6-4 Determine the force in each member of the *A*-frame truss which is used to support the bridge-deck loading shown, and indicate whether the members are in tension or compression.

6-4

Support reaction:

$+\sum M_A = 0;$ $E_y\,(20) - 3(15) - 5(10) - 3(5) = 0$ $E_y = 5.5 \text{ kip} \uparrow$

Joint E :

$+\uparrow \sum F_y = 0;$ $5.5 - F_{EG} \sin 63.43^o = 0$

$F_{EG} = 6.149 \text{ kip} = 6.15 \text{ kip (C)}$

$\xrightarrow{+} \sum F_x = 0;$ $6.149 \cos 63.43^o - F_{ED} = 0$ $F_{ED} = 2.75 \text{ kip (T)}$

Joint D :

$\xrightarrow{+} \sum F_x = 0;$ $2.75 - F_{DC} = 0$ $F_{DC} = 2.75 \text{ kip (T)}$

$+\uparrow \sum F_y = 0;$ $F_{DG} - 3 = 0$ $F_{DG} = 3 \text{ kip (T)}$

Joint G :

$+\sum F_{y'} = 0;$ $F_{GC} \cos 36.87^o - 3 \sin 26.57^o = 0$

$F_{DG} = 1.677 \text{ kip} = 1.68 \text{ kip (C)}$

$+\sum F_{x'} = 0;$ $F_{GH} - 6.149 + 3 \cos 26.57^o - 1.677 \sin 36.87^o = 0$

$F_{GH} = 4.472 \text{ kip} = 4.47 \text{ kip (C)}$

Joint H :

$\xrightarrow{+} \sum F_x = 0;$ $F_{HF} \sin 26.57 - 4.472 \sin 26.57 = 0$

$F_{HF} = 4.472 \text{ kip} = 4.47 \text{ kip (C)}$

$+\uparrow \sum F_y = 0;$ $2(4.472 \cos 26.57) - F_{HC} = 0$ $F_{HC} = 8.0 \text{ kip (T)}$

Due to the symmetry of loading and geometry

$F_{AB} = F_{ED} = 2.75 \text{ kip (T)}$ $F_{BC} = F_{DC} = 2.75 \text{ kip (T)}$ Ans

$F_{BF} = F_{DG} = 3 \text{ kip (T)}$ $F_{FC} = F_{GC} = 1.68 \text{ kip (C)}$ Ans

$F_{AF} = F_{EG} = 6.15 \text{ kip (C)}$ Ans

6-24 Determine the force in members *BE* and *EF* of the truss and indicate whether the members are in tension or compression. After sectioning the truss, solve for each force *directly*, using a single equation of equilibrium to determine each force.

6-30 Determine the force in members *FE*, *FB*, and *BC* of the truss and indicate whether the members are in tension or compression. After sectioning the truss, solve for each force *directly* using a single equilibrium equation to obtain each force. Assume that all joints are pin-connected.

6-24

$\overset{+}{\longrightarrow} \sum F_x = 0;$ $\quad -F_{BE} \sin 45^o + 10 + 5 = 0$ $\quad F_{BE} = 21.2 \text{ kN}$ (T) Ans

$+ \sum M_B = 0;$ $\quad F_{EF}(4) - 5(4) - 5(8) - 10(4) = 0$ $\quad F_{EF} = 25 \text{ kN}$ (C) Ans

6-30

$+\sum M_C = 0;$ $F_{FE}(5) - 500(10) = 0$

$F_{FE} = 1000 \text{ lb} = 1.0 \text{ kip}$ (T) Ans

$+\sum M_F = 0;$ $F_{BC} \cos 26.5 * 10 - 1000(10) - 500(20) = 0$

$F_{BC} = 2236 \text{ lb} = 2.24 \text{ kip}$ (C) Ans

Joint B :

$\sum F_{y'} = 0;$ $F_{FB} \sin \theta = 0$ $F_{EB} = 0$ Ans

6-49 Determine the reactive force at pins *A* and *C* of the two-member frame.

6-50 Determine the horizontal and vertical components of force at pins *A* and *C* of the two-member frame.

6-67 a 5-lb force is applied to the handles of the vice grip. Determine the compressive force developed on the smooth bolt shank *A* at the jaws.

