

### Objective

To design and build a bridge spanning a 50 cm gap that can support the greatest possible load at mid-span.

### Construction Rules

#### Bridge

- The bridge must span a 50.0 cm gap between two tables (Figure 1).

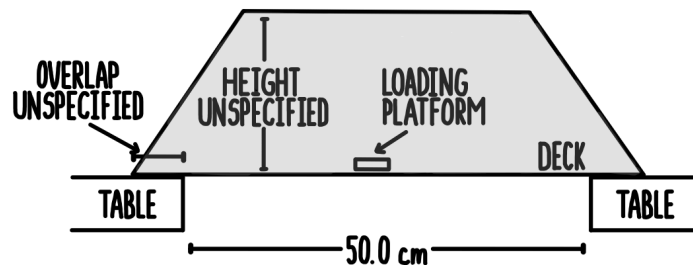


Figure 1: Sideview of the bridge setup. The bridge will be positioned between two tables placed 50 cm apart. The overlap onto the table is unspecified but it is recommended that the bridge be no less than 55.88 cm (22 inches).

- The only materials which may be used in the construction of the bridge are the following:
  - White printer paper (8.5" × 11" or 8.5" × 14")
  - Elmer's glue (generic white glue) or Elmer's glue stick (generic glue stick)
    - White glue will not discolour or change the opaque characteristic of the paper. Any white glue or glue stick that discolours the paper is not allowed.*
- While no materials other than those listed above are permitted, the following are notable prohibited materials:
  - tape
  - hot glue
- The bridge can be a maximum of 400 g.
- The bridge may not be coloured or decorated. The colour of the bridge must reflect the colour of the paper and glue used.
- The bridge must incorporate a truss design. Students should research truss designs or design their own unique truss design.
  - Bridge Design Simulation - <https://ei.jhu.edu/truss-simulator/>
- Inverted bridges are not allowed (i.e. no trusses beneath the roadway).

- The bridge must contact only the top surfaces of the support tables on either side. The bridge may not be anchored to either support table except by gravity. The bridge may not contact any other surface of the support tables, or the floor, ceiling, walls, or other object (Figure 2).

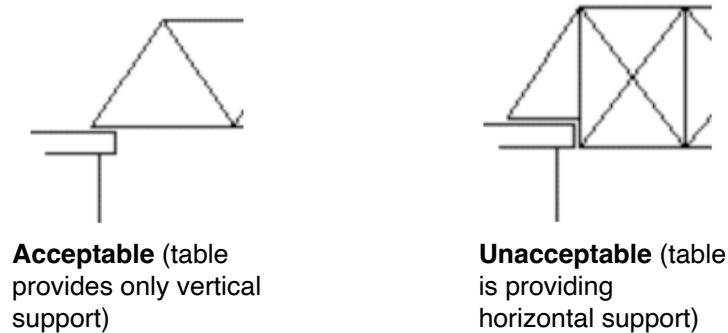


Figure 2: Acceptable and unacceptable contact with the table surface.

- The bridge must have a loading zone at which the mass will be suspended (see [loading zone](#) below).
- The bridge must have a continuous horizontal deck at least 5 cm wide without gaps (see [deck](#) below).

#### Loading Zone

- You must incorporate a "loading zone" at the midpoint of the span along the centreline of the bridge (Figure 3).
- The [loading platform](#) (to be provided in class) is a 5 cm × 10 cm flat block of wood which will be placed at the loading zone, parallel to the length of the bridge.
- A half-inch diameter hole must be located at the centre of the loading zone and pass completely through the deck and all bridge supports beneath the deck.
- A bolt will be inserted through the hole from beneath the deck and attached to the loading platform (Figure 3).

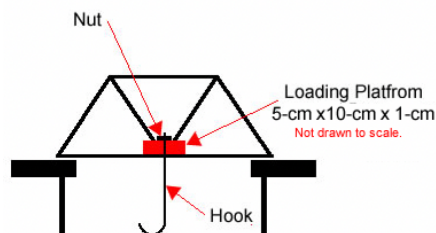
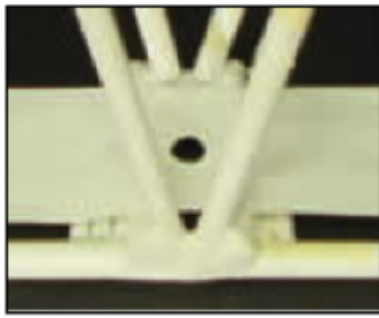


Figure 3: The loading platform will be positioned above the loading zone at the centre of the bridge.

