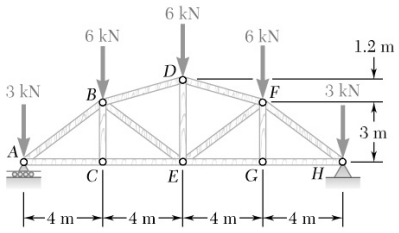
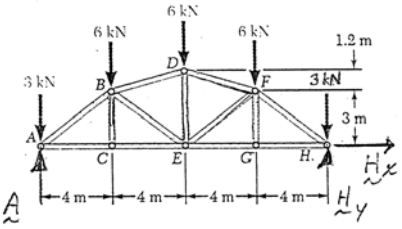


PROBLEM 6.9

Determine the force in each member of the Gambrel roof truss shown. State whether each member is in tension or compression.

SOLUTION

FBD Truss:



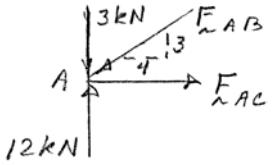
$\rightarrow \Sigma F_x = 0$: $\mathbf{H}_x = 0$

By symmetry: $\mathbf{A} = \mathbf{H}_y = 12$ kN $\uparrow$

By inspection of joints C and G, $F_{CE} = F_{AC}$ and $F_{BC} = 0$ ◀

$F_{EG} = F_{GH}$ and $F_{FG} = 0$ ◀

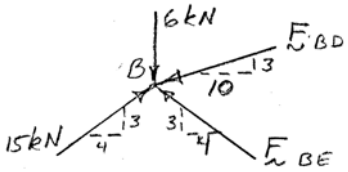
Joint A:



$\uparrow \Sigma F_y = 0$: $12 \text{ kN} - 3 \text{ kN} - \frac{3}{5}F_{AB} = 0$ $\quad F_{AB} = 15.00$ kN C ◀

$\rightarrow \Sigma F_x = 0$: $F_{AC} - \frac{4}{5}(15 \text{ kN}) = 0$ $\quad F_{AC} = 12.00$ kN T ◀

Joint B:



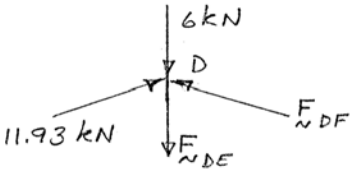
$\rightarrow \Sigma F_x = 0$: $\frac{4}{5}(15 \text{ kN}) - \frac{10}{10.44}F_{BD} - \frac{4}{5}F_{BE} = 0$

$\uparrow \Sigma F_y = 0$: $\frac{3}{5}(15 \text{ kN}) - 6 \text{ kN} - \frac{3}{10.44}F_{BD} + \frac{3}{5}F_{BE} = 0$

Solving yields $F_{BD} = 11.93$ kN C ◀

$F_{BE} = 0.714$ kN C ◀

Joint D:



$\rightarrow \Sigma F_x = 0$: by symmetry $\quad F_{DF} = 11.93$ kN C ◀

$\uparrow \Sigma F_y = 0$: $-F_{DE} - 6 \text{ kN} + 2\frac{3}{10.44}(11.93 \text{ kN}) = 0$

$F_{DE} = 0.856$ kN T ◀

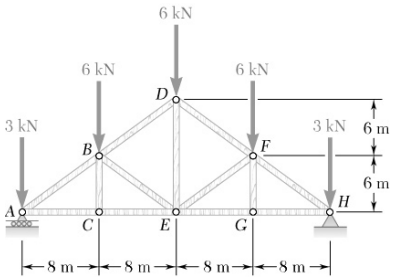
By symmetry: $F_{EF} = F_{BE}$ so $F_{EF} = 0.714$ kN C ◀

$F_{FH} = F_{AB}$ $\quad F_{FH} = 15.00$ kN C ◀

$F_{GH} = F_{AC}$ $\quad F_{GH} = 12.00$ kN T ◀

From above $F_{CE} = F_{AC}$ $\quad F_{CE} = 12.00$ kN T ◀

$F_{EG} = F_{GH}$ $\quad F_{EG} = 12.00$ kN T ◀

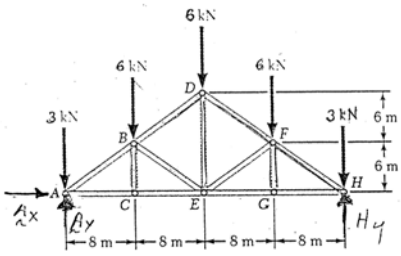


PROBLEM 6.10

Determine the force in each member of the Howe roof truss shown. State whether each member is in tension or compression.

