PROBLEM 6.45

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

SOLUTION

Free body: Truss:

\[ \sum F_y = 0: \quad k_y = 0 \]
\[ \sum M_A = 0: \quad k_y(62.5 \text{ ft}) - (6000 \text{ lb})(12.5 \text{ ft}) - (6000 \text{ lb})(25 \text{ ft}) = 0 \]
\[ k = k_y = 3600 \text{ lb} \quad \checkmark \]
\[ + \sum F_y = 0: \quad A + 3600 \text{ lb} - 6000 \text{ lb} - 6000 \text{ lb} = 0 \]
\[ A = 8400 \text{ lb} \quad \checkmark \]

We pass a section through members $CE$, $DE$, and $DF$ and use the free body shown.

\[ \sum M_D = 0: \quad F_{CE}(15 \text{ ft}) - (8400 \text{ lb})(18.75 \text{ ft}) + (6000 \text{ lb})(6.25 \text{ ft}) = 0 \]
\[ F_{CE} = +8000 \text{ lb} \quad F_{CE} = 8000 \text{ lb} \quad T \quad \checkmark \]
\[ + \sum F_y = 0: \quad 8400 \text{ lb} - 6000 \text{ lb} - \frac{15}{16.25} F_{DE} = 0 \]
\[ F_{DE} = +2600 \text{ lb} \quad F_{DE} = 2600 \text{ lb} \quad T \quad \checkmark \]
\[ + \sum M_E = 0: \quad 6000 \text{ lb}(12.5 \text{ ft}) - (8400 \text{ lb})(25 \text{ ft}) - F_{DF}(15 \text{ ft}) = 0 \]
\[ F_{DF} = -9000 \text{ lb} \quad F_{DF} = 9000 \text{ lb} \quad C \quad \checkmark \]
PROBLEM 6.47

Determine the force in members $DF$, $EF$, and $EG$ of the truss shown.

SOLUTION

Reactions:

$\mathbf{A} = \mathbf{N} = 0$

**Member $DF$:**

$+\Sigma M_E = 0$: \((16 \text{ kN})(6 \text{ m}) - \frac{3}{5} F_{DF} (4 \text{ m}) = 0$

$F_{DF} = +40 \text{ kN} \quad F_{DF} = 40.0 \text{ kN} \quad T \downarrow$

**Member $EF$:**

$+\Sigma F = 0$: \((16 \text{ kN}) \sin \beta - F_{EF} \cos \beta = 0$

$F_{EF} = 16 \tan \beta = 16(0.75) = 12 \text{ kN} \quad F_{EF} = 12.00 \text{ kN} \quad T \downarrow$

**Member $EG$:**

$+\Sigma M_F = 0$: \((16 \text{ kN})(9 \text{ m}) + \frac{4}{5} F_{EG} (3 \text{ m}) = 0$

$F_{EG} = -60 \text{ kN} \quad F_{EG} = 60.0 \text{ kN} \quad C \uparrow$
**PROBLEM 5.66**

The truss shown was designed to support the roof of a large market. For the given loading, determine the force in members KM, LM, and LN.

**SOLUTION**

Because of symmetry of loading, O - i/2 fact

We pass a section through KM, LM, LN, and use free body shown.

\[ \Sigma M_x = 0; \quad \left( -\frac{3.84}{4} F_{xy} \right) (2.69 m) \]

\[ + (4.40 \text{ kN} - 0.6 \text{ kN})(2.69 m) = 0 \]

\[ F_{xy} = 3.05 \text{ kN} \]

\[ F_{xy} = 3.05 \text{ kN} \quad C \uparrow \]

\[ \Sigma M_z = 0; \quad - F_{xy}(4.80 m) - (1.24 \text{ kN})(3.84 m) \]

\[ + (4.40 \text{ kN} - 0.6 \text{ kN})(7.44 m) = 0 \]

\[ F_{ex} = +5.022 \text{ kN} \quad F_{ex} = 5.02 \text{ kN} \quad T \downarrow \]

\[ \Sigma F_z = 0; \quad \frac{4.40}{647} F_{xy} + \frac{1.12}{4} (-3.954 \text{ kN}) - 1.24 \text{ kN} - 0.6 \text{ kN} + 4.48 \text{ kN} = 0 \]

\[ F_{xy} = -1.963 \text{ kN} \quad F_{xy} = 1.963 \text{ kN} \quad C \downarrow \]

**PROBLEM 6.61**

Determine the force in members EH and GI of the truss shown. (Hint: Use section ou.)

