9, with $b = 12$ ft, $a = 4$ ft.



Beam *BE*. Since $\frac{b}{a} = \frac{12}{4} = 3 > 2$, the concrete slab will behave as a one way slab. Thus, the tributary area for this beam is the rectangular area shown in Fig. *a* and the intensity of the distributed load is

4 in thick reinforced stone concrete slab: $(0.15 \text{ k/ft}^2)\left(\frac{4}{12} \text{ ft}\right)(4 \text{ ft}) = 0.20 \text{ k/ft}$

Floor Live load: $(0.5 \text{ k/ft}^2)(4 \text{ ft}) = \dfrac{2.00 \text{ k/ft}}{2.20 \text{ k/ft}}$ **Ans.**

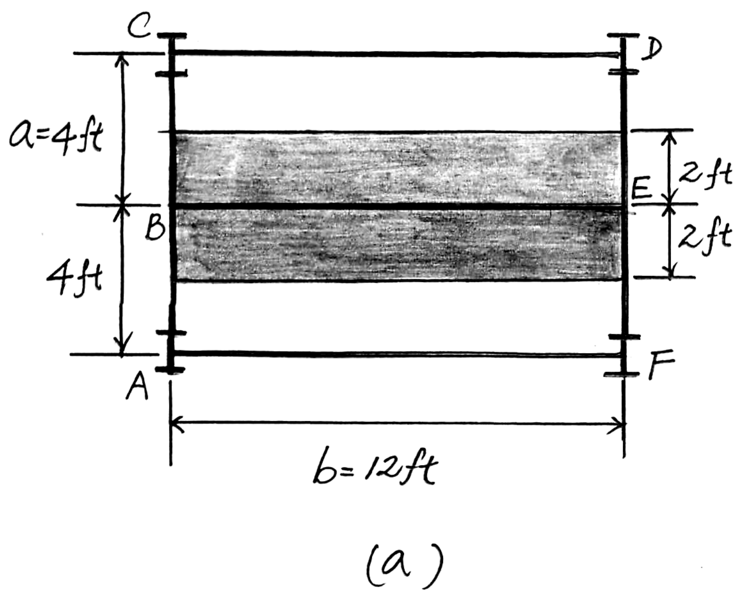
Due to symmetry, the vertical reactions at B and E are

$$B_y = E_y = \frac{(2.20 \text{ k/ft})(12 \text{ ft})}{2} = 13.2 \text{ k}$$

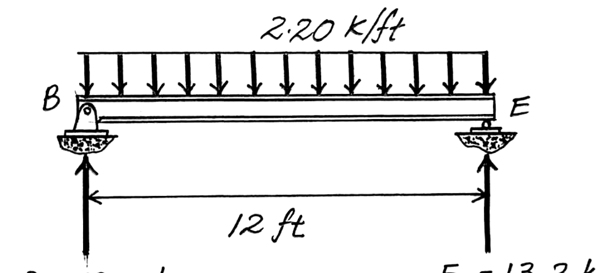
The loading diagram of this beam is shown in Fig. *b*.

Beam *FED*. The only load this beam supports is the vertical reaction of beam BE at E which is $E_y = 13.2$ k. **Ans.**

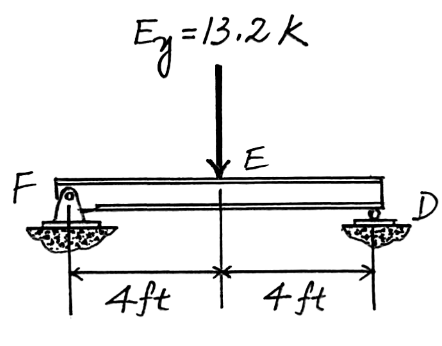
The loading diagram is shown in Fig. *c*.



(a)

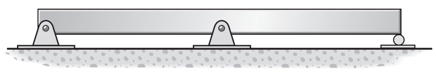


(b)

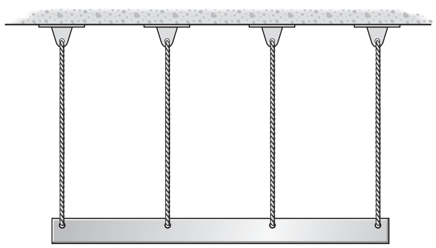


(c)

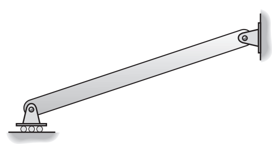
2–11. Classify each of the structures as statically determinate, statically indeterminate, or unstable. If indeterminate, specify the degree of indeterminacy. The supports or connections are to be assumed as stated.



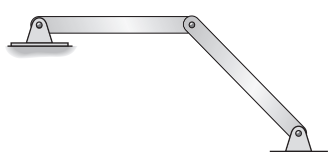
(a)



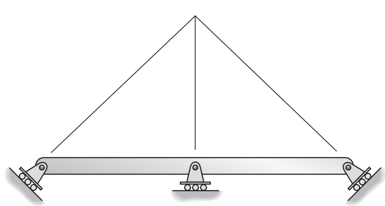
(b)



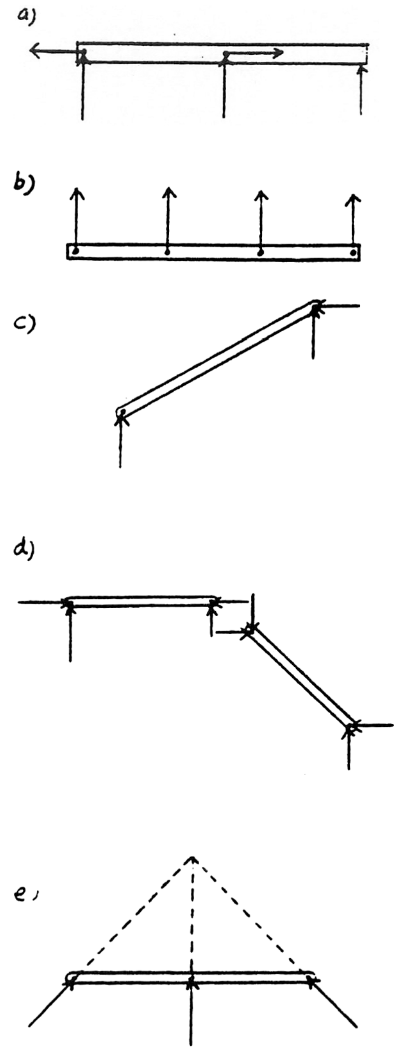
(c)



(d)



(e)



(a) $r = 5 \qquad 3n = 3(1) < 5$
Indeterminate to 2°. **Ans.**

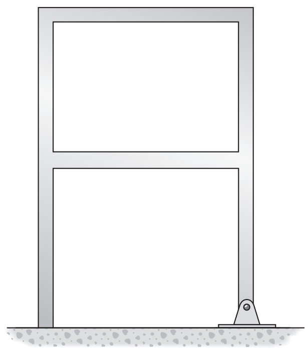
(b) Parallel reactions
Unstable. **Ans.**

(c) $r = 3 \qquad 3n = 3(1) < 3$
Statically determinate. **Ans.**

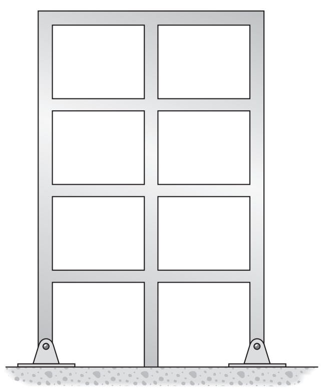
(d) $r = 6 \qquad 3n = 3(2) < 6$
Statically determinate. **Ans.**

(e) Concurrent reactions
Unstable. **Ans.**

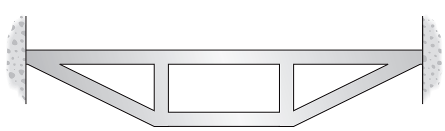
***2–12.** Classify each of the frames as statically determinate or indeterminate. If indeterminate, specify the degree of indeterminacy. All internal joints are fixed connected.



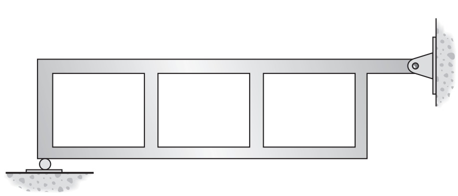
(a)



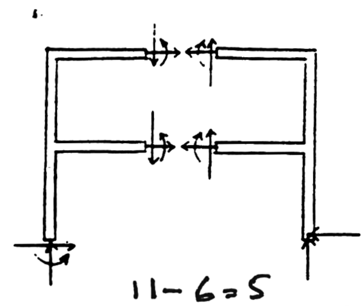
(b)

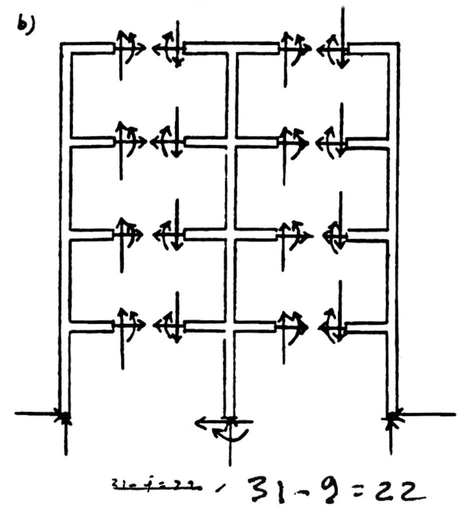


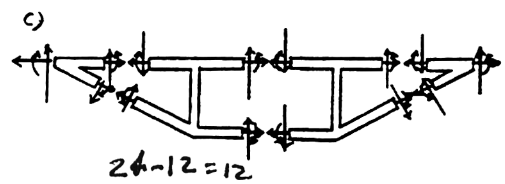
(c)

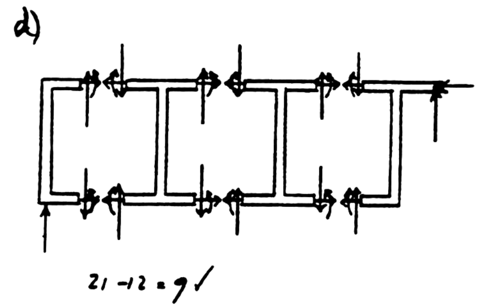


(d)









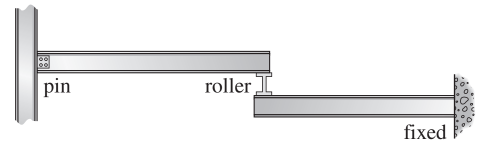
(a) Statically indeterminate to 5°. **Ans.**

(b) Statically indeterminate to 22°. **Ans.**

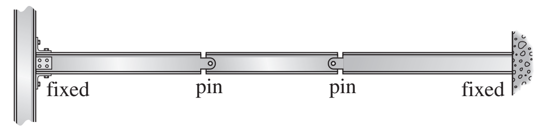
(c) Statically indeterminate to 12°. **Ans.**

(d) Statically indeterminate to 9°. **Ans.**

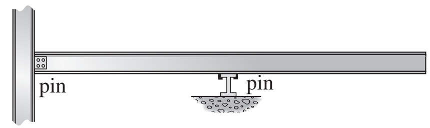
2–13. Classify each of the structures as statically determinate, statically indeterminate, stable, or unstable. If indeterminate, specify the degree of indeterminacy. The supports or connections are to be assumed as stated.



