PENSACOLA BAY BRIDGE
REPLACEMENT PROJECT

Popsicle Stick Bridge Lesson Plan – Unit III

SUSPENSION BRIDGE

Objective: "Suspension Bridge 101." After this lesson, students should be able to:

- discuss different suspension bridge designs; and
- draw a model suspension bridge.

Summary: Through a PowerPoint presentation, students learn about suspension bridges and how they manage the natural forces of compression and tension. Students also learn about the types of materials that are important to bridge construction, and consider the advantages and disadvantages of each type.

Materials: N/A

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, magnetic, 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.

s. 1003.41, Florida Statutes
Rule 6A-1.09441, F.A.C

Vocabulary:

Anchorage: Any device for securing a suspension bridge at either end. Typically a large concrete block that is anchored or secured into the ground.

Tower: a tower on a bridge (as for the support of cables or for defense); also : a tower serving as a bridgehead [1]

Cables: A very strong rope made of strands of metal wire, as used to support cable cars or suspension bridges.

Cable-stayed bridge: Like suspension bridges, cable-stayed bridges are held up by cables. However, in a cable-stayed bridge, less cable is required and the towers holding the cables are proportionately shorter.[2]

Suspension bridge: Suspension bridges are suspended from cables. The earliest suspension bridges were made of ropes or vines covered with pieces of bamboo. In modern bridges, the cables hang from towers that are attached to caissons or cofferdams, which are embedded deep in the floor of a lake or river.[3]

Compression: A pushing force that tends to shorten objects or the application of power, pressure, or exertion against an object that causes it to become squeezed, squashed, or compacted.

Tension: A pulling or stretching force that tends to lengthen objects

[1] Source: https://www.merriam-webster.com/dictionary/bridge%20tower

[2,3] Source: http://ewh.ieee.org/r10/australia/council/TISP/pdf/paddlepopbridge.pdf

Procedure:

As we travel into new cities, sometimes we have to pass over large bridge structures that are held by cables. These types of bridges are referred to as suspension bridges. Suspension bridges are easily recognized because the bridge deck is suspended from large cables.

1. Show students the Unit 3 presentation of the suspension bridge.

2. After the presentation ask the following questions. (Use the discussion questions provided below as an icebreaker prior to beginning Activity)

Discussion Questions: Ask the students and discuss as a class:

- What things must be considered when deciding whether to create a suspension or a cable-stayed bridge in a certain area?
- What are some of the common materials or elements used to create suspension bridges? (Possible answers: Cables, towers, foundations, etc.)

3. Main Activity - Students will work in small groups to draw a working picture of a suspension bridge. They will name the bridge and give information about the area the bridge serves, keeping in mind the working parameters of each bridge type. Using Activity Sheet One, label the bridge parts.

Procedure continued...

4. Suspension Bridge Writing Extension

- Read portions of the article “The Last Incan Suspension Bridge Is Made Entirely of Grass and Woven by Hand” to help the students understand how the Incans used suspension bridges. Show the students some photos of the bridges.
- Have the students write 3-4 paragraphs in response to one of the following writing prompts:

  Option 1: Write a short story about the individual whose job was to connect the bridge from one side of the valley to the other. How do you think he or she did this? Was it scary?

  Option 2: Write a short story about why a person or group wanted to cross the valley. What was on the other side? What was the motivation for building the bridge and getting to the other side?

  Option 3: Write a short story about a child in the year 2018 who finds the Incan suspension bridge and who follows it to an unexpected place.

5. Supplemental Activity - Using Activity Sheet Two, go online and find out the names of one of each of the suspension bridge types.

