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## CET-1000 Introduction to CET Balsa Bridge Final Project Rules

### REQUIREMENTS

Project teams of 2 or 3 students will be formed in order to build a bridge out of only balsa wood and glue. It is expected that all team members will share equally in the design and construction process as well as the monetary requirements of the project. The team grade will be recorded as the grade for each individual on the team.

### PROJECT OBJECTIVES

Not all learning takes place while listening to the instructor lecture. Sometimes learning occurs better with hands on approach. While you have not yet taken structural classes nor is this class intended to teach you any of those methods, there are some important things to be learned by participating in this project.

1. How to function on a team toward achieving an engineering goal.
2. How to solve problems while following a set of constraints.
3. How to attempt to provide a quality project.

### CONSTRUCTION RESTRICTIONS

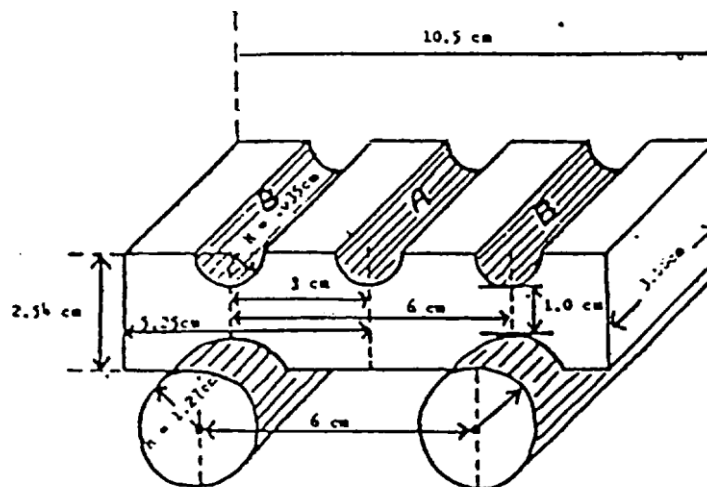
1. Materials used in the construction of the bridge shall consist only of **commercially available rectangular balsa stock and glue.**
2. The total mass of the bridge plus glue must not exceed **100.0 g**. Scales will be available at the instructor's office in order to weigh your bridge or components at any time in the construction process.
3. The bridge shall contain **no element wider than 1.0 cm (3/8 ") nor thicker than 0.65 cm (1/4 ")** Two or more elements, each separately meeting this requirement, may be laminated together to construct members exceeding these dimensions.
4. The bridge shall allow a **5.0 cm cube to pass underneath** without touching the structure. The bridge shall also allow a 40.0 cm long by 2.0 cm **high board to slide underneath** without touching the structure.
5. The bridge shall be "free standing".
6. An approximately level, **smooth roadway surface**, of **minimum length 40.0 cm** and above the 5.0 cm mark, shall be provided, across which a small metal car (e.g. Matchbox, Hot Wheels) will roll when given a single light push of the hand. This roadway shall have a **minimum width of 5.0 cm** and shall allow a 5.0 cm cube to pass freely along its extent. Note: the roadway materials must conform to rule (3).
7. No fastening mechanism (pins, nails, screws) except mechanical interlock of the balsa pieces or commercial glue is permitted.

8. The bridge design shall allow the **standard test frame** to be placed on the roadway surface with the load support rod(s) extending beyond the bridge sides.
9. The bridge shall not be painted or covered with any coating. Using a marker, the team number, section number and team member names shall be labeled somewhere for identification. Extra decorative items (flags, spires, signs, labels, striping) are allowable as long as they do not add to the structural capacity of the bridge. Judges rulings will be final in determining conformance with this rule.

### **BRIDGE TESTING**

1. The bridge pedestals shall be placed on level surfaces separated by approximately 35 cm. These surfaces shall be level with respect to each other.
2. The standard test frame will be placed on the roadway over the center of the bridge span. Depending on the bridge design, the load applied to the bridge shall either be suspended from a single 1/2 " diameter rod placed in the center slot of the test frame, or from two such rods placed in the outer slots. Where either option will work, the judge(s) shall decide on the method to be used.
3. A container shall be suspended from the load-supporting frame. To this container (which may be pre-weighted with steel weights as warranted in the opinion of the judge(s)), **dry sand and/or steel weights shall be added at a slow, steady rate, until either an audible cracking sound together with visual evidence indicates the failure of some structural member or glue joint of the bridge, or until a suitable reference point on the roadway at the centre of the span has been lowered by more than 1.0 cm.** A competitor may not participate in the addition of weight to his/her own bridge. **All decisions of the judge(s) are final.**
4. The total mass of the test frame, container, hanging devices and container contents shall be recorded as the competitor's score.

