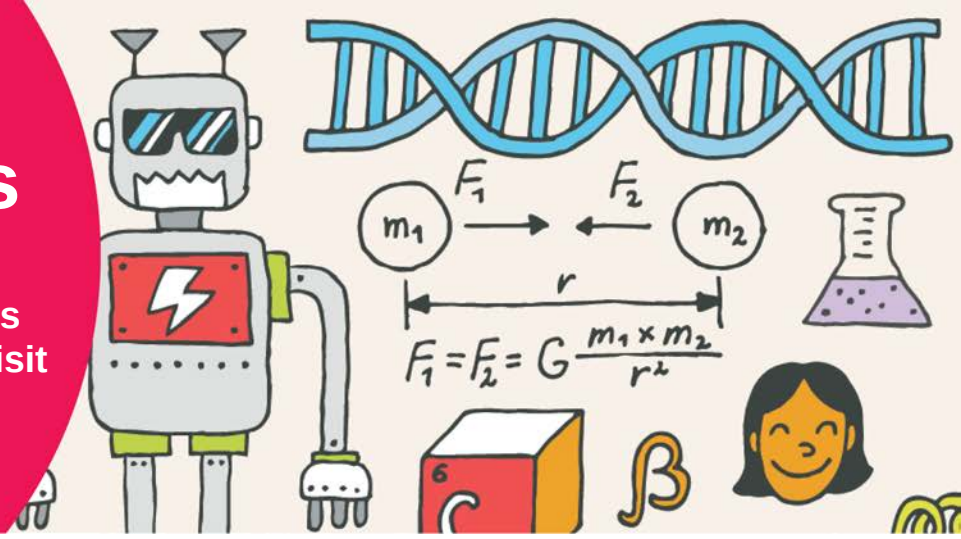
Bridge Builders

Activities to engage young minds before and after your museum visit



BEFORE YOUR VISIT

Learning Objective To discover forces acting on various types of bridges.

Activity 1: Forces acting on various types of bridges

Introduction

Start by discussing a few basic concepts about different types of bridges:

1. What are bridges used for? *(cars, trucks, trains, pedestrians, etc.*)
2. Where are they used? *(over small bodies of water, over large bodies of water, over canyons, over roads*).
3. What things have to be considered when building a bridge? (*weather in area, what will go over it, where it is, cost, material, etc.*)
4. For these reasons there are many different types of bridges that exist. Some examples are:

Suspension Bridge – built 1938

Lion's Gate Bridge; Vancouver British Columbia

Spans Burrard Inlet

Arch Bridge – built 1916

Old Mill Bridge; Toronto Ontario

Spans Humber River Valley

Post and Beam Bridge – built 1913
High Level Bridge; Edmonton Alberta
Spans North Saskatchewan River

5. Have a quick discussion on what forces are and how they act on various structures. (*There are many types of forces but primarily they can be identified as pushing or pulling or using other words tension or compression.*) Forces can be applied externally (such as gravity) or internally (from one part of a structure acting on another part).

Activity 2: Post and Beam bridges

Materials

- Two books
- Ruler (30 cm long)
- Ten pennies

Notes: For a better visual representation you could use a piece of pool noodle, long thin balloon or dampened sponge with cross-sectional lines drawn along its length to show the forces on the bridge when the load is applied rather than a ruler.

Instructions

1. Place the books at a distance from each other so that the ruler can be placed between them.
2. Place the ruler on the books.

3. Stack pennies in the center of the ruler or simply press down in the center of the ruler.
4. Observe.

- What happens to the ruler as more pennies are stacked? (*starts to bend and collapse towards the 'water')*
- What type of forces would be in the ruler? (*Pushing force along the top of the ruler (compression) and pulling forces along the bottom of the ruler (tension*)).