(a)



(b)

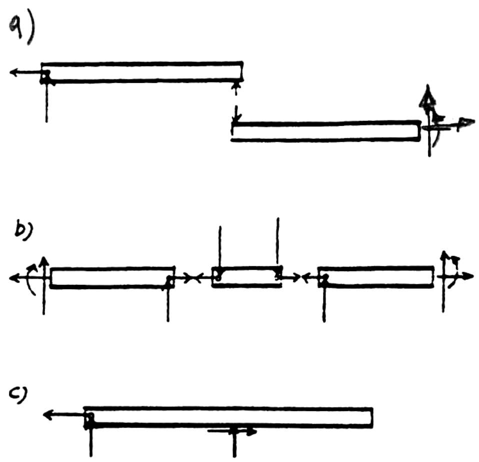


(c)

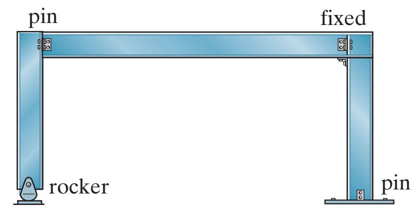
(a) $r = 6 \qquad 3n = 3(2) = 6$
Statically determinate. **Ans.**

(b) $r = 10 \qquad 3n = 3(3) < 10$
Statically indeterminate to 1°. **Ans.**

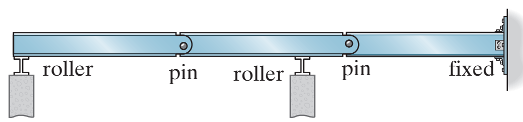
(c) $r = 4 \qquad 3n = 3(1) < 4$
Statically determinate to 1°. **Ans.**



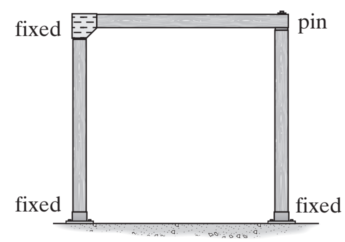
2–14. Classify each of the structures as statically determinate, statically indeterminate, stable, or unstable. If indeterminate, specify the degree of indeterminacy. The supports or connections are to be assumed as stated.



(a)



(b)



(c)

(a) $r = 5 \qquad 3n = 3(2) = 6$

$r < 3n$

Unstable.

(b) $r = 9 \qquad 3n = 3(3) = 9$

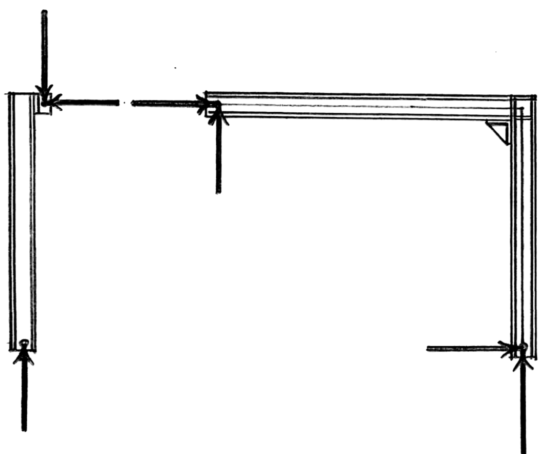
$r = 3n$

Stable and statically determinate.

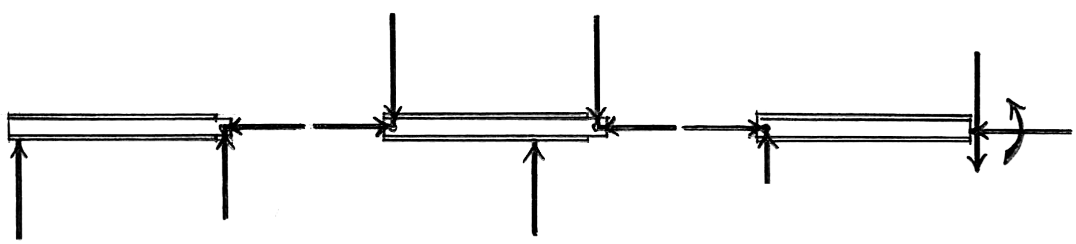
(c) $r = 8 \qquad 3n = 3(2) = 6$

$r - 3n = 8 - 6 = 2$

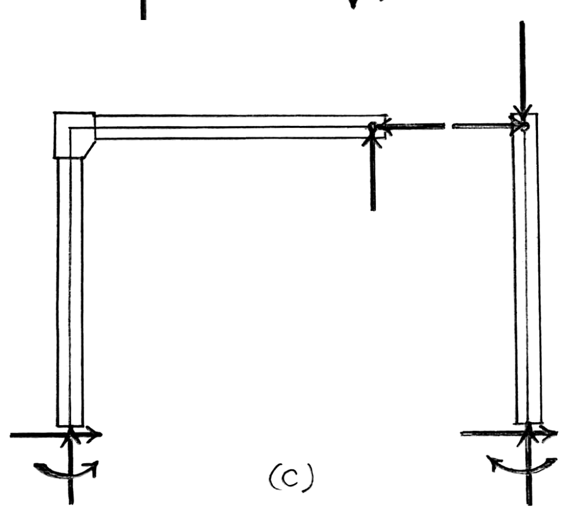
Stable and statically indeterminate to the second degree.



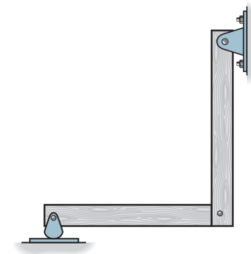
(a)



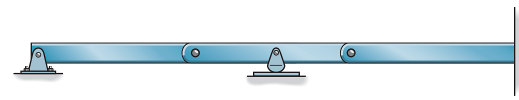
(b)



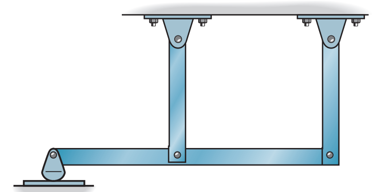
2–15. Classify each of the structures as statically determinate, statically indeterminate, or unstable. If indeterminate, specify the degree of indeterminacy.



(a)



(b)



(c)

(a) $r = 5 \qquad 3n = 3(2) = 6$

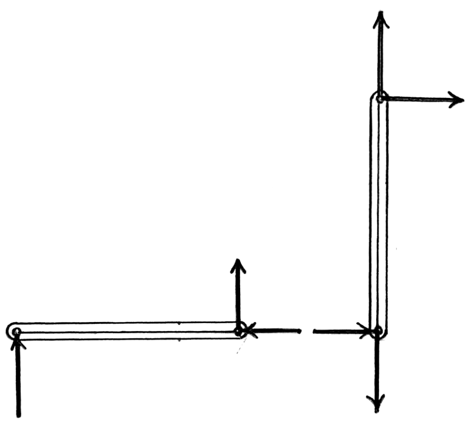
$r < 3n$

Unstable.

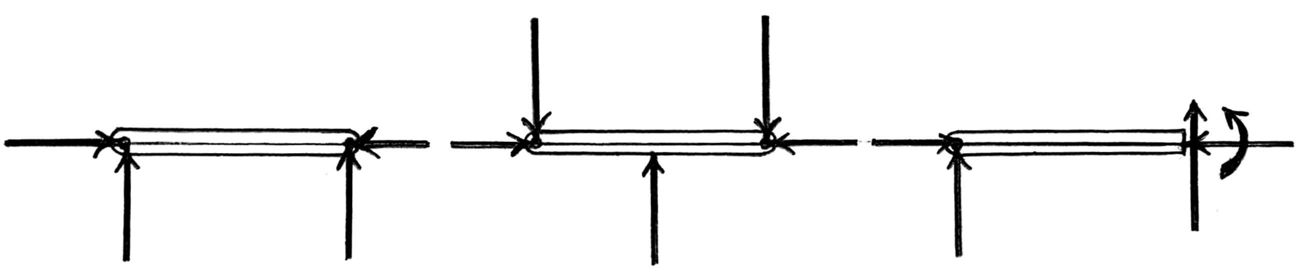
(b) $r = 10 \qquad 3n = 3(3) = 9$ and $r - 3n = 10 - 9 = 1$

Stable and statically indeterminate to first degree.

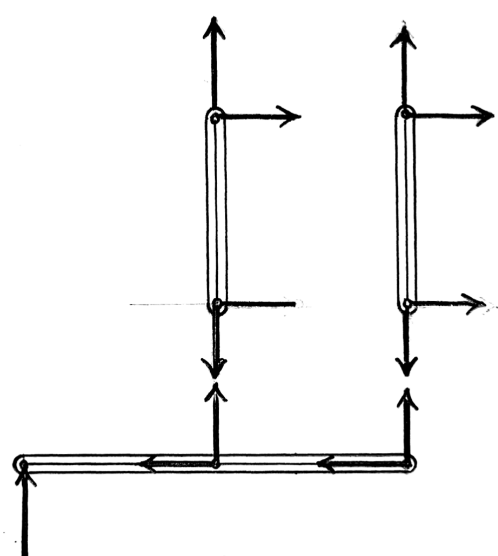
(c) Since the rocker on the horizontal member can not resist a horizontal force component, the structure is unstable.



(a)



(b)



(c)

***2–16.** Classify each of the structures as statically determinate, statically indeterminate, or unstable. If indeterminate, specify the degree of indeterminacy.

(a) $r = 6 \qquad 3n = 3(1) = 3$

$r - 3n = 6 - 3 = 3$

Stable and statically indeterminate to the third degree.

(b) $r = 4 \qquad 3n = 3(1) = 3$

$r - 3n = 4 - 3 = 1$

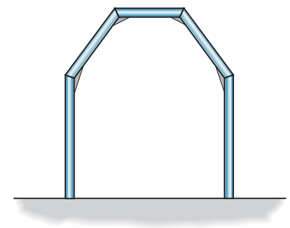
Stable and statically indeterminate to the first degree.

(c) $r = 3 \qquad 3n = 3(1) = 3 \qquad r = 3n$

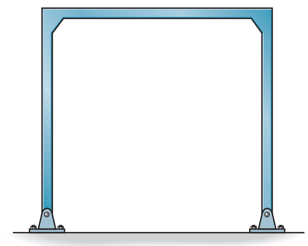
Stable and statically determinate.

(d) $r = 6 \qquad 3n = 3(2) = 6 \qquad r = 3n$

Stable and statically determinate.

