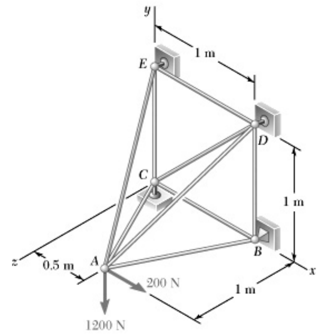
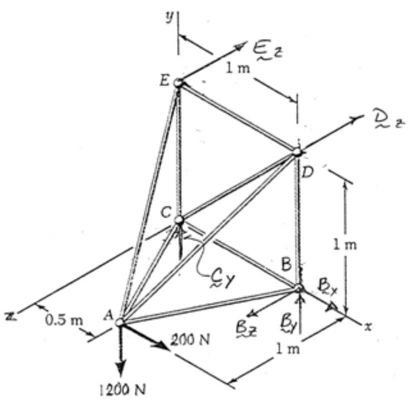


PROBLEM 6.39

The portion of a power line transmission tower shown consists of nine members and is supported by a ball and socket at *B* and short links at *C*, *D*, and *E*. Determine the force in each of the members for the given loading.

SOLUTION

FBD Truss:



$$\Sigma M_{BD} = 0: (1\text{ m})(200\text{ N} - E_z) = 0 \qquad \mathbf{E}_z = (200\text{ N})\mathbf{k}$$

$$\Sigma M_x = 0: (1\text{ m})(1200\text{ N} - E_z - D_z) = 0$$

$$D_z = 1200\text{ N} - 200\text{ N} = 1000\text{ N} \quad \mathbf{D}_Z = (1000\text{ N})\mathbf{k}$$

$$\Sigma F_z = 0: B_z - 1000\text{ N} - 200\text{ N} = 0 \qquad \mathbf{B}_z = (1200\text{ N})\mathbf{k}$$

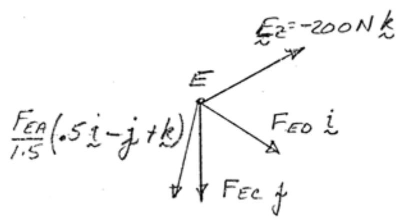
$$\Sigma M_{Bz} = 0: (.5\text{ m})(1200\text{ N}) - (1\text{ m})C_y = 0 \qquad \mathbf{C}_y = (600\text{ N})\mathbf{j}$$

$$\Sigma F_x = 0: B_x - 200\text{ N} = 0 \qquad \mathbf{B}_x = (200\text{ N})\mathbf{i}$$

$$\Sigma F_y = 0: B_y + C_y - 1200\text{ N} = 0$$

$$B_y = 1200\text{ N} - 600\text{ N} \qquad \mathbf{B}_y = (600\text{ N})\mathbf{j}$$

Joint FBDs:



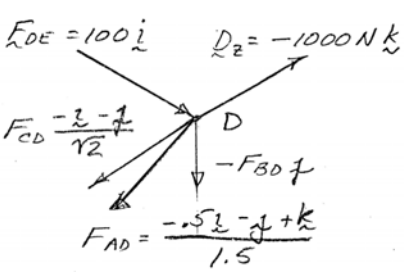
$$\Sigma F_z = 0: \frac{F_{EA}}{1.5} - 200\text{ N} = 0 \qquad F_{EA} = 300\text{ N T} \blacktriangleleft$$

$$\Sigma F_x = 0: F_{ED} + \frac{.5}{1.5}F_{EA} = 0 \qquad F_{ED} = -100\text{ N}$$

$$F_{ED} = 100\text{ N C} \blacktriangleleft$$

$$\Sigma F_y = 0: \quad -\frac{F_{EA}}{1.5} - F_{EC} = 0 \qquad F_{EC} = -200\text{ N}$$

$$F_{EC} = 200\text{ N C} \blacktriangleleft$$



$$\Sigma F_z = 0: \frac{F_{AD}}{1.5} - 1000\text{ N} = 0 \qquad F_{AD} = 1500\text{ N T} \blacktriangleleft$$

