Printout

Wednesday, February 20, 2019 7:43 AM

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

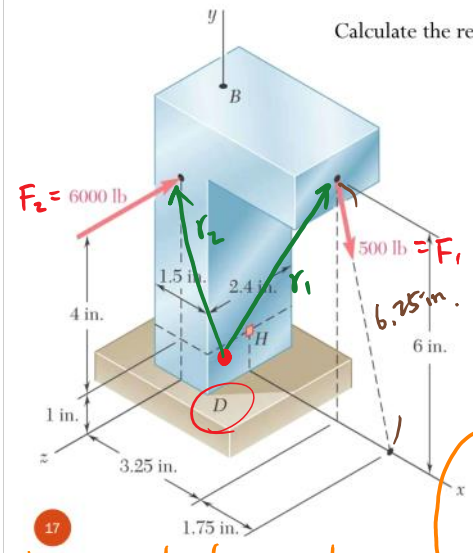
1

Objectives

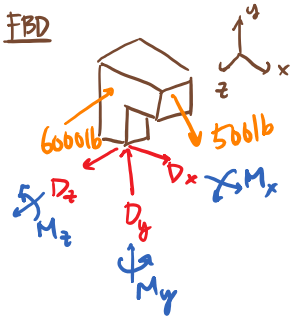
- 3D Support Reactions – Example
- Two-force members
- Structural analysis introduction

2

Calculate the reaction forces at the support.



FBD



$\vec{M}_{support} = M_x\hat{i} + M_y\hat{j} + M_z\hat{k}$

EoE (forces)

$\Sigma F_x = 500\left(\frac{1.75}{\sqrt{1.75^2+6^2}}\right) + D_x = 0$

$\Sigma F_y = -500\left(\frac{6}{\sqrt{1.75^2+6^2}}\right) + D_y = 0$

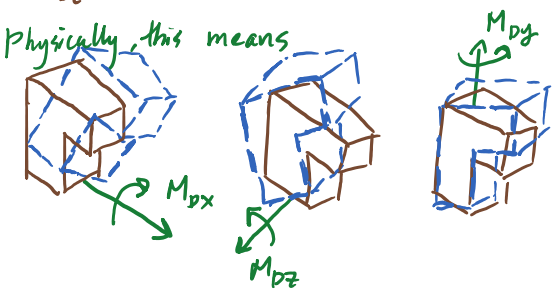
$\Sigma F_z = -6000 + D_z = 0$

The components of moment support at D can be expressed with a single vector, $\vec{M}_{support}$

EoE (moments)

$\Sigma M_{Dx} = 0$
$\Sigma M_{Dy} = 0$ or $\Sigma \vec{M}_D = 0$.
$\Sigma M_{Dz} = 0$

Physically, this means



$\Sigma \vec{M}_D = \vec{r}_1 \times \vec{F}_1 + \vec{r}_2 \times \vec{F}_2 + \vec{M}_{support} = 0$

$$\vec{r}_1 \times \vec{F}_1 = \begin{vmatrix} \hat{i} & \hat{j} & \hat{k} \\ 3.25 & 6 & 0 \\ 140 & -450 & 0 \end{vmatrix} = -2400\,\hat{k}\ \text{lb}\cdot\text{in}$$

$$\vec{r}_2 \times \vec{F}_2 = \begin{vmatrix} \hat{i} & \hat{j} & \hat{k} \\ 0 & 4 & 1.2 \\ 0 & 0 & -6000 \end{vmatrix} = -2400\,\hat{i}\ \text{lb}\cdot\text{in}$$

