

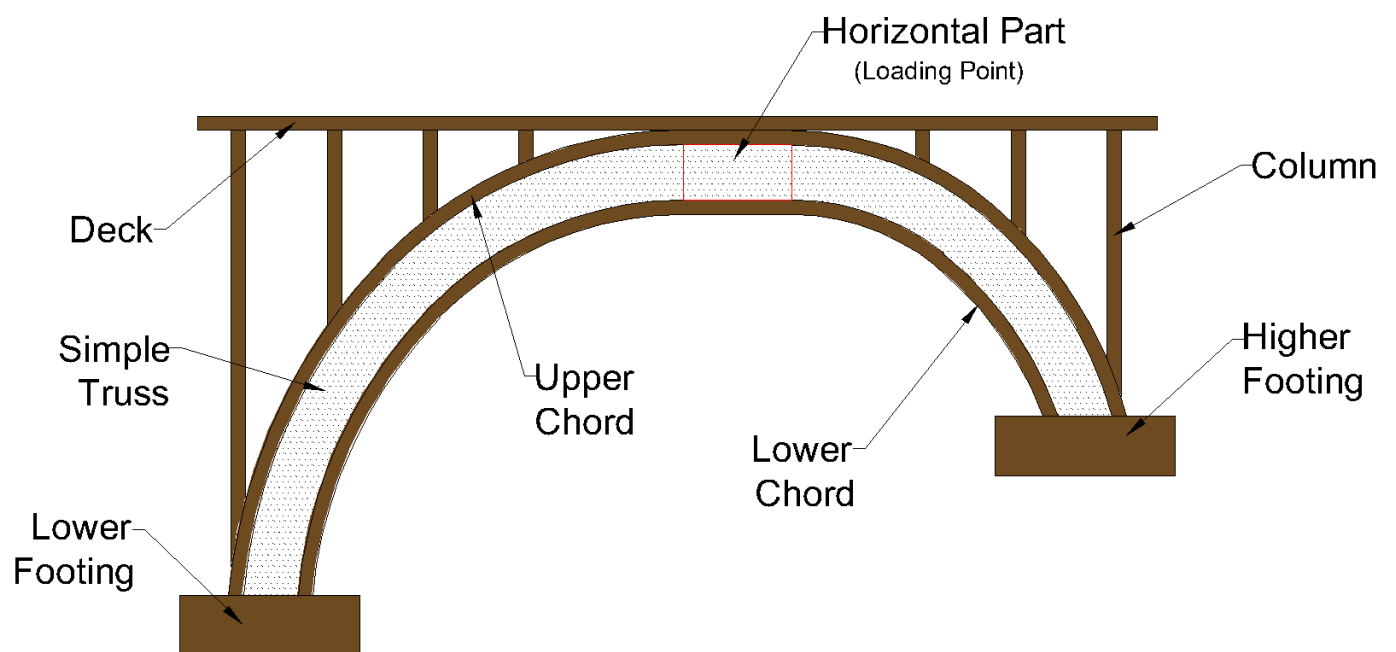
TRUSSED ARCH BRIDGE PROBLEM STATEMENT

Introduction

Designing Bridge for the hilly area is very challenging as land is too much undulated therefore designing of the bridge with footings at different levels is required for such areas. For such kind of bridge, we need to consider horizontal sway forces along with dead and live forces. Thus we are launching the competition to design Trussed Arch Bridge with different level of footings. As its name suggests, the main supporting structure in an arch bridge is curved element. The dead and live forces that act on the arch bridge are transmitted along the curved line of the arch into abutments at either end. Arch bridge transfers not only the vertical load but also the horizontal stresses to the supports and thus it is very efficient bridge for such conditions.

Task

Design a Trussed Arch Bridge using Popsicle sticks and Fevicol as adhesive (without utilizing any strengthening covering) that can sustain the greatest conceivable load without failure, fulfilling all the understated constraints.