6-84 If each of the three links of the mechanism has a weight of 25 lb, determine the angle θ for equilibrium. The spring, which always remains vertical, is unstretched when $\theta = 0^o$.

6-72 The shovel of the tractor supports the 400-kg load which has a center of mass at *G*. Determine the horizontal and vertical components of reaction at pin *A* and the force in the hydraulic cylinder *EF*. All labeled points are pin connections. The mechanism is the same on both sides and supports the load equally on both sides.

6-49

$$+\sum M_A = 0; \qquad F_C \cos 15^o(10) - 500(6 \cos 45^o) = 0$$

$$F_C = 219.6 \text{ lb} = 220 \text{ lb} \qquad \text{Ans}$$

$$\xrightarrow{+} \sum F_x = 0; \qquad A_x - 219.6 \cos 30^o = 0 \qquad A_x = 190.2 \text{ lb}$$

$$+\uparrow \sum F_y = 0; \qquad A_y - 500 + 219.6 \sin 30^o = 0 \qquad A_y = 390.2 \text{ lb}$$

$$F_A = \sqrt{A_x^2 + A_x^2} = \sqrt{190.2^2 + 390.2^2} = 434 \text{ lb} \qquad \text{Ans}$$

$$\theta = \tan^{-1}\frac{A_y}{A_x} = \tan^{-1}\frac{390.2}{190.2} = 64.0° \qquad \text{Ans}$$

6-50

$+\sum M_A = 0;$ $F_C \sin 45^o(3) - 200(3)(1.5) = 0$ $F_C = 424.26$ N

$\xrightarrow{+}\sum F_x = 0;$ $424.26 \cos 45^o - A_x = 0$ $A_x = 300$ N Ans

$+\uparrow\sum F_y = 0;$ $A_y + 424.26 \sin 45^o - 200(3) = 0$ $A_y = 300$ N Ans

For pin C :

$C_x = 424.26 \cos 45^o = 300$ N Ans
$C_y = 424.26 \sin 45^o = 300$ N Ans

6-67

From FBD (a)

$$+\sum M_E = 0; \qquad 5(4) - F_{CD}\sin 30.26^o(1) = 0 \qquad F_{CD} = 39.69 \text{ lb}$$

$$\xrightarrow{+}\sum F_x = 0; \qquad E_x - 39.693\cos 30.26^o = 0 \qquad E_x = 34.286 \text{ lb}$$

From FBD (b)

$$+\sum M_B = 0; \qquad N_A \sin 20^o(0.75) + N_A \cos 20^o(1.5) - 34.286(1.75) = 0$$

$$N_A = 36.0 \text{ lb} \qquad \text{Ans}$$

6-72

From FBD(a)

$+\sum M_B = 0;$ $F_{CD} \cos 20^o\ (0.5) - 200(9.81)(0.4) = 0$ $F_{CD} = 1670.3$ N

From FBD(b)

$+\sum M_A = 0;$ $-1670.3 \cos 20^o(0.9) + F_{EF}(0.4) = 0$

$F_{EF} = 3531.6$ N = 3.53 kN Ans

$\xrightarrow{+} \sum F_x = 0;$ $A_x + 1670.3 \cos 20^o - 3531.6 = 0$

$A_x = 1962$ N = 1.96 kN Ans

$+\uparrow \sum F_y = 0;$ $A_y - 1670.33 \sin 20^o = 0$ $A_y = 571$ N Ans

6-84

From FBD (a)

$$+\sum M_B = 0; \qquad C_x(4) = 0 \qquad C_x = 0$$

$$\xrightarrow{+} \sum F_x = 0; \qquad B_x = 0$$

$$+\uparrow \sum F_y = 0; \qquad B_y - C_y - 25 = 0 \qquad [1]$$

From FBD (b)

$$+\sum \mathrm{M}_D = 0; \qquad C_y\,(4\cos\theta) - 25(2\cos\theta) = 0 \qquad C_y = 12.5 \text{ lb}$$

From Eq. [1] $\qquad B_y - 12.5 - 25 = 0 \qquad B_y = 37.5$ lb

From FBD (c)

$$+\sum M_A = 0; \quad 60(2\sin\theta)(2\cos\theta) - 25(2\cos\theta) - 37.5(4\cos\theta) = 0$$

$$\theta = 56.4^{o} \qquad \text{Ans}$$