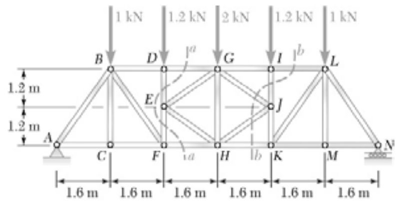
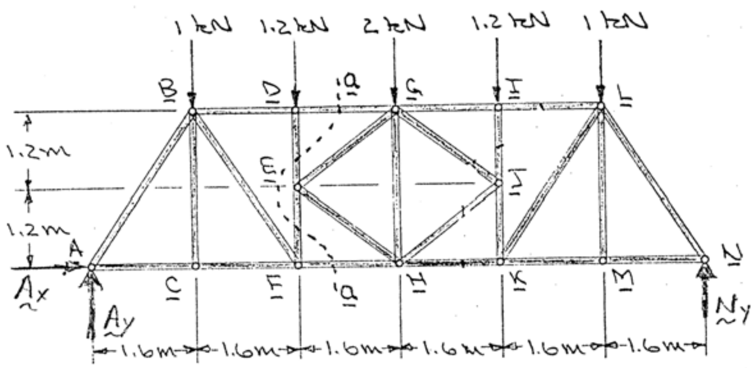
PROBLEM 6.62



Determine the force in members *DG* and *FH* of the truss shown. (*Hint:* Use section *aa*.)

SOLUTION

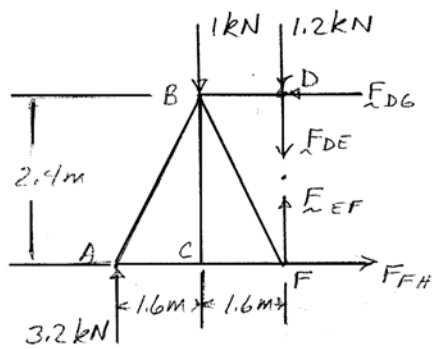
FBD Truss:



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

By symmetry: $\mathbf{A}_y = \mathbf{N}_y = 3.2 \text{ kN} \uparrow$

FBD Section:

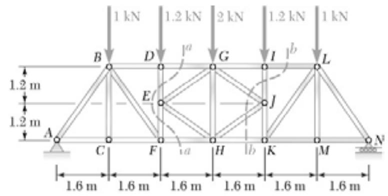


$$\circlearrowleft \Sigma M_F = 0: (2.4 \text{ m})F_{DG} - (3.2 \text{ m})(3.2 \text{ kN}) + (1.6 \text{ m})(1 \text{ kN}) = 0$$

$F_{DG} = 3.60 \text{ kN C}$ ◀

$$\circlearrowleft \Sigma M_D = 0: (2.4 \text{ m})F_{FH} + (1.6 \text{ m})(1 \text{ kN}) - (3.2 \text{ m})(3.2 \text{ kN}) = 0$$

$F_{FH} = 3.60 \text{ kN T}$ ◀

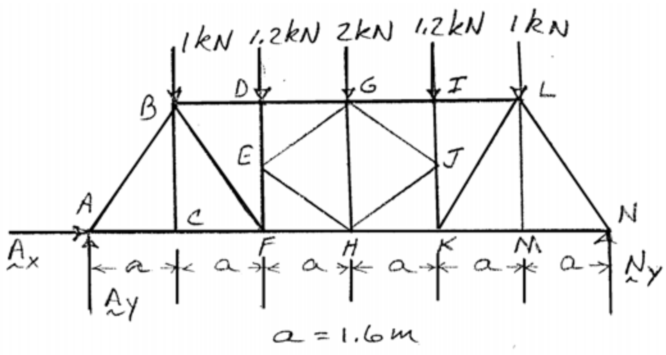


PROBLEM 6.63

Determine the force in members *IL*, *GJ*, and *HK* of the truss shown. (*Hint:* Begin with pins *I* and *J* and then use section *bb*.)

