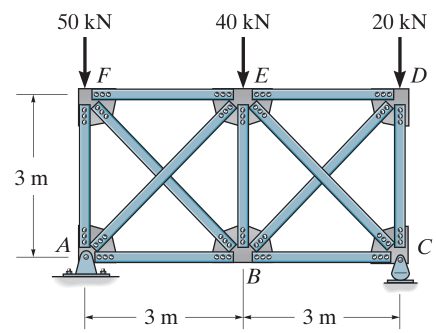
7–1. Determine (approximately) the force in each member of the truss. Assume the diagonals can support either a tensile or a compressive force.

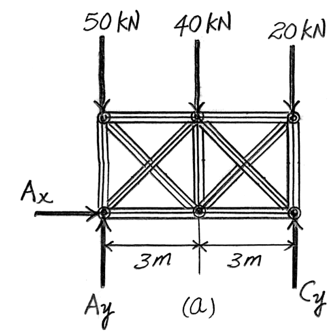


Support Reactions. Referring to Fig. *a*,

$\circlearrowleft + \sum M_A = 0; \quad C_y(6) - 40(3) - 20(6) = 0 \quad C_y = 40\text{ kN}$

$\circlearrowleft + \sum M_C = 0; \quad 40(3) + 50(6) - A_y(6) = 0 \quad A_y = 70\text{ kN}$

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



Method of Sections. It is required that $F_{BF} = F_{AE} = F_1$. Referring to Fig. *b*,

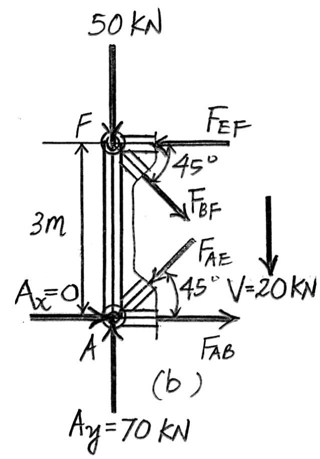
$+\uparrow \sum F_y = 0; \quad 70 - 50 - 2F_1 \sin 45° = 0 \quad F_1 = 14.14\text{ kN}$

Therefore,

$F_{BF} = 14.1\text{ kN (T)} \quad F_{AE} = 14.1\text{ kN (C)}$ **Ans.**

$\circlearrowleft + \sum M_A = 0; \quad F_{EF}(3) - 14.14 \cos 45°(3) = 0 \quad F_{EF} = 10.0\text{ kN (C)}$ **Ans.**

$\circlearrowleft + \sum M_F = 0; \quad F_{AB}(3) - 14.14 \cos 45°(3) = 0 \quad F_{AB} = 10.0\text{ kN (T)}$ **Ans.**



Also, $F_{BD} = F_{CE} = F_2$. Referring to Fig. *c*,

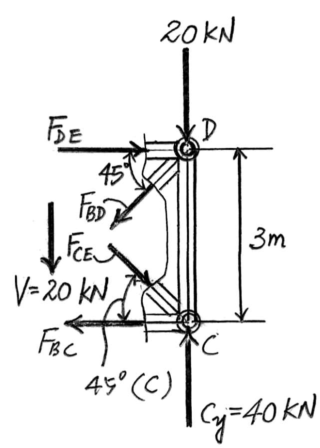
$+\uparrow \sum F_y = 0; \quad 40 - 20 - 2F_2 \sin 45° = 0 \quad F_2 = 14.14\text{ kN}$

Therefore,

$F_{BD} = 14.1\text{ kN (T)} \quad F_{CE} = 14.1\text{ kN (C)}$ **Ans.**

$\circlearrowleft + \sum M_C = 0; \quad 14.14 \cos 45°(3) - F_{DE}(3) = 0 \quad F_{DE} = 10.0\text{ kN (C)}$ **Ans.**

$\circlearrowleft + \sum M_D = 0; \quad 14.14 \cos 45°(3) - F_{BC}(3) = 0 \quad F_{BC} = 10.0\text{ kN (T)}$ **Ans.**



Method of Joints.

Joint *A*: Referring to Fig. *d*,

$+\uparrow \sum F_y = 0; \quad 70 - 14.14 \sin 45° - F_{AF} = 0 \quad F_{AF} = 60.0\text{ kN (C)}$ **Ans.**

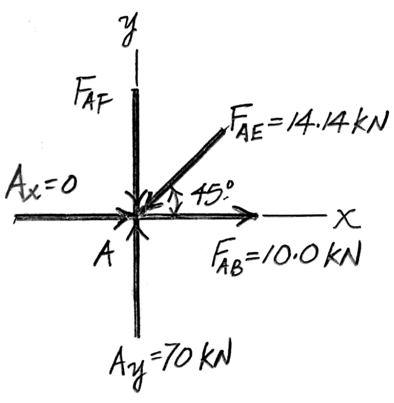
Joint *B*: Referring to Fig. *e*,

$+\uparrow \sum F_y = 0; \quad 14.14 \sin 45° + 14.14 \sin 45° - F_{BE} = 0 \quad F_{BE} = 20.0\text{ kN (C)}$ **Ans.**

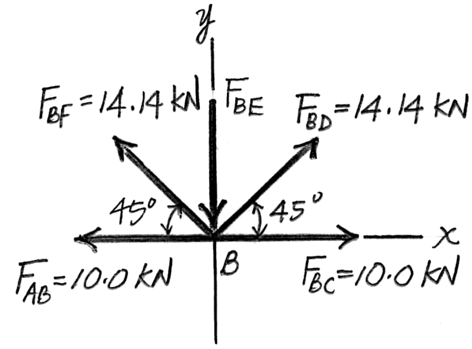
Joint *C*:

$+\uparrow \sum F_y = 0; \quad 40 - 14.14 \sin 45° - F_{CD} = 0 \quad F_{CD} = 30.0\text{ kN (C)}$ **Ans.**

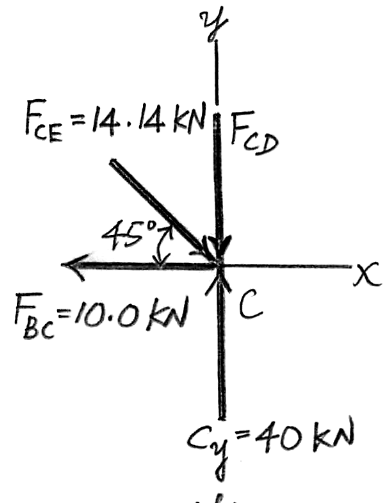
7–1. Contiuned



(d)

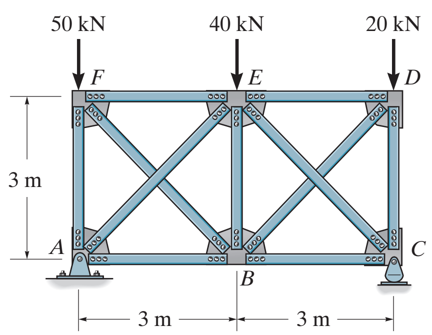


(e)



(f)

7–2. Solve Prob. 7–1 assuming that the diagonals cannot support a compressive force.



Support Reactions. Referring to Fig. *a*,

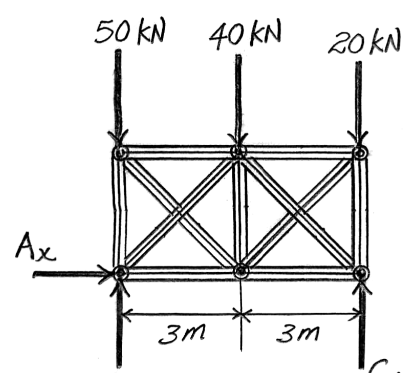
$$\circlearrowleft + \sum M_A = 0; \quad C_y(6) - 40(3) - 20(6) = 0 \quad C_y = 40 \text{ kN}$$

$$\circlearrowleft + \sum M_C = 0; \quad 40(3) + 50(6) - A_y(6) = 0 \quad A_y = 70 \text{ kN}$$

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

Method of Sections. It is required that

$$F_{AE} = F_{CE} = 0 \qquad \textbf{Ans.}$$



(a)

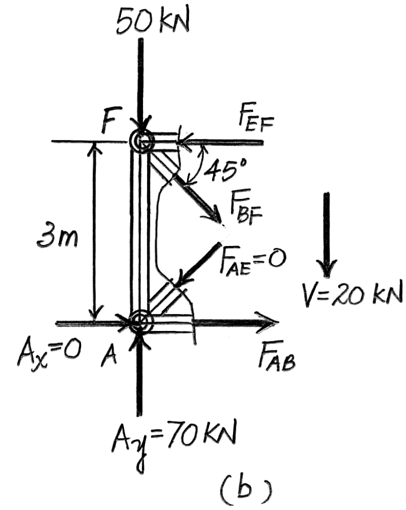
7–2. Continued

Referring to Fig. *b*,

$+\uparrow \sum F_y = 0;\ 70 - 50 - F_{BF} \sin 45° = 0\ \ F_{BF} = 28.28 \text{ kN (T)} = 28.3 \text{ kN (T)}$ **Ans.**

$\zeta + \sum M_A = 0;\quad F_{EF}(3) - 28.28 \cos 45°(3) = 0\quad F_{EF} = 20.0 \text{ kN (C)}$ **Ans.**

$\zeta + \sum M_F = 0\quad F_{AB}(3) = 0\quad F_{AB} = 0$ **Ans.**

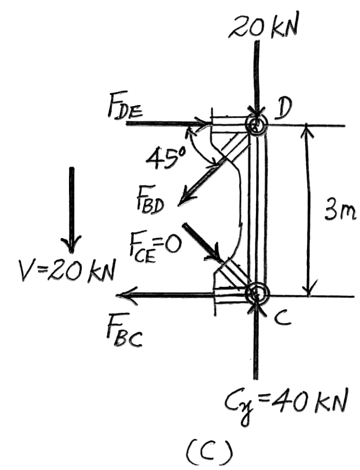


Referring to Fig. *c*,

$+\uparrow \sum F_y = 0;\ 40 - 20 - F_{BD} \sin 45° = 0\ \ F_{BD} = 28.28 \text{ kN (T)} = 28.3 \text{ kN (T)}$ **Ans.**

$\zeta + \sum M_C = 0;\quad 28.28 \cos 45°(3) - F_{DE}(3) = 0\quad F_{DE} = 20.0 \text{ kN (C)}$ **Ans.**

$\zeta + \sum M_D = 0;\quad -F_{BC}(3) = 0\quad F_{BC} = 0$ **Ans.**



Method of Joints.

Joint *A*: Referring to Fig. *d*,

$+\uparrow \sum F_y = 0;\quad 70 - F_{AF} = 0\quad F_{AF} = 70.0 \text{ kN (C)}$ **Ans.**

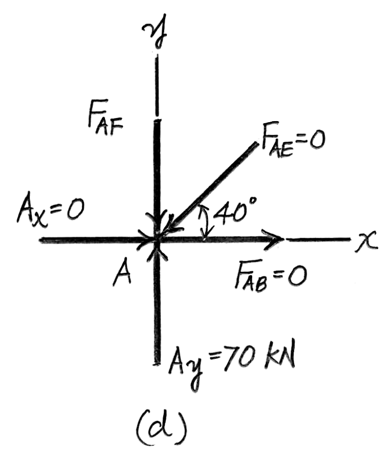
Joint *B*: Referring to Fig. *e*,

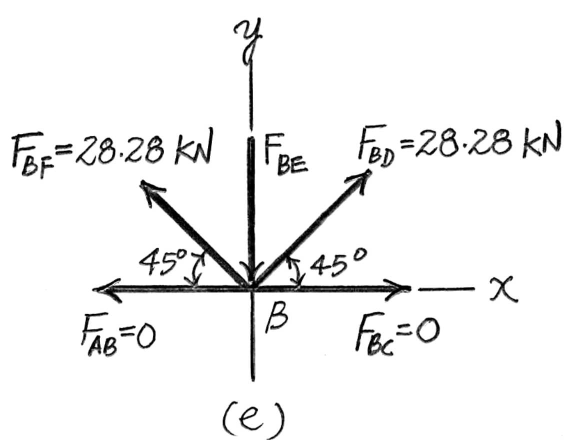
$+\uparrow \sum F_y = 0;\quad 28.28 \sin 45° + 28.28 \sin 45° - F_{BE} = 0$

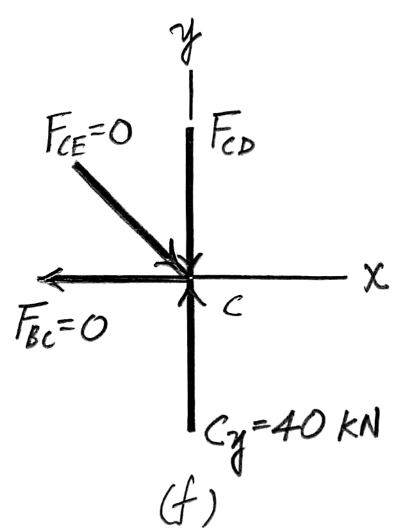
$F_{BE} = 40.0 \text{ kN (C)}$ **Ans.**

Joint *C*: Referring to Fig. *f*,

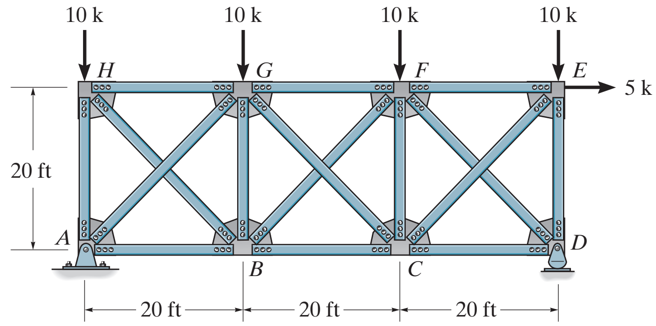
$+\uparrow \sum F_y = 0;\quad 40 - F_{CD} = 0\quad F_{CD} = 40.0 \text{ kN (C)}$ **Ans.**







7–3. Determine (approximately) the force in each member of the truss. Assume the diagonals can support either a tensile or a compressive force.

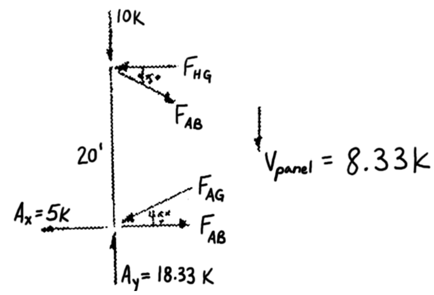


$V_{\text{Panel}} = 8.33 \text{ k}$

Assume V_{Panel} is carried equally by F_{HB} and F_{AG}, so

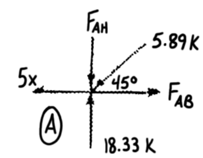
$$F_{HB} = \frac{\frac{8.33}{2}}{\cos 45°} = 5.89 \text{ k (T)}$$ **Ans.**

$$F_{AG} = \frac{\frac{8.33}{2}}{\cos 45°} = 5.89 \text{ k (C)}$$ **Ans.**



Joint *A*:

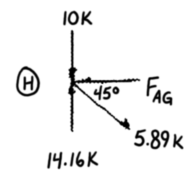
$\overset{+}{\rightarrow} \sum F_x = 0; \quad F_{AB} - 5 - 5.89 \cos 45° = 0; \quad F_{AB} = 9.17 \text{ k (T)}$ **Ans.**



$+\uparrow \sum F_y = 0; \quad -F_{AH} + 18.33 - 5.89 \sin 45° = 0; \quad F_{AH} = 14.16 \text{ k (C)}$ **Ans.**

Joint *H*:

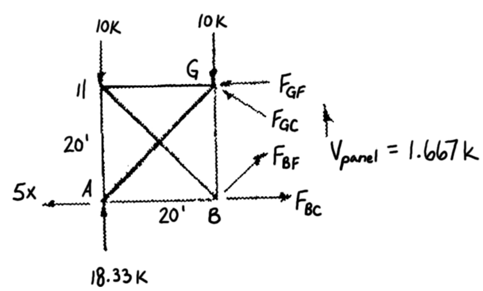
$\overset{+}{\rightarrow} \sum F_x = 0; \quad -F_{HG} + 5.89 \cos 45° = 0; \quad F_{HG} = 4.17 \text{ k (C)}$ **Ans.**



$V_{\text{Panel}} = 1.667 \text{ k}$

$$F_{GC} = \frac{\frac{1.667}{2}}{\cos 45°} = 1.18 \text{ k (C)}$$ **Ans.**

$$F_{BF} = \frac{\frac{1.667}{2}}{\cos 45°} = 1.18 \text{ k (T)}$$ **Ans.**



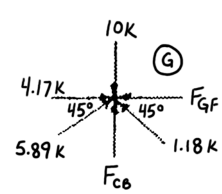
Joint *G*:

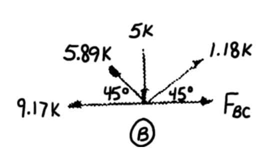
$\overset{+}{\rightarrow} \sum F_x = 0; \quad 4.17 + 5.89 \cos 45° - 1.18 \cos 45° - F_{GF} = 0$

$F_{GF} = 7.5 \text{ k (C)}$ **Ans.**

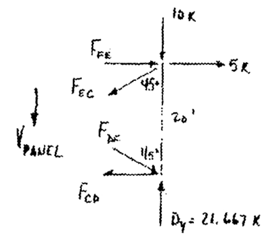
$+\uparrow \sum F_y = 0; \quad -10 + F_{GB} + 5.89 \sin 45° + 1.18 \sin 45° = 0$

$F_{GB} = 5.0 \text{ k (C)}$ **Ans.**





7–3. Continued



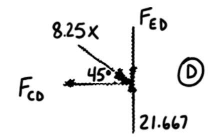
Joint *B*:

$\xrightarrow{+} \sum F_x = 0; \quad F_{BC} + 1.18 \cos 45° - 9.17 - 5.89 \cos 45° = 0$

$F_{BC} = 12.5 \text{ k (T)}$ **Ans.**

$V_{\text{Panel}} = 21.667 - 10 = 11.667 \text{ k}$

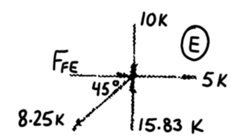
$$F_{EC} = \frac{\frac{11.667}{2}}{\cos 45°} = 8.25 \text{ k (T)}$$ **Ans.**



$$F_{DF} = \frac{\frac{11.567}{2}}{\cos 45°} = 8.25 \text{ k (C)}$$ **Ans.**

Joint *D*:

$\xrightarrow{+} \sum F_x = 0; \quad F_{CD} = 8.25 \cos 45° = 5.83 \text{ k (T)}$ **Ans.**

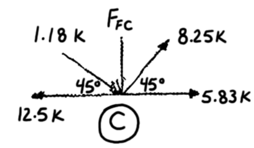


$+\uparrow \sum F_y = 0; \quad 21.667 - 8.25 \sin 45° - F_{ED} = 0$

$F_{ED} = 15.83 \text{ k (C)}$ **Ans.**

Joint *E*:

$\xrightarrow{+} \sum F_x = 0; \quad 5 + F_{FE} - 8.25 \cos 45° = 0$



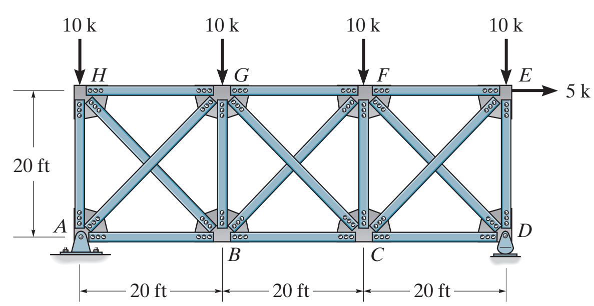
$F_{FE} = 0.833 \text{ k (C)}$ **Ans.**

Joint *C*:

$+\uparrow \sum F_y = 0; \quad -F_{FC} + 8.25 \sin 45° - 1.18 \sin 45° = 0$

$F_{FC} = 5.0 \text{ k (C)}$ **Ans.**

***7–4.** Solve Prob. 7–3 assuming that the diagonals cannot support a compressive force.



$V_{\text{Panel}} = 8.33 \text{ k}$

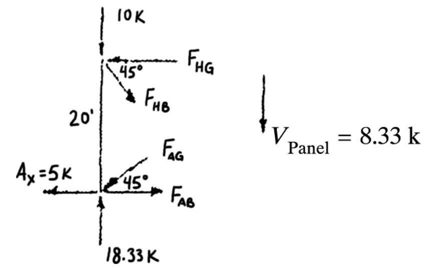
$F_{AG} = 0$ **Ans.**

$$F_{HB} = \frac{8.33}{\sin 45°} = 11.785 = 11.8 \text{ k}$$ **Ans.**

Joint *A*:

$\xrightarrow{+} \sum F_x = 0; \quad F_{AB} = 5 \text{ k (T)}$ **Ans.**

7–4. Continued

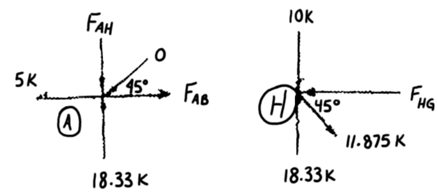


$+\uparrow \sum F_y = 0; \quad F_{AN} = 18.3 \text{ k (C)}$ **Ans.**

Joint *H*:

$\overset{+}{\rightarrow} \sum F_x = 0; \quad 11.785 \cos 45° - F_{HG} = 0$

$F_{HG} = 8.33 \text{ k (C)}$ **Ans.**

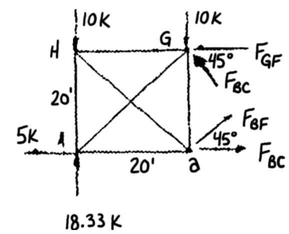


$V_{Panel} = 1.667 \text{ k}$

$F_{GC} = 0$ **Ans.**

$F_{BF} = \dfrac{1.667}{\sin 45°} = 2.36 \text{ k (T)}$ **Ans.**

Joint *B*:



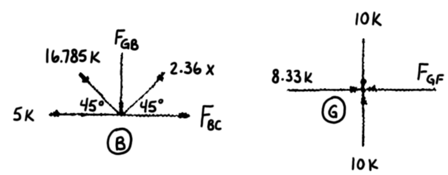
$\overset{+}{\rightarrow} \sum F_x = 0; \quad F_{BC} + 2.36 \cos 45° - 11.785 \cos 45° - 5 = 0$

$F_{BC} = 11.7 \text{ k (T)}$ **Ans.**

$+\uparrow \sum F_y = 0; \quad -F_{GB} + 11.785 \sin 45° + 2.36 \sin 45° = 0$

$F_{GB} = 10 \text{ k (C)}$ **Ans.**

Joint *G*:

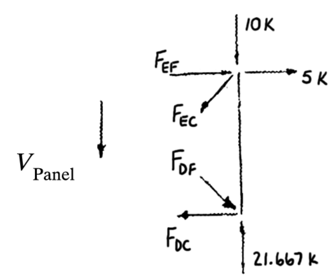


$\overset{+}{\rightarrow} \sum F_x = 0; \quad F_{GF} = 8.33 \text{ k (C)}$ **Ans.**

$V_{Panel} = 11.667 \text{ k}$

$F_{DF} = 0$ **Ans.**

$F_{EC} = \dfrac{11.667}{\sin 45°} = 16.5 \text{ k (T)}$ **Ans.**



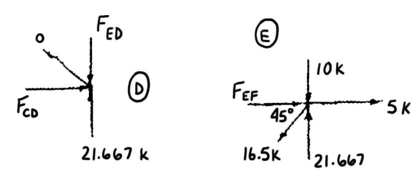
Joint *D*:

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

$+\uparrow \sum F_y = 0; \quad F_{ED} = 21.7 \text{ k (C)}$ **Ans.**

Joint *E*:

$\overset{+}{\rightarrow} \sum F_x = 0; \quad F_{EF} + 5 - 16.5 \cos 45° = 0$

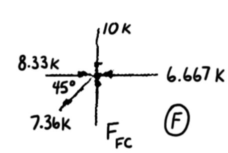


$F_{EF} = 6.67 \text{ k (C)}$ **Ans.**

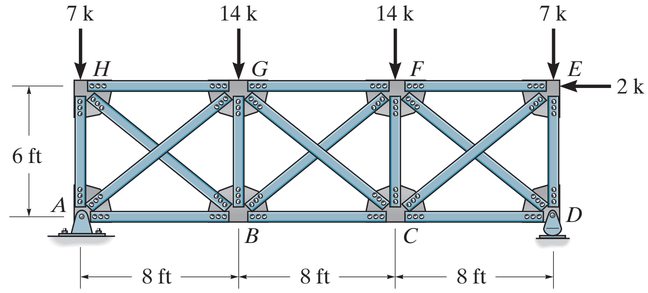
Joint *F*:

$+\uparrow \sum F_y = 0; \quad F_{FC} - 10 - 2.36 \sin 45° = 0$

$F_{FC} = 11.7 \text{ k (C)}$ **Ans.**



7–5. Determine (approximately) the force in each member of the truss. Assume the diagonals can support either a tensile or a compressive force.



Support Reactions. Referring to, Fig. *a*

$\xrightarrow{+} \sum F_x = 0; \quad A_x - 2 = 0 \quad A_x = 2 \text{ k}$

$\circlearrowleft + \sum M_A = 0; \quad D_y(24) + 2(6) - 7(24) - 14(16) - 14(8) = 0 \quad D_y = 20.5 \text{ k}$

$\circlearrowleft + \sum M_D = 0; \quad 14(8) + 14(16) + 7(24) + 2(6) - A_y(24) = 0 \quad A_y = 21.5 \text{ k}$

Method of Sections. It is required that $F_{BH} = F_{AG} = F_1$. Referring to Fig. *b*,

$+\uparrow \sum F_y = 0; \quad 21.5 - 7 - 2F_1\left(\frac{3}{5}\right) = 0 \quad F_1 = 12.08 \text{ k}$

Therefore,

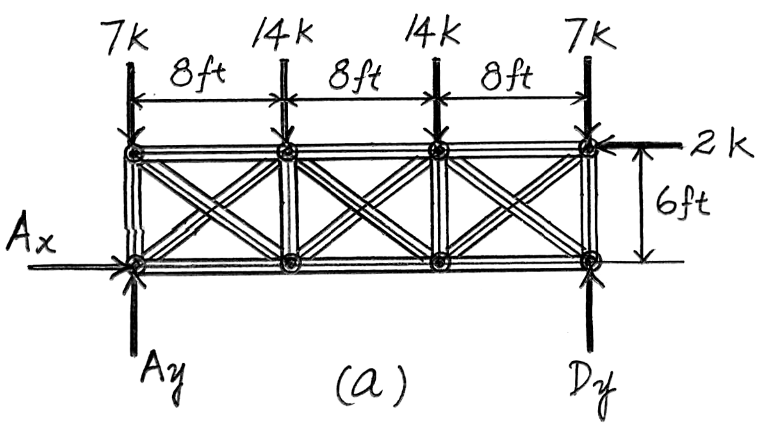
$F_{BH} = 12.1 \text{ k (T)} \quad F_{AG} = 12.1 \text{ k (C)}$ **Ans.**

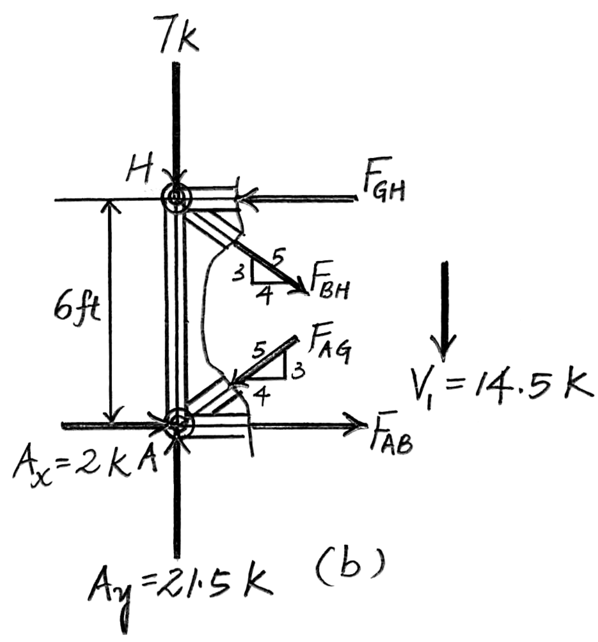
$\circlearrowleft + \sum M_H = 0; \quad F_{AB}(6) + 2(6) - 12.08\left(\frac{4}{5}\right)(6) = 0 \quad F_{AB} = 7.667 \text{ k (T)} = 7.67 \text{ k (T)}$ **Ans.**

$\circlearrowleft + \sum M_A = 0; \quad F_{GH}(6) - 12.08\left(\frac{4}{5}\right)(6) = 0 \quad F_{GH} = 9.667 \text{ k (C)} = 9.67 \text{ k (C)}$ **Ans.**

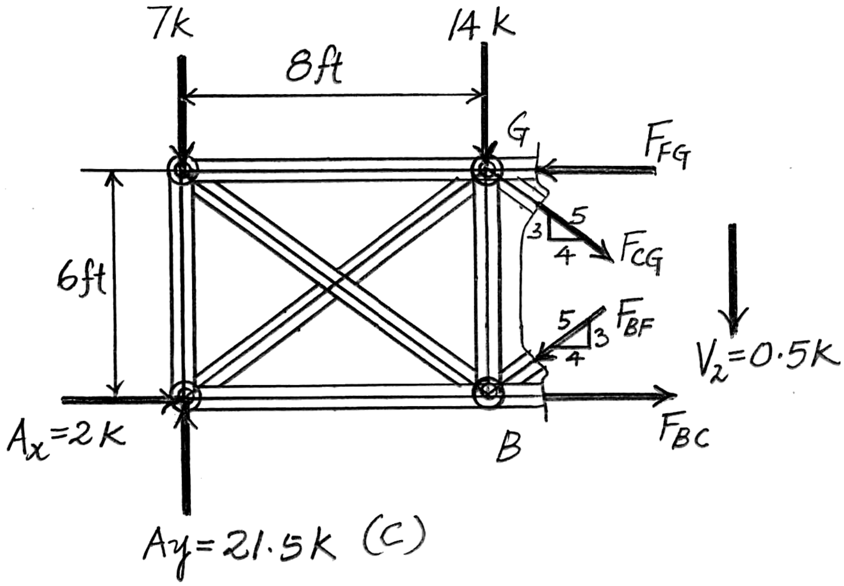
It is required that $F_{CG} = F_{BF} = F_2$. Referring to Fig. *c*,

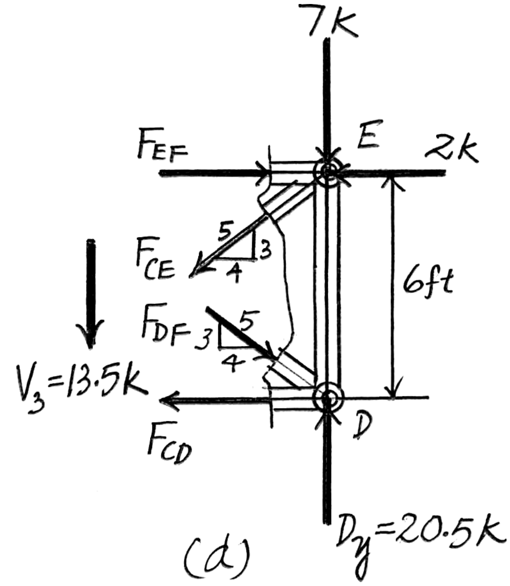
$+\uparrow \sum F_y = 0; \quad 21.5 - 7 - 14 - 2F_2\left(\frac{3}{5}\right) = 0 \quad F_2 = 0.4167 \text{ k}$





7–5. Continued





Therefore,

$F_{CG} = 0.417$ k (T) $\quad F_{BF} = 0.417$ k (C) **Ans.**

$\circlearrowleft + \sum M_B = 0;\quad F_{FG}(6) - 0.4167\left(\frac{4}{5}\right)(6) + 7(8) - 21.5(8) = 0$

$F_{FG} = 19.67$ k (C) $= 19.7$ k (C) **Ans.**

$\circlearrowleft + \sum M_G = 0;\quad F_{BC}(6) + 7(8) + 2(6) - 21.5(8) - 0.4167\left(\frac{4}{5}\right)(6) = 0$

$F_{BC} = 17.67$ k (T) $= 17.7$ k (T) **Ans.**

It is required that $F_{CE} = F_{DF} = F_3$. Referring to Fig. *d*

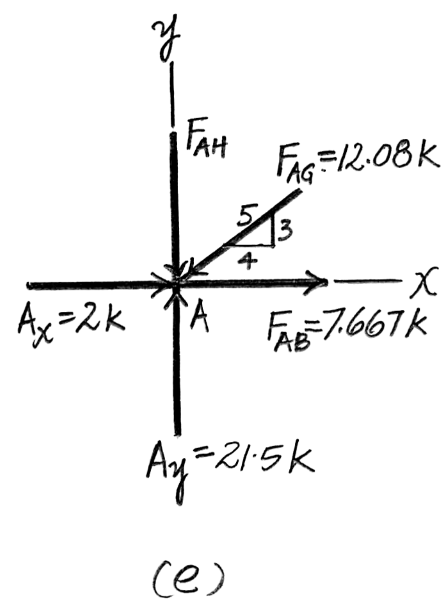
$+\uparrow \sum F_y = 0;\quad 20.5 - 7 - 2F_3\left(\frac{3}{5}\right) = 0 \quad F_3 = 11.25$ k

Therefore,

$F_{CE} = 11.25$ k (T) $\quad F_{DF} = 11.25$ k (C) **Ans.**

$\circlearrowleft + \sum M_D = 0;\quad 2(6) + 11.25\left(\frac{4}{5}\right)(6) - F_{EF}(6) = 0 \quad F_{EF} = 11.0$ k (C) **Ans.**

$\circlearrowleft + \sum M_E = 0;\quad 11.25(0.8)(6) - F_{CD}(6) = 0 \quad F_{CD} = 9.00$ k (T) **Ans.**



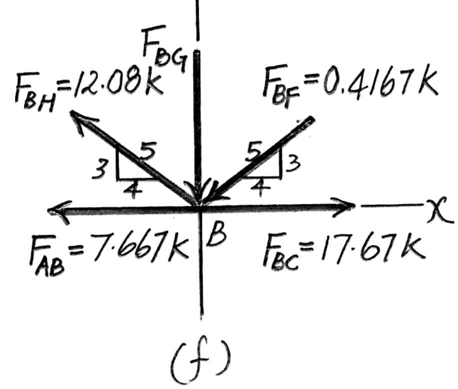
Method of Joints.

Joint *A*: Referring to Fig. *e*,

$+\uparrow \sum F_y = 0;\quad 21.5 - 12.08\left(\frac{3}{5}\right) - F_{AH} = 0 \quad F_{AH} = 14.25$ k (C) **Ans.**

Joint *B*: Referring to Fig. *f*,

$+\uparrow \sum F_y = 0;\quad 12.08\left(\frac{3}{5}\right) - 0.4167\left(\frac{3}{5}\right) - F_{BG} = 0 \quad F_{BG} = 7.00$ k (C) **Ans.**



Joint *C*: Referring Fig. *g*,

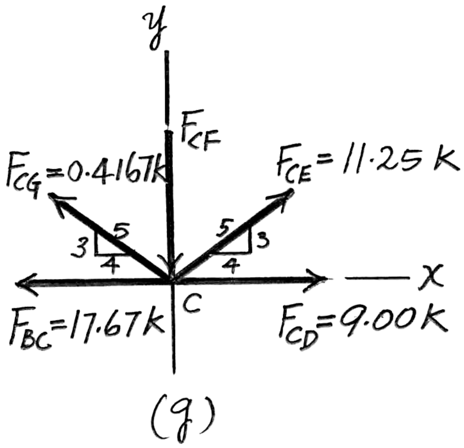
$+\uparrow \sum F_y = 0;\quad 11.25\left(\frac{3}{5}\right) + 0.4167\left(\frac{3}{5}\right) - F_{CF} = 0 \quad F_{CF} = 7.00$ k (C)

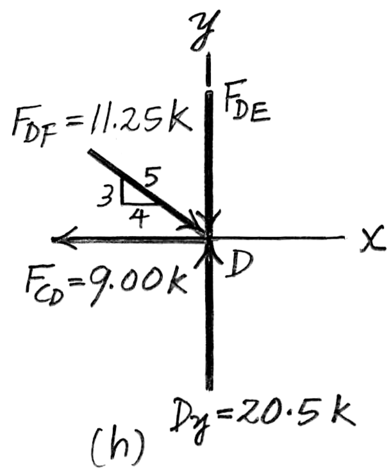
7–5. Continued

Joint *D*: Referring to Fig. *h*,

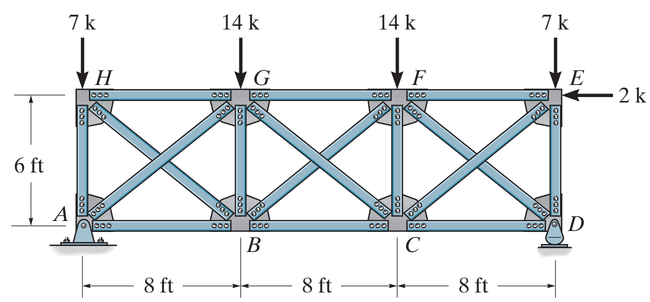
$+\uparrow\sum F_y = 0;\quad 20.5 - 11.25\left(\frac{3}{5}\right) - F_{DE} = 0$

$F_{DE} = 13.75 \text{ k}$ **Ans.**





7–6. Solve Prob. 7–5 assuming that the diagonals cannot support a compressive force.



