Statics - TAM 211

Lecture 20

November 8, 2018

Chap 7.1

Announcements

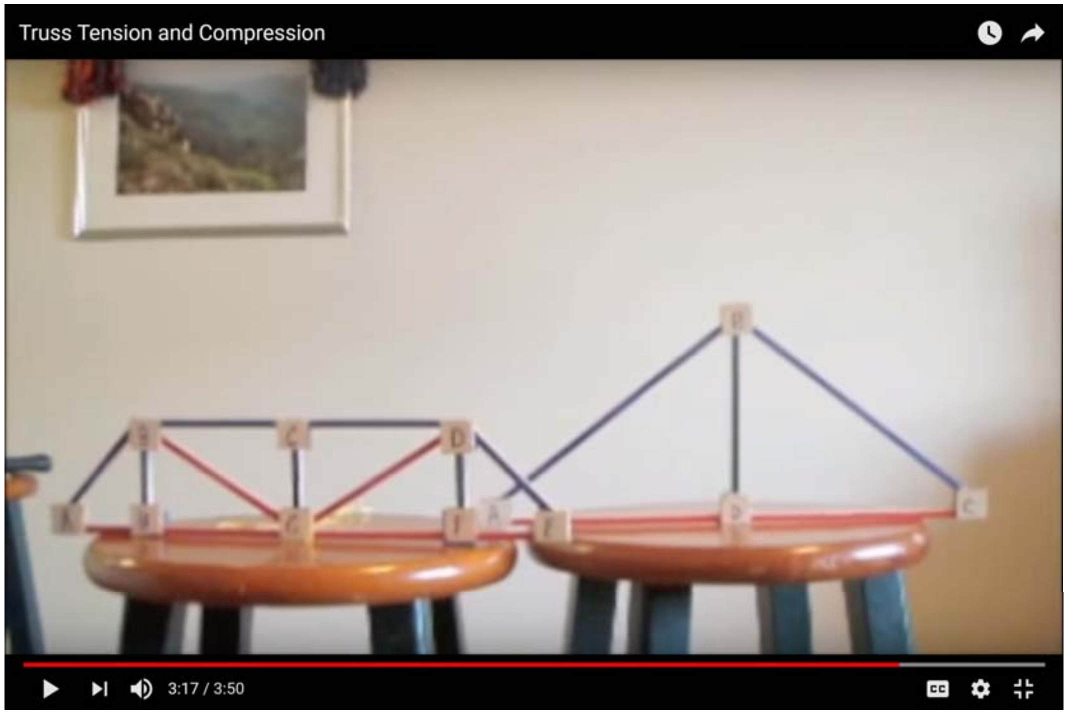
- **Upcoming deadlines:**
- Tuesday (11/12)
  - Prairie Learn HW 8
- Friday (11/16)
  - Written Assignment 8
- Quiz 4
  - During week of 11/11
  - 3D rigid body (Chap 4)
  - Structural Analysis (Chap 5)

→ computer based test.

Quiz 4 will be:

Wednesday Nov 12
D211 (ME), D331 (CEE)
9:00 - 9:50 am
Please arrive to log in

The following short video provides simple explanations of truss structures, members in tension & compression, and zero-force members
https://youtu.be/8DdOy5ftxRc



Recap: Procedure for solving for forces/moment in frames and machines

1. Identify external support reactions on entire frame or machine. Draw FDB of entire structure.
2. Identify two-force member(s) and zero-force members to simplify direction of unknown force(s).
3. Draw FDBs of individual subsystems (members). (Solve respective equations of equilibrium $\sum F_x = 0$, $\sum F_y = 0$, $\sum M_{most\ efficient\ pt} = 0$.)
4. Solve for the requested unknown forces or moments. (Look for ways to solve efficiently and quickly.)

Chapter 7: Internal Forces

Goals and Objectives

- Determine the internal loadings in members using the method of sections
- Generalize this procedure and formulate equations that describe the internal shear and moment throughout a member
- Be able to construct or identify shear and bending moment diagrams for beams when distributed loads, concentrated forces, and/or concentrated couple moments are applied

