

Hydraulic Bridge Problem Statement

Introduction:

A bridge which permits entry of the watercrafts or freight boats is normally known as the movable bridge. At the point when development depends on the water driven frameworks then it is classified as Hydraulic Bridge. For building a model, regularly utilised pressure driven gear are syringes. As the bridge is over and again opened and shut, fatigue failure is the most concerning factor than failure under steady load. Additionally, the framework is more complex because we cannot provide any footing (other than the pylon support) in order to permit watercrafts/boats to pass.

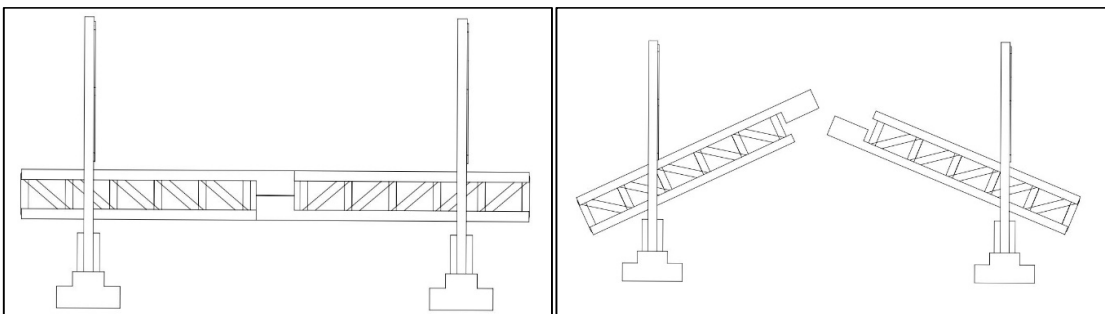


Task:

Design a Hydraulic Bridge using Popsicle sticks, syringes and Fevicol as glue (without utilising any strengthening covering) that can open to a maximum angle and sustain the greatest conceivable load without failure, fulfilling all the understated constraints.

Dimension and Material Specifications:

Bridge in General:

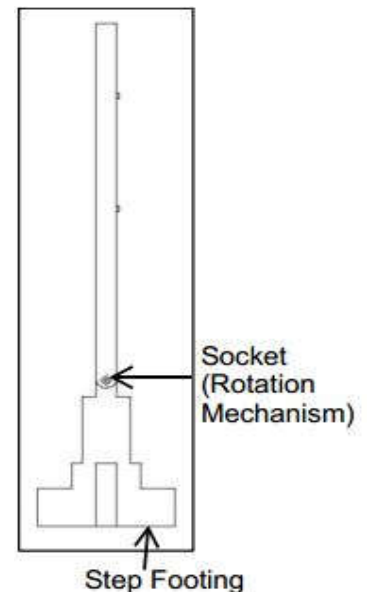


- The Hydraulic Bridge deck must be of length 800mm with an allowance of +/-20mm.
- Deck must be partitioned into two equal parts of length 400mm each and a rotation mechanism must be installed such that each half deck rotates about its respective hinge (hinge between pylon and deck).
- The maximum width of the bridge should be 80mm with an allowance of +/-10 mm (pylon excluded).

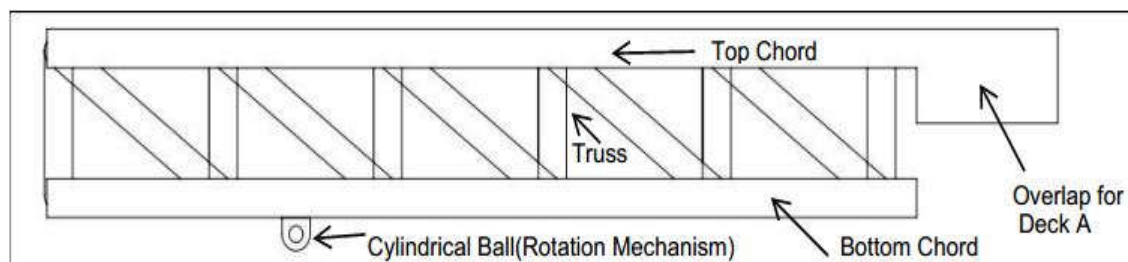
- The bridge must have only two vertical pylons and the span (isolated in two sections) and center to center distance between pylon must be 600mm with an allowance of +/- 10 mm
- The roadway (on the top) must be continuous and must permit a 65mm x 65mm x 65mm vehicle to pass through the entire length of the bridge.
- Total vertical distance of the bottom of the base chord of the deck from the base of the footing must fall inside the extent 100mm to 130mm.
- The maximum vertical distance between pylon top and base of the footing should be 400mm with an allowance of +/-10 mm.
- (Penalty Criteria for above-mentioned rules: Penalty of 5% of total score (refer Scoring section) will be deducted for each dimension exceeding the allowance limit. Further extension in dimension values will lead to direct disqualification.
- The dead load of the bridge must be less than 1.7 kg. (Penalty: Participants will be disqualified if this criterion is not satisfied)