Support Reactions. Referring to Fig. *a*,

$\xrightarrow{+}\sum F_x = 0;\quad A_x - 2 = 0 \quad A_x = 2 \text{ k}$

$\circlearrowleft +\sum M_A = 0;\quad D_y(24) + 2(6) - 7(24) - 14(16) - 14(8) = 0 \quad D_y = 20.5 \text{ k}$

$\circlearrowleft +\sum M_D = 0;\quad 14(8) + 14(16) + 7(24) + 2(6) - A_y(24) = 0 \quad A_y = 21.5 \text{ k}$

Method of Sections. It is required that

$F_{AG} = F_{BF} = F_{DF} = 0$ **Ans.**

Referring to Fig. *b*,

$+\uparrow\sum F_y = 0;\quad 21.5 - 7 - F_{BH}\left(\frac{3}{5}\right) = 0 \quad F_{BH} = 24.17 \text{ k (T)} = 24.2 \text{ k (T)}$ **Ans.**

$\circlearrowleft +\sum M_A = 0;\quad F_{GH}(6) - 24.17\left(\frac{4}{5}\right)(6) = 0 \quad F_{GH} = 19.33 \text{ k (C)} = 19.3 \text{ k (C)}$

Ans.

$\circlearrowleft +\sum M_H = 0;\quad 2(6) - F_{AB}(6) = 0 \quad F_{AB} = 2.00 \text{ k (C)}$ **Ans.**

7–6. Continued

Referring to Fig. *c*

$+\uparrow\sum F_y = 0;\quad 21.5 - 7 - 14 - F_{CG}\left(\frac{3}{5}\right) = 0 \quad F_{CG} = 0.8333\text{ k (T)} = 0.833\text{ k (T)}$ **Ans.**

$\circlearrowleft + \sum M_B = 0;\quad F_{FG}(6) + 7(8) - 21.5(8) - 0.8333\left(\frac{4}{5}\right)(6) = 0$

$F_{FG} = 20.0\ k\ (C)$ **Ans.**

$\circlearrowleft + \sum M_G = 0;\quad F_{BC}(6) + 7(8) + 2(6) - 21.5(8) = 0 \quad F_{BC} = 17.33\text{ k (T)} = 17.3\text{ k (T)}$ **Ans.**

Referring to Fig. *d*,

$+\uparrow\sum F_y = 0;\quad 20.5 - 7 - F_{CE}\left(\frac{3}{5}\right) = 0 \quad F_{CE} = 22.5\text{ k (T)}$ **Ans.**

$\circlearrowleft + \sum M_D = 0;\quad 2(6) + 22.5\left(\frac{4}{5}\right)(6) - F_{EF}(6) = 0 \quad F_{EF} = 20.0\text{ kN (C)}$ **Ans.**

$\circlearrowleft + \sum M_E = 0;\quad -F_{CD}(6) = 0 \quad F_{CD} = 0$ **Ans.**

Method of Joints.

Joint *A*: Referring to Fig. *e*,

$+\uparrow\sum F_y = 0;\quad 21.5 - F_{AH} = 0 \quad F_{AH} = 21.5\text{ k (C)}$ **Ans.**

Joint *B*: Referring to Fig. *f*,

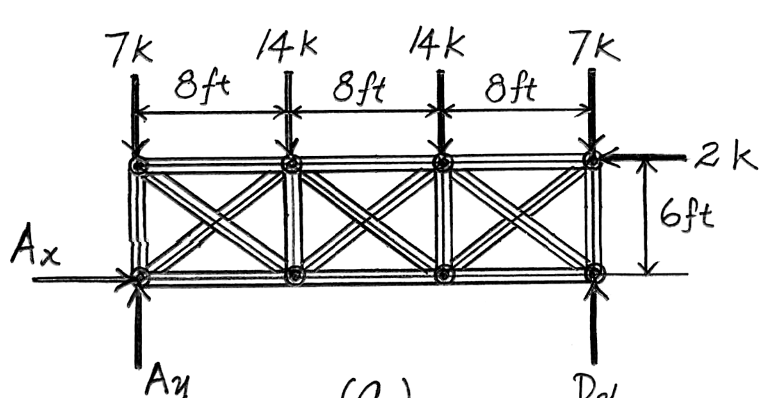
$+\uparrow\sum F_y = 0;\quad 24.17\left(\frac{3}{5}\right) - F_{BG} = 0 \quad F_{BG} = 14.5\text{ k (C)}$ **Ans.**

Joint *C*: Referring to Fig. *g*,

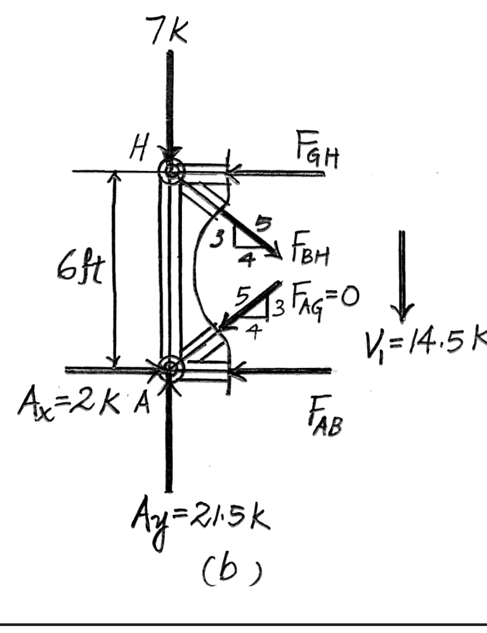
$+\uparrow\sum F_y = 0;\quad 0.8333\left(\frac{3}{5}\right) + 22.5\left(\frac{3}{5}\right) - F_{CF} = 0 \quad F_{CF} = 14.0\text{ k (C)}$ **Ans.**

Joint *D*: Referring to Fig. *h*,

$+\uparrow\sum F_y = 0;\quad 20.5 - F_{DE} = 0 \quad F_{DE} = 20.5\text{ k (C)}$ **Ans.**

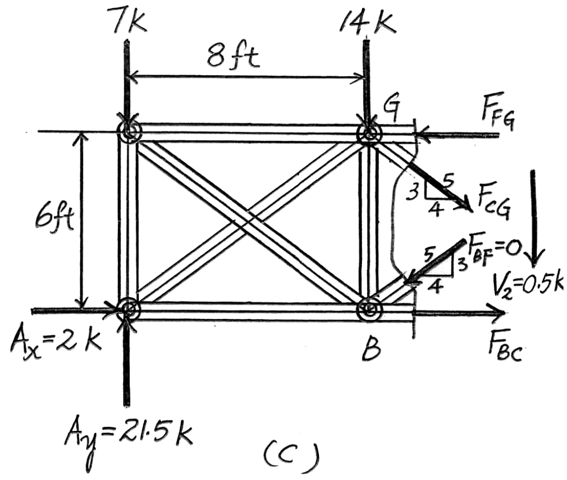


(a)

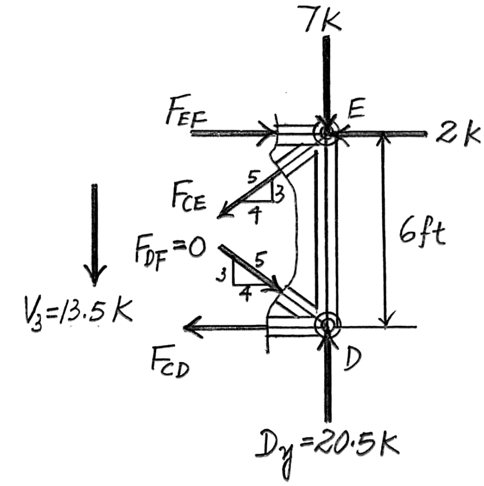


(b)

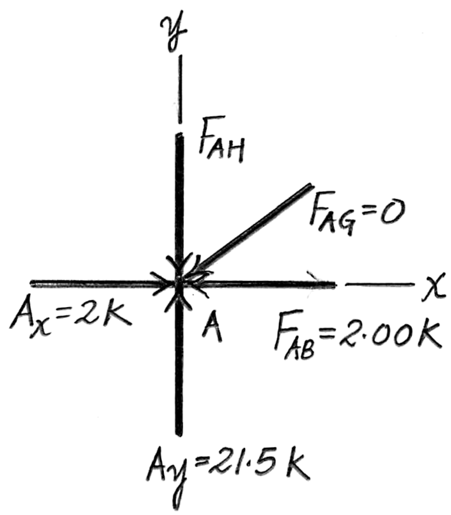
7–6. Continued



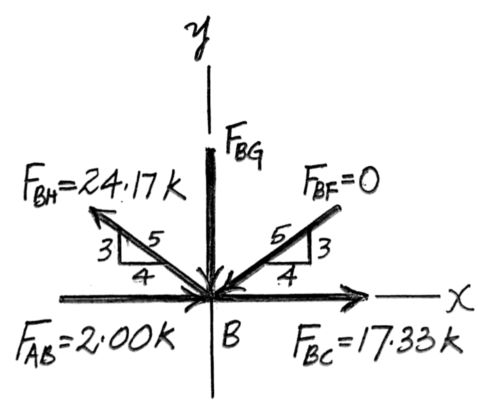
(c)



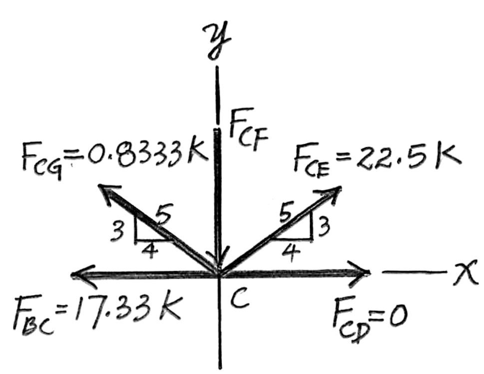
(d)



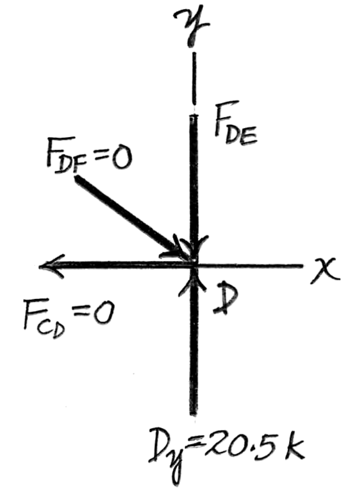
(e)



(f)

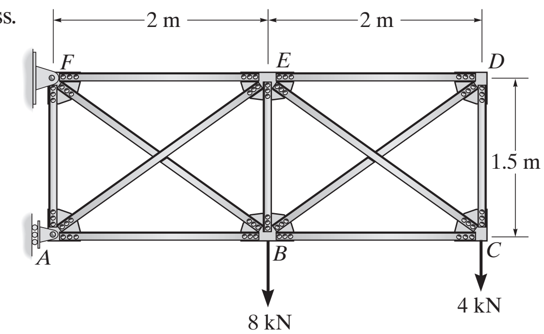


(g)

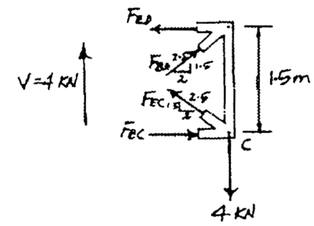


(h)

7–7. Determine (approximately) the force in each member of the truss. Assume the diagonals can support either a tensile or compressive force.



Assume $F_{BD} = F_{EC}$



$$+\uparrow \sum F_y = 0; \quad 2F_{EC}\left(\frac{1.5}{2.5}\right) - 4 = 0$$

$F_{EC} = 3.333 \text{ kN} = 3.33 \text{ kN (T)}$ **Ans.**

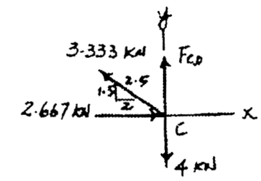
$F_{BD} = 3.333 \text{ kN} = 3.33 \text{ kN (C)}$ **Ans.**

$$\circlearrowleft + \sum M_C = 0; \quad F_{ED}(1.5) - \left(\frac{2}{2.5}\right)(3.333)(1.5) = 0$$

$F_{ED} = 2.67 \text{ kN (T)}$ **Ans.**

$$\xrightarrow{+} \sum F_x = 0; \quad F_{BC} = 2.67 \text{ kN (C)}$$ **Ans.**

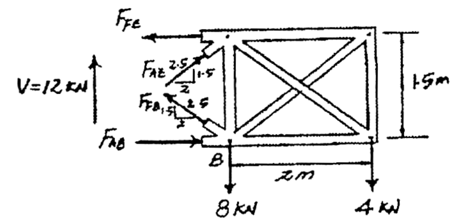
Joint *C*:



$$+\uparrow \sum F_y = 0; \quad F_{CD} + 3.333\left(\frac{1.5}{2.5}\right) - 4 = 0$$

$F_{CD} = 2.00 \text{ kN (T)}$ **Ans.**

Assume $F_{FB} = F_{AE}$



$$+\uparrow \sum F_y = 0; \quad 2F_{FB}\left(\frac{1.5}{2.5}\right) - 8 - 4 = 0$$

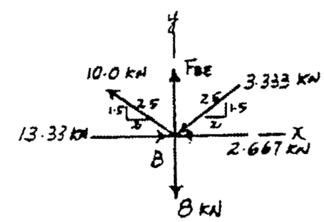
$F_{FB} = 10.0 \text{ kN (T)}$ **Ans.**

$F_{AE} = 10.0 \text{ kN (C)}$ **Ans.**

$$\circlearrowleft + \sum M_B = 0; \quad F_{FE}(1.5) - 10.0\left(\frac{2}{2.5}\right)(1.5) - 4(2) = 0$$

$F_{FE} = 13.3 \text{ kN (T)}$ **Ans.**

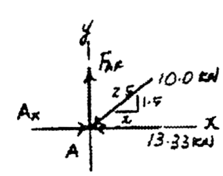
$$\xrightarrow{+} \sum F_x = 0; \quad F_{AB} = 13.3 \text{ kN (C)}$$ **Ans.**



Joint *B*:

$$+\uparrow \sum F_y = 0; \quad F_{BE} + 10.0\left(\frac{1.5}{2.5}\right) - 3.333\left(\frac{1.5}{2.5}\right) - 8 = 0$$

$F_{BE} = 4.00 \text{ kN (T)}$ **Ans.**

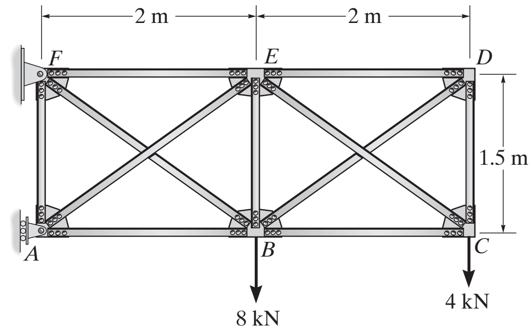


Joint *A*:

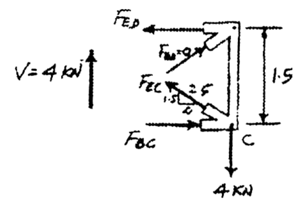
$$+\uparrow \sum F_y = 0; \quad F_{AF} - 10.0\left(\frac{1.5}{2.5}\right) = 0$$

$F_{AF} = 6.00 \text{ kN (T)}$ **Ans.**

***7–8.** Solve Prob. 7–7 assuming that the diagonals cannot support a compressive force.



Assume $F_{BD} = 0$ **Ans.**



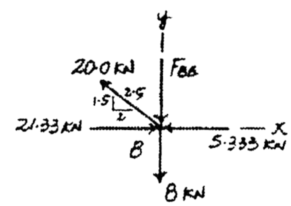
$+\uparrow \sum F_y = 0;\quad F_{EC}\left(\frac{1.5}{2.5}\right) - 4 = 0$

$F_{EC} = 6.667 \text{ kN} = 6.67 \text{ kN (T)}$ **Ans.**

$\circlearrowleft + \sum M_C = 0;\quad F_{ED} = 0$ **Ans.**

$\overset{+}{\rightarrow} \sum F_x = 0;\quad F_{BC} - 6.667\left(\frac{2}{2.5}\right) = 0$

$F_{BC} = 5.33 \text{ kN (C)}$ **Ans.**

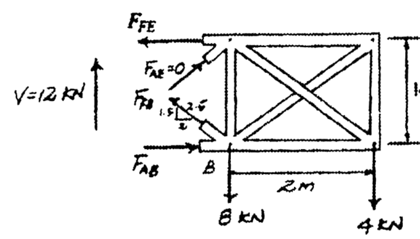


Joint *D*:

From Inspection:

$F_{CD} = 0$ **Ans.**

Assume $F_{AE} = 0$ **Ans.**



$+\uparrow \sum F_y = 0;\quad F_{FB}\left(\frac{1.5}{2.5}\right) - 8 - 4 = 0$

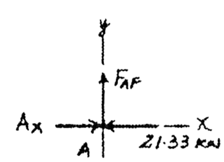
$F_{FB} = 20.0 \text{ kN (T)}$ **Ans.**

$\circlearrowleft + \sum M_B = 0;\quad F_{FE}(1.5) - 4(2) = 0$

$F_{FE} = 5.333 \text{ kN} = 5.33 \text{ kN (T)}$ **Ans.**

$\overset{+}{\rightarrow} \sum F_x = 0;\quad F_{AB} - 5.333 - 20.0\left(\frac{2}{2.5}\right) = 0$

$F_{AB} = 21.3 \text{ kN (C)}$ **Ans.**



Joint *B*:

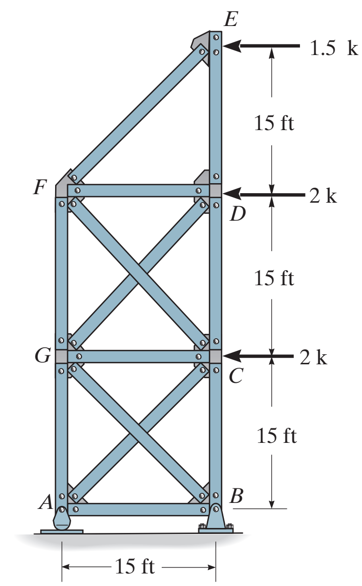
$+\uparrow \sum F_y = 0;\quad -F_{BE} - 8 + 20.0\left(\frac{1.5}{2.5}\right) = 0$

$F_{BE} = 4.00 \text{ kN (T)}$ **Ans.**

Joint *A*:

$+\uparrow \sum F_y = 0;\quad F_{AF} = 0$ **Ans.**

7–9. Determine (approximately) the force in each member of the truss. Assume the diagonals can support both tensile and compressive forces.



Method of Sections. It is required that $F_{CF} = F_{DG} = F_1$. Referring to Fig. *a*,

$$\xrightarrow{+} \sum F_x = 0; \quad 2F_1 \sin 45^\circ - 2 - 1.5 = 0 \quad F_1 = 2.475\text{ k}$$

Therefore,

$F_{CF} = 2.48\text{ k (T)} \quad F_{DG} = 2.48\text{ k (C)}$ **Ans.**

$$\circlearrowleft + \sum M_D = 0; \quad 1.5(15) + 2.475 \cos 45^\circ (15) - F_{FG}(15) = 0$$

$F_{FG} = 3.25\text{ k (C)}$ **Ans.**

$$\circlearrowleft + \sum M_F = 0; \quad 1.5(15) + 2.475 \cos 45^\circ (15) - F_{CD}(15) = 0$$

$F_{CD} = 3.25\text{ k (T)}$ **Ans.**

It is required that $F_{BG} = F_{AC} = F_2$. Referring to Fig. *b*,

$$\xrightarrow{+} \sum F_x = 0; \quad 2F_2 \sin 45^\circ - 2 - 2 - 1.5 = 0 \quad F_2 = 3.889\text{ k}$$

Therefore,

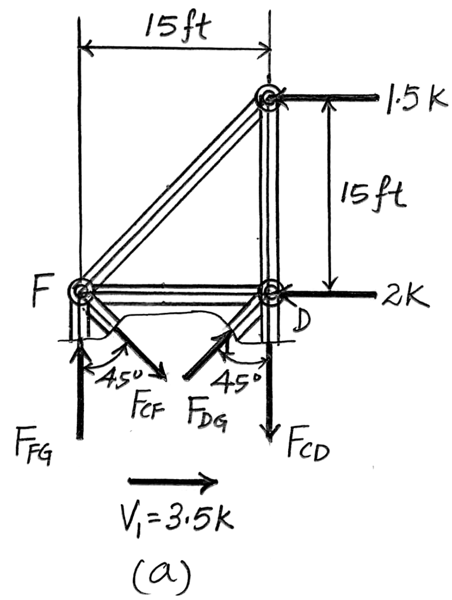
$F_{BG} = 3.89\text{ k (T)} \quad F_{AC} = 3.89\text{ k (C)}$ **Ans.**

$$\circlearrowleft + \sum M_G = 0; \quad 1.5(30) + 2(15) + 3.889 \cos 45^\circ (15) - F_{BC}(15) = 0$$

$F_{BC} = 7.75\text{ k (T)}$ **Ans.**

$$\circlearrowleft + \sum M_C = 0; \quad 1.5(30) + 2(15) + 3.889 \cos 45^\circ (15) - F_{AG}(15) = 0$$

$F_{AG} = 7.75\text{ k (C)}$ **Ans.**



Method of Joints.

Joint *E*: Referring to Fig. *c*,

$$\xrightarrow{+} \sum F_x = 0; \quad F_{EF} \cos 45^\circ - 1.5 = 0 \quad F_{EF} = 2.121\text{ k (C)} = 2.12\text{ k (C)}$$ **Ans.**

$$+\uparrow \sum F_y = 0; \quad 2.121 \sin 45^\circ - F_{DE} = 0 \quad F_{DE} = 1.50\text{ k (T)}$$ **Ans.**

Joint *F*: Referring to Fig. *d*,

$$\xrightarrow{+} \sum F_x = 0; \quad 2.475 \sin 45^\circ - 2.121 \cos 45^\circ - F_{DF} = 0$$

$F_{DF} = 0.250\text{ k (C)}$ **Ans.**

7–9. Continued

Joint *G*: Referring to Fig. *e*,

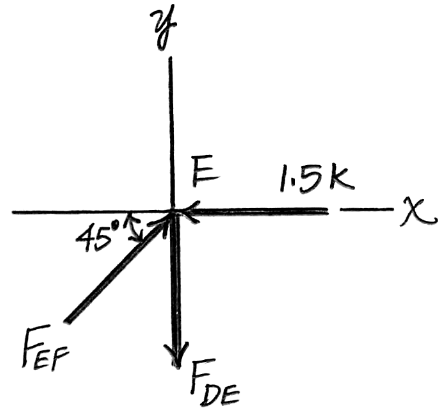
$\overset{+}{\rightarrow} \sum F_x = 0; \quad 3.889 \sin 45° - 2.475 \cos 45° - F_{CG} = 0$

$F_{CG} = 1.00 \text{ k (C)}$ **Ans.**

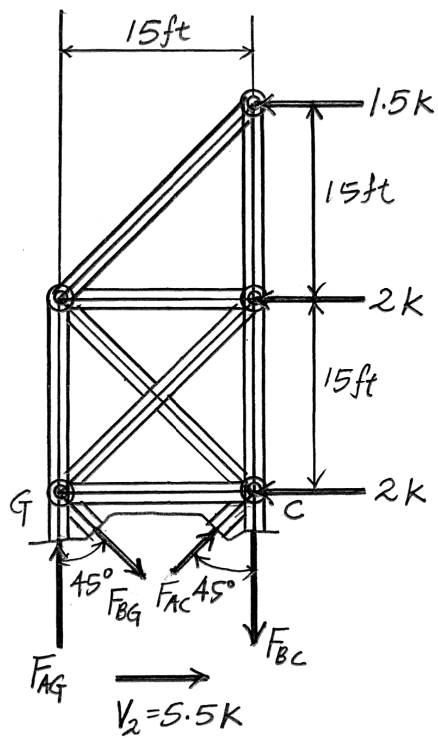
Joint *A*: Referring to Fig. *f*,

$\overset{+}{\rightarrow} \sum F_x = 0; \quad F_{AB} - 3.889 \cos 45° = 0$

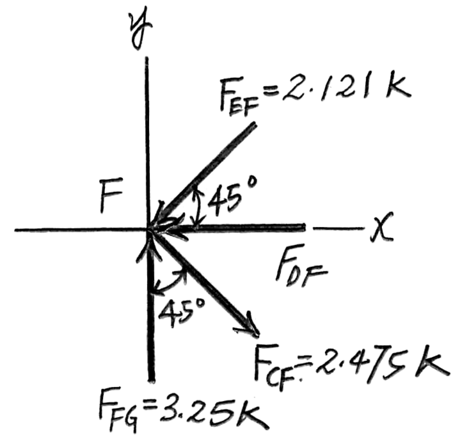
$F_{AB} = 2.75 \text{ k}$ **Ans.**



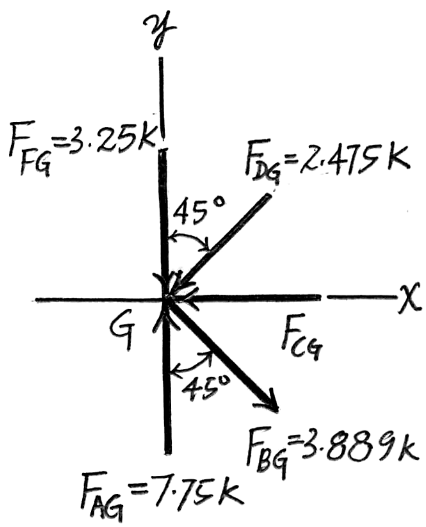
(c)



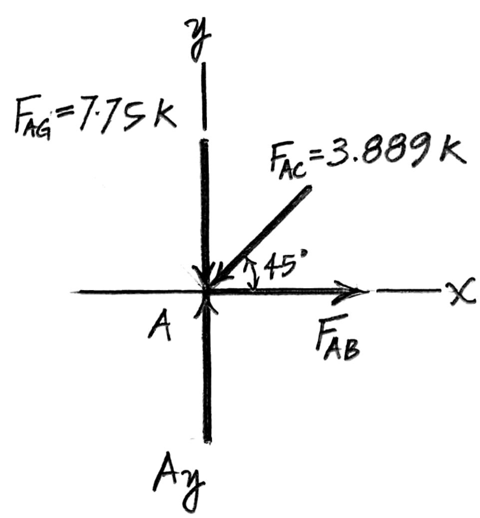
(b)



(d)

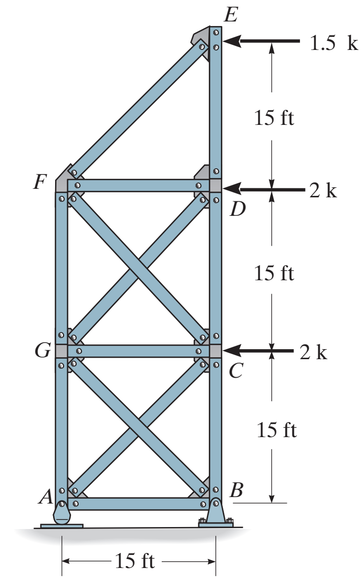


(e)



(f)

7–10. Determine (approximately) the force in each member of the truss. Assume the diagonals DG and AC cannot support a compressive force.



Method of Sections. It is required that

$F_{DG} = F_{AC} = 0$ **Ans.**

Referring to Fig. *a*,

$\overset{+}{\rightarrow}\sum F_x = 0;\quad F_{CF}\sin 45^\circ - 1.5 - 2 = 0 \quad F_{CF} = 4.950\text{ k (T)} = 4.95\text{ k (T)}$ **Ans.**

$\circlearrowleft + \sum M_F = 0;\quad 1.5(15) - F_{CD}(15) = 0 \quad F_{CD} = 1.50\text{ k (T)}$ **Ans.**

$\circlearrowleft + \sum M_D = 0;\quad 1.5(15) + 4.950\cos 45^\circ(15) - F_{FG}(15) = 0$

$F_{FG} = 5.00\text{ k (C)}$ **Ans.**

Referring to Fig. *b*,

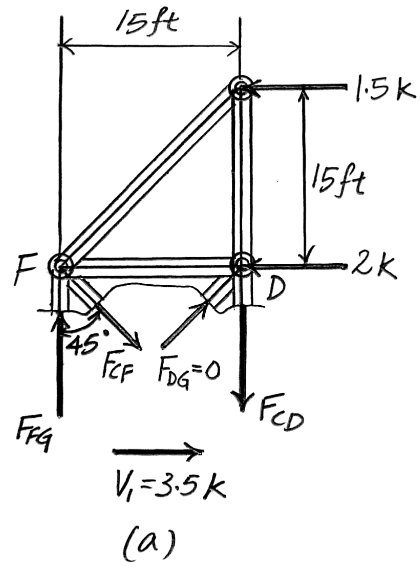
$\overset{+}{\rightarrow}\sum F_x = 0;\quad F_{BG}\sin 45^\circ - 2 - 2 - 1.5 = 0 \quad F_{BG} = 7.778\text{ k (T)} = 7.78\text{ k (T)}$

Ans.

$\circlearrowleft + \sum M_G = 0;\quad 1.5(30) + 2(15) - F_{BC}(15) = 0 \quad F_{BC} = 5.00\text{ k (T)}$ **Ans.**

$\circlearrowleft + \sum M_C = 0;\quad 1.5(30) + 2(15) + 7.778\cos 45^\circ - F_{AG}(15) = 0$

$F_{AG} = 10.5\text{ k (C)}$ **Ans.**



Method of Joints.

Joint *E*: Referring to Fig. *c*,

$\overset{+}{\rightarrow}\sum F_x = 0;\quad F_{EF}\cos 45^\circ - 1.5 = 0 \quad F_{EF} = 2.121\text{ k (C)} = 2.12\text{ k (C)}$ **Ans.**

$+\uparrow\sum F_y = 0;\quad 2.121\sin 45^\circ - F_{DE} = 0 \quad F_{DE} = 1.50\text{ k (T)}$ **Ans.**

Joint *F*: Referring to Fig. *d*,

$\overset{+}{\rightarrow}\sum F_x = 0;\quad 4.950\sin 45^\circ - 2.121\cos 45^\circ - F_{DF} = 0 \quad F_{DF} = 2.00\text{ k (C)}$ **Ans.**

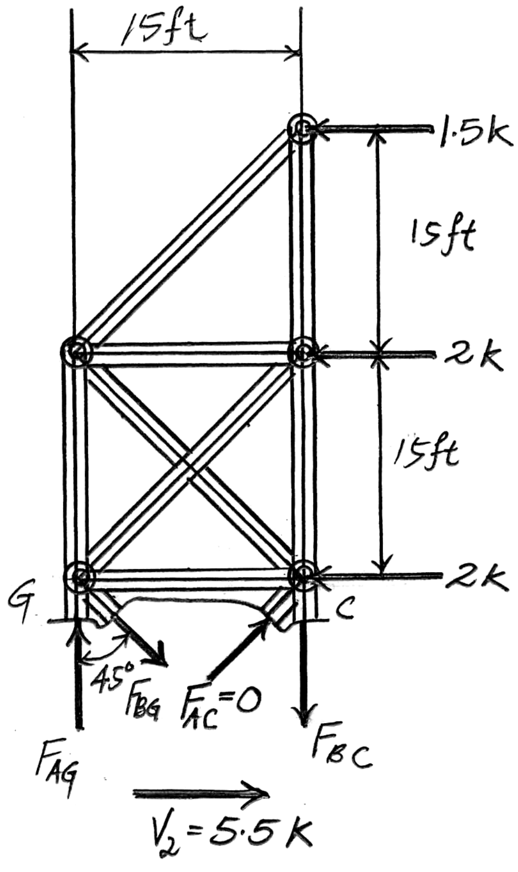
Joint *G*: Referring to Fig. *e*,

$\overset{+}{\rightarrow}\sum F_x = 0;\quad 7.778\sin 45^\circ - F_{CG} = 0 \quad F_{CG} = 5.50\text{ k (C)}$ **Ans.**

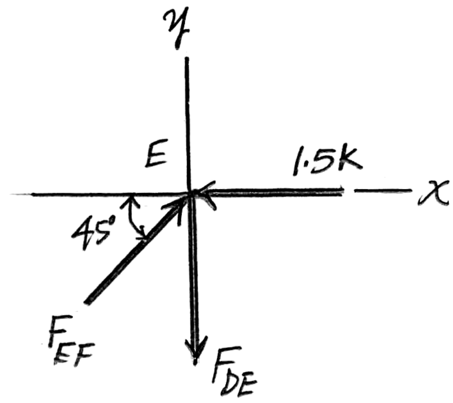
Joint *A*: Referring to Fig. *f*,

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

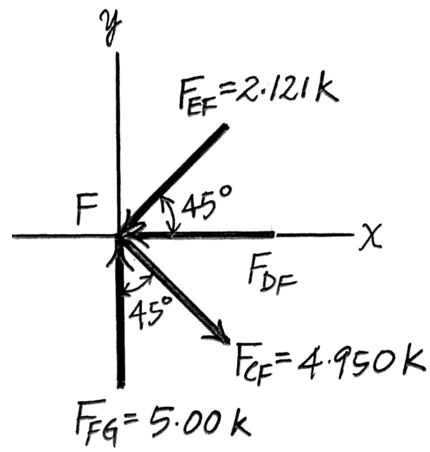
7–10. Continued



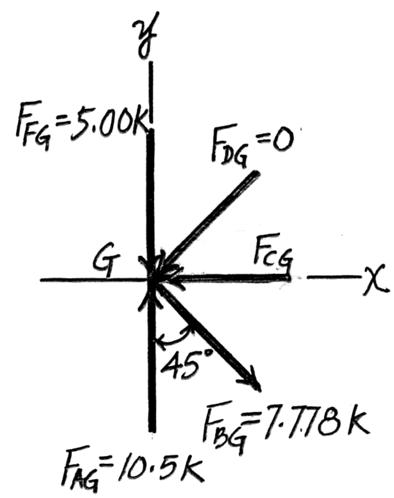
(b)



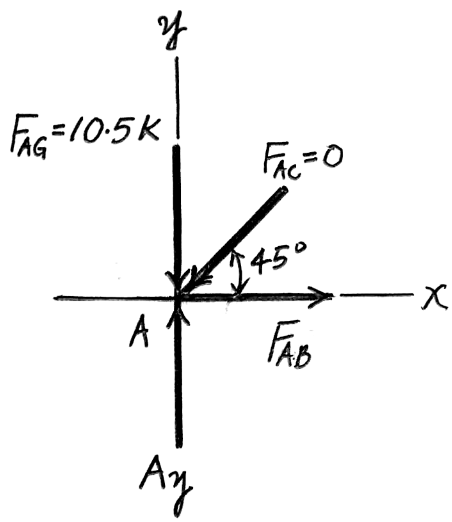
(c)



(d)

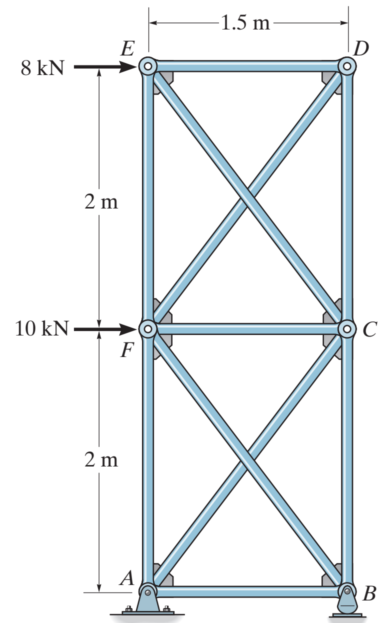


(e)



(f)

7–11. Determine (approximately) the force in each member of the truss. Assume the diagonals can support either a tensile or compressive force.



Method of Sections. It is required that $F_{CE} = F_{DF} = F_1$. Referring to Fig. *a*,

$$\xrightarrow{+} \sum F_x = 0; \quad 8 - 2F_1\left(\frac{3}{5}\right) = 0 \quad F_1 = 6.667 \text{ kN}$$

Therefore,

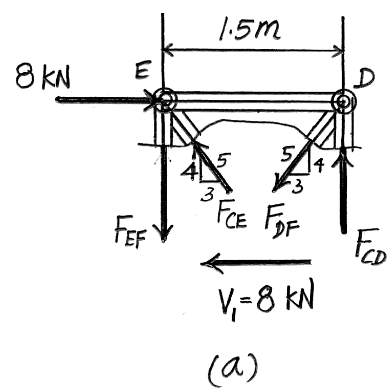
$F_{CE} = 6.67$ kN (C) $\quad F_{DF} = 6.67$ kN (T) **Ans.**

$$\circlearrowleft + \sum M_E = 0; \quad F_{CD}(1.5) - 6.667\left(\frac{4}{5}\right)(1.5) = 0 \quad F_{CD} = 5.333 \text{ kN (C)} = 5.33 \text{ kN (C)}$$

Ans.

$$\circlearrowleft + \sum M_D = 0; \quad F_{EF}(1.5) - 6.667\left(\frac{4}{5}\right)(1.5) = 0 \quad F_{EF} = 5.333 \text{ kN (T)} = 5.33 \text{ kN (T)}$$

Ans.