SOLUTION

FBD Truss:

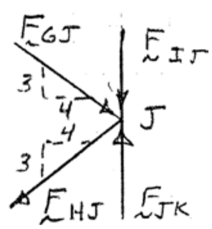


$\longrightarrow \Sigma F_x = 0: \quad \mathbf{A}_x = 0$

By symmetry: $A_x = 0$; $A_y = N_y = 3.2$ kN $\uparrow$

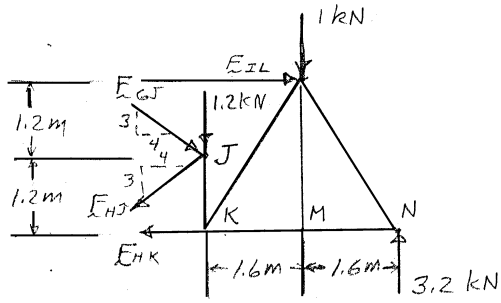
Joints: By inspection of joint *I*: $F_{GI} = F_{IL}$ and $F_{IJ} = 1.2$ kN C

By inspection of joint *J*:



$F_{GJ}\,(\mathrm{C}) = F_{HJ}\,(\mathrm{T})$

FBD Section:



$$\longrightarrow \Sigma F_x = 0; F_{IL} - F_{HK} + \frac{4}{5}\left(\cancelto{0}{F_{GJ} - F_{HJ}}\right) = 0 \qquad \text{so} \qquad F_{IL} - F_{HK} = 0$$

$$\circlearrowleft \Sigma M_J = 0: (3.2\text{ m})(3.2\text{ kN}) - (1.2\text{ m})(F_{IL} + F_{HK}) - (1.6\text{ m})(1\text{ kN}) = 0 \qquad \text{so} \qquad F_{IL} + F_{HK} = 7.2\text{ kN}$$

Solving: $F_{IL} = F_{HK} = 3.6\text{ kN}$

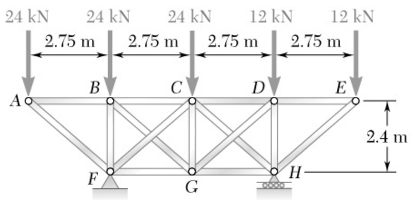
$F_{IL} = 3.60\text{ kN C}$ ◀

$F_{HK} = 3.60\text{ kN T}$ ◀

$$\uparrow \Sigma F_y = 0: 3.2\text{ kN} - 1\text{ kN} - 1.2\text{ kN} - \frac{3}{5}(F_{GJ} + F_{HJ}) = 0$$

$F_{GJ} + F_{HJ} = \frac{5}{3}\text{ kN}$ but $F_{GJ} = F_{HJ} = \frac{5}{6}\text{ kN}$

$F_{GJ} = .833\text{ kN C}$ ◀

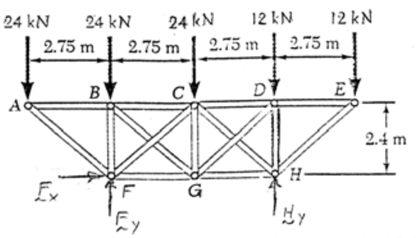


PROBLEM 6.64

The diagonal members in the center panels of the truss shown are very slender and can act only in tension; such members are known as *counters*. Determine the forces in the counters which are acting under the given loading.

SOLUTION

FBD Truss:



$$\xrightarrow{} \Sigma F_x = 0\colon \mathbf{F}_x = 0$$

$$\circlearrowleft \Sigma M_F = 0\colon (5.5 \text{ m})H_y + (2.75 \text{ m})(24 \text{ kN}) - (2.75 \text{ m})(24 \text{ kN})$$

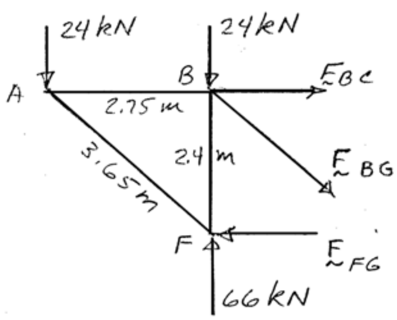
$$- (5.5 \text{ m})(12 \text{ kN}) - (8.25 \text{ m})(12 \text{ kN}) = 0$$

$$\mathbf{H}_y = 30 \text{ kN} \uparrow$$

$$\uparrow \Sigma F_y = 0\colon F_y + 30 \text{ kN} - 3(24 \text{ kN}) - 2(12 \text{ kN}) = 0$$

$$\mathbf{F}_y = 66 \text{ kN} \uparrow$$

FBD Section:



