Announcements

- **Office Hours:**
  - Office hour today (2/20) ends at 3:30pm
  - Quiz 3 starts tomorrow (Thursday, Feb. 21)!

- Upcoming deadlines:
  - Friday (2/22)
    - Written Assignment
  - Tuesday (2/16)
    - PL HW
Objectives

• 3D Support Reactions – Example

• Two-force members

• Structural analysis introduction
Calculate the reaction forces at the support.

The components of moment support at D can be expressed with a single vector \( \overrightarrow{M}_{\text{support}} \).

\[ F_E = 6000 \text{ lb}, \quad 6.75 \text{ in.} \]

\[ F_E = 1500 \text{ lb}, \quad 2.4 \text{ in.} \]

\[ P_{x} = M_{x} + H_{x} + M_{y} \]

\[ E_{\text{FX}} (\text{forces}) \]

\[ \Sigma F_x = 5000 \left( \frac{1.75}{\text{in}} \right) + D_x = 0 \]

\[ \Sigma F_y = -500 \left( \frac{2.4}{\text{in}} \right) + D_y = 0 \]

\[ \Sigma F_z = -6000 + D_z = 0 \]

\[ \Sigma M_{F} = \overrightarrow{P_{x}} \times \overrightarrow{F_{x}} + \overrightarrow{P_{z}} \times \overrightarrow{F_{z}} + \overrightarrow{M}_{\text{prop}} = 0 \]

\[ \overrightarrow{P_{x}} \times \overrightarrow{F_{x}} = \begin{bmatrix} 3.25 & 6 & 0 \\ 140 & -650 & 0 \end{bmatrix} = -2400 \hat{k} \text{ in} \]

\[ \overrightarrow{P_{z}} \times \overrightarrow{F_{z}} = \begin{bmatrix} 0 & 4 & 1.2 \\ 0 & 0 & -6000 \end{bmatrix} = -2400 \hat{k} \text{ in} \]

\[ \Sigma M_{px} = M_{x} + 2400 \text{ lb-in} = 0 \rightarrow M_{x} = 2400 \text{ lb-in} \]

\[ \Sigma M_{py} = M_{y} = 0 \]

\[ \Sigma M_{pz} = M_{z} + 2400 \text{ lb-in} = 0 \rightarrow M_{z} = 2400 \text{ lb-in} \]
The 50-lb mulching has a center of gravity at \( G \). Determine the vertical reactions at the smooth contact point \( A \).

**Strategy:** use moment equation about an axis.

\[
\sum M_y = 0 = \vec{r}_i \times \vec{W} + \vec{r}_A \times \vec{A}
\]

\( \vec{r}_i = 2 \, \text{ft} \)
\( \vec{r}_A = 3.5 \, \text{ft} \)
\( \vec{W} = -50 \, \text{lb} \)
\( \vec{A} = A \, \hat{k} \)

\[
A = \frac{100}{3.5} \, \text{lb}
\]
Two-force members

In the cases above, members AB can be considered as two-force members, provided that their weight is neglected.

The two forces must align with the line that connects the two locations where the forces are applied.

These 2 forces cannot form a couple moment if equilibrium were to be maintained.
Find the support reactions at A, given the force applied at the cage, P, is 300 lb.

Member BC is a 2-force member, so the pin joint at C has a support force with known direction, but unknown magnitude.
Three-force members

As the name implies, three-force members have forces applied at only three points.

Moment equilibrium can be satisfied only if the three forces are concurrent or parallel force system.

- If 2 are parallel, the third must be parallel as well.
- Cannot have multiple intersections of force lines of action.

Single intersection of lines of action from all 3 F.
Examples

Not a 3-force member, so it won’t follow the rules for 3-force members. (It has a moment support at A)