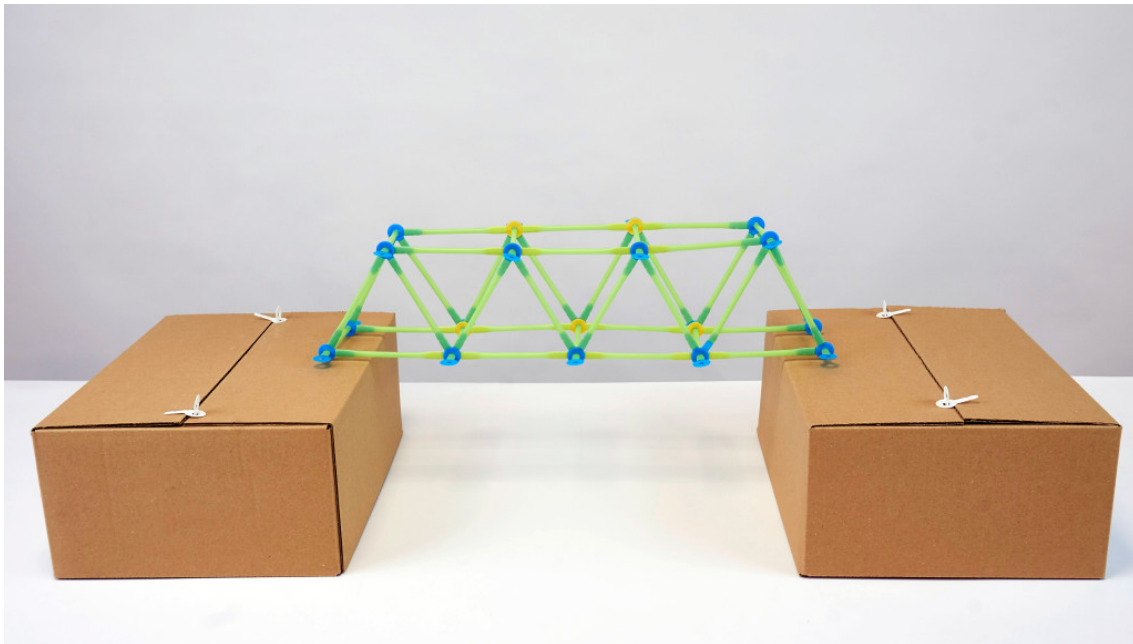


Building Bridges

Author Lindsay @ Strawbees



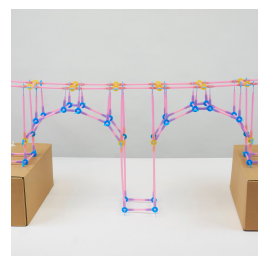
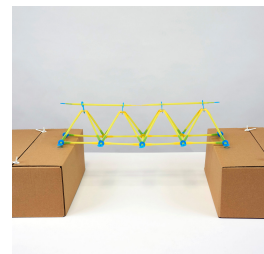
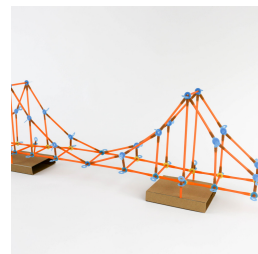
Engineer a bridge strong enough to span between two surfaces holding a weight.

ENGINEERING

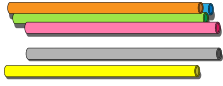
SCIENCE

- **Duration** 120 minutes
- **Class Size** 30 Students
- **Group Size** 3-4 Students
- **Overview**

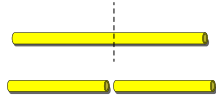
Work together in teams to design bridge models using only Strawbees and straws. Learn about the shape geometry composing bridges and draft a design on paper. Structure the bridge to build the biggest, strongest bridge to withstand a weight test.



■ Materials



Straws
700



1/2 Sized Straws
500



1-Legged Strawbees
500



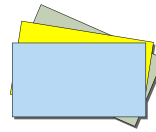
2-Legged Strawbees
400



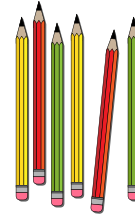
3-Legged Strawbees
300



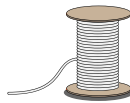
Scissors
20



Cardstock Paper
15



Pencils
15



String
1



Small Bags of Sand (1 lb)
10

■ Modifications

☐ *Lesson Split Time*

Depending on needs, this lesson can be split and taught in two 45-minute periods with an additional 15 minutes dedicated to setup and clean-up for each.