#### **Standard Test Frame**



**Overall dimensions: 10.5 cm (length) x 5.0 cm (width) x 3.7 cm (height)**

**SCORING/GRADING**

Each team will begin with an initial 100 points score. Deductions will be taken from the team's score using the following system. Each team's score will be recorded for their grade on the project. A correctly built bridge conforming to all construction restrictions and rules can receive no lower than an 85.

**Construction Deductions**

5 cm cube fails to pass under bridge	-2 pts
40 cm x 2 cm board fails to pass under bridge	-3 pts
Roadway surface is not a minimum of 40cm long x 5 cm wide	-3 pts
Roadway surface fails to pass the 5cm cube	-2 pts
Roadway surface fails to allow car to pass	-5 pts
Roadway surface below 5cm from base	-3 pts
Roadway surface fails to allow room for test frame	-10 pts
Member sizes larger than allowable 3/8" x 1/4"	-5 pts per 1/8" over per piece

**Weight Deduction**

Maximum Weight	-2 pts/g over 100 g limit.
Top 1/3 lightest of all bridges (combined both sections)	-0 pts
Middle 1/3 lightest of all bridges (combined both sections)	-2 pts
Bottom 1/3 lightest of all bridges (combined both sections)	-4 pts
Lightest average of all sections' bridges	All teams in section +2 pts *
Lightest individual bridge (between both sections)	+3 pts

**Strength Deductions** (Total load carried)

Top 1/3 strongest of all bridges (combined both sections)	-0 pts
Middle 1/3 strongest of all bridges (combined both sections)	-2.5 pts
Bottom 1/3 strongest of all bridges (combined both sections)	-5 pts
Strongest average of all sections' bridges	All teams in section +2 pts *
Strongest individual bridge (between both sections)	+3 pts

**Efficiency Deductions** (Total load carried/bridge weight)

Top 1/3 efficiency rating of all bridges (combined both sections)	-0 pts
Middle 1/3 efficiency rating of all bridges (combined both sections)	-3 pts
Bottom 1/3 efficiency rating of all bridges (combined both sections)	-6 pts
Most efficient average of all sections' bridges	All teams in section +2 pts *
Most efficient individual bridge (between both sections)	+3 pts

**Workmanship Deductions**

Projects with rough cuts, messy glue joints, oddly skewed members -1 to 5 pts

\* = Cross section teams will share in points proportionally to the number in each section.

**Disqualification**

Any team found to be making an attempt to skirt the rules by adding structural materials other than balsa wood, constructing their bridge with members that are knowingly and consistently oversized or any other form of blatantly violating the rules will have their entry disqualified and will receive a zero for the project. The instructor's ruling will be final!