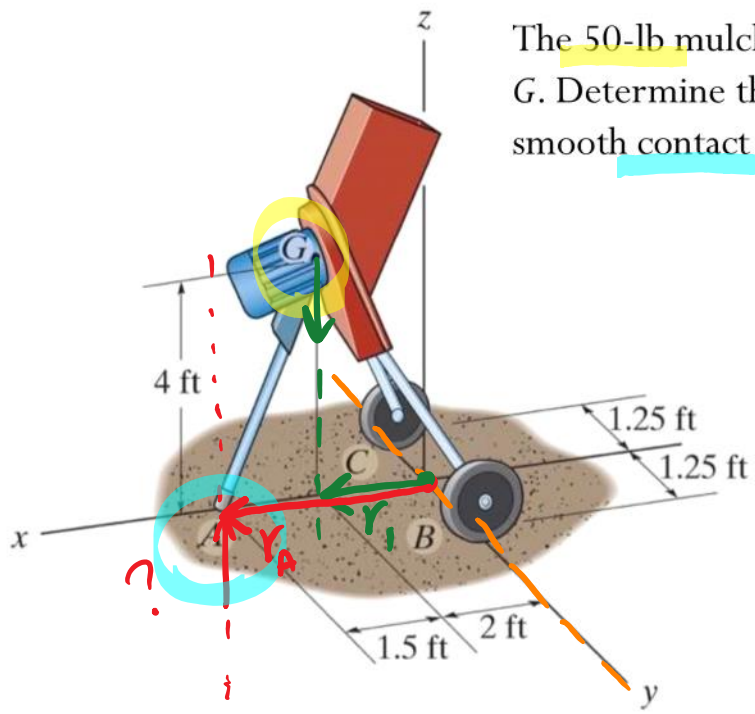
from fixed support

$\Sigma M_{Dx} = M_x - 2400\ \text{lb}\cdot\text{in} = 0 \rightarrow M_x = 2400\ \text{lb}\cdot\text{in}$

$\Sigma M_{Dy} = M_y = 0$

$\Sigma M_{Dz} = M_z - 2400\ \text{lb}\cdot\text{in} = 0 \rightarrow M_z = 2400\ \text{lb}\cdot\text{in}$

The 50-lb mulching has a center of gravity at G. Determine the vertical reactions at the smooth contact point A.



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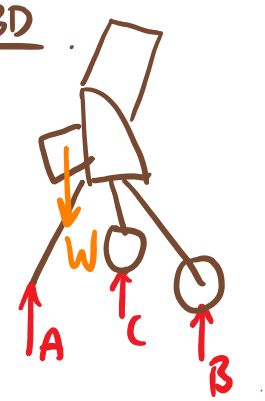


EoE

- 6 total

$\Sigma F_x = 0$

Strategy: use moment equation about an axis.

EoE

3

$\Sigma M_y = 0 = \vec{r}_1 \times \vec{W} + \vec{r}_A \times \vec{A}$

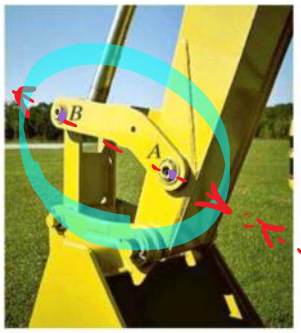
$= 100 \text{ lb}\cdot\text{ft}\,\hat{j} - 3.5A\,\hat{j}$

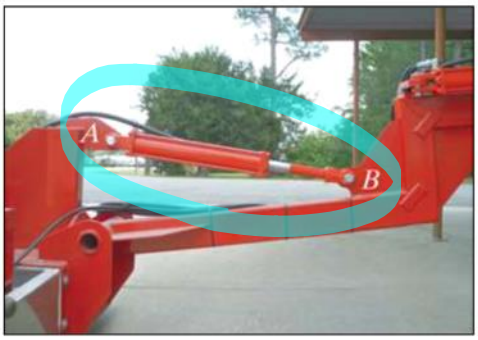
$\vec{r}_1 = 2\hat{i}$ ft $\quad \vec{r}_A = 3.5\hat{i}$ ft

