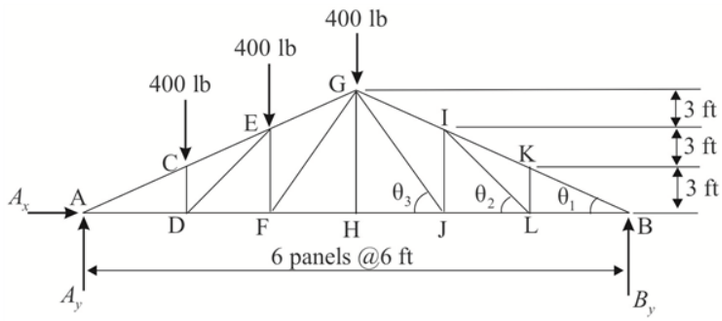
Statics and Strength of Materials for Architecture and Building Construction | (3rd Edition)

Step-by-step solution

Step 1 of 34

Free body diagram of the truss:



Comment

Step 2 of 34

From figure,

$$\tan\theta_1 = \frac{3}{6}$$
$$\theta_1 = 26.56°$$
$$\tan\theta_2 = \frac{6}{6}$$
$$\theta_2 = 45°$$
$$\tan\theta_3 = \frac{12}{6}$$
$$\theta_3 = 56.31°$$

Comments (1)

Step 3 of 34

Taking moments about A

$$\Sigma M_A = 0$$
$$(B_y)(36) - (400)(6) - (400)(12) - (400)(18) = 0$$
$$36B_y = 2400 + 4800 + 7200$$
$$B_y = \frac{14400}{36}$$
$$= 400 \text{ lb}$$

Comment

Step 4 of 34

From equilibrium equations

$$\Sigma F_x = 0$$
$$A_x = 0$$
$$\Sigma F_y = 0$$
$$A_y + B_y - 400 - 400 - 400 = 0$$
$$A_y = 1200 - 400$$
$$A_y = 800 \text{ lb}$$

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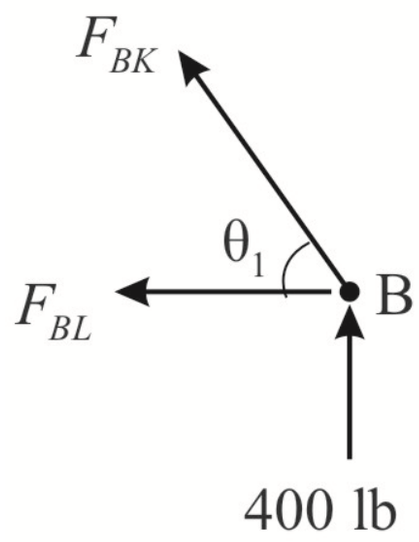
Step 5 of 34

At joint B:



Comment

Step 6 of 34

From equilibrium equations

$$\Sigma F_y = 0$$
$$F_{BK}\sin\theta_1 + 400 = 0$$
$$F_{BK} = -\frac{400}{\sin 26.56^\circ}$$
$$= -894.58 \text{ lb}$$
$$\boxed{F_{BK} = 894.58 \text{ lb(C)}}$$

Therefore, force in member BK is 894.58-lb (C)

Comment

Step 7 of 34

From equilibrium equations

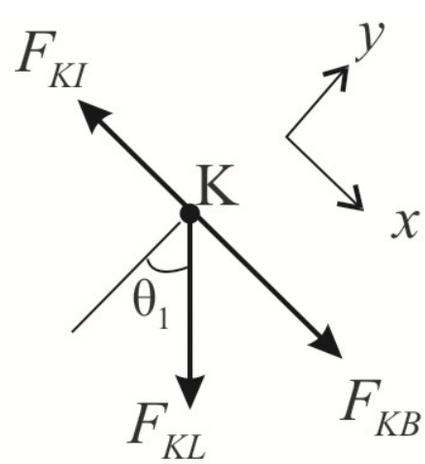
$$\Sigma F_y = 0$$
$$-F_{BL} - F_{BK}\cos\theta_1 = 0$$
$$F_{BL} = -(-894.58)\cos 26.56^\circ$$
$$= 800 \text{ lb}$$
$$\boxed{F_{BL} = 800 \text{ lb(T)}}$$

