

Challenge 3: Bridge construction

BACKGROUND

In Hong Kong a new highway between towns in the North West New Territories has been proposed to increase the efficiency of its transport system. It has been noted that due to the terrain bridges will be need to be constructed. When building these bridges special care is needed in the design and construction of the foundations for these bridges, particularly in areas underlain by a marble formation which has a varied underground structures such as fissures, sinkholes, underground streams and caverns. Earthquakes are common in this area, so movement/failure of these foundations has to be considered. The state government has asked for designs of bridges capable of being largely supported from just one mounting end (i.e. a cantilever). The designs are to be tested by pumping water to the unsupported end of the bridge until it fails, and the best design will be chosen based on both the beam length and the load capacity. A local steel fabrication industry is able to provide quantities of standard bridge girder sections to the project, entailing minimal cost and transportation.

MATERIALS

Each team is provided with:

- 100 prefabricated paddle pop sticks
- Spaghetti
- Bluetac

RULES

Each team may use any of the materials which are supplied in any way that they see fit as long as they fulfil the following requirements:

- The design has to be over 200mm long (roughly two paddle pop lengths).
- Interfering with another team's cantilever or materials will see your team receive a zero score for this challenge.
- You may only use the 100 paddle pop sticks provided. If any of your paddle pop sticks are defective, or you break any during construction, you may have them replaced: talk to a volunteer.
- You may elect where to apply the load on the bridge; this will determine your length measurement (see scoring).
- The bridge has to be built onto the attachment plate provided.
- You are allowed to test your bridge before by hand, but the official water testing may only be performed once.
- The tester's decisions and scoring are final.

TESTING

1. A representative from the team will inform a judge their bridge is ready for testing.
2. Teams will have their bridges measured prior to testing. The bridge must be greater than 200mm long, or it will be disqualified with an overall score of zero.
3. The judge will attach the loading apparatus, and pour water into the bottle until the bridge fails. The amount of water in the bottle will be measured and determine your performance score.



SCORING

The score will be comprised of two components:

- Length
 - 1 pt will be awarded for every 1cm in length of the bridge
 - Please note that a length under 200mm receives a score of 0
 - Length is measured from the front of the mounting plate to the point at which the load is applied
- Strength
 - Points awarded are equal to the mass, in grams, applied to the structure before catastrophic failure.
 - Catastrophic failure is considered to be failure such that the water bottle falls, or would fall to the ground.
 - This mass will be based on the volume of water in the bottle, and is accurate only to within 50g. Values are rounded DOWN.

Final score will be calculated by: **[Final Score] = [Length] x [Strength]**

*e.g. if your bridge is 38cm long, and supports 600g of water, your score is: 38 * 600 = 22,800*

HINTS

- Every team has the same limited materials, so you will need to be innovative with your design: plan ahead, agree on a strategy before you begin building, and stick to it!
- Triangles are the natural nemesis of flexibility...
- Quality control becomes increasingly important on projects with a large number of parts.

REFERENCES

[1] *Geological Society, London, Engineering Geology Special Publications; Potential construction problems for bridge foundations in areas underlain by a complex marble formation in Hong Kong 1995; v. 10; p. 127-134; DOI: 10.1144/GSL.ENG.1995.010.01.10*

