AT205 Laboratory Bridge Project
Fall 2022

The objective of the project is to help the students successfully apply their knowledge to create a successful bridge design. A successful design is one that satisfies all the design specifications, meets project budget, and cuts down construction time requirements.

Project requirements
Each student team has been asked to build a bridge model for crossing a **34 inch gap**. It is advisable to place beams/trusses at that distance. The bridge model must hold **as much weight as possible**. The main concern for this project is that every team must control their expenses by use the smallest amount of money possible. To complete the project, students should conform to the following design specifications:

1) The bridge must be **at least 36 inch long** and **4 inch wide**. It must be able to support **as much weight as possible *at two contact points on the top of the bridge***. It is advisable to place beams/trusses at those locations.

2) Build your bridge by using the following materials: straws, hot glue, scotch/duct tape. Use the smallest amount of materials possible (see Table 1).

- Straws – standard size = 7 inches/straw. *All full straws must be counted even if only a part of a straw was used.*
- Construction (assembly) methods – hot glue, scotch tape, or other methods.

3) "Design Efficiency" calculation as follows (see Table 2):

- Design Efficiency (DE) = Loads (lb) / Number of straws used or Loads (kg) / Number of straws used

4) The bridge construction must follow original design drawing or hand drawn sketches. **Use the drawings/sketches for calculation of every structural member of the bridge.**

5) Team members must create a Bill of Materials and calculate how many straws they needs to build the bridge. This planning activity allows the students to purchase the necessary materials for their bridge and learn about budget control.

6) Tape or glue only ½ inch contact point. Straws may not be soaked or coated with glue or epoxy. (No double frames allowed)

7) Bridge testing phase: place four contact points on the top of the bridge. ***The top bar must be 24" long***. Then use a bucket to collect small items (for example, ball bearings); keep adding weight to the bridge until it collapses; then weigh the amount of weight the bridge was able to sustain. See Fig. 1. ***All testing must be conducted when the instructor is present***.

8) Once bridge construction is complete (see Table 3), the bridge will be loaded and tested to measure the following items: (1) maximum vertical deflection, (2) maximum weight loaded, and (3) design efficiency. **The test must be video recorded by the instructor in order to be graded**.

9) Maximum overall bridge deflection must be less than 1 inch. If not, the penalty will be 10 points.

Grade point distribution

Materials saving performance	60 points
"Design Efficiency" calculation	60 Points
Time to market	40 points
Drawings or hand sketches	20 points
Analysis of bridge structural members	80 points
Peer evaluation 1	20 Points
Peer evaluation 2	20 Points
Total:	300 points

Table 1 - Materials saving performance

Place	Number of points
1st place (smallest number of straws)	70
2nd place	60
3rd place	50
4th place	40
5th place (largest number of straws)	30

Table 2 - Design Efficiency performance

Place	Number of points
1st place	70
2nd place	60
3rd place	50
4th place	40
5th place	30

Table 3 - Time to Market performance

Place	Number of points
1st place	50
2nd place	40
3rd place	30
4th place	20
5th place	10

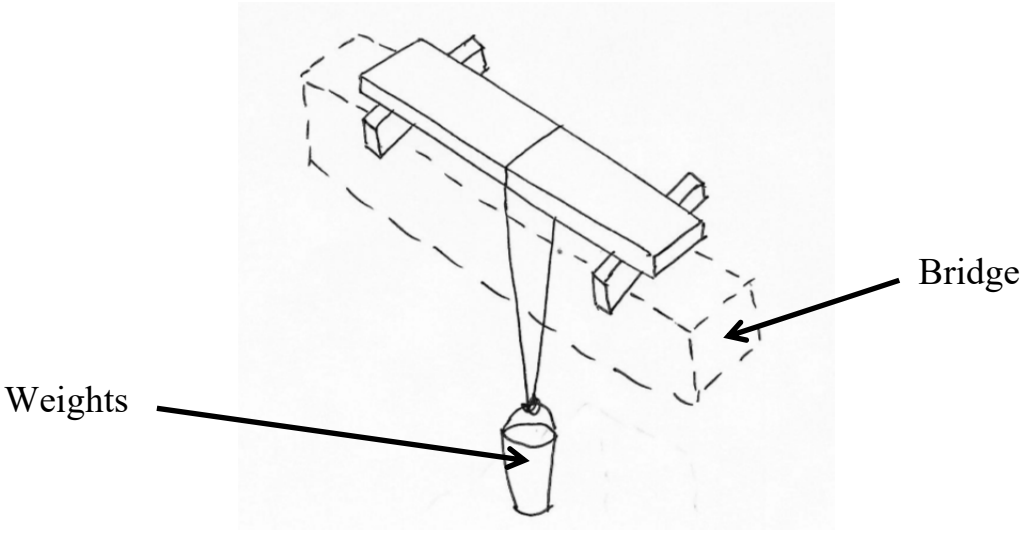
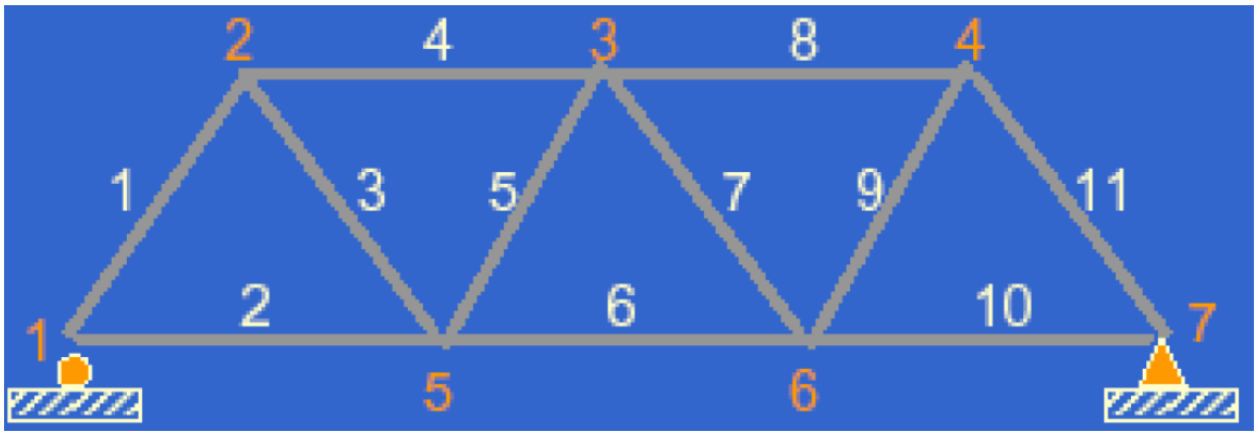


