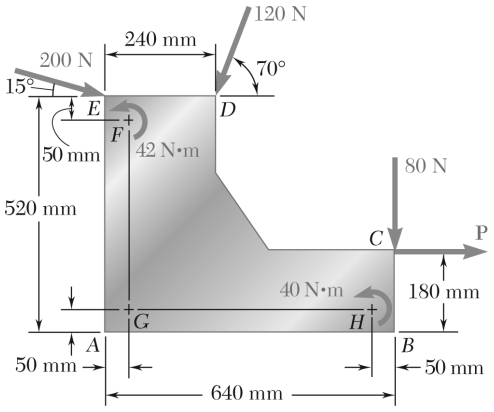
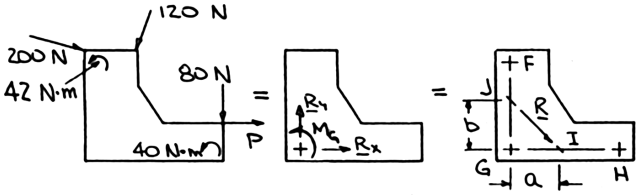


PROBLEM 3.111

A machine component is subjected to the forces and couples shown. The component is to be held in place by a single rivet that can resist a force but not a couple. For $P = 0$, determine the location of the rivet hole if it is to be located (*a*) on line *FG*, (*b*) on line *GH*.

SOLUTION

We have



First replace the applied forces and couples with an equivalent force-couple system at *G*.

Thus, $\Sigma F_x: \quad 200\cos 15° - 120\cos 70° + P = R_x$

or $$R_x = (152.142 + P)\ \text{N}$$

$$\Sigma F_y: \quad -200\sin 15° - 120\sin 70° - 80 = R_y$$

or $$R_y = -244.53\ \text{N}$$

$$\begin{aligned}\Sigma M_G: \quad & -(0.47\ \text{m})(200\ \text{N})\cos 15° + (0.05\ \text{m})(200\ \text{N})\sin 15° \\ & + (0.47\ \text{m})(120\ \text{N})\cos 70° - (0.19\ \text{m})(120\ \text{N})\sin 70° \\ & - (0.13\ \text{m})(P\ \text{N}) - (0.59\ \text{m})(80\ \text{N}) + 42\ \text{N}\cdot\text{m} \\ & + 40\ \text{N}\cdot\text{m} = M_G\end{aligned}$$

or $$M_G = -(55.544 + 0.13P)\ \text{N}\cdot\text{m} \qquad (1)$$

Setting $P = 0$ in Eq. (1):

Now with **R** at *I*, $\Sigma M_G: \quad -55.544\ \text{N}\cdot\text{m} = -a(244.53\ \text{N})$

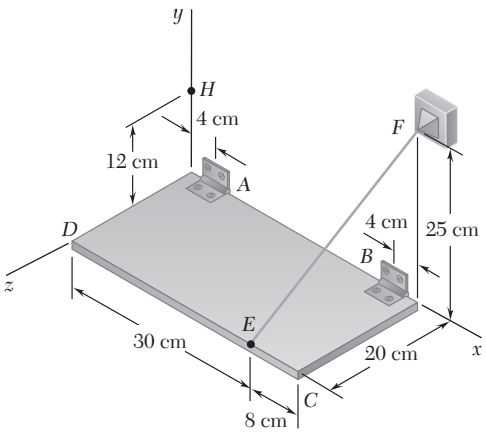
or $$a = 0.227\ \text{m}$$

and with **R** at *J*, $\Sigma M_G: \quad -55.544\ \text{N}\cdot\text{m} = -b(152.142\ \text{N})$

or $$b = 0.365\ \text{m}$$

(*a*) The rivet hole is 0.365 m above *G*. ◀

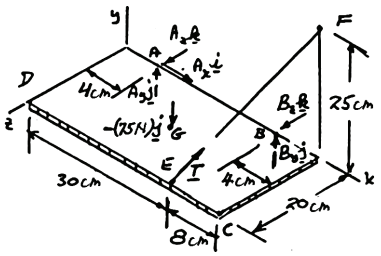
(*b*) The rivet hole is 0.227 m to the right of *G*. ◀



PROBLEM 4.115

The rectangular plate shown weighs 75 N and is held in the position shown by hinges at *A* and *B* and by cable *EF*. Assuming that the hinge at *B* does not exert any axial thrust, determine (*a*) the tension in the cable, (*b*) the reactions at *A* and *B*.