Bridge Pylon:

- The dimension of the footing of the pylon should be 135mm x 100mm for the pylon. The height of the footing must not be more than 50 mm from ground base. Participants are allowed to use any number of stick till this height. (It is highly encouraged if participants use step footing but the height must be within 50mm from the ground)
- The pylon columns must not be thicker than 15mm.
- No more than two sticks should be present at any horizontal cross section of pylon to provide cross-bracing.
- (Penalty: Participants will be disqualified if any of the above 3 rules is violated.)
- The deck must fit between the two columns of the pylon. The socket part of the rotating mechanism (as described later) must be fixed to pylon



Bridge Deck:

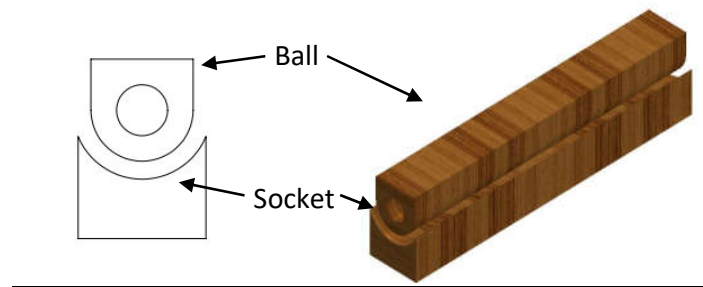


- The deck support between the top chord and the base chord must be a truss (not a beam) whose members are made of Popsicle sticks. The bridge deck should be supported on only two **longitudinal trusses**.
- The spacing between **cross bracings** (if provided) should not be less than 60 mm
- The total length of deck should be 800mm +/- 20mm which must be partitioned longitudinally into exactly two equivalent parts (around 400mm each, say deck A (left part of complete deck) and deck B (right part of complete deck)).

- Center to center distance between pylons at two opposite end must be 600mm with an allowance of +/- 10 mm.
- For the association between the two cantilever portion of deck, an overlap design should be made. This overlap should follow these criteria. The top chord of deck A must be elongated out in right side by 30 mm. Similarly, bottom chord of Deck B should be elongated out in right side by 30 mm to create an overlap. Note that in no case overlapping should exceed 30 mm +/- 5 mm. Failing this will attract a penalty of P= 5 percent of total score.
- The separation between the highest point of the top chord and the bottom of the base chord of the deck must be in between 40mm and 50mm. If the depth of deck is more than this given dimension a penalty of P= 5 percent of total score will be deducted. **The maximum thickness of the both the top and base chords should be 12mm (i.e. 1 popsicle stick width).**
- Overlap criteria for truss individuals- Not more than two Popsicle sticks should be overlapped longitudinally to make a truss member i.e. the maximum thickness of a truss member should be 5mm and **maximum width is 12mm** i.e. width of one popsicle stick.
- Joint criteria for Truss Members - Joints should resemble a pin connection i.e. all ends of members should meet exactly at the joint (a connection of approximately 15 mm diameter) and not more than 10 Popsicle sticks should be overlapped at joints.

Rotation Mechanism:

Joint between pylon and deck



- Ball and Socket joint must be present between the bridge deck and pylon support to provide rotation mechanism.
- Ball mechanism must be introduced on the bridge deck in the form of an outward convex block made of overlapping popsicle sticks (12 mm width and 12 mm depth) covering the breadth of bridge deck and then it can be filed.
- Similarly socket mechanism on pylon support in the form of an inward convex block made of overlapping Popsicle sticks (12 mm width and 12 mm depth) covering the breadth pylon support.
- A screw can be fixed to keep the bridge deck in position. In order to insert the screw a hole can be made on the ball part of joint and at corresponding axis on pylon column. Hole diameter should be slightly bigger than the screw's diameter so that bridge can rotate freely. A maximum of 2 screws (one on each pylon column) can be used for single pylon. (Penalty: Participants will be directly disqualified for breaking this rule and the bridge will not be tested)
- The mechanism (ball and socket) must be comprised of Popsicle sticks, Fevicol and maximum of 4 screws (one on each column of each pylon) only.

