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QuickView

Students determine whether bridge superstructures are made stronger by using triangular or rectangular supports.

Standards Addressed

NSTA 5-8
Students develop abilities necessary to do scientific inquiry.

- Students use appropriate tools and techniques to gather, analyze, and interpret data.
- Students think critically and logically to make the relationships between evidence and explanations.
- Students communicate scientific procedures and explanations.
- Students use mathematics in all aspects of scientific inquiry.

Students develop abilities for technological design.

- Students evaluate completed technological designs or products.

NCTM 6-8
Students select and use appropriate statistical methods to analyze data.

- Students develop and evaluate inferences and predictions that are based on data.

Students use visualization, spatial reasoning, and geometric modeling to solve problems.

- Students draw geometric objects with specified properties, such as side lengths or angle measures.

Students understand measurable attributes of objects and the units, systems, and processes of measurement.

- Students understand both metric and customary systems of measurement.

Students apply appropriate techniques, tools, and formulas to determine measurements.

- Students select and apply techniques and tools to accurately find length, area, volume, and angle measures to appropriate levels or precision.

Students recognize and apply mathematics in contexts outside of mathematics.

ITEA 6-9
Students develop abilities to assess the impact of products and systems.

- Students learn to design and use instruments to gather data.

Students will develop the abilities to apply the design process.

- Make two-dimensional and three-dimensional representations of the designed solution.
- Make a product or system and document the solution.

Time Required

180-270 minutes (will vary with class size)

Content Areas

Primary: Science
Secondary: Math, technology

Vocabulary

- compression
- substructure
- superstructure
- tension

Materials

- Toothpicks
- Glue
- Scissors or hobby knife
- Tape
- Ruler
- Graph paper
- Pencil
- Bridge tester (or container)
- Test block
- Sand, gravel, or other mass
- "Substructures and Superstructures" resource page
- "Tension and Compression" resource page
- 2 solid surfaces to use as supports
- Waxed paper

Procedure

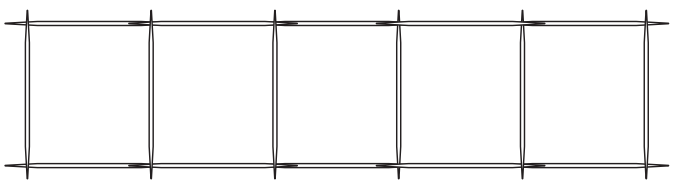
1 Read the "Substructures and Superstructures" resource page and the "Tension and Compression" resource page.

2 Hypothesize how the strength of a bridge based on rectangular structures relates to the strength of a similar structure based on triangular structures. Record your hypothesis on the back of a sheet of graph paper.

Examine each hypothesis before the test to verify that the hypothesis is a testable statement.

3 Measure the length of the individual toothpicks.

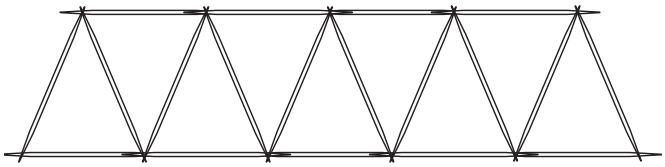
4 Use the ruler to draw a design for the roadbeds on the front of the graph paper on which you recorded your hypothesis. Use straight lines to represent the toothpicks. The roadbeds for both types of bridge will be identical. The roadbeds will be five toothpicks long with adjacent toothpicks overlapping each other one-fourth inch. Place six toothpicks between each side of the roadbeds and perpendicular to the sides: one toothpick on each end and one toothpick at each intersection of two side toothpicks. Build the roadbeds.



Toothpick bridge roadbed

5 Draw two copies of a triangular-based support superstructure side of the bridge. The top of the superstructure should be four toothpicks long and the bottom should be five toothpicks long. The top should be centered above the bottom. Ten toothpicks should be placed so that each toothpick connects one end of a toothpick on top to the end of a toothpick on bottom. The distance between the sides needs to be equal to the height of the triangles formed by the angled supports rather than the length of the toothpicks on the ends.