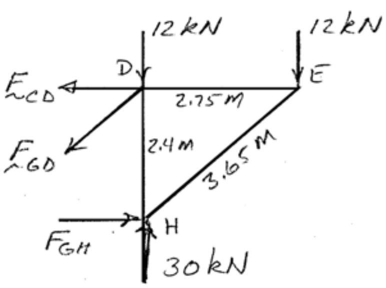
Assume there is no pretension in any counter so that, as the truss is loaded, one of each pair becomes taut while the other becomes slack.

Here tension is required in *BG* to provide downward force, so *CF* is slack.

$$\uparrow \Sigma F_y = 0\colon 66 \text{ kN} - 24 \text{ kN} - 24 \text{ kN} - \frac{2.4}{3.65}F_{BG} = 0$$

$F_{BG} = 27.375 \text{ kN}$ $\qquad$ $F_{BG} = 27.4 \text{ kN T}$ ◀

$F_{CF} = 0$ ◀



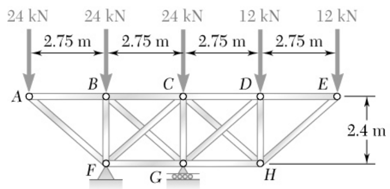
Here tension is required in *GD* to provide downward force, so *CH* is slack.

$F_{CH} = 0$ ◀

$$\uparrow \Sigma F_y = 0\colon 30 \text{ kN} - 2(12 \text{ kN}) - \frac{2.4}{3.65}F_{GD} = 0$$

$F_{GD} = 9.125 \text{ kN}$ $\qquad$ $F_{GD} = 9.13 \text{ kN T}$ ◀

PROBLEM 6.65

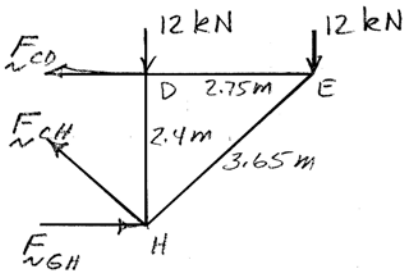


The diagonal members in the center panels of the truss shown are very slender and can act only in tension; such members are known as *counters*. Determine the forces in the counters which are acting under the given loading.

SOLUTION

Assume that there is no pretension in any counter. So that, as the truss is loaded, one of each crossing pair becomes taut while the other becomes slack.

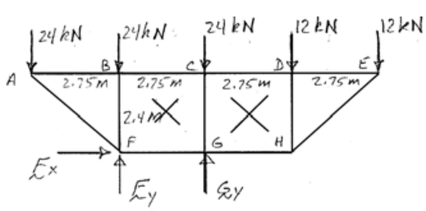
FBD Section:



Note: Tension is required in *CH* to provide upward force; thus *GD* is slack

$$\uparrow \Sigma F_y = 0: \frac{2.4}{3.65}F_{CH} - 24\text{ kN} = 0 \qquad F_{CH} = 36.5\text{ kN T} \blacktriangleleft$$

FBD Truss:



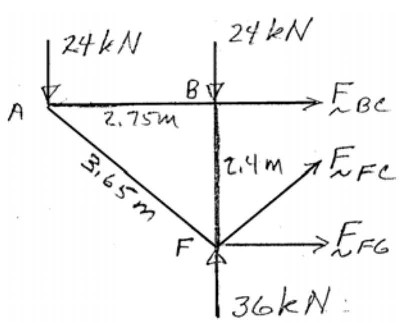
$$\Sigma M_G = 0: (5.5\text{ m})(24\text{ kN}) + (2.75\text{ m})(24\text{ kN}) - (2.75\text{ m})(F_y)$$

$$- (2.75\text{ m})(12\text{ kN}) - (5.5\text{ m})(12\text{ kN}) = 0$$

$$\mathbf{F}_y = 36\text{ kN}\uparrow$$

$$\Sigma F_x = 0: \mathbf{F}_x = 0$$

FBD Section:

