Let’s build bridges!

Introduction

Bridges are amazing structures that help us cross rivers, valleys, and even other roads. You might have heard of the famous Howrah Bridge in Kolkata or the new *Atal Setu* in Mumbai, which is (currently) the longest sea bridge in India! Have you ever heard of the *Chenab* Rail Bridge in *Jammu* and *Kashmir*, or the living bridges of Meghalaya? Are they natural or human-made? Bridges, both in India and around the world, are known for their size, beauty, and history. They connect people and places, making travel faster. In this unit, we will explore some simple bridges and learn why they are considered great examples of engineering. You may have also heard news of many bridges breaking these days. Why do you think bridges break? Let us start understanding bridges step by step.

Q1. Have you seen bridges around you? Where you have seen bridges, and what was the purpose of the bridge? Share with your classmates.

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Q2. Have you heard about any bridge breaking/collapsing? From which point did it break? What was the cause?

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Q3. Draw the bridges you have seen in your life. What geometrical shapes do they include?

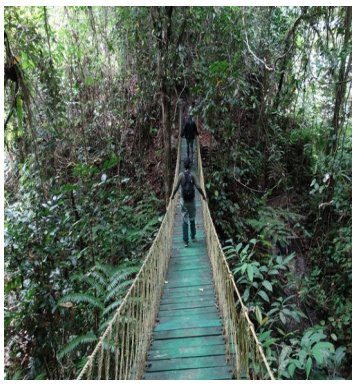
Task 1: Looking at some actual bridges: Photographs of some real bridges are given here.

(a)

(b)

(c)

(d)



(e)

(f)

(g)

(h)

(i)

Figure 1: *Various examples of bridge*

Have you seen any bridges with similar structure? Where? In each of these bridges, the flat part of the bridge is common, on which humans, animal and vehicles pass through. In addition, certain structures,

parts are made to support the flat part of the bridge.

Q4. Can you guess the materials required in building or constructing support structures in each of these bridges?

(a) _____ (b) _____ (c) _____

(d) _____ (e) _____ (f) _____

(g) _____ (h) _____ (i) _____

Q5. (a) In which of the above cases, support is given to the flat part from below? Which materials are used for these support structures?

_____

(b) In which cases support is given from above? What materials are used for the support structures?

_____

_____

Q6. What geometrical shapes you can identify in each of the bridges?

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Q7. Is there any passage of vehicles/people under the bridge? Does it affect the overall design of the bridge?

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Task 2: Making a paper bridge

Make groups of 3-4 students. We want to build a simple model of a bridge using paper as a material. Take two compass boxes/ books /blocks with equal height as two end supports. Take two unwrinkled A4 paper sheets.

Sheet 1: Can be used creatively, by folding, cutting, or gluing/taping as needed, to construct and reinforce the flat part of the bridge. The length of this structure should compulsorily be 17 cm only.

Sheet 2: Use a part of it as the flat road surface of the bridge. This flat paper will rest on the structure you created with sheet 1. You may use glue or tape to combine sheet 1 and 2.

The bridge created with those 2 sheets should rest on the end supports one centimeter on each side as shown in the figure 2. Do not use glue, tape, or staples to attach the bridge to the end supports. You are also not allowed to support the bridge from the middle.

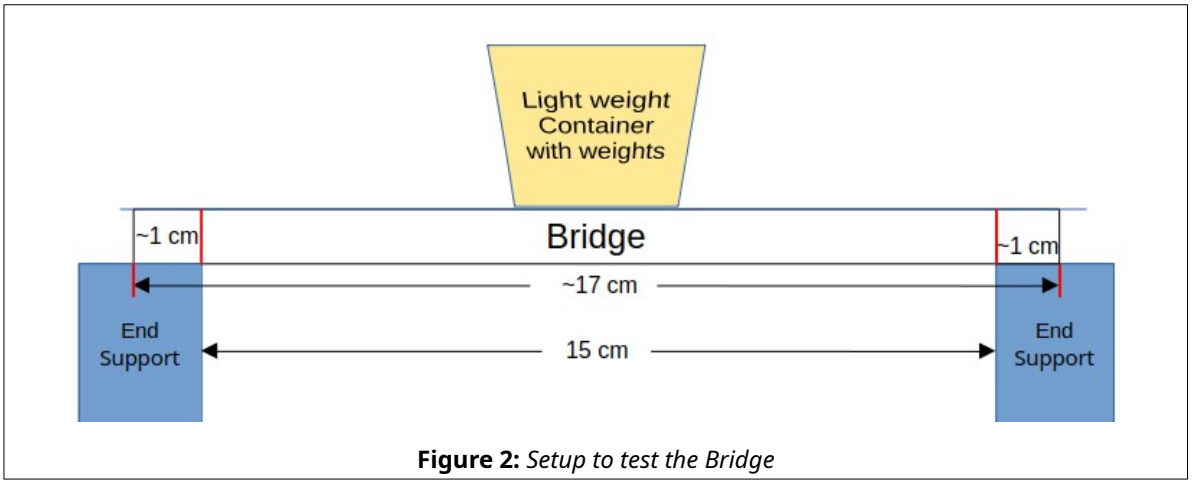

Figure 2: *Setup to test the Bridge*

Rules while making the bridge:

1) The two end supports (pillars) supporting the bridge must be placed 15 cm apart.

2) while you are allowed to cut or glue/tape to combine sheet 1 and 2, you are not allowed to use glue, tape, or staples to attach the paper bridge to the end supports (pillars) at either end.

Design a bridge capable of supporting a greater amount of weight while adhering to these rules. Some suggestive shapes for support structures using second paper are given below. You should also come up with at least one new design.

i. Plain paper with no folds and no wrinkles
ii. Rolling the paper from both ends as an arch
iii. Folding the paper such that a triangular cross section can be seen
iv. Folding paper in zigzag form
v. Folding the paper to have a U-cross section
vi. Forming cuboidal structure by folding paper
vii. Making supporting pipes by rolling both long edges of the paper

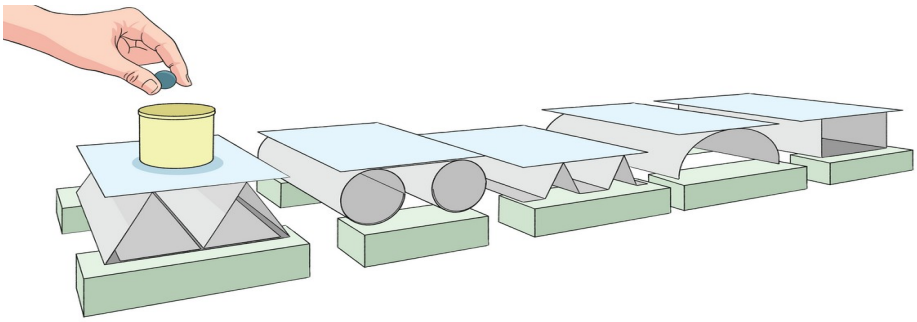

Figure 3: Suggestive p*aper structures for bridges*

4) The maximum weight that can be supported by the bridge (also known as load bearing capacity of the bridge) can now be tested by putting a lightweight container (plastic dish or paper box) in the middle of the bridge and adding small weights like *chanas*/coins/marbles to it one by one. (You don't need to calculate the total weight; simply count the number of objects placed on the bridge, as each object has approximately the same weight. For example, the bridge's capacity can be expressed as the number of objects it holds, such as 10 marbles or 5 small blocks.)

Q8. Describe the shape/structure of your bridge, and **predict** how much weight the bridge can support?

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Once you make your predictions, start adding weight to the lightweight container to test your bridges.

Rules while testing the bridge

1) You cannot place the paper cup and weights on the end support or pillar; You have to place the lightweight container only in the middle of the bridge.

2) Use the same lightweight container consistently for testing all the bridges.

3) Make sure you use the same type and size of paper for all your tests.

Note: Any paper bridge that does not adhere to the specified design constraints given earlier cannot be tested for strength or performance.

Q9. Explain significance of point 3.

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When you put too much weight in the container, the middle of the bridge will start lowering towards the ground. You can keep adding weight until the bridge collapses OR the shape gets permanently deformed, The weight at this stage can be considered just over the maximum capacity of the bridge.

	Shape/Structure of bridge structure	**Predict how much weight the bridge can support**	**How much weight did the bridge support?**
1	Plain Paper (no folds)		
2	Zig-zag		
3	…….		
4	……..		

Q10. How does the paper bridge changes to increasing loads, and what is its maximum capacity?

_____

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_____

Q11. When we add weight to the container, their total (resultant) weight (force) acts on the paper. What is the direction of this force? Are there any other forces acting on the paper?

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Q12. Which type of structure(s) is (are) not able to take much load?

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Q13. How does the design affect the strength of the bridge? What do you think happens?

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Task 3: Bridge design considerations

Design brief: Imagine you are an engineer, and you have been given the following design brief: Two towns are separated by a sea-water creek, 500 meters wide at points A and B. Across this creek we need to build a bridge that will support the weight of about 40 trucks (live load) at a time. The creek is affected by the ocean tides. At high tide, the depth of water in the creek is around 6 meters.