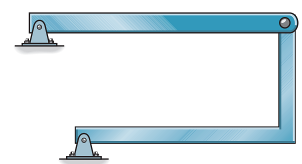


(a)

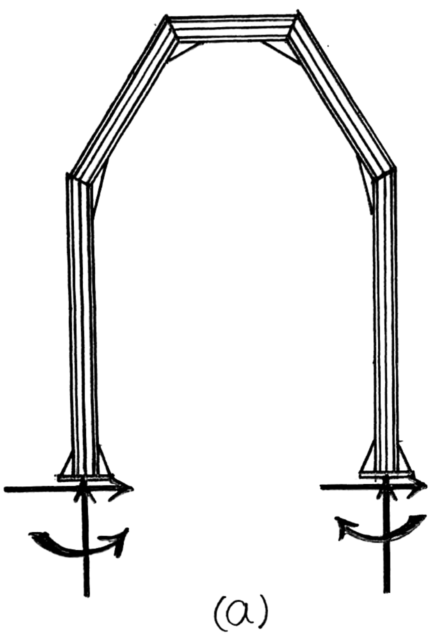


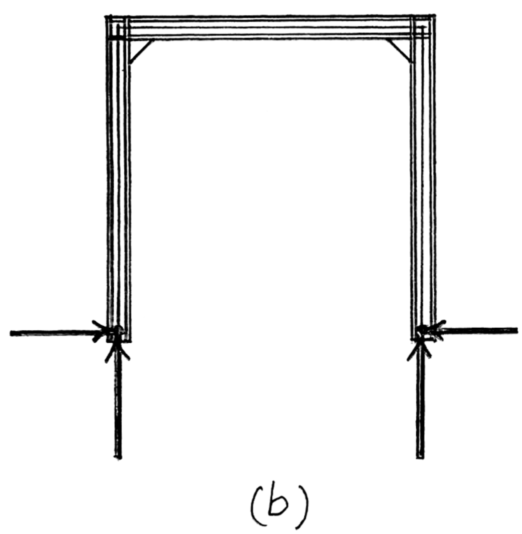
(b)

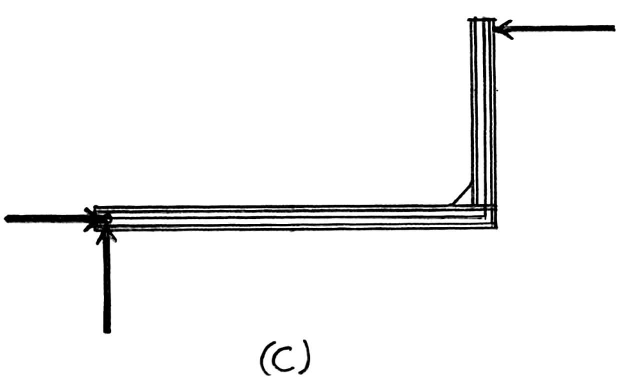
(c)

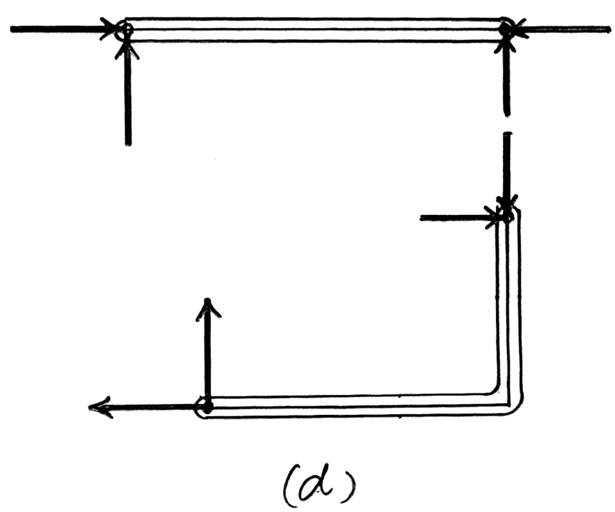


(d)

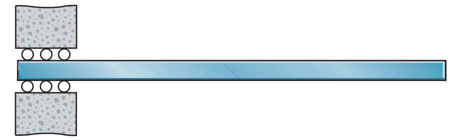




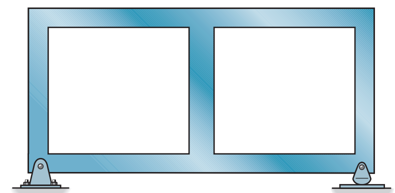




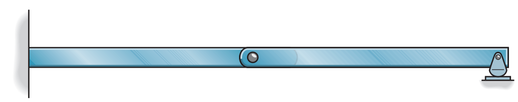
2–17. Classify each of the structures as statically determinate, statically indeterminate, stable, or unstable. If indeterminate, specify the degree of indeterminacy.



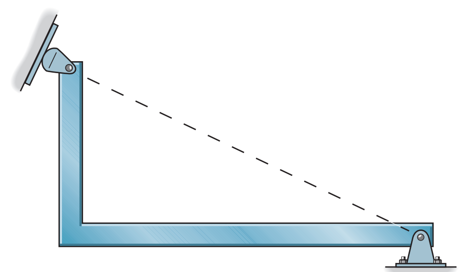
(a)



(b)



(c)



(d)

(a) $r = 2 \qquad 3n = 3(1) = 3 \qquad r < 3n$

Unstable.

(b) $r = 12 \qquad 3n = 3(2) = 6 \qquad r > 3n$

$r - 3n = 12 - 6 = 6$

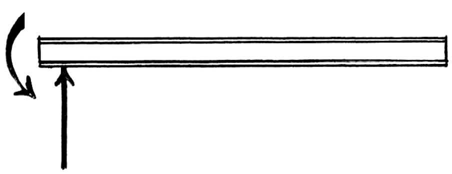
Stable and statically indeterminate to the sixth degree.

(c) $r = 6 \qquad 3n = 3(2) = 6$

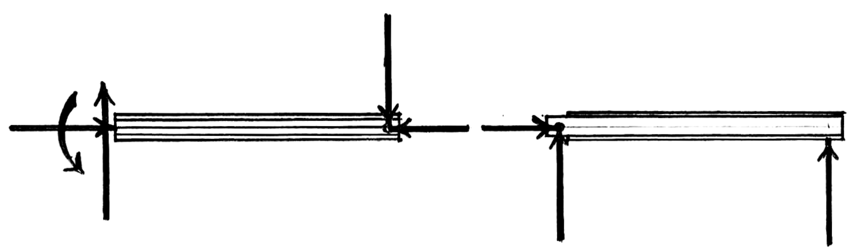
$r = 3n$

Stable and statically determinate.

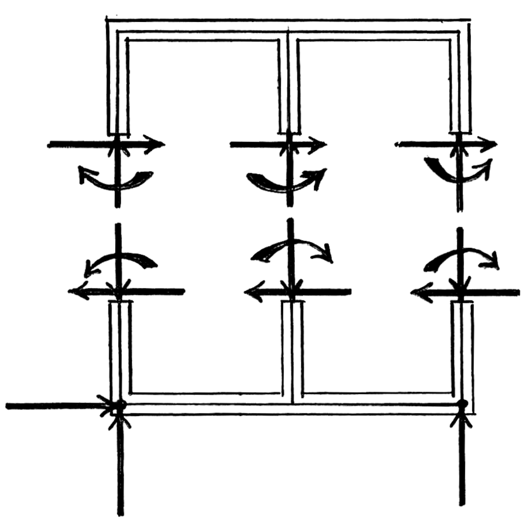
(d) Unstable since the lines of action of the reactive force components are concurrent.



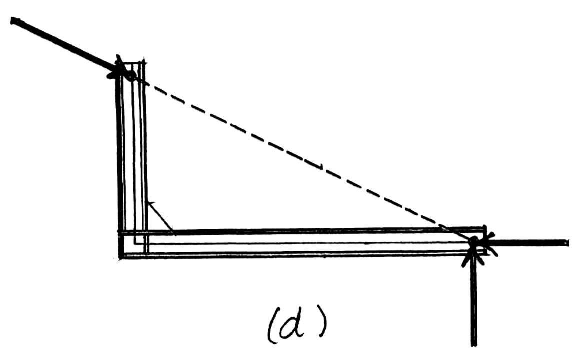
(a)



(c)

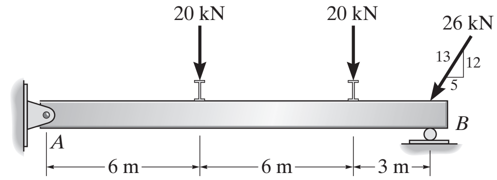


(b)



(d)

2–18. Determine the reactions on the beam. Neglect the thickness of the beam.



$\circlearrowleft + \sum M_A = 0; \quad B_y(15) - 20(6) - 20(12) - 26\left(\frac{12}{13}\right)(15) = 0$

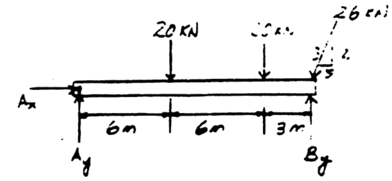
$B_y = 48.0 \text{ kN}$ **Ans.**

$+\uparrow \sum F_y = 0; \quad A_y + 48.0 - 20 - 20 - \frac{12}{13}(26) = 0$

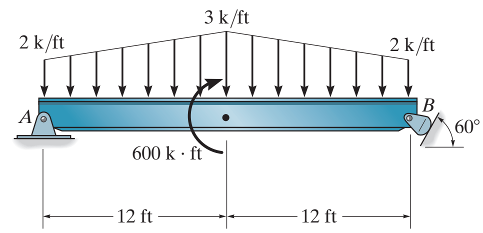
$A_y = 16.0 \text{ kN}$ **Ans.**

$\overset{+}{\rightarrow} \sum F_x = 0; \quad A_x - \left(\frac{5}{13}\right)26 = 0$

$A_x = 10.0 \text{ kN}$ **Ans.**



2–19. Determine the reactions on the beam.



$\circlearrowleft + \sum M_A = 0; \quad -60(12) - 600 + F_B \cos 60° (24) = 0$

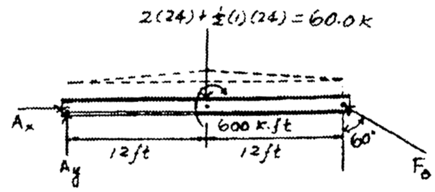
$F_B = 110.00 \text{ k} = 110 \text{ k}$ **Ans.**

$\overset{+}{\rightarrow} \sum F_x = 0; \quad A_x = 110.00 \sin 60° = 0$

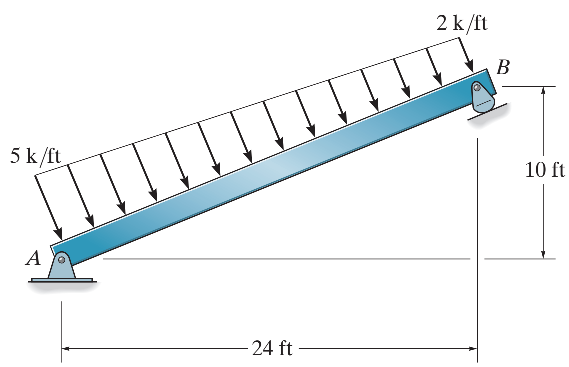
$A_x = 95.3 \text{ k}$ **Ans.**

$+\uparrow \sum F_y = 0; \quad A_y = 110.00 \cos 60° - 60 = 0$

$A_y = 5.00 \text{ k}$ **Ans.**



***2–20.** Determine the reactions on the beam.



$\circlearrowleft + \sum M_A = 0; \quad F_B(26) - 52(13) - 39\left(\frac{1}{3}\right)(26) = 0$

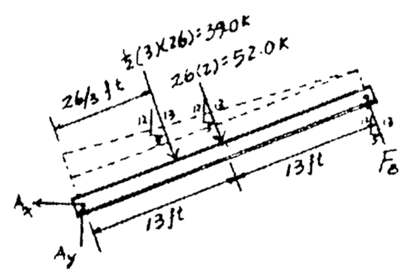
$F_B = 39.0 \text{ k}$ **Ans.**

$+\uparrow \sum Fy = 0; \quad A_y - \frac{12}{13}(39) - \left(\frac{12}{13}\right)52 + \left(\frac{12}{13}\right)(39.0) = 0$

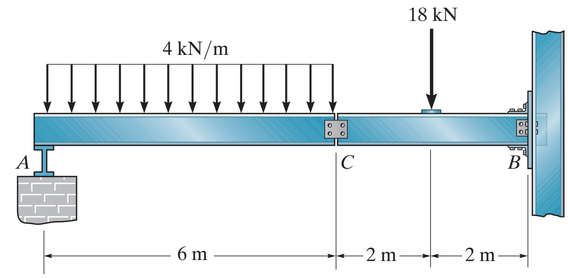
$A_y = 48.0 \text{ k}$ **Ans.**

$\overset{+}{\rightarrow} \sum F_x = 0; \quad -A_x + \left(\frac{5}{13}\right)39 + \left(\frac{5}{13}\right)52 - \left(\frac{5}{13}\right)39.0 = 0$

$A_x = 20.0 \text{ k}$ **Ans.**



2–21. Determine the reactions at the supports A and B of the compound beam. Assume there is a pin at C.