**Bridge Building Tips**

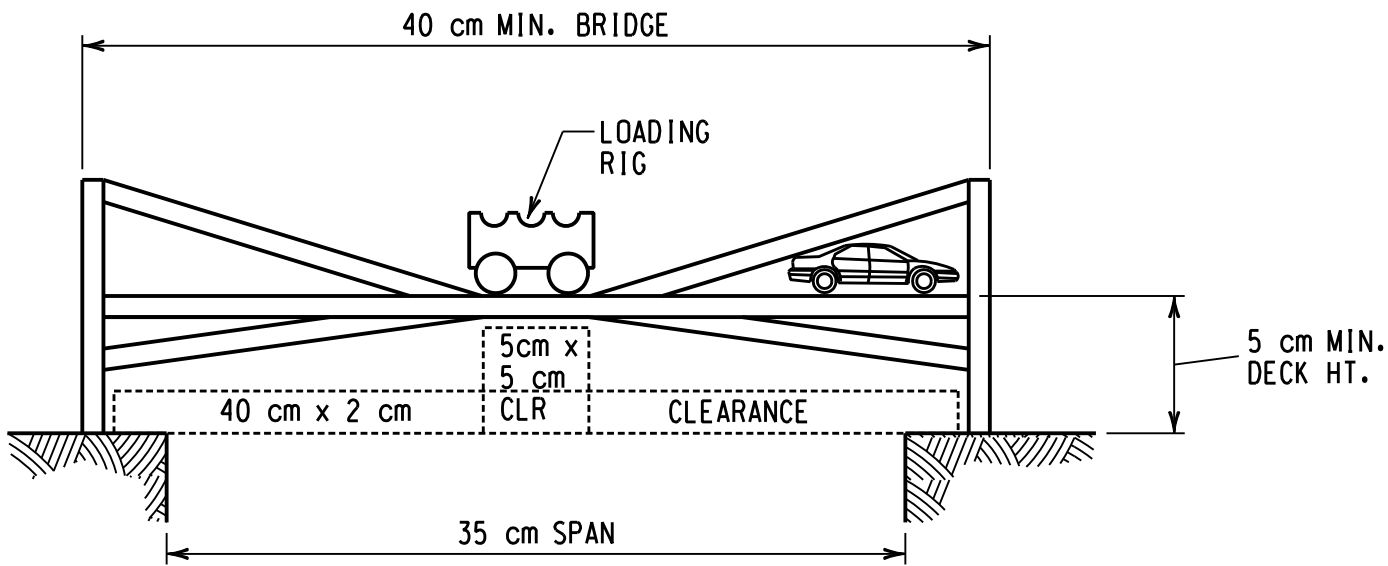
- Use a small balsa wood saw instead of an Exacto knife to make cuts.
- Cut small notches to connect bridge components.
- Use a basic carpenter's glue.
- Yellow glues contain aliphatic resin, used in the majority of winning bridges
- Fewer pieces mean fewer problems.
- Keep pedestals (feet) simple
- Clamp glued pieces for about half an hour (use protective strips to avoid damaging the balsa). If you don't have any clamps you can use binder clips or clothespins.
- Design for strength at the load application point.
- Construct roadway of thin, narrow strips of balsa.
- Don't glue down ends of road ways...they usually bend upwards under load.
- Use minimal support under roadway, except at load application points.
- Roadway must support a small Hot Wheels-type car.
- Most bridges bend inwards (as viewed from one end); consequently they require horizontal bracing across the bridge.
- Double check that a 40 cm-long board will fit between the pedestals (feet) of your bridge
- Double check that a 5 cm cube will fit underneath your bridge and along your roadway.
- Do not cover your bridge with any material. Glue should be used only to join components.
- Use light sandpaper (number 150 or higher) to gently clean your bridge and remove excess glue
- **Some common mistakes:**
  - Using a single sheet of balsa for roadway (solution: cut into strips)
  - Making outside width 5.0 cm instead of inside dimension
  - Making overall length 40 cm instead of span (between pedestals)
  - Forgetting 2.0 cm height requirement at 40 cm width
  - Not allowing room for bolt(s) on test frame

**Schedule**

Bridge Requirements presented in class.	November 4 & 5
Bridges deadline for submittal for judging.	December 15, 3pm
Bridge testing Section 001	December 16, 5-7 pm
Bridge testing Section 002	December 16, 2:45-4:45

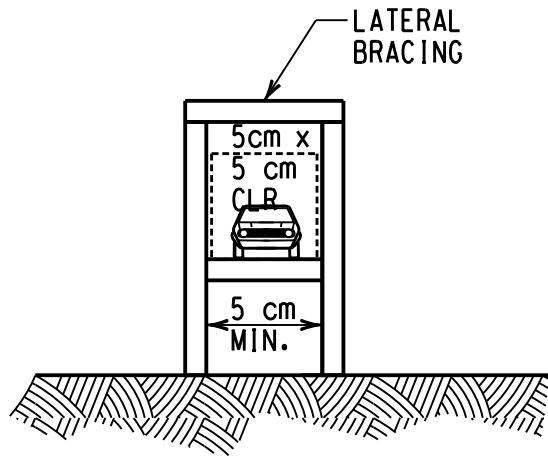
Students are welcome to attend the entire testing session of both sections.

Let's have some fun with it!!!



## BRIDGE ELEVATION

NOT TO SCALE



## END ELEVATION

NOT TO SCALE