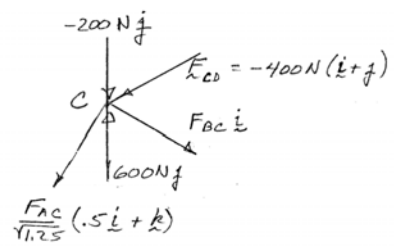
$$\Sigma F_x = 0: 100\text{ N} - \frac{0.5}{1.5}F_{AD} - \frac{1}{\sqrt{2}}F_{CD} = 0$$

$$F_{CD} = \sqrt{2}\left(100\text{ N} - \frac{1500\text{ N}}{3}\right) = -400\sqrt{2} \qquad F_{CD} = 566\text{ N C} \blacktriangleleft$$

$$\Sigma F_y = 0: \qquad -\frac{F_{CD}}{\sqrt{2}} - \frac{F_{AD}}{1.5} - F_{BD} = 0$$

$$F_{BD} = +400 - 1000 = -600\text{ N} \qquad F_{BD} = 600\text{ N C} \blacktriangleleft$$

PROBLEM 6.39 CONTINUED

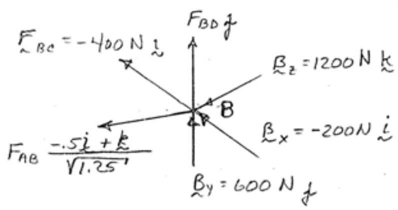


$$\uparrow \Sigma F_y = 0: 600 \text{ N} - 200 \text{ N} - 400 \text{ N} = 0$$

$$\swarrow \Sigma F_z = 0: \frac{F_{AC}}{\sqrt{1.25}} = 0 \qquad F_{AC} = 0 \blacktriangleleft$$

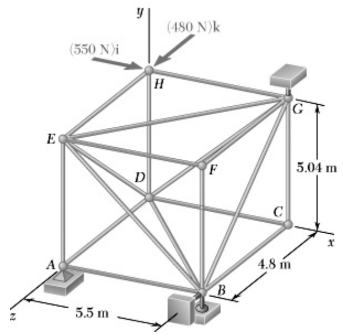
$$\searrow \Sigma F_x = 0: F_{BC} - 400 \text{ N} + \frac{.5}{\sqrt{1.25}} \cancel{F_{AC}}^{0} = 0$$

$$F_{BC} = 400 \text{ N T} \blacktriangleleft$$



$$\searrow \Sigma F_x = 0: -200 \text{ N} - 400 \text{ N} - F_{AB} \frac{.5}{\sqrt{1.25}} = 0$$

$$F_{AB} = 1200\sqrt{1.25} \text{ N} \qquad F_{AB} = 1342 \text{ N C} \blacktriangleleft$$



PROBLEM 6.40

The truss shown consists of 18 members and is supported by a ball and socket at *A*, two short links at *B*, and one short link at *G*. (*a*) Check that this truss is a simple truss, that it is completely constrained, and that the reactions at its supports are statically determinate. (*b*) For the given loading, determine the force in each of the six members joined at *E*.

SOLUTION

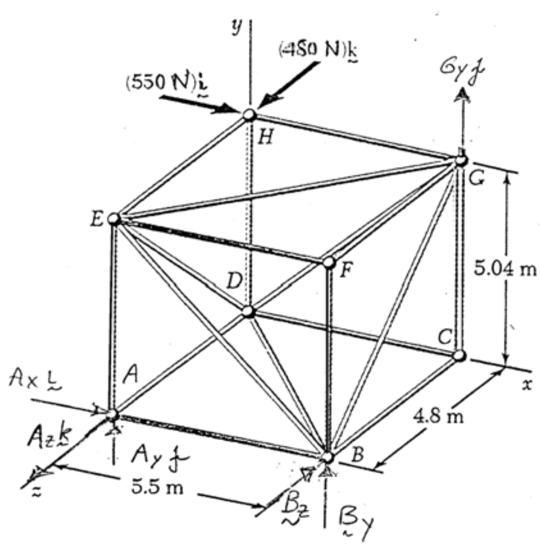
(a) To check for simple truss, start with *ABDE* and add three members at a time which meet at a single joint, thus successively adding joints *F*, *G*, *H*, and *C*, to complete the truss.

