6.4.1 In what way(s) is/are trusses different from more general frames?

5.4.1 Frames differ from trusses in the way that they have parts which are not "two-force bodies", unlike trusses, thereby making them more general structures.

In a truss, every bar is a two force body, while in a frame, one or more component is not a two-force body.

6.4.2 Consider a frame made of 3 pieces connected together. Assume that no free-body diagram cut is within a part.

a) How many different free-body diagrams can you draw?

b) For each free-body diagram how many independent scalar equations can be extracted from the equilibrium relations?

c) In total, from all the free-body diagrams, how many independent scalar equations can be extracted from the various equilibrium conditions?

a) One FBD can be drawn for each bar in the structure. Hence, in this case : 3 FBD's can be drawn.

b) For each FBD, 3 independent scalar equations can be extracted.

c) From all FBD's, 9 independent scalar equations can be derived.

Disclaimer: *We have lost track of the many people who wrote these solutions. They are not official and have not been reviewed by the authors for correctness.*

6.4.3 Consider the two-bar frame shown. Choose appropriate coordinate axes. Find

a) The reaction at D.

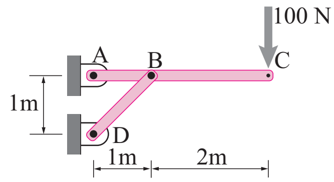
b) The tension in bar DB.

c) The reaction at A.

d) The force of DB on ABC.

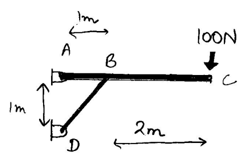
e) The moment in ABC

- just (an infinitesimal distance) to the right of A
- just to the left of B
- just to the right of B
- just to the left of C

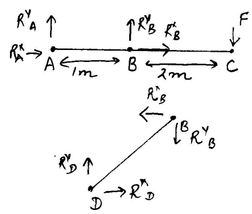


Problem 6.3

5.4.3



$b = 2;\ r = 4;\ j = 3 \qquad 2j = b + r$ ✓



for Bar AC:
$\sum \vec{F}_x = \vec{0} \Rightarrow R^x_A + R^x_B = 0$ ①

$\sum \vec{F}_y = \vec{0} \Rightarrow R^y_A + R^y_B = F$ ② (where $F = 100N$)

$\sum \vec{M}_B = \vec{0} \Rightarrow F(2)_m + R^y_A(1)_m = 0$ ③ $\Rightarrow R^y_A = -200N$

& $R^y_B = 300N$

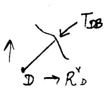
$\sum \vec{M}_D = \vec{0} \Rightarrow -R^y_B(1)_m + R^x_B(1)_m = 0$ ④ $\Rightarrow R^x_B = 300N$

for Bar BD:
$\sum \vec{F}_x = \vec{0} \Rightarrow R^x_B = R^x_D \Rightarrow R^x_D = 300N$

$\sum \vec{F}_y = \vec{0} \Rightarrow R^y_B = R^y_D \Rightarrow R^y_D = 300N$

a) Reaction at D $= \boxed{(300\hat{\imath} + 300\hat{\jmath})N}$

b)



$T_{DB} = -|\vec{R}_D| = -300\sqrt{2}N \Rightarrow \boxed{T_{DB} = -424.26N}$

c) From ① above, $R^x_A = -R^x_B = -300N$ and $R^y_A = -200N \therefore \boxed{R_A = (-300\hat{\imath} - 200\hat{\jmath})N}$

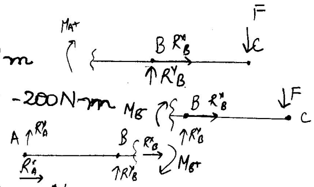
d) F_{DB} on ABC $= +\vec{R}_D = \boxed{(300\hat{\imath} + 300\hat{\jmath})N}$

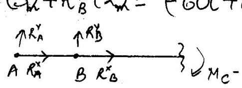
e) (i) $M_{A^+} = R^y_B(1_m) - F(3_m) = 300 - 300 = 0\ N\text{-}m$

(ii) $M_{B^-} = \cancel{R^y_A(1) - F(3)}$ $\quad M_{B^-} = -F(2_m) = -200N\text{-}m$

(iii) $M_{B^+} + R^y_A(1_m) = -200N\text{-}m$.

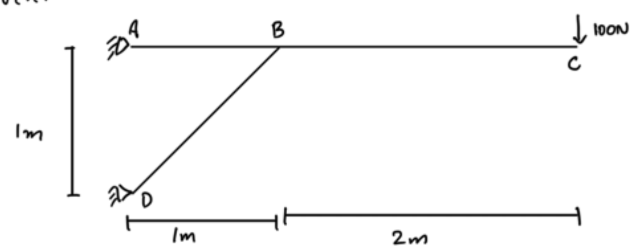
(iv) $M_{C^-} = R^y_A(3_m) + R^y_B(2_m) = (-600 + 600)\ Nm = 0\ N\text{-}m$.





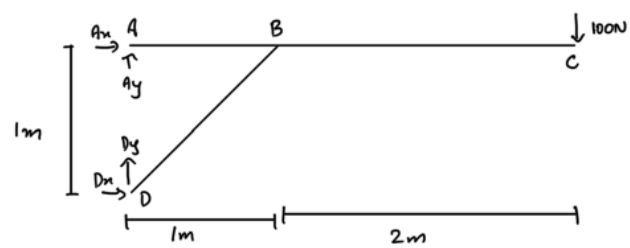
Disclaimer: *We have lost track of the many people who wrote these solutions. They are not official and have not been reviewed by the authors for correctness.*

Sketch:



$$\boxed{\text{To Find: } D_x, D_y, T_{DB}, A_x, A_y, F_{DB}, \vec{M}_{/A}, \vec{M}_{/B}, \vec{M}_{/C}}$$

FBD (Whole Structure):



a) Find Reaction Forces,

$$\Sigma F_x = 0$$

$$\Rightarrow A_x + D_x = 0$$

$$\Rightarrow A_x = -D_x$$

$$\Sigma F_y = 0$$

$$\Rightarrow A_y + D_y - 100\,N = 0$$

$$\Rightarrow A_y + D_y = 100\,N$$

$$\Sigma \vec{M}_{/B} = (\vec{r}_{A/B} \times A_y\hat{j}) + (\vec{r}_{D/B} \times D_y\hat{j}) + (\vec{r}_{D/B} \times D_x\hat{i}) + (\vec{r}_{C/B} \times -100N\hat{j})$$

$$= (-1m\hat{i} \times A_y\hat{j}) + ((-1m\hat{i} - 1m\hat{j}) \times D_y\hat{j}) + ((-1m\hat{i} - 1m\hat{j}) \times D_x\hat{i})$$

