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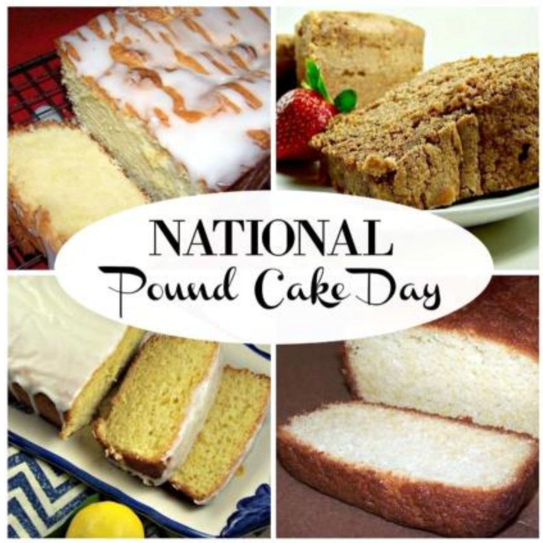
# Announcements

- Quiz 4 this week
- Frame tutorial by Professor Kersh on Course Schedule




- Upcoming deadlines:
- Tuesday (3/5)
  - PL HW
- Friday (3/8)
  - Written Assignment

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# Objectives

- Frame and Machines: Examples
- Internal Loadings
  - The method of sections

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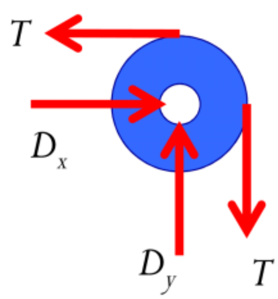
# Example

Given the weight of the cylinder is $W$, what is the loading on member $BC$ by the pulley?

Strategy: Do analysis on the pulley to relate the tension in the rope (since it will be the same as $W$) to the forces from member $BC$.

<u>FBD (A)</u>

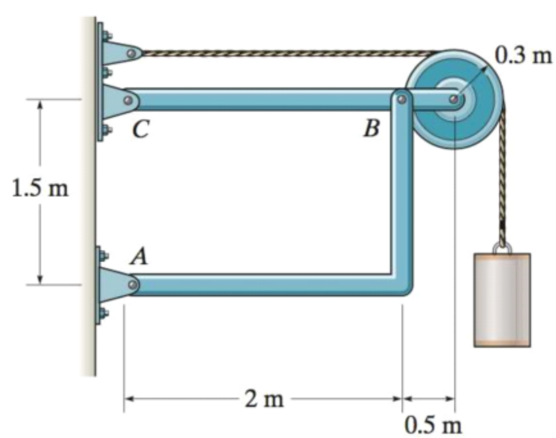



<u>EoE</u>

$$\sum F_x = D_x - T = 0$$

$$\sum F_y = D_y - T = 0$$

$$D_x = T = W$$
$$D_y = T = W$$

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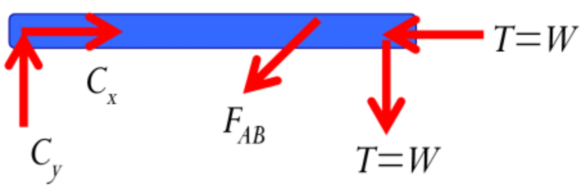
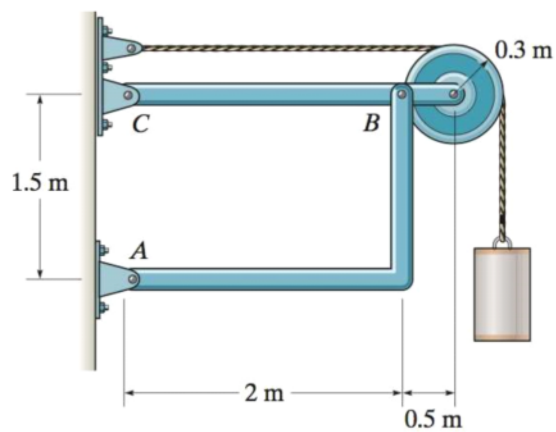
# Example

Given the weight of the cylinder is $W$, what is the loading on member $BC$ at $B$?

Strategy: Do analysis on the pulley to relate the tension in the rope (since it will be the same as $W$) to the forces from member $BC$.