$\vec{W} = -50\hat{k}$ lb $\quad \vec{A} = A\hat{k}$

$$\boxed{A = \frac{100}{3.5} \text{ lb}}$$

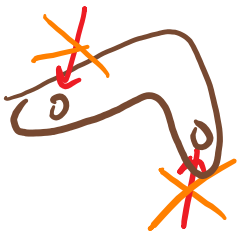
Two-force members





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

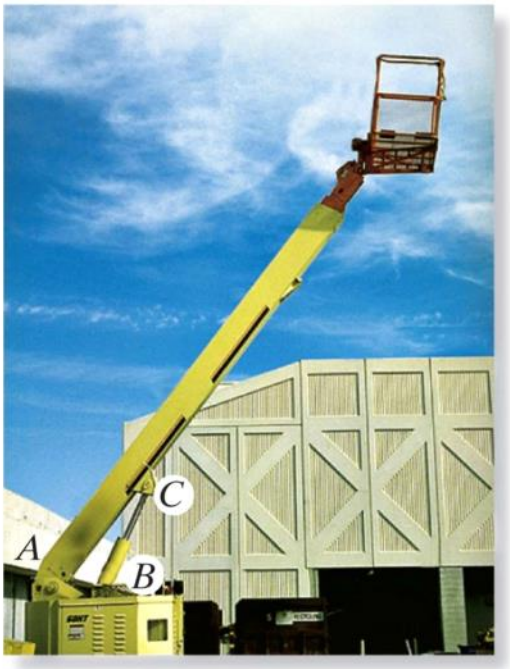
The two forces must align with the line that connects the two locations where the forces are applied.

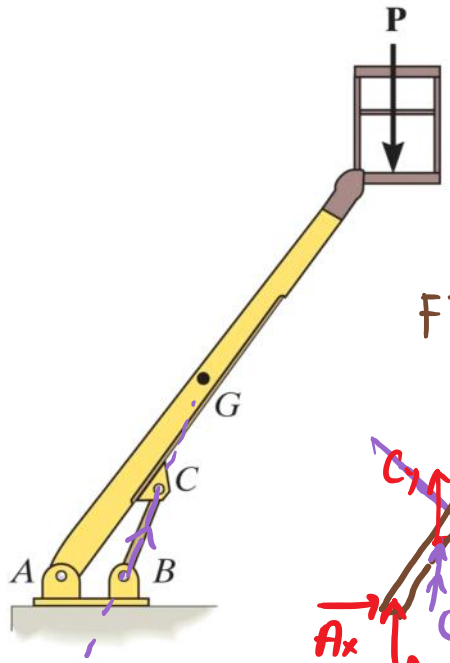


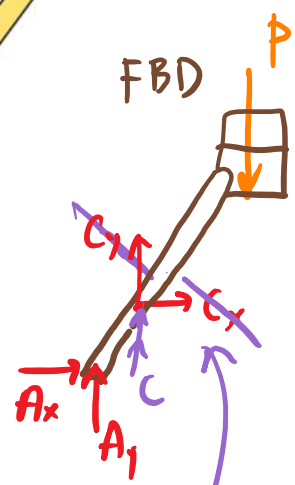
These 2 forces cannot form a couple moment if equilibrium were to maintained.

5

Find the support reactions at A, given the force applied at the cage, **P**, is 300 lb.







