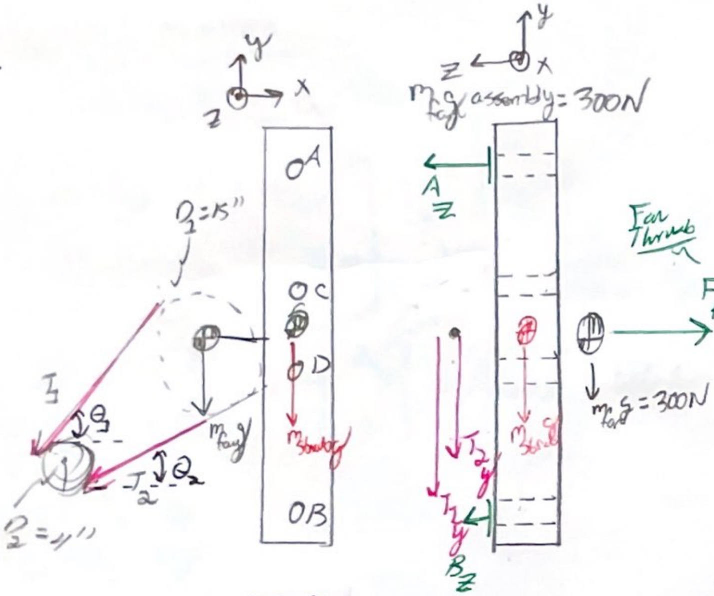
Static Analysis



Each Pin has rxns in x, y:

Unknowns: A_x B_x C_x D_x
A_y B_y C_y D_y

① $\Sigma F_x = A_x + C_x + D_x + B_x - T_2\cos\theta_2 - T_1\cos\theta_2 = 0$

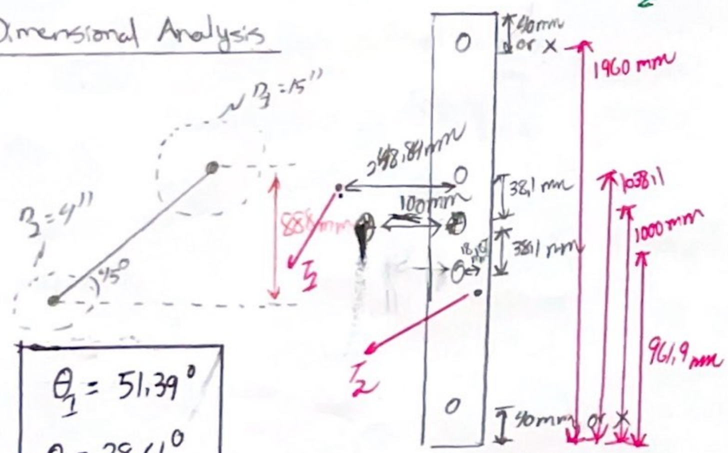
② $\Sigma F_y = A_y + C_y + D_y + B_y - T_2\sin\theta_2 - T_1\sin\theta_1 - m_{fan}g - m_{strut}g = 0$

③ $\Sigma F_z = A_z + B_z - F_{fan} = 0$ Saint-Venant's Principle ↳ Let's treat the strut as a simply-supported beam in z axis loading.

④ $\Sigma M_B^z = (m_{fan}g)(100) + (T_1\sin\theta_1)(248.84) - (T_2\sin\theta_2)(18.87)$
$+ (D_x)(961.9) + (C_x)(1038.1) - (A_x)(1960) + (T_1\cos\theta_1)(118.87)$
$+ (T_2\cos\theta_2)(851.16) = 0$

⑤ $\Sigma M^x_{cg\,fan} = (T_1\sin\theta_1 + T_2\sin\theta_2)(125.4) - (A_y + B_y + C_y + D_y + m_{strut}g)(74.6) = 0$

Dimensional Analysis



$\boxed{\theta_1 = 51.39° \quad \theta_2 = 38.61°}$

Requirement 10 Assumptions:	$C_y = D_y$
	$A_y = B_y$

② + ⑤

$2A_y + 2C_y - T_2\sin\theta_2 - T_1\sin\theta_1 - m_{fan}g - m_{strut}g = 0$
$(2A_y + 2C_y + m_{strut}g)(74.6) - (T_1\sin\theta_1 + T_2\sin\theta_2)(125.4) = 0$
} 2 eq, 2 unknowns A_y, C_y

Also Applying Requirement 10 with torsional loads (torques) Saint-Venant's Principle → Let's look at the local area around the fan support box and assume Pins C & D absorb the x-axis tension loads,