Activity 3: Suspension bridges

Materials

- Eight books
- String (approximately 90 cm long)

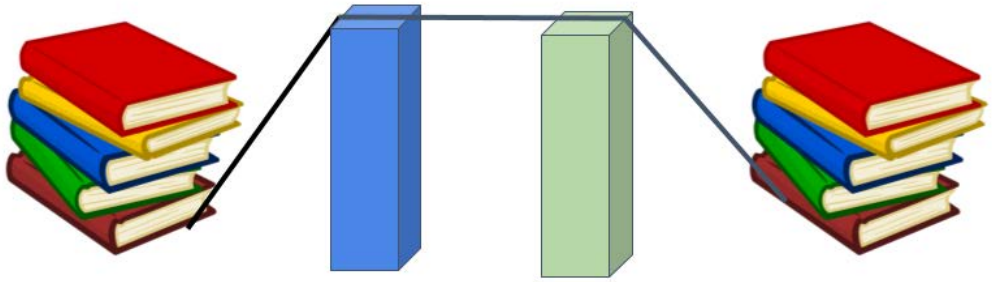
Instructions

1. Place two of the books standing on their bottom edge at a distance from each other (approximately 30 cm).
2. Place the string over the books with the center of the string in between the two books and the ends hanging over the far side of each book.
3. Push on the center of the string.
4. Observe.

- What happens if you push down on the string? (*The string will just fall as it is not supported*).

5. Place each end of the string under a stack of books.
6. Push on the center of the string once more.
7. Observe.

- What type of forces would be in the string? (*Pulling (tension*)).



Go Further

- Students can pair up facing each other with their feet approximately .5 m from one another and hold hands.
- Students lean away from each other.
- What type of force do students feel in their arms? (Same as the suspension bridge they will feel pulling forces (tension))

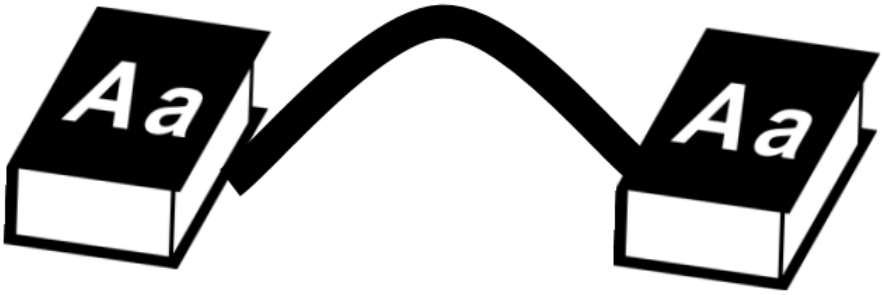
Activity 4: Arch bridges

Material

- Two books
- One strip of cardboard (approximately 30 cm long X 3 cm wide)
- Ten pennies

Procedure

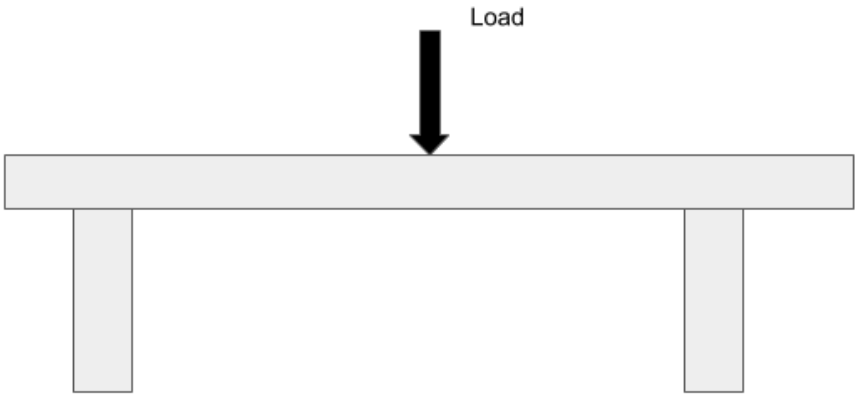
1. Place the books at a distance from each other so that the cardboard can be placed between them in an arch shape.
2. Place the cardboard strip between the two books so that it has an arch shape.