Equations of Equilibrium: First consider the FBD of segment AC in Fig. a. N_A and C_y can be determined directly by writing the moment equations of equilibrium about C and A respectively.

$\circlearrowleft + \sum M_C = 0; \quad 4(6)(3) - N_A(6) = 0 \quad N_A = 12 \text{ kN}$ **Ans.**

$\circlearrowleft + \sum M_A = 0; \quad C_y(6) - 4(6)(3) = 0 \quad C_y = 12 \text{ kN}$ **Ans.**

Then,

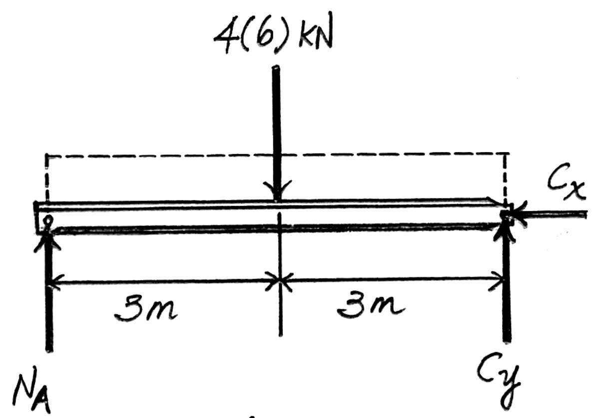
$\overset{+}{\rightarrow} \sum F_x = 0; \quad 0 - C_x = 0 \quad C_x = 0$

Using the FBD of segment CB, Fig. b,

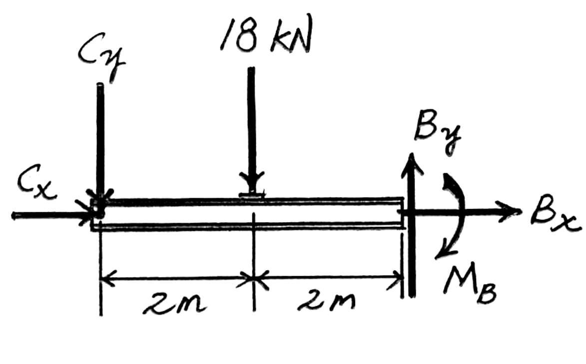
$\overset{+}{\rightarrow} \sum F_x = 0; \quad 0 + B_x = 0 \quad B_x = 0$ **Ans.**

$+\uparrow \sum F_y = 0; \quad B_y - 12 - 18 = 0 \quad B_y = 30 \text{ kN}$ **Ans.**

$\circlearrowleft + \sum M_B = 0; \quad 12(4) + 18(2) - M_B = 0 \quad M_B = 84 \text{ kN} \cdot \text{m}$ **Ans.**

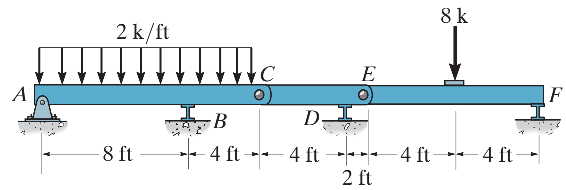


(a)



(b)

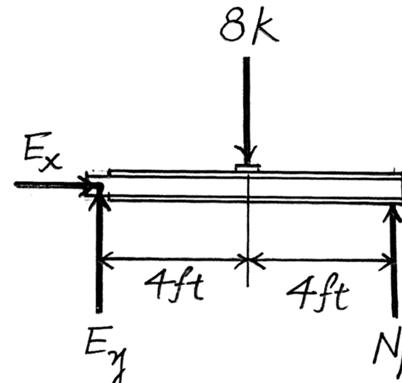
2–22. Determine the reactions at the supports A, B, D, and F.



Equations of Equilibrium: First consider the FBD of segment EF in Fig. a. N_F and E_y can be determined directly by writing the moment equations of equilibrium about E and F respectively.

$\circlearrowleft + \sum M_E = 0; \quad N_F - (8) - 8(4) = 0 \quad N_F = 4.00 \text{ k}$ **Ans.**

$\circlearrowleft + \sum M_F = 0; \quad 8(4) - E_y(8) = 0 \quad E_y = 4.00 \text{ k}$



(a)

Then

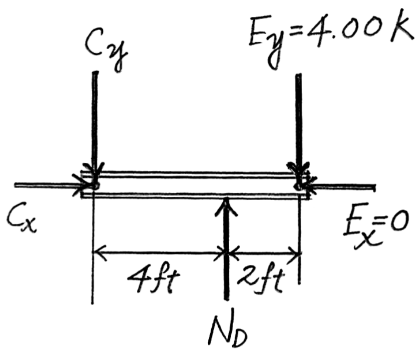
$\overset{+}{\rightarrow} \sum F_x = 0; \quad E_x = 0$

Consider the FBD of segment CDE, Fig. b,

$\overset{+}{\rightarrow} \sum F_x = 0; \quad C_x - 0 = 0 \quad C_x = 0$

$\circlearrowleft + \sum M_C = 0; \quad N_P(4) - 4.00(6) = 0 \quad N_D = 6.00 \text{ k}$ **Ans.**

$\circlearrowleft + \sum M_D = 0; \quad C_y(4) - 4.00(2) = 0 \quad C_y = 2.00 \text{ k}$



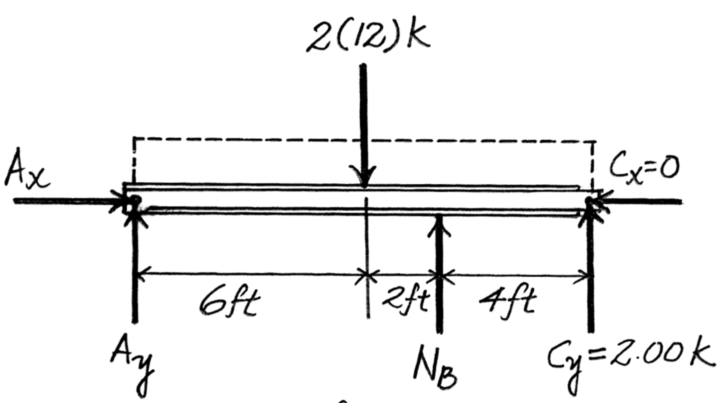
(b)

Now consider the FBD of segment ABC, Fig. c.

$\circlearrowleft + \sum M_A = 0; \quad N_B(8) + 2.00(12) - 2(12)(6) = 0 \quad N_B = 15.0 \text{ k}$ **Ans.**

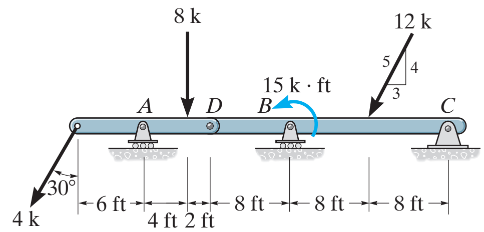
$\circlearrowleft + \sum M_B = 0; \quad 2(12)(2) + 2.00(4) - A_y(8) = 0 \quad A_y = 7.00 \text{ k}$ **Ans.**

$\overset{+}{\rightarrow} \sum F_x = 0; \quad A_x - 0 = 0 \quad A_x = 0$ **Ans.**



(c)

2–23. The compound beam is pin supported at C and supported by a roller at A and B. There is a hinge (pin) at D. Determine the reactions at the supports. Neglect the thickness of the beam.



Equations of Equilibrium: Consider the FBD of segment AD, Fig. a.

$$\overset{+}{\rightarrow}\sum F_x = 0; \quad D_x - 4\sin 30^\circ = 0 \quad D_x = 2.00 \text{ k}$$

$$\zeta + \sum M_D = 0; \quad 8(2) + 4\cos 30^\circ(12) - N_A(6) = 0 \quad N_A = 9.59 \text{ k} \qquad \textbf{Ans.}$$

$$\zeta + \sum M_A = 0; \quad D_y(6) + 4\cos 30^\circ(6) - 8(4) = 0 \quad D_y = 1.869 \text{ k}$$

Now consider the FBD of segment DBC shown in Fig. b,

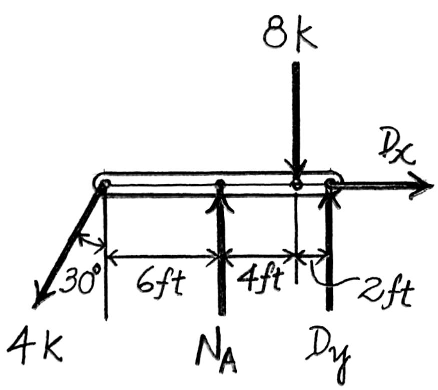
$$\overset{+}{\rightarrow}\sum F_x = 0; \quad C_x - 2.00 - 12\left(\frac{3}{5}\right) = 0 \quad C_x = 9.20 \text{ k} \qquad \textbf{Ans.}$$

$$\zeta + \sum M_C = 0; \quad 1.869(24) + 15 + 12\left(\frac{4}{5}\right)(8) - N_B(16) = 0$$

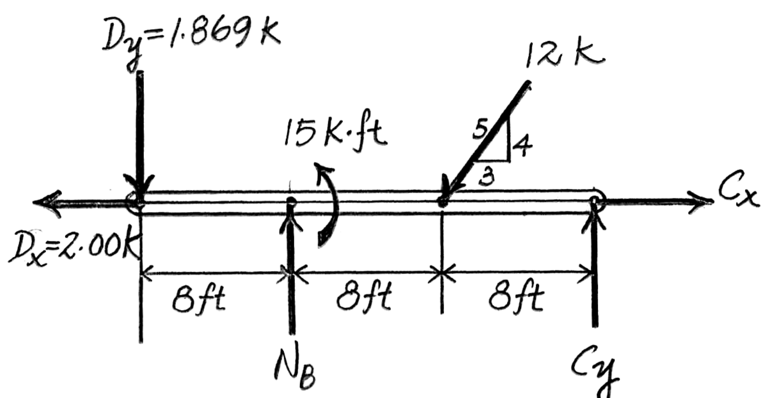
$$N_B = 8.54 \text{ k} \qquad \textbf{Ans.}$$

$$\zeta + \sum M_B = 0; \quad 1.869(8) + 15 - 12\left(\frac{4}{5}\right)(8) - C_y(16) = 0$$

$$C_y = 2.93 \text{ k} \qquad \textbf{Ans.}$$

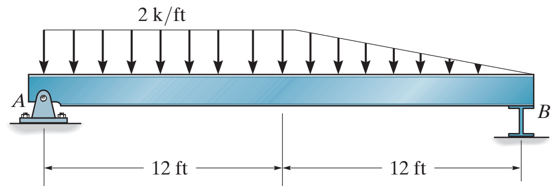


(a)



(b)