FBD (C)




EoE

$$\sum M_C = -F_{AB}\left(\frac{1.5}{2.5}\right)(2\text{ m}) - T(2.5\text{ m}) = 0$$

$$F_{AB} \approx -2.08T \approx -2.08W$$

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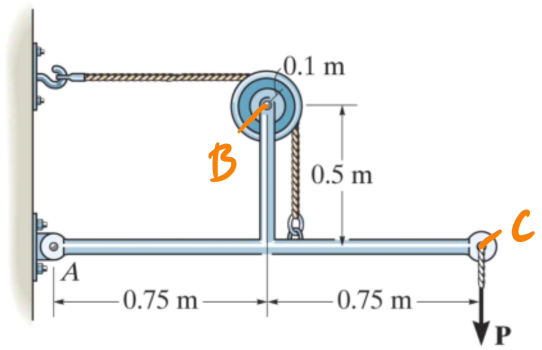



Find the force in the cable fastening the frame to the wall.

Which FBD would be the most useful?

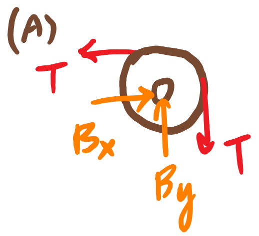
(A) The pulley (No given parameter included)

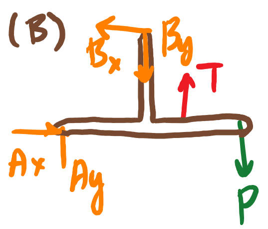
(B) The T-beam (Too many unknowns)

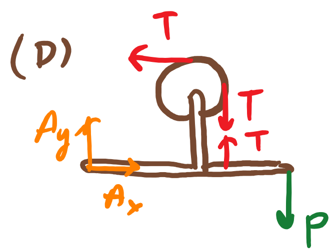
(C) The Cable

(D) T-beam + pulley

(E) None of the above




3 unknowns only : $T, A_x, A_y$

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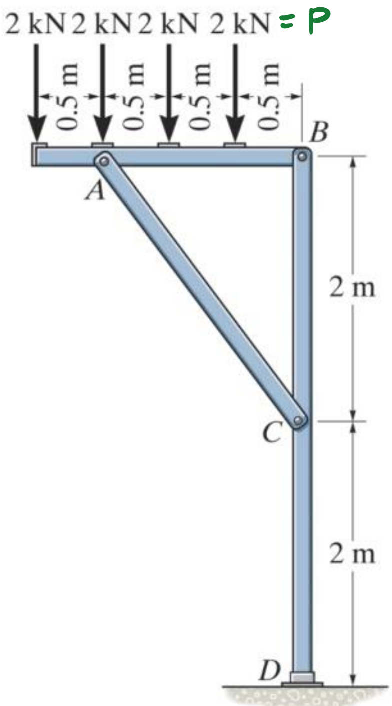



Find the force in member *AC*.

Which FBD would be the most useful?

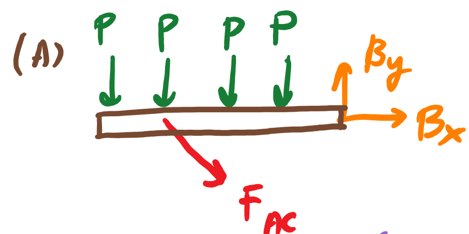
(A) Beam *AB*

(B) Beam *AC*

(C) Beam *CD*

(D) The whole assembly

(E) None of the above




(AC is a 2-force member)

→ 3 unknowns only: $F_{AC}$, $B_x$, $B_y$

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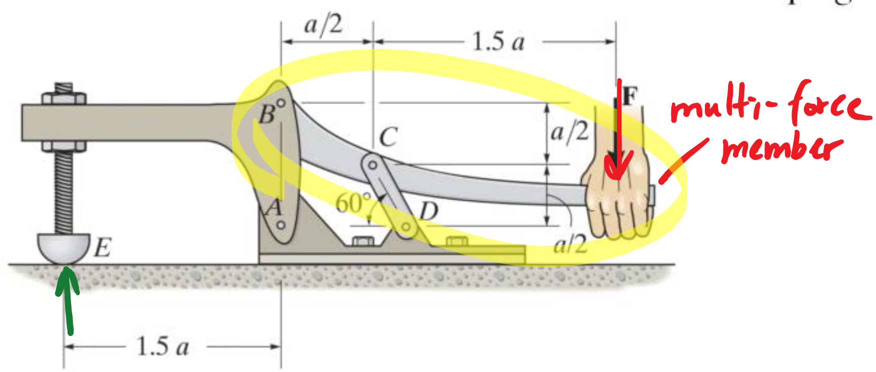
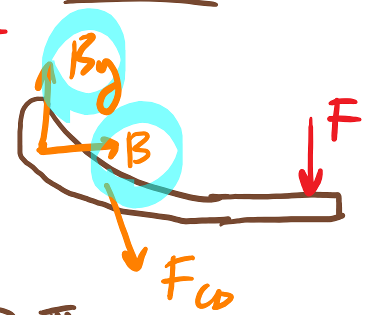
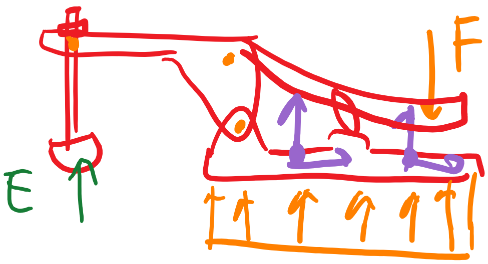
Find the clamping force at $E$.