Therefore, force in member BL is 800-lb (T)

Comments (1)

Step 8 of 34

At joint K:



From equilibrium equations

$$\sum F_y = 0$$
$$-F_{KL}\cos\theta_1 = 0$$
$$\boxed{F_{KL} = 0}$$

Therefore, member KL is a zero force member

Comment

Step 9 of 34

From equilibrium equations

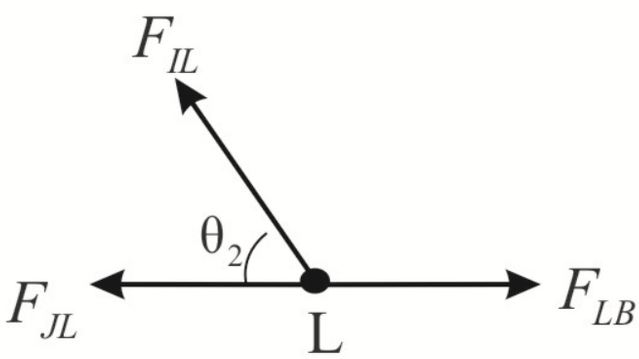
$$\sum F_x = 0$$
$$-F_{KI} + F_{KB} = 0$$
$$F_{KI} = -894.58 \text{ lb}$$
$$\boxed{F_{KI} = 894.58 \text{ lb(C)}}$$

Therefore, force in the member KI is 894.58-lb (C)

Comment

Step 10 of 34

At joint L:



Comment

Step 11 of 34

From equilibrium equations

$$\sum F_y = 0$$
$$F_{IL}\sin\theta_2 = 0$$
$$\boxed{F_{IL} = 0}$$

Therefore, member IL is a zero force member

Comment

Step 12 of 34

From equilibrium equations

$$\sum F_x = 0$$
$$-F_{JL} + F_{LB} = 0$$
$$F_{JL} = 800 \text{ lb}$$
$$\boxed{F_{JL} = 800 \text{ lb(T)}}$$

Therefore, force in the member JL is 800-lb (T)

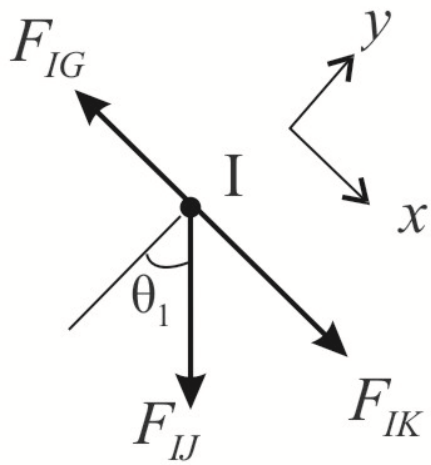
Comment

Step 13 of 34

At joint I:

Comments (1)

Step 14 of 34



Comment

Step 15 of 34

From equilibrium equations

$$\Sigma F_y = 0$$
$$F_{IJ}\cos\theta_1 = 0$$
$$\boxed{F_{IJ} = 0}$$

Therefore, member IJ is a zero force member

Comment

Step 16 of 34

From equilibrium equations

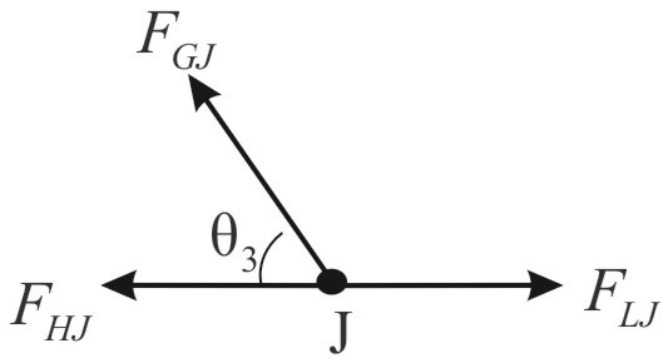
$$\Sigma F_x = 0$$
$$-F_{IG} + F_{IK} = 0$$
$$F_{IG} = -894.58 \text{ lb}$$
$$\boxed{F_{IG} = 894.58 \text{ lb(C)}}$$