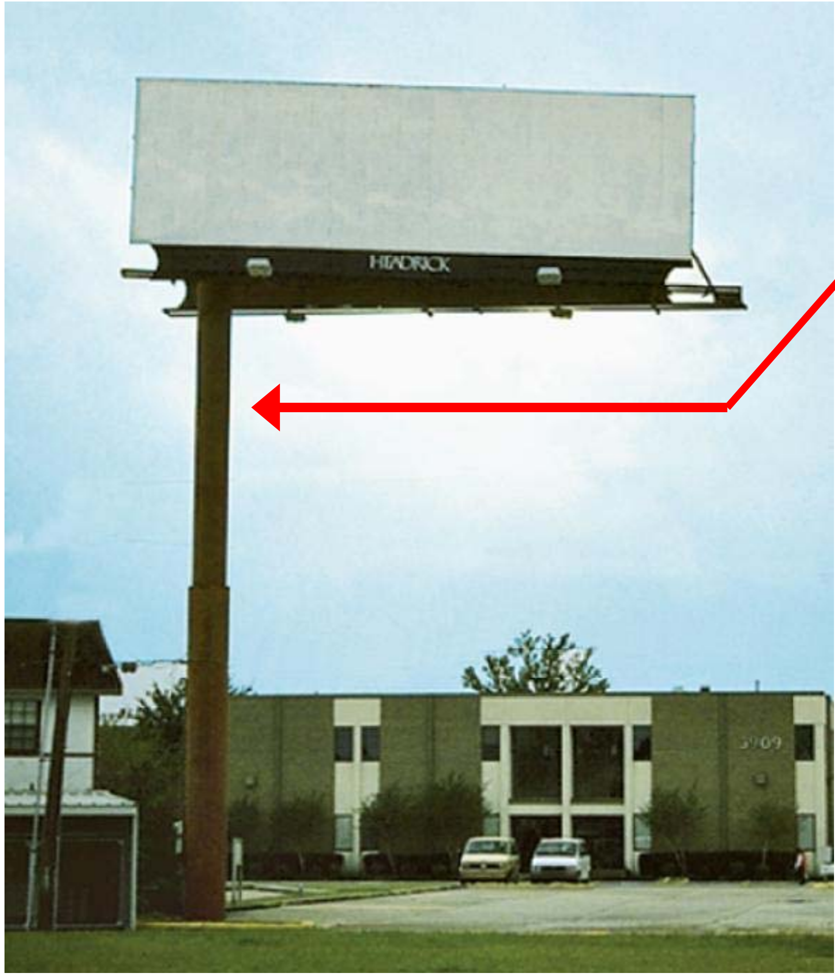
Internal loadings developed in structural members

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.

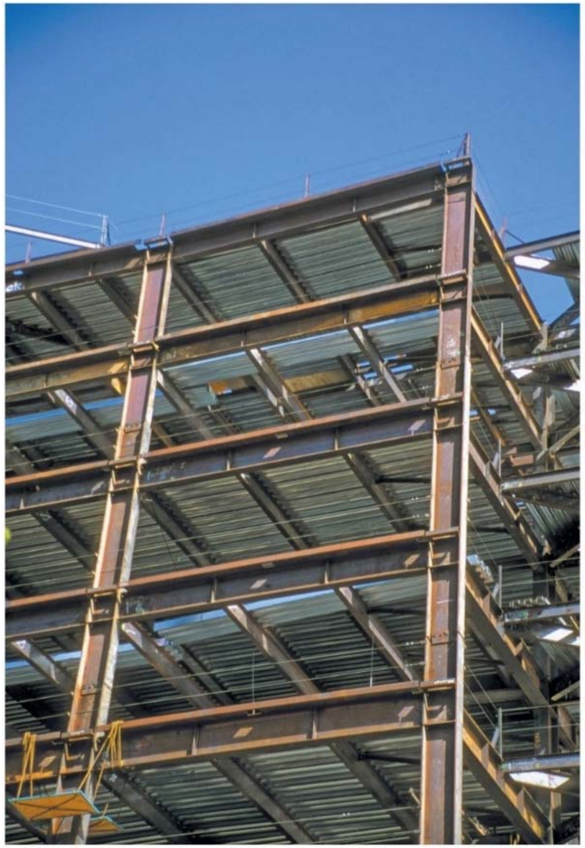
Internal loadings developed in structural members



A fixed column supports these rectangular billboards.