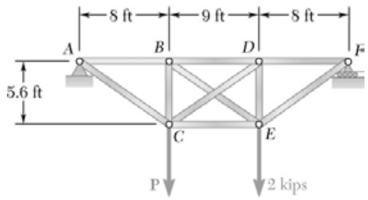


Note: Tension is required in *FC* to provide upward force; so *BG* is slack.

$$\Sigma F_y = 0: (36 - 24 - 24)\text{ kN} + \frac{2.4}{3.65}F_{FC} = 0$$

$$F_{FC} = 18.25\text{ kN T} \blacktriangleleft$$

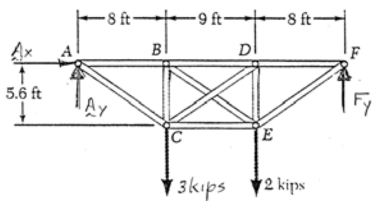
PROBLEM 6.66



The diagonal members in the center panel of the truss shown are very slender and can act only in tension; such members are known as *counters*. Determine the force in members *BD* and *CE* and in the counter which is acting when $P = 3$ kips.

SOLUTION

FBD Truss:



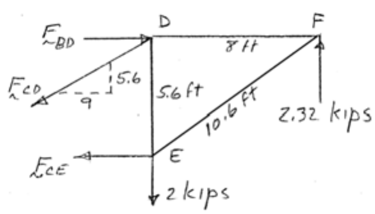
$$\rightarrow \Sigma F_x = 0: \mathbf{A}_x = 0$$

$$\circlearrowleft \Sigma M_A = 0: (25 \text{ ft})F_y - (17 \text{ ft})(2 \text{ kips}) - (8 \text{ ft})(3 \text{ kips}) = 0$$

$$\mathbf{F}_y = 2.32 \text{ kips} \uparrow$$

Assume there is no pretension in either counter so that, as the truss is loaded, one becomes taut while the other becomes slack.

FBD Section:



Here tension is required in *CD* to provide downward force, so

$$F_{BE} = 0$$

$$\uparrow \Sigma F_y = 0: 2.32 \text{ kips} - 2 \text{ kips} - \frac{5.6}{10.6} F_{CD} = 0$$

$$F_{CD} = 0.6057 \text{ kip} \qquad F_{CD} = 606 \text{ lb T} \blacktriangleleft$$

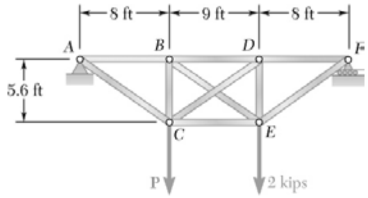
$$\circlearrowleft \Sigma M_D = 0: (8 \text{ ft})(2.32 \text{ kips}) - (5.6 \text{ ft})F_{CE} = 0$$

$$F_{CE} = 3.314 \text{ kips} \qquad F_{CE} = 3.31 \text{ kips T} \blacktriangleleft$$

$$\rightarrow \Sigma F_x = 0: F_{BD} - \frac{9}{10.6}(0.6057 \text{ kip}) - 3.314 \text{ kips} = 0$$

$$F_{BD} = 3.829 \text{ kips} \qquad F_{BD} = 3.83 \text{ kips C} \blacktriangleleft$$

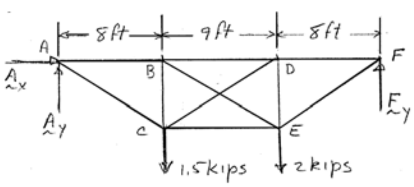
PROBLEM 6.67



Solve Prob. 6.66 when $P = 1.5$ kips.