It is required that $F_{BF} = F_{AC} = F_2$ Referring to Fig. *b*,

$$\xrightarrow{+} \sum F_x = 0; \quad 8 + 10 - 2F_2\left(\frac{3}{5}\right) = 0 \quad F_2 = 15.0 \text{ kN}$$

Therefore,

$F_{BF} = 15.0$ kN (C) $\quad F_{AC} = 15.0$ kN (T) **Ans.**

$$\circlearrowleft + \sum M_F = 0; \quad F_{BC}(1.5) - 15.0\left(\frac{4}{5}\right)(1.5) - 8(2) = 0$$

$F_{BC} = 22.67$ kN (C) $= 22.7$ kN (C) **Ans.**

$$\circlearrowleft + \sum M_C = 0; \quad F_{AF}(1.5) - 15.0\left(\frac{4}{5}\right)(1.5) - 8(2) = 0$$

$F_{AF} = 22.67$ kN (T) $= 22.7$ kN (T) **Ans.**

Method of Joints.

Joint *D*: Referring to Fig. *c*,

$$\xrightarrow{+} \sum F_x = 0; \quad F_{DE} - 6.667\left(\frac{3}{5}\right) = 0 \quad F_{DE} = 4.00 \text{ kN (C)}$$ **Ans.**

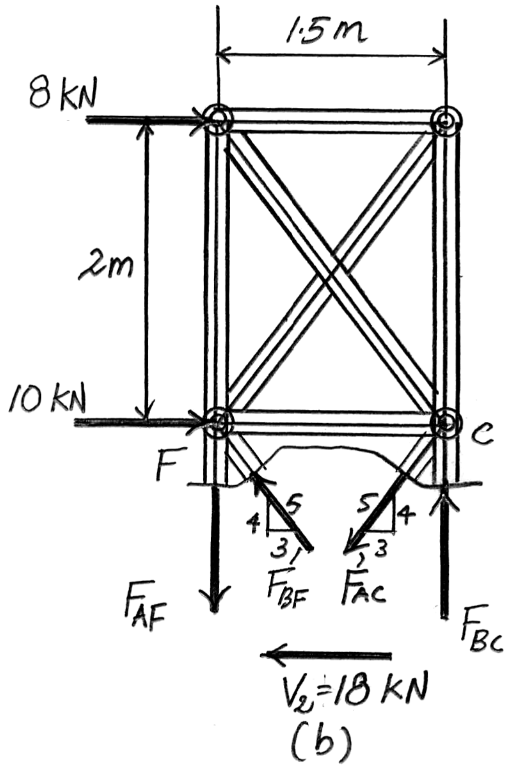
Joint *C*: Referring to Fig. *d*,

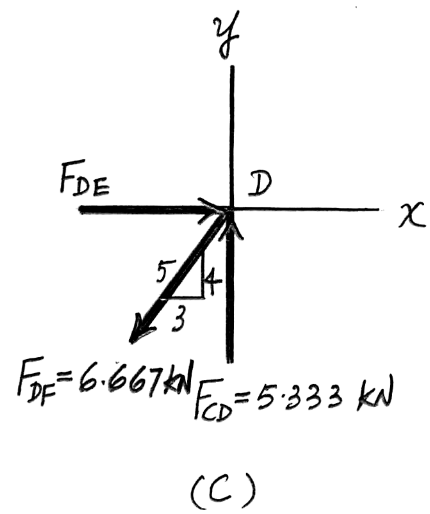
$$\xrightarrow{+} \sum F_x = 0; \quad F_{CF} + 6.667\left(\frac{3}{5}\right) - 15.0\left(\frac{3}{5}\right) = 0 \quad F_{CF} = 5.00 \text{ kN (C)}$$ **Ans.**

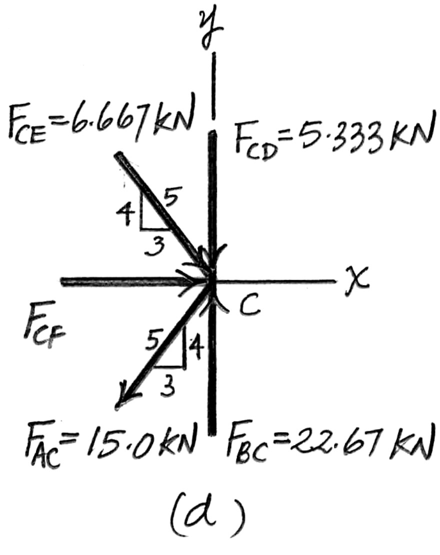
Joint *B*: Referring to Fig. *e*,

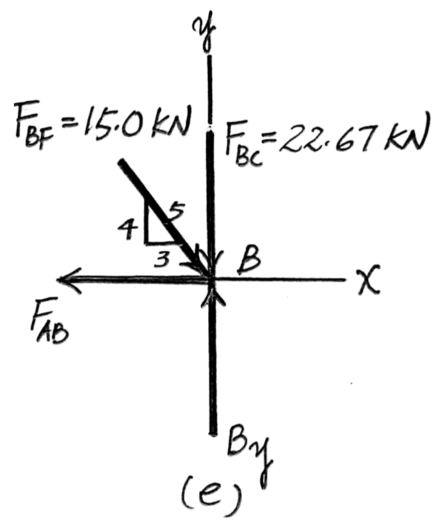
$$\xrightarrow{+} \sum F_x = 0; \quad 15.0\left(\frac{3}{5}\right) - F_{AB} = 9.00 \text{ kN (T)}$$ **Ans.**

7–11. Continued

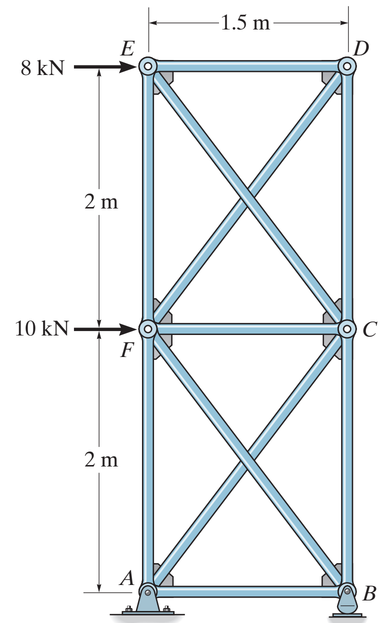








***7–12.** Determine (approximately) the force in each member of the truss. Assume the diagonals cannot support a compressive force.



Method of Sections. It is required that

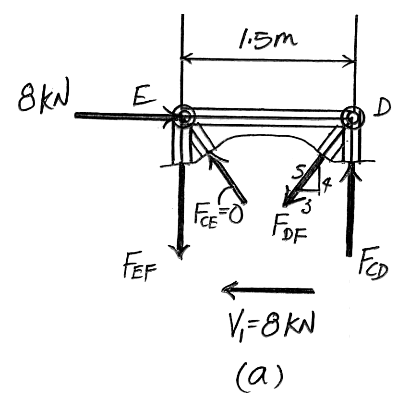
$$F_{CE} = F_{BF} = 0 \qquad \textbf{Ans.}$$

Referring to Fig. *a*,

$$\xrightarrow{+} \sum F_x = 0; \quad 8 - F_{DF}\left(\frac{3}{5}\right) = 0 \quad F_{DF} = 13.33 \text{ kN (T)} = 13.3 \text{ kN (T)} \qquad \textbf{Ans.}$$

$$\circlearrowleft + \sum M_E = 0; \quad F_{CD}(1.5) - 13.33\left(\frac{4}{5}\right)(1.5) = 0 \quad F_{CD} = 10.67 \text{ kN (C)} = 10.7 \text{ kN (C)} \qquad \textbf{Ans.}$$

$$\circlearrowleft + \sum M_D = 0; \quad F_{EF}(1.5) = 0 \quad F_{EF} = 0 \qquad \textbf{Ans.}$$



Referring to Fig. *b*,

$$\xrightarrow{+} \sum F_x = 0; \quad 8 + 10 - F_{AC}\left(\frac{3}{5}\right) = 0 \quad F_{AC} = 30.0 \text{ kN (T)} \qquad \textbf{Ans.}$$

$$\circlearrowleft + \sum M_C = 0; \quad F_{AF}(1.5) - 8(2) = 0 \quad F_{AF} = 10.67 \text{ kN (T)} \qquad \textbf{Ans.}$$

$$\circlearrowleft + \sum M_F = 0; \quad F_{BC}(1.5) - 30.0\left(\frac{4}{5}\right)(1.5) - 8(2) = 0$$

$$F_{BC} = 34.67 \text{ kN (C)} = 34.7 \text{ kN (C)} \qquad \textbf{Ans.}$$

Method of Joints.

Joint *E*: Referring to Fig. *c*,

$$\xrightarrow{+} \sum F_x = 0; \quad 8 - F_{DE} = 0 \quad F_{DE} = 8.00 \text{ kN (C)} \qquad \textbf{Ans.}$$

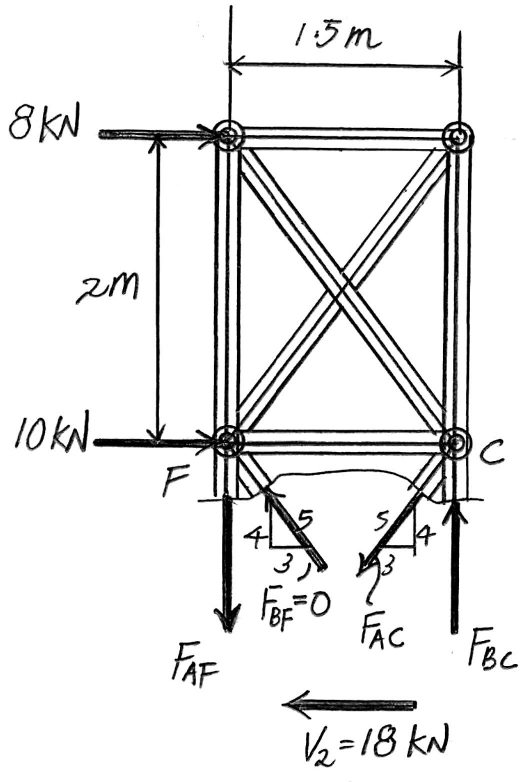
Joint *C*: Referring to Fig. *d*,

$$\xrightarrow{+} \sum F_x = 0; \quad F_{CF} - 30.0\left(\frac{3}{5}\right) = 0 \quad F_{CF} = 18.0 \text{ kN (C)} \qquad \textbf{Ans.}$$

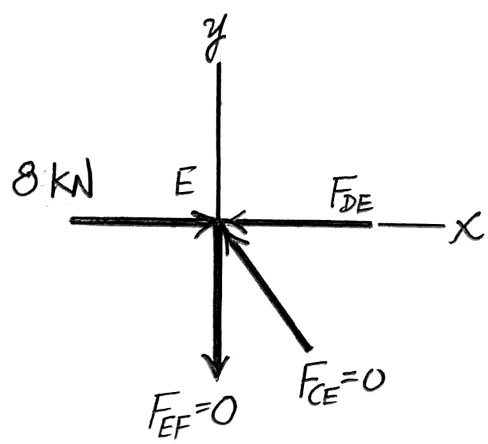
Joint *B*: Referring to Fig. *e*,

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

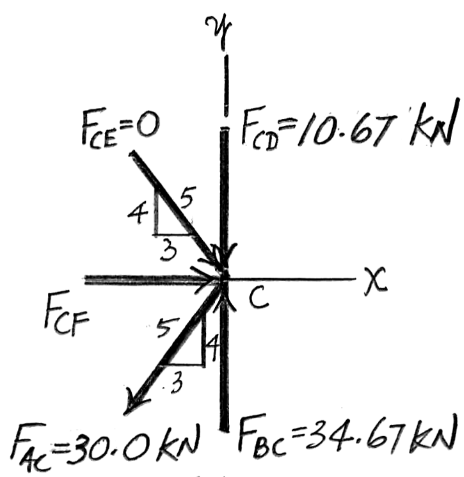
7–12. Continued



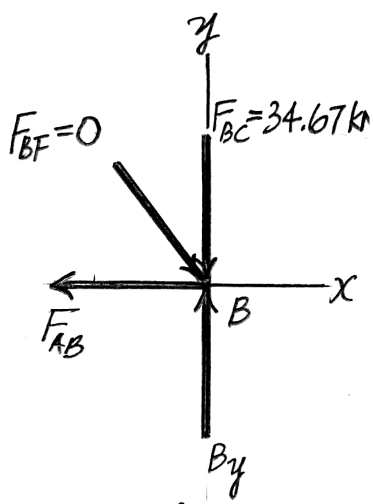
(b)



(c)

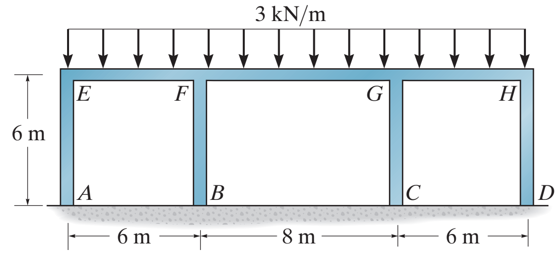


(d)



(e)

7–13. Determine (approximately) the internal moments at joints A and B of the frame.



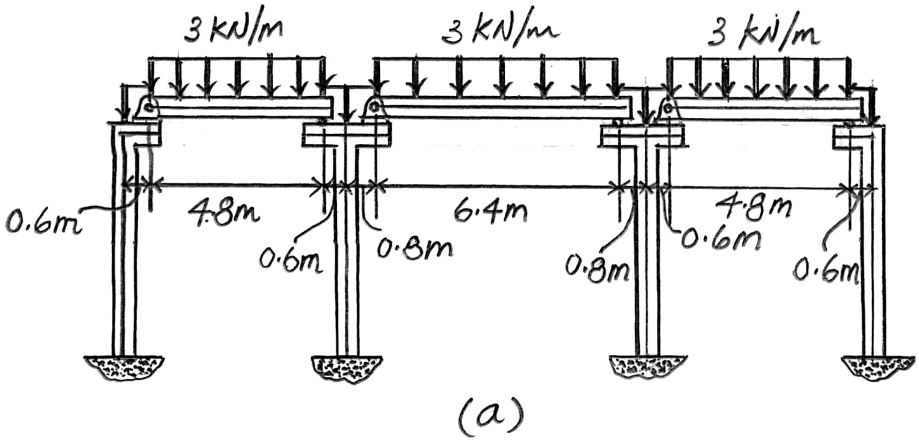
The frame can be simplified to that shown in Fig. *a*, referring to Fig. *b*,

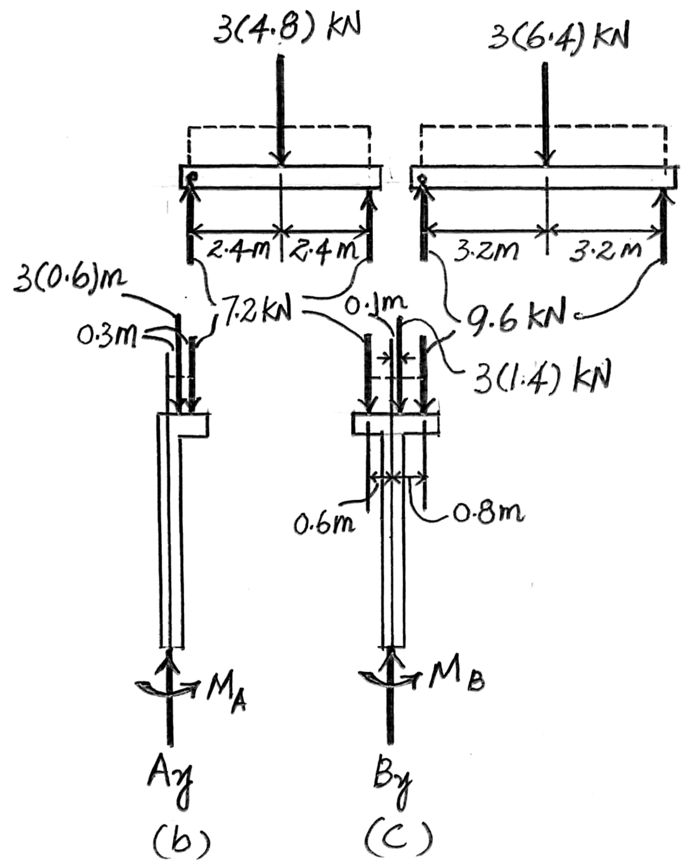
$\circlearrowleft + \sum M_A = 0; \quad M_A - 7.2(0.6) - 3(0.6)(0.3) = 0 \quad M_A = 4.86\ \text{kN} \cdot \text{m}$ **Ans.**

Referring to Fig. *c*,

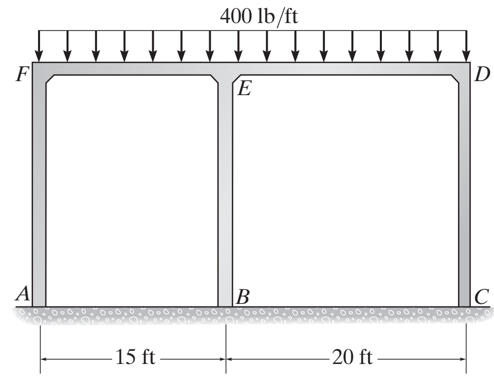
$\circlearrowleft + \sum M_B = 0; \quad M_B - 9.6(0.8) - 3(1.4)(0.1) + 7.2(0.6) = 0$

$M_B = 3.78\ \text{kN} \cdot \text{m}$ **Ans.**





7–14. Determine (approximately) the internal moments at joints F and D of the frame.

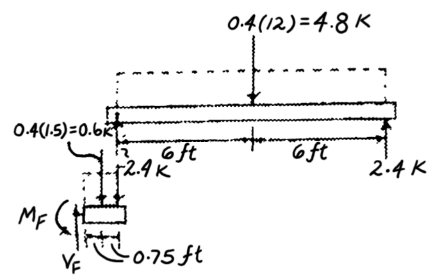


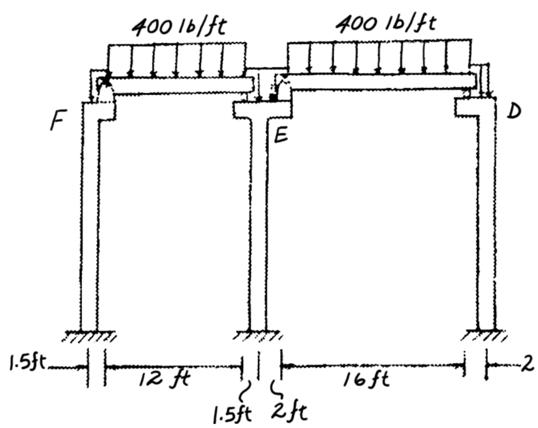
$\circlearrowleft + \sum M_F = 0; \quad M_F - 0.6(0.75) - 2.4(1.5) = 0$

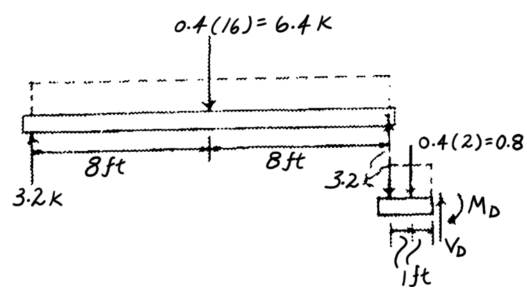
$M_F = 4.05 \text{ k} \cdot \text{ft}$ **Ans.**

$\circlearrowleft + \sum M_D = 0; \quad -M_D + 0.8(1) + 3.2(2) = 0$

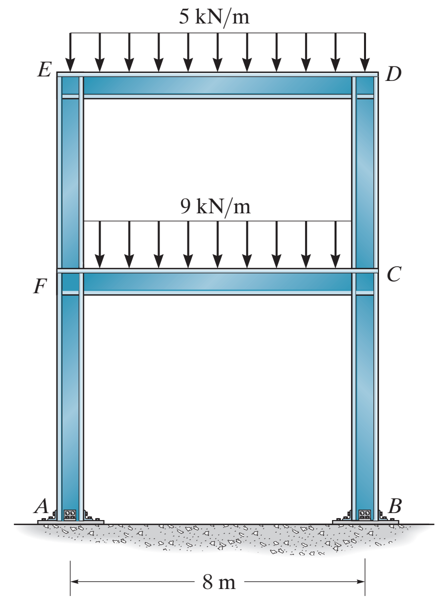
$M_D = 7.20 \text{ k} \cdot \text{ft}$ **Ans.**







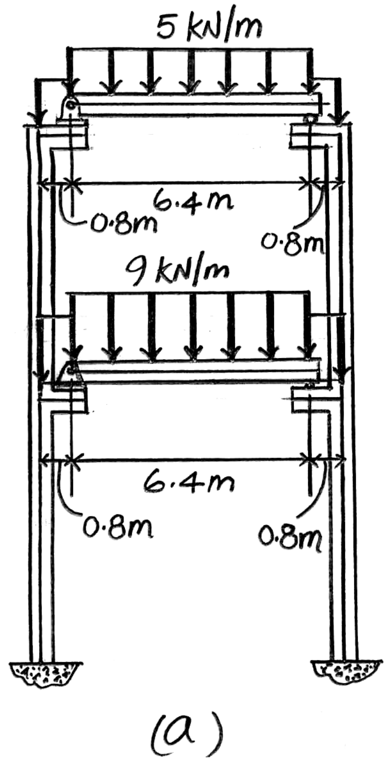
7–15. Determine (approximately) the internal moment at A caused by the vertical loading.

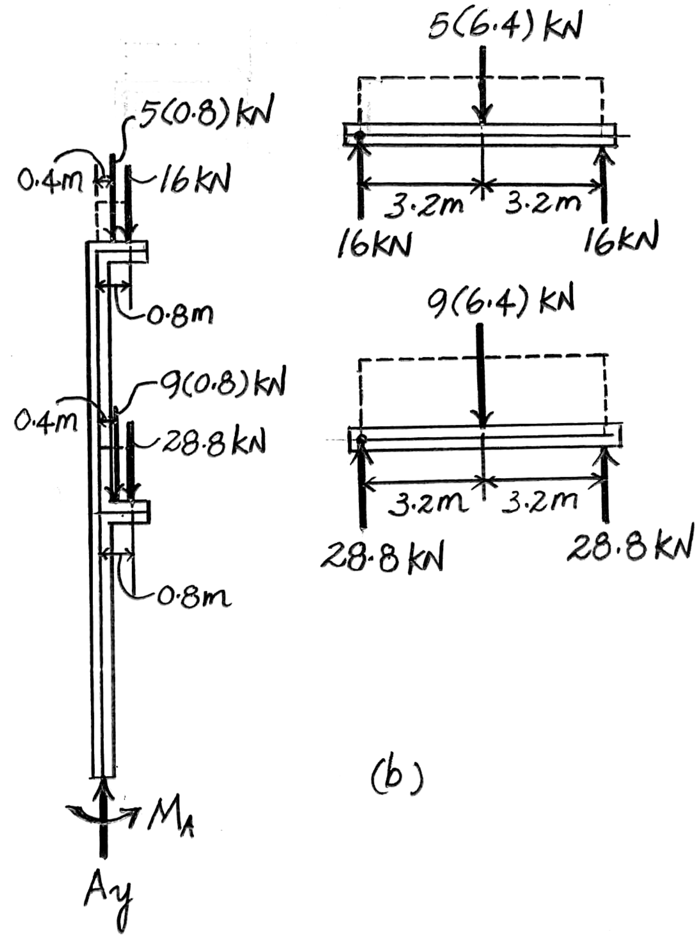


The frame can be simplified to that shown in Fig. a, Referring to Fig. b,

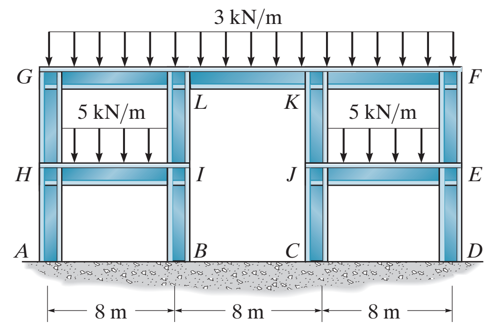
$$\circlearrowleft + \sum M_A = 0; \quad M_A - 5(0.8)(0.4) - 16(0.8) - 9(0.8)(0.4) - 28.8(0.8) = 0$$

$$M_A = 40.32 \text{ kN}\cdot\text{m} = 40.3 \text{ kN}\cdot\text{m} \qquad \textbf{Ans.}$$





***7–16.** Determine (approximately) the internal moments at A and B caused by the vertical loading.



The frame can be simplified to that shown in Fig. *a*. The reactions of the 3 kN/m and 5 kN/m uniform distributed loads are shown in Fig. *b* and *c* respectively. Referring to Fig. *d*,

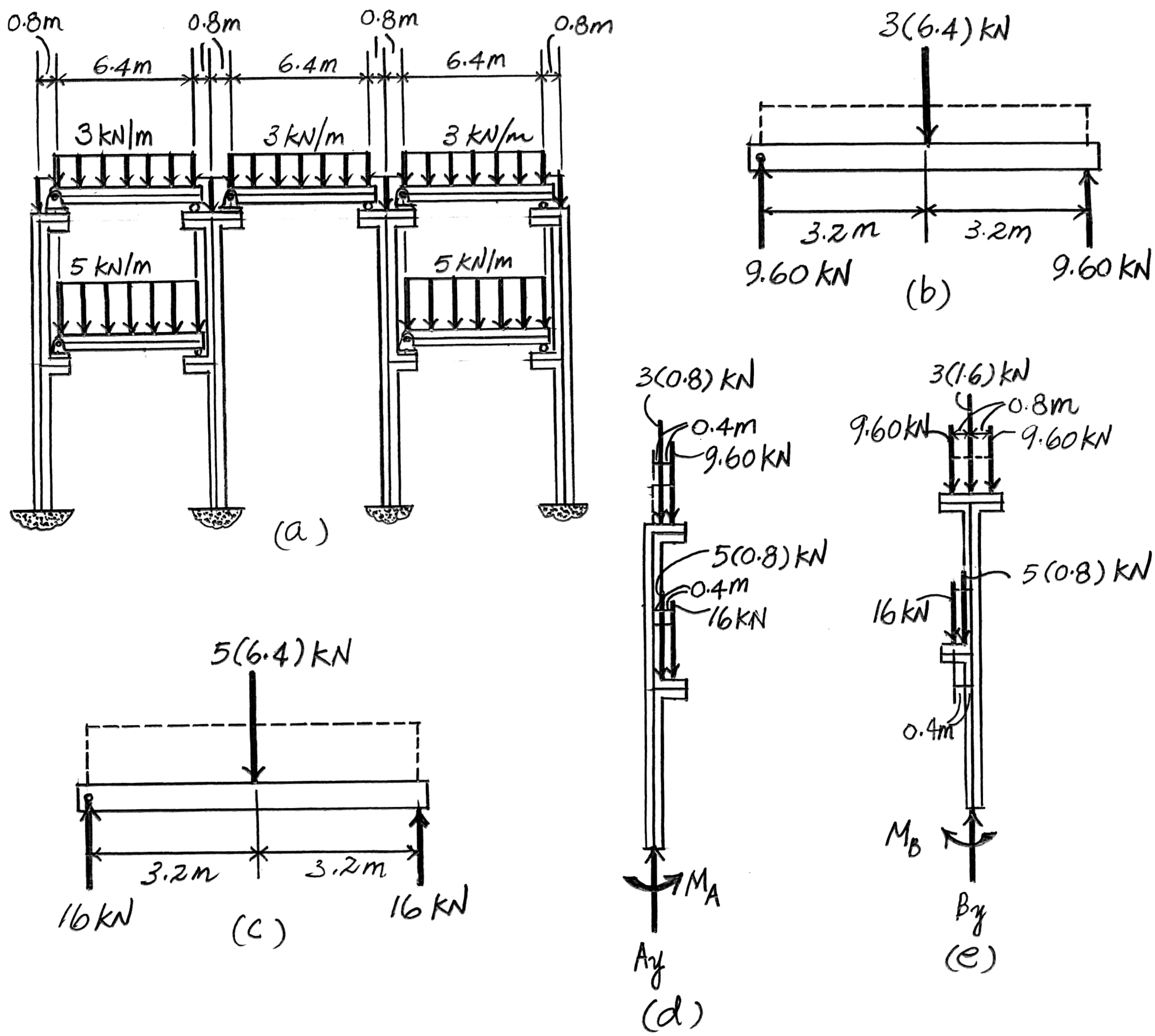
$$\circlearrowleft + \sum M_A = 0;\; M_A - 3(0.8)(0.4) - 9.6(0.8) - 5(0.8)(0.4) - 16(0.8) = 0$$

$$M_A = 23.04 \text{ kN} \cdot \text{m} = 23.0 \text{ kN} \cdot \text{m}$$ **Ans.**

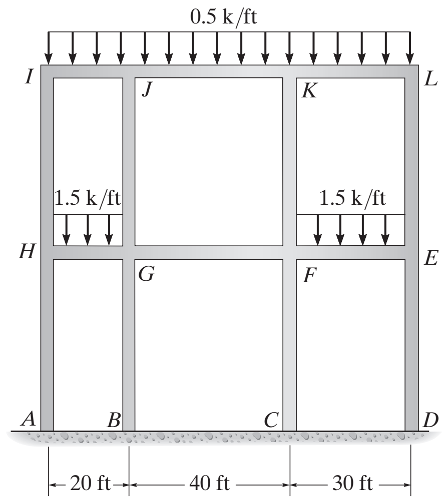
Referring to Fig. *e*,

$$\circlearrowleft + \sum M_B = 0;\; 9.60(0.8) - 9.60(0.8) + 5(0.8)(0.4) + 16(0.8) - M_B = 0$$

$$M_B = 14.4 \text{ kN} \cdot \text{m}$$ **Ans.**



7–17. Determine (approximately) the internal moments at joints I and L. Also, what is the internal moment at joint H caused by member HG?



Joint I:

$\circlearrowleft + \sum M_I = 0; \qquad M_I - 1.0(1) - 4.0(2) = 0$

$M_I = 9.00 \text{ k} \cdot \text{ft}$ **Ans.**

Joint L:

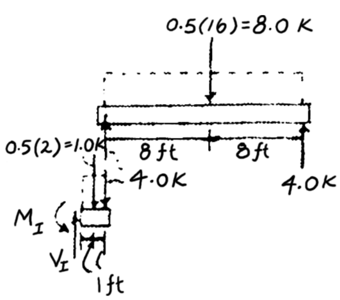
$\circlearrowleft + \sum M_L = 0; \qquad M_L - 6.0(3) - 1.5(1.5) = 0$

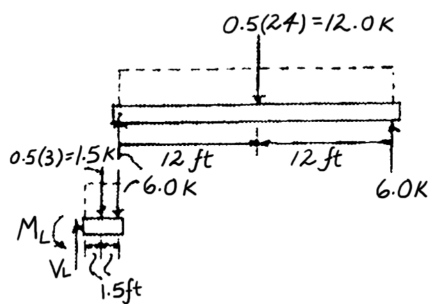
$M_L = 20.25 \text{ k} \cdot \text{ft}$ **Ans.**

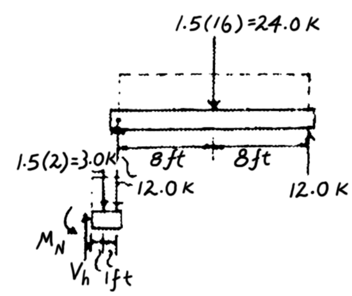
Joint H:

$\circlearrowleft + \sum M_H = 0; \qquad M_H - 3.0(1) - 12.0(2) = 0$

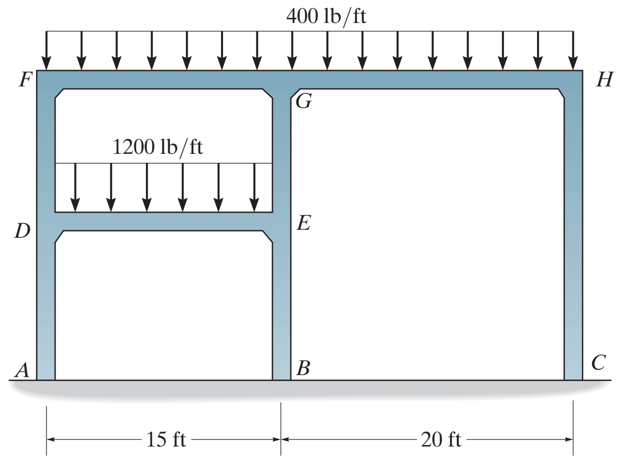
$M_H = 27.0 \text{ k} \cdot \text{ft}$ **Ans.**







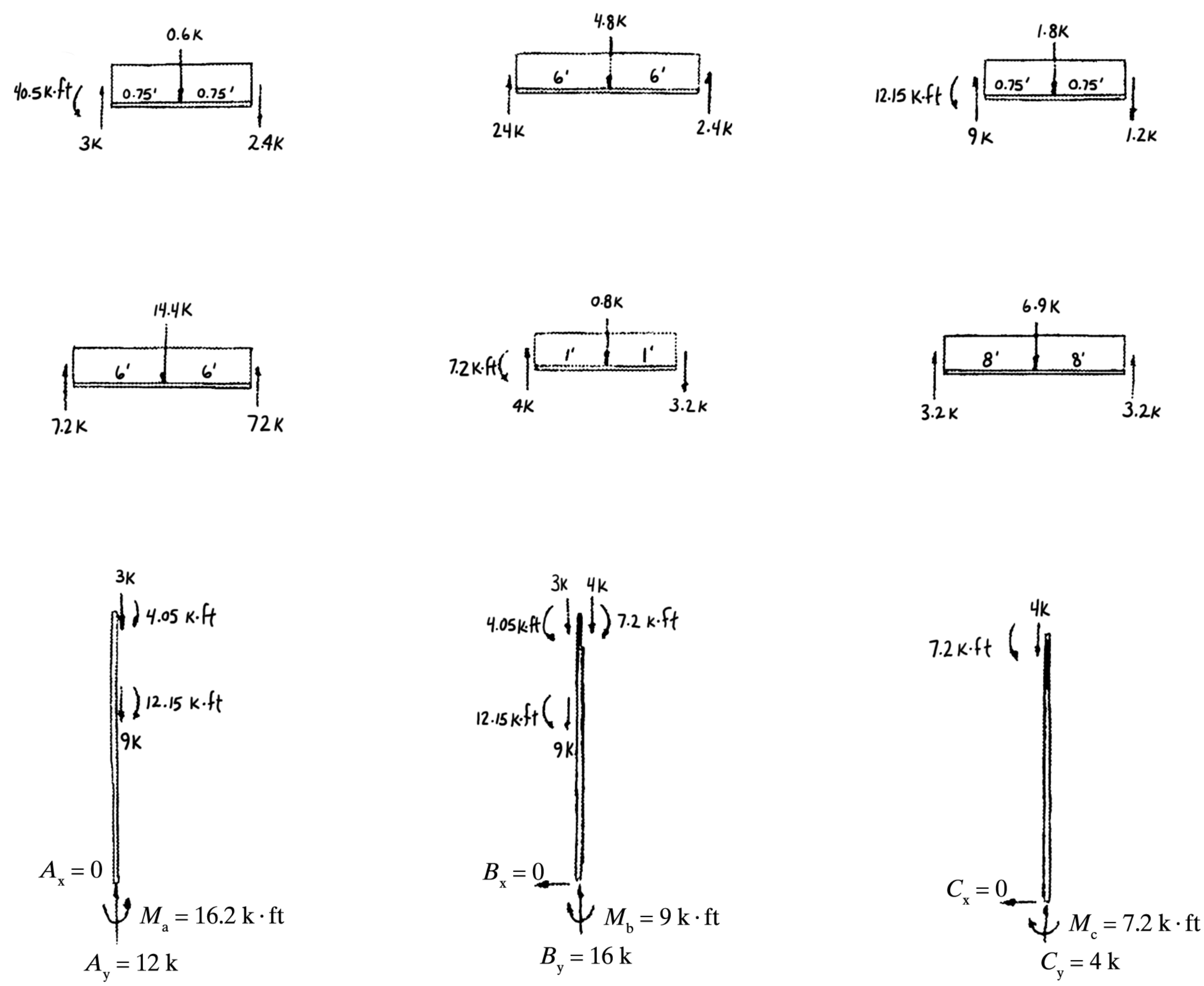
7–18. Determine (approximately) the support actions at A, B, and C of the frame.



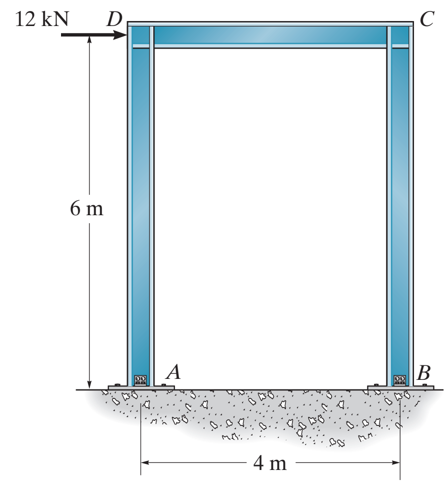
$A_x = 0$ $\quad B_x = 0$ $\quad C_x = 0$ **Ans.**

$A_y = 12$ k $\quad B_y = 16$ k $\quad C_y = 4$ k **Ans.**

$M_A = 16.2$ k · ft $\quad M_B = 9$ k · ft $\quad M_C = 7.2$ k · ft **Ans.**



7–19. Determine (approximately) the support reactions at A and B of the portal frame. Assume the supports are (a) pinned, and (b) fixed.



