PENSACOLA BAY BRIDGE
REPLACEMENT PROJECT

Popsicle Stick Bridge Lesson Plan – Unit VIII

BUILDING A POPSICLE STICK BRIDGE

Purpose:

This lesson will allow students to explore civic engineering by constructing a bridge out of popsicle sticks. Working as a group, students will be challenged to construct a bridge with the following features:

- spans at least 14 inches and is suspended at least 12 inches off the floor
- is able to hold 5 pounds for at least 1 minute
- is constructed with the minimum amount of resources, and
- is aesthetically pleasing

Objectives:

- Develop a bridge model that integrates real-life bridge designs.
- Construct a structurally sound bridge out of popsicle sticks and glue.
- Measure the effectiveness of a bridge by testing its ability to hold 5 pounds for 1 minute.
- Present bridge designs at the conclusion of the project.

Time Required:

- Two to three 45-minute class periods

Materials:

- Popsicle sticks (at least 300 per group)
- Wood glue
- Tape
- Binder clips or clothes pins
- Matchbox cars (2 per group)

ACADEMIC STANDARDS

Objectives:

SC.6.P.13.1

Investigate and describe types of forces including contact forces and forces acting at a distance, such as electrical, magnet- ic, and gravitational.

SC.6.P.13.2

Explore the Law of Gravity by recognizing that every object exerts gravitational force on every other object and that the force depends on how much mass the objects have and how far apart they are.

SC.7.P.11.2

Investigate and describe the transformation of energy from one form to another.

SC.7.P.11.3

Cite evidence to explain that energy cannot be created nor destroyed, only changed from one form to another.

SC.8.N.1.1

Define a problem from the eighth grade curriculum using appropriate reference materials to support scientific understanding, plan and carry out scientific investigations of various types, such as systematic observations or experiments, identify variables, collect and organize data, interpret data in charts, tables, and graphics, analyze information, make predictions, and defend conclusions.

SC.8.N.1.5

Analyze the methods used to develop a scientific explanation as seen in different fields of science.

SC.8.N.1.6

Understand that scientific investigations involve the collection of relevant empirical evidence, the use of logical reasoning, and the application of imagination in devising hypotheses, predictions, explanations and models to make sense of the collected evidence.

Next Generation Science Standards:

MS-ETS1-1

Define the criteria and constraints of a design problem with sufficient precision to ensure a successful solution, taking into account relevant scientific principles and potential impacts on people and the environment that may limit possible solutions.

MS-ETS1-2

Evaluate competing design solutions using a systematic process to determine how well they meet the criteria and constraints of the problem.

Procedure (Teacher):

Day 1

1. Present the project and explain the basic steps that the students will be completing over the next 2 to 3 class periods.

    • The students will be pretending that they work for an engineering firm that is designing a bridge. The Department of Transportation wants to see a model of the bridge, so they will be making a model using popsicle sticks.

2. Present information about bridges.

    • Using PowerPoint or Google slides, show students diagrams of bridges and examples of various bridge types.

    • Have the students label the diagrams on the Student Resources page during the presentation and list examples of each type.

    • Discuss the following questions with students:

        - Has anyone visited any of the famous bridges mentioned?
        - Are any of bridges located near (or in the same state as) the school?
        - Which bridge type looks like the easiest one to build? Why?
        - Which bridge is the most aesthetically pleasing? Why?

3. Explain that all major bridges are built with taxpayer dollars, so they must serve the public by being as efficient, safe, cost efficient, and visual pleasing as possible.

4. Divide the students into groups of 3. Explain how the groups will divide three team roles among themselves, but emphasize that group members will all work together to build their bridge.

    • Team Leader – Acts as group representative and helps focus the group on the task
    • Resource Manager – Keeps track of resources used
    • Design Manager – Draws the bridge outline with input from the other members of the team

5. Allow the students to work together to determine the team roles and to record their information on the Bridge Planning page .

6. Students should spend the remainder of the class period designing and drawing their bridge.

Day 2

1. Distribute materials to the resource managers. Optionally, add a real-life component and give each team play money with which to purchase materials from a distributor (i.e., the teacher).

2. Students should use the remaining class period to build their bridges. Review the bridge-building requirements with the class:The bridge must be at least 14 inches long.

    - The bridge must be at least 14 inches long.
    - Only the materials that the teacher provides may be used.
    - The bridge must be attractive and neat.
    - The bridge must be able to hold 5 pounds for at least 1 minute.
    - The bridge must be wide enough for two cars to pass each other (use toy cars for scale).