FBD II

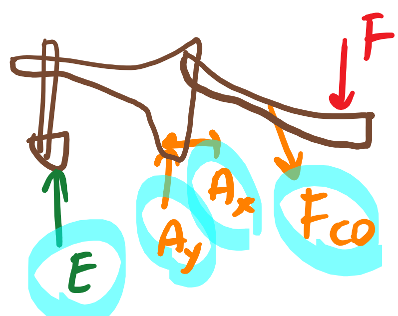



FBD I




→ too many unknowns.

FBD III




→ Between FBD II and III, there are only 6 unique unknowns, which can all be solved by using the 2 sets of 3 EoE for each FBD. (6 EoE total)

From FBD II,

$$\Sigma M_B = 0 = -\left(\frac{a}{2}\right)F_{CD}\sin 60° + \left(\frac{a}{2}\right)F_{CD}\cos 60° - (2a)F$$

$$\rightarrow F_{CD} = \frac{4F}{\cos 60° - \sin 60°}$$

From FBD III,

$$\Sigma M_A = 0 = (-1.5a)E + \left(\frac{-a}{2}\right)F_{CD}\cos 60° + \left(\frac{-a}{2}\right)F_{CD}\sin 60° - 2aF$$

$$E = \frac{4}{3}F\left(\frac{\cos 60° + \sin 60°}{\cos 60° - \sin 60°} + 1\right)$$

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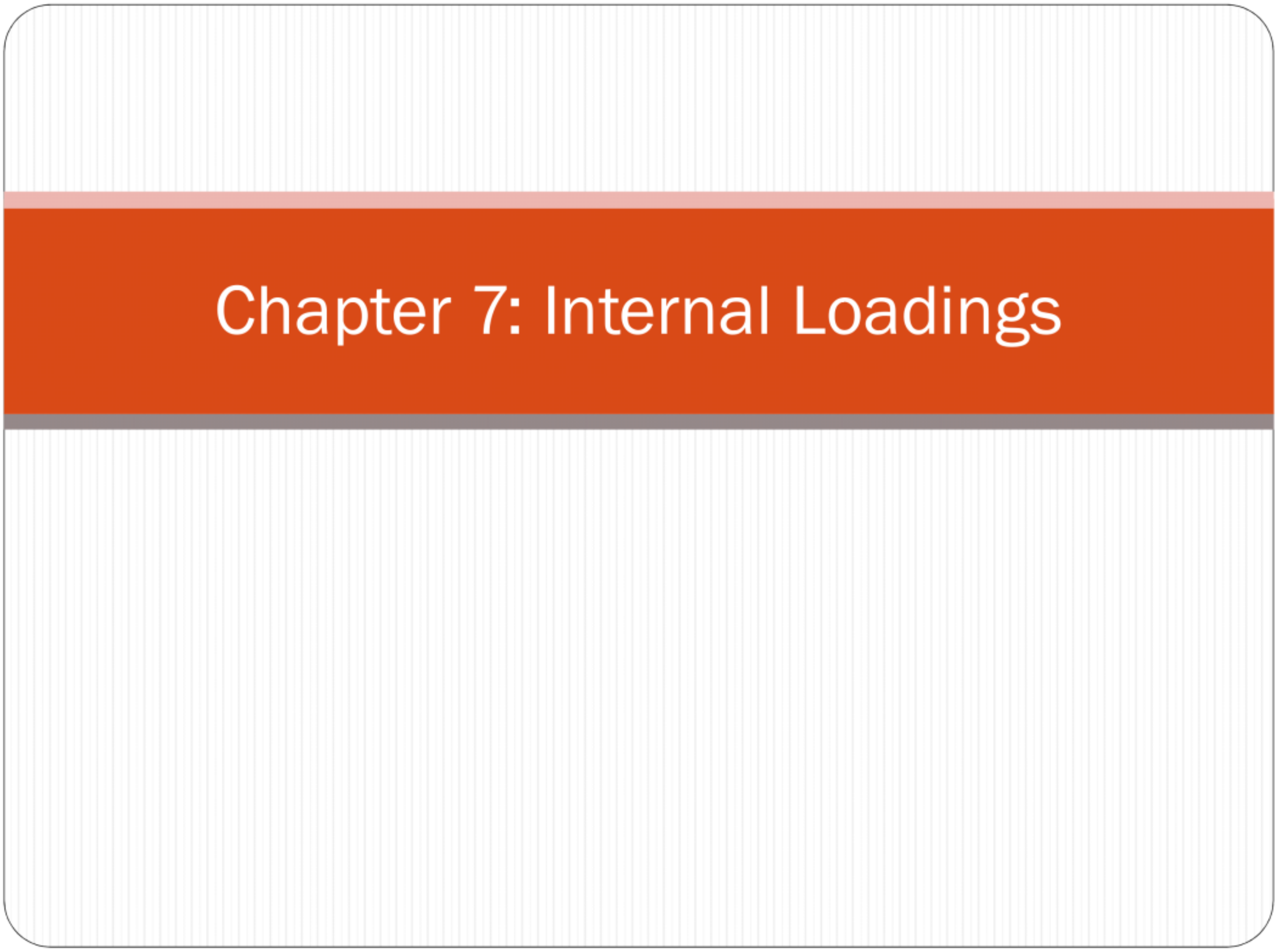
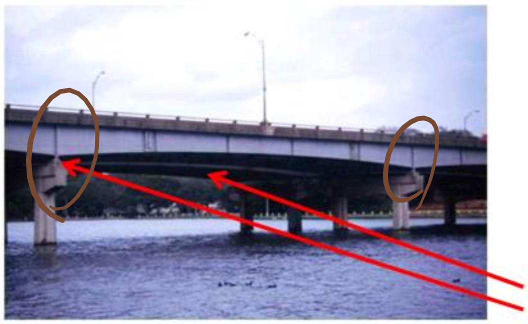


