THE BALSA BUILDING COMPETITION

FROM THE SYLLABUS:

THE BALSA BUILDING COMPETITION

At the end of the semester, each student will design and construct a small building structure, entirely out of wood and CA glue (“super glue”). The small building will need to support two dead weights (steel plates), each at a different floor level. The building will be subjected to several base shaking load cases, each with a known frequencies and amplitude for a standard period of time. The goal will be to produce the lightest building that successfully survives the base shaking. The grade assigned will be based on the following formulae:

- Grade = 75 if the building does not survive any of the load cases
- Grade = 85 if the building survives one or more of the load cases
- Grade = $100 - 10 \left( \frac{R - 1}{n} \right)$ if the building survives all of the load cases. $R = \text{the entry’s rank for lightness among passing buildings}$, where $R=1$ signifies the lightest building. $n = \text{the number of passing entries}$.

The actual competition will take place during the last day of class, December 9th. Two class days will also be dedicated to the use of cutting and gluing the building together. Prior to this, students will have modeled and designed the structure. The building weight will be determined by subtracting the weight of the plywood base from the total weight.

Materials and Tools Provided

- Balsa, razor knives, CA glue (cyanoacrylate – AKA super glue) and accelerator
- Plywood base

Rules

Overview

The Building will be glued to the plywood base, provided. The plywood base will be fixed to the shake table and subjected to 0.375-inch amplitude shaking at the following frequencies:

- Test 1: 100 rpm for 10 seconds
- Test 2: 200 rpm for 10 seconds
- Test 3: 400 rpm for 10 seconds

Students are advised to think about the fact that the shake table necessarily accelerates to these frequencies from the at-rest position.

Dimensions and Weights

- Weights will be applied at two floor levels. At each floor level, (2) 3” x 3” x 1/4” steel plates will “sandwich” the structural supports provided by the building. The steel plates will have ¼” diameter holes in their centers for the purpose of bolting the plates to the balsa structure. The balsa structure must not interfere with the bolt and the balsa structure must provide stable support of the two plates. The two plates may be separated by no more than ½”. The heights of the top plates must be within the following ranges (measured from the plywood base):
  - Lower floor: top plate between 10” and 11” above the plywood base.
  - Upper floor: top plate between 20” and 21” above the plywood base.
- Entryway: each floor must have at least one opening that allows a 3” x 3” x 8” block of wood to be inserted such that the block of wood could be fully enclosed if the structure supported an exterior wall.

Balsa Properties

- Elastic Modulus: 500 ksi
- Unit Weight: 8 lb/ft³
- Bending and Tensile Strength parallel to the grain: 1 ksi
- Bending and Tensile Strength perpendicular to the grain: 0 ksi
- Compression (buckling): it is most reasonable to assume that Euler’s equation for buckling will be valid up until the material strength is reached.