Day 3

1. Ask the teams of students to decide who will present the bridge to the class. The presentation should include the discussion topics listed on the Presentation Planning page.

2. After each team is finished presenting, test its bridge by adding weights in 1-pound increments. Have students record their observations of the bridge after each increment on their data sheets.

3. Follow up questions (“Reflect”) are provided as an enrichment activity or homework.

ADDITIONAL TOOLS

The following videos may be helpful as you plan and prepare for the Popsicle Bridge Lesson:

How to Build Bridges with Popsicle Sticks

How to Build a Strong Truss Bridge with Triangles

RUBRIC

Bridge Name:

Group Members:

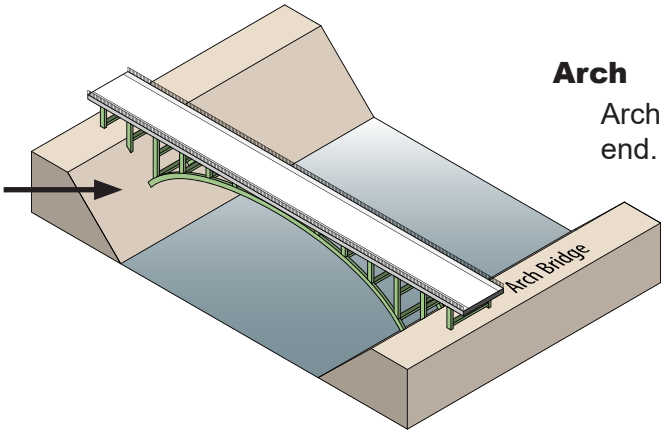
	Excellent (5)	Good (4)	Average (3)	Fair (2)	Poor (1)
Effectiveness	The bridge held more than 5 pounds for over 5 minutes and did not curve significantly.	The bridge held 5 pounds for at least 1 minute and did not curve significantly.	The bridge held 5 pounds for at least several seconds and either curved slightly or did not curve before breaking.	The bridge held 3 or more pounds for at least several seconds and curved before breaking.	The bridge held fewer than 3 pounds and curved significantly.
Design	The team took great care to construct the bridge according to the design.	The team attempted to build the bridge according to the design but made 1-2 slight modifications.	Team attempted to build the bridge according to the design but made major modifications.	The team was not able to build the bridge according to the original design.	The team made no attempt to build the bridge according to the original design.
Creativity	The team was extremely creative in the design and construction of its bridge, using extra time and effort to make the bridge an original creation.	The team was very creative in the design and construction of its bridge looks like an original creation.	The team was mostly creative in the design and construction of its bridge.	The team made a small effort to be slightly creative in the design and construction of its bridge.	The team did not appear to be concerned about creativity.
Aesthetics	The bridge was extremely attractive, symmetrical, and clean, and it incorporated design elements from actual bridges; the team used extra time and effort to do their best.	The bridge was attractive, symmetrical, and neat.	The bridge was attractive, and the construction was mostly neat, but a few areas could be improved upon.	The bridge had limited aesthetics, and it could have been tidier.	The team did not take care to make the bridge visually appealing, and the bridge was not neat or symmetrical in any way.
Teamwork	Every member of the team was on-task and focused on the activity for the entire project, and all team members actively contributed to the group and remained engaged.	The team members were mostly focused on the project for the duration of the activity, and they all contributed to the project in some way.	The team members were somewhat on task. Some students were more focused than others.	The team members were often distracted but made some contributions and remained mildly engaged in the activity.	The team members were distracted much of the time and were not engaged in the activity as much as they should have been.
TOTAL:					

Comments

STUDENT RESOURCES

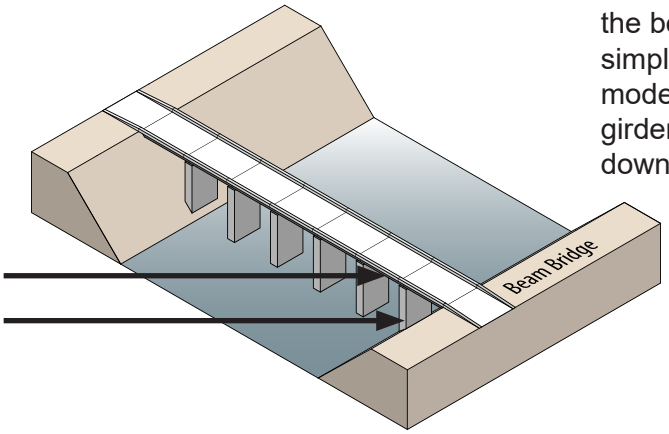
Types of Bridges

The six main types of bridges are arch, beam, cable-stayed, cantilever, suspension, and truss.
Source: http://tryengineering.org/lessons/popsiclebridge.pdf



