



THE CITADEL
CIVIL AND ENVIRONMENTAL
ENGINEERING

2023
ENGINEERS WEEK
STORM THE CITADEL
BRIDGE COMPETITION

BRIDGE EVALUATION AND AWARDS

Individual bridges will be registered at the beginning of the competition. Students may contribute to one submitted bridge. Students may work in teams. Award categories and judging criteria for the Low Country Bridge Competition are summarized below:

Best Structural Design

Bridges will be loaded at mid-span until the Design Load of 445N (100lb) has been placed on the structure unless failure occurs at a lighter load. The lightest bridge to support the Design Load will be identified as the “Best Structural Design” as it will have the highest efficiency of Design Load to Weight ratio.

$$efficiency = 445 N / weight$$

Additional recognition will be given to the 1st Runner Up and 2nd Runner Up. These awards will be given to the second and third lightest bridge that supports the design load. If fewer than three structures successfully resist the design load, any remaining awards will be given to the bridge that supports the most weight less than the design load. If a tie exists in load, the tie will be broken with efficiency using the load supported and not the design load.

$$efficiency = (failure\ load < 445\ N) / weight$$

Example:

Bridge	Mass (N)	Failure Load (N)	Efficiency	Rank
4	17.7	558	$445/17.7 = 25.1$	1
2	23.5	823	$445/23.5 = 18.9$	2
1	6.9	407	$407/6.9 = 59.0$	3
5	8.8	407	$407/8.8 = 46.2$	4
3	3.1	208	$208/3.1 = 67.1$	5
6	2.8	200	$200/2.8 = 71.4$	6

Best Architectural Design

Prior to load testing, bridges will be evaluated by a panel of judges for best architectural design. Structural designs should be Efficient, Economic, and Elegant as well as Imaginative, Inspirational, and Innovative (Billington, *The Tower and the Bridge*, 1983). A bridge should be aesthetically appealing but also feel psychologically safe. The judges of Best Architectural design will evaluate the quality of the finished product, general aesthetics, and perceived soundness. These criteria are subjective and are at the sole discretion of the panel of judges. Their decision is final.

Best Technical Design

Prior to load testing, bridges will be evaluated by a panel of judges based on sound reasoning of bridge design as reflected in the constructed bridge. For this portion of the competition, **design documentation is required**. Documentation should include the final bridge drawing and summary of design criteria. Within a five page limit, the design document may include pertinent information such as drawings, photographs, figures, tables and descriptions used in the design process. Evaluated, but rejected, bridge designs may also be included to demonstrate the design process. The judges' decision of the best technical design is final.

SPONSOR CONTACT INFORMATION

For information regarding this event, clarification on bridge competition rules, or any other questions, please contact Dr. Timothy Wood, t.a.wood@citadel.edu.

BRIDGE LOADING

Bridges will be loaded at midspan using a 120mm-by-120mm plate. This plate must be able to sit evenly on top of the bridge structure. See Figure 2.

Design load: 445N (100lb)

Bridges should be designed to resist a 445N load applied at midspan without failure of any bridge members, member connections, or failure of the overall bridge structure.

Minimum load: 25N (5lb)

To be considered for the various award categories, a bridge must support a minimum of 25N (5lb) load applied at midspan without failure of any bridge members, member connections, or failure of the overall bridge structure.

MATERIALS

The bridge itself may only consist of:

- Wooden craft sticks: 113mm by 10mm (4½in by ¾in)
- Carpenters wood glue

No other materials, including but not limited to other types of wood, may be used in the final bridge. The craft sticks may be manipulated physically by cutting them to any size and bending them into any desired shape. Traditional joinery techniques are permitted with only craft sticks and glue. Temporary supports and clamps to aid in the drying process are allowed but must be removed before competition. Sticks may not be chemically treated in any manner by the team or their associates. The safety of each team through the construction and testing process is the responsibility of their advisors and schools. Bridges may not be painted and glue may not be colored. Recommended supplies for design and construction include, but are not limited to:

- Bridge Building apps (bridgedesigner.org, Bridge Basher, etc.)
- Engineer's computation paper
- Tracing paper
- Straight edge
- Calculator
- Sandpaper
- Glue applicator
- Craft or hobby knife
- Trimmers
- Binder clips

BRIDGE SPECIFICATIONS

Length: Between 900mm and 950mm

Each end of the bridge must extend at least 50mm and not more than 75mm beyond the edge of the bridge abutments (platform on which it will be supported). Therefore, the bridge must be at least 900mm long and cannot be longer than 950mm. See Figure 1.

Clear span: 800mm

The bridge must be self-supporting with a clear span of 800mm as shown in Figure 1.

Cross-section Dimensions:

Height: Between 100mm and 150mm

The bridge structure at its maximum point must be no taller than 150mm including the 80mm tall travel path but greater than 100mm with or without the travel path, as shown in Figure 1. Note that the entire bridge and travel path must fit in the model bridge dimensions shown in Figure 1 (i.e., no substructures are permitted). The bridge need not be uniform in height but must still conform to the dimensions for width and travel path.

Width: Between 150mm and 200mm

The total width of the bridge shall be no narrower than 150 mm at every point along the length. The total bridge width shall be no wider than a maximum of 200 mm as shown in Figure 2.