Disclaimer: *We have lost track of the many people who wrote these solutions. They are not official and have not been reviewed by the authors for correctness.*

$$+ (2m\hat{\imath} \times -100N\hat{\jmath}) = \vec{0}$$

$$= [-A_y m - D_y m - D_x m - 200\,Nm]\hat{k} = \vec{0}$$

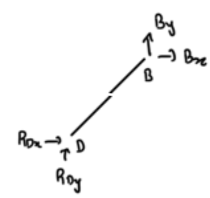
$$\Rightarrow -100\,Nm - D_x m - 200\,Nm = 0$$

$$\Rightarrow \boxed{D_x = -300\,N}$$

$$A_x = 300\,N$$

Find D_y,

FBD (Section):



$$\Sigma F_x = 0$$

$$\Rightarrow D_x + B_x = 0$$

$$\Rightarrow B_x = 300\,N$$

$$\Sigma F_y = 0$$

$$\Rightarrow D_y + B_y = 0$$

$$\Sigma \vec{M}_{/D} = (\vec{r}_{B/D} \times B_y\hat{\jmath}) + (\vec{r}_{B/D} \times B_x\hat{\imath})$$

$$= (\hat{\imath} + \hat{\jmath})m \times B_y\hat{\jmath} + (\hat{\imath} + \hat{\jmath})m \times B_x\hat{\imath}$$

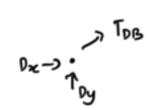
$$= (B_y + B_x)m\hat{k} = \vec{0}$$

$$\Rightarrow B_y = -300\,N$$

$$\Rightarrow \boxed{D_y = 300\,N}$$

b) Find T_{DB},

FBD (Joint):



$$\Sigma F_x = 0$$

$$\Rightarrow D_x + T_{DB}\cos 45 = 0$$

$$\Rightarrow \boxed{T_{DB} = 300\sqrt{2}\,N}$$

Disclaimer: *We have lost track of the many people who wrote these solutions. They are not official and have not been reviewed by the authors for correctness.*

c) From Previous Calculation,

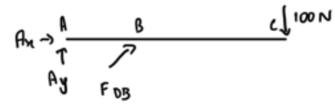
$$\boxed{A_x = 300N}$$

$$A_y = 100N - D_y$$

$$\boxed{A_y = -200N}$$

d) Find F_{DB},

FBD (Section):



$$\Sigma F_x = 0$$

$$\Rightarrow A_x + F_{DB} \cos 45 = 0$$

$$\boxed{F_{DB} = -300\sqrt{2}\ N}$$

e) Moment across any point in a static rigid body is 0. Hence,

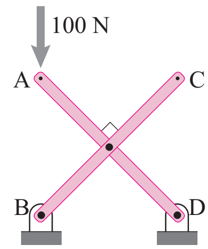
$$\boxed{\begin{gathered} \vec{M}_{/A} = \vec{0} \\ \vec{M}_{/B} = \vec{0} \\ \vec{M}_{/C} = \vec{0} \end{gathered}}$$

6.4.4 Two 1m bars are pinned together, at their middles, at right angles. Find

a) the reactions at B and D,

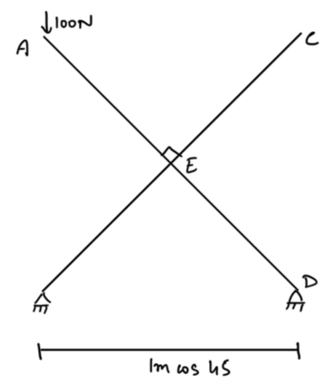
b) the force of BC on AD, &

c) the moment in AD just above the hinge,



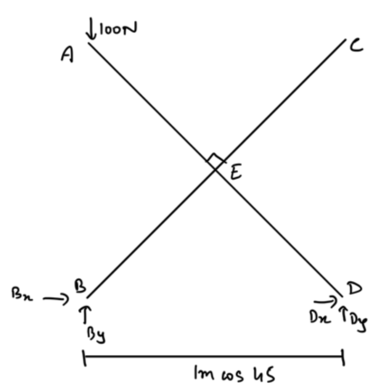
Problem 6.4

Sketch:



$\boxed{\text{To Find: } B_x, B_y, D_x, D_y, T_{BC}, \vec{M}_{/E}}$

FBD (Whole Structure):



a) Find Reaction Forces:

$$\Sigma F_x = 0$$

$$\Rightarrow B_x + D_x = 0$$

$$\Sigma F_y = 0$$

$$\Rightarrow -100N + B_y + D_y = 0$$

$$\Sigma \vec{M}_{/B} = \vec{r}_{D/B} \times D_y \hat{\jmath}$$

Disclaimer: *We have lost track of the many people who wrote these solutions. They are not official and have not been reviewed by the authors for correctness.*

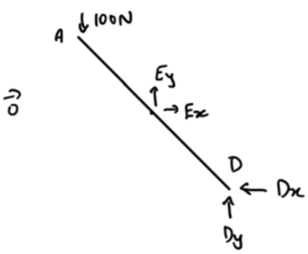
$= 1\,m \cos 45\, \hat{i} \times D_y \hat{j}$

$= (D_y \times 1m \cos 45)\, \hat{k} = \vec{0}$

$\boxed{D_y = 0 \qquad B_y = 100N}$

Find D_x, B_x

FBD (section):



$$\sum \vec{M}_{/E} = \vec{r}_{A/E} \times (-100N)\hat{j} + (\vec{r}_{D/E} \times D_x\hat{i}) + (\vec{r}_{D/E} \times D_y\hat{j}) = \vec{0}$$

$$= \left[\tfrac{1}{2}m(-\hat{i}+\hat{j}) \times (-100N\hat{j})\right] + \left[\tfrac{1}{2}m(\hat{i}-\hat{j}) \times (D_x\hat{i})\right] + \left[\tfrac{1}{2}m(\hat{i}-\hat{j}) \times (D_y\hat{j})\right] = \vec{0}$$

$$\Rightarrow \left[-50\,Nm - \frac{D_x}{2}m\right]\hat{k} = \vec{0}$$

$$\Rightarrow \boxed{D_x = -100N \qquad B_x = 100N}$$

b) $\sum F_x = 0$ [From section Above]

