PROB. 4.116

SOLVE 4.115 ASSUMING EF IS REPLACED BY EH.

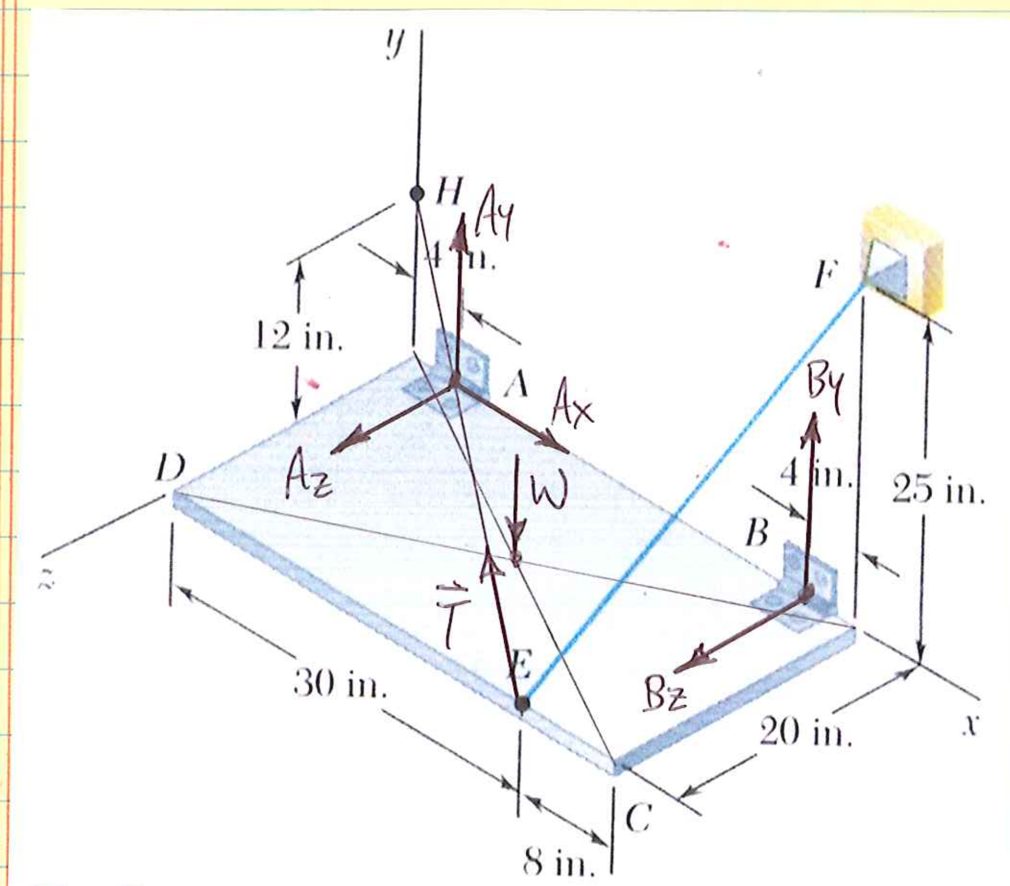

Fig. P4.115

LOCATE POINTS: $A(4,0,0)^{IN}$, $B(34,0,0)^{IN}$,

$E(30,0,20)^{IN}$, $CG(19,0,10)^{IN}$, $H(0,12,0)^{IN}$

DEFINE FORCE VECTORS:

$$\vec{A} = (A_x)\hat{i} + (A_y)\hat{j} + (A_z)\hat{k} \; ^{LB}$$

PROB. 4.116 CONT.

$\vec{B} = (B_y)\hat{j} + (B_z)\hat{k}$ LB

$\vec{W} = (-75)\hat{j}$ LB

$\vec{T}$: $dx = X_H - X_E = 0 - 30 = -30$ IN

$dy = Y_H - Y_E = 12 - 0 = 12$ IN

$dz = Z_H - Z_E = 0 - 20 = -20$ IN

$d = \sqrt{30^2 + 12^2 + 20^2} = 38$ IN

$T_x = T\frac{dx}{d} = T\left(\frac{-30}{38}\right) = -0.789\,T$

$T_y = T\frac{dy}{d} = T\left(\frac{12}{38}\right) = 0.316\,T$

$T_z = T\frac{dz}{d} = T\left(\frac{-20}{38}\right) = -0.526\,T$

$\vec{T} = (-0.789\,T)\hat{i} + (0.316\,T)\hat{j} + (-0.526\,T)\hat{k}$ LB

SOLVE FOR $\vec{T}$ DIRECTLY BY SETTING $\vec{M}_0 \cdot \hat{i} = 0$

$\vec{M}_0 = \vec{r}_{CG} \times \vec{W} + \vec{r}_E \times \vec{T}$

$\vec{r}_{CG} = (19)\hat{i} + (10)\hat{k}$ IN, $\vec{r}_E = (30)\hat{i} + (20)\hat{k}$ IN

PROB. 4.116 CONT.