☐ *Bridging Teams*

A large challenge for students is to focus on how to build 1 bridge structure as a team. Encourage groups to take on the following roles: the Joint Maker, creates the joints out of Strawbees pieces, the Beam Maker, the person that measures and trims the straws to size from the drawing, and the Builders, who are responsible for assembling the bridge together.

☐ *Stockpile of Cut Straws*

Alternatively to letting students cut straws, use a stockpile of trimmed straws, both 1/2 and 1/3 the size of a full length straw, and set aside for students to use for future projects.

■ Learning Objectives

- ☐ Understand the basic principles of the geometric shapes used in the construction of bridges and architecture.
- ☐ Learn about a method of physical model making engineers undertake to explain scientific concepts and begin to visualize the factors taken in building a bridge.
- ☐ Experience real-world applicability of the benefit of using different bridge designs for serving different needs and purposes.
- ☐ Be introduced to Civil Engineering, a discipline focused on the development and maintenance of manmade and naturally built environments and constructions.
- ☐ Identify variables that can be modified, such as the number of straws or shapes to use which can alter an experiment and be improved.

■ Teaching Assessment

During the design process, students are not only using the drawing of the bridge to make their bridge, but also serve as an assessment for you to see their planning process and guesstimation of materials needed to build. You can use this point to check in with students to ask them questions about their design and what their hypothesis for the will be. As students begin to build, you will be looking for the groups that work well in communication and collaborating on a design decision and the creative execution, just like real civil engineer teams. Near the end of the lesson, during the testing phase students will have an evaluation period to see how their bridges performed and have the opportunity to observe other team bridges.

After the tests are completed, review the learning objectives and have a few students describe what they learned throughout the challenge. Ask them about their thoughts when building a simple beam bridge to a truss system and how much weight their design was able to withstand before collapsing, if applicable. If there is time, students can draw a new design and build another bridge to test and put their improved hypothesis to the test. If there is no more additional time, you can ask students what changes they would make to their bridge if they could remake it.

■ Preparation

- ① Cut large sheets of paper for students to draft the actual size of their bridge designs onto.
- ② To inspire and prepare your students search and print images of a beam, truss, and suspension bridge to use as talking points for this lesson.

Beam Bridge: Tianjin Grand, China Truss Bridge: Little Belt, Denmark Suspension Bridge: Golden Gate, USA

■ Lesson Steps

1. Introduction

Duration: 5 minutes

Ask your students the challenges you would face as an engineer developing the bridge. Share that engineers analyze the conditions that call for a bridge and determine the design and materials needed for environmental factors. Ask your students how they think geometry helps with the design and what shapes benefit the most. Find and share images of bridges around the world and have your students identify what shapes do they see the most then a hypothesis as to why those shapes work.

Students will iterate and research a few types of bridges: Beam, Truss, Arch bridges ultimately working their way up to designing the Suspension bridge using only Strawbees and string. After learning how to build a few iterations of bridge designs with Strawbees students will be placed on top of a table surface to hold at least 2 lb weights.

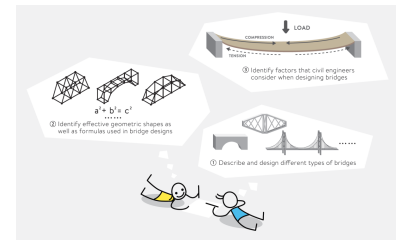
2. How Does Bridge Design Work?

Duration: 10 minutes

Let your students know they will take time to draft bridge designs on paper as a way to come up with solutions to potential problems before they begin building with Strawbees! Introduce some aspects of what makes bridges safe, and how complicated foundations, balance, and weight can be when designing and building a bridge.

To build bridges with Strawbees, share with the class the parts that make up the bridge. Assembled altogether the straws will make the structural elements of beams and columns with Strawbees joining them altogether. If constructed well the straws will become capable of resisting tension, compression, and tension during the test and will accept the load as long as the weight is distributed. In the vocabulary list, go over the different types of forces that affect bridges. For the suspension bridge challenge,

Out of all of these, ask your students which type of force is likely to affect the Suspension bridge the most?

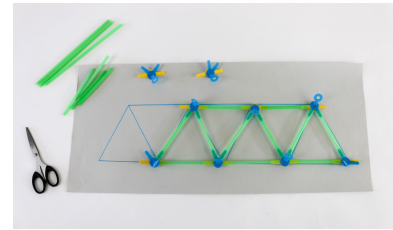


3. Bridge Drafting

Duration: 10 minutes

Give your student teams sheets of paper, rulers, and pencils to start drafting their bridge design.