***2–24.** Determine the reactions on the beam. The support at B can be assumed to be a roller.

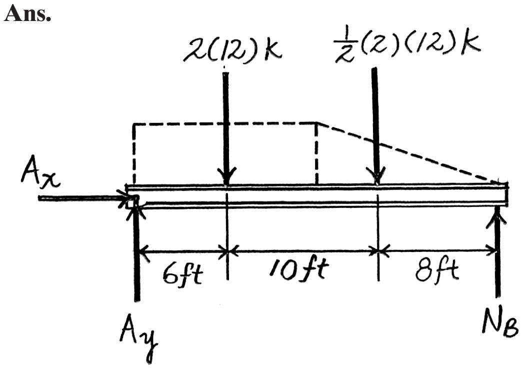


Equations of Equilibrium:

$$\circlearrowleft + \sum M_A = 0; \quad N_B(24) - 2(12)(6) - \frac{1}{2}(2)(12)(16) = 0 \qquad N_B = 14.0 \text{ k} \quad \textbf{Ans.}$$

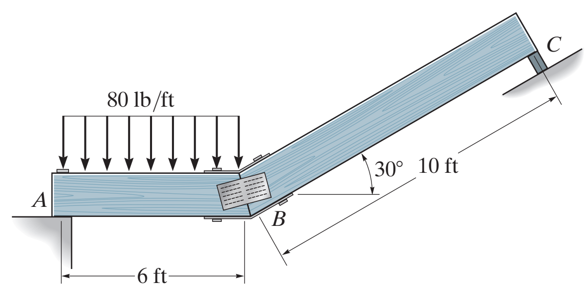
$$\circlearrowleft + \sum M_B = 0; \quad \frac{1}{2}(2)(12)(8) + 2(12)(18) - A_y(24) = 0 \qquad A_y = 22.0 \text{ k} \quad \textbf{Ans.}$$

$$\overset{+}{\rightarrow} \sum F_x = 0; \quad A_x = 0 \qquad \textbf{Ans.}$$



(a)

2–25. Determine the reactions at the smooth support C and pinned support A. Assume the connection at B is fixed connected.



$$\circlearrowleft + \sum M_A = 0; \quad C_y(10 + 6 \sin 60°) - 480(3) = 0$$

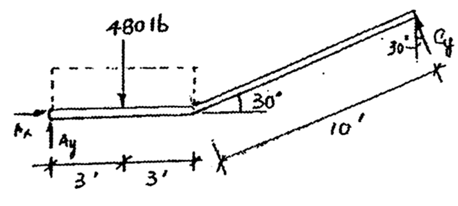
$$C_y = 94.76 \text{ lb} = 94.8 \text{ lb} \qquad \textbf{Ans.}$$

$$\overset{+}{\rightarrow} \sum F_x = 0; \quad A_x - 94.76 \sin 30° = 0$$

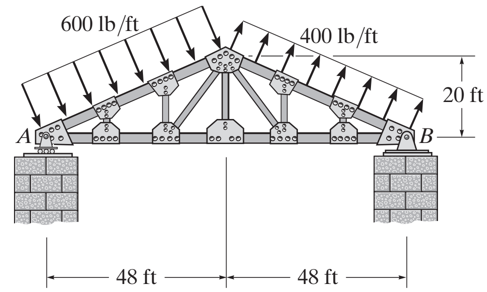
$$A_y = 47.4 \text{ lb} \qquad \textbf{Ans.}$$

$$+\uparrow \sum F_y = 0; \quad A_y + 94.76 \cos 30° - 480 = 0$$

$$A_y = 398 \text{ lb} \qquad \textbf{Ans.}$$



2–26. Determine the reactions at the truss supports A and B. The distributed loading is caused by wind.



$$\circlearrowleft + \sum M_A = 0; \quad B_y(96) + \left(\frac{12}{13}\right)20.8(72) - \left(\frac{5}{13}\right)20.8(10)$$

$$-\left(\frac{12}{13}\right)31.2(24) - \left(\frac{5}{13}\right)31.2(10) = 0$$

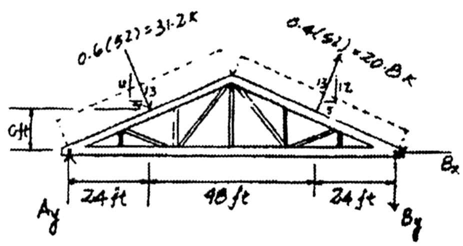
$B_y = 5.117 \text{ kN} = 5.12 \text{ kN}$ **Ans.**

$$+\uparrow \sum F_y = 0; \quad A_y - 5.117 + \left(\frac{12}{13}\right)20.8 - \left(\frac{12}{13}\right)31.2 = 0$$

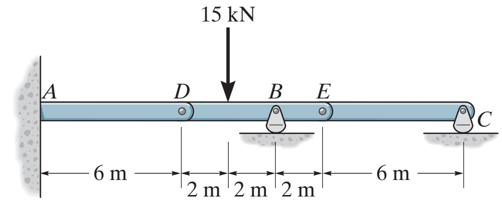
$A_y = 14.7 \text{ kN}$ **Ans.**

$$\overset{+}{\rightarrow} \sum F_x = 0; \quad -B_x + \left(\frac{5}{13}\right)31.2 + \left(\frac{5}{13}\right)20.8 = 0$$

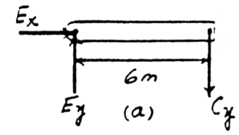
$B_x = 20.0 \text{ kN}$ **Ans.**



2–27. The compound beam is fixed at A and supported by a rocker at B and C. There are hinges pins at D and E. Determine the reactions at the supports.



Equations of Equilibrium: From FBD(a),

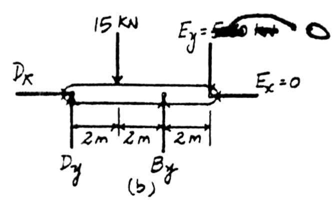


$\zeta + \sum M_E = 0; \quad C_y(6) = 0 \quad C_y = 0$ **Ans.**

$+\uparrow \sum F_y = 0; \quad E_y - 0 = 0 \quad E_y = 0$

$\overset{+}{\rightarrow} \sum F_x = 0; \quad E_x = 0$

From FBD (b),



$\zeta + \sum M_D = 0; \quad B_y(4) - 15(2) = 0$

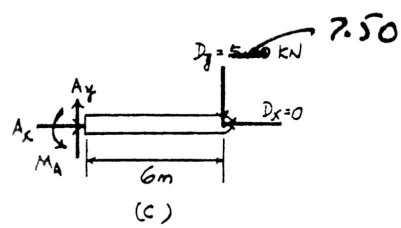
$B_y = 7.50 \text{ kN}$ **Ans.**

$+\uparrow \sum F_y = 0; \quad D_y + 7.50 - 15 = 0$

$D_y = 7.50 \text{ kN}$

$\overset{+}{\rightarrow} \sum F_x = 0; \quad D_x = 0$

From FBD (c),



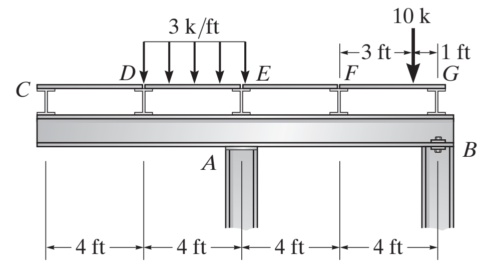
$\zeta + \sum M_A = 0; \quad M_A - 7.50(6) = 0$

$M_A = 45.0 \text{ kN} \cdot \text{m}$ **Ans.**

$+\uparrow \sum F_y = 0; \quad A_y - 7.50 = 0 \quad A_y = 7.50 \text{ kN}$ **Ans.**

$\overset{+}{\rightarrow} \sum F_x = 0; \quad A_x = 0$ **Ans.**

***2–28.** Determine the reactions at the supports A and B. The floor decks CD, DE, EF, and FG transmit their loads to the girder on smooth supports. Assume A is a roller and B is a pin.



Consider the entire system.

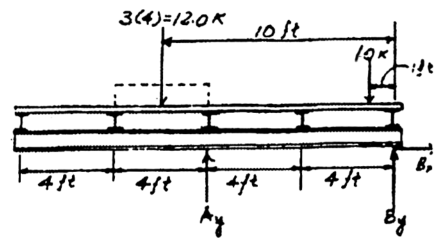
$\curvearrowleft + \sum M_B = 0; \quad 10(1) + 12(10) - A_y(8) = 0$

$A_y = 16.25 \text{ k} = 16.3 \text{ k}$ **Ans.**

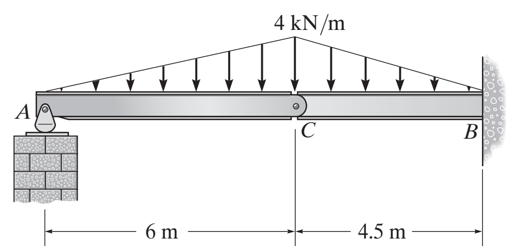
$\overset{+}{\rightarrow} \sum F_x = 0; \quad B_x = 0$ **Ans.**

$+\uparrow \sum F_y = 0; \quad 16.25 - 12 - 10 + B_y = 0$

$B_y = 5.75 \text{ k}$ **Ans.**



2–29. Determine the reactions at the supports A and B of the compound beam. There is a pin at C.



Member AC:

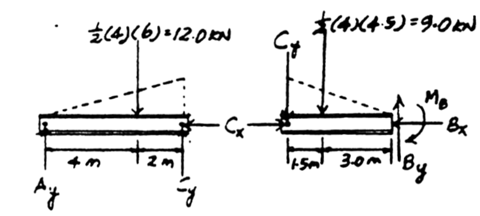
$\curvearrowleft + \sum M_C = 0; -A_y(6) + 12(2) = 0$

$A_y = 4.00 \text{ kN}$ **Ans.**

$+\uparrow \sum F_y = 0; \quad C_y + 4.00 - 12 = 0$

$C_y = 8.00 \text{ kN}$

$\overset{+}{\rightarrow} \sum F_x = 0; \quad C_x = 0$



Member CB:

$\curvearrowleft + \sum M_B = 0; -M_B + 8.00(4.5) + 9(3) = 0$

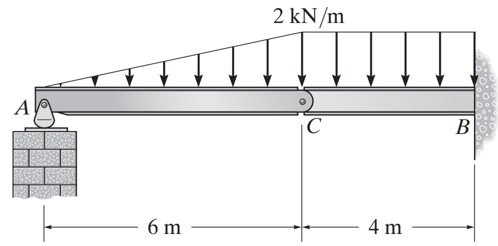
$M_B = 63.0 \text{ kN} \cdot \text{m}$ **Ans.**

$+\uparrow \sum F_y = 0; \quad B_y - 8 - 9 = 0$

$B_y = 17.0 \text{ kN}$ **Ans.**

$\overset{+}{\rightarrow} \sum F_x = 0; \quad B_x = 0$ **Ans.**

2–30. Determine the reactions at the supports A and B of the compound beam. There is a pin at C.