Therefore, force in the member IG is 894.58-lb (C)

Comment

Step 17 of 34

At joint J:



Comment

Step 18 of 34

From equilibrium equations

$$\Sigma F_y = 0$$
$$F_{GJ} \sin\theta_3 = 0$$
$$\boxed{F_{GJ} = 0}$$

Therefore, member GJ is a zero force member

From equilibrium equations

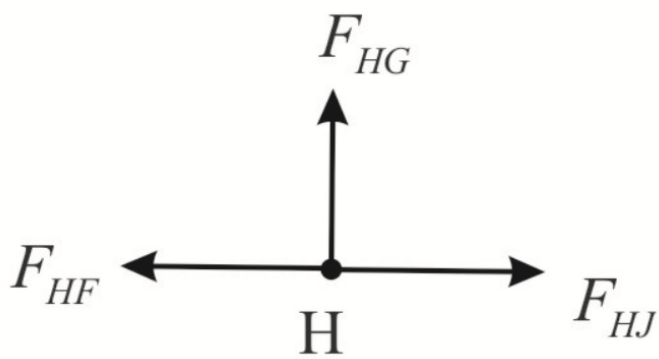
$$\Sigma F_x = 0$$
$$-F_{HJ} + F_{LJ} = 0$$
$$F_{HJ} = 800 \text{ lb}$$
$$\boxed{F_{HJ} = 800 \text{ lb}(\text{T})}$$

Therefore, force in the member HJ is 800-lb (T)

Comment

Step 19 of 34

At joint H:



Comment

Step 20 of 34

From equilibrium equations

$$\Sigma F_y = 0$$
$$F_{HG} = 0$$
$$\boxed{F_{HG} = 0}$$

Therefore, member HG is a zero force member

Comment

Step 21 of 34

From equilibrium equations

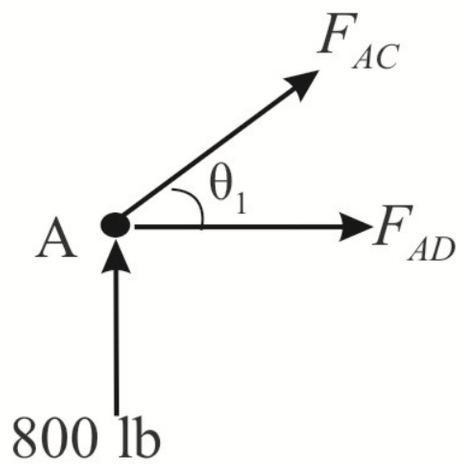
$$\Sigma F_x = 0$$
$$-F_{HF} + F_{HJ} = 0$$
$$F_{HF} = 800 \text{ lb}$$
$$\boxed{F_{HF} = 800 \text{ lb}(\text{T})}$$

Therefore, force in the member HF is 800-lb (T)

Comment

Step 22 of 34

At joint A:



Comment

Step 23 of 34

From equilibrium equations

$$\Sigma F_y = 0$$
$$F_{AC}\sin\theta_1 + 800 = 0$$
$$F_{AC} = \frac{-800}{\sin 26.56°}$$
$$= -1789.2 \text{ lb}$$
$$\boxed{F_{AC} = 1789.2 \text{ lb(C)}}$$

Therefore, force in the member AC is 1789.2-lb (C)