$\Rightarrow D_x + E_x = 0$

$\Rightarrow \boxed{E_x = 100N}$

$\sum F_y = 0$

Disclaimer: *We have lost track of the many people who wrote these solutions. They are not official and have not been reviewed by the authors for correctness.*

$\Rightarrow D_y + E_y - 100\,N = 0$

$$\boxed{E_y = 100N}$$

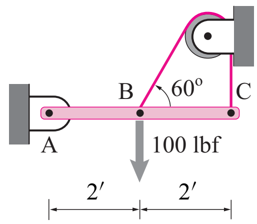
c) $\boxed{\vec{M}_{/E} = \vec{0}}$ [Moment across a point on a static rigid body is zero]

6.4.5 For the structure shown find

a) the tension in the string

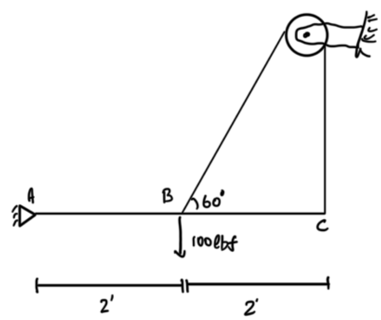
b) the reaction at A

c) the moment in ABC just to the right of B



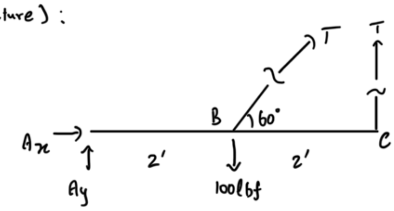
Problem 6.5

Sketch:



$\boxed{\text{To Find: } T_{string}, A_x, A_y, \vec{M}_{/B}}$

FBD (Whole Structure):



a) $\sum \vec{M}_{/A} = (\vec{r}_{B/A} \times -100\,\text{lbf}\,\hat{i}) + (\vec{r}_{B/A} \times \sin 60\, T_{string}\,\hat{j}) + (\vec{r}_{C/A} \times T\hat{j}) = \vec{0}$

$= (2\,\text{ft}\,\hat{i} \times -100\,\text{lbf}\,\hat{j}) + (2\,\text{ft}\,\hat{i} \times \sin 60\, T\,\hat{j})$

$+ (4\,\text{ft}\,\hat{i} \times T\,\hat{j}) = \vec{0}$

$= [-200\,\text{ft lbf} + \sqrt{3}\,\text{ft}\,T + 4\,\text{ft}\,T]\,\hat{k} = \vec{0}$

$\Rightarrow T = \dfrac{200}{(\sqrt{3}+4)}\,\text{lbf}$

Disclaimer: *We have lost track of the many people who wrote these solutions. They are not official and have not been reviewed by the authors for correctness.*

$$\boxed{T = 34.89\ \text{lbf}}$$

b) Since the system is in static equilibrium, the pulley can be reduced to a pin joint.

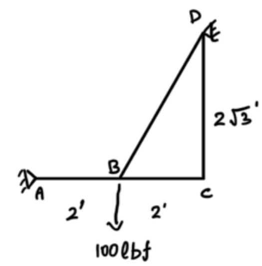
$\Sigma F_x = 0$

$\Rightarrow A_x + D_x = 0$

$\Sigma F_y = 0$

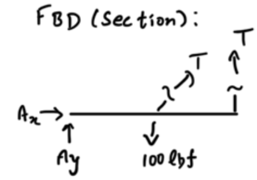
$\Rightarrow A_y + D_y = 100\ \text{lbf}$

FBD (Section)



Find A_x, A_y:

FBD (Section):



$\Sigma F_x = 0$

$\Rightarrow A_x + T\cos 60 = 0$

$\Rightarrow A_x = \dfrac{-100}{(\sqrt{3}+4)}\ \text{lbf}$

$$\boxed{A_x = 17.44\ \text{lbf}}$$

$\Sigma F_y = 0$

$\Rightarrow A_y - 100\ \text{lbf} + T\sin 60 + T = 0$

$\Rightarrow A_y = 100 - \dfrac{200}{(\sqrt{3}+4)}\left(\dfrac{2+\sqrt{3}}{2}\right)\ \text{lbf}$

$$\boxed{A_y = 34.89\ \text{lbf}}$$

Disclaimer: *We have lost track of the many people who wrote these solutions. They are not official and have not been reviewed by the authors for correctness.*

c) Find $\sum \vec{M}_{/B}$

$$\sum \vec{M}_{/B} = (\vec{r}_{A/B} \times A_y \hat{j}) + (\vec{r}_{C/B} \times T\hat{j})$$

$$= (-2\,\text{in}\,\hat{\imath} \times A_y \hat{j}) + (2\,\text{in}\,\hat{\imath} \times T\hat{j})$$

$$= 0\hat{k}$$

$$\boxed{\vec{M}_{/B} = \vec{0}}$$

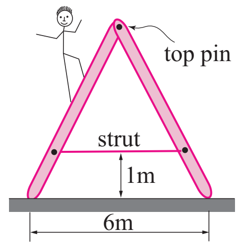
6.4.6 An A-frame aluminum ladder consists of two uniform 5 m, 150 N sections that are pinned at the top and held from splitting by a massless strut $1m$ above the slippery floor. An 800 N person has climbed halfway up the left side.

a) Find the reactions (the forces of the ground on the two ladder sections).

b) Find the force of the left section on the right at the top pin.

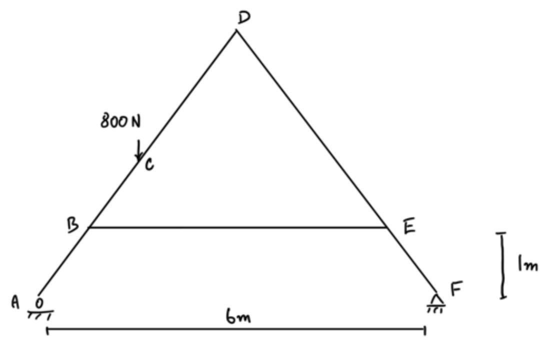
c) Find the tension in the connection strut.

d) Find the moment in the right leg of the ladder just above the tension strut.