$$\vec{r}_{CG} \times \vec{W} = \begin{vmatrix} \hat{i} & \hat{j} & \hat{k} \\ 19 & 0 & 0 \\ 0 & -75 & 0 \end{vmatrix}$$

$$= [0 - (10)(-75)]\hat{i} - [0]\hat{j} + [(19)(75) - 0]\hat{k}$$

$$= (750)\hat{i} + (-1425)\hat{k} \text{ IN.}\cdot\text{LB}$$

$$\vec{r}_E \times \vec{T} = \begin{vmatrix} \hat{i} & \hat{j} & \hat{k} \\ 30 & 0 & 20 \\ -0.789T & 0.316T & -0.526T \end{vmatrix}$$

$$= [0 - (20)(0.316T)]\hat{i} - [(30)(-0.526T) - (20)(-0.789T)]\hat{j}$$

$$+ [(30)(0.316T) - 0]\hat{k}$$

$$= (-6.32T)\hat{i} + (9.48T)\hat{k} \text{ IN.}\cdot\text{LB}$$

$$\vec{M}_O = (750 - 6.32T)\hat{i} + (-1425 + 9.48T)\hat{k} \text{ IN.}\cdot\text{LB}$$

$$\vec{M}_O \cdot \hat{i} = 750 - 6.32T = 0 \Rightarrow \underline{T = 118.7 \text{ LB}}$$

$$\vec{T} = [-0.789(118.7)]\hat{i} + [0.316(118.7)]\hat{j}$$

$$+ [-0.526(118.7)]\hat{k}$$

PROB. 4.116 CONT. ④

$\vec{T} = (-93.6)\hat{i} + (37.5)\hat{j} + (-62.4)\hat{k}$ LB

$\Sigma F_x = 0: \quad A_x - 93.6 = 0 \Rightarrow \underline{A_x = 93.6}$ LB

$\Sigma F_y = 0: \quad A_y + B_y + 37.5 - 75 = 0$

$A_y = -B_y + 37.5$ ①

$\Sigma F_z = 0: \quad A_z + B_z - 62.4 = 0$

$A_z = -B_z + 62.4$ ②

$\Sigma \vec{M}_A = \vec{r}_{ACG} \times \vec{W} + \vec{r}_{AE} \times \vec{T} + \vec{r}_{AB} \times \vec{B} = 0$

POSITION VECTORS:

$\vec{r}_{ACG}: \; dx = X_{CG} - X_A = 19 - 4 = 15$ IN

$dy = Y_{CG} - Y_A = 0$

$dz = Z_{CG} - Z_A = 10 - 0 = 10$ IN

$\vec{r}_{ACG} = (15)\hat{i} + (10)\hat{k}$ IN

$\vec{r}_{AE}: \; dx = X_E - X_A = 30 - 4 = 26$ IN

$d_y = Y_E - Y_A = 0$

$d_z = Z_E - Z_A = 20 - 0 = 20^{IN}$

$\vec{r}_{AE} = (26)\hat{i} + (20)\hat{k}^{\ IN}$

$\vec{r}_{AB}$: $d_x = X_B - X_A = 34 - 4 = 30^{IN}$, $d_y = 0$, $d_z = 0$

$\vec{r}_{AB} = (30)\hat{i}^{\ IN}$

$$\vec{r}_{ACG} \times \vec{W} = \begin{vmatrix} \hat{i} & \hat{j} & \hat{k} \\ 15 & 0 & 10 \\ 0 & -75 & 0 \end{vmatrix}$$

$= [0 - (10)(-75)]\hat{i} - [0]\hat{j} + [(15)(-75) - 0]\hat{k}$

$= (750)\hat{i} + (-1125)\hat{k}^{\ IN \cdot LB}$

$$\vec{r}_{AE} \times \vec{T} = \begin{vmatrix} \hat{i} & \hat{j} & \hat{k} \\ 26 & 0 & 20 \\ -93.6 & 37.5 & -62.4 \end{vmatrix}$$

$= [0 - (20)(37.5)]\hat{i} - [(26)(-62.4) - (20)(-93.6)]\hat{j}$

$+ [(26)(37.5) - 0]\hat{k}$

$$\vec{r}_{AE} \times \vec{T} = (-750)\hat{i} + (-250)\hat{j} + (975)\hat{k} \text{ IN.LB}$$

$$\vec{r}_{AB} \times \vec{B} = \begin{vmatrix} \hat{i} & \hat{j} & \hat{k} \\ 30 & 0 & 0 \\ 0 & B_y & B_z \end{vmatrix}$$

$$= [0]\hat{i} - [(30)B_z - 0]\hat{j} + [(30)B_y - 0]\hat{k}$$

$$= (-30B_z)\hat{j} + (30B_y)\hat{k}$$

$$\vec{M}_A = (750 - 750)\hat{i} + (-250 - 30B_z)\hat{j}$$

$$+ (-1125 + 975 + 30B_y)\hat{k} = 0$$

$$\underline{B_z} = \left(\frac{-250}{30}\right) = \underline{-8.33 \text{ LB}}$$

$$\underline{B_y} = \frac{1}{30}(1125 - 975) = \underline{5 \text{ LB}}$$

① : $\underline{A_y} = -(5) + 37.5 = \underline{32.5 \text{ LB}}$

② : $\underline{A_z} = -(-8.33) + 62.4 = \underline{70.7 \text{ LB}}$

$$\underline{\vec{A} = (93.6)\hat{i} + (32.5)\hat{j} + (70.7)\hat{k} \text{ LB}}$$

$$\underline{\vec{B} = (5)\hat{j} + (-8.33)\hat{k} \text{ LB}}$$