They can use pictures of bridge examples as inspiration for their designs. Students can begin trimming and assembling straws and Strawbees together to ultimately build two sides of the bridge using the same drawing. Members of each group can identify how many beams will intersect at each joint and make Strawbees connectors for each one. The best bridge designs with Strawbees are when they are not loose, especially at the joints.



4. Bridge Design

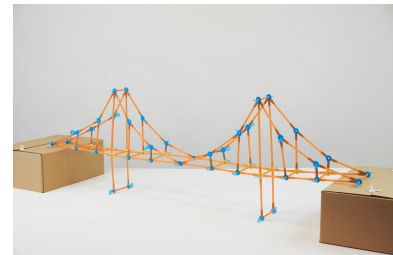
Duration: 60 minutes

Have students begin to connect both sides of their bridges together, they will need to slip the straw through the head of the Strawbees connected at a joint. To secure it in place they will need to slip a 1-Legged Strawbee through the opening of the straw until you hear a click which means it's locked in place. Make sure to squeeze the opening of the straw for easy insertion of the Strawbee.

When students begin the development of their Suspension bridge challenge them to combine it with another design. Encourage students to make more than one model of a bridge they want to test, which is part of the process in this challenge.

Students that reach completion of their bridge design can conduct a simple test of checking the joints and shifting the bridge in their hands. If the bridge expands in and out, they must check their joints and the strength of their materials to ensure it will pass. If students are using string, they can test their bridge between two surfaces with no weight in the center.

Let students know when they design their bridge to think of a way to anchor the ends down to the surfaces when ready to test. Depending on what is used to anchor, students can make something on the ends of their bridges to be clamped or weighed down by more weights. The suspension bridge must be able to move from one surface to another as part of the challenge.



5. Testing

Duration: 30 minutes

Once students are finished making their bridges, announce that it's time to put them to the test! Arrange to have 1 large table surface cleared with two small cardboard boxes to place the suspension bridge on. Have these boxes separated at least 19 inches apart.

The weights will be placed by you, attaching small bags of sand or any other type of weight found in your space. For well-designed bridges made by students, you can continue to place more weights in the center to see how hard the bridge can hold.

If a bridge falls apart during the testing phase, ask your students to take notes of what type of force makes the bridge succumb: compression, torsion, shearing, or tension.

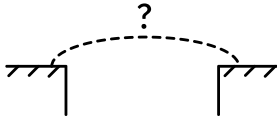
6. Reflection

Duration: 10 minutes

At the end, ask your students their thoughts on what was successful for their bridges and what they would do that was different in their design. Poll the class on how many times they saw a bridge fall due to each force and ask them why they think they saw that particular force in action.

Depending on the state of the bridge, you can have students redesign a new and stronger version of their previous model after going through the process.

■ Vocabulary



Bridge

A built structure creating a pathway over an obstacle.



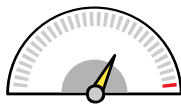
Beam Bridge

A structural path with at least two beams side by side and a deck, or floor, placed on top.



Compression

A force that pushes.



Limit

A set restriction on what can be done.



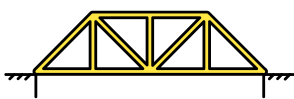
Arch Bridge

A structure that pushes loads along curved foundations to dissipate the force toward the supports on the ends.



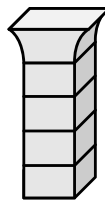
Suspension bridge

A structure with towers with vertical suspension cables attached to a deck hanging below.



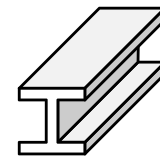
Truss Bridge

A bridge structure composed primarily out of triangular shapes.



Column

The vertical supports in a structure that transfers the load to the foundation from the roof and beams to resist compression.

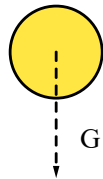


Beam

The horizontal structures that disperses the load to resist bending.

Beam Bridge

A structural path with at least two beams side by side and a deck, or floor, placed on top.



Gravity

The force from a physical body attracting another physical body with mass to its center.



Weak

A deficiency in strength or physical capabilities.

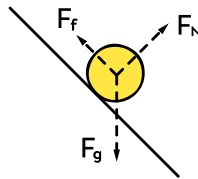
Torsion

A twisting force.



Joint

A point of a structure or shape where the parts are combined together.

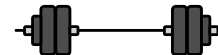


Force

The exertion of energy with great strength.

Tension

The state of being stretched from force.



Strength

The physical capability of endurance and resistance of force.



Test

A method of measuring the skill capability of a group or characteristic of something to pass through a set of conditions.



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