For printed base, referring to Fig. *a* and *b*,

$\circlearrowleft + \sum M_A = 0;$ $\quad E_x(6) + E_y(2) - 12(6) = 0$ (1)

$\circlearrowleft + \sum M_B = 0;$ $\quad E_y(6) - E_x(6) = 0$ (2)

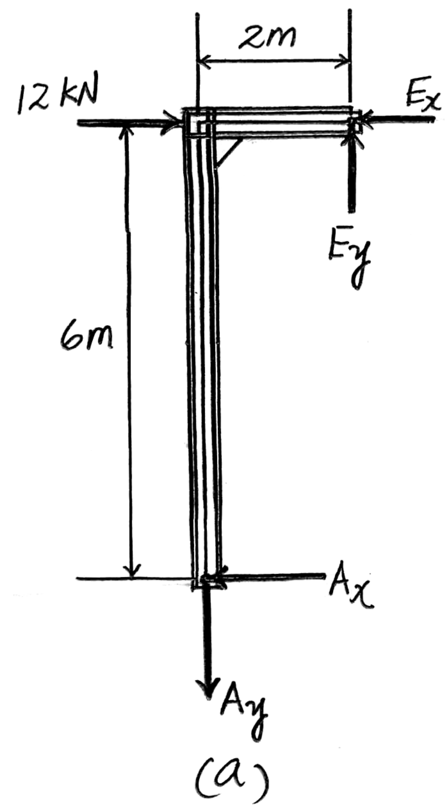
Solving Eqs. (1) and (2) yield

$E_y = 18.0\text{ kN}$ $\quad E_x = 6.00\text{ kN}$

Referring to Fig. *a*,

$\overset{+}{\rightarrow} \sum F_x = 0;$ $\quad 12 - 6.00 - A_x = 0$ $\quad A_x = 6.00\text{ kN}$ **Ans.**

$+\uparrow \sum F_y = 0;$ $\quad 18.0 - A_y = 0$ $\quad A_y = 18.0\text{ kN}$ **Ans.**



Referring to Fig. *b*,

$\overset{+}{\rightarrow} \sum F_x = 0;$ $\quad 6.00 - B_x = 0$ $\quad B_x = 6.00\text{ kN}$ **Ans.**

$+\uparrow \sum F_y = 0;$ $\quad B_y - 18.0 = 0$ $\quad B_y = 18.0\text{ kN}$ **Ans.**

For the fixed base, referring to Fig. *c* and *d*,

$\circlearrowleft + \sum M_E = 0;$ $\quad F_x(3) + F_y(2) - 12(3) = 0$ (1)

$\circlearrowleft + \sum M_G = 0;$ $\quad F_y(2) - F_x(3) = 0$ (2)

Solving Eqs (1) and (2) yields,

$F_y = 9.00\text{ kN}$ $\quad F_x = 6.00\text{ kN}$

Referring to Fig. *c*,

$\overset{+}{\rightarrow} \sum F_x = 0;$ $\quad 12 - 6.00 - E_x = 0$ $\quad E_x = 6.00\text{ kN}$

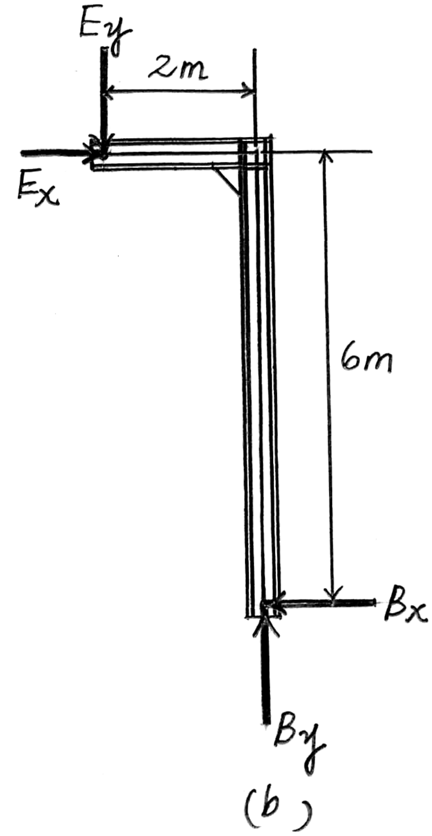
$+\uparrow \sum F_y = 0;$ $\quad 9.00 - E_y = 0$ $\quad E_y = 9.00\text{ kN}$

Referring to Fig. *d*,

$\overset{+}{\rightarrow} \sum F_x = 0;$ $\quad 6.00 - G_x = 0$ $\quad G_x = 6.00\text{ kN}$

$+\uparrow \sum F_y = 0;$ $\quad G_y - 9.00 = 0$ $\quad G_y = 9.00\text{ kN}$

7–19. Continued



Referring to Fig. *e*,

$\overset{+}{\rightarrow} \sum F_x = 0;$ $\quad 6.00 - A_x = 0$ $\quad A_x = 6.00 \text{ kN}$ **Ans.**

$+\uparrow \sum F_y = 0;$ $\quad 9.00 - A_y = 0$ $\quad A_y = 9.00 \text{ kN}$ **Ans.**

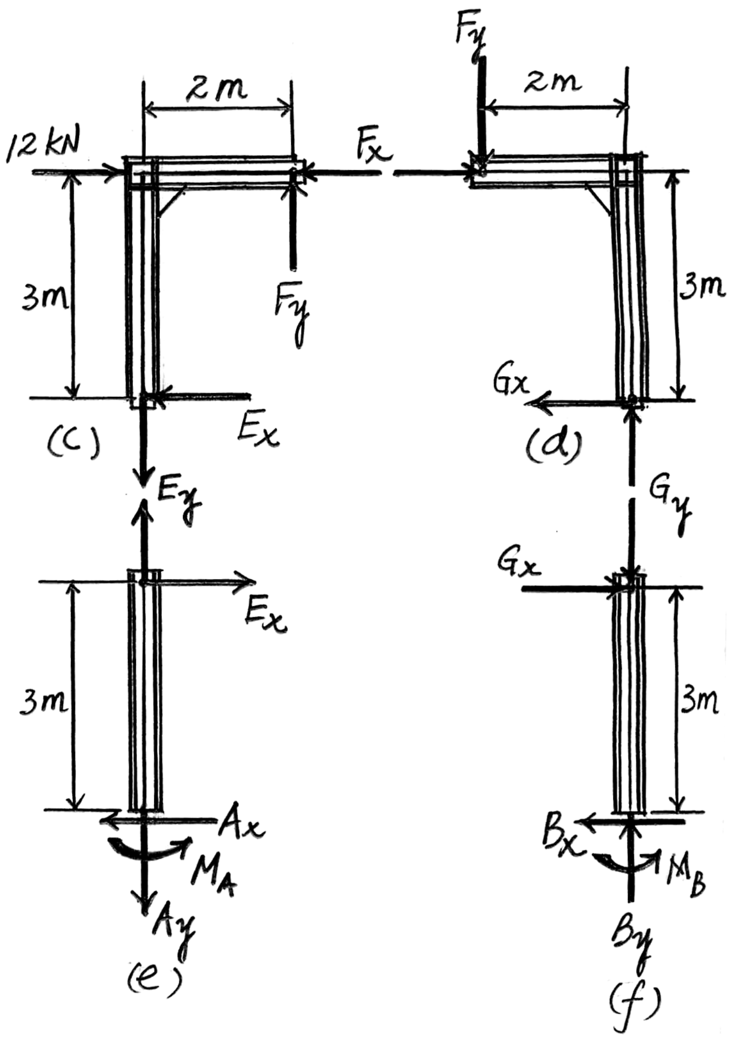
$\circlearrowleft + \sum M_A = 0;$ $\quad M_A - 6.00(3) = 0$ $\quad M_A = 18.0 \text{ kN} \cdot \text{m}$ **Ans.**

Referring to Fig. *f*,

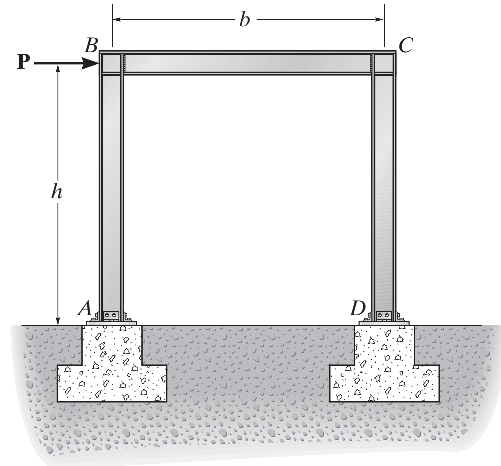
$\overset{+}{\rightarrow} \sum F_x = 0;$ $\quad 6.00 - B_x = 0$ $\quad B_x = 6.00 \text{ kN}$ **Ans.**

$+\uparrow \sum F_y = 0;$ $\quad B_y - 9.00 = 0$ $\quad B_y = 9.00 \text{ kN}$ **Ans.**

$\circlearrowleft + \sum M_B = 0;$ $\quad M_B - 6.00(3) = 0$ $\quad M_B = 18.0 \text{ kN} \cdot \text{m}$ **Ans.**



***7–20.** Determine (approximately) the internal moment and shear at the ends of each member of the portal frame. Assume the supports at A and D are partially fixed, such that an inflection point is located at $h/3$ from the bottom of each column.



$$\circlearrowleft + \sum M_B = 0; \qquad G_y(b) - P\left(\frac{2h}{3}\right) = 0$$

$$G_y = P\left(\frac{2h}{3b}\right)$$

$$+\uparrow \sum F_y = 0; \qquad E_y = \frac{2Ph}{3b} = 0$$

$$E_y = \frac{2Ph}{3b}$$

$$M_A = M_D = \frac{P}{2}\left(\frac{h}{3}\right) = \frac{Ph}{6} \qquad \textbf{Ans.}$$

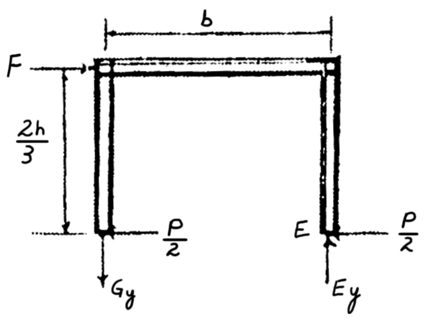
$$M_B = M_C = \frac{P}{2}\left(\frac{2h}{3}\right) = \frac{Ph}{3} \qquad \textbf{Ans.}$$

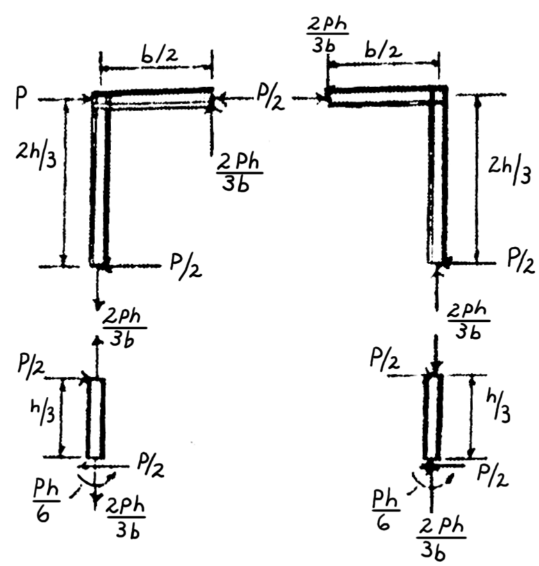
Member BC:

$$V_B = V_C = \frac{2Ph}{3b} \qquad \textbf{Ans.}$$

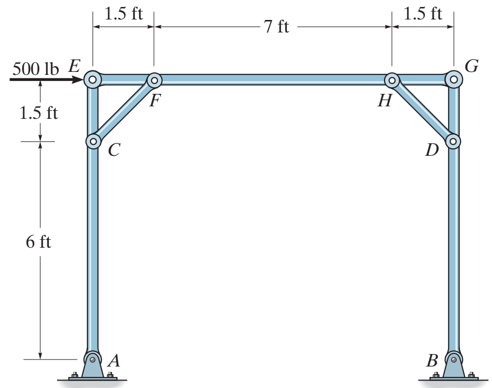
Members AB and CD:

$$V_A = V_B = V_C = V_D = \frac{P}{2} \qquad \textbf{Ans.}$$





7–21. Draw (approximately) the moment diagram for member *ACE* of the portal constructed with a *rigid* member *EG* and knee braces *CF* and *DH*. Assume that all points of connection are pins. Also determine the force in the knee brace *CF*.



Inflection points are at *A* and *B*.

From FBD (1):

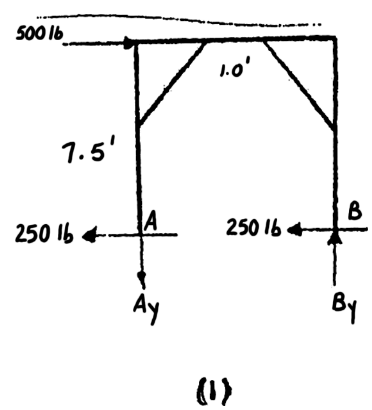
$\circlearrowleft + \sum M_B = 0; \quad A_y(10) - 500(7.5) = 0; \quad A_y = 375 \text{ lb}$

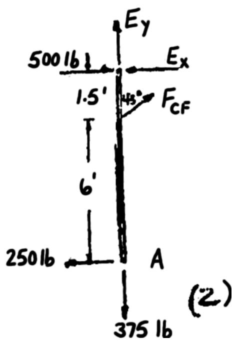
From FBD (2):

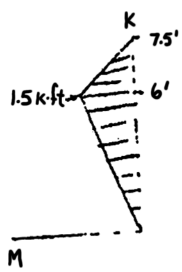
$\circlearrowleft + \sum M_E = 0; \quad 250(7.5) - F_{CF}(\sin 45°)(1.5) = 0; \quad F_{CF} = 1.77 \text{ k(T)}$ **Ans.**

$\xrightarrow{+} \sum F_x = 0; \quad -250 + 1767.8(\sin 45°) + 500 - E_x = 0$

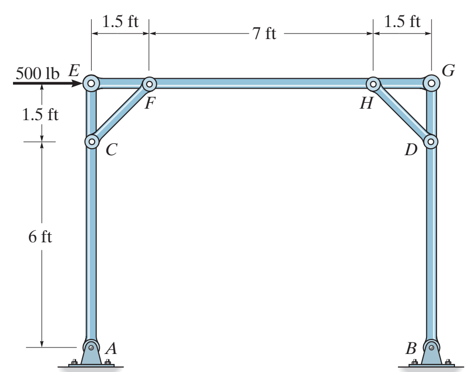
$E_x = 1500 \text{ lb}$







***7–22.** Solve Prob. 7–21 if the supports at *A* and *B* are fixed instead of pinned.



Inflection points are as mid-points of columns

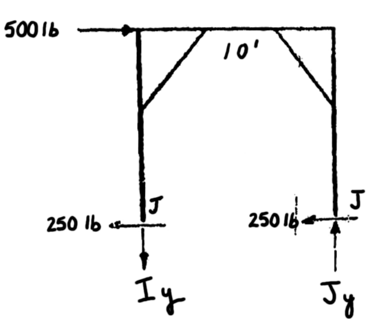
$\circlearrowleft + \sum M_I = 0; \quad J_y(10) - 500(3.5) = 0; \quad J_y = 175 \text{ lb}$

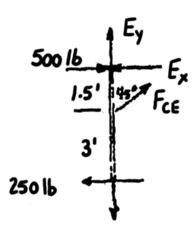
$+\uparrow \sum F_y = 0; \quad -I_y + 175 = 0; \quad I_y = 175 \text{ lb}$

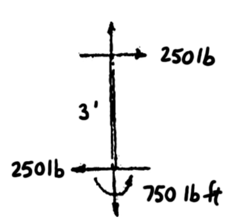
$\circlearrowleft + \sum M_E = 0; \quad 250(4.5) - F_{CE}(\sin 45°)(1.5) = 0; \quad F_{CE} = 1.06 \text{ k(T)}$ **Ans.**

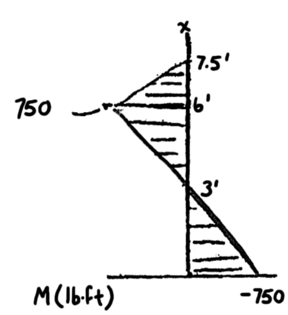
$\xrightarrow{+} \sum F_x = 0; \quad 500 + 1060.66(\sin 45°) - 250 - E_x = 0;$

$E_x = 1.00 \text{ k}$

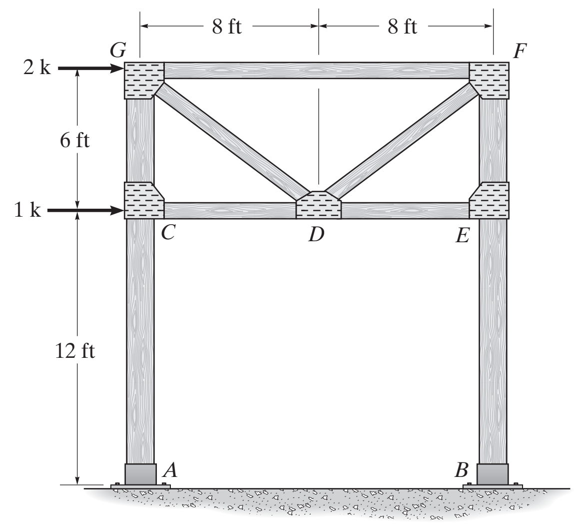








7–23. Determine (approximately) the force in each truss member of the portal frame. Also find the reactions at the fixed column supports A and B. Assume all members of the truss to be pin connected at their ends.



Assume that the horizontal reactive force component at fixed supports A and B are equal. Thus

$$A_x = B_x = \frac{2+1}{2} = 1.50 \text{ k} \qquad \textbf{Ans.}$$

Also, the points of inflection H and I are at 6 ft above A and B respectively. Referring to Fig. a,

$$\circlearrowleft + \sum M_I = 0; \quad H_y(16) - 1(6) - 2(12) = 0 \qquad H_y = 1.875 \text{ k}$$

$$+\uparrow \sum F_y = 0; \quad I_y - 1.875 = 0 \qquad I_y = 1.875 \text{ k}$$

Referring to Fig. b,

$$\xrightarrow{+} \sum F_x = 0; \quad H_x - 1.50 = 0 \qquad H_x = 1.50 \text{ k}$$

$$+\uparrow \sum F_y = 0; \quad 1.875 - A_y = 0 \qquad A_y = 1.875 \text{ k} \qquad \textbf{Ans.}$$

$$\circlearrowleft + \sum M_A = 0; \quad M_A - 1.50(6) = 0 \qquad M_A = 9.00 \text{ k} \cdot \text{ft} \qquad \textbf{Ans.}$$

Referring to Fig. c,

$$\xrightarrow{+} \sum F_x = 0; \quad 1.50 - B_x = 0 \qquad B_x = 1.50 \text{ k}$$

$$+\uparrow \sum F_y = 0; \quad B_y - 1.875 = 0 \qquad B_y = 1.875 \text{ k} \qquad \textbf{Ans.}$$

$$\circlearrowleft + \sum M_B = 0; \quad M_B - 1.50(6) = 0 \qquad M_B = 9.00 \text{ k} \cdot \text{ft} \qquad \textbf{Ans.}$$

Using the method of sections, Fig. d,

$$+\uparrow \sum F_y = 0; \quad F_{DG}\left(\frac{3}{5}\right) - 1.875 = 0 \qquad F_{DG} = 3.125 \text{ k (C)} \qquad \textbf{Ans.}$$

$$\circlearrowleft + \sum M_G = 0; \quad F_{CD}(6) + 1(6) - 1.50(12) = 0 \qquad F_{CD} = 2.00 \text{ k (C)} \qquad \textbf{Ans.}$$

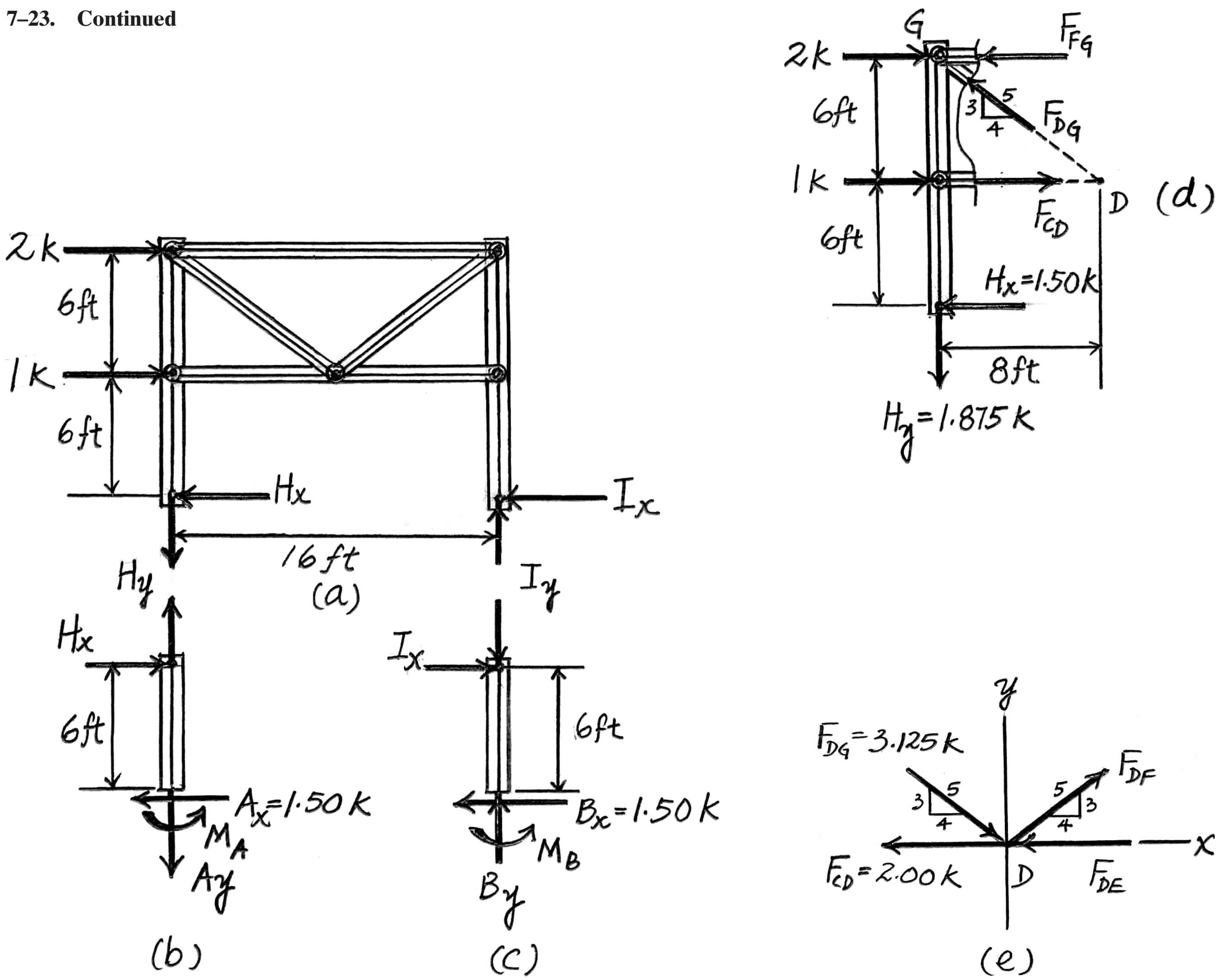
$$\circlearrowleft + \sum M_D = 0; \quad F_{FG}(6) - 2(6) + 1.5(6) + 1.875(8) = 0 \qquad F_{FG} = 1.00 \text{ k (C)} \qquad \textbf{Ans.}$$

Using the method of Joints, Fig. e,

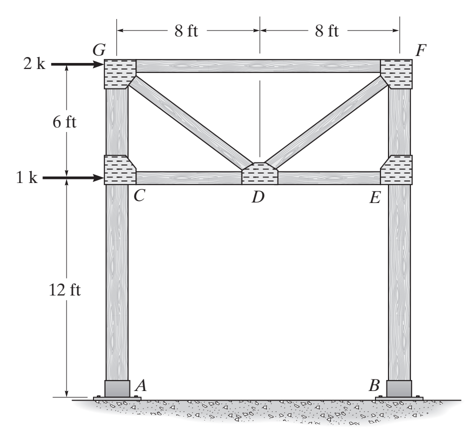
$$+\uparrow \sum F_y = 0; \quad F_{DF}\left(\frac{3}{5}\right) - 3.125\left(\frac{3}{5}\right) = 0 \qquad F_{DF} = 3.125 \text{ k (T)} \qquad \textbf{Ans.}$$

$$\xrightarrow{+} \sum F_x = 0; \quad 3.125\left(\frac{4}{5}\right) + 3.125\left(\frac{4}{5}\right) - 2.00 - F_{DE} = 0 \quad F_{DE} = 3.00 \text{ k (C)} \qquad \textbf{Ans.}$$

7–23. Continued



***7–24.** Solve Prob. 7–23 if the supports at A and B are pinned instead of fixed.



Assume that the horizontal reactive force component at pinal supports A and B are equal. Thus,

$$A_x = B_x = \frac{H2}{2} = 1.50 \text{ k} \qquad \textbf{Ans.}$$

Referring to Fig. a,

$$\circlearrowleft + \sum M_B = 0; \quad A_y(16) - 1(12) - 2(18) = 0 \quad A_y = 3.00 \text{ k} \qquad \textbf{Ans.}$$

$$+\uparrow \sum F_y = 0; \quad B_y - 3.00 = 0 \quad B_y = 3.00 \text{ k} \qquad \textbf{Ans.}$$

7–24. Continued

Using the method of sections and referring to Fig. *b*,

$+\uparrow\sum F_y = 0;\quad F_{DG}\left(\frac{3}{5}\right) - 3.00 = 0 \qquad F_{DG} = 5.00\text{ k (C)}$ **Ans.**

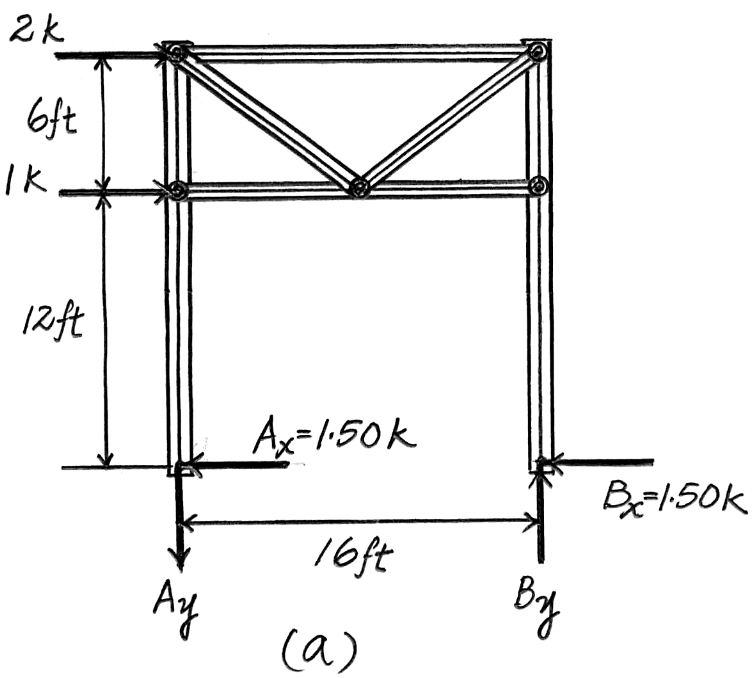
$\circlearrowleft+\sum M_D = 0;\quad F_{GF}(6) - 2(6) - 1.5(12) + 3(8) = 0 \qquad F_{GF} = 1.00\text{ k (C)}$ **Ans.**

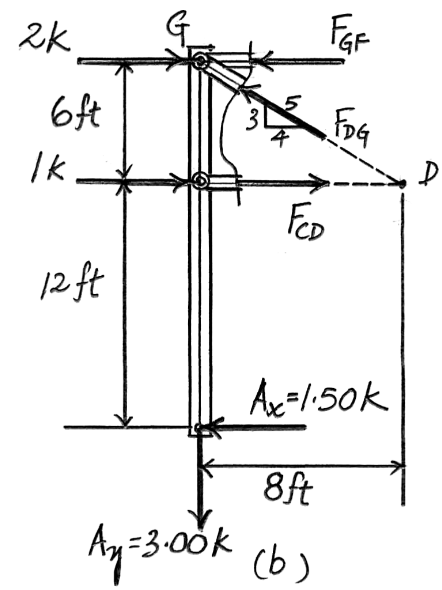
$\circlearrowleft+\sum M_G = 0;\quad F_{CD}(6) + 1(6) - 1.50(18) = 0 \qquad F_{CD} = 3.50\text{ k (T)}$ **Ans.**

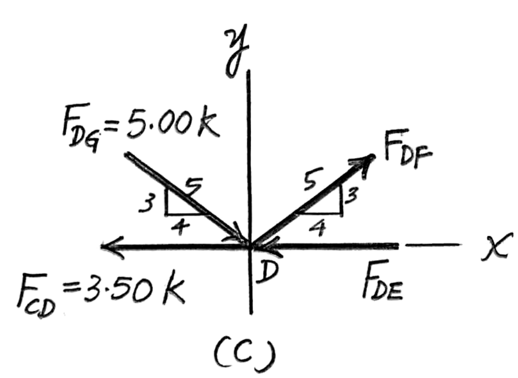
Using the method of joints, Fig. *c*,

$+\uparrow\sum F_y = 0;\quad F_{DF}\left(\frac{3}{5}\right) - 5.00\left(\frac{3}{5}\right) = 0 \qquad F_{DF} = 5.00\text{ k (T)}$ **Ans.**

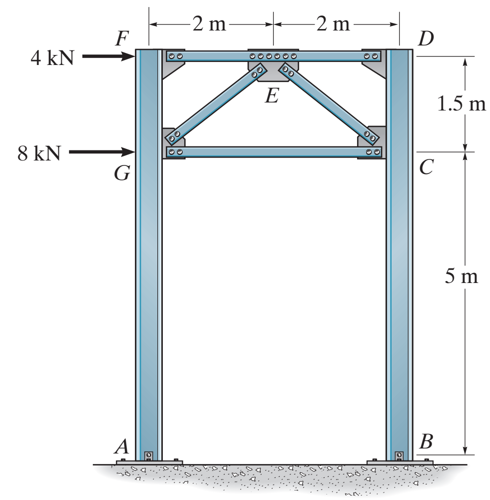
$\xrightarrow{+}\sum F_x = 0;\quad 5.00\left(\frac{4}{5}\right) + 5.00\left(\frac{4}{5}\right) - 3.50 - F_{DE} = 0 \qquad F_{DE} = 4.50\text{ k (C)}$ **Ans.**







7–25. Draw (approximately) the moment diagram for column *AGF* of the portal. Assume all truss members and the columns to be pin connected at their ends. Also determine the force in all the truss members.



Assume that the horizontal force components at pin supports A and B are equal.

Thus,

$$A_x = B_x = \frac{4 + 8}{2} = 6.00 \text{ kN}$$

Referring to Fig. *a*,

$$\curvearrowleft + \sum M_A = 0; \quad B_y(4) - 8(5) - 4(6.5) = 0 \quad B_y = 16.5 \text{ kN}$$

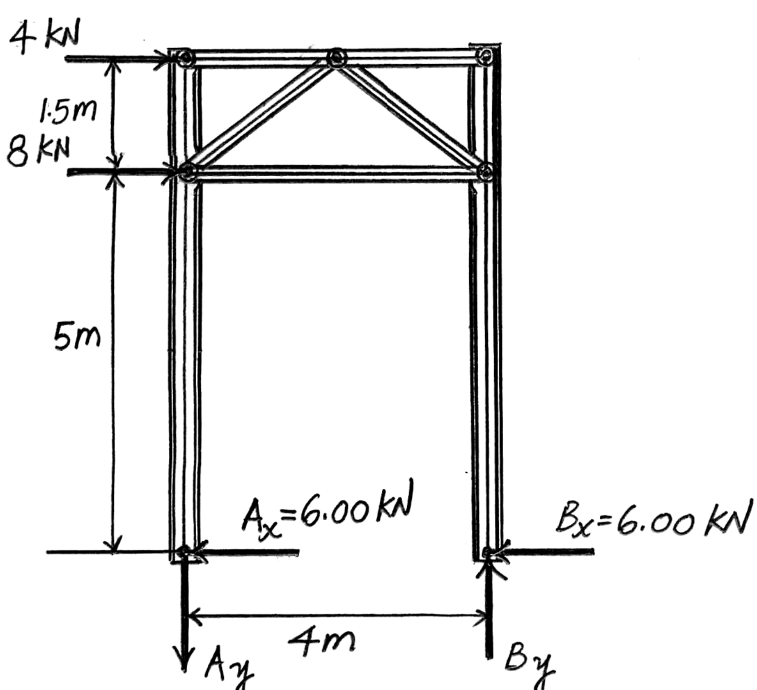
$$+\uparrow \sum F_y = 0; \quad 16.5 - A_y = 0 \quad A_y = 16.5 \text{ kN}$$

Using the method of sections, Fig. *b*,

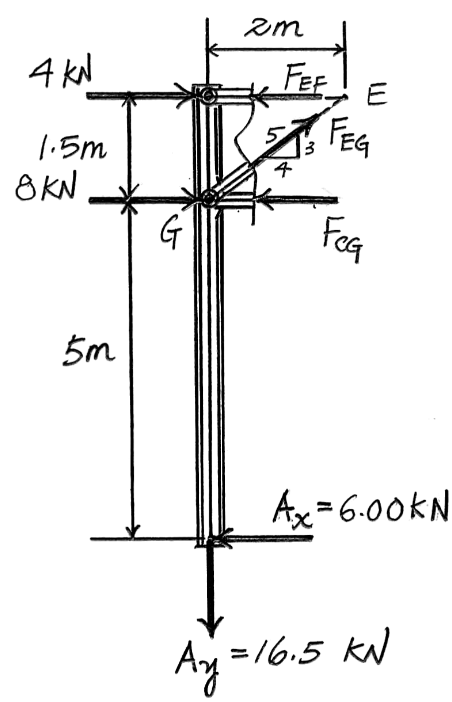
$$+\uparrow \sum F_y = 0; \quad F_{EG}\left(\frac{3}{5}\right) - 16.5 = 0 \quad F_{EG} = 27.5 \text{ kN (T)}$$ **Ans.**

$$\curvearrowleft + \sum M_G = 0; \quad F_{EF}(1.5) - 4(1.5) - 6.00(5) = 0 \quad F_{EF} = 24.0 \text{ kN (C)}$$ **Ans.**

$$\curvearrowleft + \sum M_E = 0; \quad 8(1.5) + 16.5(2) - 6(6.5) - F_{CG}(1.5) = 0 \quad F_{CG} = 4.00 \text{ kN (C)}$$ **Ans.**



(a)



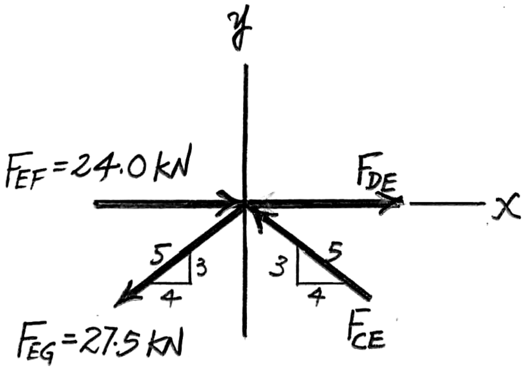
(b)

7–25. Continued

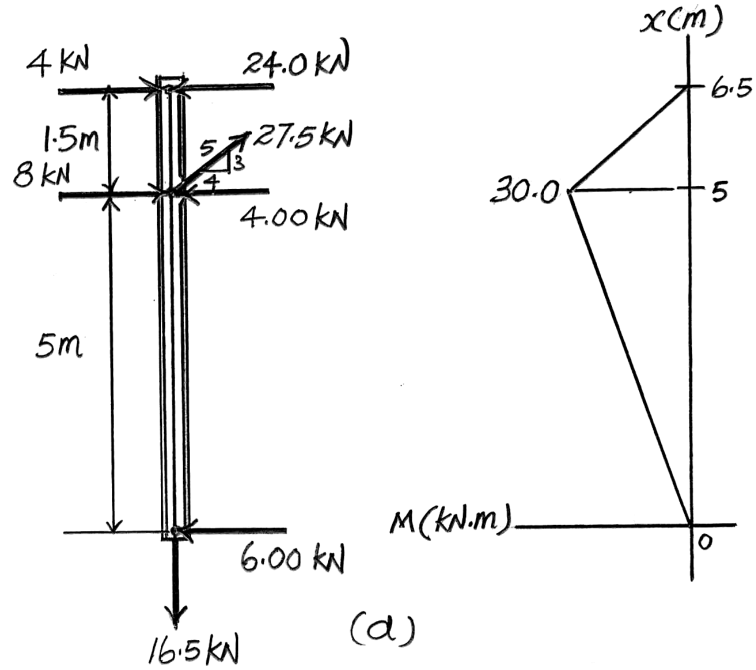
Using the method of joints, Fig. *c*,

$$+\uparrow \sum F_y = 0; \quad F_{CE}\left(\frac{3}{5}\right) - 27.5\left(\frac{3}{5}\right) = 0 \quad F_{CE} = 27.5 \text{ kN (C)} \qquad \textbf{Ans.}$$

$$\overset{+}{\rightarrow} \sum F_x = 0; \quad 24 - 27.5\left(\frac{4}{5}\right) - 27.5\left(\frac{4}{5}\right) + F_{DE} = 0 \quad F_{DE} = 20.0 \text{ kN (T)} \qquad \textbf{Ans.}$$

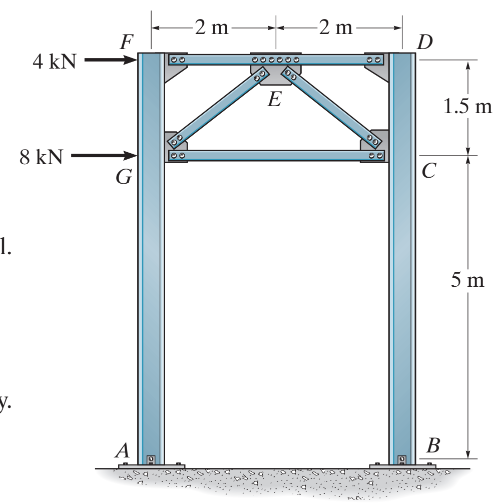


(c)



(a)

7–26. Draw (approximately) the moment diagram for column *AGF* of the portal. Assume all the members of the truss to be pin connected at their ends. The columns are fixed at *A* and *B*. Also determine the force in all the truss members.