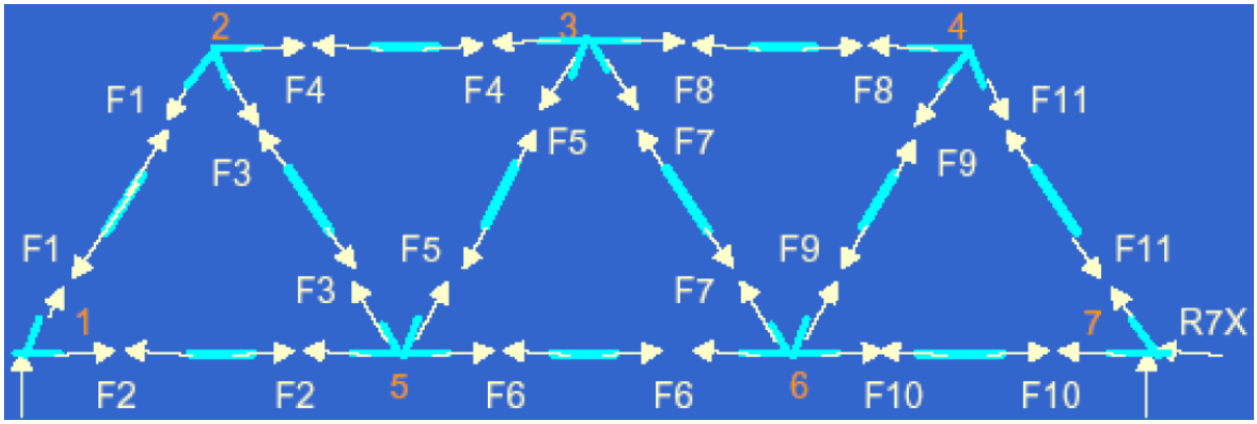
Fig. 1. Bridge Test Setup

Assumptions:

1. The bridge is represented by its frontal projection (2D vs. 3D) as a simple truss.
2. The elements are connected at their ends to form joints that behave like frictionless pins.
3. All forces acting on the truss are applied at the joints.
4. There is no bending occurs at any element.
5. The members, joints, and loads all lie in a single plane.
6. All truss members are weightless.
7. Assume all angles have the "design" values (as per drawing or sketch), even they might change during the load test of the bridge.
8. Load is applied at two symmetrical points at well indicated joints on the top of the bridge.
9. There are only two symmetrical bridge supports; only two vertical reaction forces should be calculated.
10. It is assumed that there are no horizontal reaction forces at the supports.

Internal force distribution inside every truss must be calculated.





Step to take:

1. Calculate reaction forces at the supports using the test load and global equilibrium.
2. Define each truss.
3. Draw ***each node*** separately including the member forces and if relevant, the applied forces and reaction forces on the node. By convention, we draw the direction of the member forces away from the node (see Figure above). This does not mean that all forces are tensile. Compressive forces will come out negative. The reaction forces should be drawn in the positive axis directions and applied forces should remain in their original direction!
4. Sum all the forces per node and per direction and equate them to zero for equilibrium.
5. Solve the obtained equations from the previous item to get the unknown forces, both member and reaction forces.
6. ***The load for every element must be calculated***.
7. *Detailed calculations must be included for each node or/and element. Lack of calculations will result in earning 0 for the assignment.*
8. Check global equilibrium to see whether the reaction forces come out right. This gives additional confidence in the solution. Calculations must be included.

Only one designated student from a team is allowed to submit electronic version of the final deliverables (drawings/sketches, test video, and calculations). Submission from multiple students will lead to grade reduction.

Peer evaluations

- Teams will assigned by the course instructor.
- The peer evaluations will be available on BrightSpace. They will affect a final grade. The reviews must be taking seriously. Each student must answer all questions to receive a full credit. Responses must be at least 150 words long. Shorter responses will result in earing 0 points for an assignment. All responses will be kept confidential. Only a short summary of evaluations will be available at the end of the semester upon request.
- Poor project participation feedback will result in earning 0 points for the lab portion of the course.

Schedule:

- **Peer Evaluation 1:** open Oct 12, 2022 at 00:01am; close Oct 19, 2022 at 11:59pm.
- **Peer Evaluation 2:** open Nov 28, 2022 at 00:01am; close Dec 5, 2022 at 11:59pm.

Deadlines:

- All team's bridges must be tested by Monday, November 21, 2022 at 12:30 pm.
- Last day to submit the project deliverables (drawings or sketches, test images, and calculations) is Wednesday, Nov 30, 2022 at 1:20 pm.
- Only one designated student from a team is allowed to submit electronic version of the final deliverables (drawings/sketches, images, and calculations). Submission from multiple students will lead to grade reduction.