ACTIVITY # 1

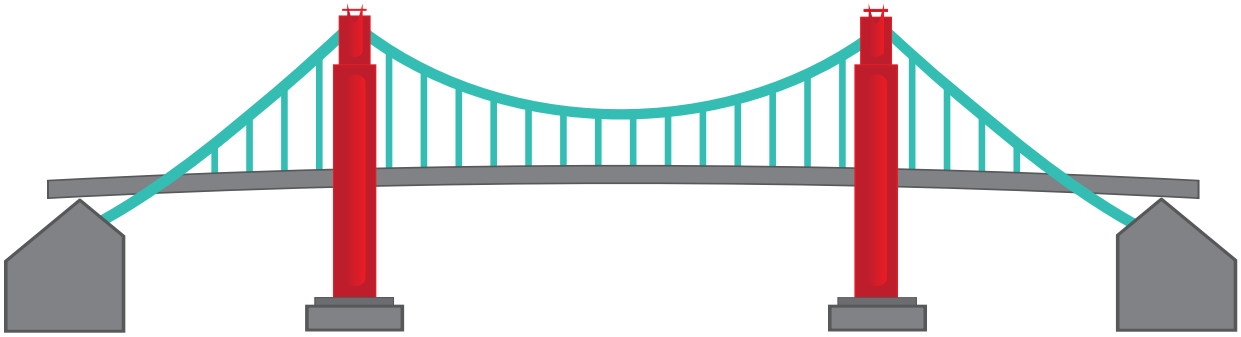
Draw a Suspension Bridge

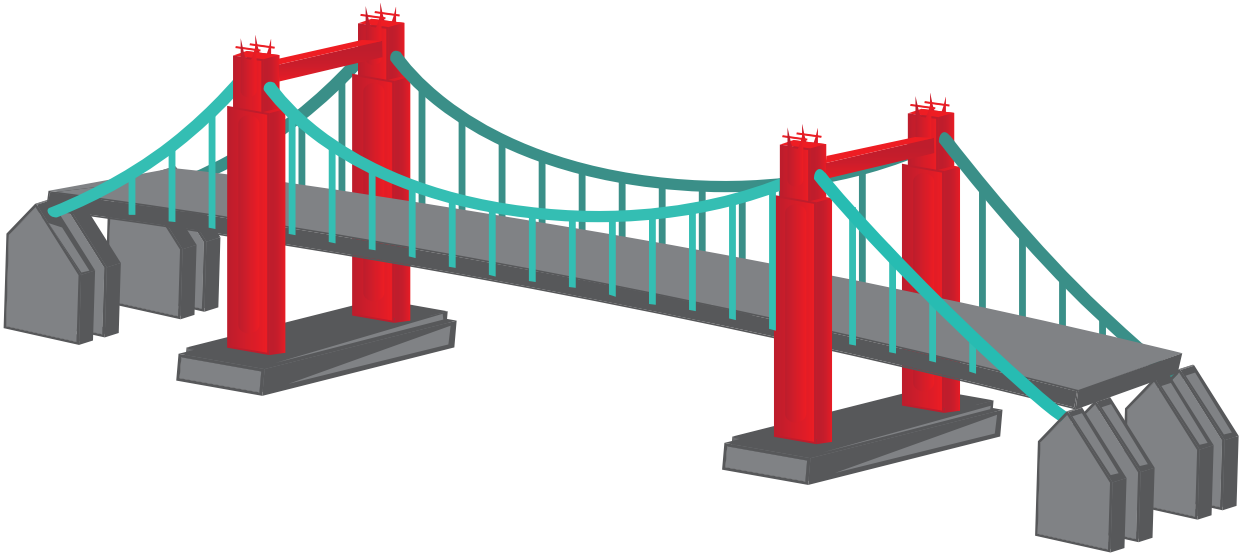
ACTIVITY # 2

Label the Suspension Bridge

(Use the vocabulary words provided below.)