SOLUTION

FBD Truss:



$$\circlearrowleft \Sigma M_A = 0: (25 \text{ ft})F_y - (17 \text{ ft})(2 \text{ kips}) - (8 \text{ ft})(1.5 \text{ kips}) = 0$$

$$\mathbf{F}_y = 1.84 \text{ kips} \uparrow$$

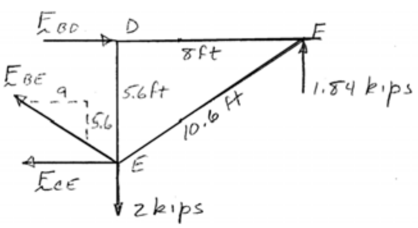
Here tension is needed in BE to provide upward force, so $F_{CD} = 0$

FBD Section:

$$\uparrow \Sigma F_y = 0: \frac{5.6}{10.6} F_{BE} + 1.84 \text{ kips} - 2 \text{ kips} = 0$$

$$F_{BE} = 0.03029 \text{ kip}$$

$$F_{BE} = 303 \text{ lb T} \blacktriangleleft$$



$$\circlearrowleft \Sigma M_E = 0: (8 \text{ ft})(1.84 \text{ kips}) - (5.6 \text{ ft})F_{BD} = 0$$

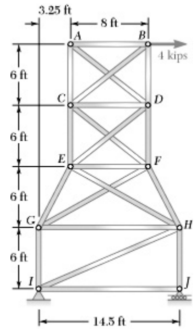
$$F_{BD} = 2.629 \text{ kips}$$

$$F_{BD} = 2.63 \text{ kips C} \blacktriangleleft$$

$$\rightarrow \Sigma F_x = 0: 2.629 \text{ kips} - \frac{9}{10.6}(0.3029 \text{ kip}) - F_{CE} = 0$$

$$F_{CE} = 2.371 \text{ kips}$$

$$F_{CE} = 2.37 \text{ kips T} \blacktriangleleft$$

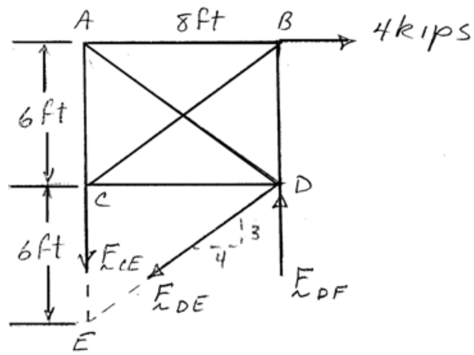


PROBLEM 6.68

The diagonal members *CF* and *DE* of the truss shown are very slender and can act only in tension; such members are known as *counters*. Determine the force in members *CE* and *DF* and in the counter which is acting.

SOLUTION

FBD Section:



DE must be in tension to provide leftward force, so *CF* is slack.

$$\longrightarrow \Sigma F_x = 0: 4 \text{ kips} - \frac{4}{5}F_{DE} = 0$$

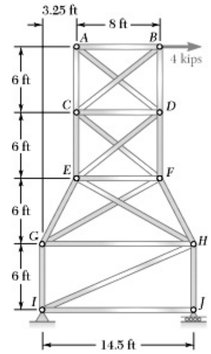
$$F_{DE} = 5.00 \text{ kips T} \blacktriangleleft$$

$$\circlearrowleft \Sigma M_D = 0: (8 \text{ ft})F_{CE} - (6 \text{ ft})(4 \text{ kips}) = 0$$

$$F_{CE} = 3.00 \text{ kips T} \blacktriangleleft$$

$$\circlearrowleft \Sigma M_E = 0: (8 \text{ ft})F_{DF} - (12 \text{ ft})(4 \text{ kips}) = 0$$

$$F_{DF} = 6.00 \text{ kips C} \blacktriangleleft$$

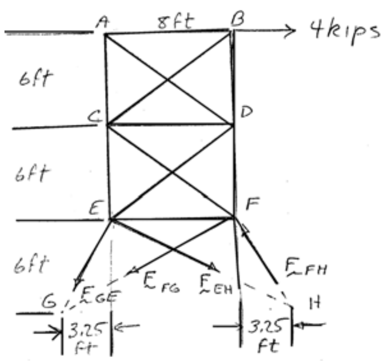


PROBLEM 6.69

The diagonal members *EH* and *FG* of the truss shown are very slender and can act only in tension; such members are known as *counters*. Determine the force in members *EG* and *FH* and in the counter which is acting.