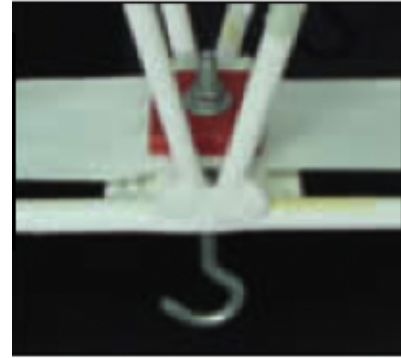
*A poorly designed and reinforced loading zone may result in structural failure only at the loading zone. This unfortunate oversight may leave the rest of the bridge structurally intact. Loading zone reinforcement should not be limited to excess use of glue but may include the construction of additional members (i.e. layers and/or joint construction). Remember the entire weight supported by the bridge is applied at the loading zone.*



Example Loading Zone



Loading Platform (to be provided)



Example Loading Zone with Loading Platform

Figure 4: Example of the loading zone constructed at the centre of a bridge. A half-inch diameter hole is located at the loading zone allowing for a bolt to pass through and attach to the loading platform as pictured. Note that the purpose of these pictures is to aid in the explanation of the bridge project requirements. These pictures are not intended to be examples of quality construction or design.

### Deck

- The bridge must include a decking of paper to provide a suitable road surface at least 5 cm wide across the full span of the bridge (Figure 5).
- Four conditions must be met:
  1. The deck may not have any gaps (with the exception of the half-inch diameter hole required for the loading platform).
  2. A block of wood 5 cm × 10 cm × 1 cm representing a car must be able to move along the length of the deck unobstructed from end to end.
  3. The highest point of the deck may be no higher than 5 cm above the tabletop to allow for loading zone reinforcement.
  4. The deck of the bridge must either be flat across its entire span or inclined upwards towards the loading zone (Figure 6).

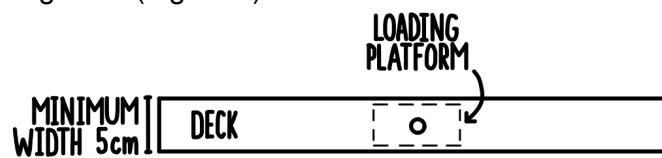


Figure 5: Overhead view of the deck. The loading platform will be placed above the deck. A half-inch diameter hole allows for the bolt to pass through and attach to the loading platform.

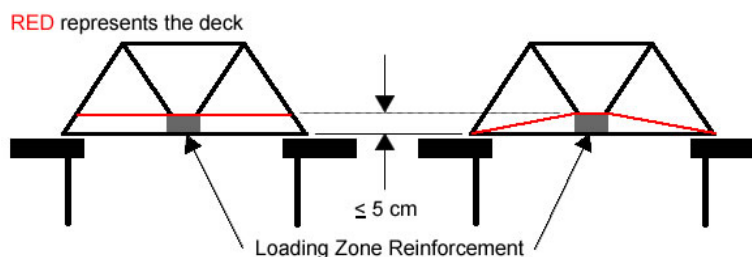


Figure 6: Sideview of two acceptable deck configurations. The deck must pass over the loading zone. To allow for loading zone reinforcement, the deck may be elevated a maximum of 5 cm from the table surface.

## **Bridge Testing**

1. All bridges must be registered on the competition date. All bridges will be inspected to ensure that all contestants have met the construction rules.
2. The loading platform will be secured at the loading zone.
3. The loading apparatus will be attached to the loading platform.
4. A load (force) will be applied to the loading zone by placing weights on the loading apparatus in increments of 10 or 20 lbs.
5. The load will be increased until structural failure is reached.
6. Structural failure is defined as:
  - the loading platform pulls through the loading zone,
  - the roadway deflects vertically 3 cm, or
  - the bridge is pulled through the 50 cm gap.

## Scoring

Bridges will receive a grade based on either the greatest load applied without structural failure or placing among all contestants, whichever is higher. Ties will be broken by the mass of the bridge with the least massive bridge winning.

Maximum Load	Grade
200 lbs	100
190 lbs	99
180 lbs	98
170 lbs	97
160 lbs	96
150 lbs	95
140 lbs	94
130 lbs	93
120 lbs	92
110 lbs	91
100 lbs	90
90 lbs	89
80 lbs	88
70 lbs	87
60 lbs	86
50 lbs	85
40 lbs	84
30 lbs	83
20 lbs	82
10 lbs	81
Loading Apparatus Only	80
Bridge supports its own weight	60
Bridge collapses under its own weight	0

Place	Grade
1st	100
2nd	98
3rd	96
4th	94
5th	92

One bonus point will be awarded for every 20 lbs in excess of 200 lbs.