

Truss Bridge Design Activity

Objective

To create a truss bridge that can span over a 24 inch gap and withstand the most applied load using only the materials provided, and to fully document the team's activity and deliverable.

Finished bridges are due at the beginning of class on Thursday, October 23rd. Finished Design Activity Write Ups are due at the beginning of class on Tuesday, October 28th.

A Performance Deliverable grade of 100% will be awarded to a team whose bridge:

- sustains the overall heaviest load without *failure* and can sustain at least 50 lbs. of load

or

- has the highest load to cost ratio and can sustain at least 50 lbs. of load

A Performance Deliverable grade of 50% will be awarded to a team whose bridge:

- cannot withstand 50 lbs. of load before failure

All other teams' Performance Deliverable grades will be determined based on the amount of load the bridge can withstand before failure.

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|-----------------------------|---|
| • 50 lbs. - 69 lbs. = 65% | • 130 lbs. - 149 lbs. = 85% |
| • 70 lbs. - 89 lbs. = 70% | • 150 lbs. - 169 lbs. = 90% |
| • 90 lbs. - 109 lbs. = 75% | • Ms. Earnhart standing on it (170-ish lbs.) plus any more load = 95% |
| • 110 lbs. - 129 lbs. = 80% | |

The definition of “failure” in this activity is when any member or joint of the bridge arrives at its yield strength and begins to deform in any way. The definition of load to cost ratio is the calculation of the yield strength divided by the total cost of the bridge.

Materials

Teams may use a maximum of:

- 300 small craft sticks (\$8.39 per pack of 1,000)
- 10 large craft sticks (\$7.27 per pack of 500)
- Two “plastic I-beam thingys” (\$0.10 per item)
- 15 hot glue sticks (\$7.99 per pack of 100)
- 2 manila folders (\$7.99 per pack of 100)
- 2 meters of cotton string (\$6.29 per ball of 475 ft.)

There will be no replacement of materials at any time. Teams may use tools such as (but not limited to) scissors, hobby knives, hot glue guns, rulers, compasses and protractors, but the bridge itself may not be composed of any materials outside of the aforementioned list.

Schedule & Testing Procedure

Students will be given all class time to work between now and the due date of the project. Students may also elect to work outside of class time, as long as all work time is documented in logbooks. Students may not work in the wood or metal shop without proper training/approval and having a safety contract on file with the teacher.

Bridges will be tested with a 50 lb. load with the centroid of the load directly above or below the centroid of the bridge. This means that the load can either be stacked on top of the bridge, or suspended below the bridge with rope. At the time of testing, the team and the teacher will work together to figure out the most appropriate way to apply the load.

Requirements & Grading

Documentation: 50% of total grade

All teams will submit a full Design Activity Write Up, due in the teacher's e-mail inbox by the beginning of the next non-CCP class period after bridge testing (Tuesday, October 28th). The write up is a formal document (FDR/FR style) that chronicles the team's efforts from kick off until the final analysis of the finished deliverable. It will be graded on overall quality, professionalism, completeness, and correctness.

Write Up will consist of:

- Cover Page: with team member names, class period, title of project, due date, teacher name
- Table of Contents: with correct page numbers for sections and subsections, numbers on every page
- Statement of Objectives: describing the design challenge, rules, goals, and any other pertinent information to familiarize the reader with what is going on
- Theory/Collaboration: describing how the group came to the design decision that they made, and scientific reasoning/justification behind the decision. Any DEVO's or Bench/Course tests should be included here. *Include at least 1 logbook citation from each group member (LastName, Date of Entry).*
- Graphic Documentation of Deliverable: Labeled Solidworks renderings of the following -
 - Each individual member of the bridge (excluding items such as string, rubber bands, etc.)
 - An assembly of the whole bridge (string, rubber bands, and other "2D" items can be drawn in MS Paint)
 - An orthographic drawing (3 views + isometric) of the full assembly, with all relevant dimensions labeled
- Mathematical Documentation of Deliverable: An Excel document demonstrating the cost and mass of each individual bridge member, and the total cost and mass of the whole deliverable. Pay attention to units, formatting, and using equations within cells. Round all numbers to the hundreds place (0.00).
- (Post Test) Mathematical Modeling/Proof of Concept: Perform a mathematical analysis on the bridge for when the 50 lb. load was applied to it. Determine which joints were under the load, which joints were experiencing reaction forces, and analyze the forces acting on *at least 4 joints (not symmetrical to each other)*. Include the total weight of the bridge when determining reaction forces (reaction forces = load + bridge weight).
- (Post Test) Final Evaluation: A write up describing the outcome of testing the bridge. How successful was it? How much load did it support? When and how did it begin to fail? In retrospect, what would the group do differently to improve upon the bridge's performance? If the bridge failed to meet minimum requirements, explain in detail why this occurred, and use cause & effect to trace back the origins of failure. *Include at least 1 logbook citation from each group member (LastName, Date of Entry).*

Performance of Deliverable: 50% of total grade

Bridge must span across a 24 inch gap. Bridge must sustain 50 lbs.. of load, as applied evenly to the bridge, with the centroid of the load directly above or below the centroid of the bridge. See *Objective* for grading procedures.