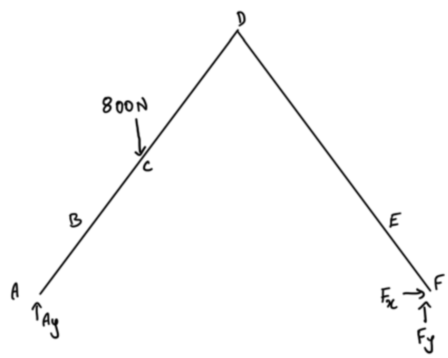
Problem 6.6

Sketch :



To Find : $A_y, F_x, F_y, D_y, D_x, E_y, E_x$

FBD (Whole Structure):



a) Find Reaction Forces,

$$\sum F_x = 0$$

$$\Rightarrow F_x = 0$$

$$\sum F_y = 0$$

$$\Rightarrow A_y + F_y - 800\,N = 0$$

$$\Rightarrow A_y + F_y = 800\,N$$

$$\sum \vec{M}_{/F} = (\vec{r}_{FC} \times (-800N)\hat{j}) + (\vec{r}_{FA} \times A_y\hat{j}) = \vec{0}$$

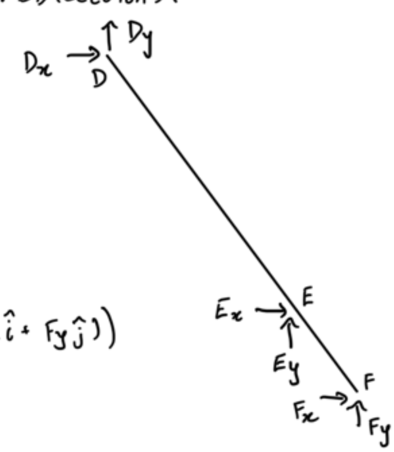
$$= ((-4.5m\,\hat{i} + 2m\,\hat{j}) \times (-800N)\hat{j}) + (-6m\,\hat{i} \times A_y\hat{j}) = \vec{0}$$

$$= (3600\,Nm - 6A_y\,m)\hat{k} = \vec{0}$$

$$\boxed{\begin{aligned} A_y &= 600\,N \\ F_y &= 200\,N \end{aligned}}$$

b) Find Forces on the left section on the right of the top pin,

FBD (Section):



$$\sum F_x = 0$$

$$\Rightarrow D_x + E_x = 0$$

$$\sum F_y = 0$$

$$\Rightarrow D_y + E_y + 200N = 0$$

$$\sum \vec{M}_{/E} = (\vec{r}_{ED} \times (D_x\hat{i} + D_y\hat{j})) + (\vec{r}_{EF} \times (F_x\hat{i} + F_y\hat{j}))$$

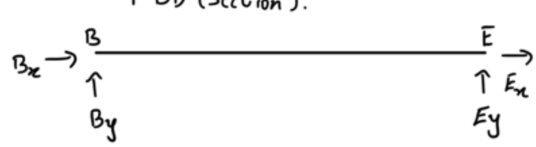
$$= (-2.25m\,\hat{i} + 3m\,\hat{j}) \times (D_x\hat{i} + D_y\hat{j})$$

$$+ (0.75m\,\hat{i} - 1m\,\hat{j}) \times (F_x\hat{i} + F_y\hat{j}) = \vec{0}$$

$$= (-2.25D_y + 3D_x + 0.75F_y - F_x)m\,\hat{k} = \vec{0}$$

$$= (3D_x - 2.25D_y + 150\,N)m = 0$$

F BD (Section):



$$\sum F_x = 0$$

$$\Rightarrow B_x + E_x = 0$$

$$\sum F_y = 0$$

Disclaimer: *We have lost track of the many people who wrote these solutions. They are not official and have not been reviewed by the authors for correctness.*

$$\Rightarrow B_y + E_y = 0$$

$$\sum \vec{M}_{/B} = (\vec{r}_{BE} \times E_y \hat{j}) = \vec{0}$$

$$= (4.5\hat{i} \times E_y \hat{j}) = \vec{0}$$

$$= 4.5 E_y \hat{k} = \vec{0}$$

$$\Rightarrow E_y = 0\,\text{N}$$

$$\boxed{\begin{aligned} D_y &= -200\,\text{N} \\ D_x &= -200\,\text{N} \end{aligned}}$$

c)

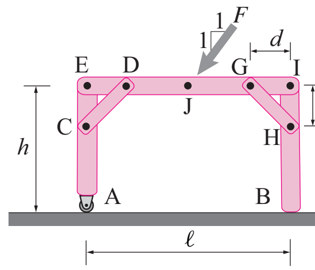
$$\boxed{\begin{aligned} E_x &= 200\,\text{N} \\ E_y &= 0\,\text{N} \end{aligned}}$$

6.4.7 To make a model of a table statically determinate, we assume that leg EA slides easily on the floor. Assume the other leg does not slip. A force $F = 200\,\text{N}$ acts at 45° at the center of the table. Use $h = 1\,\text{m}$, $\ell = 2\,\text{m}$, and $d = .25\,\text{m}$. Find

a) the reactions at A and B,

b) the tension in GH,

c) the moment in IHB just below H.



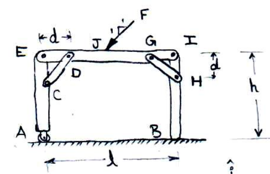
Problem 6.7

5.4.7

(a) Find reactions at A and B.

(b) Tension in GH ?

(c) Moment in IHB just below H.



(a) The free body diagram of the table is shown in the adjacent figure. Fig. 1.

Let the location of the force F be $EJ = \frac{l}{2}$.