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

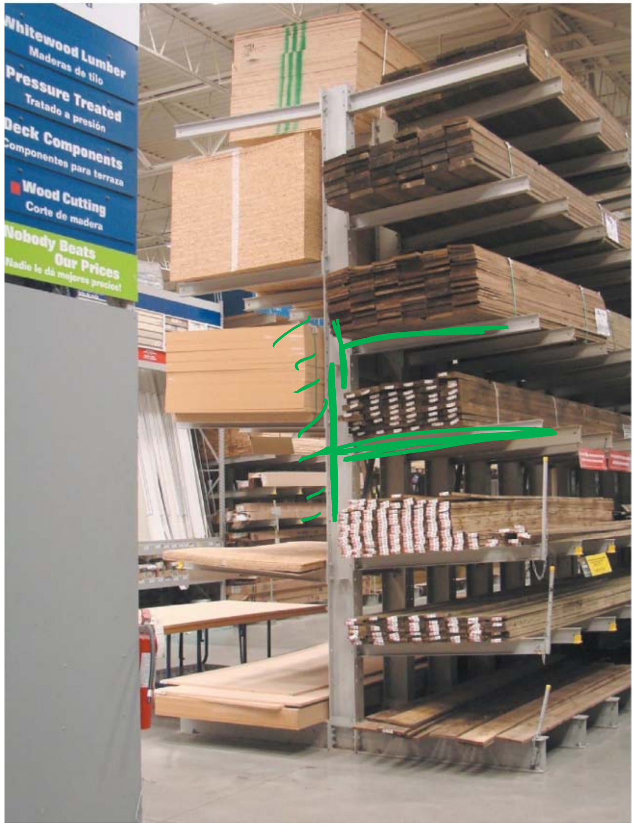
Internal loadings developed in structural members



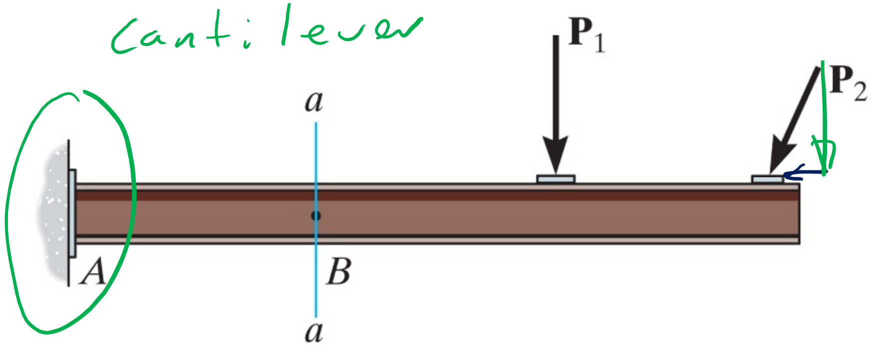
Beams:
Length >> Cross section

Loads:
⊥ to beams

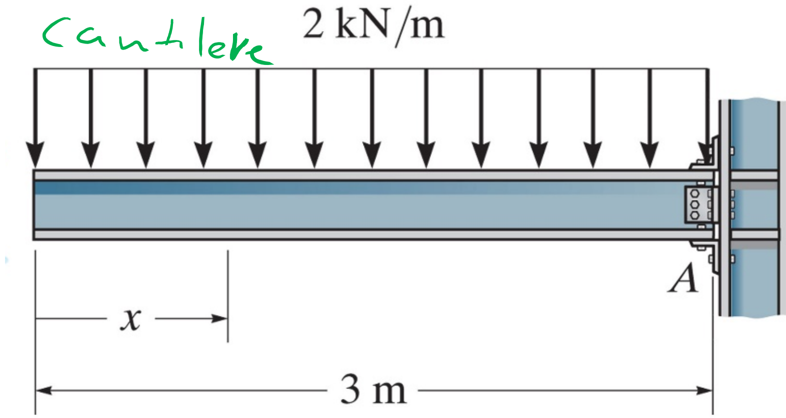
Supports:
Simple supports: pin, roller, cantilever (fixed)