Member AC:

$\circlearrowleft + \sum M_C = 0; \quad -A_y(6) + 6(2) = 0; \quad A_y = 2.00 \text{ kN}$ **Ans.**

$\overset{+}{\rightarrow} \sum F_x = 0; \quad C_x = 0$

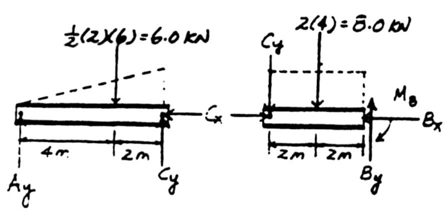
$+\uparrow \sum F_y = 0; \quad 2.00 - 6 + C_y = 0; \quad C_y = 4.00 \text{ kN}$

Member BC:

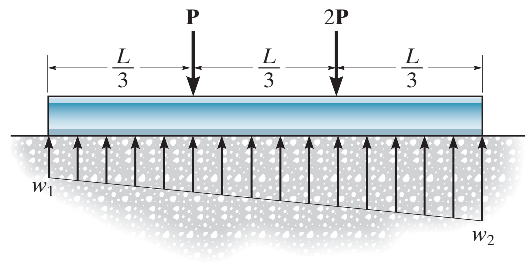
$+\uparrow \sum F_y = 0; \quad -4.00 - 8 + B_y = 0; \quad B_y = 12.0 \text{ kN}$ **Ans.**

$\overset{+}{\rightarrow} \sum F_x = 0; \quad 0 - B_x = 0; \quad B_x = 0$ **Ans.**

$\circlearrowleft + \sum M_B = 0; \quad -M_B + 8(2) + 4.00(4) = 0; \quad M_B = 32.0 \text{ kN} \cdot \text{m}$ **Ans.**



2–31. The beam is subjected to the two concentrated loads as shown. Assuming that the foundation exerts a linearly varying load distribution on its bottom, determine the load intensities w_1 and w_2 for equilibrium (a) in terms of the parameters shown; (b) set $P = 500$ lb, $L = 12$ ft.



Equations of Equilibrium: The load intensity w_1 can be determined directly by summing moments about point A.

$$\circlearrowleft + \sum M_A = 0; \quad P\left(\frac{L}{3}\right) - w_1 L\left(\frac{L}{6}\right) = 0$$

$$w_1 = \frac{2P}{L} \qquad \textbf{Ans.}$$

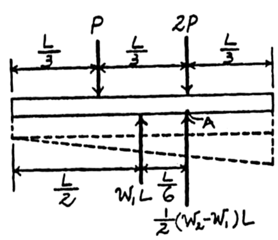
$$+\uparrow \sum F_y = 0; \quad \frac{1}{2}\left(w_2 - \frac{2P}{L}\right)L + \frac{2P}{L}(L) - 3P = 0$$

$$w_2 = \left(\frac{4P}{L}\right) \qquad \textbf{Ans.}$$

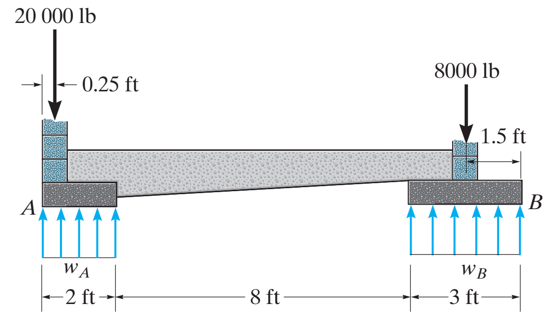
If $P = 500$ lb and $L = 12$ ft,

$$w_1 = \frac{2(500)}{12} = 83.3 \text{ lb/ft} \qquad \textbf{Ans.}$$

$$w_2 = \frac{4(500)}{12} = 167 \text{ lb/ft} \qquad \textbf{Ans.}$$



***2–32** The cantilever footing is used to support a wall near its edge A so that it causes a uniform soil pressure under the footing. Determine the uniform distribution loads, w_A and w_B, measured in lb/ft at pads A and B, necessary to support the wall forces of 8000 lb and 20 000 lb.

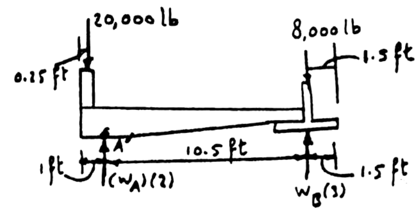


$$\circlearrowleft + \sum M_A = 0; \quad -8000(10.5) + w_B\,(3)(10.5) + 20\,000(0.75) = 0$$

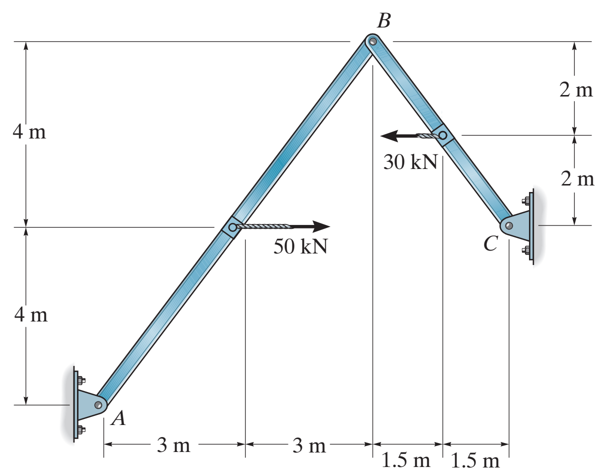
$$w_B = 2190.5\ \text{lb/ft} = 2.19\ \text{k/ft} \qquad \textbf{Ans.}$$

$$+\uparrow \sum F_y = 0; \quad 2190.5(3) - 28\,000 + w_A\,(2) = 0$$

$$w_A = 10.7\ \text{k/ft} \qquad \textbf{Ans.}$$



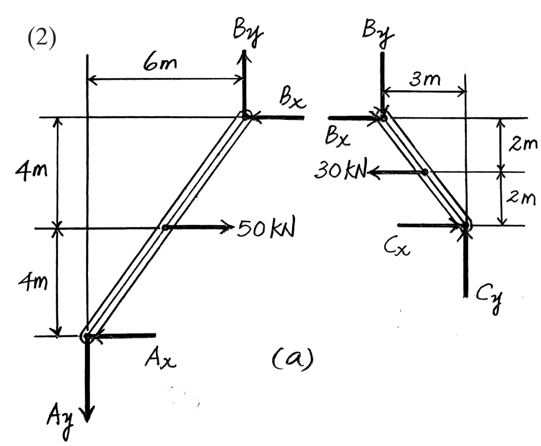
2–33. Determine the horizontal and vertical components of reaction acting at the supports A and C.



Equations of Equilibrium: Referring to the FBDs of segments AB and BC respectively shown in Fig. a,

$$\circlearrowleft + \sum M_A = 0; \quad B_x\,(8) + B_y\,(6) - 50(4) = 0 \qquad (1)$$

$$\circlearrowleft + \sum M_C = 0; \quad B_y\,(3) - B_x\,(4) + 30(2) = 0 \qquad (2)$$



(a)

2–33. Continued

Solving,

$B_y = 6.667\text{ kN} \quad B_x = 20.0\text{ kN}$

Segment AB,

$\overset{+}{\rightarrow}\sum F_x = 0; \quad 50 - 20.0 - A_x = 0 \quad A_x = 30.0\text{ kN}$ **Ans.**

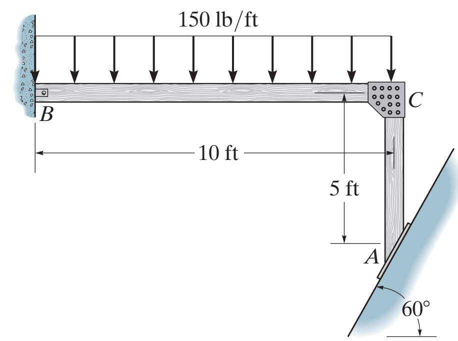
$+\uparrow\sum F_y = 0; \quad 6.667 - A_y = 0 \quad A_y = 6.67\text{ kN}$ **Ans.**

Segment BC,

$\overset{+}{\rightarrow}\sum F_x = 0; \quad C_x + 20.0 - 30 = 0 \quad C_x - 10.0\text{ kN}$ **Ans.**

$+\uparrow\sum F_y = 0; \quad C_y - 6.667 = 0 \quad Cy = 6.67\text{ kN}$ **Ans.**

2–34. Determine the reactions at the smooth support A and the pin support B. The joint at C is fixed connected.



Equations of Equilibrium: Referring to the FBD in Fig. *a*.

$\circlearrowleft + \sum M_B = 0; \quad N_A \cos 60°(10) - N_A \sin 60°(5) - 150(10)(5) = 0$

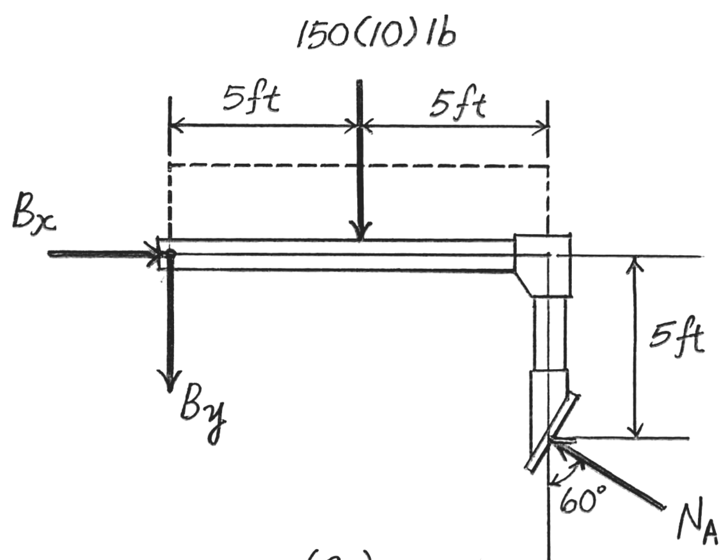
$N_A = 11196.15\text{ lb} = 11.2\text{ k}$ **Ans.**

$\overset{+}{\rightarrow}\sum F_x = 0; \quad B_x - 11196.15 \sin 60° = 0$

$B_x = 9696.15\text{ lb} = 9.70\text{ k}$ **Ans.**

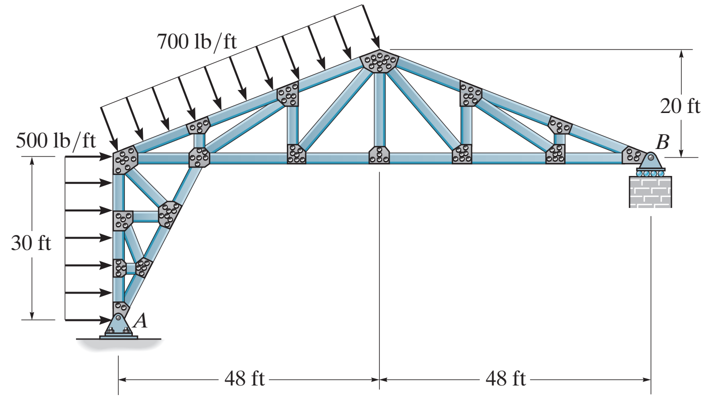
$+\uparrow\sum F_y = 0; \quad 11196.15 \cos 60° - 150(10) - B_y = 0$ **Ans.**

$B_y = 4098.08\text{ lb} = 4.10\text{ k}$



(a)

2–35. Determine the reactions at the supports A and B.