Comment

Step 24 of 34

From equilibrium equations

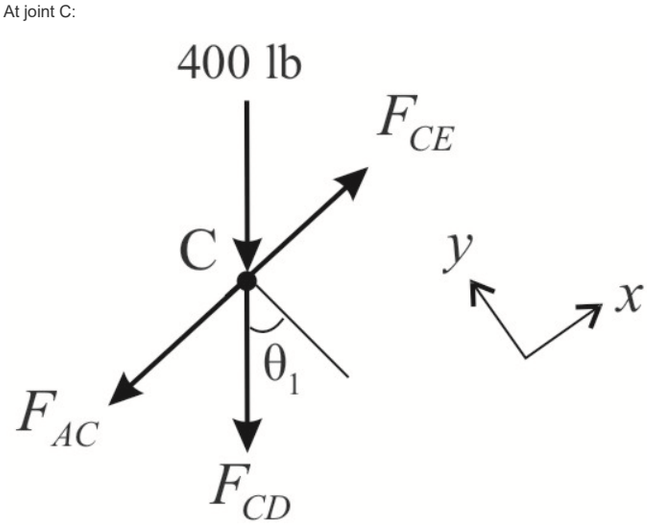
$$\Sigma F_x = 0$$
$$F_{AD} + F_{AC}\cos\theta_1 = 0$$
$$F_{AD} = -(-1789.2)\cos 26.56°$$
$$= 1600 \text{ lb}$$
$$\boxed{F_{AD} = 1600 \text{ lb(T)}}$$

Therefore, force in the member AD is 1600-lb (T)

Comment

Step 25 of 34

At joint C:



Comment

Step 26 of 34

From equilibrium equations

$$\sum F_y = 0$$
$$-400\cos\theta_1 - F_{CD}\cos\theta_1 = 0$$
$$F_{CD} = -400 \text{ lb}$$
$$\boxed{F_{CD} = 400 \text{ lb(C)}}$$

Therefore, force in the member CD is 400-lb (C)

From equilibrium equations

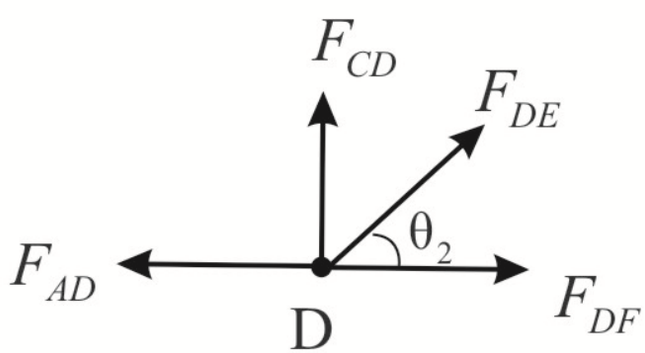
$$\sum F_x = 0$$
$$-F_{AC} + F_{CE} - (400 + F_{CD})\sin\theta_1 = 0$$
$$-F_{AC} + F_{CE} - (400 - 400)\sin\theta_1 = 0$$
$$F_{CE} = F_{CA}$$
$$F_{CE} = -1789.2 \text{ lb}$$
$$\boxed{F_{CE} = 1789.2 \text{ lb(C)}}$$

Therefore, force in the member CE is 1789.2-lb (C)

Comment

Step 27 of 34

At joint D:



Comment

Step 28 of 34

From equilibrium equations

$$\sum F_y = 0$$
$$F_{CD} + F_{DE}\sin\theta_2 = 0$$
$$F_{DE} = -\frac{-400}{\sin 45°}$$
$$= 565.7 \text{ lb}$$
$$\boxed{F_{DE} = 565.7 \text{ lb(T)}}$$

Therefore, force in the member DE is 565.7-lb (T)

