

Engineering Olympics 2009

Competition: The Mackintosh Bridge 2009

Competition Type: Bridge Construction

Objective: To construct a bridge that will span a given distance and be able to withstand an applied gravity load.

Engineering Discipline: Civil Engineering, Mechanics of materials, Statics

Related Topics: Free body diagrams, force distribution, geometry, trigonometry

Evaluation:

The score for each bridge will be the ratio of load held to mass of the bridge.

Design/Material Constraints:

The bridge must span the 20 inches between the supports.

The maximum width of any part of the bridge shall be equal to the length of one flat toothpick (approximately 2 1/4 inches).

No part of the bridge shall extend more than 4 inches below the top surface of the supports.

No part of the bridge shall extend more than 6 inches above the top surface of the supports.

Bridges may bear on no more than 1 inch of the top surface of each support.

The mass of each bridge shall not exceed 50 grams.

Bridges are to be constructed of only generic flat or rectangular toothpicks. Toothpicks must have a rectangular cross-section over its entire length, no rounded tips.

Structural members may have no more than a 3 toothpick cross-section at any location with the only exception being the immediate area of the joint. A joint or intersection must be clearly identifiable as such and not be able to be confused as a laminated beam.

Bridge elements that are parallel (within +/-10deg) must be more than 0.5 inch apart.

Any and all gaps between toothpicks will be treated as separate elements.

No joint may have an intersection of longer than 0.25 inch long.

The toothpicks must be bonded using Elmer's White School Glue.

Bridges are not to be painted. This will ensure that competitors use only the specified materials in the construction of their bridges.

Excessive amounts of glue will result in removal of the bridge from the competition. The head judge will determine if excessive amounts of glue have been used.

Student MUST BRING AND WEAR SAFETY GLASSES.

Supports:

New support description: This year the support apparatus and load will be a new design (see Figure 1 below). The bridge will be placed on a platform and have weight-lifting weights placed on top of the bridge instead of hanging a bucket from the bridge.

The support will be a platform with 6 inch tall embankments for the bridge to rest on.

There will be 20 inches between the embankments. Half way between the embankments

will be a 1 inch diameter pipe that will be used to align the weights. The bridge must be designed so that the 1 inch pipe goes directly through the center of the bridge. A 12 by 12 inch weighting platform will be placed on top of the bridge in an orientation that minimizes the contact area with the bridge (i.e. not at an angle to the bridge). A weighting platform will have a hole in the center for the pipe to go through. This platform will weigh approximately 2 to 5 pounds; the exact weight will be given at a later date.

Procedure:

New procedure: A 15 minute time limit will begin when the team enters the test area to break their bridge. The bridge team will set the bridge on the support embankments and then set the weighting platform and a 5 pound weight on the top of the bridge. The bridge must hold this load for 10 seconds. Any bridge that fails to hold this load for 10 seconds will not receive any points. The bridge team will load their bridge to failure by placing weights on top of the weighting platform. The load held by the bridge will be the total load causing the bridge to fail minus the last weight placed on the platform. The load held will be determined once bridge fails or at 15 minutes - whichever comes first. The weights available will be limited to the following:

- Four of each of the following: $1.25^{+0.06}_{-0.00}$ lb, $5^{+0.20}_{-0.31}$ lb, & $10^{+0.50}_{-0.66}$ lb
- Eight of each of the following: $2.5^{+0.09}_{-0.02}$ lb

Notes/Clarifications:

At joints and intersection you may have more than 3 toothpicks.

A joint or intersection must be clearly identifiable as such and not be able to be confused as a laminated beam. So, 6, 9, 12, etc.... toothpicks intersection at a joint should be ok. No joint may have an intersection of longer than 0.25 inch long.

Tie Breaker:

If two teams have the same final score (ratio of load held to mass of the bridge); the team with the lighter bridge will win. If both bridges are the same mass and hold the same load, the two teams will be awarded the same place. The following place will not be awarded.