Assume that the horizontal force components at fixed supports *A* and *B* are equal. Thus,

$$A_x = B_x = \frac{4 + 8}{2} = 6.00 \text{ kN}$$

Also, the points of inflection *H* and *I* are 2.5 m above *A* and *B*, respectively. Referring to Fig. *a*,

$$\circlearrowleft + \sum M_I = 0; \quad H_y(4) - 8(2.5) - 4(4) = 0 \qquad H_y = 9.00 \text{ kN}$$

$$+\uparrow \sum F_y = 0; \quad I_y - 9.00 = 0 \qquad I_y = 9.00 \text{ kN}$$

7–26. Continued

Referring to Fig. *b*,

$\xrightarrow{+} \sum F_x = 0;\quad H_x - 6.00 = 0 \qquad H_x = 6.00 \text{ kN}$

$+\uparrow \sum F_y = 0;\quad 9.00 - A_y = 0 \qquad A_y = 9.00 \text{ kN}$

$\circlearrowleft + \sum M_A = 0;\quad M_A - 6.00(2.5) = 0 \qquad M_A = 15.0 \text{ kN}\cdot\text{m}$

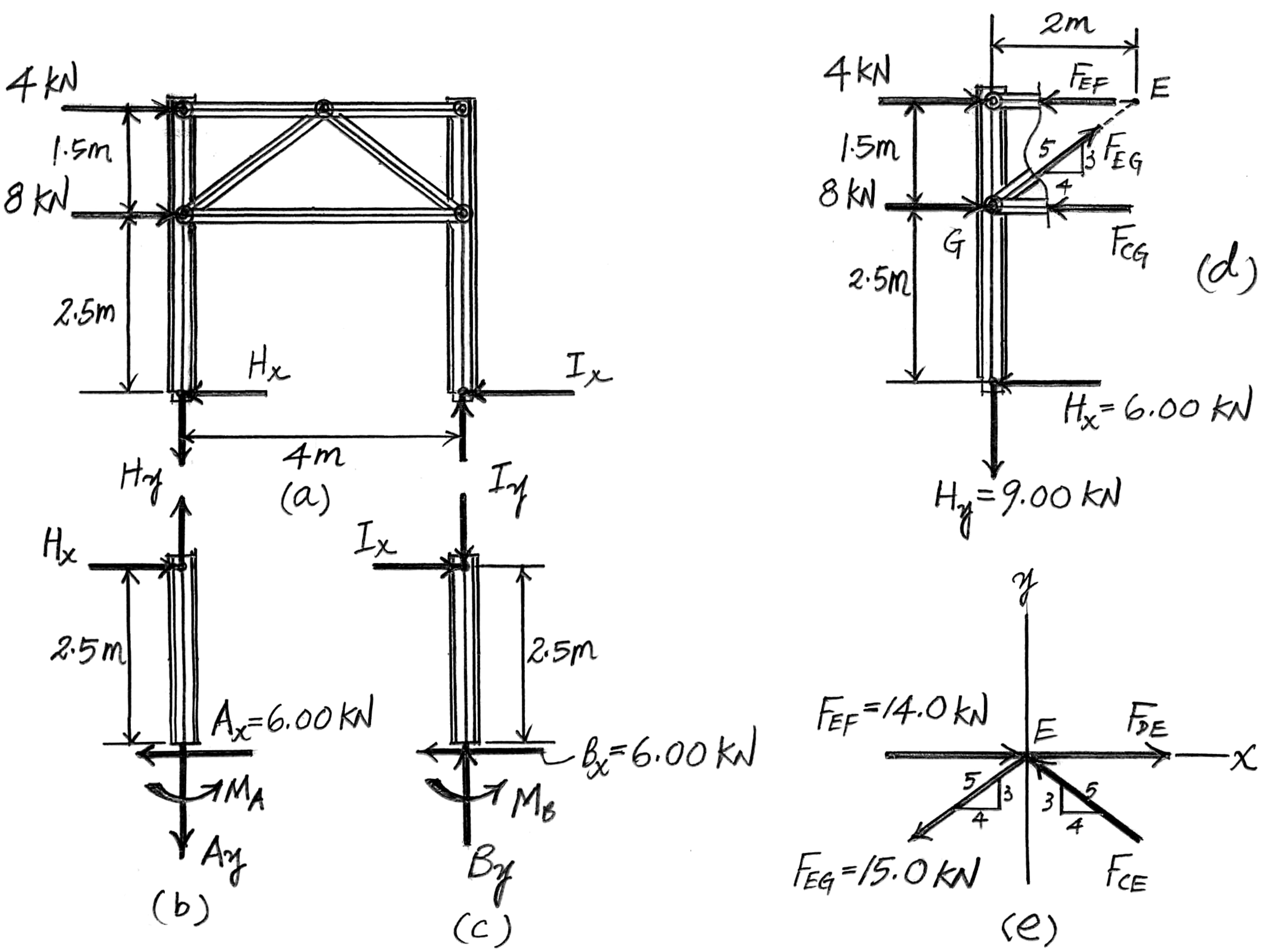
Using the method of sections, Fig. *d*,

$+\uparrow \sum F_y = 0;\quad F_{EG}\left(\frac{3}{5}\right) - 9.00 = 0 \qquad F_{EG} = 15.0 \text{ kN(T)}$ **Ans.**

$\circlearrowleft + \sum M_E = 0;\quad 8(1.5) + 9.00(2) - 6.00(4) - F_{CG}(1.5) = 0$

$F_{CG} = 4.00 \text{ kN (C)}$ **Ans.**

$\circlearrowleft + \sum M_G = 0;\quad F_{EF}(1.5) - 4(1.5) - 6(2.5) = 0 \qquad F_{EF} = 14.0 \text{ kN (C)}$ **Ans.**



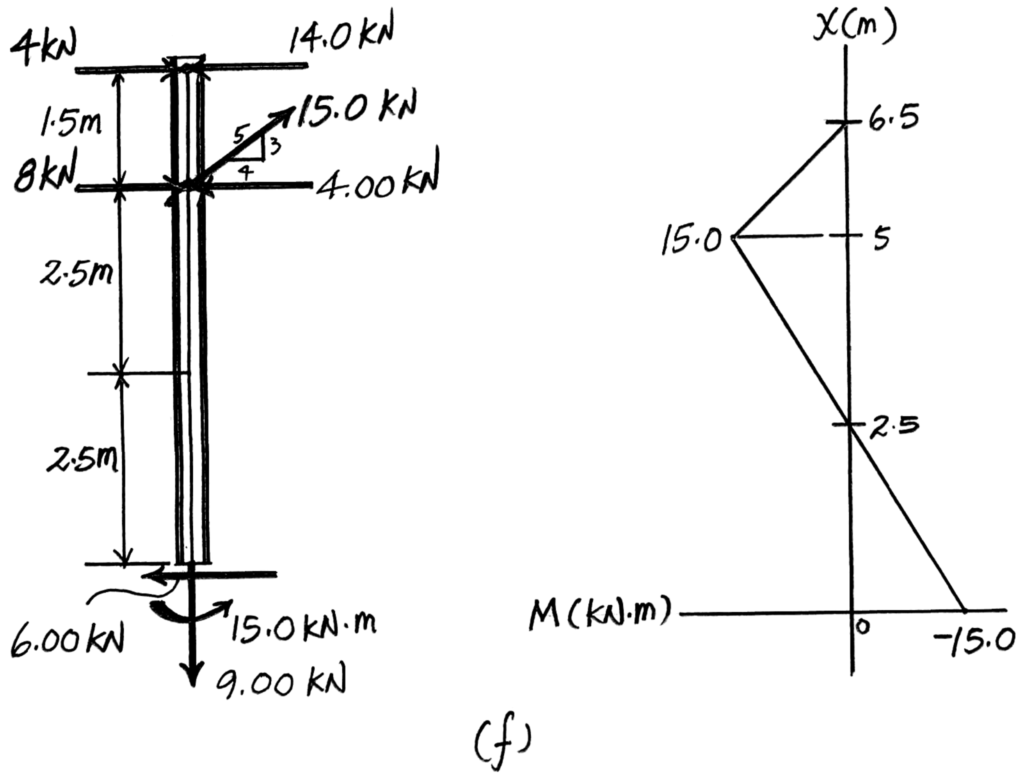
7–26. Continued

Using the method of joints, Fig. *e*,

$+\uparrow \sum F_y = 0; \qquad F_{CE}\left(\frac{3}{5}\right) - 15.0\left(\frac{3}{5}\right) = 0 \qquad F_{CE} = 15.0 \text{ kN (C)}$ **Ans.**

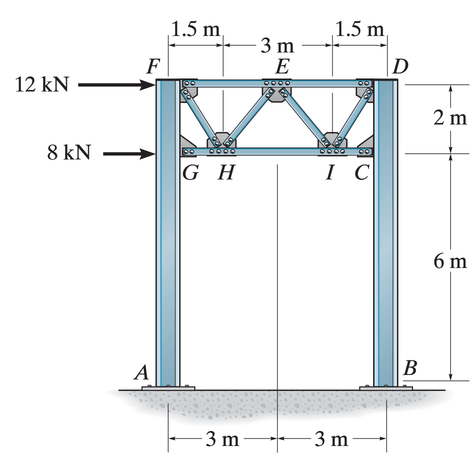
$\xrightarrow{+} \sum F_x = 0; \qquad F_{DE} + 14.0 - 15.0\left(\frac{4}{5}\right) - 15.0\left(\frac{4}{5}\right) = 0$

$F_{DE} = 10.0 \text{ kN (T)}$ **Ans.**



(f)

7–27. Determine (approximately) the force in each truss member of the portal frame. Also find the reactions at the fixed column supports *A* and *B*. Assume all members of the truss to be pin connected at their ends.



Assume that the horizontal force components at fixed supports *A* and *B* are equal. Thus,

$A_x = B_x = \dfrac{12 + 8}{2} = 10.0 \text{ kN}$ **Ans.**

Also, the points of inflection *J* and *K* are 3 m above *A* and *B* respectively. Referring to Fig. *a*,

$\circlearrowleft + \sum M_k = 0; \quad J_y(6) - 8(3) - 12(5) = 0 \quad J_y = 14.0 \text{ kN}$

$+\uparrow \sum F_y = 0; \quad K_y - 14.0 = 0 \quad K_y = 14.0 \text{ kN}$

7–27. Continued

Referring to Fig. *b*,

$\overset{+}{\rightarrow} \sum F_x = 0; \quad J_x - 10.0 = 0 \quad J_x = 10.0 \text{ kN}$

$+\uparrow \sum F_y = 0; \quad 14.0 - A_y = 0 \quad A_y = 14.0 \text{ kN}$ **Ans.**

$\circlearrowleft + \sum M_A = 0; \quad M_A - 10.0(3) = 0 \quad M_A = 30.0 \text{ kN} \cdot \text{m}$ **Ans.**

Referring to Fig. *c*,

$\overset{+}{\rightarrow} \sum F_x = 0; \quad B_x - 10.0 = 0 \quad B_x = 10.0 \text{ kN}$

$+\uparrow \sum F_y = 0; \quad B_y - 14.0 = 0 \quad B_y = 14.0 \text{ kN}$ **Ans.**

$\circlearrowleft + \sum M_B = 0; \quad M_B - 10.0(3) = 0 \quad M_B = 30.0 \text{ kN} \cdot \text{m}$ **Ans.**

Using the metod of sections, Fig. *d*,

$+\uparrow \sum F_y = 0; \quad F_{FH}\left(\frac{4}{5}\right) - 14.0 = 0 \quad F_{FH} = 17.5 \text{ kN (C)}$ **Ans.**

$\circlearrowleft + \sum M_H = 0; \quad F_{EF}(2) + 14.0(1.5) - 12(2) - 10.0(3) = 0 \quad F_{EF} = 16.5 \text{ kN (C)}$ **Ans.**

$\circlearrowleft + \sum M_F = 0; \quad F_{GH}(2) + 8(2) - 10.0(5) = 0 \quad F_{GH} = 17.0 \text{ kN (T)}$ **Ans.**

Using the method of joints, Fig. *e* (Joint *H*),

$+\uparrow \sum F_y = 0; \quad F_{EH}\left(\frac{4}{5}\right) - 17.5\left(\frac{4}{5}\right) = 0 \quad F_{EH} = 17.5 \text{ kN (T)}$ **Ans.**

$\overset{+}{\rightarrow} \sum F_x = 0; \quad 17.5\left(\frac{3}{5}\right) + 17.5\left(\frac{3}{5}\right) - 17.0 - F_{HI} = 0 \quad F_{HI} = 4.00 \text{ kN (C)}$ **Ans.**

Referring Fig. *f* (Joint *E*),

$+\uparrow \sum F_y = 0; \quad F_{EI}\left(\frac{4}{5}\right) - 17.5\left(\frac{4}{5}\right) = 0 \quad F_{EI} = 17.5 \text{ kN (C)}$ **Ans.**

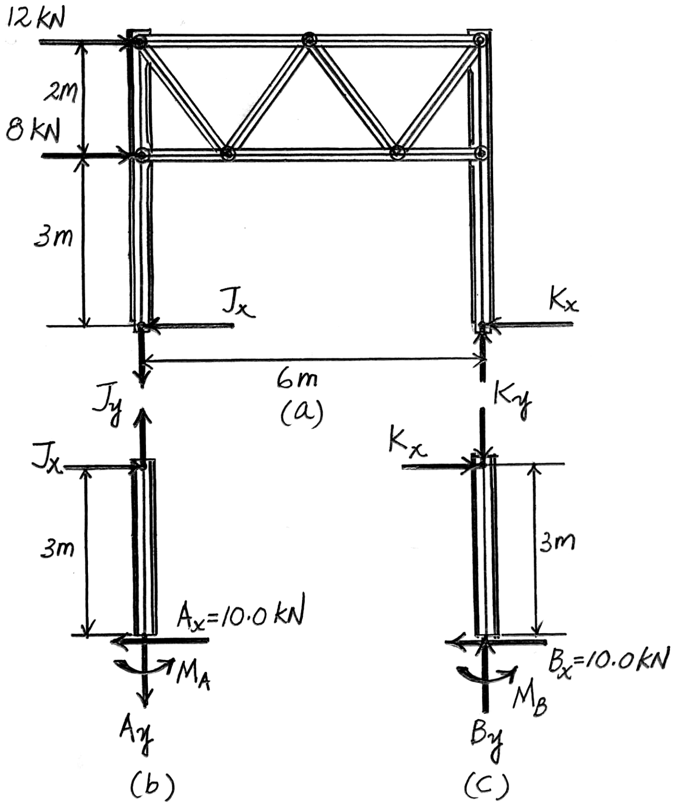
$\overset{+}{\rightarrow} \sum F_x = 0 \quad F_{DE} + 16.5 - 17.5\left(\frac{3}{5}\right) - 17.5\left(\frac{3}{5}\right) = 0 \quad F_{DE} = 4.50 \text{ kN (T)}$ **Ans.**

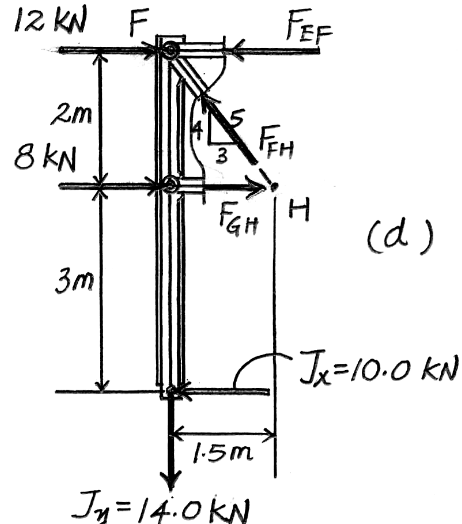
Referring to Fig. *g* (Joint *I*),

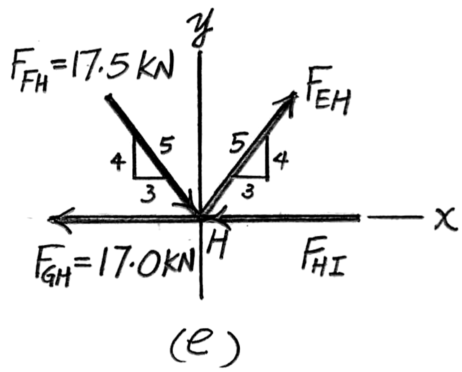
$+\uparrow \sum F_y = 0; \quad F_{DI}\left(\frac{4}{5}\right) - 17.5\left(\frac{4}{5}\right) = 0 \quad F_{DI} = 17.5 \text{ kN (T)}$ **Ans.**

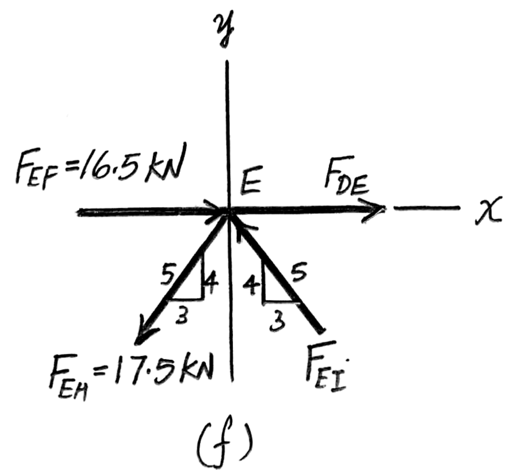
$\overset{+}{\rightarrow} \sum F_x = 0; \quad 17.5\left(\frac{3}{5}\right) + 17.5\left(\frac{3}{5}\right) + 4.00 - F_{CI} = 0 \quad F_{CI} = 25.0 \text{ kN (C)}$ **Ans.**

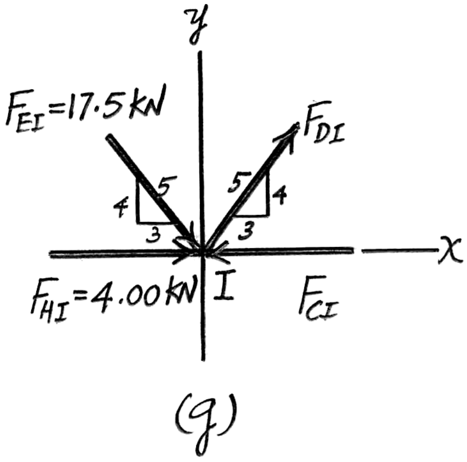
7–27. Continued



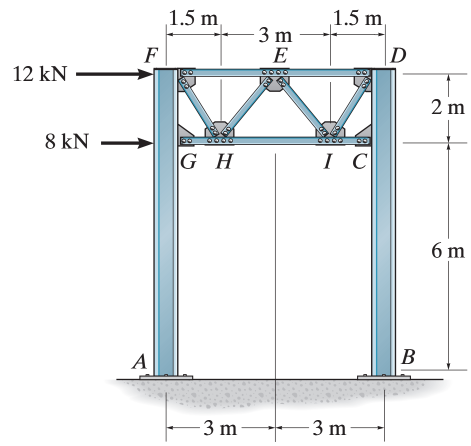








***7–28.** Solve Prob. 7–27 if the supports at A and B are pinned instead of fixed.



Assume that the horizontal force components at pin supports A and B are equal. Thus,

$$A_x = B_x = \frac{12 + 8}{2} = 10.0 \text{ kN} \qquad \textbf{Ans.}$$

Referring to Fig. a,

$$\circlearrowleft + \sum M_B = 0; \quad A_y(6) - 8(6) - 12(8) = 0 \quad A_y = 24.0 \text{ kN} \qquad \textbf{Ans.}$$

$$+\uparrow \sum F_y = 0; \quad B_y - 24.0 = 0 \quad B_y = 24.0 \text{ kN} \qquad \textbf{Ans.}$$

Using the method of sections, Fig. b,

$$+\uparrow \sum F_y = 0; \quad F_{FH}\left(\frac{4}{5}\right) - 24.0 = 0 \quad F_{FH} = 30.0 \text{ kN (C)} \qquad \textbf{Ans.}$$

$$\circlearrowleft + \sum M_H = 0; \quad F_{EF}(2) + 24.0(1.5) - 12(2) - 10.0(6) = 0$$

$$F_{EF} = 24.0 \text{ kN (C)} \qquad \textbf{Ans.}$$

$$\circlearrowleft + \sum M_F = 0; \quad F_{GH}(2) + 8(2) - 10.0(8) = 0 \quad F_{GH} = 32.0 \text{ kN (T)} \qquad \textbf{Ans.}$$

Using method of joints, Fig. c (Joint H),

$$+\uparrow \sum F_y = 0; \quad F_{EH}\left(\frac{4}{5}\right) - 30.0\left(\frac{4}{5}\right) = 0 \quad F_{EH} = 30.0 \text{ kN (T)} \qquad \textbf{Ans.}$$

$$\overset{+}{\rightarrow} \sum F_x = 0; \quad 30.0\left(\frac{3}{5}\right) + 30.0\left(\frac{3}{5}\right) - 32.0 - F_{HI} = 0 \quad F_{HI} = 4.00 \text{ kN (C)} \qquad \textbf{Ans.}$$

Referring to Fig. d (Joint E),

$$+\uparrow \sum F_y = 0; \quad F_{EI}\left(\frac{4}{5}\right) - 30.0\left(\frac{4}{5}\right) = 0 \quad F_{EI} = 30.0 \text{ kN (C)} \qquad \textbf{Ans.}$$

$$\overset{+}{\rightarrow} \sum F_x = 0; \quad F_{DE} + 24.0 - 30.0\left(\frac{3}{5}\right) - 30.0\left(\frac{3}{5}\right) = 0 \quad F_{DE} = 12.0 \text{ kN (T)} \qquad \textbf{Ans.}$$

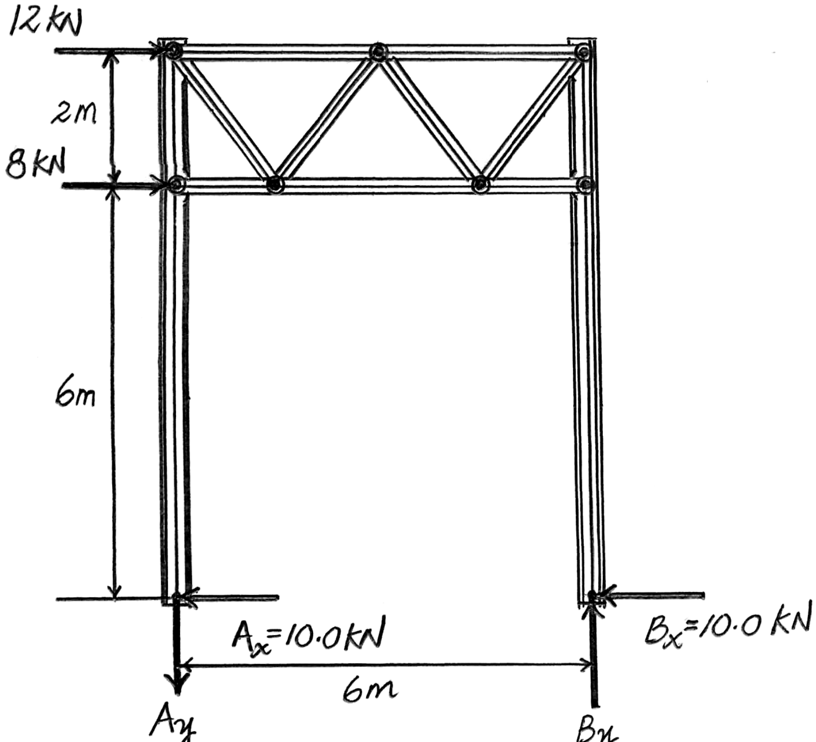
Referring to Fig. e (Joint I),

$$+\uparrow \sum F_y = 0; \quad F_{DI}\left(\frac{4}{5}\right) - 30.0\left(\frac{4}{5}\right) = 0 \quad F_{DI} = 30.0 \text{ kN (T)} \qquad \textbf{Ans.}$$

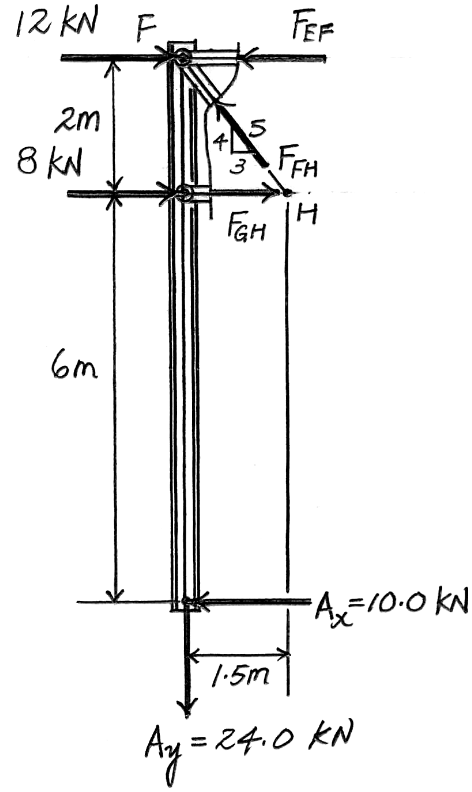
$$\overset{+}{\rightarrow} \sum F_x = 0; \quad 30.0\left(\frac{3}{5}\right) + 30.0\left(\frac{3}{5}\right) + 4.00 - F_{CI} = 0$$

$$F_{CI} = 40.0 \text{ kN (C)} \qquad \textbf{Ans.}$$

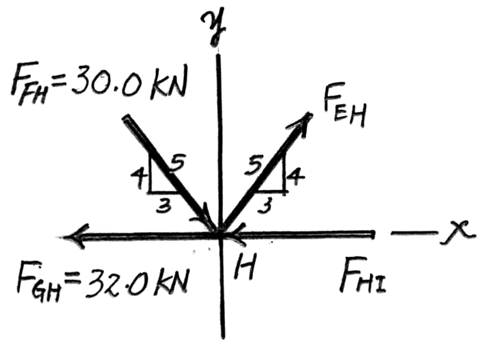
7–28. Continued



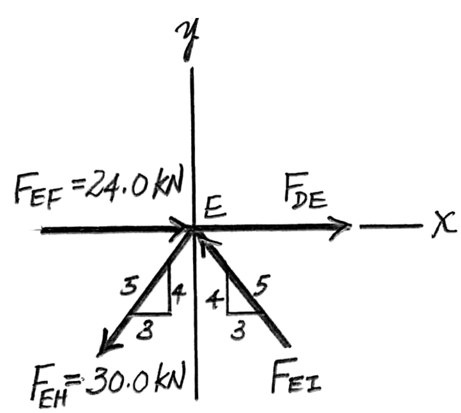
(a)



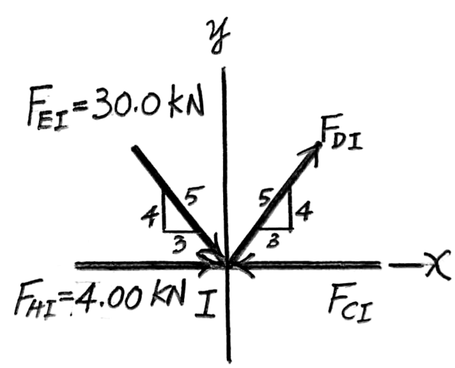
(b)



(c)

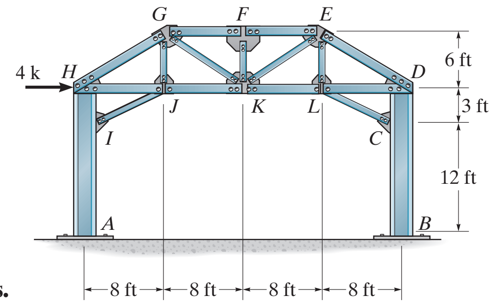


(d)



(e)

7–29. Determine (approximately) the force in members *GF*, *GK*, and *JK* of the portal frame. Also find the reactions at the fixed column supports *A* and *B*. Assume all members of the truss to be connected at their ends.



Assume that the horizontal force components at fixed supports *A* and *B* are equal. Thus,

$$A_x = B_x = \frac{4}{2} = 2.00 \text{ k} \qquad \textbf{Ans.}$$

Also, the points of inflection *N* and *O* are at 6 ft above *A* and *B* respectively. Referring to Fig. *a*,

$$\circlearrowleft + \sum M_B = 0; \quad N_y(32) - 4(9) = 0 \quad N_y = 1.125 \text{ k}$$

$$\circlearrowleft + \sum M_N = 0; \quad O_y(32) - 4(9) = 0 \quad O_y = 1.125 \text{ k}$$

Referring to Fig. *b*,

$$\overset{+}{\rightarrow} \sum F_x = 0; \quad N_x - 2.00 = 0 \quad N_x = 2.00 \text{ k}$$

$$+\uparrow \sum F_y = 0; \quad 1.125 - A_y = 0 \quad A_y = 1.125 \text{ k} \qquad \textbf{Ans.}$$

$$\circlearrowleft + \sum M_A = 0; \quad M_A - 2.00(6) = 0 \quad M_A = 12.0 \text{ k} \cdot \text{ft} \qquad \textbf{Ans.}$$

Referring to Fig. *c*,

$$\overset{+}{\rightarrow} \sum F_x = 0; \quad B_x - 2.00 = 0 \quad B_x = 2.00 \text{ k}$$

$$+\uparrow \sum F_y = 0; \quad B_y - 1.125 = 0 \quad B_y = 1.125 \text{ k} \qquad \textbf{Ans.}$$

$$\circlearrowleft + \sum M_B = 0; \quad M_B - 2.00(6) = 0 \quad M_B = 12.0 \text{ k} \cdot \text{ft} \qquad \textbf{Ans.}$$

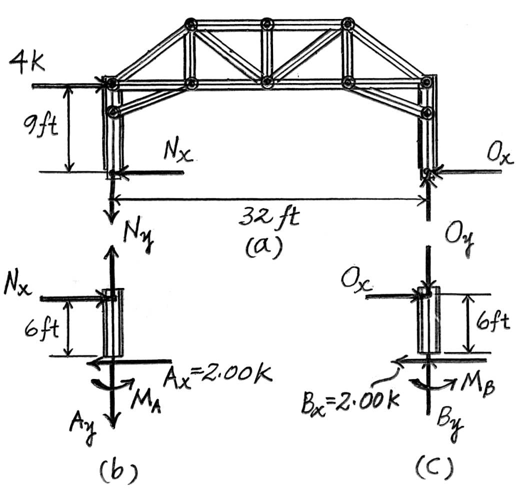
Using the method of sections, Fig. *d*,

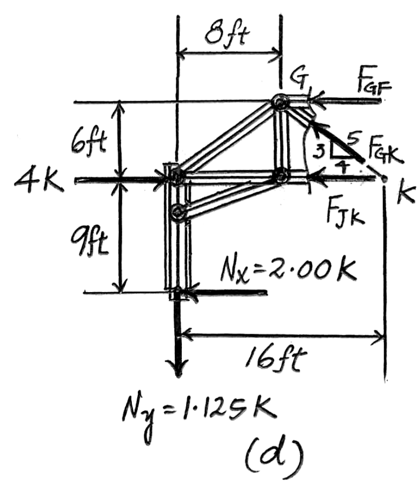
$$+\uparrow \sum F_y = 0; \quad F_{GK}\left(\frac{3}{5}\right) - 1.125 = 0 \quad F_{GK} = 1.875 \text{ k (C)} \qquad \textbf{Ans.}$$

$$\circlearrowleft + \sum M_K = 0; \quad F_{GF}(6) + 1.125(16) - 2(9) = 0 \quad F_{GF} = 0 \qquad \textbf{Ans.}$$

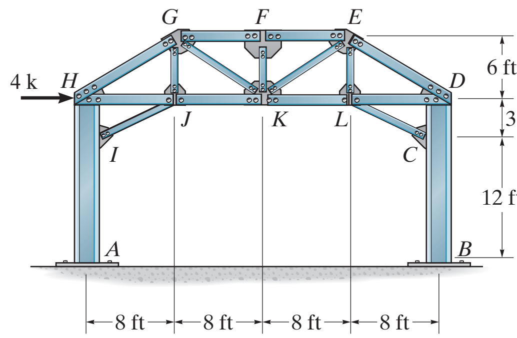
$$\circlearrowleft + \sum M_G = 0; \quad -F_{JK}(6) + 4(6) + 1.125(8) - 2.00(15) = 0$$

$$F_{JK} = 0.500 \text{ k (C)} \qquad \textbf{Ans.}$$





7–30. Solve Prob. 7–29 if the supports at A and B are pin connected instead of fixed.



Assume that the horizontal force components at pin supports A and B are equal. Thus,

$$A_x = B_x = \frac{4}{2} = 2.00 \text{ k}$$ **Ans.**

Referring to Fig. *a*,

$\circlearrowleft + \sum M_A = 0;\quad B_y(32) - 4(15) = 0 \quad B_y = 1.875 \text{ k}$ **Ans.**

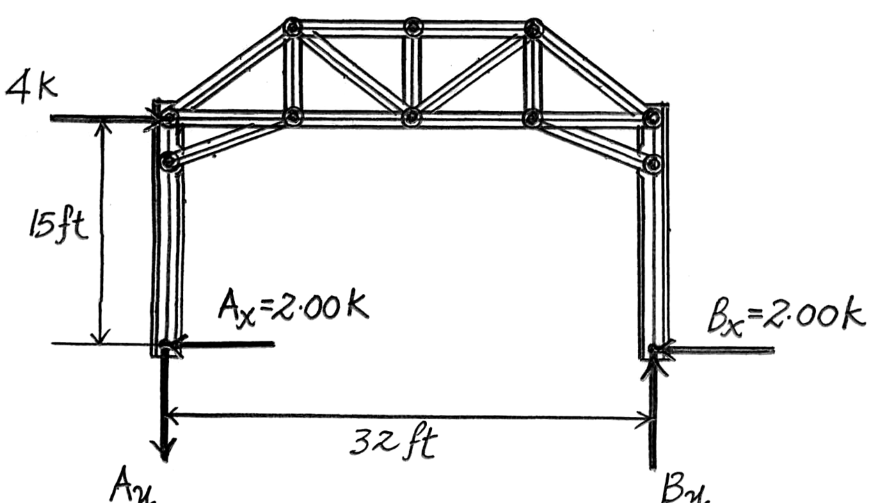
$+\uparrow \sum F_y = 0;\quad 1.875 - A_y = 0 \quad A_y = 1.875 \text{ k}$ **Ans.**

Using the method of sections, Fig. *b*,

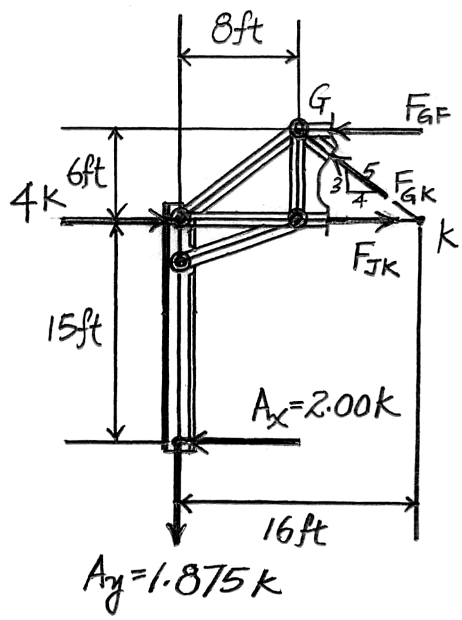
$+\uparrow \sum F_y = 0;\quad F_{GK}\left(\frac{3}{5}\right) - 1.875 = 0 \quad F_{GK} = 3.125 \text{ k (C)}$ **Ans.**

$\circlearrowleft + \sum M_x = 0;\quad F_{GF}(6) + 1.875(16) - 2.00(15) = 0 \quad F_{GF} = 0$ **Ans.**

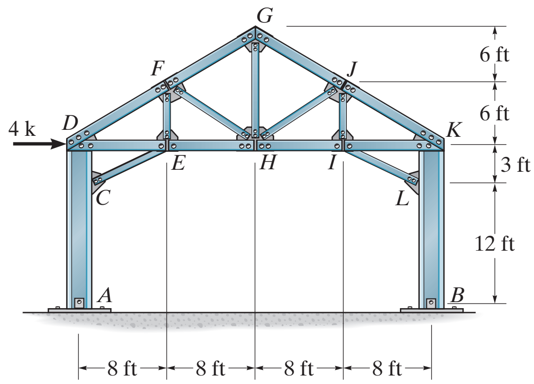
$\circlearrowleft + \sum M_G = 0;\quad 4(6) + 1.875(8) - 2.00(21) + F_{JK}(6) = 0 \quad F_{JK} = 0.500 \text{ k (T)}$ **Ans.**



(a)



7–31. Draw (approximately) the moment diagram for column *ACD* of the portal. Assume all truss members and the columns to be pin connected at their ends. Also determine the force in members *FG*, *FH*, and *EH*.



