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

1

Monday, October 15, 2018 11:16 AM

Objectives

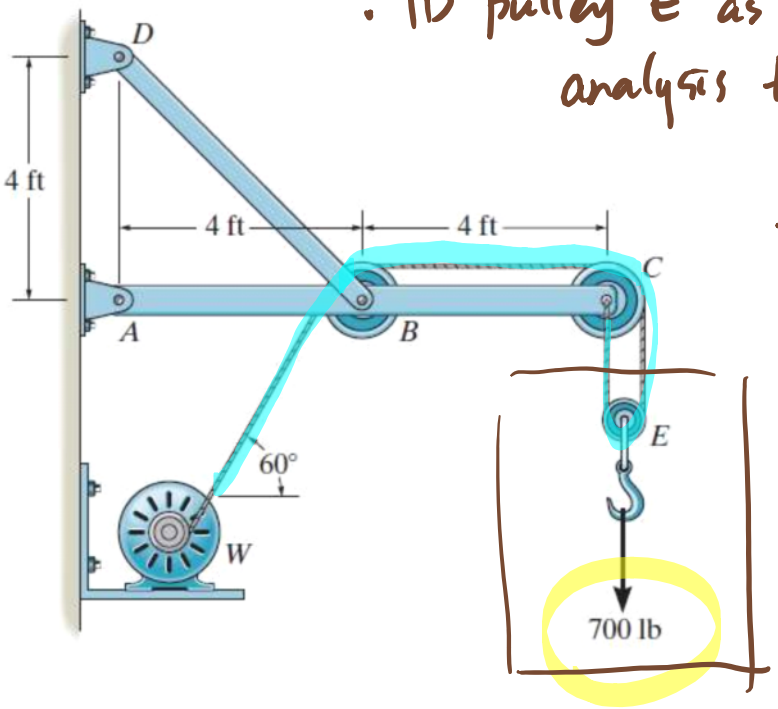
- Frame and Machines Example
- Internal Loadings
  - Determine the internal loadings in members using the method of sections

2

Monday, October 15, 2018 11:16 AM

Given: The wall crane supports an external load of 700 lb.

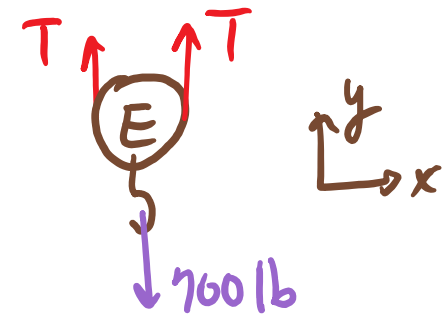
Find: The force in the cable at winch motor *W*.



3

- 1D pulley E as the member to do analysis to find T

FBD



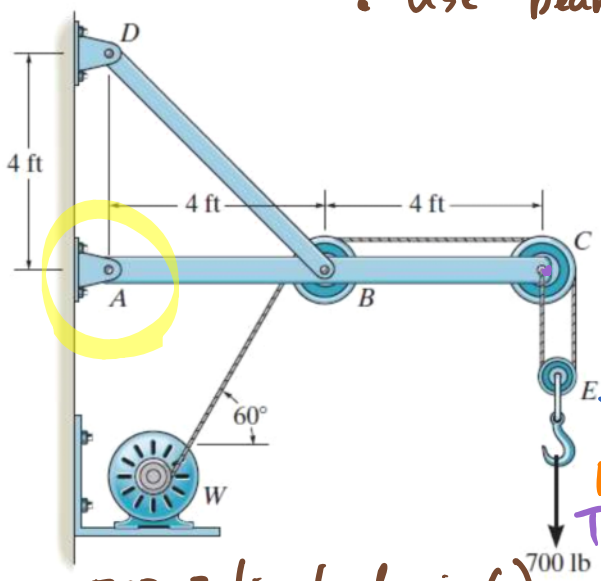
EoE

$\Sigma F_y = 0 = 2T - 700\,lb = 0$

$\rightarrow \boxed{T = 350\,lb}$

Given: The wall crane supports an external load of 700 lb.

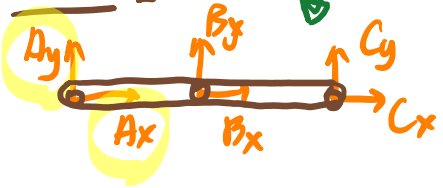
Find: The pin reactions at A on beam ABC.



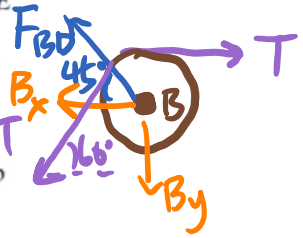
• Use beam ABC.

No given parameters

FBD 1

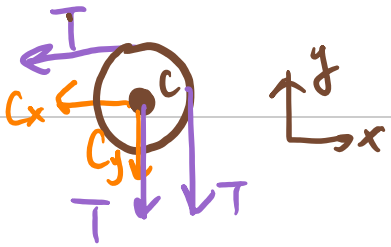


FBD 2 (include pin B)



F_{BD}: from 2-force member BD.

