Announcements

- Frame tutorial by Professor Kersh on Course Schedule
- No 10-11am office Wed (10/17) – email for appointment
- Come to office hours and talk to a staff team member in person for quiz concept related issues

- Upcoming deadlines:
  - Tuesday (10/16)
    - PL HW & Study Consent Form
  - Friday (10/19)
    - Written Assignment
Objectives

- Frame and Machines Example

- Internal Loadings
  - Determine the internal loadings in members using the method of sections
**Given:** The wall crane supports an external load of 700 lb.

**Find:** The force in the cable at winch motor $W$.

- ID pulley $E$ as the member to do analysis to find $T$.

\[ \sum F_y = 0 = 2T - 700 \text{lb} = 0 \]

\[ \Rightarrow T = 350 \text{lb} \]
**Given:** The wall crane supports an external load of 700 lb.

**Find:** The pin reactions at $A$ on beam $ABC$. 

Use beam $ABC$. 

FBD 1

No given parameters

FBD 2 (include pin B)

FBD 3 (include pin C)

$E_oE_2$ (solve for $B_x, B_y$)

$E_oE_3$

$\Sigma F_x = -T - C_x = 0$

$\Sigma F_y = -C_y - T - T = 0$

$\Rightarrow C_x = -T, \ C_y = -2T.$

$E_oE_1$

$\Sigma F_x = A_x + B_x + C_x = 0, \ \Sigma F_y = A_y + B_y + C_y = 0$
\[ \Sigma F_x = A_x + B_x + C_x = 0, \quad \Sigma F_y = A_y + B_y + C_y = 0 \]
\[ \Sigma M_A = B_y(4ft) + C_y(8ft) = 0 \]

- Substitute in \( B_x, B_y, C_x, C_y \) from 2 & 3

\[
\begin{align*}
\Sigma F_x &= A_x + \frac{1}{2}T - F_{BD} \cos 45^\circ - T = 0 \\
\Sigma F_y &= A_y + F_{BD} \sin 45^\circ - T \sin 60^\circ - 2T = 0 \\
\Sigma M_A &= (F_{BD} \sin 45^\circ - T \sin 60^\circ)(4ft) + (-2T)(8ft) = 0
\end{align*}
\]

\[ \Rightarrow F_{BD} = 8T + T \sin 60^\circ = T(8 + \sin 60^\circ) \]

~ force on 2-force member BD.

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**Alternative FBD for ABC (with pins in)**

**Alternative FBD for pulley wheel C**

* Note: if pin is include in one body (e.g. ABC), do not include it in its counterpart (e.g. wheel C)

**Alternative FBD for ABC + pulleys (+ pins)**
Internal Loadings
Internal loadings developed in structural members

Beams are structural members designed to support loads applied perpendicularly to their axes.

Beams can be used to support the span of bridges. They are often thicker at the supports than at the center of the span.

Why are the beams tapered? Internal forces are important in making such a design decision.
Internal loadings developed in structural members

A fixed column supports these rectangular billboards.

Usually such columns are wider/thicker at the bottom than at the top. Why?
Internal loadings developed in structural members
Internal loadings developed in structural members

Structural Design: need to know the loading acting within the member in order to be sure the material can resist this loading.

**Cutting** members at internal points reveal **internal forces and moments**.

3 internal loading components:

1.) Normal Force

![Normal Force Diagram]

2.) Shear Force

![Shear Force Diagram]

3.) Bending Moment

![Bending Moment Diagram]