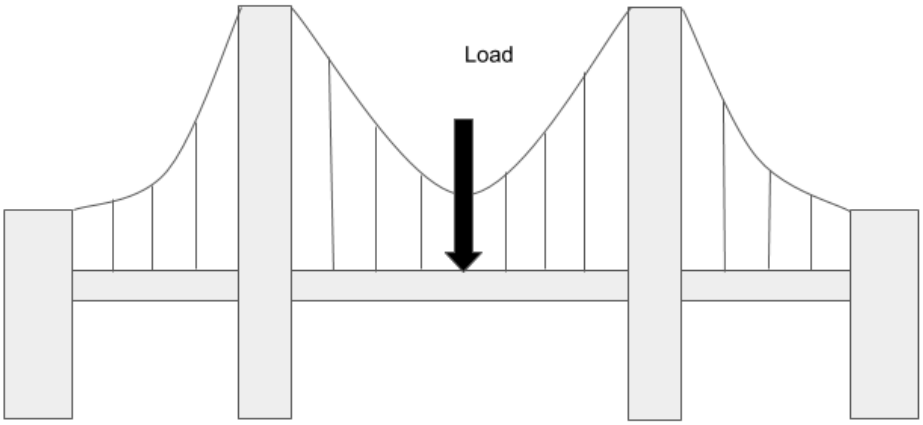
3. Stack pennies in the center of the cardboard.
4. Observe
    a. What happens to the cardboard as more pennies are stacked? (*starts to bend and collapse towards the 'water')*
    b. What type of forces would be in the cardboard? (*Pushing - compression*)
    c. Can this shape withstand more weight than the flat ('post and beam') type of bridge? (*yes*)**.** Try it out by placing the cardboard strip flat along the top of the books.

Using arrows, draw the forces acting on the various bridges when a point load is applied to the center of the bridge.