cantilever



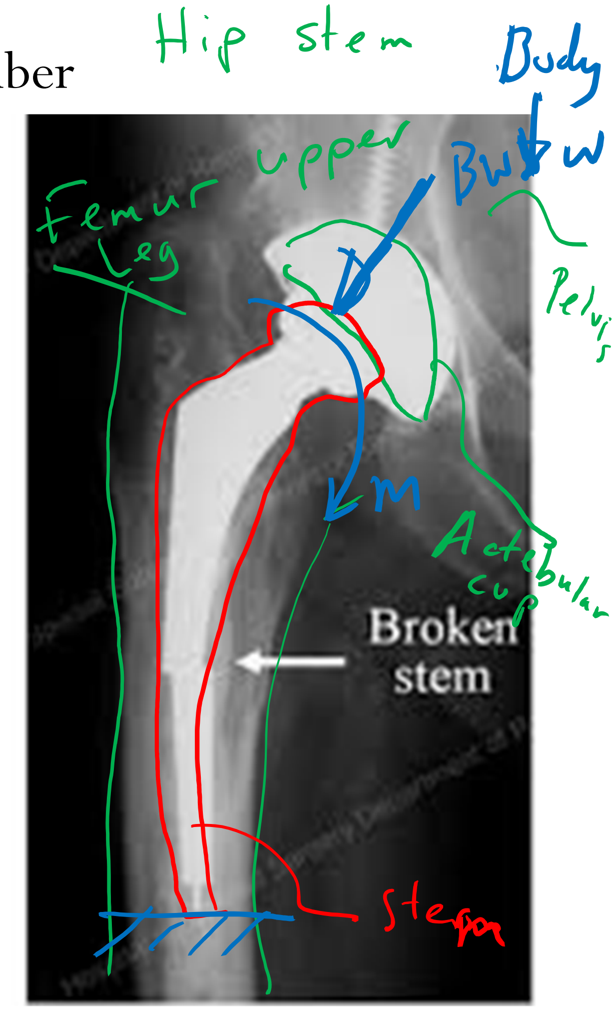
cantilever



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.** ⟹ Use Method of Sections



https://www.youtube.com/watch?v=hLfNCAHPL8c BCT540 Truss Test, Group 2

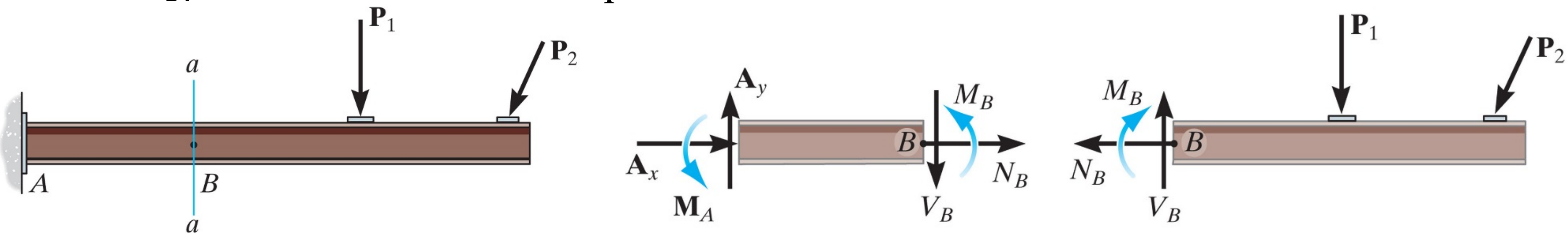
https://www.youtube.com/watch?v=YdqvGGFIbfc Steel Rebar Tensile Test

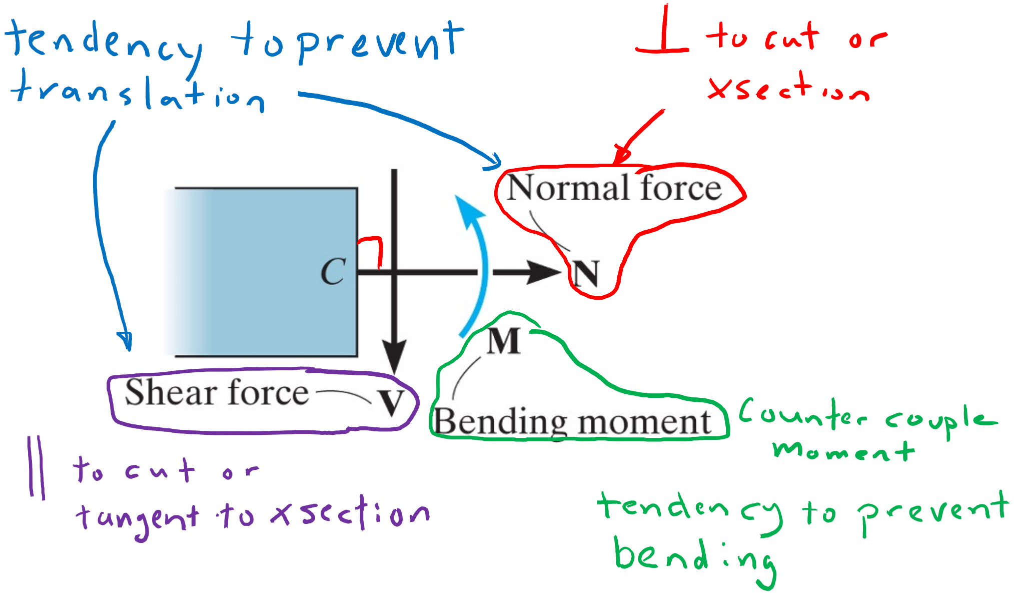
Internal loadings developed in structural members