FBD 3 (include pin C)



EoE 3

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

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

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

EoE 2 (solve for B_x, B_y)

$$\Sigma F_x = T - B_x - T\cos 60° - F_{BD}\cos 45° = 0$$

$$\Sigma F_y = F_{BD}\sin 45° - T\sin 60° - B_y = 0$$

$$\Sigma M_B = Tr - Tr = 0$$

$$\Rightarrow \begin{cases} B_y = F_{BD}\sin 45° - T\sin 60° \\ B_x = T(\underbrace{1 - \cos 60°}_{\frac{1}{2}}) - F_{BD}\cos 45° \end{cases}$$

EoE 1

$$\Sigma F_x = A_x + B_x + C_x = 0, \qquad \Sigma F_y = A_y + B_y + C_y = 0$$

$$\Sigma F_x = A_x + B_x + C_x = 0, \quad \Sigma F_y = A_y + B_y + C_y = 0$$

$$\Sigma M_A = B_y(4\,ft) + C_y(8\,ft) = 0$$

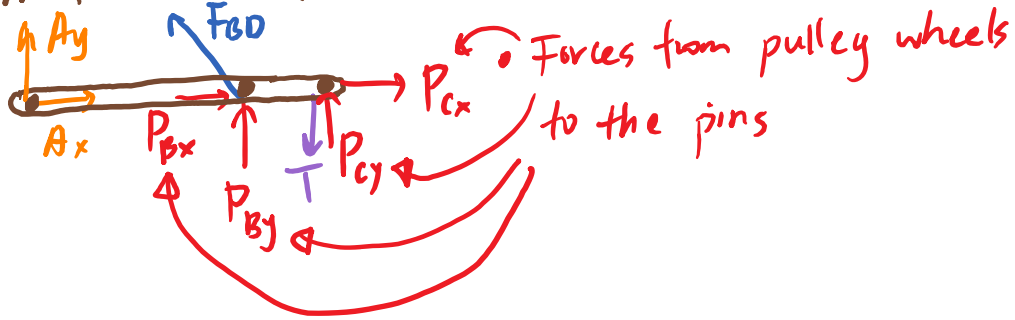
- Substitute in B_x, B_y, C_x, C_y from 2 & 3

$$\Rightarrow \begin{cases} \Sigma F_x = A_x + \frac{1}{2}T - F_{BD}\cos 45^\circ - T = 0 \\ \Sigma F_y = A_y + F_{BD}\sin 45^\circ - T\sin 60^\circ - 2T = 0 \\ \Sigma M_A = (F_{BD}\sin 45^\circ - T\sin 60^\circ)(4\,ft) + (-2T)(8\,ft) = 0 \end{cases}$$

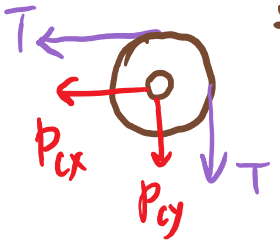
$$\Rightarrow \boxed{F_{BD} = 8T + T\sin 60^\circ = T(8 + \sin 60^\circ)}$$

~ force on 2-force member BD.

Alternative FBD for ABC (with pins in)

