

# Association of Civil Engineers (ACE)

Indian Institute of Technology, Patna

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## Spagaridge Rules

Celesta 2016

### • Introduction

The first bridges built by humans were probably just wooden planks or boulders placed on a flowing stream. But today, engineers have built bridges to cross vast stretches of rivers. Before actually constructing a bridge, we need to model it and test its performance in the lab.

Celesta brings you a chance of showing your engineering skills with noodles!

So, get innovative and build your bridge model with this unconventional construction material.

### • Objective

Design and construct a model of a single span truss bridge with the help of **spaghetti noodles** satisfying the constraints stated below.

### • Event Structure

- **Round 1:** The teams shall mail a zip file containing the abstract of their design to [ace@iitp.ac.in](mailto:ace@iitp.ac.in). The abstract should contain the following:
  - Drawings of the design (isometric and orthographic views) with proper dimensioning on AutoCAD or clear pictures of handmade sketches. Clearly state the specifications and advantages of your design and any innovative idea that you have.
  - Analysis of the design according to the dimensions specified in the problem statement in a simulation software namely Bridge Designer 2016.  
*The analysis is mandatory. Workshop for the same shall be conducted.*  
**The teams will be shortlisted for Round 2 on the basis of their abstracts.**
- **Round 2:** The shortlisted teams shall construct their bridge under the surveillance of the organising team at IIT Patna.
- **Round 3:** The model built by each team will be tested till failure (yielding) by applying an incremental static load.

### • Team Size

Each team should have 3 or 4 members.

### • Dimension specifications

The dimensions of the bridge model must be within the following limits:

- Length: 56-60 cm
- Width : 10-11 cm
- Height: 12-16 cm
- There should be a proper clearance for a 10cm X 8cm X 8cm box to pass through the span of the bridge.
- The members of the bridge can be built by grouping a maximum of 8 sticks of Spaghetti noodles together.

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- **Weight specification**

The bridge model should weigh 350 grams or less.

- **Arena specifications**

- The arena has two wooden columns representing the landmass on the sides of a river.
- The distance between the inner edges of these columns is 46 cm.
- One cylindrical support of diameter 2cm and length 15cm is placed on each of the wooden column.
- One of the cylindrical supports is fixed to the column and the other is free to act as a roller.
- The arena is as shown below:

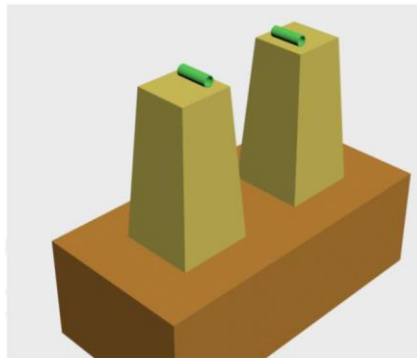


Figure1. Isometric View

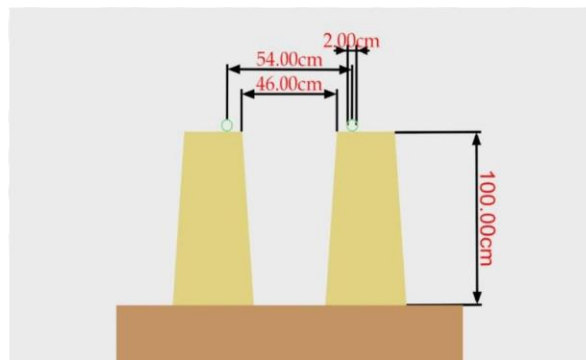


Figure2. Front View

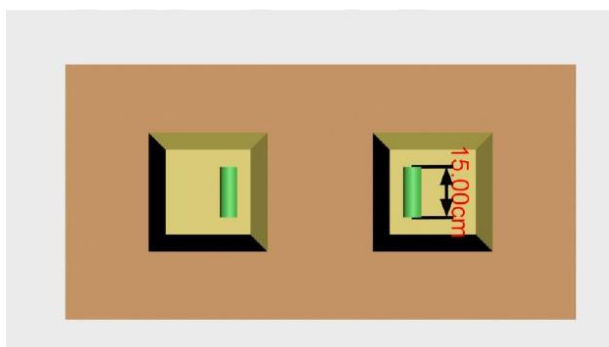


Figure3. Top View

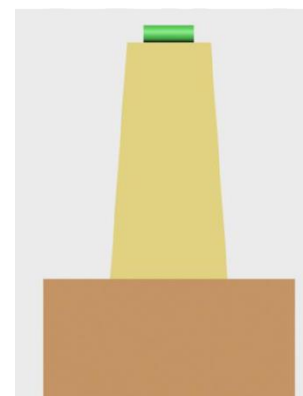


Figure4. Side View

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- A sample spaghetti bridge placed on cylindrical supports is shown below:



- **Materials**

The teams shall be provided the construction materials. The teams can bring required tools to build the structure.

The following materials will be provided:

- Spaghetti noodles
  - Cutter
  - Pencils
  - Ruler
  - A3 size sheet
  - Glue
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- **Some properties of spaghetti (dry):**
    - Ultimate tensile strength  $\sim 2000$  psi
    - Stiffness (Young's modulus)  $E \sim 10,000,000$  psi
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- **Testing of the structures**
    - The dimensions and weight of each structure will be measured. Structures violating the dimensional and weight specifications will be penalised according to the rules.
    - Each structure will be mounted on the arena over the two cylindrical supports shown in the arena.
    - A 20 cm X 8 cm wide plate will be placed symmetrically on the base of the structure.
    - The centre of the plate will be bolted to a screw-jack which will apply load on the structure. The screw-jack will be connected to a load cell to measure the load being applied.
    - The structure will then be loaded and a continuous monitoring of its deflection and load will be done until it fails. The maximum load taken by the structure will be noted.

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## • Evaluation of the structures

The structures will be evaluated on the basis of their performance under loading as well as on the basis of aesthetics.

- The efficiency of each structure will be calculated according to the following formula:

$$e = (\text{Maximum Load}) / (\text{Weight of Structure})$$

- Evaluation on the basis of aesthetics will be done by judges and will include criteria like:
  - Innovation in design
  - Cleanliness of work
  - Overall look of the structure

## • Scoring

The final score of each structure will be calculated according to the following rules:

- 70% weightage - Efficiency

Maximum efficiency by any structure will be taken as the constant 'E' and points will be calculated according to the formula:  $X = (e/E) * 70$

- 30% weightage - Aesthetics

Each structure will be graded by the judges on a scale of 0-30.

## • Penalties

Penalties as mentioned below will be imposed if the structure violates the dimensional or weight specifications.

- **Weight exceeds the limit**  
(Penalty of 15% of the total score)
- **Dimensional specifications are not met**  
(Penalty of 10% of the total score)
- **Use of any material other than that provided**  
(Penalty of 50% of the total score or can lead to disqualification as decided by the judges)

In case of any discrepancies, the decision taken by the judges and the coordinators will be final and bounding.

**Pranav Suresh**  
Co-ordinator

**Abhishek Anand**  
PG Co-ordinator

**Dr.Vaibhav Singhal**  
Faculty In-charge