700 lb/ft at 52 ft = 36,400 lb or 36.4 k

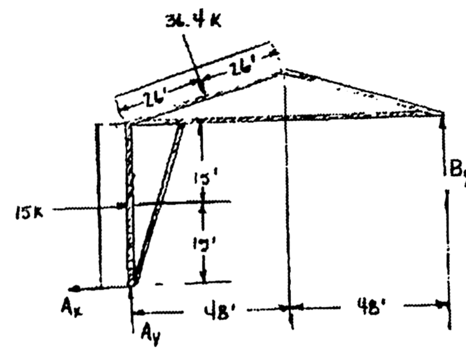
500 lb/ft at 30 ft = 15,000 lb or 15.0 k

$\circlearrowleft + \sum M_A = 0; \quad 96(B_y) - 24\left(\frac{48}{52}\right)(36.4) - 40\left(\frac{20}{52}\right)(36.4) - 15(15) = 0$

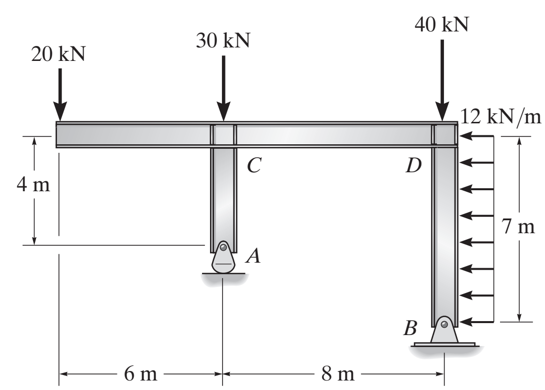
$B_y = 16.58 \text{ k} = 16.6 \text{ k}$ **Ans.**

$\overset{+}{\rightarrow} \sum F_x = 0; \quad 15 + \frac{20}{52}(36.4) - A_x = 0; \quad A_x = 29.0 \text{ k}$ **Ans.**

$+\uparrow \sum F_y = 0; \quad A_y + B_y - \frac{48}{52}(36.4) = 0; \quad A_y = 17.0 \text{ k}$ **Ans.**



***2–36.** Determine the horizontal and vertical components of reaction at the supports A and B. Assume the joints at C and D are fixed connections.



$\circlearrowleft + \sum M_B = 0; \quad 20(14) + 30(8) + 84(3.5) - A_y(8) = 0$

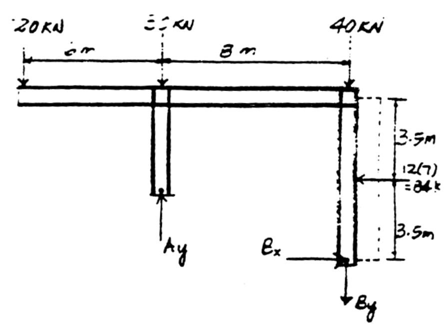
$A_y = 101.75 \text{ kN} = 102 \text{ kN}$ **Ans.**

$\overset{+}{\rightarrow} \sum F_x = 0; \quad B_x - 84 = 0$

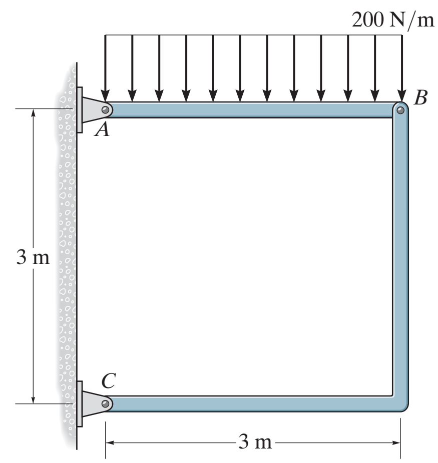
$B_x = 84.0 \text{ kN}$ **Ans.**

$+\uparrow \sum F_y = 0; \quad 101.75 - 20 - 30 - 40 - B_y = 0$

$B_y = 11.8 \text{ kN}$ **Ans.**



2–37. Determine the horizontal and vertical components force at pins A and C of the two-member frame.



Free Body Diagram: The solution for this problem will be simplified if one realizes that member BC is a two force member.

Equations of Equilibrium:

$\zeta + \sum M_A = 0; \quad F_{BC} \cos 45° (3) - 600 (1.5) = 0$

$F_{BC} = 424.26 \text{ N}$

$+\uparrow \sum F_y = 0; \quad A_y + 424.26 \cos 45° - 600 = 0$

$A_y = 300 \text{ N}$ **Ans.**

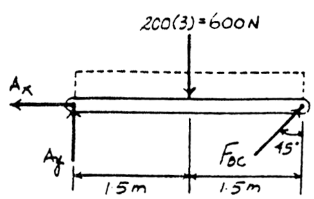
$\overset{+}{\rightarrow} \sum F_x = 0; \quad 424.26 \sin 45° - A_x = 0$ **Ans.**

$A_x = 300 \text{ N}$

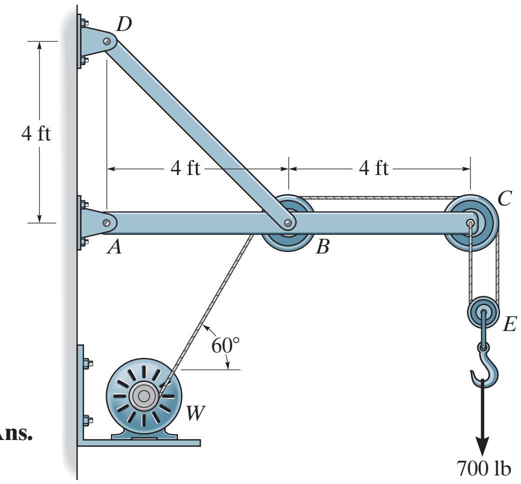
For pin C,

$C_x = F_{BC} \sin 45° = 424.26 \sin 45° = 300 \text{ N}$ **Ans.**

$C_y = F_{BC} \cos 45° = 424.26 \cos 45° = 300 \text{ N}$ **Ans.**



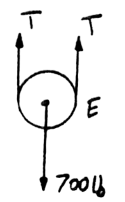
2–38. The wall crane supports a load of 700 lb. Determine the horizontal and vertical components of reaction at the pins A and D. Also, what is the force in the cable at the winch W?



Pulley E:

$+\uparrow \Sigma F_y = 0; \quad 2T - 700 = 0$

$T = 350 \text{ lb}$ **Ans.**



Member ABC:

$\circlearrowleft + \sum M_A = 0; \quad T_{BD} \sin 45° (4) - 350 \sin 60°(4) - 700(8) = 0$

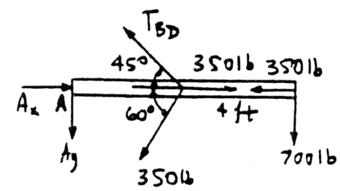
$T_{BD} = 2409 \text{ lb}$

$+\uparrow \sum F_y = 0; \quad A_y + 2409 \sin 45° - 350 \sin 60° - 700 = 0$

$A_y = 700 \text{ lb}$ **Ans.**

$\overset{+}{\rightarrow} \sum F_x = 0; \quad A_x - 2409 \cos 45° - 350 \cos 60° + 350 - 350 = 0$

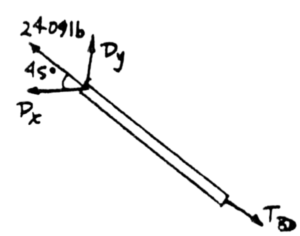
$A_x = 1.88 \text{ k}$ **Ans.**



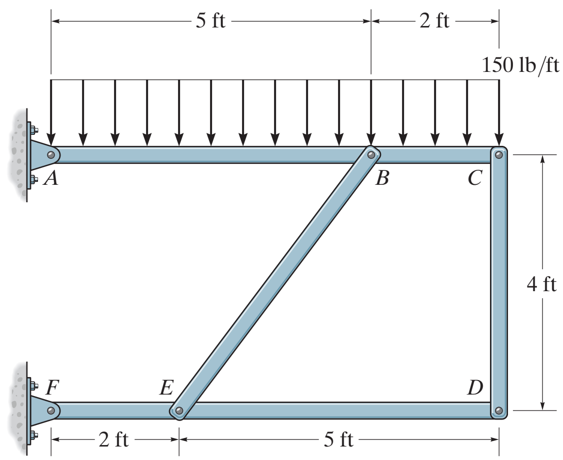
At D:

$D_x = 2409 \cos 45° = 1703.1 \text{ lb} = 1.70 \text{ k}$ **Ans.**

$D_y = 2409 \sin 45° = 1.70 \text{ k}$ **Ans.**



2–39. Determine the resultant forces at pins B and C on member ABC of the four-member frame.

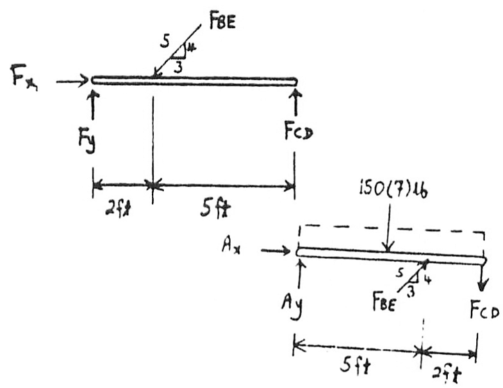


$$\zeta + \sum M_F = 0; \quad F_{CD}(7) - \frac{4}{5}F_{BE}(2) = 0$$

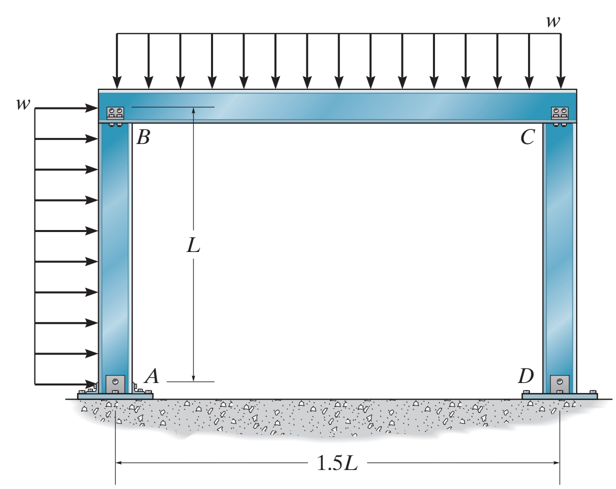
$$\zeta + \sum M_A = 0; \quad -150(7)(3.5) + \frac{4}{5}F_{BE}(5) - F_{CD}(7) = 0$$

$$F_{BE} = 1531 \text{ lb} = 1.53 \text{ k} \qquad \textbf{Ans.}$$

$$F_{CD} = 350 \text{ lb} \qquad \textbf{Ans.}$$



***2–40.** Determine the reactions at the supports is A and D. Assume A is fixed and B and C and D are pins.



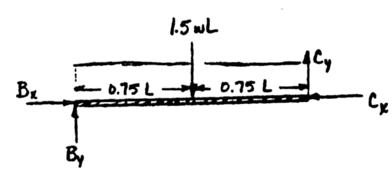
Member BC:

$$\zeta + \sum M_B = 0; \quad C_y(1.5L) - (1.5wL)\left(\frac{1.5L}{2}\right) = 0$$

$$C_y = 0.75\, wL$$

$$+\uparrow \sum F_y = 0; \quad B_y - 1.5wL + 0.75\, wL = 0$$

$$B_y = 0.75\, wL$$



Member CD:

$$\zeta + \sum M_D = 0; \quad C_x = 0$$

$$\xrightarrow{+} \sum F_x = 0; \quad D_x = 0 \qquad \textbf{Ans.}$$

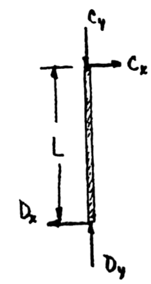
$$+\uparrow \sum F_y = 0; \quad D_y - 0.75wL = 0$$

$$D_y = 0.75\, wL \qquad \textbf{Ans.}$$

***2–40. Continued**

Member *BC*:

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



Member *AB*:

$\overset{+}{\rightarrow}\sum F_x = 0;\ wL - A_x = 0$ **Ans.**

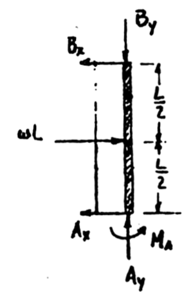
$A_x = wL$ **Ans.**

$+\uparrow\sum F_y = 0; \quad A_y - 0.75\,wL = 0$

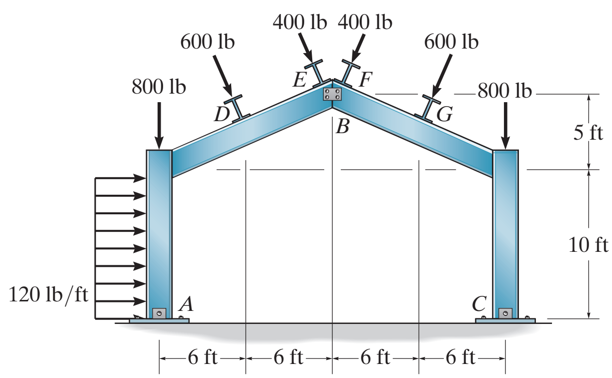
$A_y = 0.75\,wL$ **Ans.**

$\circlearrowleft + \sum M_A = 0; \quad M_A - wL\left(\frac{L}{2}\right) = 0$

$M_A = \frac{wL^2}{2}$ **Ans.**



2–41. Determine the horizontal and vertical reactions at the connections *A* and *C* of the gable frame. Assume that *A*, *B*, and *C* are pin connections. The purlin loads such as *D* and *E* are applied perpendicular to the center line of each girder.