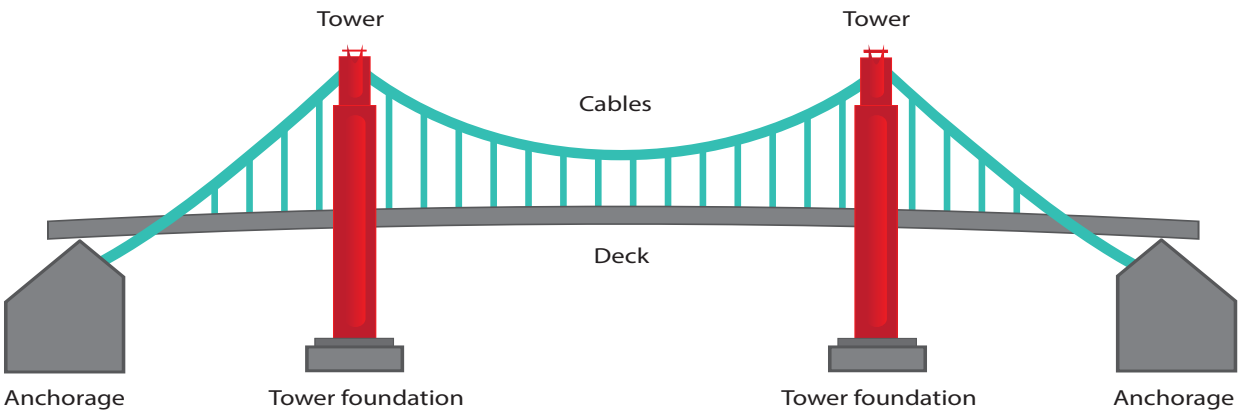
Vocabulary: towers, cables, deck, anchorages, tower foundations

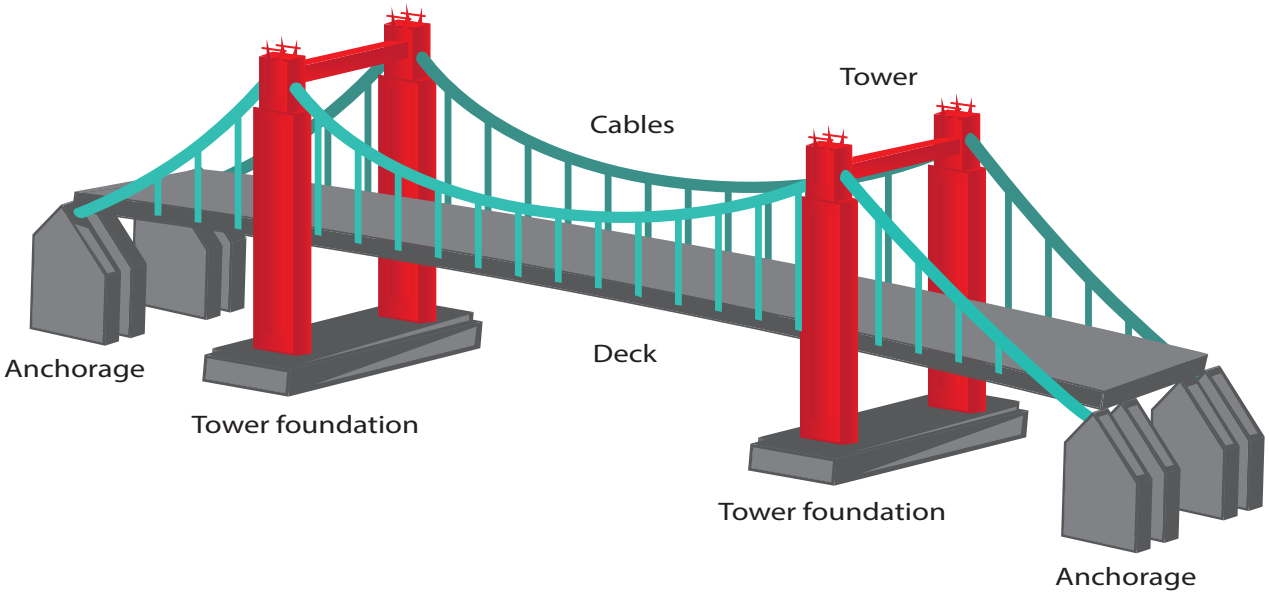




ACTIVITY # 2 ANSWER KEY

Suspension Bridge





ACTIVITY #3

Suspension Bridges Around the World

Working in pairs, find famous suspension bridges around the world. Give the name, location and the length (span) of the bridge. (Use an additional sheet of paper if necessary.)