Assume that the horizontal force components at pin supports *A* and *B* are equal. Thus,

$$A_x = B_x = \frac{4}{2} = 2.00 \text{ k}$$

Referring to Fig. *a*,

$$\circlearrowleft + \sum M_B = 0; \quad A_y(32) - 4(15) = 0 \quad A_y = 1.875 \text{ k}$$

Using the method of sections, Fig. *b*,

$$\circlearrowleft + \sum M_H = 0; \quad F_{FG}\left(\frac{3}{5}\right)(16) + 1.875(16) - 2.00(15) = 0 \quad F_{FG} = 0$$ **Ans.**

$$\circlearrowleft + \sum M_F = 0; \quad 4(6) + 1.875(8) - 2.00(21) + F_{EH}(6) = 0$$

$$F_{EH} = 0.500 \text{ k (T)}$$ **Ans.**

$$\circlearrowleft + \sum M_D = 0; \quad F_{FH}\left(\frac{3}{5}\right)(16) - 2.00(15) = 0 \quad F_{FH} = 3.125 \text{ k (C)}$$ **Ans.**

Also, referring to Fig. *c*,

$$\circlearrowleft + \sum M_E = 0; \quad F_{DF}\left(\frac{3}{5}\right)(8) + 1.875(8) - 2.00(15) = 0$$

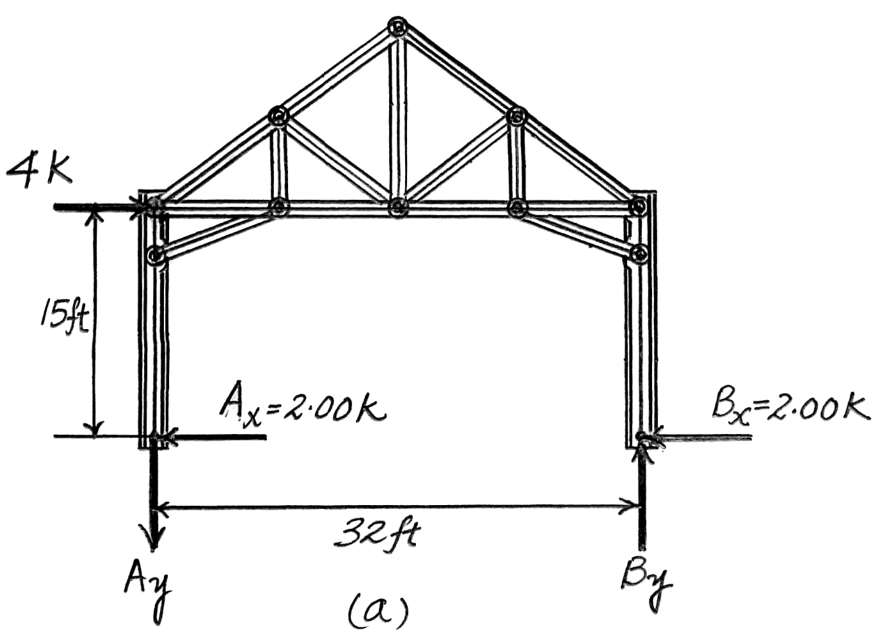
$$F_{DF} = 3.125 \text{ k (C)}$$

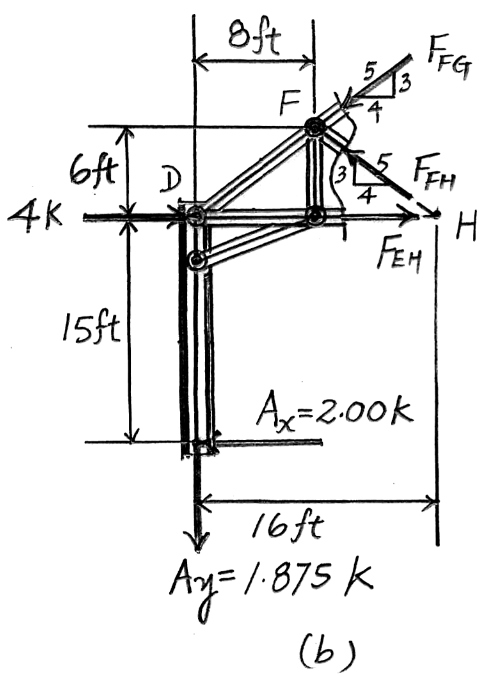
$$\circlearrowleft + \sum M_D = 0; \quad F_{CE}\left(\frac{3}{\sqrt{73}}\right)(8) - 2.00(15) = 0$$

$$F_{CE} = 10.68 \text{ k (T)}$$

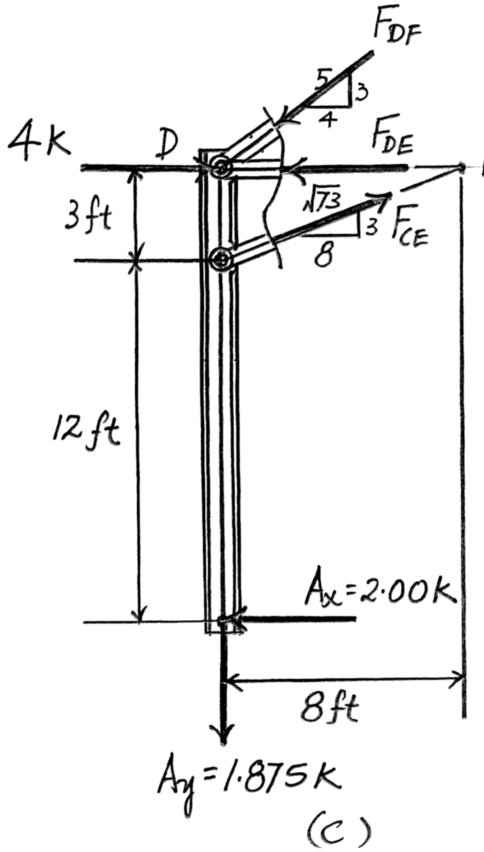
$$\xrightarrow{+} \sum F_x = 0; \quad 4 + 10.68\left(\frac{8}{\sqrt{73}}\right) - 3.125\left(\frac{4}{5}\right) - 2.00 - F_{DE} = 0$$

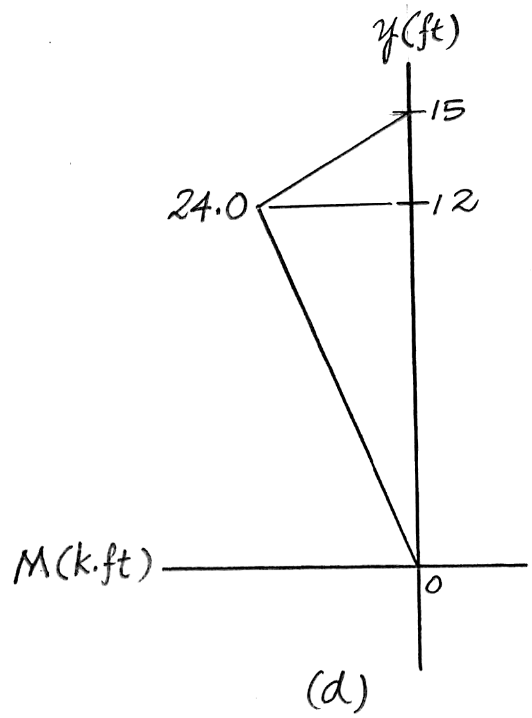
$$F_{DE} = 9.50 \text{ k (C)}$$



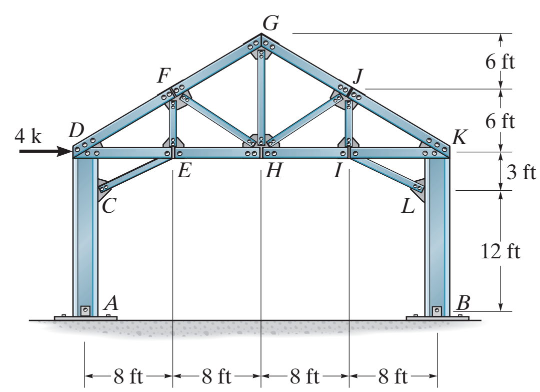


7–31. Continued





***7–32.** Solve Prob. 7–31 if the supports at A and B are fixed instead of pinned.



Assume that the horizontal force components at fixed supports A and B are equal. Thus,

$$A_x = B_x = \frac{4}{2} = 2.00\text{ k}$$

Also, the points of inflection N and O are 6 ft above A and B respectively. Referring to Fig. a,

$$\zeta + \sum M_O = 0; \quad N_y(32) - 4(9) = 0 \quad N_y = 1.125\text{ k}$$

Referring to Fig. b,

$$\overset{+}{\rightarrow} \sum F_x = 0; \quad N_x - 2.00 = 0 \quad N_x = 2.00\text{ k}$$

$$\zeta + \sum M_A = 0; \quad M_A - 2.00(6) = 0 \quad M_A = 12.0\text{ k ft}$$

$$+\uparrow \sum F_y = 0; \quad 1.125 - A_y = 0 \quad A_y = 1.125\text{ k}$$

7–32. Continued

Using the method of sections, Fig. *d*,

$\circlearrowleft + \sum M_H = 0; \quad F_{FG}\left(\frac{3}{5}\right)(16) + 1.125(16) - 2.00(9) = 0 \quad F_{FG} = 0$ **Ans.**

$\circlearrowleft + \sum M_F = 0; \quad -F_{EH}(6) + 4(6) + 1.125(8) - 2.00(15) = 0 \quad F_{EH} = 0.500 \text{ k (C)}$ **Ans.**

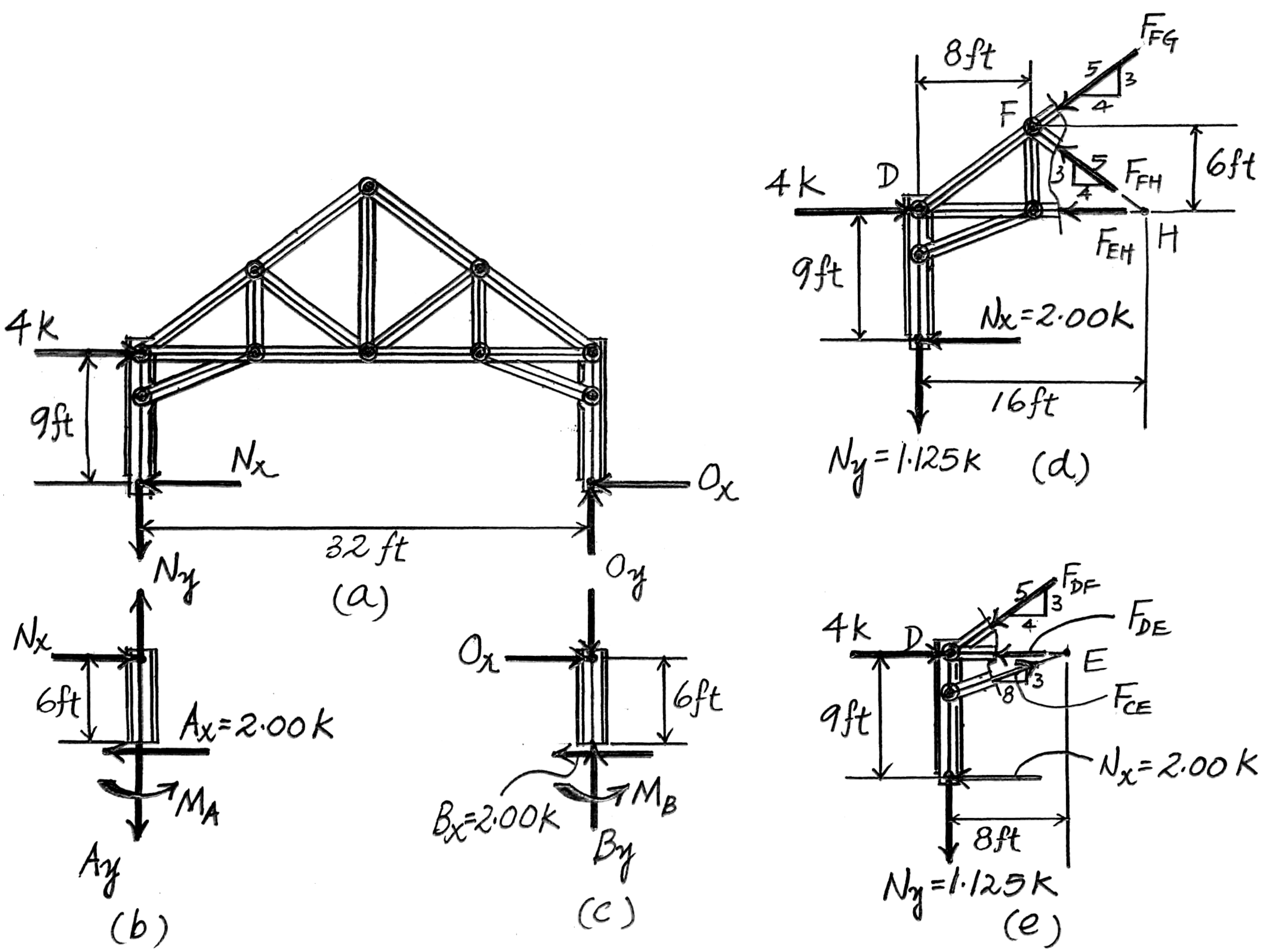
$\circlearrowleft + \sum M_D = 0; \quad F_{FH}\left(\frac{3}{5}\right)(16) - 2.00(9) = 0 \quad F_{FH} = 1.875 \text{ k (C)}$ **Ans.**

Also, referring to Fig *e*,

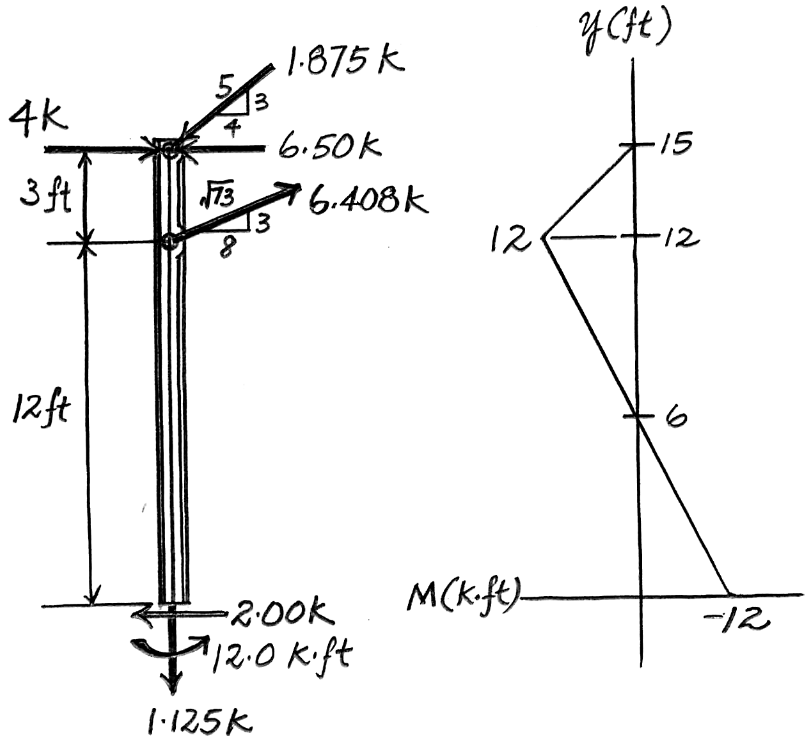
$\circlearrowleft + \sum M_E = 0; \quad F_{DF}\left(\frac{3}{5}\right)(8) + 1.125(8) - 2.00(9) = 0 \quad F_{DF} = 1.875 \text{ k (C)}$

$\circlearrowleft + \sum M_D = 0; \quad F_{CE}\left(\frac{3}{\sqrt{73}}\right)(8) - 2.00(9) = 0 \quad F_{CE} = 6.408 \text{ k (T)}$

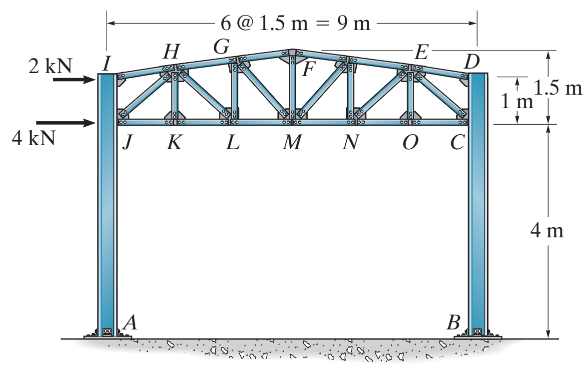
$\overset{+}{\rightarrow} \sum F_x = 0; \quad 4 + 6.408\left(\frac{8}{\sqrt{73}}\right) - 1.875\left(\frac{4}{5}\right) - 2.00 - F_{DE} = 0 \quad F_{DE} = 6.50 \text{ k (C)}$



7–32. Continued



7–33. Draw (approximately) the moment diagram for column *AJI* of the portal. Assume all truss members and the columns to be pin connected at their ends. Also determine the force in members *HG*, *HL*, and *KL*.



Assume the horizontal force components at pin supports A and B to be equal. Thus,

$$A_x = B_x = \frac{2 + 4}{2} = 3.00 \text{ kN}$$

Referring to Fig. *a*,

$$\circlearrowleft + \sum M_B = 0; \quad A_y(9) - 4(4) - 2(5) = 0 \quad A_y = 2.889 \text{ kN}$$

Using the method of sections, Fig. *b*,

$$\circlearrowleft + \sum M_L = 0; \quad F_{HG} \cos 6.340° (1.167) + F_{HG} \sin 6.340° (1.5) + 2.889(3) - 2(1) - 3.00(4) = 0$$

$$F_{HG} = 4.025 \text{ kN (C)} = 4.02 \text{ kN (C)} \qquad \textbf{Ans.}$$

$$\circlearrowleft + \sum M_H = 0; \quad F_{KL}(1.167) + 2(0.167) + 4(1.167) + 2.889(1.5) - 3.00(5.167) = 0$$

$$F_{KL} = 5.286 \text{ kN (T)} = 5.29 \text{ kN (T)} \qquad \textbf{Ans.}$$

$$+\uparrow \sum F_y = 0; \quad F_{HL} \cos 52.13° - 4.025 \sin 6.340° - 2.889 = 0$$

$$F_{HL} = 5.429 \text{ kN (C)} = 5.43 \text{ kN (C)} \qquad \textbf{Ans.}$$

7–33. Continued

Also, referring to Fig. *c*,

$\zeta + \sum M_H = 0; \quad F_{JK}(1.167) + 2(0.167) + 4(1.167) + 2.889(1.5) - 3.00(5.167) = 0$

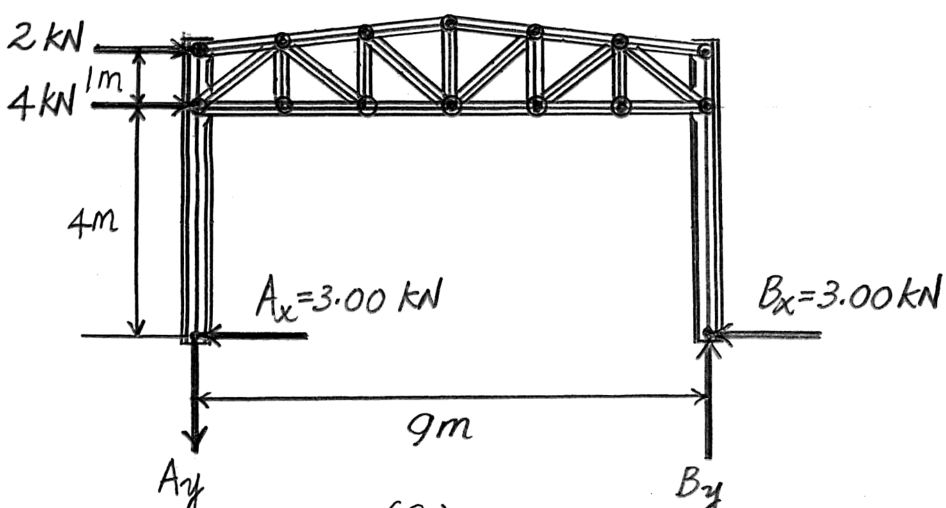
$F_{JK} = 5.286 \text{ kN (T)}$

$\zeta + \sum M_J = 0; \quad F_{IH} \cos 6.340° \ (1) - 2(1) - 3.00(4) = 0$

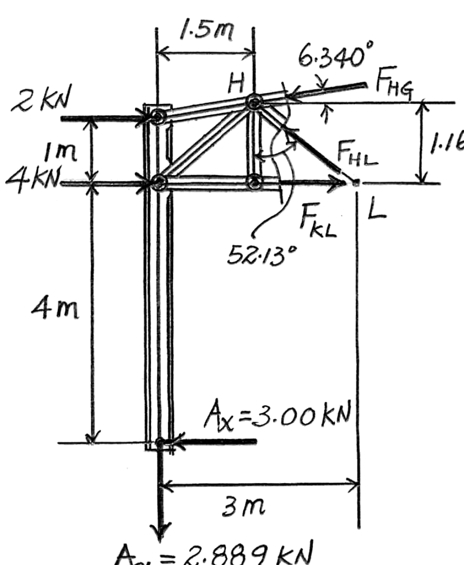
$F_{IH} = 14.09 \text{ kN (C)}$

$+\uparrow \sum F_y = 0; \quad F_{JH} \sin 37.87° - 14.09 \sin 6.340° - 2.889 = 0$

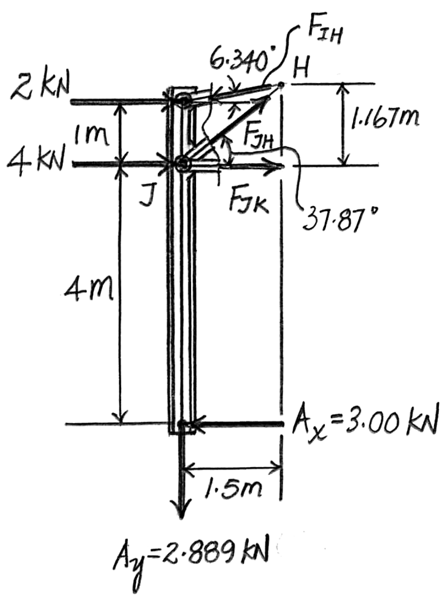
$F_{JH} = 7.239 \text{ kN (T)}$



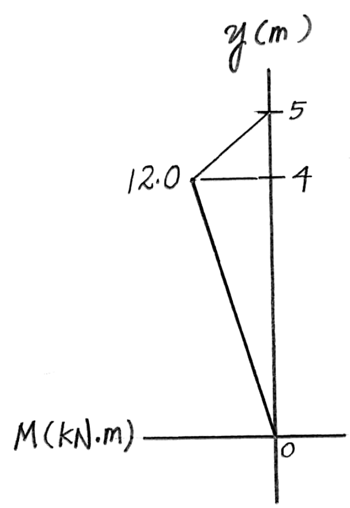
(a)



(b)

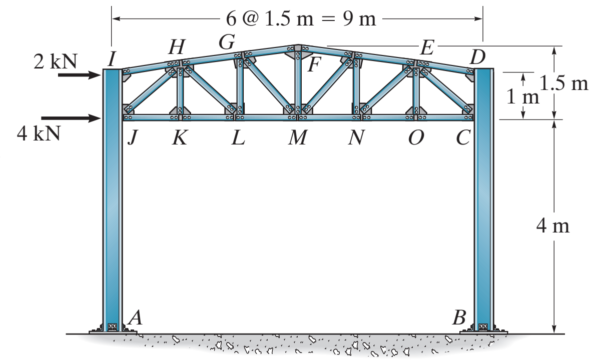


(c)



(d)

7–34. Solve Prob. 7–33 if the supports at A and B are fixed instead of pinned.



Assume that the horizontal force components at fixed supports A and B are equal. Therefore,

$$A_x = B_x = \frac{2 + 4}{2} = 3.00 \text{ kN}$$

Also, the reflection points P and R are located 2 m above A and B respectively. Referring to Fig. *a*

$$\circlearrowleft + \sum M_R = 0; \quad P_y(9) - 4(2) - 2(3) = 0 \quad P_y = 1.556 \text{ kN}$$

Referring to Fig. *b*,

$$\overset{+}{\rightarrow} \sum F_x = 0; \quad P_x - 3.00 = 0 \quad P_x = 3.00 \text{ kN}$$

$$\circlearrowleft + \sum M_A = 0; \quad M_A - 3.00(2) = 0 \quad M_A = 6.00 \text{ kN} \cdot \text{m}$$

$$+\uparrow \sum F_y = 0; \quad 1.556 - A_y = 0 \quad A_y = 1.556 \text{ kN}$$

Using the method of sections, Fig. *d*,

$$\circlearrowleft + \sum M_L = 0; \quad F_{HG} \cos 6.340° (1.167) + F_{HG} \sin 6.340° (1.5) + 1.556(3) - 3.00(2) - 2(1) = 0$$

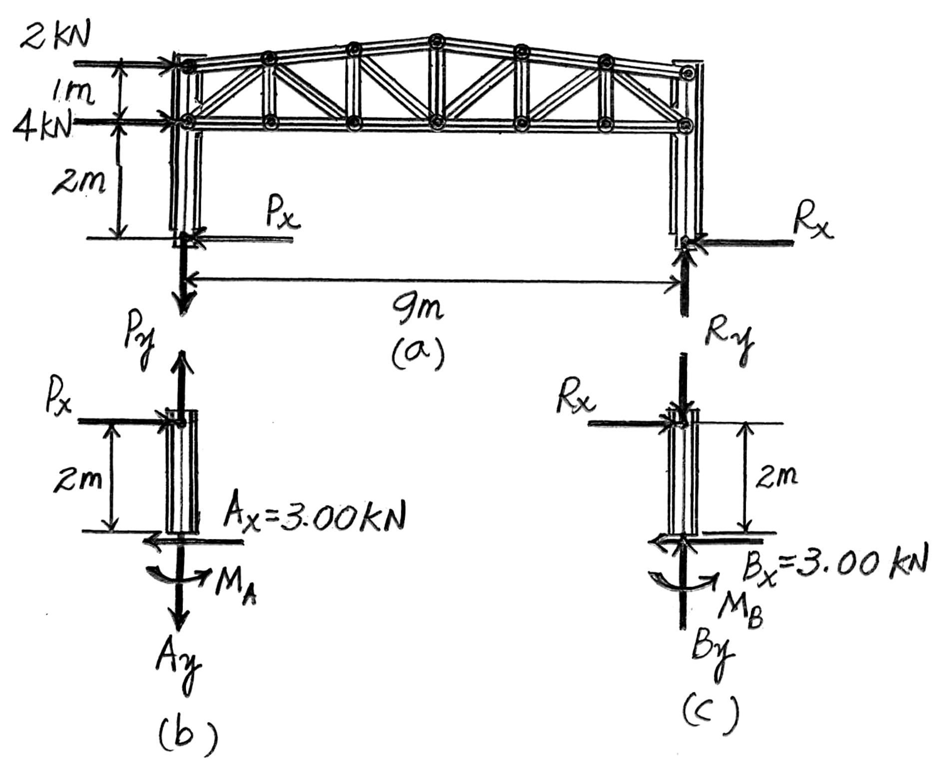
$$F_{HG} = 2.515 \text{ kN (C)} = 2.52 \text{ kN (C)} \qquad \textbf{Ans.}$$

$$\circlearrowleft + \sum M_H = 0; \quad F_{KL}(1.167) + 2(0.167) + 4(1.167) + 1.556(1.5) - 3.00(3.167) = 0$$

$$F_{KL} = 1.857 \text{ kN (T)} = 1.86 \text{ kN (T)} \qquad \textbf{Ans.}$$

$$+\uparrow \sum F_y = 0; \quad F_{HL} \cos 52.13° - 2.515 \sin 6.340° - 1.556 = 0$$

$$F_{HL} = 2.986 \text{ kN (C)} = 2.99 \text{ kN (C)} \qquad \textbf{Ans.}$$



7–34. Continued

Also referring to Fig. *e*,

$\circlearrowleft + \sum M_H = 0; \quad F_{JK}(1.167) + 4(1.167) + 2(0.167) + 1.556(1.5) - 3.00(3.167) = 0$

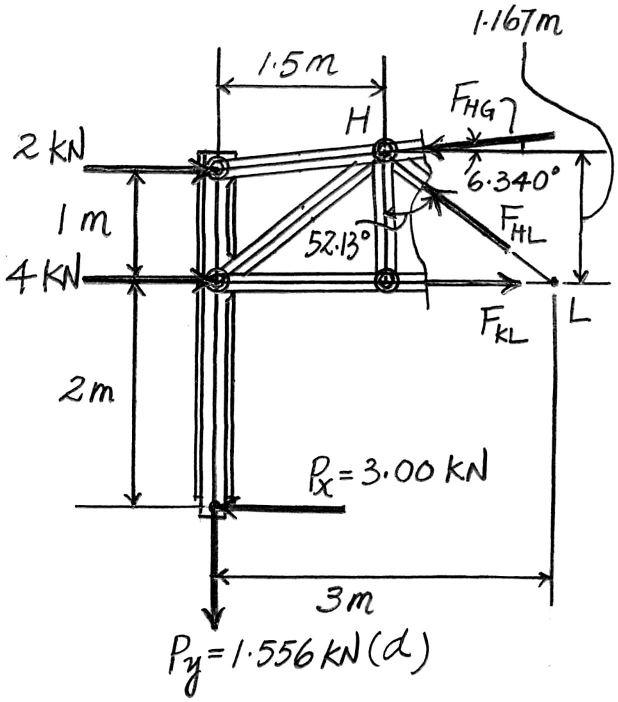
$F_{JK} = 1.857 \text{ kN (T)}$

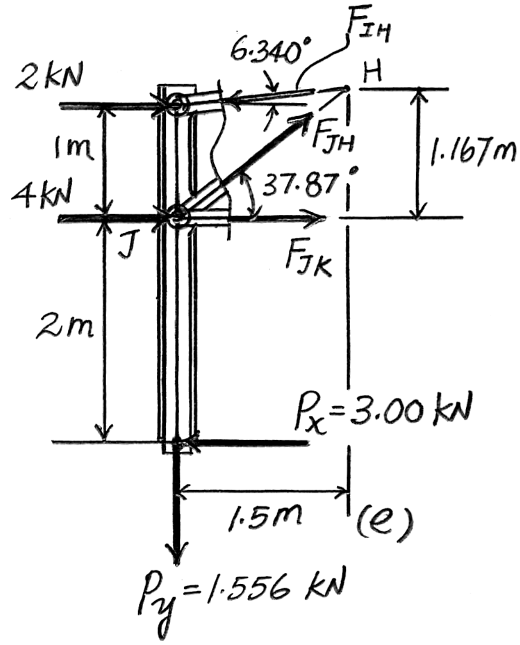
$\circlearrowleft + \sum M_J = 0; \quad F_{IH} \cos 6.340° (1) - 2(1) - 3.00(2) = 0$

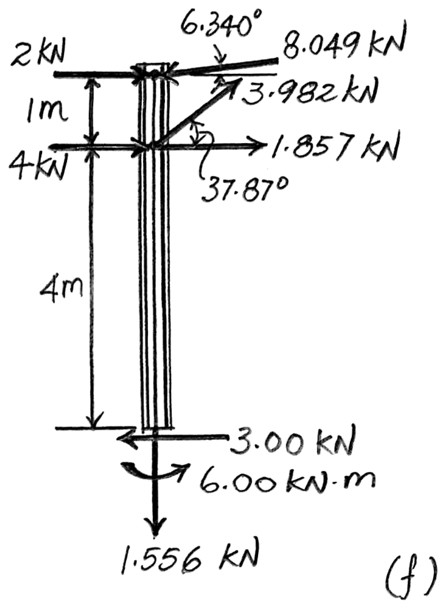
$F_{IH} = 8.049 \text{ kN (C)}$

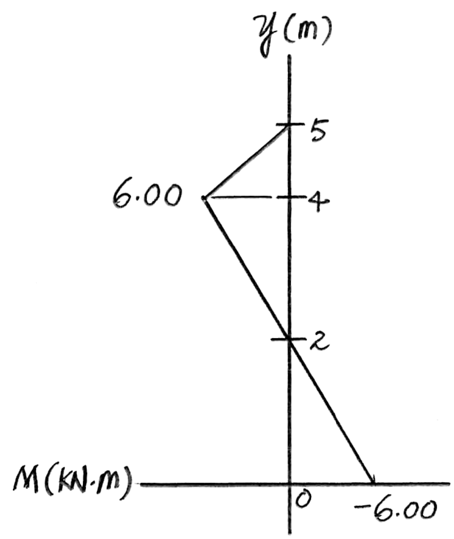
$+\uparrow \sum F_y = 0; \quad F_{JH} \sin 37.87° - 8.049 \sin 6.340° - 1.556 = 0$

$F_{JH} = 3.982 \text{ kN (T)}$

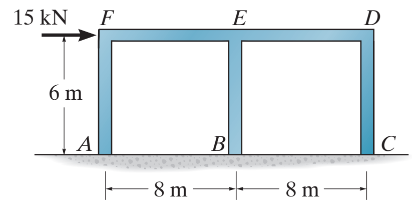


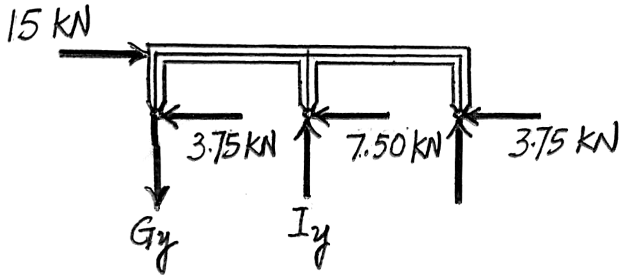


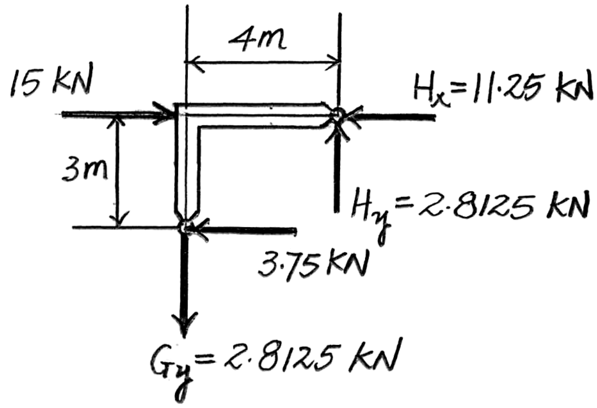


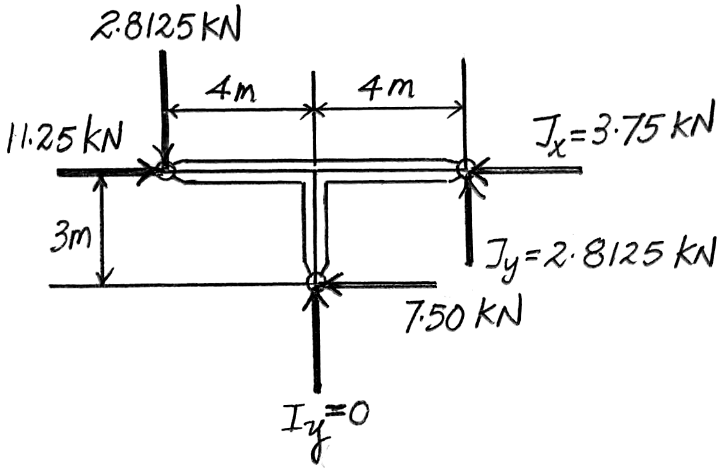


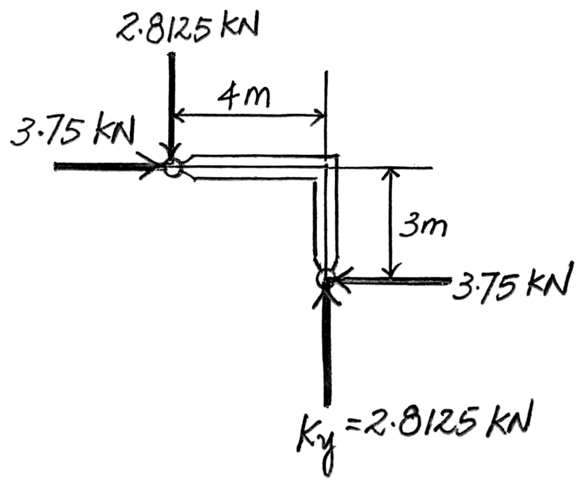
7–35. Use the portal method of analysis and draw the moment diagram for girder *FED*.