SOLUTION



$$\mathbf{r}_{B/A} = (38-8)\mathbf{i} = 30\mathbf{i}$$

$$\mathbf{r}_{E/A} = (30-4)\mathbf{i} + 20\mathbf{k}$$
$$= 26\mathbf{i} + 20\mathbf{k}$$

$$\mathbf{r}_{G/A} = \frac{38}{2}\mathbf{i} + 10\mathbf{k}$$
$$= 19\mathbf{i} + 10\mathbf{k}$$

$$\overrightarrow{EF} = 8\mathbf{i} + 25\mathbf{j} - 20\mathbf{k}$$

$$EF = 33 \text{ cm}$$

$$\mathbf{T} = T\frac{\overrightarrow{AE}}{AE} = \frac{T}{33}(8\mathbf{i} + 25\mathbf{j} - 20\mathbf{k})$$

$$\Sigma\mathbf{M}_A = 0: \quad \mathbf{r}_{E/A} \times \mathbf{T} + \mathbf{r}_{G/A} \times (-75\mathbf{j}) + \mathbf{r}_{B/A} \times \mathbf{B} = 0$$

$$\begin{vmatrix} \mathbf{i} & \mathbf{j} & \mathbf{k} \\ 26 & 0 & 20 \\ 8 & 25 & -20 \end{vmatrix} \frac{T}{33} + \begin{vmatrix} \mathbf{i} & \mathbf{j} & \mathbf{k} \\ 19 & 0 & 10 \\ 0 & -75 & 0 \end{vmatrix} + \begin{vmatrix} \mathbf{i} & \mathbf{j} & \mathbf{k} \\ 30 & 0 & 0 \\ 0 & B_y & B_z \end{vmatrix} = 0$$

Coefficient of **i**: $$-(25)(20)\frac{T}{33} + 750 = 0: \qquad T = 49.5 \text{ N} \blacktriangleleft$$

Coefficient of **j**: $$(160 + 520)\frac{49.5}{33} - 30B_z = 0: \quad B_z = 34 \text{ N}$$

Coefficient of **k**: $$(26)(25)\frac{49.5}{33} - 1425 + 30B_y = 0: \quad B_y = 15 \text{ N}$$

$$\mathbf{B} = (15 \text{ N})\mathbf{j} + (34 \text{ N})\mathbf{k} \blacktriangleleft$$

PROBLEM 4.115 (Continued)

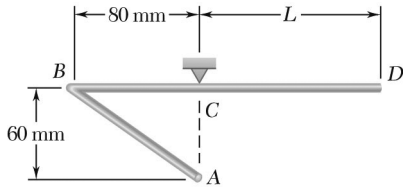
$$\Sigma\mathbf{F} = 0: \quad \mathbf{A} + \mathbf{B} + \mathbf{T} - (75 \text{ N})\mathbf{j} = 0$$

Coefficient of **i**: $$A_x + \frac{8}{33}(49.5) = 0 \quad A_x = -12.00 \text{ N}$$

Coefficient of **j**: $$A_y + 15 + \frac{25}{33}(49.5) - 75 = 0 \quad A_y = 22.5 \text{ N}$$

Coefficient of **k**: $$A_z + 34 - \frac{20}{33}(49.5) = 0 \quad A_z = -4.00 \text{ N}$$

$$\mathbf{A} = -(12.00 \text{ N})\mathbf{i} + (22.5 \text{ N})\mathbf{j} - (4.00 \text{ N})\mathbf{k} \blacktriangleleft$$



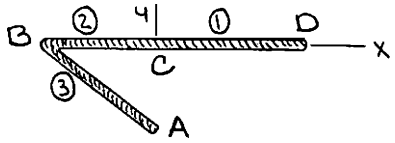
PROBLEM 5.28

The homogeneous wire *ABCD* is bent as shown and is attached to a hinge at *C*. Determine the length *L* for which portion *BCD* of the wire is horizontal.

SOLUTION

First note that for equilibrium, the center of gravity of the wire must lie on a vertical line through *C*. Further, because the wire is homogeneous, the center of gravity of the wire will coincide with the centroid of the corresponding line. Thus,

$$\bar{X} = 0 \text{ so that } \Sigma \bar{X} L = 0$$



Then
$$\frac{L^2}{2} + (-40 \text{ mm})(80 \text{ mm}) + (-40 \text{ mm})(100 \text{ mm}) = 0$$

$$L^2 = 14,400 \text{ mm}^2 \qquad L = 120.0 \text{ mm} \blacktriangleleft$$