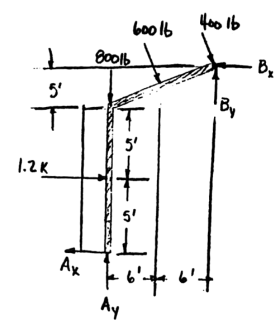


Member *AB*:

$\circlearrowleft + \sum M_A = 0; \quad B_x(15) + B_y(12) - (1200)(5) - 600\left(\frac{12}{13}\right)(16) - 600\left(\frac{5}{13}\right)(12.5)$

$- 400\left(\frac{12}{13}\right)(12) - 400\left(\frac{5}{13}\right)(15) = 0$

$B_x(15) + B_y(12) = 18{,}946.154 \qquad (1)$

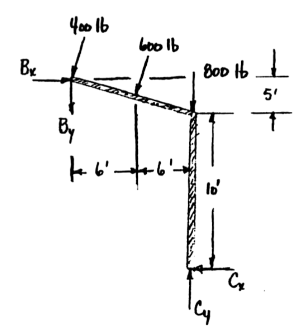


Member *BC*:

$\circlearrowleft + \sum M_C = 0; \quad -(B_x)(15) + B_y(12) + (600)\left(\frac{12}{13}\right)(6) + 600\left(\frac{5}{13}\right)(12.5)$

$+ 400\left(\frac{12}{13}\right)(12) + 400\left(\frac{5}{13}\right)(15) = 0$

$B_x(15) - B_y(12) = 12.946.15 \qquad (2)$



2–41. Continued

Solving Eqs. (1) and (2),

$$B_x = 1063.08 \text{ lb}, \qquad B_y = 250.0 \text{ lb}$$

Member AB:

$$\overset{+}{\rightarrow} \sum F_x = 0; \qquad -A_x + 1200 + 1000\left(\frac{5}{13}\right) - 1063.08 = 0$$

$$A_x = 522 \text{ lb} \qquad \textbf{Ans.}$$

$$+\uparrow \sum F_y = 0; \qquad A_y - 800 - 1000\left(\frac{12}{13}\right) + 250 = 0$$

$$A_y = 1473 \text{ lb} = 1.47 \text{ k} \qquad \textbf{Ans.}$$

Member BC:

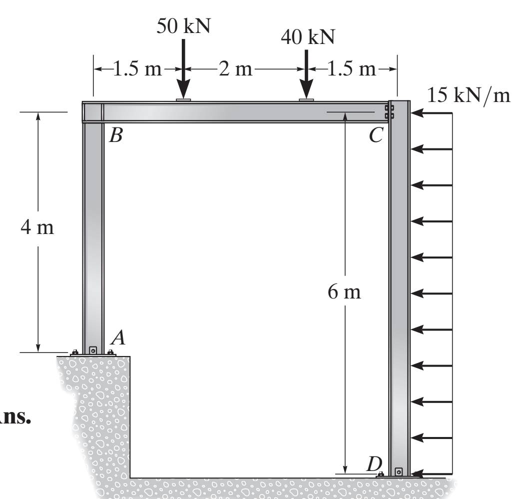
$$\overset{+}{\rightarrow} \sum F_x = 0; \qquad -C_x - 1000\left(\frac{5}{13}\right) + 1063.08 = 0$$

$$C_x = 678 \text{ lb} \qquad \textbf{Ans.}$$

$$+\uparrow \sum F_y = 0; \qquad C_y - 800 - 1000\left(\frac{12}{13}\right) + 250.0 = 0$$

$$C_y = 1973 \text{ lb} = 1.97 \text{ k} \qquad \textbf{Ans.}$$

2–42. Determine the horizontal and vertical components of reaction at A, C, and D. Assume the frame is pin connected at A, C, and D, and there is a fixed-connected joint at B.



Member CD:

$$\circlearrowleft + \sum M_D = 0; \qquad -C_x(6) + 90(3) = 0$$

$$C_x = 45.0 \text{ kN} \qquad \textbf{Ans.}$$

$$\overset{+}{\rightarrow} \sum F_x = 0; \quad D_x + 45 - 90 = 0$$

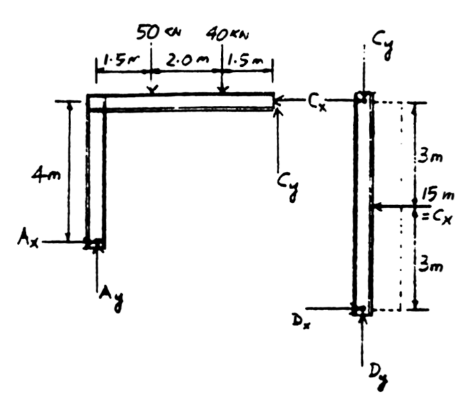
$$D_x = 45.0 \text{ kN} \qquad \textbf{Ans.}$$

$$+\uparrow \sum F_y = 0; \qquad D_y - C_y = 0 \qquad (1)$$

Member ABC:

$$\circlearrowleft + \sum M_A = 0; \qquad C_y(5) + 45.0(4) - 50(1.5) - 40(3.5) = 0$$

$$C_y = 7.00 \text{ kN} \qquad \textbf{Ans.}$$



2–42. Continued

$+\uparrow \sum F_y = 0;$ $\quad A_y + 7.00 - 50 - 40 = 0$

$A_y = 83.0 \text{ kN}$ **Ans.**

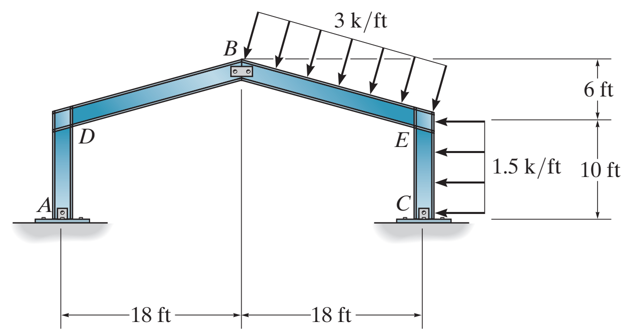
$\overset{+}{\rightarrow} \sum F_x = 0;$ $\quad A_x - 45.0 = 0$

$A_x = 45.0 \text{ kN}$ **Ans.**

From Eq. (1).

$D_y = 7.00 \text{ kN}$ **Ans.**

2–43. Determine the horizontal and vertical components at A, B, and C. Assume the frame is pin connected at these points. The joints at D and E are fixed connected.



$\zeta + \sum M_A = 0; \quad -18 \text{ ft } (B_y) + 16 \text{ ft } (B_x) = 0$ (1)

$\zeta + \sum M_C = 0; \; 15 \text{ k } (5\text{ft}) + 9 \text{ ft } (56.92 \text{ k } (\cos 18.43°)) + 13 \text{ ft } (56.92 \text{ k } (\sin 18.43°))$

$-16 \text{ ft } (B_x) - 18 \text{ ft } (B_x) = 0$ (2)

Solving Eq. 1 & 2

$B_x = 24.84 \text{ k}$ **Ans.**

$B_y = 22.08 \text{ k}$ **Ans.**

$\overset{+}{\rightarrow} \sum F_x = 0; \quad A_x - 24.84 \text{ k} = 0$

$A_x = 24.84 \text{ k}$

$+\uparrow \sum F_y = 0; \quad A_y - 22.08 \text{ k} = 0$

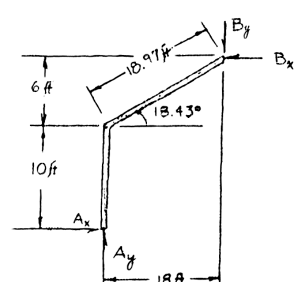
$A_y = 22.08 \text{ k}$

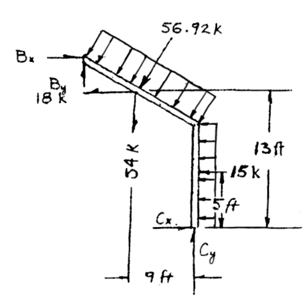
$\overset{+}{\rightarrow} \sum F_x = 0; \quad C_x - 15 \text{ k} - \sin(18.43°)(56.92 \text{ k}) + 24.84 \text{ k}$

$C_x = 8.16 \text{ k}$ **Ans.**

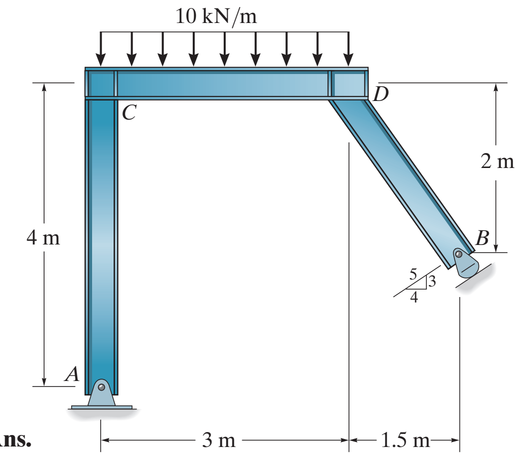
$+\uparrow \sum F_y = 0; \quad Cy + 22.08 \text{ k} - \cos(18.43°)(56.92 \text{ k}) = 0$

$Cy = 31.9 \text{ k}$ **Ans.**



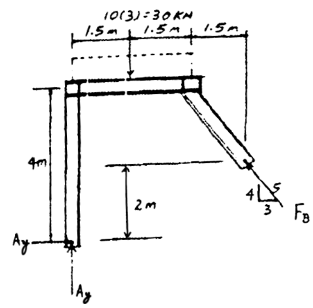


***2–44.** Determine the reactions at the supports A and B. The joints C and D are fixed connected.



$$\circlearrowleft + \sum M_A = 0; \quad \frac{4}{5} F_B(4.5) + \frac{3}{5} F_B(2) - 30(1.5) = 0$$

$$F_B = 9.375 \text{ kN} = 9.38 \text{ kN}$$ **Ans.**



$$+\uparrow \sum F_y = 0; \quad A_y + \frac{4}{5}(9.375) - 30 = 0$$

$$A_y = 22.5 \text{ kN}$$ **Ans.**

$$\overset{+}{\rightarrow} \sum F_x = 0; \quad A_x - \frac{3}{5}(9.375) = 0$$

$$A_x = 5.63 \text{ kN}$$ **Ans.**