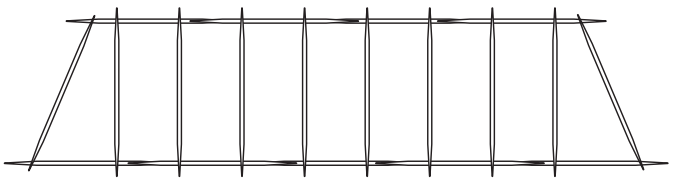
The height of the superstructure will be less than the height of the toothpick because the slanted beams are each made from a single toothpick.



Triangular support bridge side

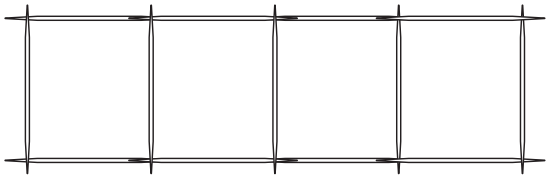
6 Draw two copies of a rectangular-based support superstructure side of the bridge. The side should have an outside boundary identical to the triangular-based support superstructure. Inside the frame, eight evenly spaced toothpicks should be placed perpendicular to both sides so they connect the two sides. Build the sides.

The height of the superstructure will be less than the height of a toothpick because the slanted beams are each made from a single toothpick.



Rectangular support bridge side

7 Build a top for each bridge similar to the roadbed but only four toothpicks long. Do not build a substructure for the bridge.



Bridge top

8 Assemble the bridges with the roadbeds and tops between the sides. Make sure the tops of the bridges are attached to the tops of the sides and the roadbeds are attached to the bottoms of the sides. Use tape to hold the bridges together temporarily.

Use a minimal amount of tape.

9 Add glue along the joints connecting the parts of the bridge.

Do not allow students to use excessive amounts of glue or their bridges will be artificially strengthened.

10 When the glue has dried, remove the tape.

Allow the glue to dry overnight.

11 Place the bridge across the space between two supports.

Two flat tables of the same height work well as supports.

12 Place a test block along the roadbed.

Make sure the test block does not overlap either support. Ideally, the test block should be two inches shorter than the span between supports.

13 Attach the bridge tester container to the test block so that the container hangs straight down from the block.

If a commercial bridge tester is used, consult the instructions that accompanied it.

14 Gradually add sand, gravel, or another mass to the container until the bridge breaks.

If you use a commercial tester, consult the instructions that accompany the tester.

15 Measure the amount of mass each bridge supported. Record this information under your hypothesis on the back of the graph paper.

16 Write a conclusion explaining your findings and evaluating your hypothesis.

Each student's conclusion should be at least one paragraph long.

Quick View

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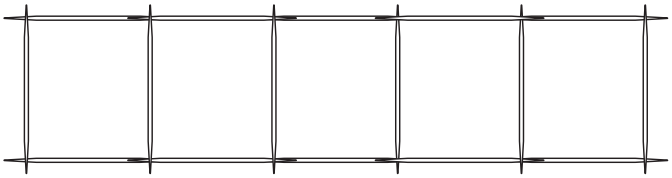

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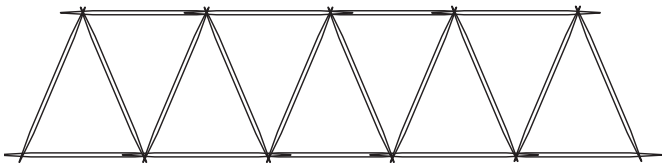

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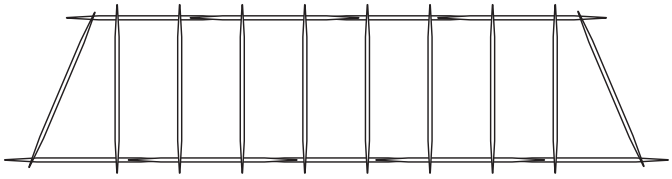

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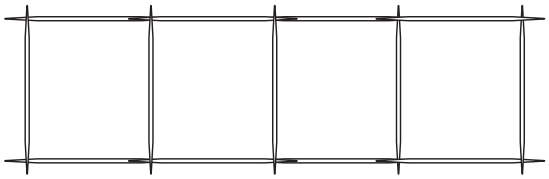

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