N, V, M ← key labels to learn

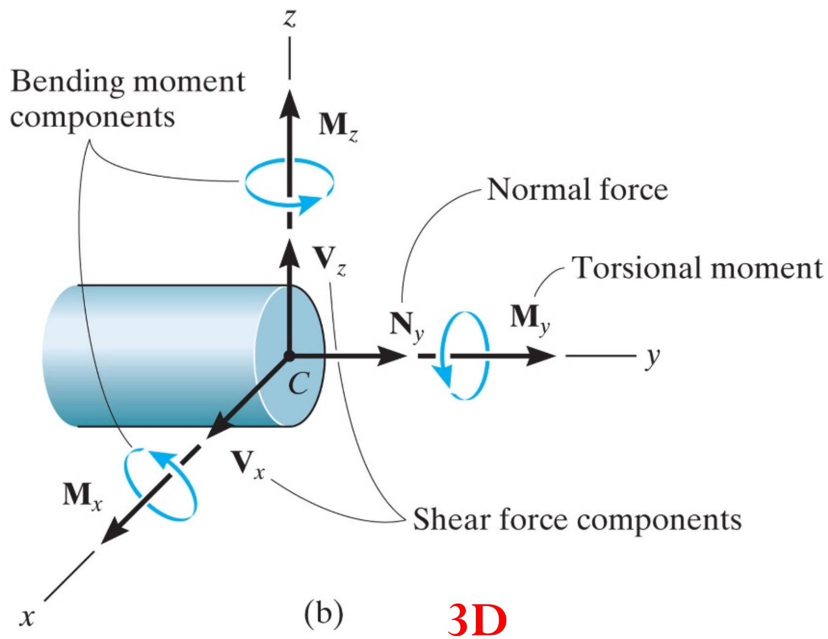
Structural Design: need to know the loading acting within the member in order to be sure the material can resist this loading

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



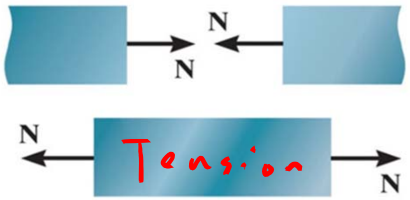


2D

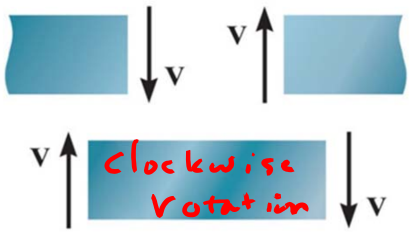


(b) **3D**

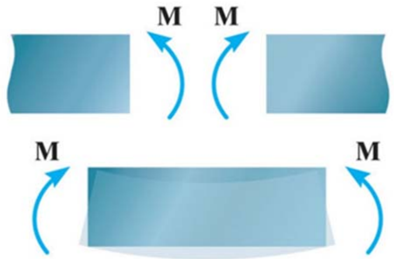
Sign conventions:



Positive normal force

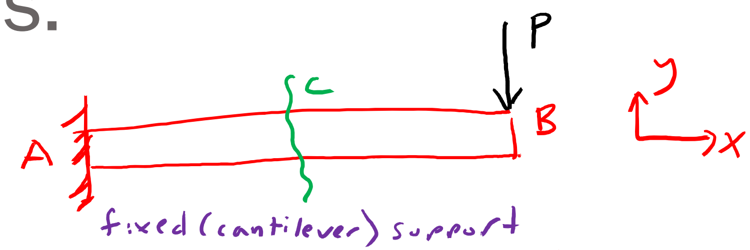


Positive shear



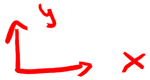
Positive moment

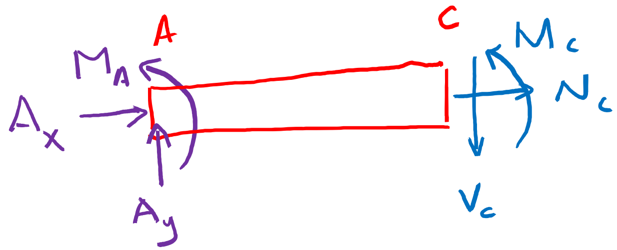
Concave up



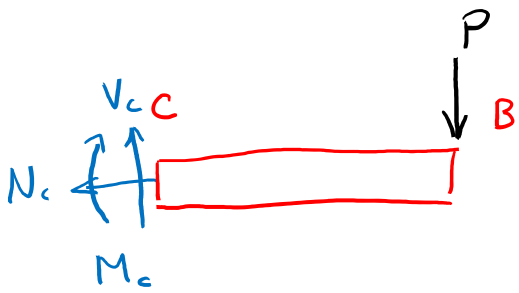
If beam AB is cut at C, draw FBDs of sections AC, CB illustrating assumptions of N, V, M drawn in positive directions.

FBD AC:

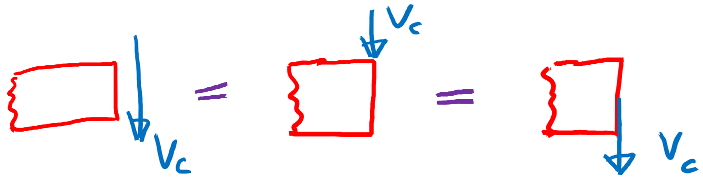




FBD CB:

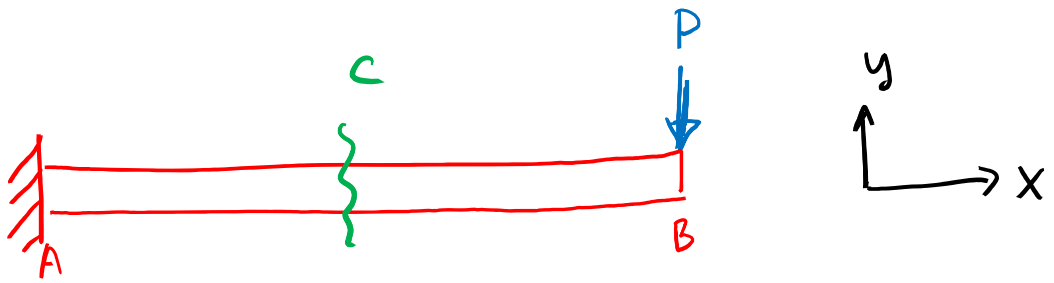


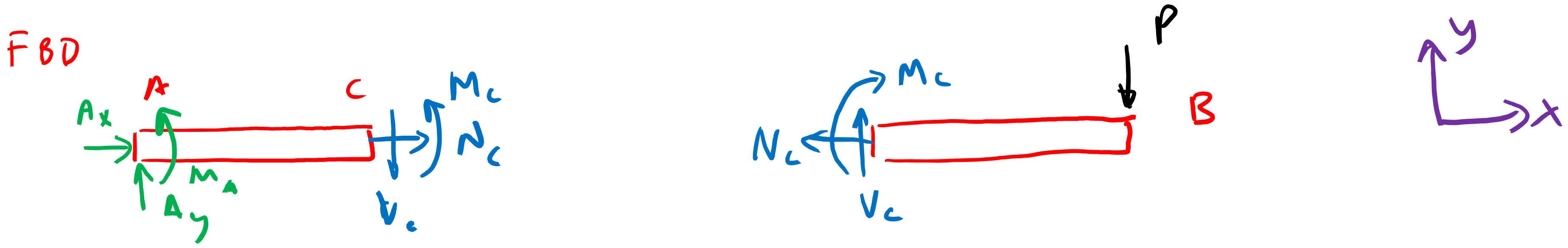
Note: although draw V off the side of the cut section, V is actually applied at the cut.



What sign to give N, V and M terms in equations of equilbrium?

Follow the positive orientations of the coordinate system.





$$+\rightarrow \sum F_x: A_x + N_c = 0$$

$$+\uparrow \sum F_y: A_y - V_c = 0$$

$$+\circlearrowleft \sum M_A: M_A + M_c - r_{AC} V_c = 0$$

$$+\rightarrow \sum F_x: -N_c = 0$$

$$+\uparrow \sum F_y: V_c - P = 0$$

$$+\circlearrowleft \sum M_B: -M_c - r_{CB} V_c = 0$$

Procedure for analysis:

1. Find support reactions (free-body diagram of entire structure)
2. Pass an imaginary section through the member
3. Draw a free-body diagram of the segment that has the least number of loads on it
4. Apply the equations of equilibrium

Find the internal forces and moments at B (just to the left of load P) and at C (just to the right of load P)