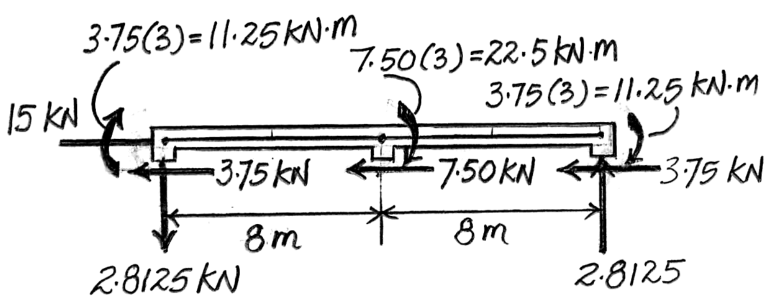


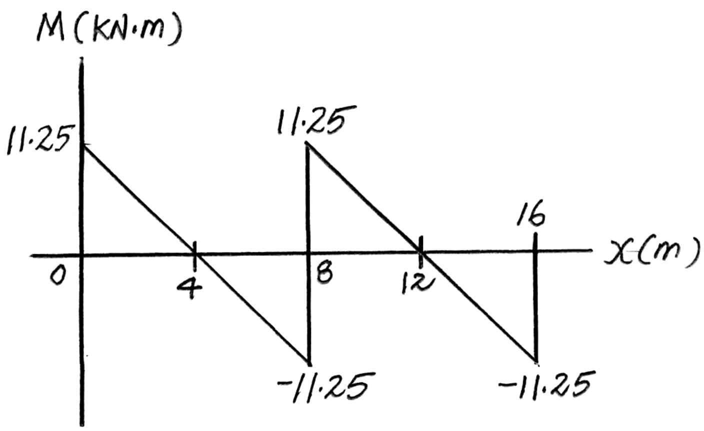




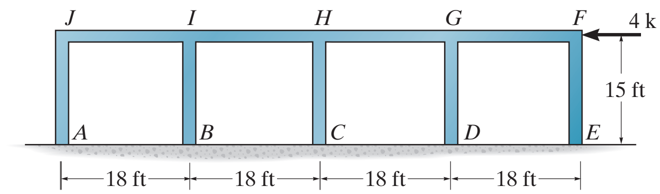


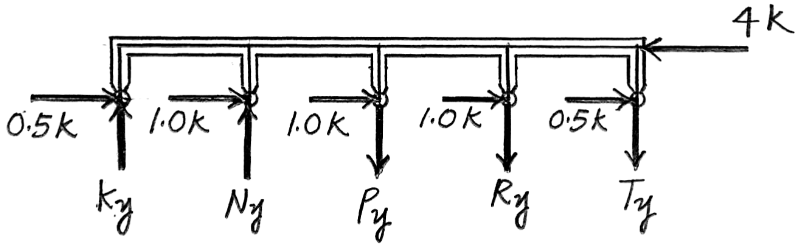


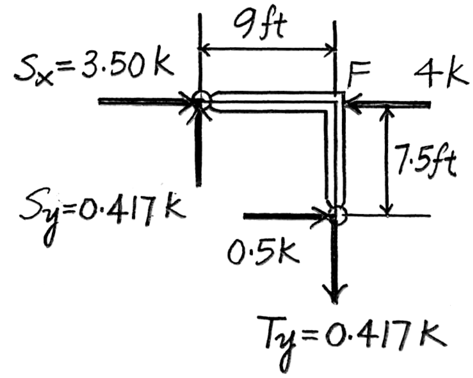


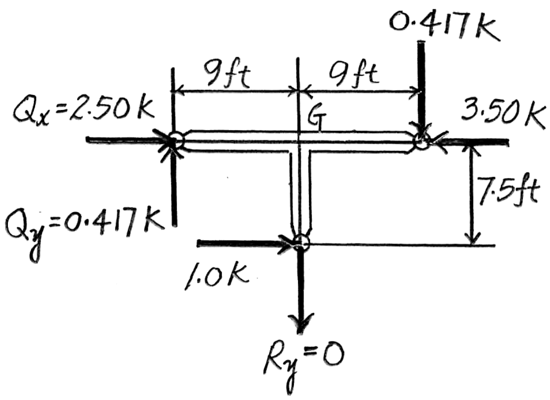


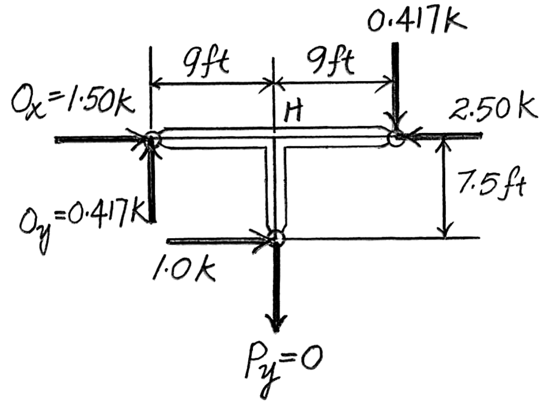
***7–36.** Use the portal method of analysis and draw the moment diagram for girder *JIHGF*.

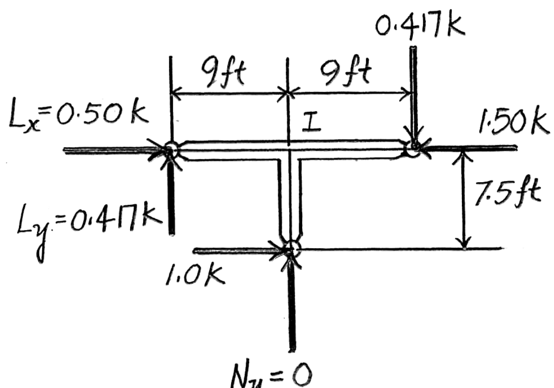


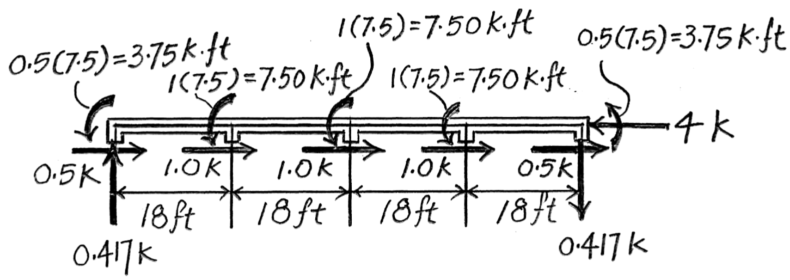


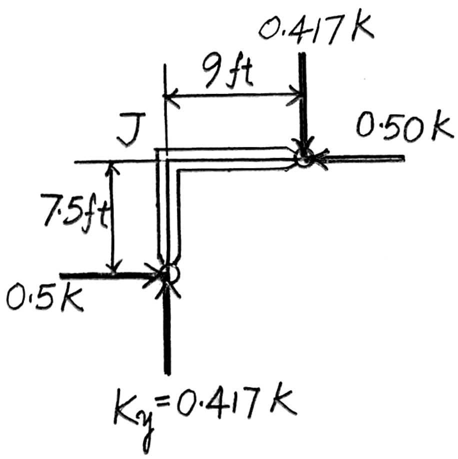


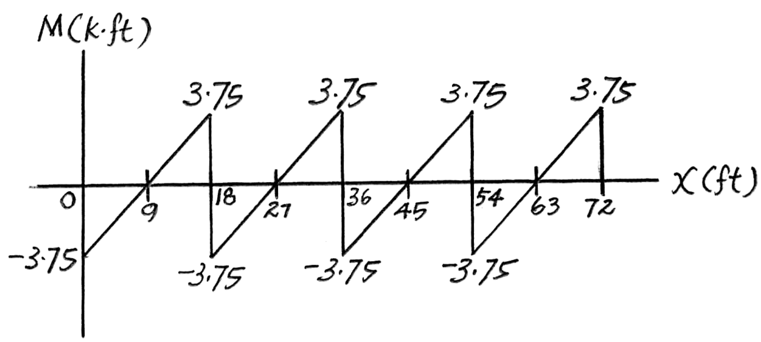




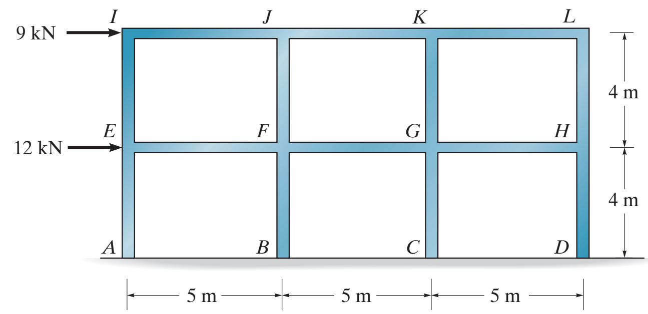


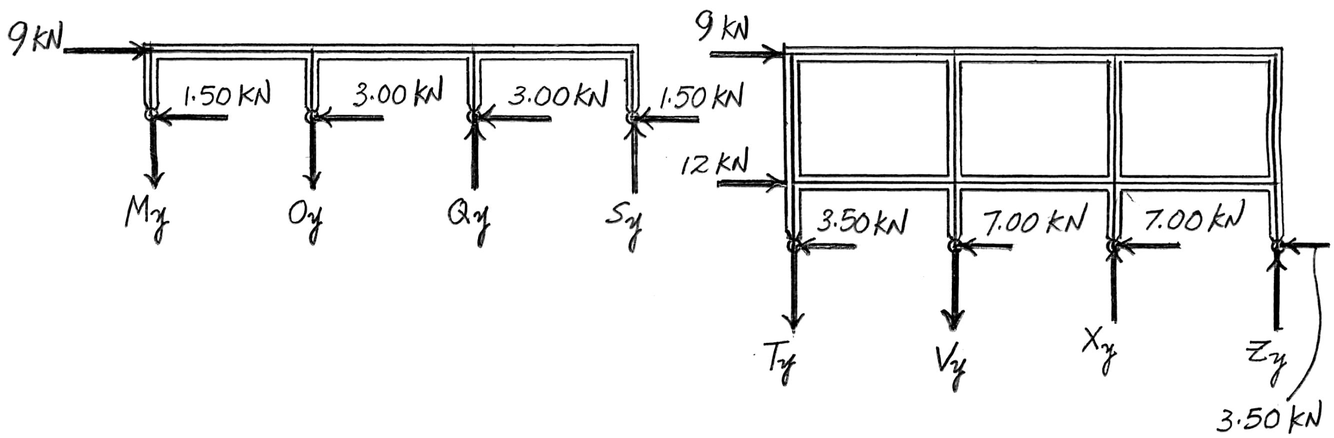


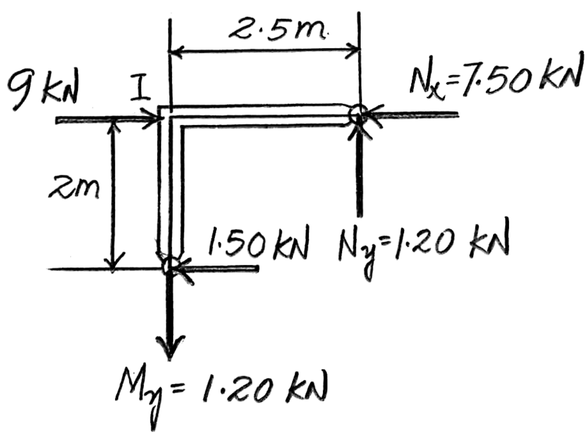


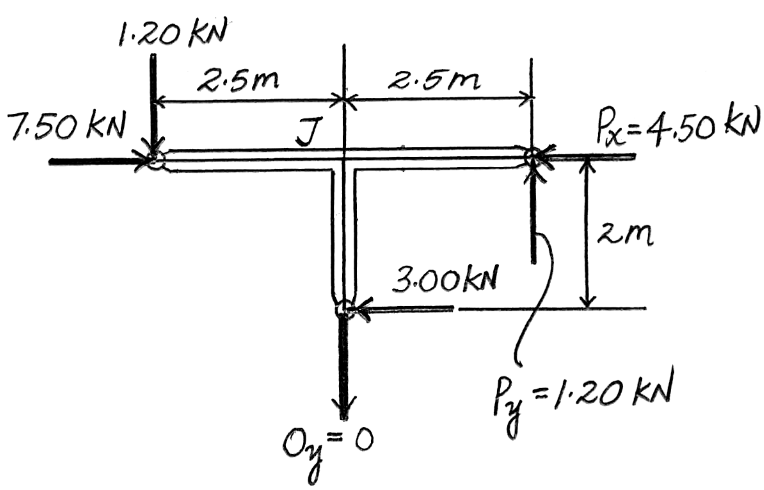


7–37. Use the portal method and determine (approximately) the reactions at supports *A*, *B*, *C*, and *D*.

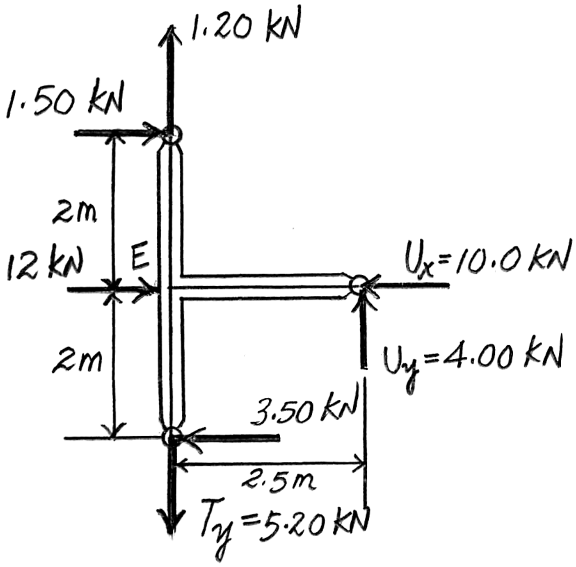


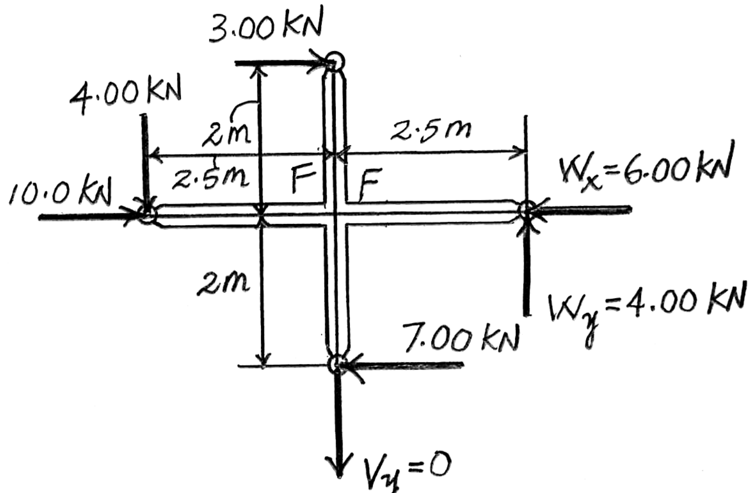


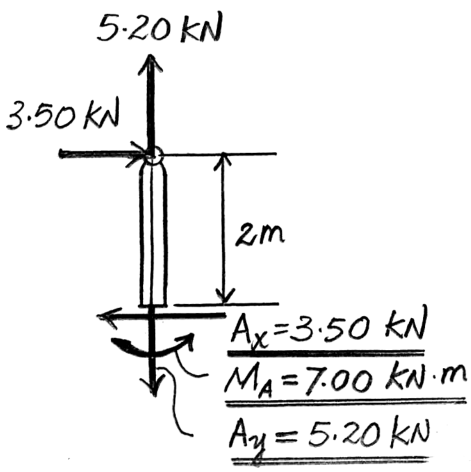


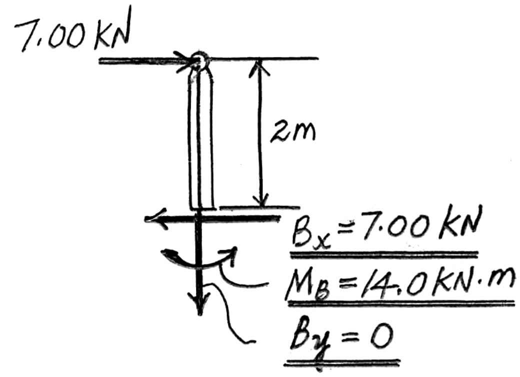


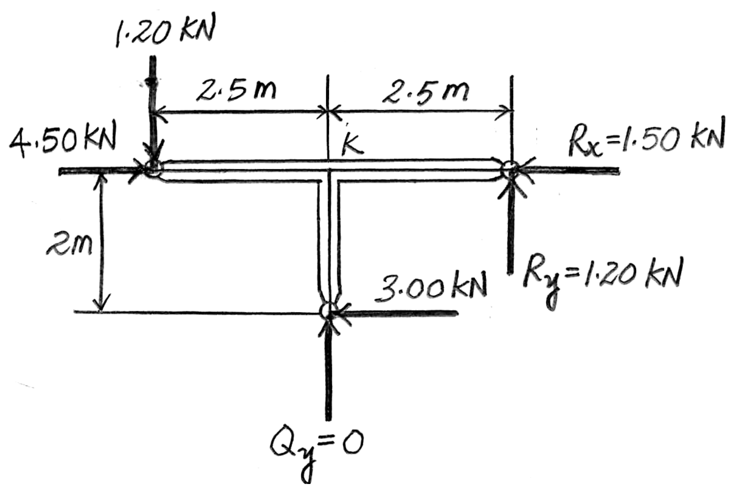
7–37. Continued

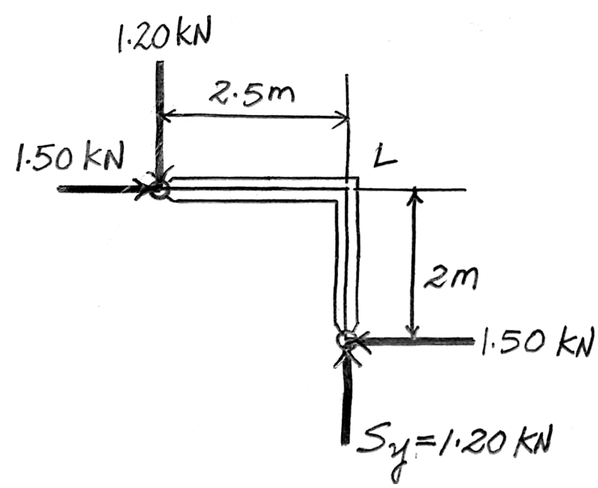












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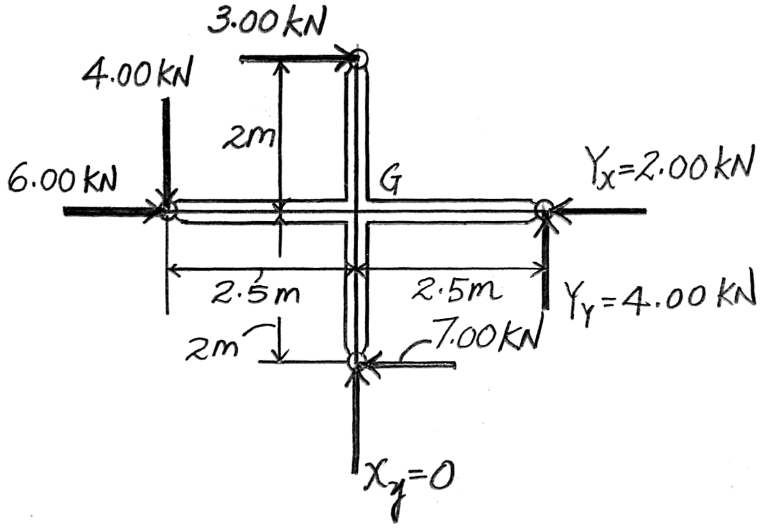
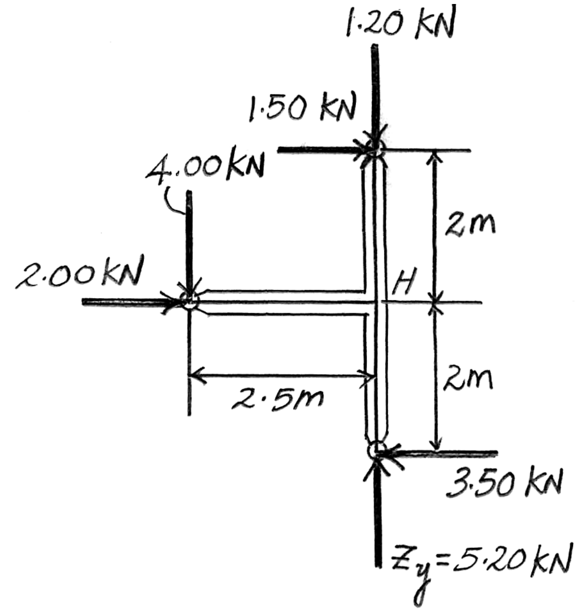
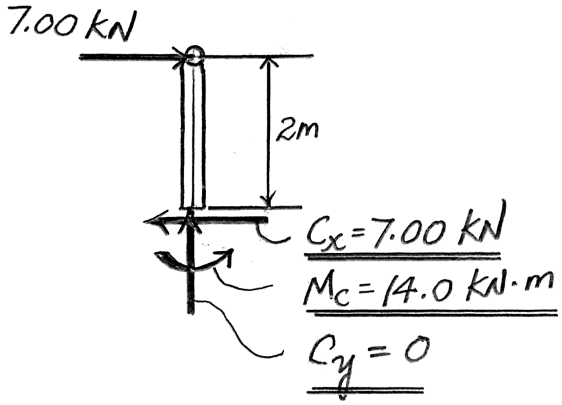
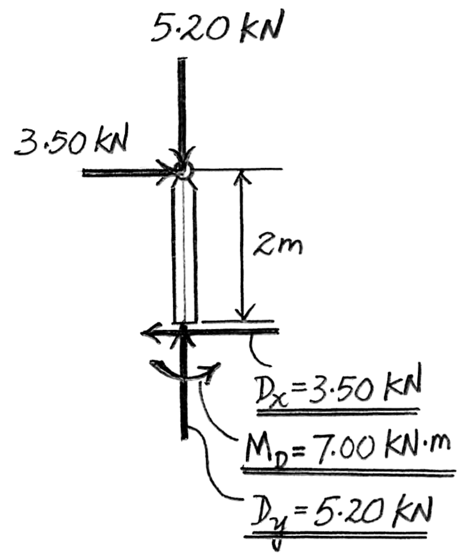
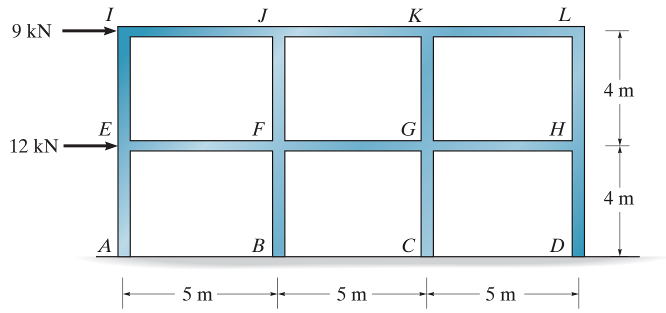


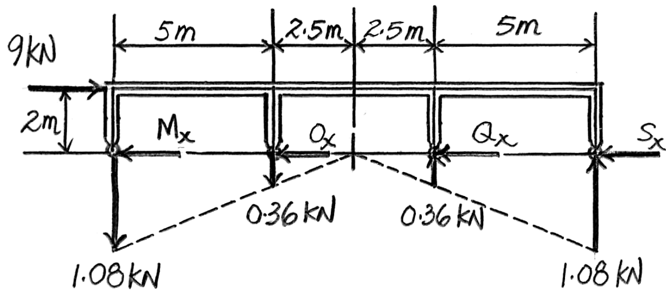


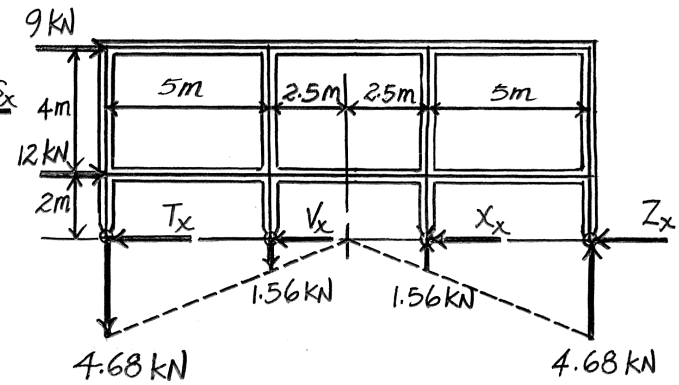


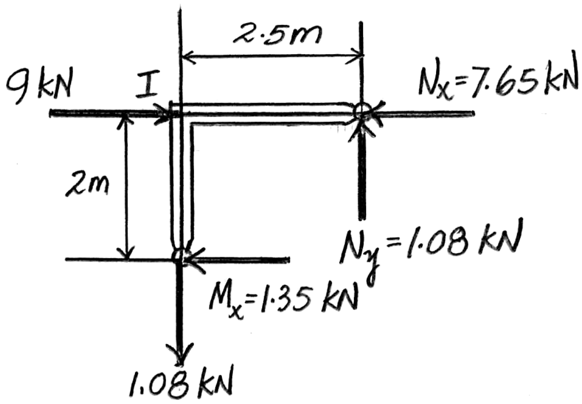


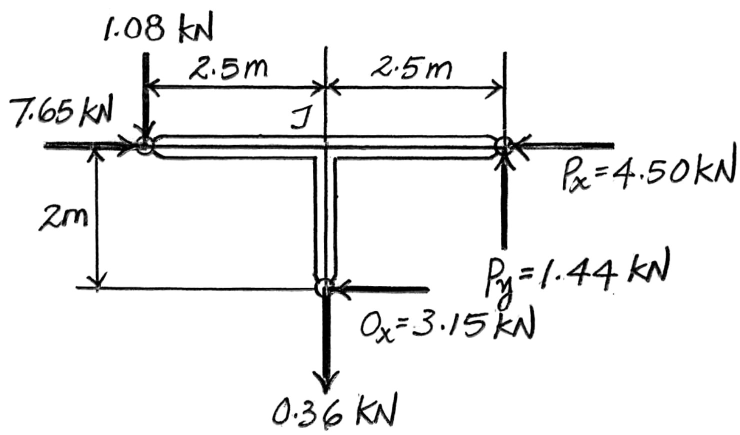
7–38. Use the cantilever method and determine (approximately) the reactions at supports *A*, *B*, *C*, and *D*. All columns have the same cross-sectional area.

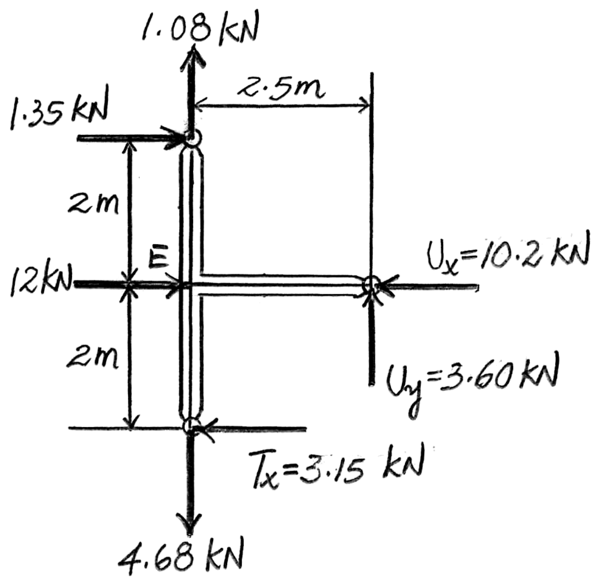


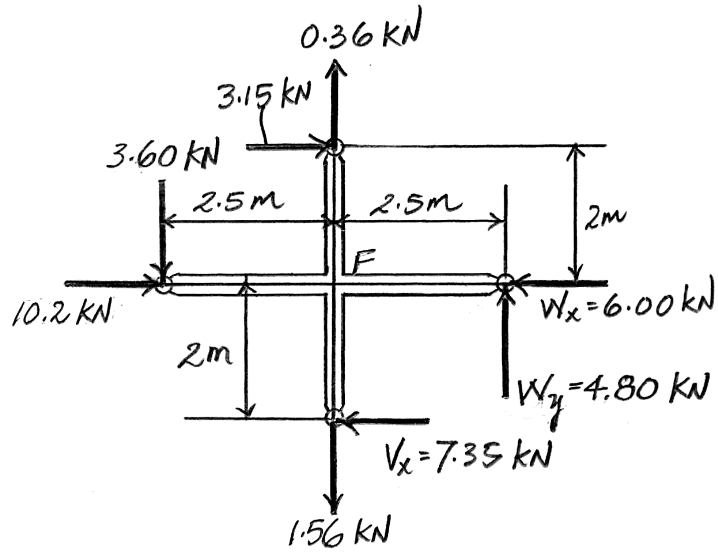




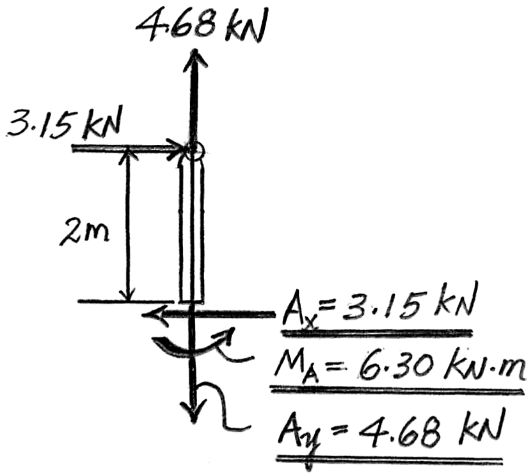


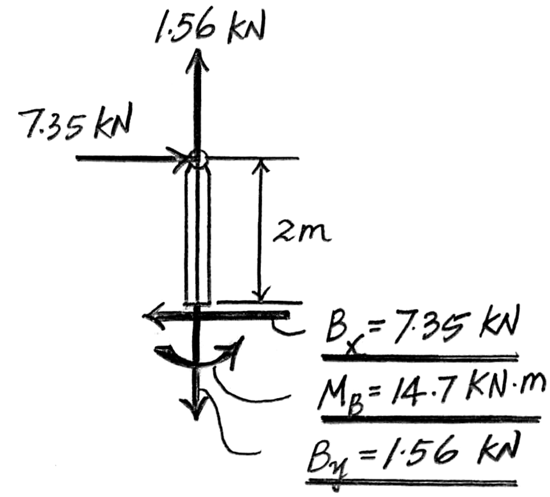


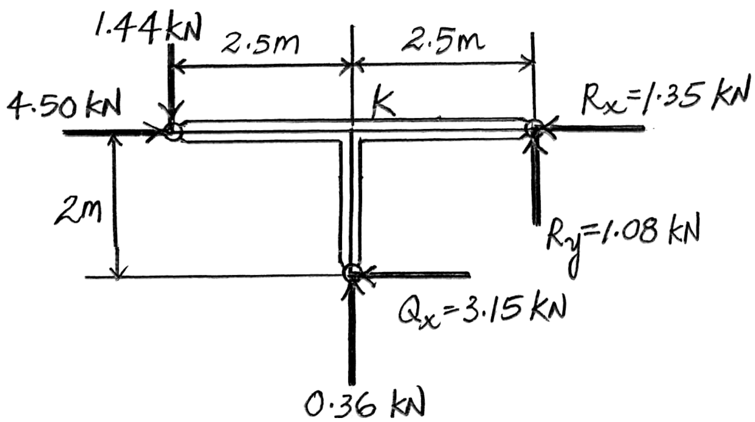


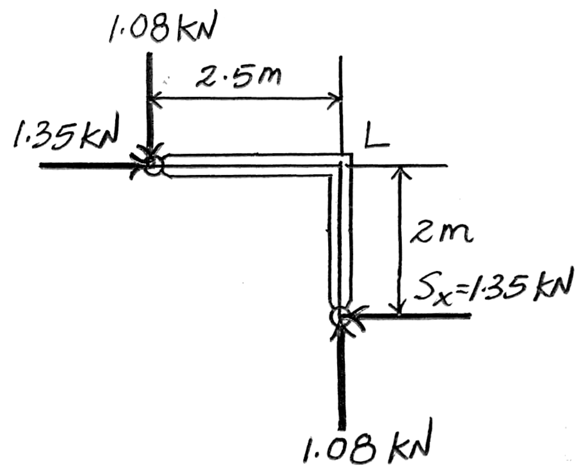


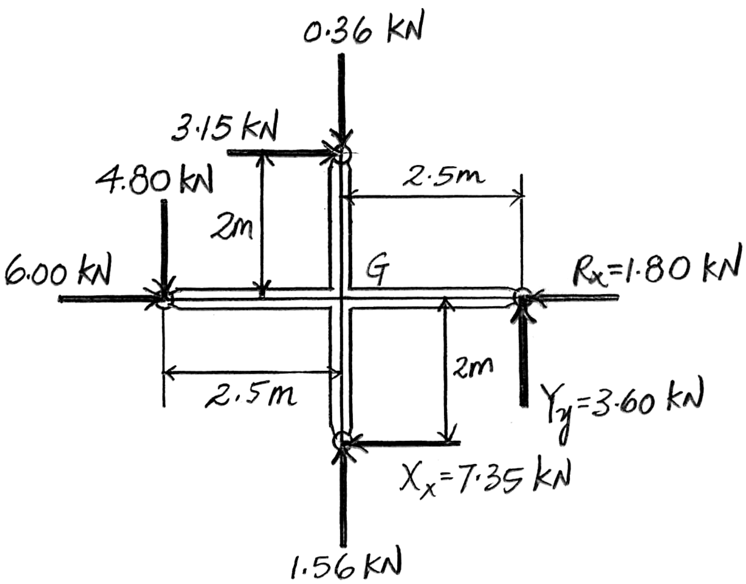
7–38. Continued

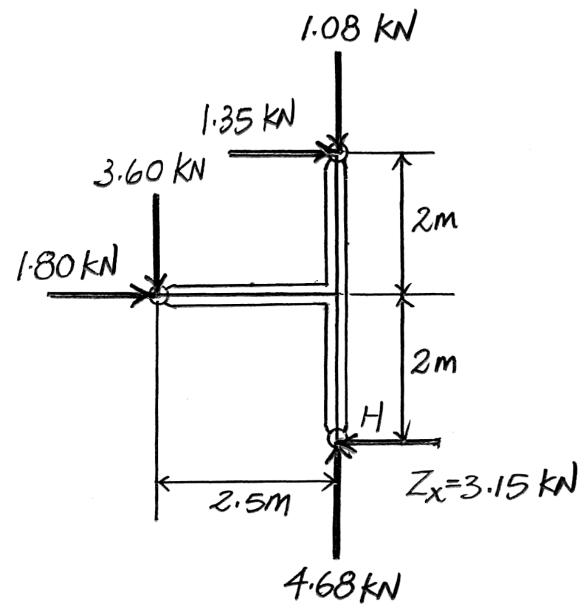




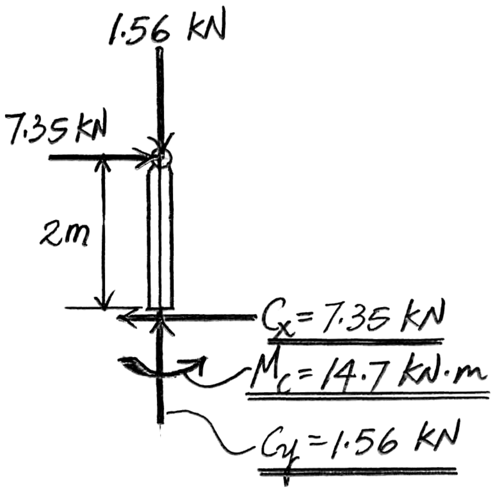


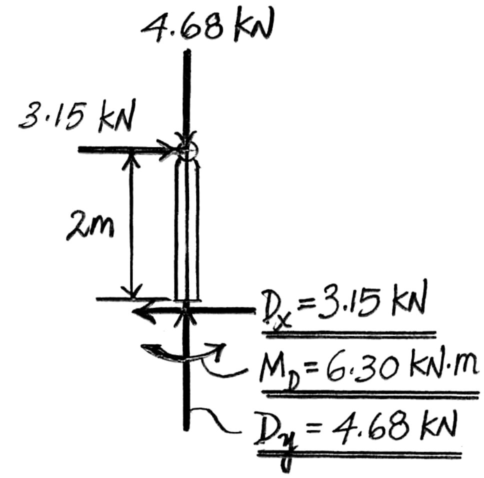




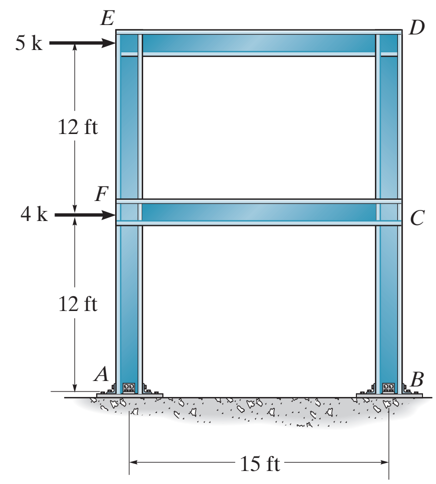


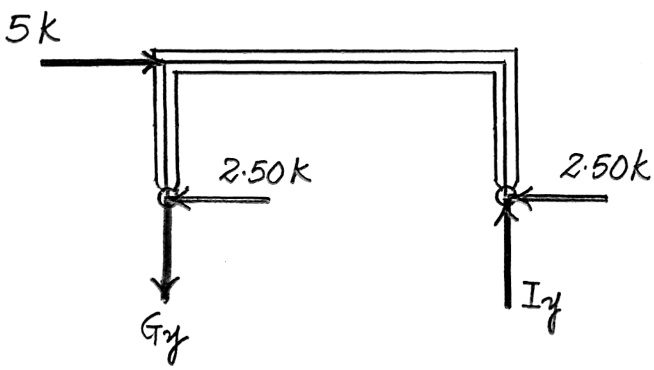
7–38. Continued

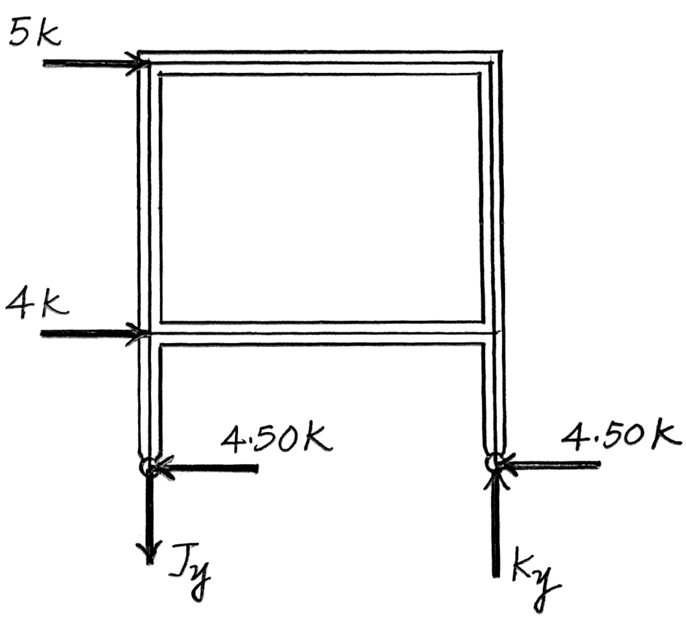


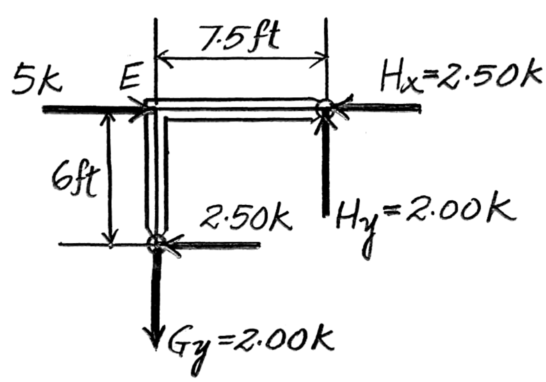


7–39. Use the portal method of analysis and draw the moment diagram for column *AFE*.