Dimension and Material Specifications:

Bridge in General:

- The bridge must be deck arch bridge only.
- The Arch Bridge deck must be of length 800mm with an allowance of ± 20 mm.
- The maximum width of the bridge should be 80mm with an allowance of ± 10 mm.
- The difference in the level of the base of footings must be 150 mm with an allowance of ± 10 mm.
- The height difference between roadway and base of the lower footing must be 450mm with an allowance of ± 10 mm.
- The bridge should have maximum 14 vertical columns (7 pairs) connecting deck and arch.
- Centre to Centre horizontal distance of footing should be 680mm with an allowance of ± 20 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.

Bridge Arch:

- The Arch should be made of two similar Frames (called as Arch Frame).
- The Arch frame can be circular, parabolic or any other innovative curve.
- Each Arch Frame support between the top chord and bottom chord must be simple truss (not a beam) whose members are made of popsicle sticks.
- At any cross-section, the separation between the highest point of the top chord and the bottom of the base chord of the arch frame must be 70mm with an allowance of ± 10 mm.
- The depth of each chords should not be more than 12mm (i.e. 1 popsicle stick width) and maximum 2 popsicle stick can longitudinally overlap for it.
- Bottom chords of the two parallel Arch frames should be connected at joint by single popsicle stick.
- No longitudinal overlapping of popsicle sticks is allowed in any truss members (i.e. a single popsicle should be used).
- 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 15mm diameter) and not more than 10 Popsicle sticks should be overlapped at joints.
- There should be horizontal part in both top and bottom chord of length 90mm with an allowance of ± 10 mm. Centre of this straight part should be at distance (Horizontal distance) of 400mm with an allowance of ± 10 mm from the **center of lower footing**.

Column:

- The column should start at the deck and should end at upper chord of the arch.
- No more than 2 Popsicle sticks should be used in the column. However, Participants can attach 2 additional popsicle stick of length no more than 20mm at the joints of truss.
- Columns must be connected by lateral truss only.
- No more than two sticks should be present at any horizontal cross-section of two connected columns to provide cross-bracing.

Deck and Roadway:

- The deck must be beam member which can be supported by column or directly by arch.
- Maximum 4 popsicle sticks can be overlapped for width of beam and maximum depth of beam should be 15 mm.
- Only two beams are to be made to support the roadway.
- The roadway must be continuous and horizontal. See Testing and judging criteria for further information.

Footing:

- The dimension of the footing should be 150mm x 120mm. The depth of the footing should be 50 mm.
- Participants are allowed to use any number of sticks in the footing.

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 into any shape or size.
- Adhesives can't be connected on the free surface of a part made of Popsicle sticks to enhance strength.
- The team will be disqualified if found using any other material other than those mentioned

Testing Criteria:

- The dimensions of the structure will be measured and the weight of the bridge will be noted down.
- Testing setup will have two arms (which will provide a base for footings of the bridge) with a level difference of 150mm.
- The difference in the level of two ends of the roadway after putting the bridge in testing setup will be measured.

- The loading would be done on the bridge using a loading plate-chain system at the horizontal straight part of the bridge.
- The 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.
- The maximum difference in the level of two ends of the roadway after putting in testing setup 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.
- Difference in the level of two ends of the roadway just after putting in testing setup(H) in mm.

Marking Schemes:

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

$$S1=L/W$$

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

$$S2=(1-H/200)$$

Final Scoring:

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

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

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 qualified participant.
- The student should form teams comprising of maximum 4 members and minimum 2 members. Students from different colleges can also form a single team.
- The 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 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.
- **Queries related to Problem Statement will be entertained only by mail.** Mail id for any query is mentioned below.
- Any query related to this competition should be asked by **Team Leader only**.

Contact information:

For any queries regarding this competition register a query on Query Portal on the 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 Bridgelt competition: Team Leader Name_AAKAAR ID)

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ALL THE BEST!!!

TEAM COMPETITIONS, AAKAAR 2018