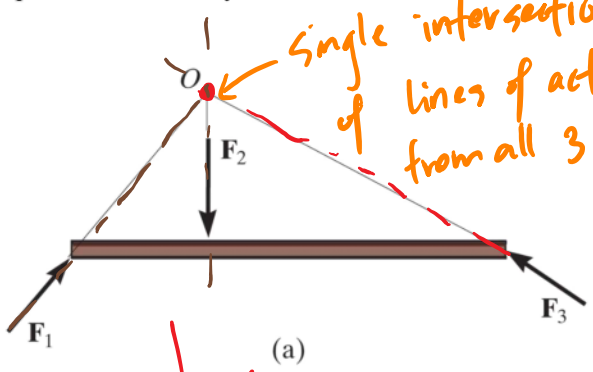
6

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

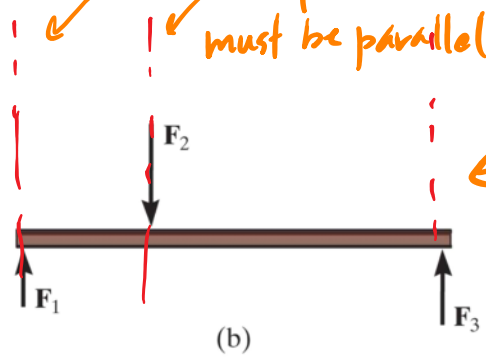
Three-force members

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

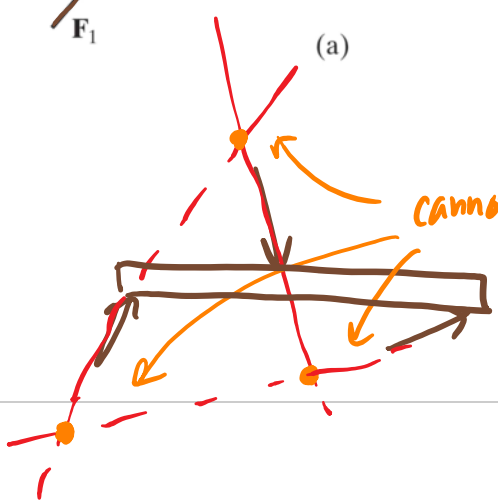


Single intersection of lines of action from all 3 F.



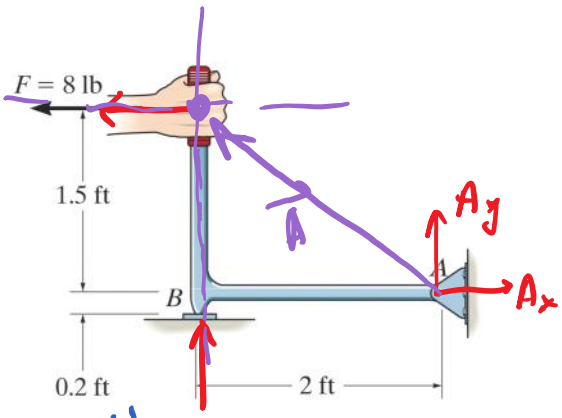
If 2 are parallel, the third must be parallel as well.

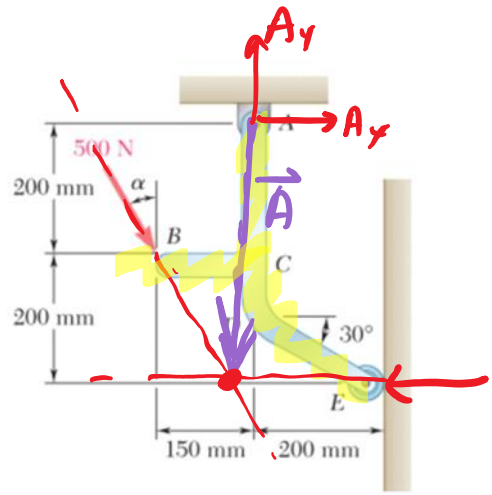
Three-force member

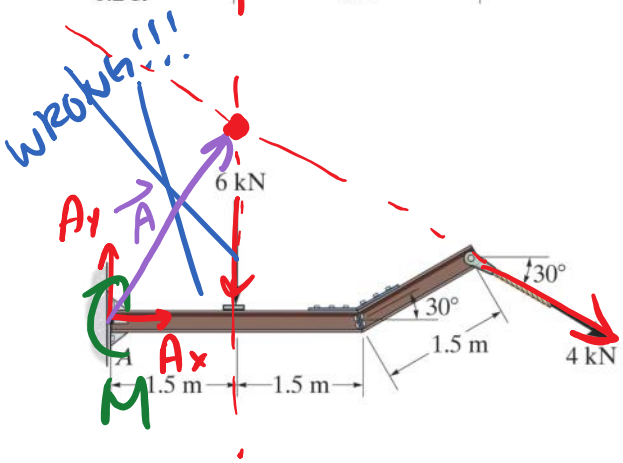


cannot have multiple intersections of force lines of action.

Examples







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