Applying force balance, $\Sigma \underline{F} = \underline{0}$

$\Rightarrow \left\{ R_1 \hat{j} + R_2 \hat{i} + R_3 \hat{j} - \frac{F}{\sqrt{2}} \hat{i} - \frac{F}{\sqrt{2}} \hat{j} = \underline{0} \right\}$

$\{\}\cdot\hat{i} \Rightarrow R_2 = \frac{F}{\sqrt{2}}$ —(1)

$\{\}\cdot\hat{j} \Rightarrow R_1 + R_3 = \frac{F}{\sqrt{2}}$ —(2)

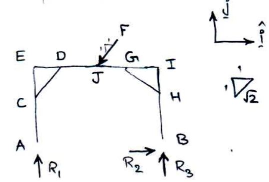
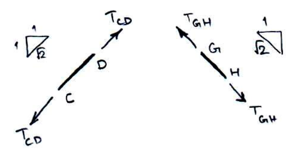


Fig. 1



Using moment balance about B, $\Sigma \underline{M}_{/B} = \underline{0}$

$\Rightarrow -l\hat{i} \times R_1 \hat{j} + \left(h\hat{j} - \frac{l}{2}\hat{i}\right) \times \left(-\frac{F}{\sqrt{2}}\hat{i} - \frac{F}{\sqrt{2}}\hat{j}\right) = \underline{0}$

$\Rightarrow \left\{ -R_1 l \hat{k} + \frac{Fh}{\sqrt{2}} \hat{k} + \frac{Fl}{2\sqrt{2}} \hat{k} = \underline{0} \right\}$

$\{\}\cdot\hat{k} \Rightarrow R_1 = \frac{F(2h+l)}{2l\sqrt{2}}$ —(3) From (2) and (3) we have $R_3 = \frac{F(l-2h)}{2l\sqrt{2}}$ —(4)

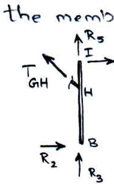
Given that $F = 200\text{N}$, $l = 2\text{m}$, $h = 1\text{m}$, $d = 0.25\text{m}$

$\Rightarrow$ Reactions at A and B are: $\boxed{R_1 = 141.4\,\text{N}}$, $\boxed{R_2 = 141.4\,\text{N}}$; $\boxed{R_3 = 0\text{N}}$

(b) To find the tension in GH, consider the FBD of the member BI:

Apply force balance to BI, $\{\Sigma \underline{F} = \underline{0}\}\cdot\hat{j}$

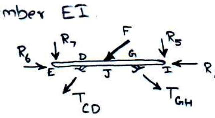
$\Rightarrow R_3 + R_5 + \frac{T_{GH}}{\sqrt{2}} = 0 \Rightarrow T_{GH} = -\sqrt{2}R_5$ —(5)



FBD of BI

To find R_5, consider the FBD of the member EI

Applying moment balance about E, $\Sigma \underline{M}_{/E} = \underline{0}$



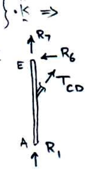
$\Rightarrow d\hat{i} \times \left[-\frac{T_{CD}}{\sqrt{2}}(\hat{i}+\hat{j})\right] + \frac{l}{2}\hat{i} \times \left[-\frac{F}{\sqrt{2}}(\hat{i}+\hat{j})\right] + (l-d)\hat{i} \times \left[\frac{T_{GH}}{\sqrt{2}}(\hat{i}-\hat{j})\right] + l\hat{i} \times -R_5\hat{j} = \underline{0}$

From (5),

$\Rightarrow \left\{ -\frac{T_{CD}}{\sqrt{2}} d\hat{k} - \frac{Fl}{2\sqrt{2}}\hat{k} - \frac{T_{GH}}{\sqrt{2}}(l-d)\hat{k} + \frac{T_{GH}}{\sqrt{2}} l\hat{k} = \underline{0} \right\}\cdot\hat{k} \Rightarrow T_{GH} = T_{CD} + \frac{Fl}{2d}$ —(6)

Consider the FBD of the member AE

Applying moment balance about E, $\Sigma \underline{M}_{/E} = \underline{0} \Rightarrow T_{CD} = 0$



$\therefore$ From (6) $T_{GH} = \frac{Fl}{2d}$ (or) $\boxed{T_{GH} = 800\text{N}}$

Alternatively, T_{GH} can be obtained by taking moment balance about 'I' in FBD of BI: $\Sigma \underline{M}_{/I} = \underline{0}$

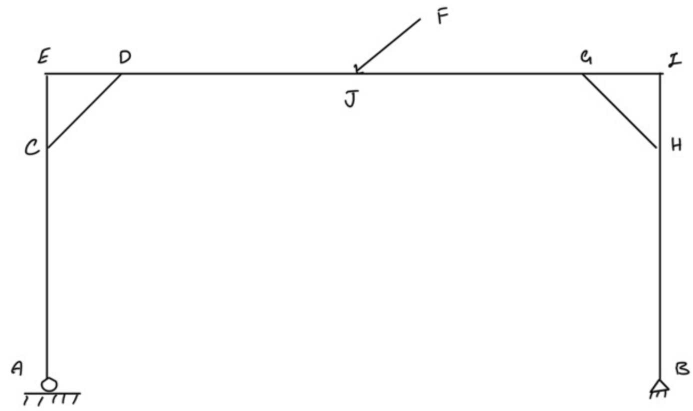
$\left\{ -d\hat{j} \times \frac{T_{GH}}{\sqrt{2}}(-\hat{i}+\hat{j}) - h\hat{j} \times R_2\hat{i} = \underline{0} \right\}\cdot\hat{k} \Rightarrow T_{GH} = 800\text{N}$

(c) The moment in the member IHB, just below H is obtained from reaction R_2, $M_H = (h-d)(-\hat{j}) \times R_2\hat{i} = R_2(h-d)\hat{k} = \frac{F}{\sqrt{2}}(h-d)\hat{k} = \frac{150}{\sqrt{2}}\,\text{Nm}$

$\therefore$ Moment just below H, $\boxed{M_{BH}^{-} = 106.07\,\text{Nm}}$

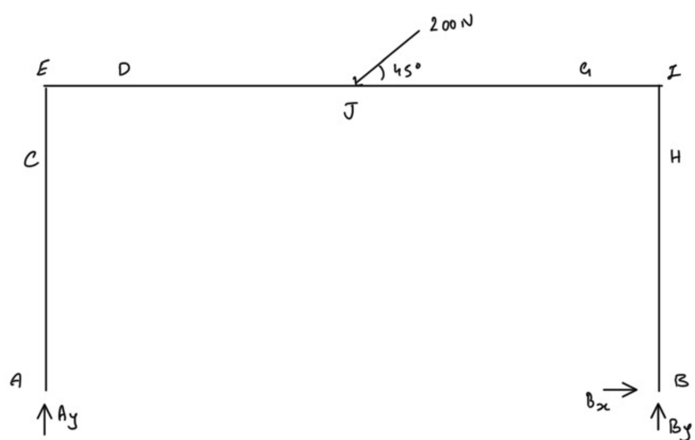
Disclaimer: *We have lost track of the many people who wrote these solutions. They are not official and have not been reviewed by the authors for correctness.*