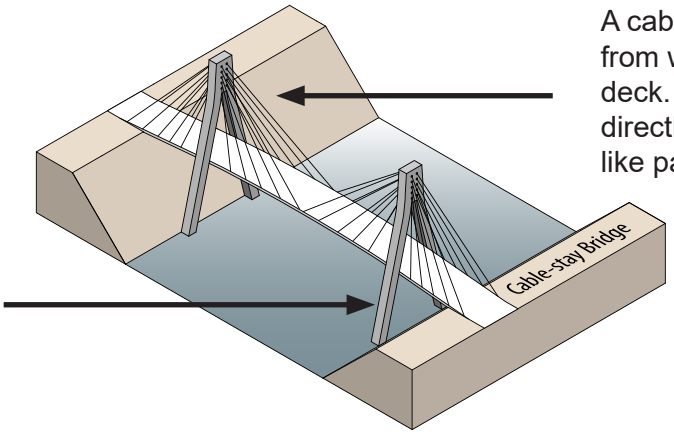
Arch

Arch bridges are arch-shaped and have abutments at each end.



Beam

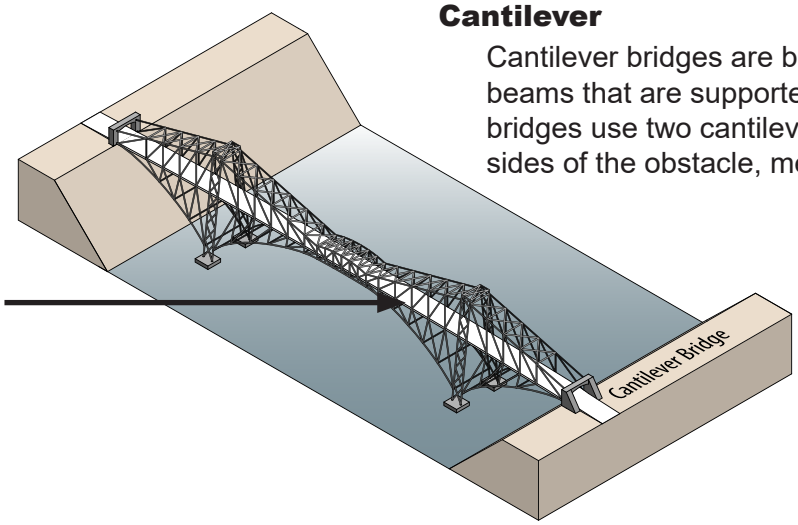
Beam bridges are horizontal beams and piers that support the beams at each end . The earliest beam bridges were simple structures made of logs or similar materials. In modern times, most beam bridges use large boxes of steel girders. The weight on top of the beams pushes straight down on the piers.



Cable-stayed

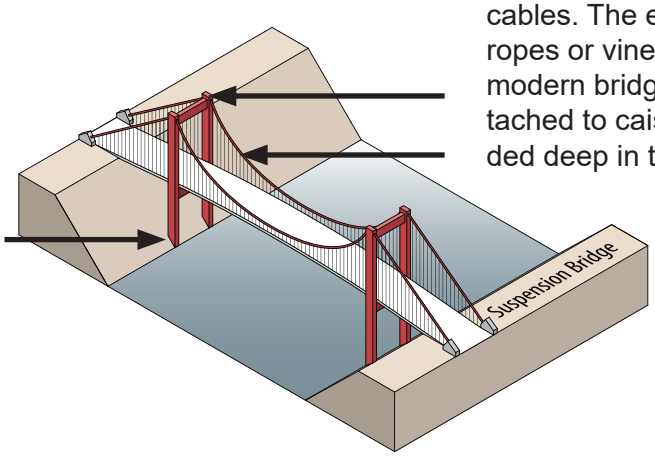
A cable-stayed bridge has one or more towers (or pylons), from which cables hang; these cables support the bridge deck. The cables are a distinctive feature, and they run directly from the tower to the deck, normally forming a fan-like pattern or a series of parallel lines.