**SOLUTION**

Reactions:

\[ \Sigma F_x = 0; \quad A_x = 0 \]

\[ + \Sigma M_{p} = 0; \quad 12(45) + 12(30) + 12(15) - A_y(90) = 0 \]

\[ A_y = 12 \text{ kips} \]

\[ \Sigma F_y = 0; \quad 12 - 12 - 12 + P = 0 \quad P = 24 \text{ kips} \]

\[ + \Sigma M_{q} = 0; \quad -12 \text{ kips}(30 \text{ ft}) - F_{ex}(0.6 \text{ kips}) = 0 \]

\[ F_{ex} = -22.5 \text{ kips} \quad F_{ex} = 22.5 \text{ kips} \quad C \downarrow \]

\[ - \Sigma F_z = 0; \quad F_{xy} = -22.5 \text{ kips} \quad F_{xy} = 22.5 \text{ kips} \quad T \uparrow \]
PROBLEM 6.76

Determine the force in member $BD$ and the components of the reaction at $C$.

SOLUTION

We note that $BD$ is a two-force member. The force it exerts on $ABC$, therefore, is directed along line $BD$.

Free body: $ABC$:

Attaching $F_{BD}$ at $D$ and resolving it into components, we write

$$\sum M_C = 0: \quad (400 \text{ N})(135 \text{ mm}) + \left(\frac{450}{510} F_{BD}\right)(240 \text{ mm}) = 0$$

$$F_{BD} = -255 \text{ N} \quad F_{BD} = 255 \text{ N} \quad C \downarrow$$

$$\sum F_x = 0: \quad C_x + \frac{240}{510}(-255 \text{ N}) = 0$$

$$C_x = +120.0 \text{ N} \quad C_x = 120.0 \text{ N} \quad \uparrow$$

$$\sum F_y = 0: \quad C_y - 400 \text{ N} + \frac{450}{510}(-255 \text{ N}) = 0$$

$$C_y = +625 \text{ N} \quad C_y = 625 \text{ N} \uparrow$$


**PROBLEM 6.88**

Determine all the forces exerted on member $AB$ if the frame is loaded by a 40-lb force directed horizontally to the right and applied (a) at Point $D$, (b) at Point $E$.

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**SOLUTION**

**Free body: Entire frame:**

Location of 40-lb force on its line of action $DE$ is immaterial.

\[ \sum M_A = 0: \quad H(48 \text{ in.}) - (40 \text{ lb})(30 \text{ in.}) = 0 \]

\[ I = 25.0 \text{ lb} \]

(a) and (b) \[ I = 25.0 \text{ lb} \]

We note that $AB$, $BC$, and $FG$ are two-force members.

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**Free body: Member $AB$:**

\[ \tan \alpha = \frac{20}{48} = \frac{5}{12} \quad \alpha = 22.5^\circ \]

(a) **Force applied at $D$:**

\[ \sum F_y = 0: \quad -\frac{5}{13}A + 25 = 0 \]

\[ A = 65.0 \text{ lb} \]

\[ A = 65.0 \text{ lb} \quad \angle = 22.6^\circ \]

\[ \sum M_D = 0: \quad \frac{12}{13}(65 \text{ lb})(40 \text{ in.}) - C(20 \text{ in.}) = 0 \]

\[ C = 120.0 \text{ lb} \]

\[ \sum F_x = 0: \quad -\frac{12}{13}(65 \text{ lb}) + 120 \text{ lb} + G = 0 \]

\[ G = 60.0 \text{ lb} \]

