

MIT OpenCourseWare  
<http://ocw.mit.edu>

4.440 / 4.462 Basic Structural Design  
Spring 2009

For information about citing these materials or our Terms of Use, visit: <http://ocw.mit.edu/terms>.

## Structural Design Project #1

Description: Design a balsa wood column to support axial load. Verify the design with an analysis to predict the ultimate load and failure mode. Build the structure with the specified materials and test to failure.

Goal: Design a minimum weight structure which can support the maximum possible axial force. As a measure of performance, the failure load will be divided by the weight of the structure. For each column, we will also determine the maximum force times the length squared as a weighted measure of performance to reward taller columns. Your column must have a minimum height of 12" and must be less than 5" in diameter at any point. Columns may not be more than 36" tall.

### Materials

You may use only balsa wood and dental floss. Suggested properties of balsa wood are:

Modulus of Elasticity,  $E = 600,000$  psi

Failure Stress,  $\sigma_{cr} = 1,000$  psi (in both tension and compression, parallel to grain)

NOTE: These properties vary substantially for balsa wood of differing density and quality. Similarly, the mechanical properties of dental floss vary widely. You may want to research your material properties independently.

You may use smaller balsa wood elements to build up larger sections, but no single element may have a cross-sectional area greater than 0.125 square inches ( $1/8$  in<sup>2</sup>). (For example, you may use thin strips of balsa  $1/4$ " x  $1/2$ " to build up sections with an area greater than 0.125 square inches, but you may not use solid balsa pieces which are  $1/2$ " x  $1/2$ ".) No more than *four* pieces of wood may be glued together to make a single built-up member. There are no restrictions on the type of glue used.

### Deliverables

Your final report must include a description of your design and supporting calculations. Draw a simple plan and elevation of your structure showing dimensions. Calculate the sectional properties of gross area and moment of inertia for the critical section. Calculate the load capacity of your column and state all assumptions clearly. Include graphs of the load-displacement curve and the stress-strain curve for your column. Estimate the modulus of elasticity of balsa in compression by determining the slope of the elastic portion of the stress-strain curve. Your calculations should not exceed two pages of 8.5" x 11" and above all you should seek clarity in your design and analysis. The total report should be three pages or less.

### Project Schedule

Week 2	Project assigned
Week 3	Design in lab
Week 4	Load testing of structures
Week 5	Project report due