$\tau_{y,\,bolt} = (T_1\cos\theta_1 + T_2\cos\theta_2)(508) - (F_{fan})(100) - (C_x - D_x)(76.2) = 0$
$C_x + B_x = T_1\cos\theta_1 + T_2\cos\theta_2$
} 2 eq, 2 unknowns C_x, D_x

→ Can now find A_x, B_x by plugging back into ① & ④

Static Equilibrium Matrices

② & ③ → Finds A_y, B_y, C_y, D_y

$$bVector = \begin{bmatrix} T_{1y} + T_{2y} + W_{fan} + W_{strut} \\ 125.4T_{1y} + 125.4T_{2y} - 74.6W_{strut} \end{bmatrix}$$ Linearly Independent

$$AMatrix = \begin{bmatrix} 2 & 2 \\ 149.2 & 149.2 \end{bmatrix} \quad x = \begin{bmatrix} A_y \\ C_y \end{bmatrix} = A_{matrix} \backslash bVector$$

Cannot Do This Calc

updated Version

$$2A_y = 2C_y + W_{strut}$$

$$2A_y - 2C_y = W_{strut}$$

$$2C_y = W_{fan} + T_{1y} + T_{2y}$$

$$bVector = \begin{bmatrix} W_{strut} \\ W_{fan} + T_{1y} + T_{2y} \end{bmatrix}$$

$$A_{matrix} = \begin{bmatrix} 2 & -2 \\ 0 & 2 \end{bmatrix}$$

Requirement 10 → $A_y = B_y$
$C_y = D_y$

Torsion/Torque Equation → Finds C_x, D_x

$$bVector = \begin{bmatrix} -50.8T_{1x} - 50.8T_{2x} + 100F_{fan} \\ T_{1x} + T_{2x} \end{bmatrix}$$

$$AMatrix = \begin{bmatrix} -76.2 & 76.2 \\ 1 & 1 \end{bmatrix} \quad x = \begin{bmatrix} C_x \\ D_x \end{bmatrix} = A_{matrix} \backslash bVector$$

① & ④ → Finds A_x, B_x

$$bVector = \begin{bmatrix} T_{1x} + T_{2x} - C_x - D_x \\ -248.84T_{1y} + 18.87T_{2y} + 961.9D_x + 1038.1C_x - 118.87T_{1x} - 851.16T_{2x} - 100W_{fan} \end{bmatrix}$$

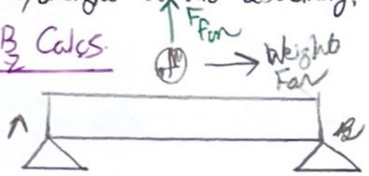
$$A_{matrix} = \begin{bmatrix} 1 & 1 \\ -1960 & 0 \end{bmatrix} \quad x = \begin{bmatrix} A_x \\ B_x \end{bmatrix} = A_{matrix} \backslash bVector$$

Z-Axis Pin Reactions

Modeling Assumptions: (Global Loading Assumption)

Pin reactions A_z & B_z are simply supported beam reactions which act against Fan Thrust Load & mass/weight of fan assembly.

A_z & B_z Calcs.



$$bVector = \begin{bmatrix} 960\,F_{fan} + 74.6\,W_{fan} \\ F_{fan} \end{bmatrix}$$

$$AMatrix = \begin{bmatrix} 1 & 0 \\ 1 & 1 \end{bmatrix}$$

$$\Sigma M_B = (A_z)(1920) - (F_{fan})(1000-40) - (W_{fan})(74.6)$$

$$1920 A_z = (F_{fan})(960) + (W_{fan})(74.6)$$

$$A_z + B_z = F_{fan}$$

Modeling Assumptions: (Localized Loading Assumption)

Pin reactions C_z & D_z are calculated using ΣF & ΣM for the internal fan support box system. **C_z & D_z Calcs**

$$\Sigma F = C_z + D_z - F_{fan} = 0$$

$$bVector = \begin{bmatrix} F_{fan} \\ 38.1 F_{fan} + 74.6 W_{fan} - 125.4 I_{1y} - 125.4 I_{2y} \end{bmatrix}$$

$$C_z + D_z = F_{fan}$$

$$\Sigma M_D = (D_z)(76.2) - (F_{fan})(38.1) - (W_{fan})(74.6) + (I_{1y} + I_{2y})(125.4) = 0$$

$$76.2 D_z = 38.1 F_{fan} + 74.6 W_{fan} - 125.4(I_{1y} + I_{2y})$$

$$Amatrix = \begin{bmatrix} 1 & 1 \\ 0 & 76.2 \end{bmatrix}$$

Pulley Dimensions