Continent Name ______________________ **Population** ______________________
Key Geographic Features ____

Name	Location	Length (Span)

Continent Name ______________________ **Population** ______________________
Key Geographic Features ____

Name	Location	Length (Span)

Continent Name ______________________ **Population** ______________________
Key Geographic Features ____

Name	Location	Length (Span)

Continent Name ______________________ **Population** ______________________
Key Geographic Features ____

Name	Location	Length (Span)

Continent Name ______________________ **Population** ______________________
Key Geographic Features ____

Name	Location	Length (Span)

Continent Name ______________________ **Population** ______________________
Key Geographic Features ____

Name	Location	Length (Span)

Continent Name ______________________ **Population** ______________________
Key Geographic Features ____

Name	Location	Length (Span)

RESOURCES:

The World's Most Spectacular Bridges
https://www.nationalgeographic.com/travel/lists/activities/best-bridges-in-world/

Bridge | Engineering | Britannica.com
https://www.britannica.com/technology/bridge-engineering

Bridge - Wikipedia
https://en.wikipedia.org/wiki/Bridge

TEACHER BACKGROUND INFORMATION

Suspension Bridge Design - The Basics

Suspension bridges are identified by their appearance, with towers and massive cables holding up the main bridge roadway; perhaps the most famous example in the world is the Golden Gate Bridge in San Francisco.

They can span huge distances because they dissipate forces incredibly effectively; the design allows the roadway to be suspended by the cables, and the large towers suppport cables. The loads from the deck/roadway, which includes the weight of the traffic and the weight of the deck itself, are transferred into the cables as a tension force. The suspension cable pushes down on the towers as a compression force which the towers transfer down into the earth. The suspension cables also exert a tension force into the anchorages, which resist the tension mainly through their massive weight. At the same time, supporting cables, which run horizontal to the bridge between the end anchorage points, receive the tension stress from the bridge and dissipate it through the large anchorages into the ground.

Conventional Suspension Bridge

Their “elongated M” shape often categorizes conventional suspension bridges. The large saddles atop the structure create the “M shape”. In these bridges, large cables are hung between towers on either side of the beam bridge. These towers also anchor the bridge structure into the earth at either end.

Next, smaller cables stretch to support the beam bridge or roadway. In this structure, the cables are very important for managing the heavy weight. As vehicles drive along the suspension bridge, the weight of the vehicles, the roadway’s weight, and other forces on the bridge deck create tension in the cables. The cables then transfer their force to the towers. The force becomes compressive in the towers, and the towers send this force to the earth. Suspension bridges are quite effective at supporting roadways and/or trains for extended distances. Today’s modern suspension bridges are from 2,000 to 7,000 feet (610-2,134m) in length and some have even been designed to go over 12,000 feet (2.5 miles between piers)!

Cable-Stayed Bridge

A second type of bridge that utilizes cables to support its loads is called a cable-stayed bridge. Although cables are used in this type of structure, these cables carry and dissipate the loads directly to the towers much differently than in suspension bridges. The loads in the cables are directly proportional to the angle the cables make with the bridge deck and are broken into a vertical and horizontal component. Cables can be splayed out in rows “like a harp“ or in other patterns, only limited by imagination.

TEACHER BACKGROUND INFORMATION CONTINUED

The cables in the cable-stayed bridge support the deck through tension that pulls down on the tower, compressing it. The deck is also in compression because the tension in the cable pulls the deck back towards the tower (big triangle). Typical cable-stayed bridges are great for medium- and long-span bridges, working well in distances from 500 to 3,000 feet (152-914m). Cable-stayed bridges are known for their contemporary aesthetics. It is amazing what engineers can create as human travel aids with their depth of knowledge about how compressive and tension forces work in our world.

ASSESSMENT UNIT 3

The intent of this lesson is to provide a visual interpretation as well as an understanding of the effects of compression and tension forces on an object. The presentation will show that forces acting on the objects can affect the strength and length of a bridge.