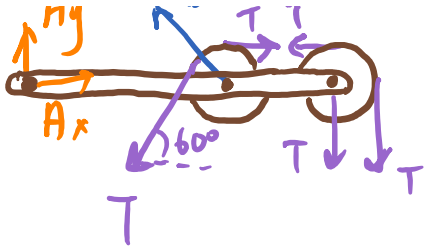


Alternative FBD for pulley wheel C



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

Alternative FBD for ABC + pulleys (+ pins)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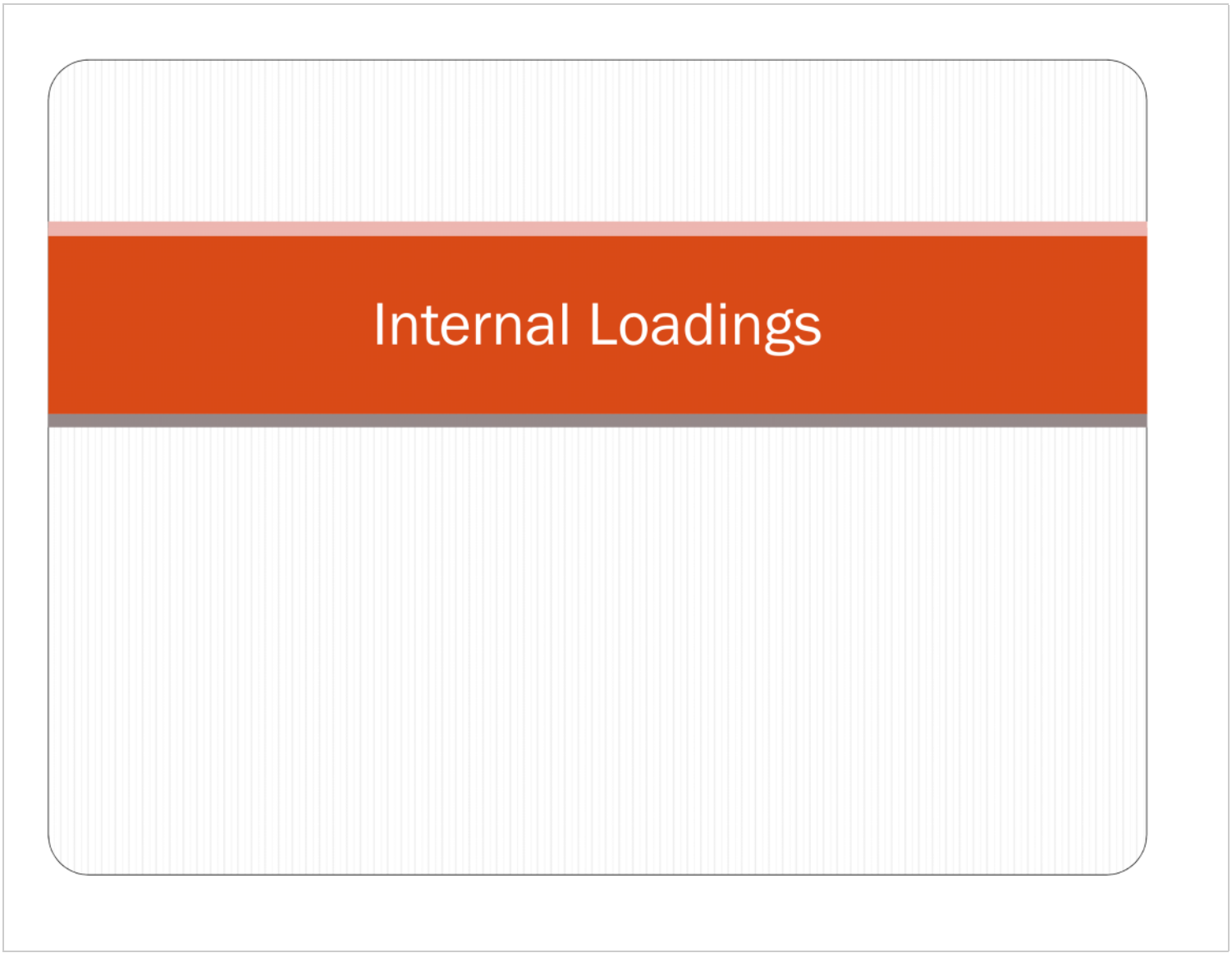

Internal Loadings

Internal loadings developed in structural members

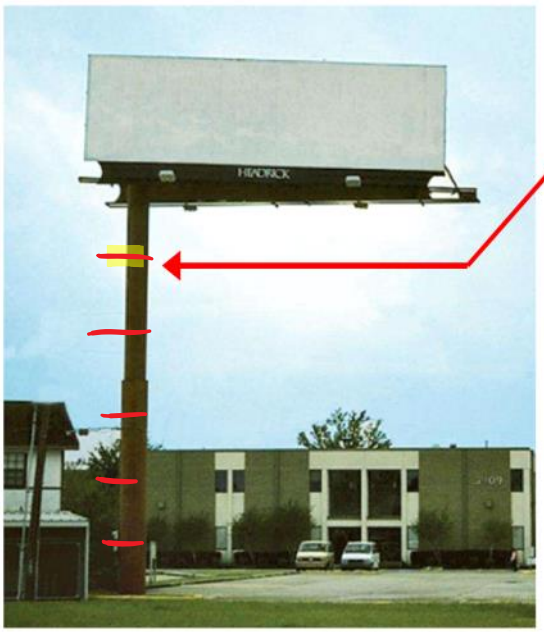
Beams are structural members designed to support loads applied perpendicularly to their axes.

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.

9

Internal loadings developed in structural members



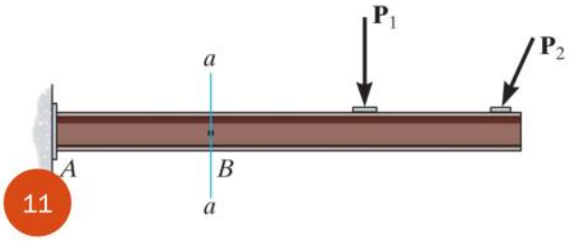
A fixed column supports these rectangular billboards.

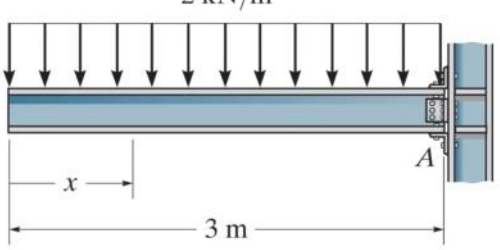
Usually such columns are wider/thicker at the bottom than at the top. Why?

10

Monday, October 15, 2018 11:16 AM

Internal loadings developed in structural members





Monday, October 15, 2018 11:16 AM

Internal loadings developed in structural members

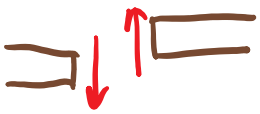
Structural Design: need to know the loading acting within the member in order to be sure the material can resist this loading

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

3 internal loading components:

1.) Normal Force

2.) Shear Force



12

3) Bending Moment