Sketch:



$\boxed{\text{To Find}: A_y, B_x, B_y, H_x, H_y}$

FBD (Whole Structure)



a) Find Reaction Forces,

$\Sigma F_x = 0$

$\Rightarrow B_x - 200\text{N} \cos 45 = 0$

$\Rightarrow \boxed{B_x = 100\sqrt{2}\ \text{N}}$

$\Sigma F_y = 0$

$\Rightarrow A_y + B_y - 200\text{N} \sin 45 = 0$

Disclaimer: *We have lost track of the many people who wrote these solutions. They are not official and have not been reviewed by the authors for correctness.*

$$\Rightarrow A_y + B_y = 100\sqrt{2}\ N$$

$$\sum \vec{M}_{/B} = \vec{0}$$

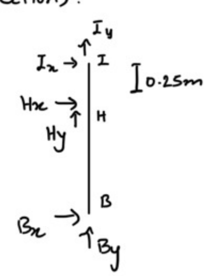
$$= (-2m\hat{\imath} \times A_y\hat{\jmath}) + \left[(-1m\hat{\imath} + 1m\hat{\jmath}) \times (-\tfrac{1}{\sqrt{2}}\hat{\imath} - \tfrac{1}{\sqrt{2}}\hat{\jmath})200N\right]$$

$$\Rightarrow [-2mA_y + 200\sqrt{2}\ Nm]\hat{k} = \vec{0}$$

$$\boxed{\begin{array}{l} A_y = 100\sqrt{2}\ N \\ B_y = 0 \end{array}}$$

b) Find H_x, H_y,

FBD (Section):



$$\sum \vec{M}_{/I} = \vec{0}$$

$$= (\vec{r}_{IH} \times H_x\hat{\imath}) + (\vec{r}_{IB} \times B_x\hat{\imath})$$

$$= ((-0.25m\hat{\jmath}) \times H_x\hat{\imath}) + ((-1m\hat{\jmath}) \times B_x\hat{\imath})$$

$$= (-0.25H_x m - B_x m)\hat{k} = \vec{0}$$

$$\Rightarrow \quad H_x = -4B_x$$

$$\boxed{H_x = -400\sqrt{2}\ N}$$

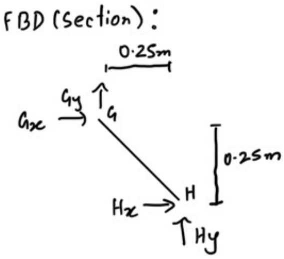
$$\sum F_y = 0$$

$$\Rightarrow I_y + B_y + H_y = 0$$

$$\Rightarrow H_y = -I_y$$

$$\sum \vec{M}_{/G} = \vec{0}$$

FBD (Section):



$$= (\vec{r}_{GH} \times (H_x\hat{\imath} + H_y\hat{\jmath}))$$

$$= (0.25\hat{\imath} - 0.25\hat{\jmath})m \times (H_x\hat{\imath} + H_y\hat{\jmath})$$

$$= (0.25H_y - 0.25H_x)m\hat{k} = \vec{0}$$

$$\boxed{H_y = -400\sqrt{2}\ \text{N}}$$

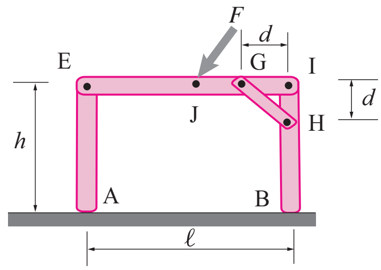
Disclaimer: *We have lost track of the many people who wrote these solutions. They are not official and have not been reviewed by the authors for correctness.*

6.4.8 Another way to make a model of a table statically determinate (see problem 6.4.7) is to assume that one leg is not braced. Now, neither leg can slip. A force $F = 200\,\mathrm{N}$ acts at 45° at the center of the table. Use $F = 200\,\mathrm{N}$, $h = 1\,\mathrm{m}$, $\ell = 2\,\mathrm{m}$, and $d = .25\,\mathrm{m}$. Find

a) the reactions at A and B

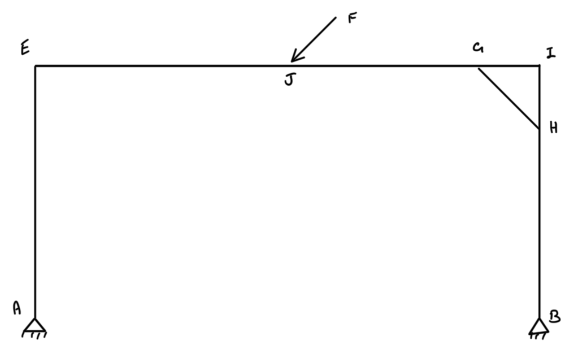
b) the tension in GH

c) the moment in IHB just below H



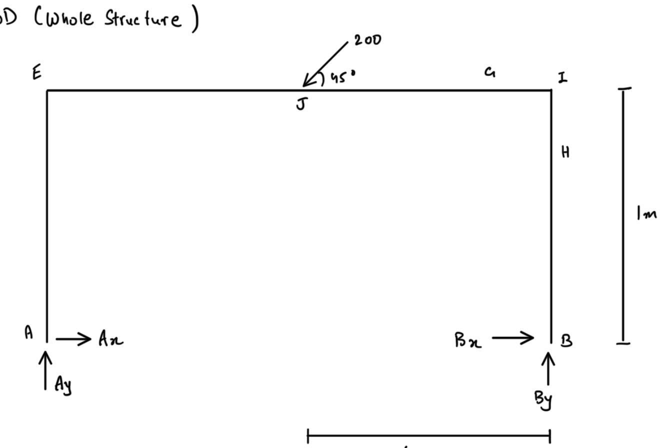
Problem 6.8

Sketch:



$\boxed{\text{To Find: } A_x, B_x, A_y, B_y, H_x, H_y}$

FBD (Whole Structure)



Find Reaction Forces,

$\Sigma F_x = 0$

$\Rightarrow A_x + B_x = 100\sqrt{2}\ \mathrm{N}$

$\Sigma F_y = 0$

$\Rightarrow A_y + B_y = 100\sqrt{2}\ \mathrm{N}$

$$\sum \vec{M}_{/B} = (\vec{r}_{BA} \times A_y \hat{j}) + (\vec{r}_{BJ} \times \vec{F}) = \vec{0}$$

