

### 3D Equilibrium II Problem 1

Determine the tensions in the cables and the components of reaction acting on the smooth collar at A necessary to hold the sign of weight  $W = 50 \text{ lb}$  in equilibrium. The center of gravity for the sign is at  $G$ .

$$\begin{aligned} a &= 4 \text{ ft} & g &= 1 \text{ ft} \\ b &= 3 \text{ ft} & h &= 1 \text{ ft} \\ c &= 2 \text{ ft} & i &= 2 \text{ ft} \\ d &= 2 \text{ ft} & j &= 2 \text{ ft} \\ e &= 2.5 \text{ ft} & k &= 3 \text{ ft} \\ f &= 2.5 \text{ ft} & & \end{aligned}$$

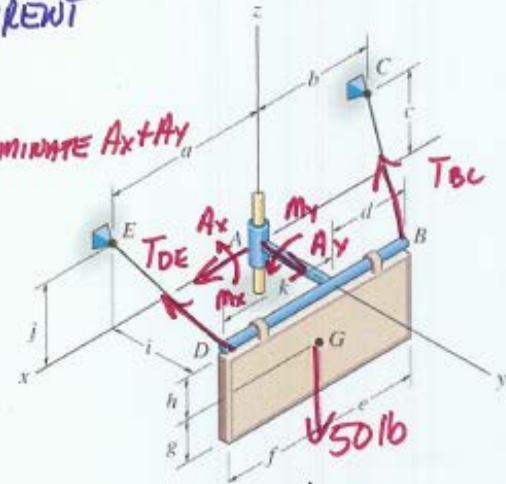
$$\vec{U}_{DE} = \frac{[1 - 2 \ 2]}{\sqrt{1^2 + (-2)^2 + 2^2}} = [0.333 \ -0.667 \ 0.667]$$

$$\vec{U}_{BC} = \frac{[-1 \ -2 \ 2]}{\sqrt{(-1)^2 + (-2)^2 + 2^2}} = [-0.333 \ -0.667 \ 0.667]$$

NONCOLLINEAR

6 EQUATIONS  
6 UNKNWS

$\Sigma M_A$  TO ELIMINATE  $A_x$  &  $A_y$



FORCES, MOMS  
REACTIONS

$\vec{F}_{PT \Rightarrow F}$

$\vec{F}$

$\vec{r} \times \vec{F}$ , couples  
MOMENT REACTIONS

$$T_{DE} \quad [4 \ 0 \ 2]$$

$$[0.333 \ -0.667 \ 0.667] T_{DE}$$

$$[1.334 \ -2 \ -2.67] T_{DE}$$

$$T_{BC} \quad [-3 \ 0 \ 2]$$

$$[-0.333 \ -0.667 \ 0.667] T_{BC}$$

$$[1.334 \ 1.335 \ 2] T_{BC}$$

$$50 \text{ lb} \quad [0.5 \ 2 \ -1]$$

$$[0 \ 0 \ -50]$$

$$[-100 \ 25 \ 0]$$

$$\vec{M}_A \quad \underline{\underline{\quad}}$$

$$\underline{\underline{\quad}}$$

$$[m_x \ m_y \ 0]$$

$$\vec{A} \quad [0 \ 0 \ 0]$$

$$[A_x \ A_y \ 0]$$

$$[0 \ 0 \ 0]$$

$$\text{①} \quad \text{②} \quad \text{③}$$

$$\text{④} \quad \text{⑤} \quad \text{⑥}$$

EQUILIBRIUM EQNS

EQNS 3+6

$$\sum F_z = 0 = .667 T_{DE} + .667 T_{BC} - 50 + 0 = 0$$

$$\sum F_x = 0 = .333 T_{DE} - .333 T_{BC} + A_x \Rightarrow A_x = 3.61$$

$$\sum M_z = 0 = -2.67 T_{DE} + 2 T_{BC} + 0 + 0 = 0$$

$$\sum F_y = 0 = -0.667 T_{DE} - 0.667 T_{BC} + A_y \Rightarrow A_y = 50 \text{ lb}$$

$$T_{BC} = 42.9 \text{ lb}$$

$$\sum M_x = 0 = 1.334 T_{DE} + 1.334 T_{BC} - 100 + M_x + 0$$

$$T_{DE} = 32.1 \text{ lb}$$

$$M_x = 0$$

$$\sum M_y = 0 = -2 T_{DE} + 1.335 T_{BC} + 25 + M_y + 0$$

$$M_y = -17.9 \text{ ft-lb}$$

$$\vec{A} = [3.6 \ 50 \ 0] \text{ lb}$$

$$\vec{M}_A = [0 \ -17.9 \ 0] \text{ ft-lb}$$