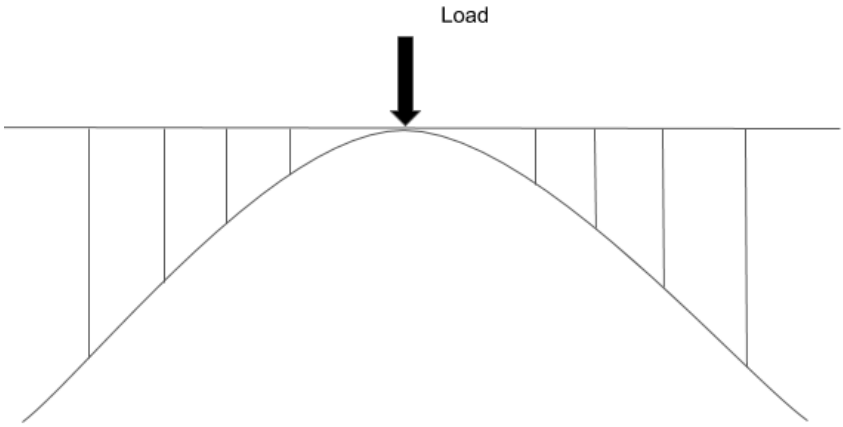
Post and Beam Bridge



Suspension Bridge



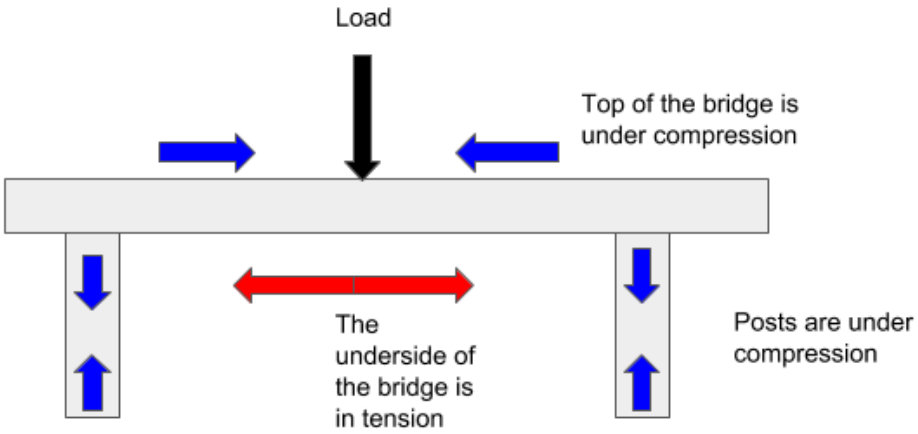
Arch Bridge



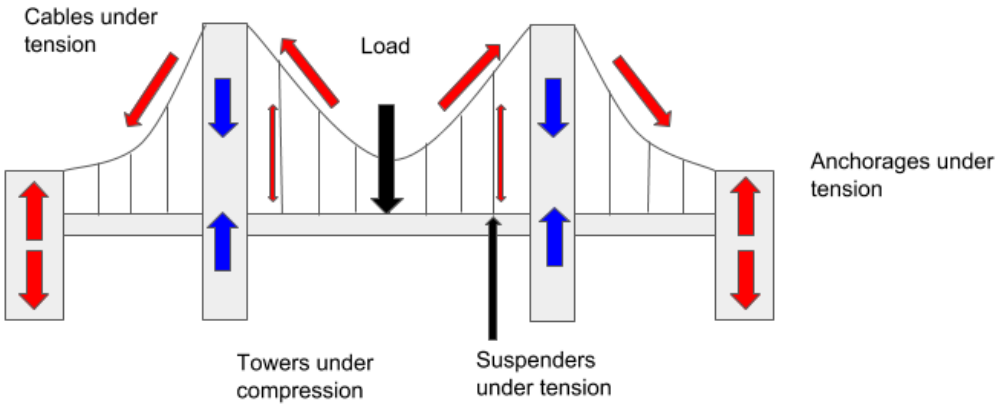
ACTIVITY SHEET - ANSWERS

Using arrows, draw the forces acting on the various bridges when a point load is applied to the center of the bridge.

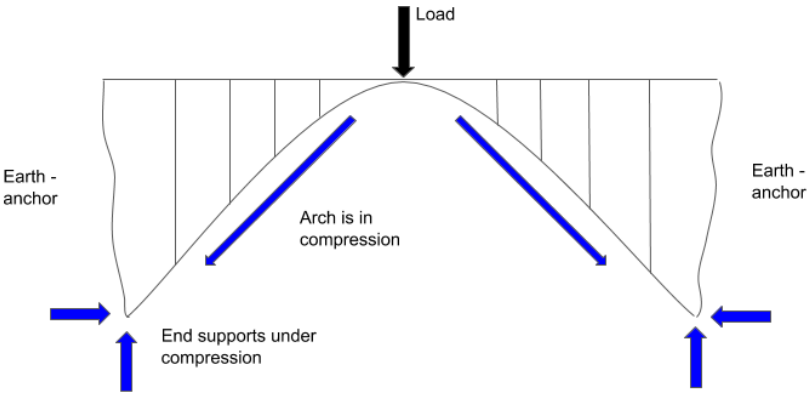
Post and Beam Bridge



Suspension Bridge



Arch Bridge



AFTER YOUR VISIT

REFLECTION

Learning Objective

Have students reflect upon their time at the museum, the bridges they built and how the bridges performed when tested.

Material

- **Table of results – if available**
- **Photos of completed bridges – if available**

Instructions

Discuss with students results from the bridges that were built in the workshop. What worked well? What didn't work? What challenges were there? Did the bridges that were the most successful in testing have anything in common? Did the bridges that were the least successful in testing have anything in common?

ACTIVITY – MAKE A SUSPENSION BRIDGE

Learning Objective

To build a suspension bridge that is capable of supporting a load.