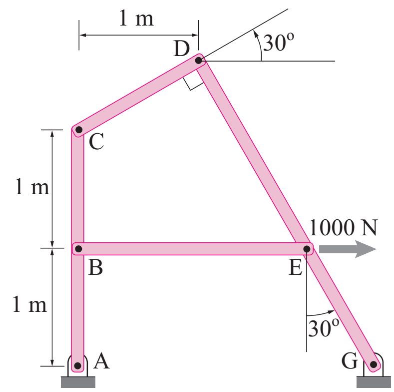
$$= (-2m\,\hat{i}) \times A_y \hat{j} + \left((-\hat{i} + \hat{j})m \times (-1/\sqrt{2}\,\hat{i} - 1/\sqrt{2}\,\hat{j})\,200N \right) = \vec{0}$$

$$= (-2m\,A_y + 200\sqrt{2}\ Nm)\hat{k} = \vec{0}$$

$$\boxed{\begin{array}{l} A_y = 100\sqrt{2}\ N \\ B_y = 0\ N \end{array}}$$

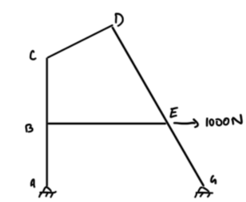
Disclaimer: *We have lost track of the many people who wrote these solutions. They are not official and have not been reviewed by the authors for correctness.*

6.4.9 For the structure shown find the reaction at A.

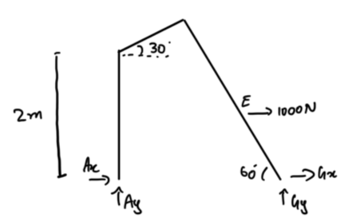


Problem 6.9

Sketch:



FBD (Whole Structure):



Find Reaction Forces,

$$\sum F_x = 0$$

$$= A_x + G_x + 1000\text{N} \quad - (i)$$

$$\sum F_y = 0$$

$$= A_y + G_y$$

$$\sum \vec{M}_{/F} = \vec{0}$$

$$= (\vec{r}_{FE} \times 1000\text{N}\,\hat{i}) + (\vec{r}_{FA} \times (A_x\hat{i} + A_y\hat{j})) = \vec{0}$$

$$= (-1\text{m} \cot 60\,\hat{i} + 1\text{m}\,\hat{j}) \times 1000\text{N}\,\hat{i} + (2.5 \cot 60 + \cos 30)\hat{i}\,\text{m} \times A_y\hat{j} = \vec{0}$$

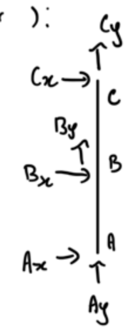
Disclaimer: *We have lost track of the many people who wrote these solutions. They are not official and have not been reviewed by the authors for correctness.*

$$= \left[1000\,N - \frac{4\sqrt{3}}{3} A_y \right] m\hat{k} = \vec{0}$$

$$\boxed{A_y = 250\sqrt{3}\,N}$$

$$G_y = -250\sqrt{3}\,N$$

FBD(Bar):



$$\sum \vec{M}_{/C} = \vec{0}$$

$$= (\vec{r}_{CB} \times B_x\hat{i}) + (\vec{r}_{CA} \times A_x\hat{i}) = \vec{0}$$

$$= (-1m\hat{j} \times B_x\hat{i}) + (-2m\hat{j} \times A_x\hat{i}) = \vec{0}$$

$$= (-1m\,B_x - 2m A_x)\hat{k} = \vec{0}$$

$$\Rightarrow A_x = \frac{-B_x}{2}$$

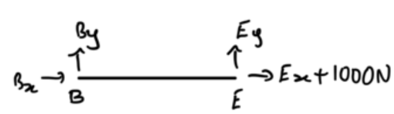
$$\sum F_x = 0$$

$$= A_x + B_x + C_x$$

$$= -A_x + C_x = 0$$

$$\Rightarrow C_x = A_x$$

FBD (Bar) :



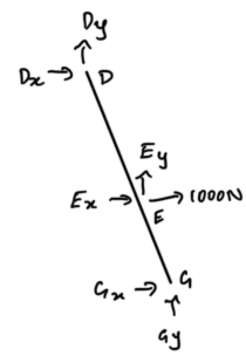
$$\sum F_x = 0$$

$$= B_x + E_x + 1000N = 0$$

$$\Rightarrow -2A_x + E_x + 1000N = 0$$

$$\therefore \quad A_x = \frac{E_x + 1000\,N}{2}$$

FBD (Bar):

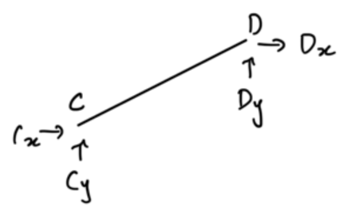


$$\Sigma F_x = 0$$

$$= G_x + E_x + D_x + 1000\,N$$

$$= G_x + 2A_x + D_x = 0$$

FBD (Bar):



$$\Sigma F_x = 0$$

$$= C_x + D_x = 0$$

$$\Rightarrow \quad D_x = -C_x$$

$$= -A_x$$

Disclaimer: *We have lost track of the many people who wrote these solutions. They are not official and have not been reviewed by the authors for correctness.*

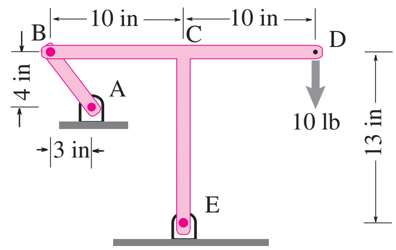
6.4.10 The structure consists of two pieces: bar AB and 'T' EBCD. They are connected to each other with a hinge at B. They are connected to the ground with hinges at A and E. The force of gravity is negligible. Find

a) The reaction at A.

b) The reaction at E.

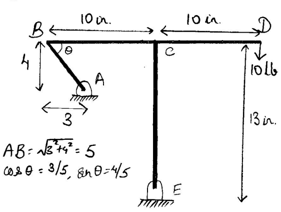
c) The moment in BCED just to the left of C.

d) Why are these forces so big or small? (Your answer should be in words).



