

FA2023: Bridge Design Project

Introduction

Each individual is to build a bridge made from basswood and hot glue. The object is to construct the bridge with the highest load to bridge weight ratio while still meeting the design constraints. Bridges will be loaded until they fail.

Grading - Bridges

Bridges are judged based on:

- Aesthetics - elegance and neatness, e.g., an attractive design, no gobs of messy glue, no obvious twisting.
- Loading capacity - The more the bridge can handle before failing, the better.
- Bridge mass - must weigh no more than amount specified in competition rules.
- Performance under load - maximum load to weight ratio.

Grading - Project Report

Bridge Final Reports are graded based on:

1. Writing aspects - i.e., format, spelling, grammar, references, & clarity. See the project report section. Given that you've been asked to turn in a project report, understand that you are expected to treat the assignment with some depth. A Project Report is a significant document.
2. Technical aspects - i.e., describing the design process you followed (problem identification, problem definition, search, constraints, criteria, alternative solutions, analysis, decision, specification, & communication). See below for more on the design steps.

Real World Scenario: You work for a civil engineering company that has been approached by the city to build another bridge to access the city. But before the city starts construction, they want to see a proof of concept. You need to build a 1:1000 scale model with the following:

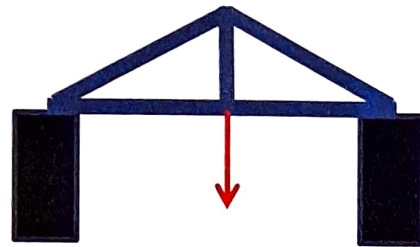
- a) Steel I-beam used in the construction will be modeled by sticks of basswood. Each full stick of basswood has a length of _____ and will cost \$3050 per stick.
- b) 5 rivets will be represented by a "dot" of hot glue, requiring 3 hours of labor and \$50 in equipment and consumables. An average glue drop has a mass of 0.04 g and each glue stick has a mass of ~4 g, so there are approximately 100 dots of glue/glue stick. Each glue stick is estimated to cost: \$5000, or \$1250 per gram.
- c) The loading will be represented by a force applied to an aluminum plate 50mm x 80mm. The bridge must support a minimum load of 20N.

Specifications

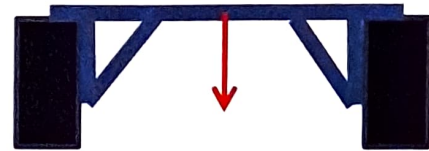
1. The bridge is to be built from basswood sticks and hot glue. Each participant will be provided with 15 basswood sticks, a low-temp hot glue gun, and 15 sticks of hot glue. The materials will be accounted for before and after construction, and the totals used will be used to estimate the cost of the bridge project.

minimum of 50mm wide w/ gap through center for screw
stretching = high maximum load
high weight = higher max load
want max forces to be tension not compression
triangles everywhere

2. The bridge shall be free-standing and must span two level surfaces which are 44 cm apart. Thus, the bridge needs to be MORE than 44 cm long to make contact with the support surfaces at the ends.
3. The support for the bridge shall be from the top of the level surfaces. The edges of the level surfaces cannot be used in any way for support. Any vertical surfaces cannot be used in any way for support. If at any point in the loading the bridge shifts to use the vertical surfaces for support, it will be disqualified.

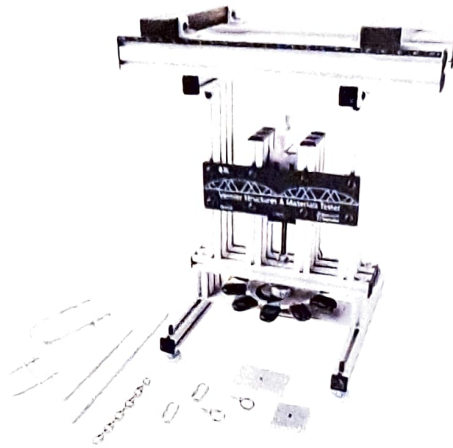


Ok



Not Ok

4. The bridge must be constructed so that a deck could be added to provide a suitable road surface across the full span of the bridge at approximately the height of the two level surfaces. A block 50mm wide x 50mm tall x 80mm long representing a vehicle must be able to move along the length of the hypothetical deck. You do not have to build the actual deck (unless you think it would make the bridge more structurally sound – but it will add weight to the final bridge.)
5. The maximum vertical depth of the bridge, from the highest point in its structure to the lowest cannot exceed 50 cm. This does not include the loading platform. The bridge can go above and/or below the support surfaces, as long as they do not touch the vertical sides of the support surfaces.
6. Basswood sticks may be modified by cutting into shorter lengths, and cut at angles for better connections.. Any unused portions of sticks will not count against the total weight of the bridge, but will be included in the cost estimation.
7. Sticks may not be laminated – i.e. glued adjacent to one another to produce a thicker stick. However, spacer sticks can be placed between the two sticks at intervals so that there are gaps between two sticks.
8. The loading will be simulated by a force applied to an aluminum plate 50mm wide by 80mm long. It attaches to the testing apparatus by means of a threaded bolt that must run through the center of the bridge deck. Leave an opening at least 10mm in diameter in the center for the bolt to pass through to attach to the loading platform. Make sure that the loading plate is adequately supported by the deck of the bridge. (This is the only portion that should provide a strong deck support – a strong set of trusses won't win if the loading platform pulls through the bottom of the bridge.)
9. The testing apparatus (the Vernier Structures and Materials Tester: VSMT) will pull down on the platform, and measure the force needed to cause a given displacement. This will be measured and recorded producing a force vs displacement graph.



10. Testing will continue until the load force continues to decrease with increasing displacement (this is usually after a significant load bearing component has failed) or when a component of the bridge touches some portion of the VSMT other than the horizontal support surfaces.
11. The bridge must be able to support a minimum load of 20 N.
12. The different bridge designs will be judged against one another using a max load/weight ratio and a max load/cost ratio. Bonus points are awarded for amount of max load past the minimum requirement.

Note: These rules were adopted from the Johns Hopkins Spaghetti Bridge contest, which in turn are similar to rules developed for contests at Okanagan University College.