SOLUTION

FBD Truss:



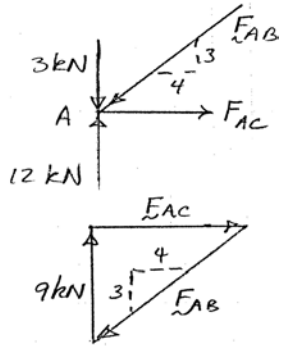
$\rightarrow \Sigma F_x = 0$: $\mathbf{A}_x = 0$

By symmetry: $\mathbf{A}_y = \mathbf{H}_y = 12 \text{ kN} \uparrow$

and $F_{FH} = F_{AB}$; $F_{GH} = F_{AC}$; $F_{FG} = F_{BC}$

$F_{DF} = F_{BD}$; $F_{EF} = F_{BE}$; $F_{EG} = F_{CE}$

Joint FBDs:



$$\frac{9 \text{ kN}}{3} = \frac{F_{AC}}{4} = \frac{F_{AB}}{5}$$

$F_{AC} = 12.00 \text{ kN T}$ ◀

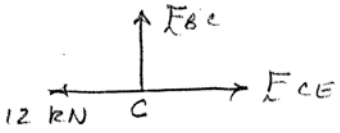
$F_{AB} = 15.00 \text{ kN C}$ ◀

so $F_{FH} = 15.00 \text{ kN C}$ ◀

By inspection: $F_{GH} = 12.00 \text{ kN T}$ ◀

$F_{BC} = 0$; $F_{CE} = 12 \text{ kN}$ $F_{BC} = 0 = F_{FG}$ ◀

Joint *C*:



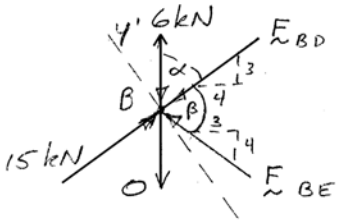
$F_{CE} = 12.00 \text{ kN T}$ ◀

$F_{EG} = 12.00 \text{ kN T}$ ◀

Note: $\alpha = \tan^{-1}\frac{4}{3}$ so $\sin\alpha = 0.8$

$\beta = 2\tan^{-1}\frac{3}{4}$ so $\sin\beta = 0.96$

Joint *B*:



$\nwarrow \Sigma F_{y'} = 0$: $-6 \text{ kN} \sin\alpha + F_{BE} \sin\beta = 0$

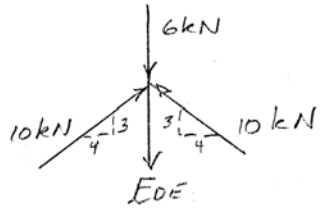
$F_{BE} = 5.00 \text{ kN C}$ ◀

so $F_{EF} = 5.00 \text{ kN C}$ ◀

$\uparrow \Sigma F_y = 0$: $-6 \text{ kN} - \frac{3}{5}F_{BD} + \frac{3}{5}F_{BE} + \frac{3}{5}(15 \text{ kN}) = 0$

PROBLEM 6.10 CONTINUED

Joint *D*:

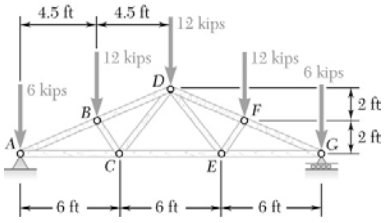


$$\frac{3}{5}F_{BD} = \frac{3}{5}(5\text{ kN}) + \frac{3}{5}(15\text{ kN}) - 6\text{ kN} \qquad F_{BD} = 10.00\text{ kN C} \blacktriangleleft$$

$$\text{so } F_{DF} = 10.00\text{ kN C} \blacktriangleleft$$

$$\uparrow \Sigma F_y = 0\text{: } -6\text{ kN} + 2\left(\frac{3}{5}10\text{ kN}\right) - F_{DE} = 0 \qquad F_{DE} = 6.00\text{ kN T} \blacktriangleleft$$

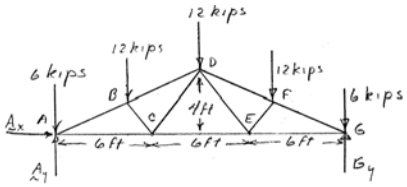
PROBLEM 6.11



Determine the force in each member of the Fink roof truss shown. State whether each member is in tension or compression.