(b) **Force applied at $E$:**

\[ \sum F_y = 0: \quad -\frac{5}{13}A + 25 = 0 \]

\[ A = 65.0 \text{ lb} \]

\[ A = 65.0 \text{ lb} \quad \angle = 22.6^\circ \]

\[ \sum M_D = 0: \quad \frac{12}{13}(65 \text{ lb})(40 \text{ in.}) - C(20 \text{ in.}) - (40 \text{ lb})(10 \text{ in.}) = 0 \]

\[ C = 100.0 \text{ lb} \]

\[ \sum F_x = 0: \quad -\frac{12}{13}(65 \text{ lb}) + 100 \text{ lb} + 40 \text{ lb} + G = 0 \]

\[ G = 80.0 \text{ lb} \]
**PROBLEM 6.103**

For the frame and loading shown, determine the components of the forces acting on member CDE at C and D.

**SOLUTION**

**Free body: Entire frame:**

\[ + \sum M_A = 0: \quad A_y - 25 \text{ lb} = 0 \]

\[ A_y = 25 \text{ lb} \]

\[ \sum F_x = 0: \quad A_x (6.928 + 2 \times 3.464) - (25 \text{ lb})(12 \text{ in}) = 0 \]

\[ A_x = 21.65 \text{ lb} \]

\[ \sum F_y = 0: \quad F - 21.65 \text{ lb} = 0 \]

\[ F = 21.65 \text{ lb} \]

**Free body: Member CDE:**

\[ + \sum M_C = 0: \quad D_y (4 \text{ in}) - (25 \text{ lb})(10 \text{ in}) = 0 \]

\[ D_y = 62.5 \text{ lb} \]

\[ \sum F_x = 0: \quad -C_y + 62.5 \text{ lb} - 25 \text{ lb} = 0 \]

\[ C_y = 37.5 \text{ lb} \]

**Free body: Member ABD:**

\[ + \sum M_B = 0: \quad D_x (3.464 \text{ in}) + (21.65 \text{ lb})(6.928 \text{ in}) \]

\[-(25 \text{ lb})(4 \text{ in}) - (62.5 \text{ lb})(2 \text{ in}) = 0 \]

\[ D_x = +21.65 \text{ lb} \]

**Return to free body: Member CDE:**

From above:

\[ D_x = +21.65 \text{ lb} \]

\[ \sum F_x = 0: \quad C_x - 21.65 \text{ lb} = 0 \]

\[ C_x = +21.65 \text{ lb} \]

\[ D_y = 21.7 \text{ lb} \]

\[ C_y = 21.7 \text{ lb} \]
PROBLEM 6.170

Knowing that each pulley has a radius of 250 mm, determine the components of the reactions at D and E.

SOLUTION

Free body: Entire assembly:

\[ \sum M_B = 0: \quad (4.8 \text{ kN})(4.25 \text{ m}) - D_x(1.5 \text{ m}) = 0 \]

\[ D_x = +13.60 \text{ kN} \quad D_x = 13.60 \text{ kN} \rightarrow \]

\[ \sum F_x = 0: \quad E_x + 13.60 \text{ kN} = 0 \]

\[ E_x = -13.60 \text{ kN} \quad E_x = 13.60 \text{ kN} \rightarrow \]

\[ \sum F_y = 0: \quad D_y + E_y - 4.8 \text{ kN} = 0 \]

(1)

Free body: Member ACE:

\[ \sum M_A = 0: \quad (4.8 \text{ kN})(2.25 \text{ m}) + E_y(4 \text{ m}) = 0 \]

\[ E_y = -2.70 \text{ kN} \quad E_y = 2.70 \text{ kN} \downarrow \]

From Eq. (1):

\[ D_y - 2.70 \text{ kN} - 4.80 \text{ kN} = 0 \]

\[ D_y = 7.50 \text{ kN} \quad D_y = 7.50 \text{ kN} \downarrow \]