This is, therefore, a simple truss. ◀

There are six reaction force components, none of which are in-line, so they are determined by the six equilibrium equations. Constraints prevent motion. Truss is completely constrained and ◀

statically determinate ◀

(b) FBD Truss:



$$\Sigma M_{BC} = 0: (5.04\text{ m})(550\text{ N}) + (5.5\text{ m})(A_y) = 0 \qquad \mathbf{A}_y = -(504\text{ N})\,\mathbf{j}$$

$$\Sigma M_{BF} = 0: (5.5\text{ m})(A_z + 480\text{ N}) - (4.8\text{ m})(550\text{ N}) = 0 \qquad \mathbf{A}_z = 0$$

By inspection of joint *C*: $F_{DC} = F_{BC} = F_{GC} = 0$

By inspection of joint *A*: $F_{AE} = -A_y = 504\text{ N}\ \text{T}$ ◀

$F_{AD} = A_z = 0$

By inspection of joint *H*: $F_{DH} = 0$

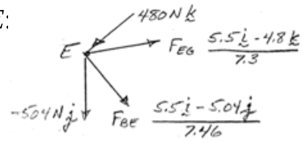
$F_{EH} = 480\text{ N}\ \text{C}$ ◀

By inspection of joint *F*: $F_{EF} = 0$ ◀

PROBLEM 6.40 CONTINUED

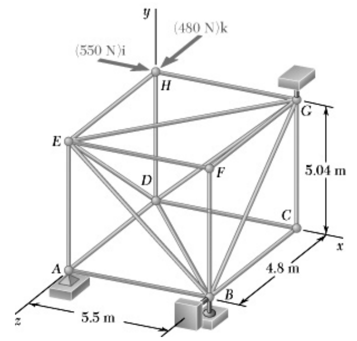
Then, since *ED* is the only non-zero member at *D*, not in the plane *BDG*, $F_{DE} = 0$ ◀

Joint *E*:



$\Sigma F_z = 0\text{: } 480\text{ N} - \dfrac{4.8}{7.3}F_{EG} = 0$ $\qquad F_{EG} = 730\text{ N T}$ ◀

$\Sigma F_y = 0\text{: } -504\text{ N} - \dfrac{5.04}{7.46}F_{BE} = 0$ $\qquad F_{BE} = -746\text{ N}$ $\quad F_{BE} = 746\text{ N C}$ ◀



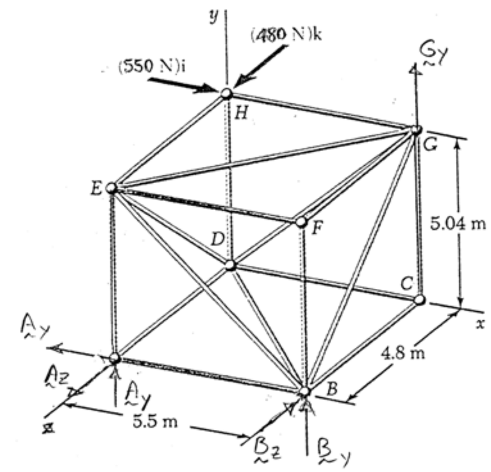
PROBLEM 6.41

The truss shown consists of 18 members and is supported by a ball and socket at *A*, two short links at *B*, and one short link at *G*. (*a*) Check that this truss is a simple truss, that it is completely constrained, and that the reactions at its supports are statically determinate. (*b*) For the given loading, determine the force in each of the six members joined at *G*.

SOLUTION

(a) See part (a) solution 6.40 above

(b) FBD Truss:



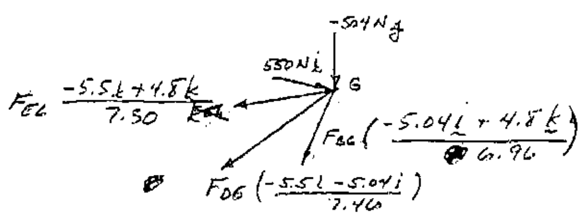
$$\Sigma M_{AB} = 0: \; (4.8 \text{ m})G_y + (5.04 \text{ m})(480 \text{ N}) = 0 \qquad \mathbf{G}_y = -504 \text{ N}$$

