TAM 203

Homework Solution

Due 4/10/08

12.72

let P be the centroid of plate

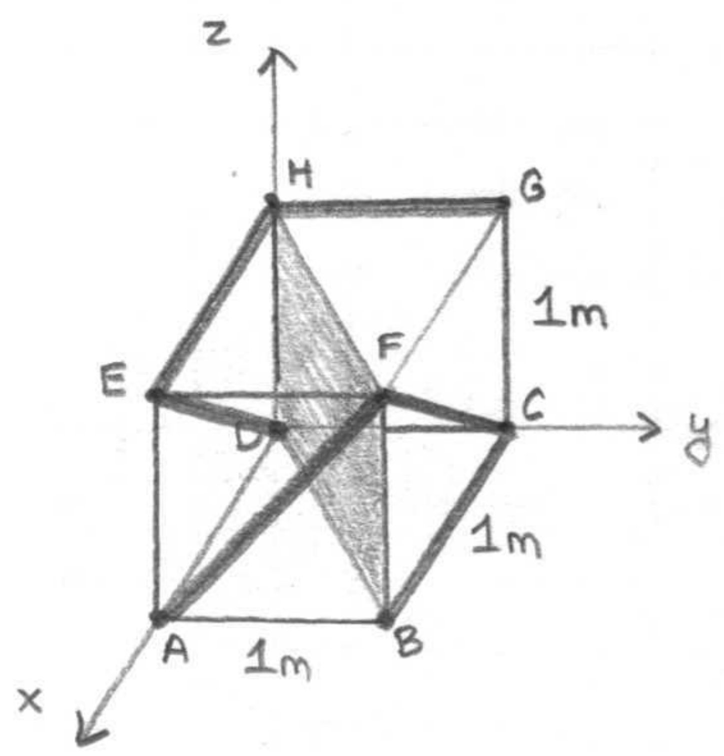

Plate DBFH has mass $m = 2\ \text{kg}$, held by six massless rods:

AF, CB, CF, GH, ED, EH

Points A, C, E + G accelerate with

$\vec{a} = 3\ \text{m/s}^2\ \hat{\imath}$

a) $\{\Sigma \vec{F}\}\cdot\hat{\imath} = m\vec{a}\cdot\hat{\imath} = (2\ \text{kg})(3\ \text{m/s}^2) = \boxed{6\ \text{N}}$

b) To find $\vec{F}_{CB}$, take angular momentum balance about F:

$$\Sigma \vec{M}_{/F} = \dot{\vec{H}}_F = \vec{r}_{P/F} \times m\vec{a} = \tfrac{1}{2}(\hat{\imath}+\hat{\jmath}+\hat{k}) \times (6\hat{\imath})$$

$$= 3\left[(\hat{\imath}\times\hat{\imath}) + (\hat{\jmath}\times\hat{\imath}) + (\hat{k}\times\hat{\imath})\right] = 3(\hat{\jmath} - \hat{k})$$

$$\therefore\ \Sigma \vec{M}_{/F} = 3\ \text{N-m}\ (\hat{\jmath} - \hat{k})$$

$$\Sigma \vec{M}_F = \vec{r}_{H/F} \times \vec{T}_{HE} + \vec{r}_{H/F} \times \vec{T}_{HG} + \vec{r}_{D/F} \times \vec{T}_{DE} + \vec{r}_{B/F} \times \vec{T}_{BC}$$

$$= T_{HE}\begin{vmatrix} \hat{\imath} & \hat{\jmath} & \hat{k} \\ 1 & 1 & 0 \\ 1 & 0 & 0 \end{vmatrix} + T_{HG}\begin{vmatrix} \hat{\imath} & \hat{\jmath} & \hat{k} \\ 1 & 1 & 0 \\ 0 & 1 & 0 \end{vmatrix} + \frac{T_{DE}}{\sqrt{2}}\begin{vmatrix} \hat{\imath} & \hat{\jmath} & \hat{k} \\ 1 & 1 & 1 \\ 1 & 0 & 1 \end{vmatrix} + T_{BC}\begin{vmatrix} \hat{\imath} & \hat{\jmath} & \hat{k} \\ 0 & 0 & 1 \\ -1 & 0 & 0 \end{vmatrix}$$

$$= T_{HE}(-\hat{k}) + T_{HG}(\hat{k}) + \frac{T_{DE}}{\sqrt{2}}(\hat{\imath} - \hat{k}) + T_{BC}(-\hat{\jmath})$$

$$\therefore\ \frac{T_{DE}}{\sqrt{2}}\hat{\imath} - T_{BC}\hat{\jmath} + \left(T_{HG} - T_{HE} - \frac{T_{DE}}{\sqrt{2}}\right)\hat{k} = 3\hat{\jmath} - 3\hat{k}$$

$$\{\}\cdot\hat{\jmath} \longrightarrow -T_{BC} = 3 \qquad \therefore\ T_{BC} = -3\text{N}$$

OR $\boxed{\vec{T}_{BC} = (-3\text{N})\,\hat{\imath}}$