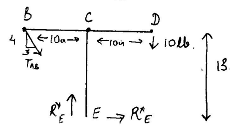
Problem 6.10

5.4.10



$AB = \sqrt{3^2+4^2} = 5$

$\cos\theta = 3/5$, $\sin\theta = 4/5$



Assuming member AB is in tension.

$\Sigma F_x = 0 \Rightarrow R_E^x + T_{AB}\left(\frac{3}{5}\right)lb = 0$

$\Sigma F_y = 0 \Rightarrow R_E^y - 10\,lb - T_{AB}\left(\frac{4}{5}\right)lb = 0$

$\Sigma \vec{M}_E = \vec{0} \Rightarrow -(10\times10)lb\,in - T_{AB}^{(lb)}\left(\frac{3}{5}\right)\times 13\,in + T_{AB}^{(lb)}\left(\frac{4}{5}\right)\times 10\,in = 0$

$\Rightarrow \frac{T_{AB}^{(lb)}}{5}(40-39)_{in} = 100\,lb\,in \Rightarrow T_{AB} = 500\,lb.$

$R_E^x = -\frac{3}{5}T_{AB}^{(lb)} = -300\,lb$ $\quad R_E^y = 10\,lb + \frac{4}{5}T_{AB}^{(lb)}$

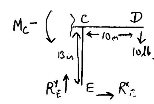
$= 410\,lb.$

$\therefore R_E = (-300\hat{\imath} + 410\hat{\jmath})\,lb.$

a) $R_A = T_{AB}\left(\frac{3}{5}\right)\hat{\imath} + T_{AB}\left(\frac{4}{5}\right)(-\hat{\jmath}) \Rightarrow \boxed{R_A = (300\hat{\imath} - 400\hat{\jmath})\,lb}$

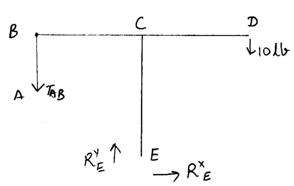
b) $\boxed{R_E = (-300\hat{\imath} + 410\hat{\jmath})\,lb}$

c) $M_{C^-} - 10\,lb\,(10\,in) + R_E^{x\,(lb)}(13\,in) = 0 \Rightarrow M_{C^-} = (100+3900)\,lb\,in = \boxed{4000\,lb.in}$



d) The forces are large due to the tilt in link AB.

If AB is positioned such that $\theta = 90°$, the forces (reactions and tension) are of a lower order of magnitude.



$\Sigma F_x = 0 \Rightarrow R_E^x = 0$

$\Sigma F_y = 0 \Rightarrow R_E^y - T_{AB} - 10\,lb = 0$

$\Sigma \vec{M}_E = \vec{0} \Rightarrow -(10)^{(lb)}(10\,in) + T_{AB}^{(lb)}\times 10\,in = 0$

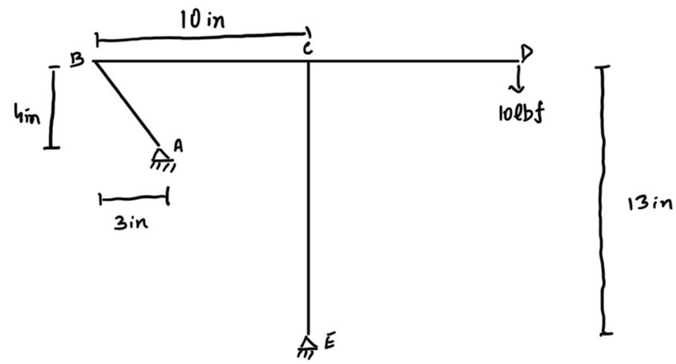
$\Rightarrow T_{AB} = 10\,lb.$

$R_E^y = 20\,lb.$

Note that these are much lower in magnitude than the values obtained with $\theta = \tan^{-1}(4/3)$

Disclaimer: *We have lost track of the many people who wrote these solutions. They are not official and have not been reviewed by the authors for correctness.*

Sketch



Find Reaction Forces,

$\sum F_x = 0$

$= A_x + E_x$

$\sum F_y = 0$

$= A_y + E_y - 10\,lbf = 0$

$\Rightarrow A_y + E_y = 10\,lbf$

$\sum \vec{M}_{/E} = \vec{0}$

$= (\vec{r}_{EA} \times (A_x\hat{i} + A_y\hat{j})) + (\vec{r}_{ED} \times (-10\,lbf\,\hat{j})) = \vec{0}$

$= ((-7\hat{i} + 9\hat{j})\,in \times (A_x\hat{i} + A_y\hat{j})) + ((10\hat{i} + 13\hat{j})\,in \times (-10\,lbf)) = \vec{0}$

$= (-7A_y - 9A_x - 100\,lbf)\,in\,\hat{k} = \vec{0}$

$\Rightarrow 7A_y + 9A_x = -100\,lbf \quad - (i)$

Disclaimer: *We have lost track of the many people who wrote these solutions. They are not official and have not been reviewed by the authors for correctness.*

$$\sum \vec{M}_{/B} = \vec{0}$$

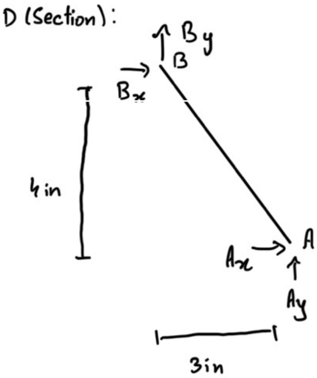
$$= \vec{r}_{BA} \times (A_x \hat{i} + A_y \hat{j}) = \vec{0}$$

$$= (3\hat{i} - 4\hat{j})\,\text{in} \times (A_x \hat{i} + A_y \hat{j}) = \vec{0}$$

$$= (3A_y + 4A_x)\,\text{in}\,\hat{k} = \vec{0}$$

$$\Rightarrow \quad A_y = -\tfrac{4}{3} A_x$$

FBD (Section):



Plug into (i)

$$\tfrac{28}{3} A_x + 9 A_x = -100\,\text{lbf}$$

$$\boxed{\begin{aligned} A_x &= 5.45\,\text{lbf} \\ A_y &= -7.27\,\text{lbf} \\ E_x &= -5.45\,\text{lbf} \\ E_y &= -17.27\,\text{lbf} \end{aligned}}$$