By inspection of joint *C*: $F_{CG} = 0$ ◀

By inspection of joint *H*: $F_{HG} = 550 \text{ N} \;\; \text{C}$ ◀

By inspection of joint *F*: $F_{FG} = 0$ ◀

Joint *G*:



$$\Sigma F_x = 0: 550 \text{ N} - \frac{5.5}{7.46}F_{DG} - \frac{5.5}{7.30}F_{EG} = 0$$

PROBLEM 6.41 CONTINUED

$$\uparrow \Sigma F_y = 0: -504\text{ N} - \frac{5.04}{7.46}F_{DG} - \frac{5.04}{6.96}F_{BG} = 0$$

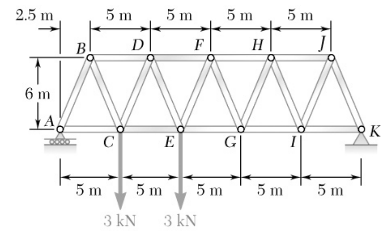
$$\swarrow \Sigma F_z = 0: \frac{4.8}{7.30}F_{EG} + \frac{4.8}{6.96}F_{BG} = 0$$

Solving:

$F_{BG} = -696\text{ N}$ $\quad$ $F_{BG} = 696\text{ N C}$ ◀

$F_{DG} = 0$ $\quad$ $F_{DG} = 0$ ◀

$F_{EG} = 730\text{ N}$ $\quad$ $F_{EG} = 730\text{ N T}$ ◀

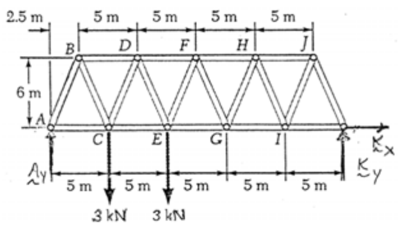


PROBLEM 6.42

A Warren bridge truss is loaded as shown. Determine the force in members *CE*, *DE*, and *DF*.

SOLUTION

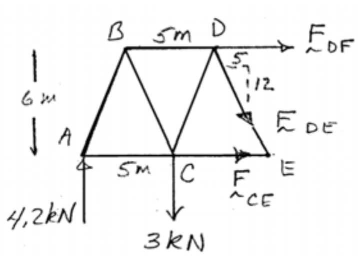
FBD Truss:



$$\circlearrowleft \Sigma M_K = 0\colon (15\text{ m})(3\text{ kN}) + (20\text{ m})(3\text{ kN}) - (25\text{ m})A_y = 0$$

$$\mathbf{A}_y = 4.2\text{ kN} \uparrow$$

Section ABDC:



$$\circlearrowleft \Sigma M_D = 0\colon (6\text{ m})F_{CE} + (2.5\text{ m})(3\text{ kN}) - (7.5\text{ m})(4.2\text{ kN}) = 0$$

$$F_{CE} = 4\text{ kN} \qquad F_{CE} = 4.00\text{ kN T} \blacktriangleleft$$

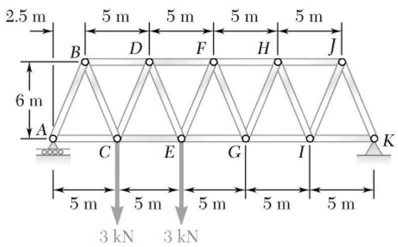
$$\uparrow \Sigma F_y = 0\colon 4.2\text{ kN} - 3\text{ kN} - \frac{12}{13}F_{DE} = 0$$

$$F_{DE} = 1.3\text{ kN} \qquad F_{DE} = 1.300\text{ kN T} \blacktriangleleft$$

$$\longrightarrow \Sigma F_x = 0\colon F_{DF} + \frac{5}{13}F_{DE} + F_{CE} = 0$$

$$F_{DF} = -\frac{5}{13}(1.3\text{ kN}) - (4\text{ kN}) = -4.5\text{ kN}$$

$$F_{DF} = 4.50\text{ kN C} \blacktriangleleft$$

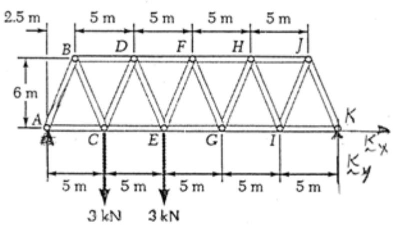


PROBLEM 6.43

A Warren bridge truss is loaded as shown. Determine the force in members *EG*, *FG*, and *FH*.