Comment

Step 29 of 34

From equilibrium equations

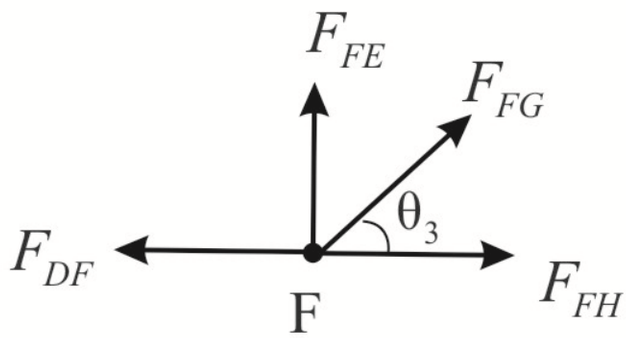
$$\sum F_x = 0$$
$$-F_{AD} + F_{DF} + F_{DE}\cos\theta_2 = 0$$
$$F_{DF} = 1600 - (565.7\cos 45°)$$
$$= 1200 \text{ lb}$$
$$\boxed{F_{DF} = 1200 \text{ lb(T)}}$$

Therefore, force in the member DF is 1200-lb (T)

Comment

Step 30 of 34

At joint F:



Comment

Step 31 of 34

From equilibrium equations

$$\Sigma F_x = 0$$
$$F_{FG}\cos\theta_3 - F_{DF} + F_{FH} = 0$$
$$F_{FG} = \frac{1200-800}{\cos 56.31°}$$
$$= 721.1 \text{ lb}$$
$$\boxed{F_{FG} = 721.1 \text{ lb(T)}}$$

Therefore, force in the member FG is 721.1-lb (T)

Comment

Step 32 of 34

From equilibrium equations

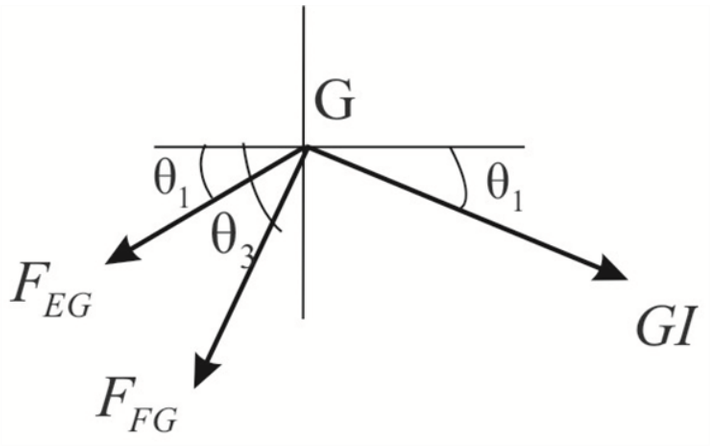
$$\Sigma F_y = 0$$
$$F_{FE} + F_{FG}\sin\theta_3 = 0$$
$$F_{FE} = -721.1\sin 56.31°$$
$$= -600 \text{ lb}$$
$$\boxed{F_{FE} = 600 \text{ lb(C)}}$$

Therefore, force in the member FE is 600-lb (C)

Comment

Step 33 of 34

At joint G:



Comment

Step 34 of 34

From equilibrium equations

$$\Sigma F_x = 0$$
$$-F_{EG}\cos\theta_1 - F_{FG}\cos\theta_3 + F_{GI}\cos\theta_1 = 0$$

$$F_{EG} = \frac{-721.1\cos 56.31 - 894.58\cos 26.56^\circ}{\cos 26.56^{\circ\circ}}$$
$$= \frac{-400 - 800}{\cos 26.56^\circ}$$
$$= -1341.6 \text{ lb}$$
$$\boxed{F_{EG} = 1341.6 \text{ lb(C)}}$$

Therefore, force in the member EG is 1341.6-lb (C)

Comment

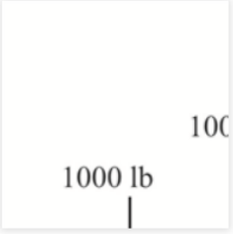
Was this solution helpful? 9 0

Recommended solutions for you in Chapter 3

Chapter 3, Solution 45SP

Free body diagram of the truss:

See solution



Chapter 3, Solution 16P

Draw the free body diagram of the frame.

See solution

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