Bridge and Testing Apparatus:

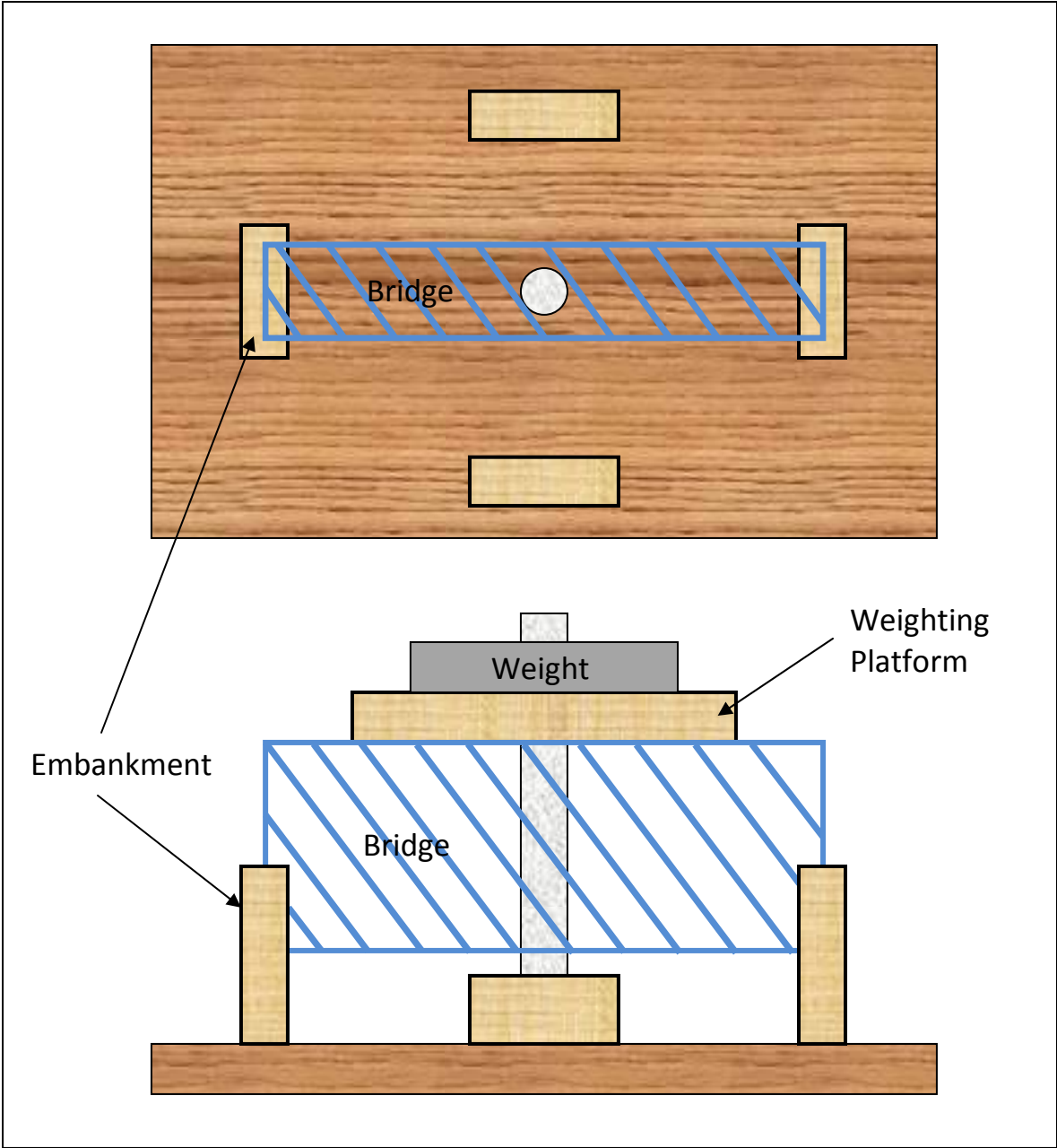


Figure 1: Top and front view of bridge and testing apparatus (drawing is not to scale).