SOLUTION

FBD Truss:



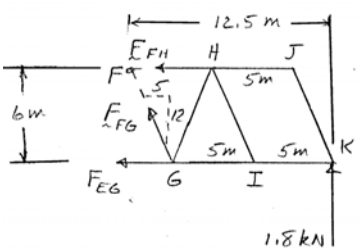
$$\rightarrow \Sigma F_x = 0: \mathbf{K}_x = 0$$

$$\circlearrowleft \Sigma M_A = 0: (25\text{ m})K_y - (10\text{ m})(3\text{ kN}) - (5\text{ m})(3\text{ kN}) = 0$$

$$\mathbf{K}_y = 1.8\text{ kN} \uparrow$$

$$\circlearrowleft \Sigma M_G = 0: (10\text{ m})(1.8\text{ kN}) + (6\text{ m})F_{FH} = 0$$

Section FBD:



$F_{FH} = -3\text{ kN}$ $\qquad$ $F_{FH} = 3.00\text{ kN C} \blacktriangleleft$

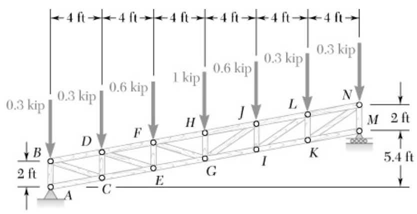
$$\circlearrowleft \Sigma M_F = 0: (12.5\text{ m})(1.8\text{ kN}) - (6\text{ m})(F_{EG}) = 0$$

$F_{EG} = 3.75\text{ kN}$ $\qquad$ $F_{EG} = 3.75\text{ kN T} \blacktriangleleft$

$$\uparrow \Sigma F_y = 0: \frac{12}{13}F_{FG} + 1.8\text{ kN} = 0$$

$F_{FG} = -1.95\text{ kN}$ $\qquad$ $F_{FG} = 1.950\text{ kN C} \blacktriangleleft$

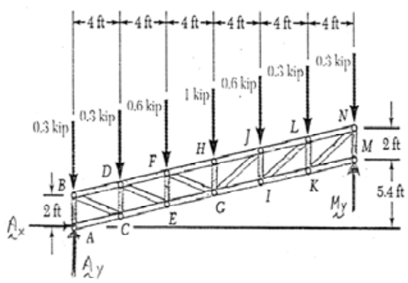
PROBLEM 6.44



A parallel chord Howe truss is loaded as shown. Determine the force in members *CE*, *DE*, and *DF*.

SOLUTION

FBD Truss:



$$\rightarrow \Sigma F_x = 0: \mathbf{A}_x = 0$$

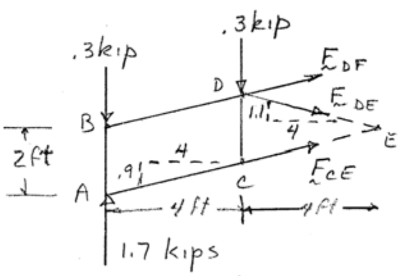
$$\circlearrowleft \Sigma M_M = 0: (4\text{ ft})\big[1(0.3\text{ kip}) + 2(0.6\text{ kip}) + 3(1\text{ kip}) + 4(0.6\text{ kip}) + 5(0.3\text{ kip}) + 6(0.3\text{ kip}) - 6A_y\big] = 0$$

$$\mathbf{A}_y = 1.7\text{ kips} \uparrow$$

$$\circlearrowleft \Sigma M_D = 0: (4\text{ ft})(3\text{ kips} - 1.7\text{ kips}) + (2\text{ ft})\left(\frac{4}{4.1}F_{CE} = 0\right)$$

$$F_{CE} = 2.87\text{ kips} \qquad F_{CE} = 2.87\text{ kips T} \blacktriangleleft$$

FBD Section:



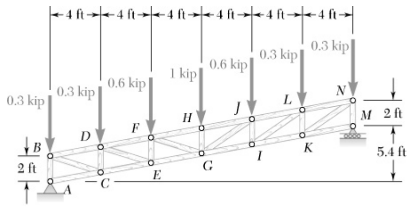
$$\circlearrowleft \Sigma M_E = 0: (8\text{ ft})(3\text{ kips} - 1.7\text{ kips}) + (4\text{ ft})(0.3\text{ kip}) - (2\text{ ft})\left(\frac{4}{4.1}F_{DF}\right) = 0$$

$$F_{DF} = -5.125\text{ kips} \qquad F_{DF} = 5.13\text{ kips C} \blacktriangleleft$$

$$\rightarrow \Sigma F_x = 0: \frac{4}{4.1}(F_{DF} + F_{CE}) + \frac{4}{\sqrt{17.21}}F_{DE} = 0$$

$$F_{DE} = -\frac{\sqrt{17.21}}{4.1}(-5.125 + 2.87)\text{kips} \qquad F_{DE} = 2.28\text{ kips}$$

$$F_{DE} = 2.28\text{ kips T} \blacktriangleleft$$

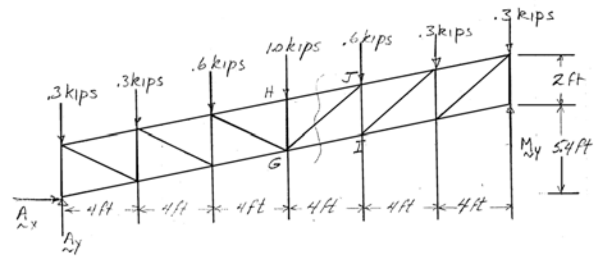


PROBLEM 6.45

A parallel chord Howe truss is loaded as shown. Determine the force in members *GI*, *GJ*, and *HJ*.

SOLUTION

FBD Truss:

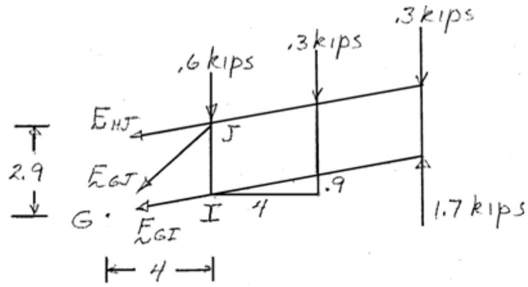


$$\circlearrowleft \Sigma M_A = (24 \text{ ft})M_y - 4 \text{ ft}(0.3 \text{ kip}) - 8 \text{ ft}(0.6 \text{ kip}) - 12 \text{ ft}(1 \text{ kip})$$

$$- 16 \text{ ft}(0.6 \text{ kip}) - 20 \text{ ft}(0.3 \text{ kip}) - 24 \text{ ft}(0.3 \text{ kip}) = 0$$

$$\mathbf{M}_y = 1.7 \text{ kips}$$

FBD Section:



$$\circlearrowleft \Sigma M_J = 8 \text{ ft}(1.7 - 0.3) \text{ kips} - 4 \text{ ft}(0.3 \text{ kip}) - 2 \text{ ft}\left(\frac{4}{4.1}F_{GI}\right) = 0$$

$$F_{GI} = 5.125 \text{ kips} \qquad F_{GI} = 5.3 \text{ kips T} \blacktriangleleft$$

$$\circlearrowleft \Sigma M_G = 12 \text{ ft}(1.7 - 0.3) \text{ kips} - 8 \text{ ft}(0.3 \text{ kip})$$

$$- 4 \text{ ft}(0.6 \text{ kip}) + 2 \text{ ft}\left(\frac{4}{4.1}F_{HJ}\right) = 0$$

$$F_{HJ} = -6.15 \text{ kips} = 6.15 \text{ kips C} \blacktriangleleft$$

$$\longrightarrow \Sigma F_x = \frac{4}{4.1}(6.15 - 5.125) \text{ kips} - \frac{4}{4.94}F_{GJ}$$

$$F_{GJ} = 1.235 \text{ kips T} \blacktriangleleft$$