

## Bridge Building

*Updated: December 18, 2009*

- LEVEL:** High School
- DESIGN TYPE:** Prepared In Advance
- DESIGN TEAM COMPOSITION:** 2 – 4 students per design team

### DESIGN CHALLENGE:

A bridge is defined as a structure carrying a pathway or roadway over a depression or obstacle. All designs must have a continuous solid roadway as an integral part of the structure. Efficiency is based on the ratio of load the bridge can withstand and weight of the bridge. Efficiency is an important concept when building any item because when less material is used to provide an adequate design, less money is spent. Your challenge is to design and build a bridge that can withstand the maximum load.

### MATERIALS:

The bridge must be constructed from any standard Popsicle sticks (wood, solid, nominally 11.3 cm. x 1.0 cm) and water-soluble wood glue. Sticks can be sanded, cut, trimmed, mitered or laminated.

- No other materials may be used. Do not decorate or coat the bridge with any materials such as paint, stain, or glue.

### CHALLENGE RULES:

Failure to adhere to measurements as given in the Rules will cause disqualification of the bridge.

- Each school can have a maximum of two teams.
- Each team can supply only one bridge.
- Each team shall be co-ed.
- A student can only be on one team.
- All students should be present during the loading and questioning portion of the test.

### Specifications

- The bridge must fit the following dimensions (also see attached drawing)
  - i. Bridge will span an opening of 600 mm.
  - ii. Bridge width – maximum of 120 mm.
  - iii. Total weight of bridge – maximum of 500 grams.
  - iv. No limit on height
  - v. Roadbed length – Maximum of 650 mm.
  - vi. Roadbed width – must pass a car with an axle width of 50 mm.
  - vii. Roadbed height – maximum of 30 mm above the surface of the test supports.

- An opening to insert a 6.35 mm (¼”) hook through must be provided in the center of the bridge (at the intersection of the centerline of the roadbed and the mid-span of the bridge). The max opening size is 20 mm x 20 mm.
- The ends of the bridge must lie flat on the testing supports. When placed on the supports, the bridge should not wobble when touched.
- No portion of the bridge, loaded or unloaded shall extend or sag more than 2 cm below the top of the test support.
- A test car (provided) must be able to roll end-to-end without falling off or through the roadbed. You will need a guardrail. Guardrails are safety requirements on most bridges.

### Loading

- The bridge supports will be 600 mm apart and the load will be applied at the mid-span.
- The load will be applied through a wooden block resting on the roadbed (judges will supply the loading block). The block will be 50 mm x 50 mm x 20 mm. (Make certain the roadbed can support the block.) The load will be applied to the loading block by a loading hook which will be put through the hole at the center of the bridge and screwed into the block.

### Testing

All bridges are to be visually inspected to make sure that it meets the specifications. If a bridge has a problem, the team can take it back to rework. However, once the bridge passes the inspection it will be impounded and no additional modifications will be allowed.

### Load Testing

- The bridge will be centered on the supports.
- A rod will be hung from the bridge. All loads will be placed on the rod.
- Loading will take place in the following increments
  - Initial load of 4.5 kilograms (10 lb) will be placed. The bridge must be able to hold this to continue.
  - Loading increments will be placed at .45 kilograms (1 lb) increments until a maximum load of 11.4 kilograms (25 lb) is reached or the bridge fails.
- Failure is defined as the inability of the bridge to carry additional load without breakage of any part of the bridge, or if any part of the bridge extends more than 2 cm below the top of the testing supports.

### **SCORING:**

Designs are scored based on the following formula:

$$\text{Bridge Efficiency} = \frac{\text{Maximum Applied Load (grams)} \times 1000}{\text{Weight of Bridge (grams)}}$$

**Note: The Maximum Applied Load will not exceed 11.4 kg.**

The bridges with the highest structural efficiencies will be the winners. In the event of a tie the lightest bridge will be the winner.

- After the bridge has been tested, the students will review their bridge design and performance with an evaluator. The students need to be prepared to answer questions on the basic concepts of this competition, how they designed their bridge, how the bridge performed and what might be done to improve the design.
- Bridges will be maintained in possession of the supervisor until they are released at the end of the event, and assuming there are no pending arbitrations

Awards will be given for 1<sup>st</sup>, 2<sup>nd</sup> and 3<sup>rd</sup> place design teams.