SOLUTION

FBD Truss:



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

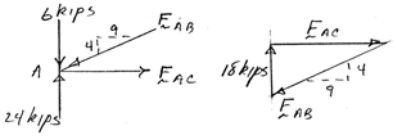
By symmetry: $\mathbf{A}_y = \mathbf{G}_y = 24 \text{ kips} \uparrow$

also; $F_{FG} = F_{AB}$; $F_{EG} = F_{AC}$; $F_{EF} = F_{BC}$

$F_{DF} = F_{BD}$; $F_{DE} = F_{CD}$

Joint FBDs:

Joint *A*:



$$\frac{18 \text{ kips}}{4} = \frac{F_{AC}}{9} = \frac{F_{AB}}{\sqrt{97}};$$

$F_{AC} = 40.5 \text{ kips}$ T ◀

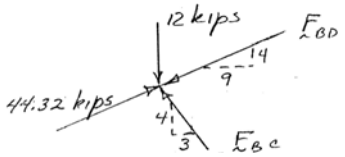
$F_{AB} = 44.32 \text{ kips}$

$F_{AB} = 44.3 \text{ kips}$ C ◀

so $F_{FG} = 44.3 \text{ kips}$ C ◀

$F_{EG} = 40.5 \text{ kips}$ T ◀

Joint *B*:



$$\rightarrow \Sigma F_x = 0: \frac{9}{\sqrt{97}}(44.32 \text{ kips} - F_{BD}) - \frac{3}{5}F_{BC} = 0$$

$$\uparrow \Sigma F_y = 0: \frac{4}{\sqrt{97}}(44.32 \text{ kips} - F_{BD}) + \frac{4}{5}F_{BC} - 12 = 0$$

Solving:

$F_{BC} = 11.25 \text{ kips}$ C ◀

$F_{BD} = 36.9 \text{ kips}$ C ◀

so $F_{EF} = 11.25 \text{ kips}$ C ◀

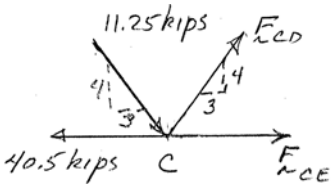
$F_{DF} = 36.9 \text{ kips}$ C ◀

PROBLEM 6.11 CONTINUED

$$\uparrow \Sigma F_y = 0: \frac{4}{5}(11.25 \text{ kips}) - \frac{4}{5}F_{CD} = 0 \qquad F_{CD} = 11.25 \text{ kips T} \blacktriangleleft$$

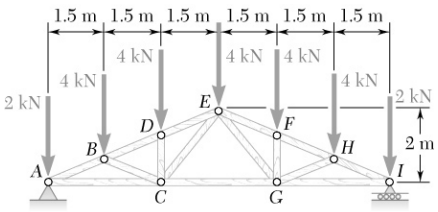
Joint C:

$$F_{DE} = 11.25 \text{ kips T} \blacktriangleleft$$



$$\rightarrow \Sigma F_x = 0: F_{CE} + 2\left[\frac{3}{5}(11.25 \text{ kips})\right] - 40.5 \text{ kips} = 0$$

$$F_{CE} = 27.0 \text{ kips T} \blacktriangleleft$$

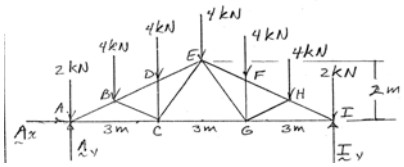


PROBLEM 6.12

Determine the force in each member of the fan roof truss shown. State whether each member is in tension or compression.

SOLUTION

FBD Truss:



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

By symmetry: $\mathbf{A}_y = \mathbf{I}_y = 12 \text{ kN} \uparrow$

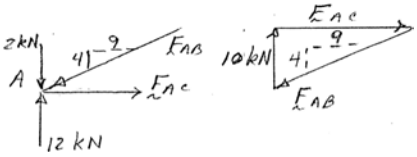
and $F_{AB} = F_{HI}; \; F_{AC} = F_{GI}; \; F_{BC} = F_{GH}$

$F_{BD} = F_{FH}; \; F_{DC} = F_{FG}; \; F_{DE} = F_{EF}$

$F_{CE} = F_{EG}$

Joint FBDs:

Joint *A*:



$$\frac{10 \text{ kN}}{4} = \frac{F_{AC}}{9} = \frac{F_{AB}}{\sqrt{97}}$$

$F_{AC} = 22.5 \text{ kN T} \blacktriangleleft$

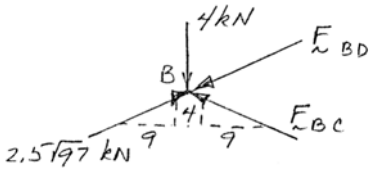
so $F_{GI} = 22.5 \text{ kN T} \blacktriangleleft$

$F_{AB} = 2.5\sqrt{97} \text{ kN}$

$F_{AB} = 24.6 \text{ kN C} \blacktriangleleft$

so $F_{HI} = 24.6 \text{ kN C} \blacktriangleleft$

Joint *B*:



$$\rightarrow \Sigma F_x = 0: \; 22.5 \text{ kN} - \frac{9}{\sqrt{97}}\left(F_{BD} + F_{BC}\right) = 0$$

$$\uparrow \Sigma F_y = 0: \; 10 \text{ kN} - 4 \text{ kN} + \frac{4}{\sqrt{97}}\left(F_{BC} - F_{BD}\right) = 0$$

Solving:

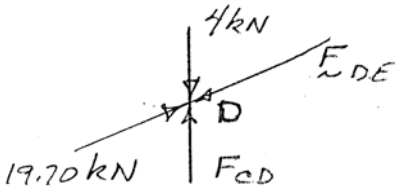
$F_{BD} = 19.70 \text{ kN C} \blacktriangleleft$

so $F_{FH} = 19.70 \text{ kN C} \blacktriangleleft$

and $F_{BC} = 4.92 \text{ kN C} \blacktriangleleft$

so $F_{GH} = 4.92 \text{ kN C} \blacktriangleleft$

Joint *D*:



By inspection:

$F_{DE} = 19.70 \text{ kN C} \blacktriangleleft$

so $F_{EF} = 19.70 \text{ kN C} \blacktriangleleft$

and $F_{CD} = 4.00 \text{ kN C} \blacktriangleleft$

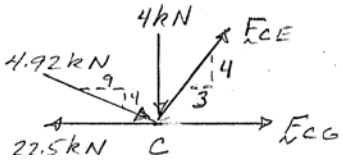
so $F_{FG} = 4.00 \text{ kN C} \blacktriangleleft$

PROBLEM 6.12 CONTINUED

Joint *C*:

$$\rightarrow \Sigma F_x = 0: -22.5\text{ kN} + \frac{9}{\sqrt{97}}(4.92\text{ kN}) + \frac{3}{5}F_{CE} + F_{CG} = 0$$

$$\uparrow \Sigma F_y = 0: -4\text{ kN} - \frac{4}{\sqrt{97}}(4.92\text{ kN}) + \frac{4}{5}F_{CE} = 0$$



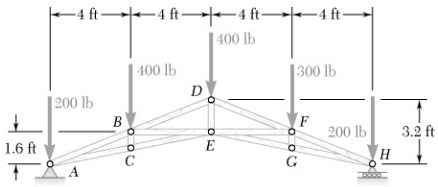
Solving:

$$F_{CE} = 7.50\text{ kN T} \blacktriangleleft$$

$$so \quad F_{EG} = 7.50\text{ kN T} \blacktriangleleft$$

$$\text{and } F_{CG} = 13.50\text{ kN T} \blacktriangleleft$$

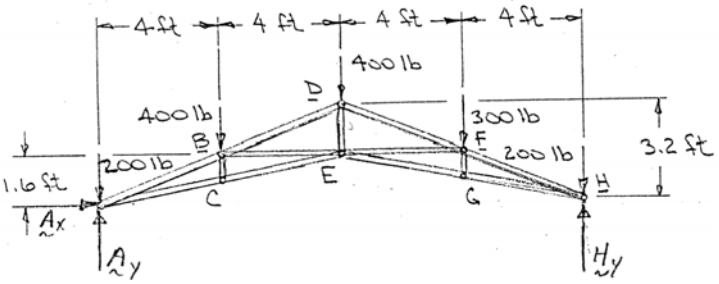
PROBLEM 6.13



Determine the force in each member of the roof truss shown. State whether each member is in tension or compression.