SOLUTION

FBD Section:



It is not obvious which counter is active, so assume *FG* is (and thus *EH* is slack)

$$\circlearrowleft \Sigma M_F = 0\text{: } (8 \text{ ft})\left(\frac{6}{6.824}F_{GE}\right) - (12 \text{ ft})(4 \text{ kips}) = 0$$

$$F_{GE} = 6.824 \text{ kips T}$$

$$\circlearrowleft \Sigma M_G = 0\text{: } (14.5 \text{ ft})\left(\frac{6}{6.824}F_{FH}\right) - (18 \text{ ft})(4 \text{ kips}) = 0$$

$$F_{FH} = 5.647 \text{ kips C}$$

$$\uparrow \Sigma F_y = 0\text{: } \left(\frac{6}{6.824}\right)(5.647 \text{ kips} - 6.824 \text{ kips}) - \frac{6}{12.75}F_{FG} = 0$$

This gives $F_{FG} < 0$ which is impossible, so the assumption is wrong, *FG* is slack, and *EH* is in tension.

Then
$$\circlearrowleft \Sigma M_E = 0\text{: } (8 \text{ ft})\left(\frac{6}{6.824}F_{FH}\right) - (12 \text{ ft})(4 \text{ kips}) = 0$$

$$F_{FH} = 6.824 \text{ kips}$$

$$F_{FH} = 6.83 \text{ kips C} \blacktriangleleft$$

$$\circlearrowleft \Sigma M_H = 0\text{: } (14.5 \text{ ft})\left(\frac{6}{6.824}F_{GE}\right) - (18 \text{ ft})(4 \text{ kips}) = 0$$

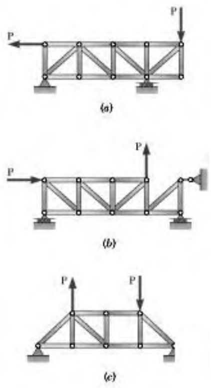
$$F_{GE} = 5.647 \text{ kips}$$

$$F_{GE} = 5.65 \text{ kips T} \blacktriangleleft$$

$$\uparrow \Sigma F_y = 0\text{: } \frac{6}{6.824}(6.824 \text{ kips} - 5.647 \text{ kips}) - \frac{6}{12.75}F_{EH} = 0$$

$$F_{EH} = 2.198 \text{ kips}$$

$$F_{EH} = 2.20 \text{ kips T} \blacktriangleleft$$



PROBLEM 6.70

Classify each of the structures shown as completely, partially, or improperly constrained; if completely constrained, further classify it as determinate or indeterminate. (All members can act both in tension and in compression.)

SOLUTION

Structure (a):

Simple truss with $r = 4, \quad m = 16, \quad n = 10$

So $m + r = 20 = 2n$ so completely constrained and determinate ◀

Structure (b):

Compound truss with $r = 3, \quad m = 16, \quad n = 10$

So $m + r = 19 < 2n = 20$ so partially constrained ◀

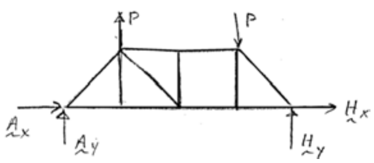
Structure (c):

Non-simple truss with $r = 4, \quad m = 12, \quad n = 8$

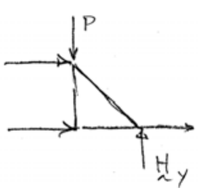
So $m + r = 16 = 2n$ but must examine further, note that reaction forces

$\mathbf{A}_x$ and $\mathbf{H}_x$ are aligned, so no equilibrium equation will resolve them.

$\therefore$ Statically indeterminate ◀



Also consider



For $\Sigma F_y = 0$: $H_y = 0$, but then $\Sigma M_A \neq 0$ in FBD Truss,

$\therefore$ Improperly constrained ◀