Cantilever



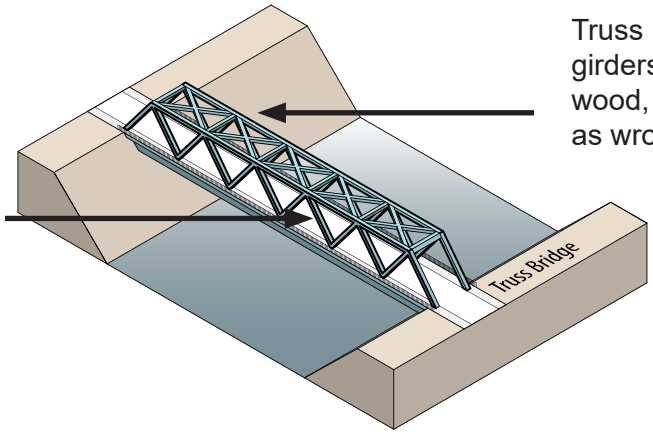
Cantilever bridges are built using cantilevers—horizontal beams that are supported on only one end. Most cantilever bridges use two cantilever arms that extend from opposite sides of the obstacle, meeting in the center.

Suspension



The platforms of suspension bridges are suspended from cables. The earliest suspension bridges were made of ropes or vines that were covered with pieces of bamboo. In modern bridges, the cables hang from towers that are attached to caissons or cofferdams, which are in turn embedded deep in the floor of a lake or river.

Truss



Truss bridges have solid decks and lattices of pin-jointed girders on the sides. Early truss bridges were made of wood, but modern truss bridges are made of metals such as wrought iron and steel.

Procedure (Student):

Imagine that you and your teammates are part of a team of engineers who have been given the challenge of designing a bridge for your state's Department of Transportation (DOT). Before choosing to hire your firm for the job, the DOT would like to see a model of your design so that it can prove the bridge's structural integrity. In an effort to save taxpayer dollars, the DOT would like you to be as efficient as possible with resources. Thus, please minimize your use of materials without sacrificing safety and quality. The taxpayers are also very discerning, and they would like the bridge to add beauty to the landscape. The DOT will thus be looking for a bridge that combines quality with aesthetics.

Please keep the following requirements in mind as you plan your project (see the rubric for specific details on grading):

1. The bridge must be at least 14 inches long.
2. You may only use the materials available from your teacher.
3. The bridge must be attractive and neat.
4. The bridge must be able to hold 5 pounds for at least 1 minute.
5. The bridge must be wide enough for two cars to pass each other (use toy cars for scale).

Complete the following steps with your teammates:

STAGE 1 – Planning

1. Meet with your teammates to determine who will serve in each of these three roles: the team leader (who acts as the group representative and manages tasks), the resource manager (who keeps track of the items the group has used), and the designer (who creates the design). All teammates will help build the bridge. Record the job assignments on the Bridge Planning page.
2. As a team, discuss which type of bridge you will use as a model; record this on the Bridge Planning page.
3. Make a detailed sketch of the bridge to use as a guide during your construction.

STAGE 2 – Construction

1. Work together as a team to construct your bridge.
2. You may use the tape and/or binder clips to secure the pieces as the glue dries. Remember to keep the bridge neat and attractive.
3. Be certain to construct the bridge according to the requirements on this page.

STAGE 3 – Presenting and Testing

1. As a team, meet to discuss how you will present your bridge to your classmates.
2. When it is your turn, present your bridge to your teacher and classmates, then test it.

BRIDGE PLANNING

Name of Bridge: _____

Style(s) Used: _____

Roles

Team Leader: _____

Resource Manager: _____

Design Manager: _____

Resources Used (number of popsicle sticks, bottles of glue, etc.): _____

_____

_____

Draw your bridge here:

PRESENTATION PLANNING

When presenting your bridge to your classmates, please discuss the following:

Name of your bridge:

Type of bridge it is modeled after:

Reason for choosing that bridge type:

Point out special design features:

Share what you may have done differently:

REFLECT

1. Did your team successfully construct a bridge that held 5 pounds for 1 minute? If not, why did the bridge fail?

2. What was the most challenging part of the construction project?

3. If you had to build a second bridge, what would you change?

4. What kinds of trade-offs do you think engineers must make in terms of functionality, safety, budget and aesthetics when building a real bridge?

BRIDGE TESTING

Teammates:
Each bridge will be tested with 1, 2, 3, and 4 pounds for 30 seconds each. If the bridge remains intact after these tests, it will then be tested with 5 pounds for 1 minute. For bridges that survive this test, further weights can be added to find the bridge's breaking point (if desired).

Pounds	Time	Structural observations
1	30 sec	
2	30 sec	
3	30 sec	
4	30 sec	
5	60 sec	

The amount of materials may be quantified by the following methods:

1. Weighing the bridge

2. Listing the amounts used of each material:
   Number of popsicle sticks:
   Amount of glue:
   Amount of tape: