

STEM *Sims*™

# Bridge Metal



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**Do you need an idea for a scientific study?**

**Try out one of our ideas or make one of your own.**

Start right now learning about the basics of building and maintaining the strongest bridges. Take the following brief quiz to see how much you already know about how to test the strength of different metals for bridging and how to design a strong bridge. See the bottom of page 4 to check your answers.

1. About how many vehicle traffic bridges are currently in the United States?
  - a. 6,000
  - b. 60,000
  - c. 600,000
  - d. 6,000,000
2. About what percentage of vehicle traffic bridges in the United States are currently rated as “structurally deficient” or “functionally obsolete?”
  - a. 5%
  - b. 10%
  - c. 25%
  - d. 55%
3. What is the estimated cost to repair or replace vehicle traffic bridges in the United States that are currently rated as “structurally deficient” or “functionally obsolete?”
  - a. \$10,000,000
  - b. \$100,000,000
  - c. \$15,000,000,000
  - d. \$150,000,000,000
4. How many deaths due to bridge collapses have been reported in the United States between the years 1960 – 2015?
  - a. 37
  - b. 342
  - c. 3,544
  - d. 53,882
5. Most major bridge collapses in the United States between the years 2000 – 2018 were due to:
  - a. bridge design flaws.
  - b. bridge material failures.
  - c. collisions of vehicles or ships with the bridge structure.
  - d. natural disasters.

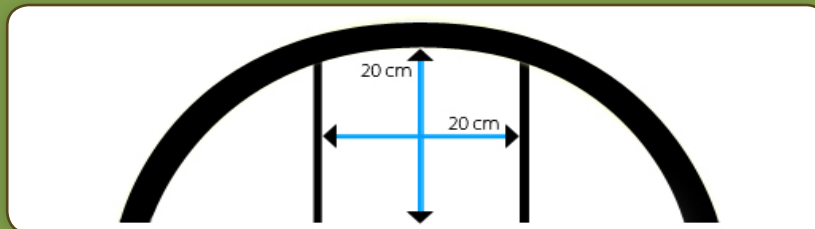


## Bridge Building

**Your task is to design and build the strongest bridge possible using the given materials. The bridge must have the design specifications listed below.**

### Design Specifications

1. The bridge must be free standing on a tabletop, except for two small pieces of masking tape anchoring each end of the bridge to the tabletop.
2. The bridge must span a total distance of 80 centimeters.
3. The center span of the bridge must allow a box with a width and height of 20 centimeters to pass under the bridge as shown in figure 1.
4. The deck of the bridge must be at least 3 straws wide, start from the tabletop level, rise up to allow the box to pass under the bridge, and return to the tabletop level.
5. The bridge must support the greatest weight possible from the center of the bridge span.



### Materials Required for Each Group

- 50- drinking straws
- 50- paperclips
- one-pair scissors
- two 5-cm long pieces of masking tape
- \*one-box of metal washers to test bridge strength (one per class)

### Procedure

#### Part 1. Building Your Bridge

Using only the available materials, build your bridge according to the design specifications.

#### Part 2. Testing Your Bridge

1. Bend a new paperclip to form a weight hanger.
2. Attach the weight hanger on the middle of the bridge to be tested.
3. Place one washer on the weight hanger attached to the bridge.
4. Continue adding washers, one at a time, until the bridge collapses.
5. Note and record the number of washers required to collapse the bridge.

### After Your Bridge Test

1. Draw and label the forces acting on your bridge when you had washers suspended from the weight hanger.
2. Discuss how you could have changed your bridge design to improve the bridge's strength.

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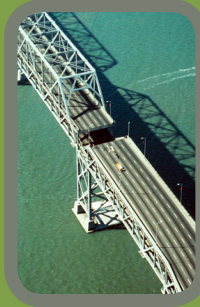
## Rate a Bridge

Transportation's Federal Highway Administration created a National Bridge Inventory that lists and rates bridges in terms of their safety. The rating scale goes from 0 to 9. The scale appears in the table below.

Rating	Bridge Condition Description
0	Bridge closed
1	This value of rating code not used
2	Basically intolerable requiring high priority of replacement
3	Basically intolerable requiring high priority of corrective action
4	Meets minimum tolerable limits to be left in place as is
5	Somewhat better than minimum adequacy to tolerate being left in place as is
6	Equal to present minimum criteria
7	Better than present minimum criteria
8	Equal to present desirable criteria
9	Superior to present desirable criteria

The rating scale also describes bridges as being "structurally deficient" or "functionally obsolete". This does not necessarily indicate that the bridge is unsafe, only that certain restrictions must be placed on the use of the bridge. For instance, limits might be placed on the speed or weight of vehicles that can use the bridge.

A study completed in 2018 reported that 7.5% bridges in the United States were categorized as "structurally deficient." The report estimated that \$50 billion in repairs would be needed to bring these bridges up to the higher standards. The report also stated that 8.5% U.S. bridges were rated "functionally obsolete." The total cost to replace those bridges...an estimated 100 billion dollars.



All of the components of a bridge are rated, such as the width of the safety shoulders, the condition of the roadways that lead up to the bridge, and how often the bridge area is flooded. The volume and type of traffic that uses the bridge must also be factored into determining just how safe a bridge is for its current use. The safety of a bridge depends on many factors other than the design and fitness of the materials that make up the bridge's structure.

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The Science Fair Kits project was funded in part under the Department of Homeland Security Science and Technology Directorate grant contract #N10PC20003. Its contents are solely the responsibilities of the authors and do not necessarily represent the official views of the Department of Homeland Security.

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