Piston Mechanism

- A syringe should be used as a piston to rotate (open) the bridge deck.
- In order to create pressure, air or water can be used in the syringe.
- A maximum of 4 syringes should be used to create the complete mechanism for rotating the bridge.
- Pipes can be used to connect two syringes or for syringe to bridge connection.
- If syringes or pipes are directly connected to bridge in your mechanism then it should be done using M-Seal only
- In order to rotate the bridge deck, one syringe must be attached as pistons for each deck and pylon connection. This syringe must be filled with a fluid and attached to another syringe which would be regulated by the participant in order to rotate the bridge deck. Participants won't be allowed to touch the deck while rotating

Material Constraints:

- Popsicle sticks (maximum length 120 mm, width 12 mm and thickness 2 mm) and Fevicol MR White glue must be used to construct the bridge. The Popsicle sticks can be cut or trimmed to any shape or size.
- Needle should be removed before using plastic syringes
- **M-Seal** must only be utilised to join syringe to the bridge pylon and M-Seal should not be used anywhere else. (Violation of this rule will lead to direct disqualification)
- Adhesives can't be connected on the free surface of a part made of Popsicle sticks or syringe to enhance strength.
- The team will be disqualified if found using any other material other than those mentioned in any part of the structure.

Testing Criteria:

- The dimensions of the structure will be measured and the weight of the bridge will be noted down.
- Angle of rotation of the bottom chord of the bridge deck will be measured (max angle)
- The loading would be done on the bridge using a loading plate-chain system at the center of the bridge. Two plates will be fixed on both side (on outer surfaces) of bridge deck at the center (i.e. the overlapping point of deck A and B) while the chain will be wrapped around the block where it will be loaded.
- Load will increase at a continuous rate and the maximum load sustained by the bridge before the failure will be the noted (see the definition of failure).

Definition of failure:

The structure is considered failed when any of the following happens:

- Any part of the structure fails while loading
- The loading machine registers maximum load and then load starts decreasing
- Vertical Deflection of the top of the deck exceeds 40mm.

Judging Criteria

The judging of the structure is based on 3 important criteria:

- Dead weight of the Bridge (W) in kg
- Load carried by the structure before failure (L) in kg
- Average rotation angle of the bottom chord of deck A (Θ_A) and deck B (Θ_B)

$$\Theta = (\Theta_A + \Theta_B) / 2$$

Marking Schemes:

The value of S1 is determined by ratio of load carried by the structure before failure and dead weight of bridge,

$$S1 = \frac{L}{W}$$

The value of S2 is determined according to the formula below,

$$S2 = \frac{\theta}{60}$$

Final Scoring:

Final competition results will be calculated based on the following formula,

$$\text{Final Score} = S1 * S2 * \left(1 - \frac{P}{100}\right)$$

Where P is the total points of penalty incurred by the team.

In case of a tie, the team with the higher S1 will receive the higher rank. In the unlikely event the teams are still tied, the team with higher S2 will receive the higher rank.

Rules:

- Bring from home competition so certificates will be awarded to every participant.
- Student should form teams comprising of maximum 5 members. Students from different colleges can also form a single team.
- Shape of the deck must be rectangular in the longitudinal direction.
- Once the structure is measured, you are not permitted to change your structure.
- In order to rotate the bridge deck, one syringe must be attached as pistons for each deck and pylon connection. This syringe must be filled with a fluid and attached to another syringe which would be regulated by the participant in order to rotate the bridge deck. Participants won't be allowed to touch the deck while rotating.

- In case that any of these requirements are not met, point deductions (as mentioned) or disqualification might be forced at the sole discretion of the organisers.
- No certificate will be provided to disqualified teams.
- Team AAKAAR's choice will be last and authoritative on all.
- The organisers hold all rights to change any or all of the above rules as they deem fit.

Contact information:

For any queries regarding this competition register a query on Query Portal on website. We will try our best to revert back as soon as possible. Please avoid contacting AAKAAR team members directly without following the first step. Queries already mentioned in comments won't be entertained again.

Email Id: aakaar.competitions@gmail.com

(Subject: Query regarding BridgeIt competition: Team Leader Name_AAKAAR ID)

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ALL THE BEST!!!

TEAM COMPETITIONS, AAKAAR 2017