Figure 4: *Aerial view of Towns A and B separated by a river*

At the most basic level, bridges serve as paths for transport. But in some sense they also are the links between two communities or cultures (for example, the 2 towns mentioned in the design brief). The design of the bridge is influenced by a number of factors. Use the given example to discuss the kind of factors an engineer may need to think about before designing a bridge. This will give a better understanding of any design problem.

Q14. What factors would you consider while building this bridge? Some factors are listed below. List at least 10 more.
i) Stability of bridge during strong water flow
ii) Materials that will bear the weight of the bridge
iii) Cost of construction

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Q15. What kind of environmental harm can happen due to construction of a bridge?

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Q16. What all you can do to make the construction of this bridge less harmful for the environment?

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Task 4 (Possible extension) : Using a different material - Threads

Now that we have looked at 'paper' as a material to build bridges and tested various designs, let us try to make use of thread to design stronger bridges. Can you think of ways to do it?

You can do this activity in groups. You can use cardboard/chart paper and threads to design a bridge such that the load is taken up by the thread, giving more strength to the bridge. You also need to ensure that the pillars supporting the entire structure have a firm support themselves. Here is an example:

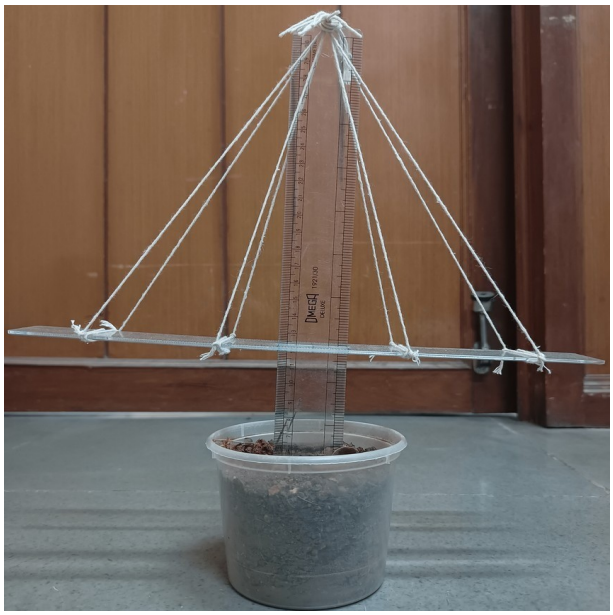

Figure 5 : *Making a bridge using threads*

Q17. Can you describe this picture? What are the materials used? How does the structure help in load bearing?

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As you can see, here we have used plastic scale to make the skeleton of the bridge. You can instead use multiple layers of paper or cardboard to make it and then tie threads (you might have to punch holes or cut small slits in the cardboard for the threads to stay and not slide away) to it to help bear the load.

Q18. Is there some particular pattern in which you tie threads?

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Feel free to design your own bridge, but make sure that threads are doing the weight lifting and not there just for aesthetics.

Q19. How will you test if the threads you used are actually the ones bearing weight?

_____

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Image Sources

Figure 1: Photographs of Various Real Bridges

(a): ExportersIndia. (n.d.). *Foot over bridges, structure type: Prefabricated* [Product photograph]. https://www.exportersindia.com/product-detail/structural-steel-fabricated-foot-over-bridges-4126495.htm Retrieved October 3, 2025,

(b): Doodles43. (n.d.). *Golden Gate Bridge San Francisco* [Photograph]. Pixabay. https://pixabay.com/photos/golden-gate-bridge-san-francisco-1549662/ Retrieved October 3, 2025, from

(c), (e), (g): Muralidhar, A. (n.d.). *Bridge photographs (c, e, g)* [Personal photographs].

(d): alex1965. (n.d.). *Stone Bridge Verona* [Photograph]. Pixabay. https://pixabay.com/photos/stone-bridge-verona-italy-3067953/ Retrieved October 3, 2025, from

(f): ANI. (2024, June 21). *Indian Railway conducts a trial run on the newly constructed world's highest railway bridge—Chenab Rail Bridge* [Photograph]. The Hindu. https://www.thehindu.com/news/national/railways-conducts-trial-run-on-worlds-highest-arch-rail-bridge-in-j-k/article68314011.ece

(h): Ganesh Mohan T. (n.d.). *Umshiang Double-Decker Root Bridge 01* [Photograph]. Wikimedia Commons. https://commons.wikimedia.org/wiki/File:Umshiang_Double-Decker_Root_Bridge_01.jpg Retrieved October 3, 2025, from https://creativecommons.org/licenses/by-sa/4.0/

(i): Pinterest. (n.d.). *Natural tree bridge over stream* [Photograph]. https://i.pinimg.com/originals/d8/16/2c/d8162c3debb12949ef18761342008de8.jpg Retrieved October 3, 2025

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