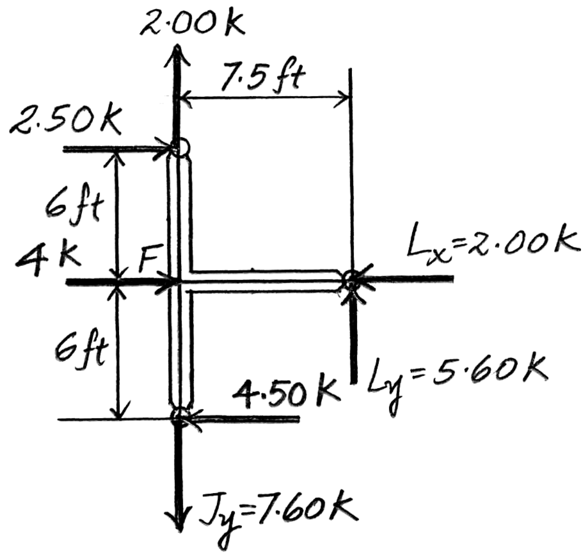


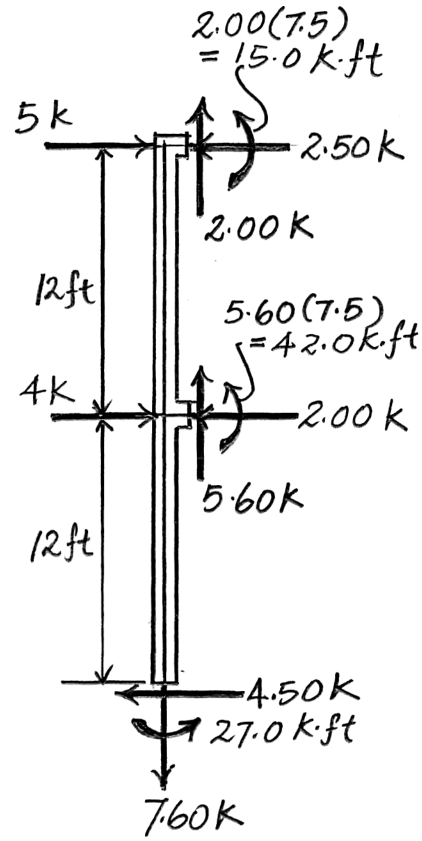


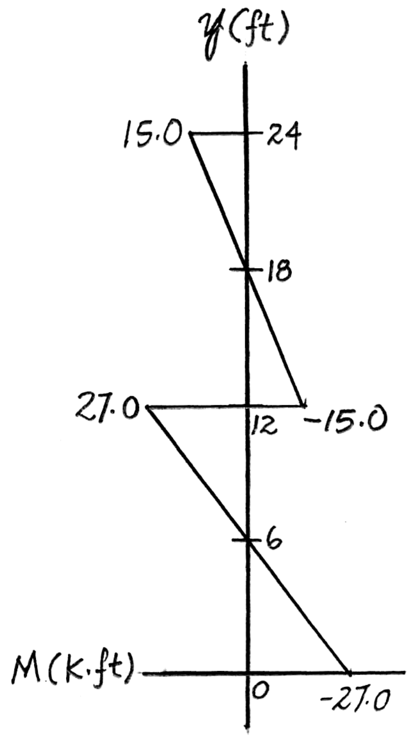


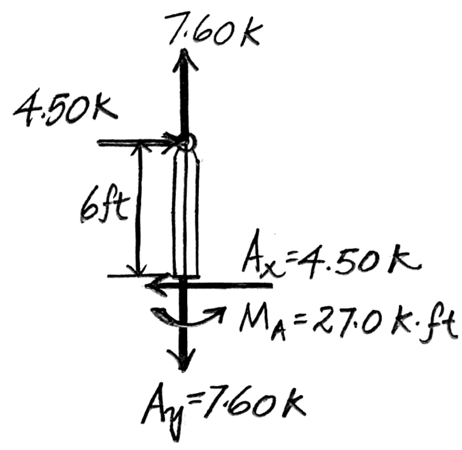


7–39. Continued

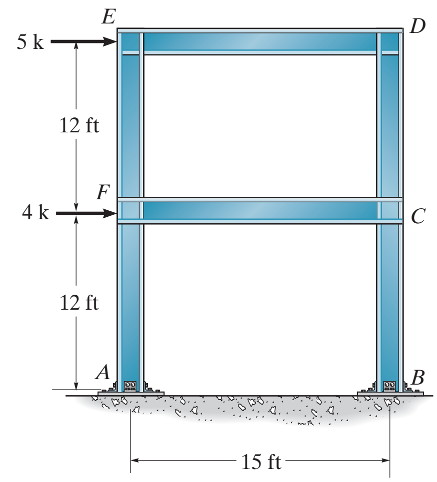


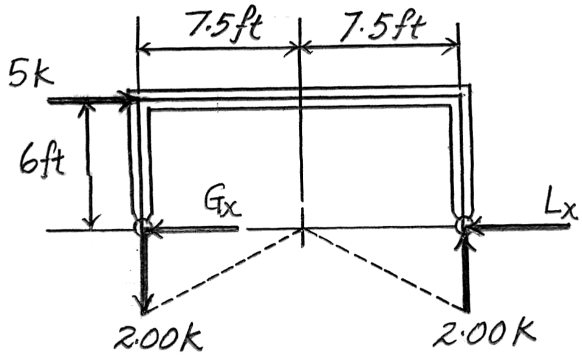


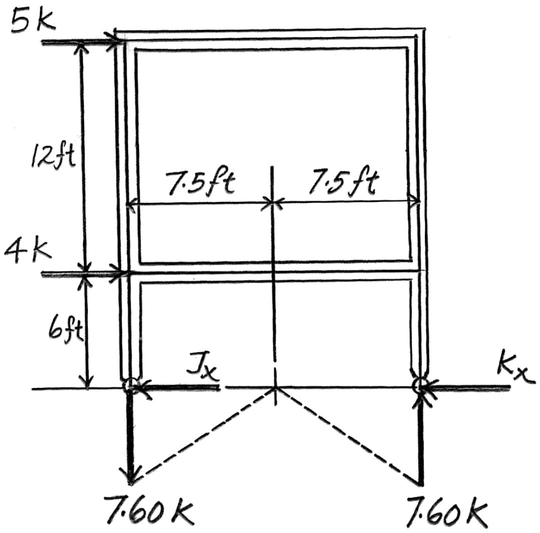


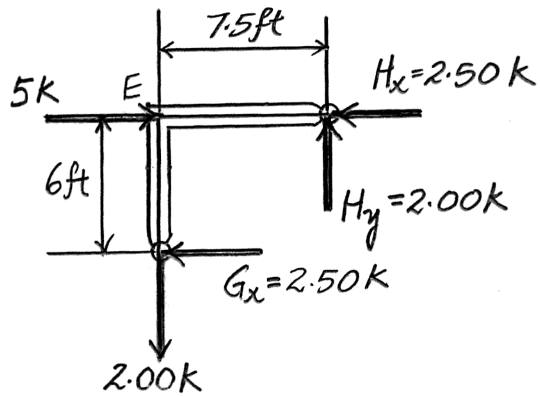


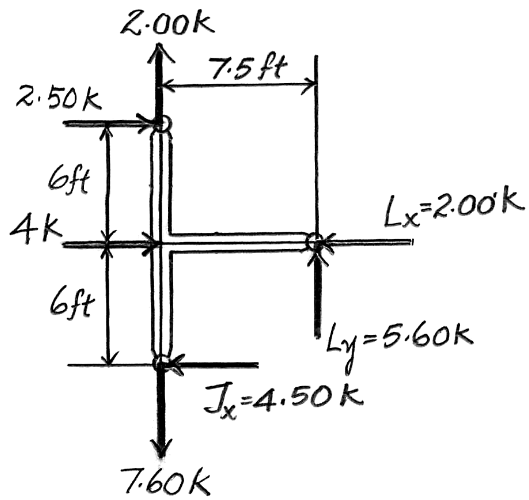
***7–40.** Solve Prob. 7–39 using the cantilever method of analysis. All the columns have the same cross-sectional area.

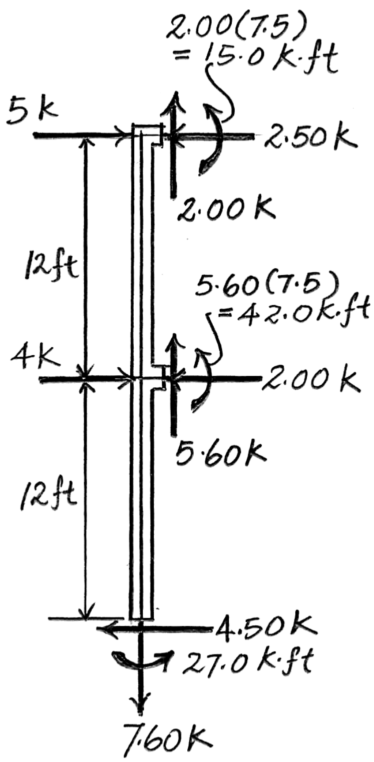


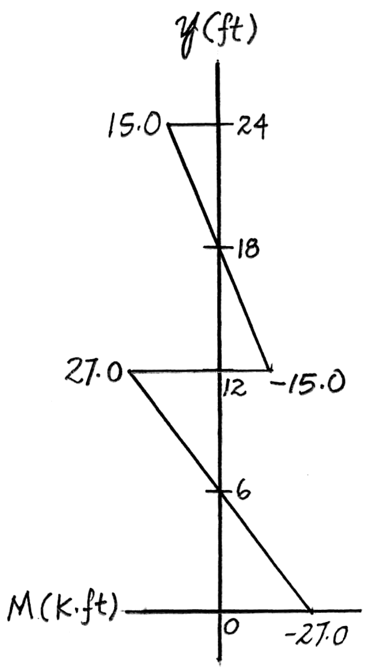


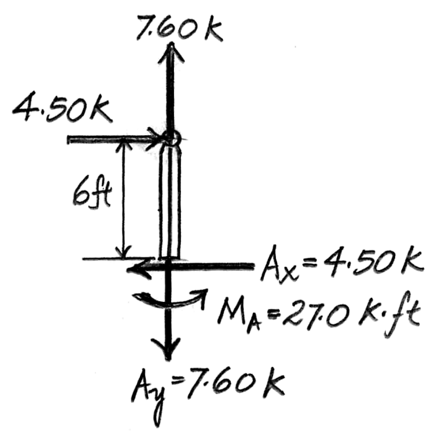




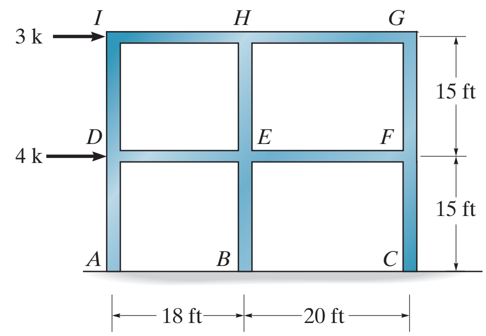


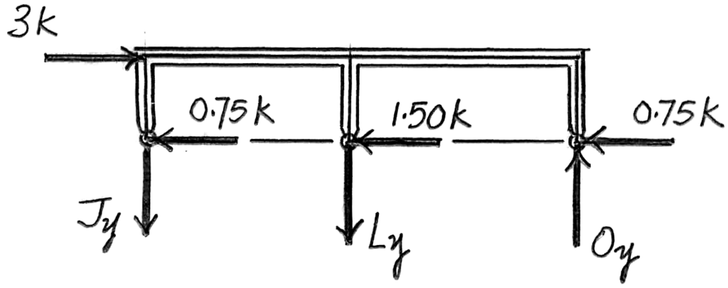


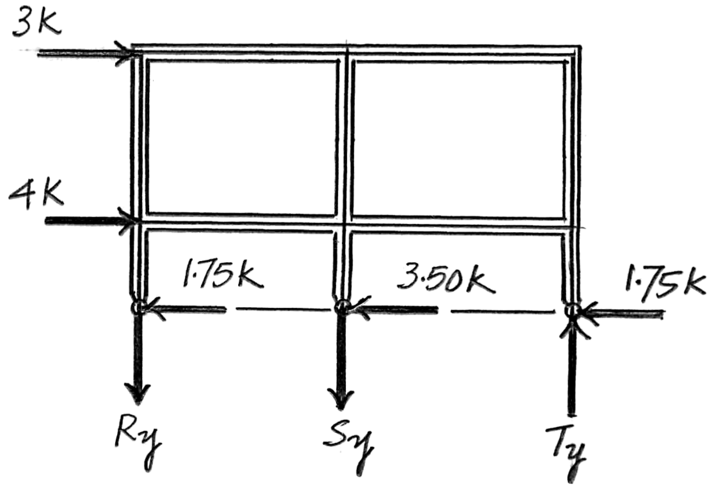


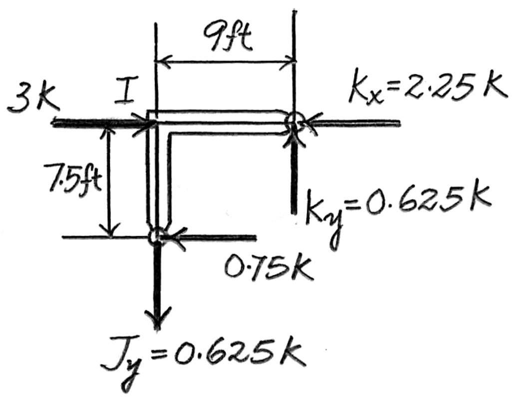


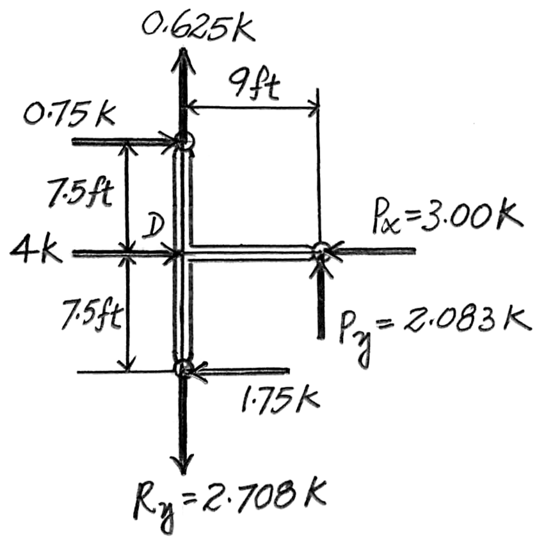
7–41. Use the portal method and determine (approximately) the reactions at A.

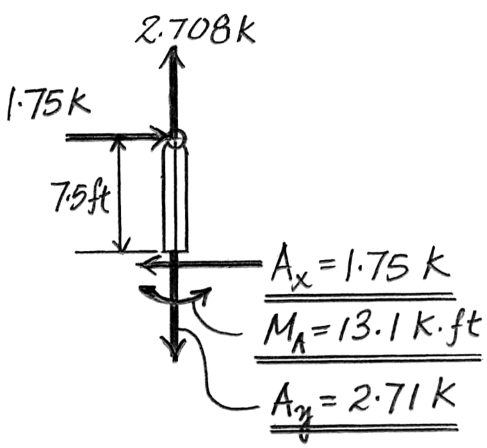




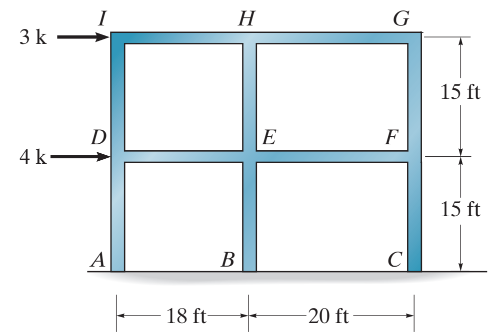


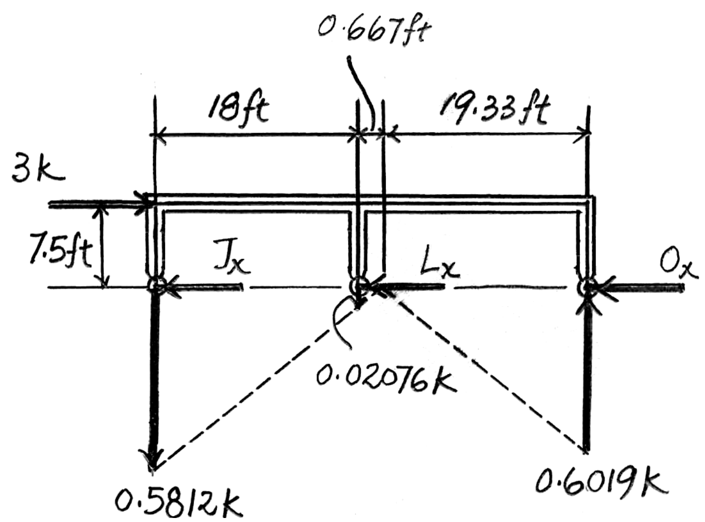


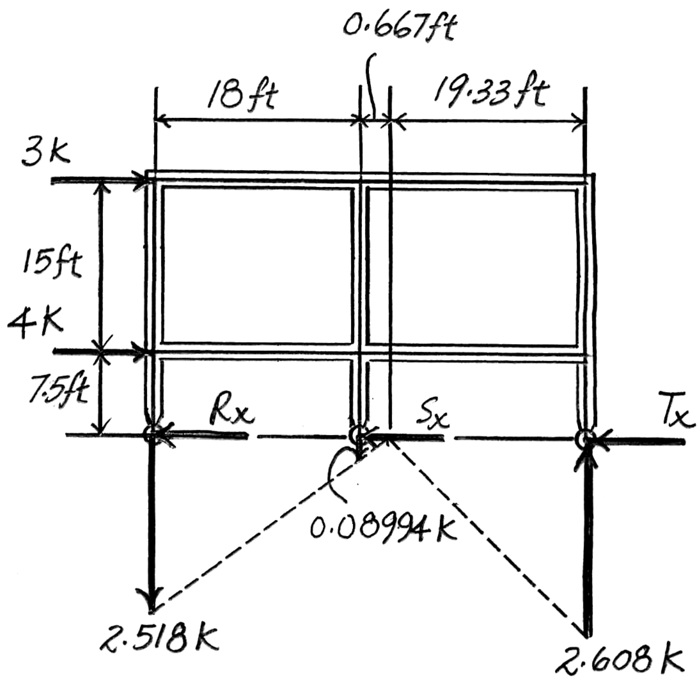


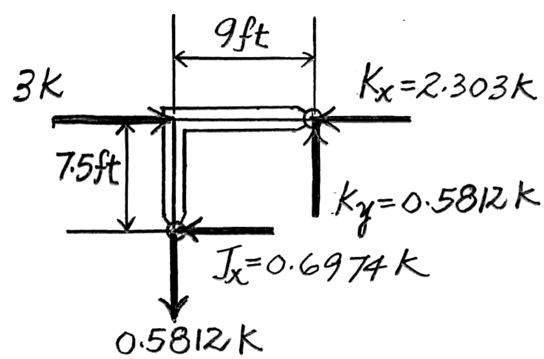


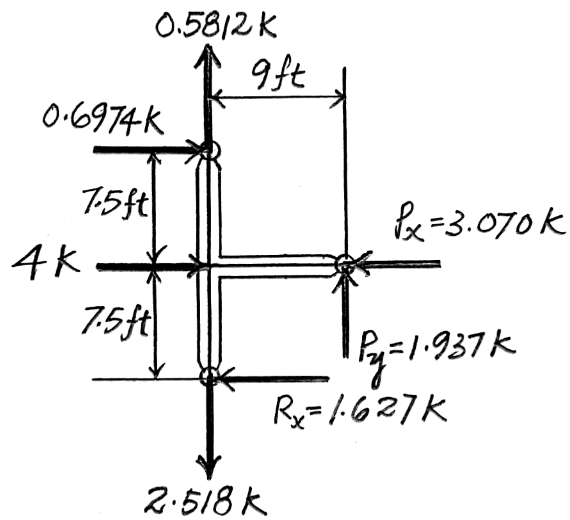
7–42. Use the cantilever method and determine (approximately) the reactions at A. All of the columns have the same cross-sectional area.

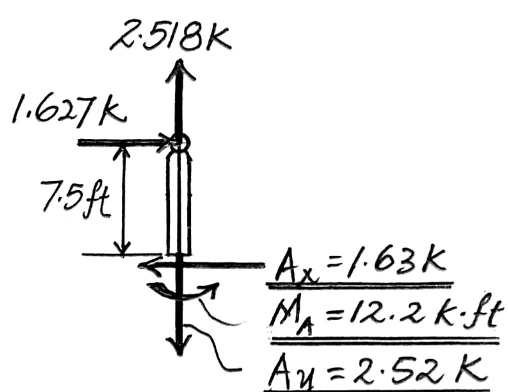




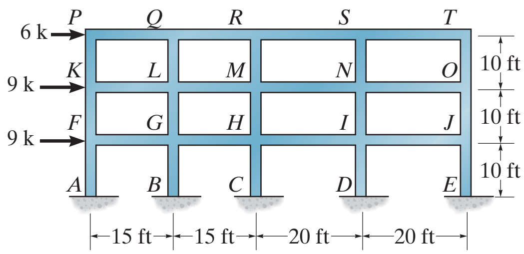


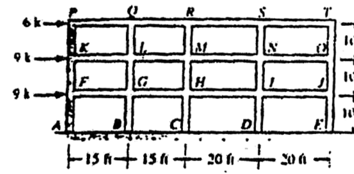






7–43. Draw (approximately) the moment diagram for girder *PQRST* and column *BGLQ* of the building frame. Use the portal method.





Top story

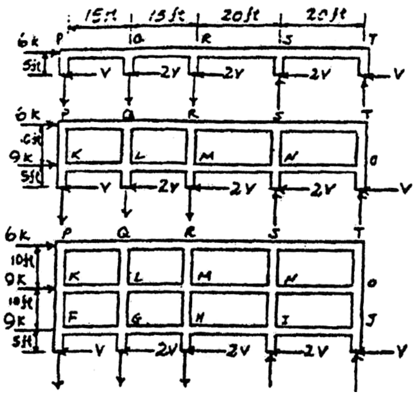
$\xrightarrow{+} \sum F_x = 0; \quad 6 - 8V = 0; \qquad V = 0.75\text{ k}$

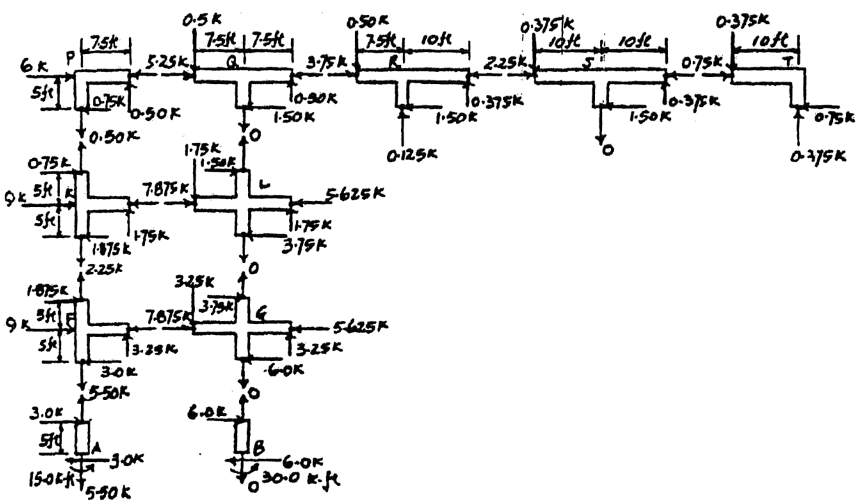
Second story

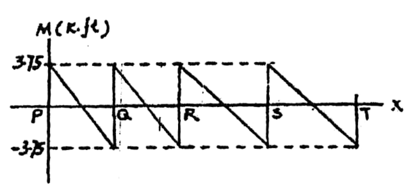
$\xrightarrow{+} \sum F_x = 0; \quad 6 + 9 - 8V = 0; \qquad V = 1.875\text{ k}$

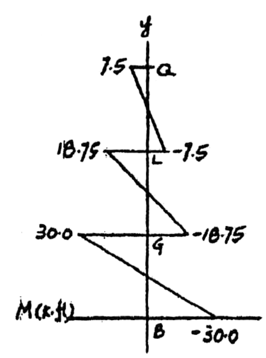
Bottom story

$\xrightarrow{+} \sum F_x = 0; \quad 6 + 9 + 9 - 8V = 0; \qquad V = 3.0\text{ k}$

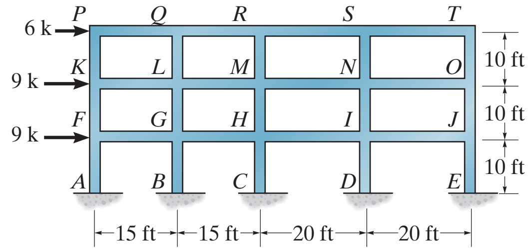




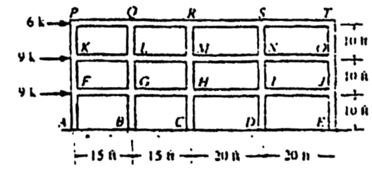




***7–44.** Draw (approximately) the moment diagram for girder *PQRST* and column *BGLQ* of the building frame. All columns have the same cross-sectional area. Use the cantilever method.

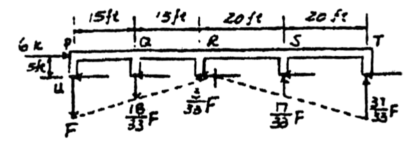


$$\bar{x} = \frac{15 + 30 + 50 + 70}{5} = 33 \text{ ft}$$



$$\zeta + \sum M_U = 0; \qquad -6(5) - \frac{18}{33}F(15) - \frac{3}{33}F(30) + \frac{17}{33}F(50) + \frac{37}{33}F(70) = 0$$

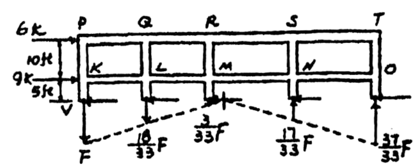
$$F = 0.3214 \text{ k}$$



$$\zeta + \sum M_V = 0;$$

$$-6(15) - 9(5) - \frac{18}{33}F(15) - \frac{3}{33}F(30) + \frac{17}{33}F(50) + \frac{37}{33}F(70) = 0$$

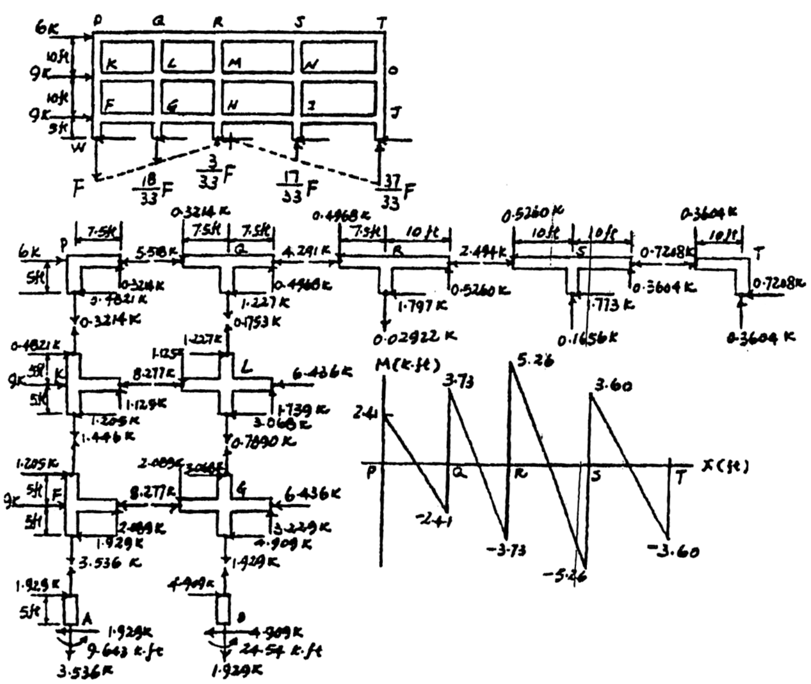
$$F = 1.446 \text{ k}$$

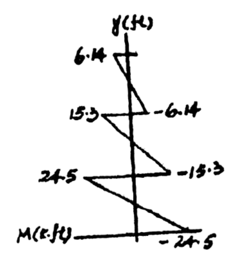


$$\zeta + \sum M_W = 0;$$

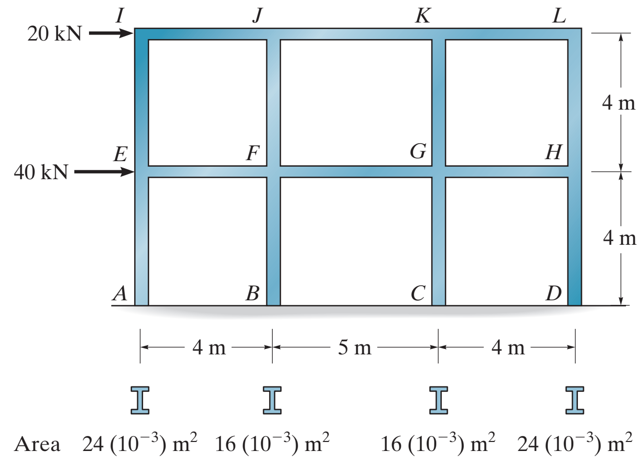
$$-6(25) - 9(15) - 9(5) - \frac{18}{33}F(15) - \frac{3}{33}F(30) + \frac{17}{33}F(50) + \frac{37}{33}F(70) = 0$$

$$F = 3.536 \text{ k}$$



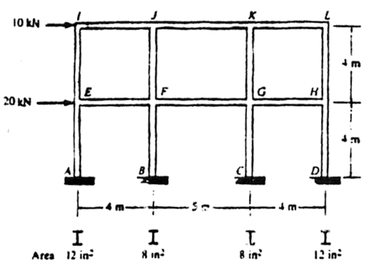


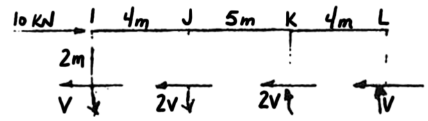
7–45. Draw the moment diagram for girder *IJKL* of the building frame. Use the portal method of analysis.

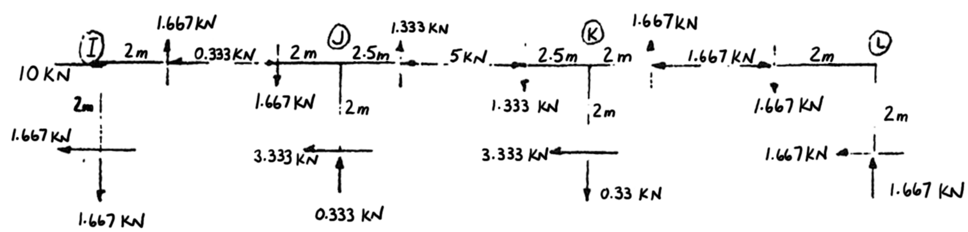


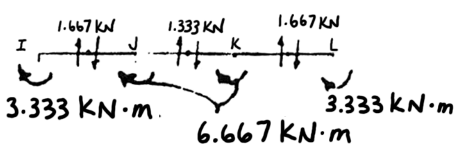
$\xrightarrow{+} \sum F_x = 0; \qquad 10 - 6V = 0; \qquad V = 1.667 \text{ kN}$

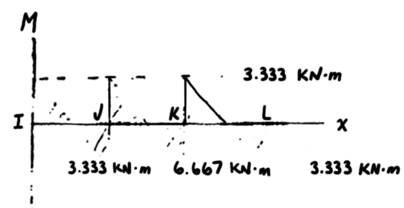
The equilibrium of each segment is shown on the FBDs.



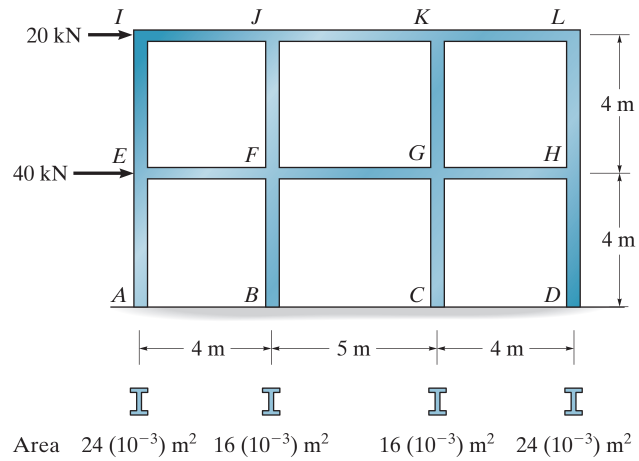








***7–46.** Solve Prob. 7–45 using the cantilever method of analysis. Each column has the cross-sectional area indicated.



The centroid of column area is in center of framework.

Since $\sigma = \dfrac{F}{A}$, then

$$\sigma_1 = \left(\frac{6.5}{2.5}\right)\sigma_2; \qquad \frac{F_1}{12} = \frac{6.5}{2.5}\left(\frac{F_2}{8}\right); \qquad F_1 = 3.90\,F_2$$

$$\sigma_4 = \sigma_1; \qquad F_4 = F_1$$

$$\sigma_2 = \sigma_3; \qquad F_2 = F_3$$

$$\circlearrowleft + \sum M_M = 0; \qquad -2(10) - 4(F_2) + 9(F_2) + 13(3.90\,F_2) = 0$$

$$F_2 = 0.359\text{ k}$$

$$F_1 = 1.400\text{ k}$$

The equilibrium of each segment is shown on the FBDs.