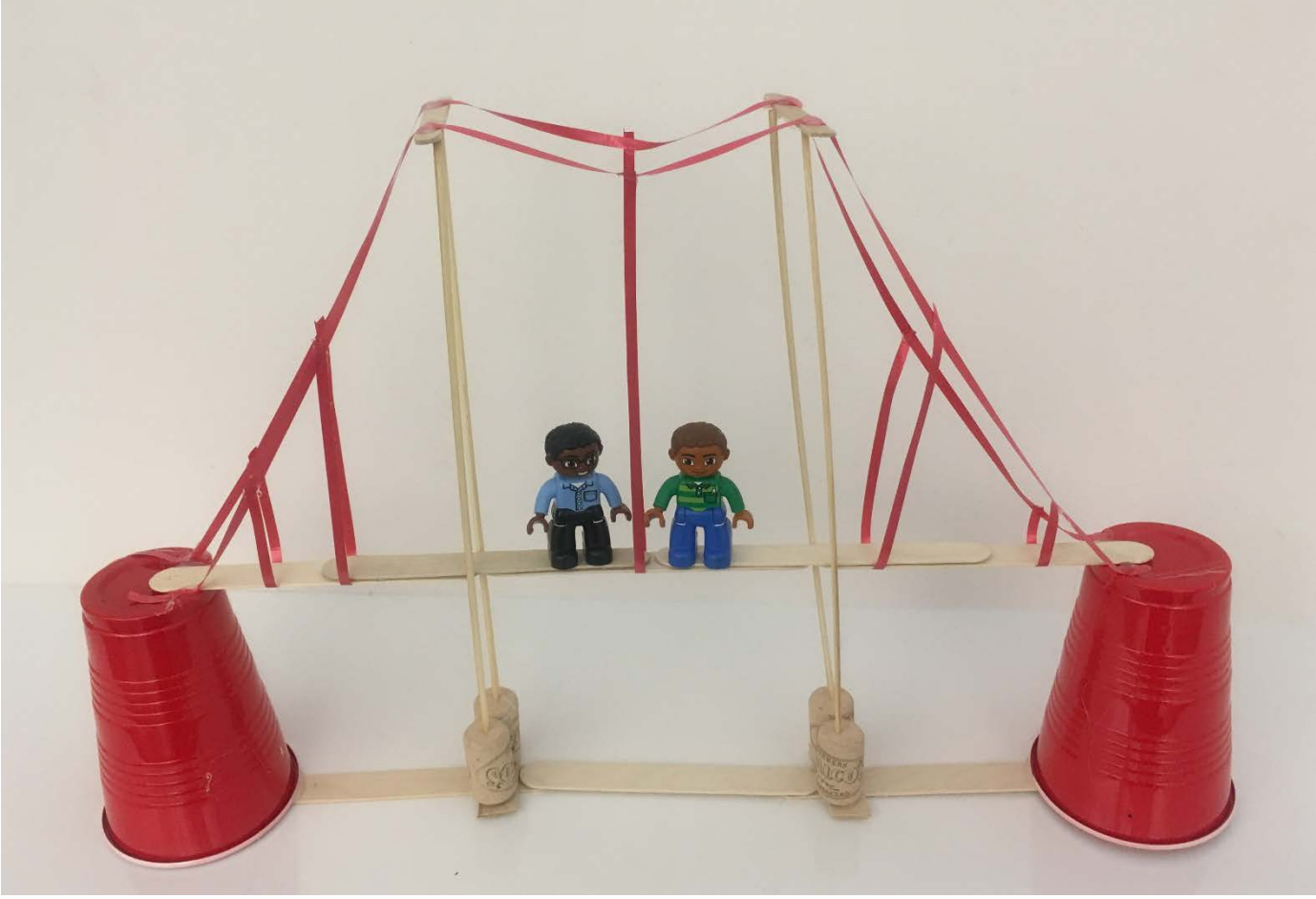
Material

- Whatever type of recycled/craft supplies that can be collected: string, cardboard, empty toilet paper rolls, popsicle sticks, straws, pencils, clothespins, bullnose clips, paper clips
- Glue, tape, scissors, hot glue guns (if available)

Instructions

1. Discuss with students that you want them to build a suspension bridge and describe which materials will be available.
2. Agree with students what the requirements will be for the design of the bridge: what distance does the bridge need to span? How much load you want it to carry? Etc. (Our example bridge had a minimum span of 30 cm and was able to support a load of at least 50g)
3. The building of the bridges can either be done in groups or individually.
4. Remind students that they must consider the support posts as well as what they will use to make the roadway.
5. Students can draw a plan of the bridge that they will build.
6. Have students build their bridges.
7. As a class discuss problems that were encountered during the building of the bridges and how these problems were overcome.

Example:



Go Further

- If time allows test the bridges and see how they cope with a load applied.

- Another important part of suspension bridges is their stability. How stable are the bridges? Discuss with students how the stability can affect the life of the bridge. How would the bridge react if there were strong winds blowing? Watch the Tacoma Narrows bridge failure (https://www.youtube.com/watch?v=nFzu6CNtqec). This bridge failed because the engineers didn't fully consider wind loads on the bridge. After the failure the bridge was redesigned to allow the wind to flow through better instead of having solid areas that resisted the wind (even the roadway included openings to allow the wind to flow). Stiffening struts were also added.