Travel path: Greater than 100mm wide and 80mm high

The roadway must be located within the gross bridge dimensions and must be a minimum of 100mm wide and 80mm high. These minimum dimensions must extend continuously throughout the entire length of the structure and cannot be penetrated by any structural bridge members. See Figure 2. The roadway must be flat, and a block 100mm wide and 80mm high must be able to fit through (or over) the bridge as a car would pass over the bridge. Traffic may pass either through the truss configuration such as the bridge truss on I-526 passing over the Wando River, or over the bridge as on a girder bridge. *Note that sticks are not required to represent the roadway along the bottom of the structure (i.e. the "roadway" may have empty spaces).*

Loading platform:

For all bridges, the designer must include supporting members for the 120mm-by-120mm block that applies the load at midspan on top of the structure. See Figures 1 and 2.

Weight:

This project focuses on meeting design load requirements and design optimization, therefore there is no weight limit.

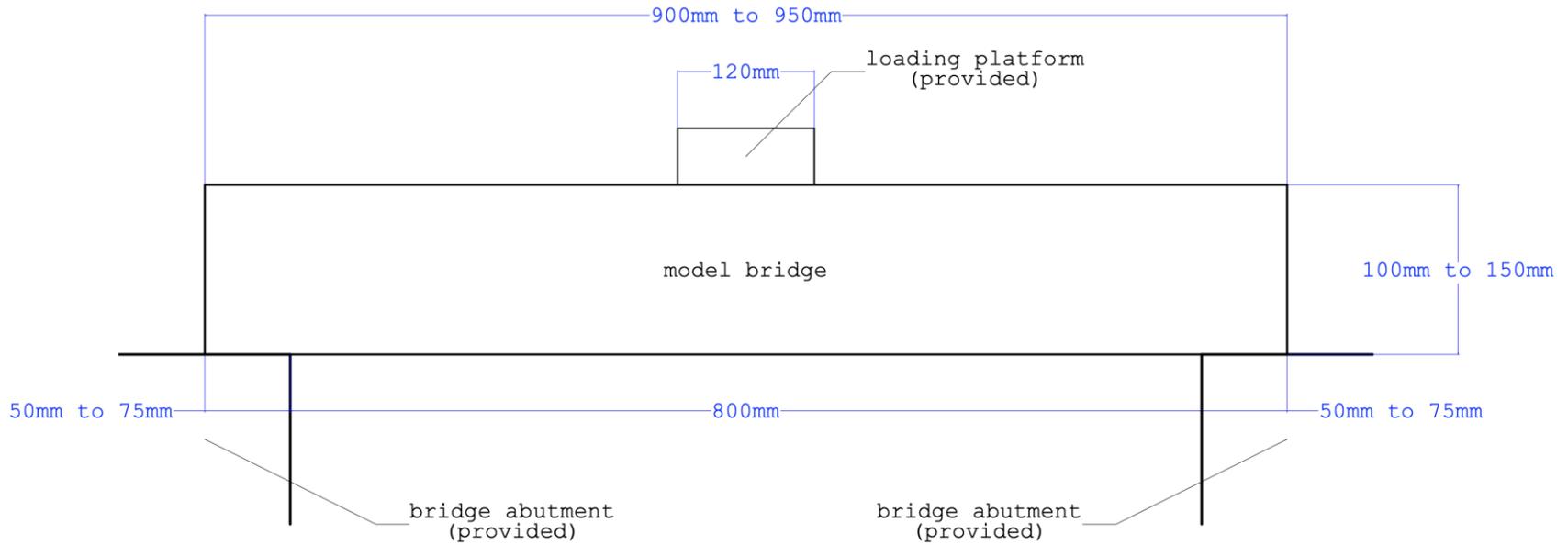


FIGURE 1. SIDE VIEW DIMENSIONS OF MODEL BRIDGE WITH LOADING AT MIDSPAN.

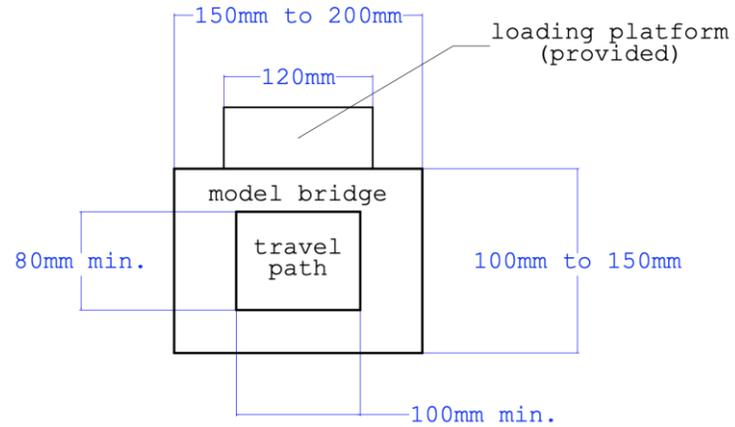


FIGURE 2. END VIEW DIMENSION OF MODEL BRIDGE WITH LOADING AT CENTER AND CLEAR TRAVEL PATH THROUGH THE BRIDGE.