SOLUTION

FBD Truss:



$$\circlearrowleft \Sigma M_A = 0: (16\text{ ft})H_y - (16\text{ ft})(200\text{ lb}) - (12\text{ ft})(300\text{ lb}) - (8\text{ ft})(400\text{ lb}) - (4\text{ ft})(400\text{ lb}) = 0$$

$$\mathbf{H}_y = 725\text{ lb} \uparrow$$

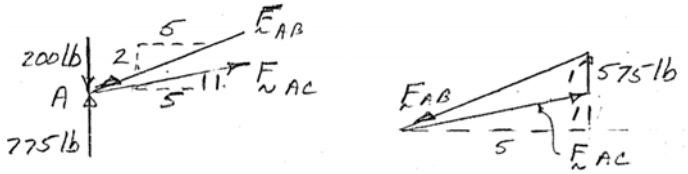
$$\uparrow \Sigma F_y = 0: A_y - 200\text{ lb} - 400\text{ lb} - 400\text{ lb} - 300\text{ lb} - 200\text{ lb} + 725\text{ lb} = 0$$

$$\mathbf{A}_y = 775\text{ lb} \uparrow$$

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

Joint FBDs:

Joint *A*:



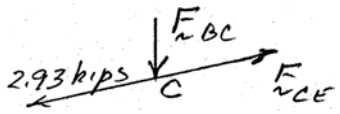
$$\frac{575\text{ lb}}{1} = \frac{F_{AC}}{\sqrt{26}} = \frac{F_{AB}}{\sqrt{29}}$$

$F_{AB} = 3096.5\text{ lb};\ F_{AB} = 3.10\text{ kips}$ C ◀

$F_{AC} = 2931.9\text{ lb};\ F_{AC} = 2.93\text{ kips}$ T ◀

PROBLEM 6.13 CONTINUED

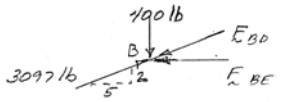
Joint *C*:



By inspection: $F_{BC} = 0$ ◀

$F_{CE} = 2.93$ kips T ◀

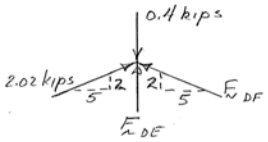
Joint *B*:



$\uparrow \Sigma F_y = 0$: $\frac{2}{\sqrt{29}}(3097 \text{ lb}) - 400 \text{ lb} - \frac{2}{\sqrt{29}} F_{BD} = 0$ $F_{BD} = 2020.0$ lb; $F_{BD} = 2.02$ kips C ◀

$\rightarrow \Sigma F_x = 0$: $\frac{5}{\sqrt{29}}(3097 - 2020)\text{lb} - F_{BE} = 0$ $F_{BE} = 1000.0$ lb; $F_{BE} = 1.000$ kip C ◀

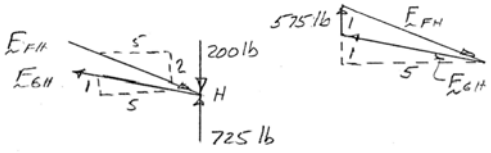
Joint *D*:



$\rightarrow \Sigma F_x = 0$: $\frac{5}{\sqrt{29}}(2.02 \text{ kips} - F_{DF}) = 0$ $F_{DF} = 2.02$ kips C ◀

$\uparrow \Sigma F_y = 0$: $F_{DE} + 2\frac{2}{\sqrt{29}}(2.02 \text{ kips}) - 0.4 \text{ kips} = 0$ $F_{DE} = 1.100$ kips C ◀

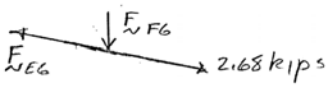
Joint *H*:



$\frac{525 \text{ lb}}{1} = \frac{F_{FH}}{\sqrt{29}} = \frac{F_{GH}}{\sqrt{26}}$ $F_{FH} = 2827$ lb; $F_{FH} = 2.83$ kips C ◀

$F_{GH} = 2677$ lb; $F_{GH} = 2.68$ kips T ◀

Joint *G*:

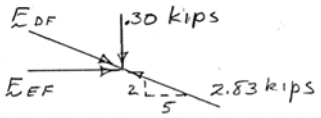


By inspection: $F_{EG} = 2.68$ kips T ◀

$F_{FG} = 0$ ◀

PROBLEM 6.13 CONTINUED

Joint F:



$$\uparrow \Sigma F_y = 0: \frac{2}{\sqrt{29}}\left(2.83 \text{ kips} - F_{DF}\right) - 0.3 \text{ kips} = 0 \qquad F_{DF} = 2.02 \text{ kips}$$

$$\rightarrow \Sigma F_x = 0: F_{EF} + \frac{5}{\sqrt{29}}\left(2.02 \text{ kips} - 2.827 \text{ kips}\right) = 0 \qquad F_{EF} = 0.750 \text{ kips C} \blacktriangleleft$$