Lab 1.1 Statics Team Build - Cantilever

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Introductory Task (5 mins): Cantilevers and Free Body Diagrams

A cantilever is a structural element with a fixed support at only one end. When subjected to the structural load shown below, the fixed support will have two reaction components, a moment (torque) and a vertical load.

Draw a FBD of a cantilevered beam with a fixed support at one end and a point load at the other.

![Free Body Diagram](image)

Determine the moment (torque) at the support due to the 2.5 lb load. \(M\) (lb-ft) = _______________________

Team Project (50 mins): Application of cantilevers to biomedical engineering

Problem Statement
When holding a weight out with your arm, it is acting like a cantilever. You are going to design and build a simple prosthetic forearm using the listed materials. Your cantilever (arm) will be clamped to our testing frame and a hanging weight will be shifted down the cantilever arm from the supported end until it breaks. Your cantilever should be designed to hold 2.5 lbs at a maximum length. The deflection of the cantilever must not exceed 1”. To simulate the constraints of a true prosthetic arm, the entire structure at testing position must fit inside a 3-inch diameter pipe.

Materials:
- 1 piece of basswood (0.25”x0.25”x 24”)
- 2 ft masking tape
- 10 popsicle sticks
- 2 ft string
Design Challenge: Your cantilever should be designed to hold 2.5 lbs at a maximum length. The deflection of the cantilever must not exceed 1”.

Allowable Design Considerations:
Note: The entire structure (string, sticks, tape) must fit inside a 3-inch diameter pipe.

- Extend the cantilever beyond the testing block on the support end, not exceeding 2 inches behind front of block
- Orient the testing block with the notch up or down.
- Place the testing block on top of or below your cantilever.
- Brace against the testing frame below the cantilever.
- Connect your cantilever to the testing frame or clamp.
- Laminate pieces horizontally, as long as the width at the support end does not exceed 1.75 inches
- Laminate pieces vertically, as long as there is a flat surface for the testing block to rest on.

Task 1: (5 min) Propose feasible solutions
Each person should sketch out a potential solution. Strength, stability, and aesthetics should be considered in your design. You can use the whiteboard for your sketches. Allowable design considerations are listed on the next page.

Task 2: (5 min) Decide on a solution
Discuss your potential solutions with your teammates. Based on your discussion, decide on a design. This could be one of the individually developed solutions, a combination of the proposed solutions, or even an entirely new solution.

Task 3: (20 min) Build your cantilever and write your report.
Using the given materials, build your cantilever. You are allowed to cut the wood, popsicle sticks, and string. Figure out how to work efficiently as a team. Working beyond the time results in a disqualification.

Task 4: (10 min) Test your section’s cantilevers
You are limited to 1 minute to setup and clamp your cantilever in the testing frame. The weight will be placed at the supported end and slid slowly down the cantilever until it breaks, reaches deflection limit, or the weight reaches the end of the cantilever.

Task 5: (10 min) Cantilever Feedback Form
- Each team must complete one form in a professional, well-written manner.
- Fill out the online form to report on your team experience.

Answer the following questions using the online feedback form (due tonight at 11:59PM)
1. Enter the NETID of team members not present
2. Describe (in 2-3 complete sentences) the basic premise of your design. What were the features of your design that made it unique among others in your lab section?
3. Describe the process your team used to select the final design.
4. How did you go about constructing your cantilever?
5. Describe your cantilever’s success/failure. Did it exceed the deflection limit or did it break? What aspects of your design can you attribute to your success or failure?
6. At what distance were you able to successfully support the weight? (inches)
7. What was the moment at the support due to the weight? (pound-inches)
8. Describe one strength AND one weakness of your teamwork today. What can your team do to be more effective?