# Internal loadings developed in structural members



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.

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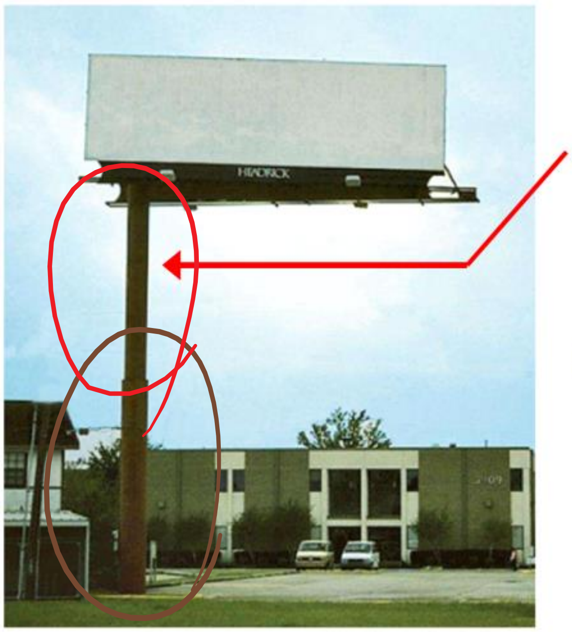
# Internal loadings developed in structural members




A fixed column supports these rectangular billboards.

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

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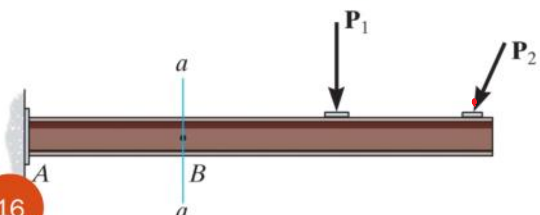
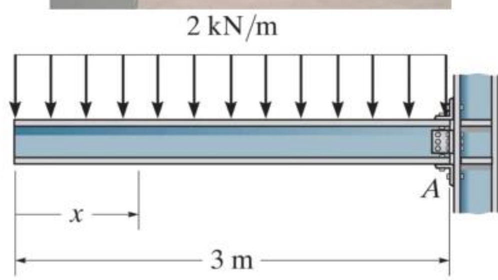
## Internal loadings developed in structural members

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## 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.**