Building Our Bridge to Fun!

Civil Engineering in the Classroom

Main Goals of this Activity

- Learn about how bridges are used and why we need them
- Identify forces acting on a bridge
- Hands-on activity: build two type of bridges (with two type of materials)
- Measure deflection of a span using LEGO ultrasonic sensor
- Gather data (load vs. deflection)

Introduction

What is a bridge? Why do we need build bridges?

Water supply

Crossing rivers or water bodies

Traffic

Engineering for bridges

Construction Materials:
-Concrete
-Steel
-Wood
-Stone
-Brick

Bridges are structures to provide passage over water, roadways, and more!

Engineering for bridges: History

Primitive People:
- Logs
- Slabs of Rocks
- Intertwined Vines or Ropes

Roman Empire—First Great Bridge Builders
- Timber Truss Bridges
- Masonry Arch Bridges

Europeans
- Followed Roman Empire style until iron and steel was used

Nineteenth Century
- Modern Long Bridges
- Moveable Bridges

Engineering for bridges: Primitive Bridges

Rock Bridges

Rope Bridges

Log Bridges

Engineering for bridges: Loads

Primary Loads acting in a bridge

Weight of the bridge → DEAD LOAD

Traffic: cars, trucks, people →

Wind, snow →

Dynamic: earthquake and vibrations →

LIVE LOAD

Engineering for bridges: Primary forces

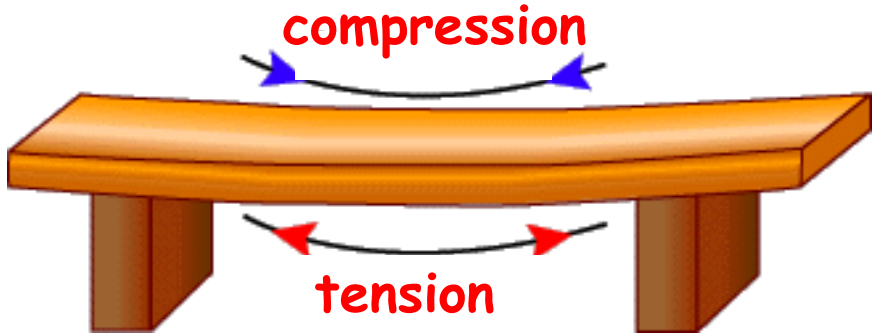
Tension: magnitude of the *pulling* force that acts to *lengthen* an object, usually by a string, cable, or chain.

Compression: a *pushing* force that acts to *shorten* the thing that it is acting on. Opposite to tension.

Engineering for bridges: Primary forces

Demo: Use a sponge to represent a beam. When loaded with weight, the divots (holes) on top __close__ and the divots (holes) on bottom __open__

Conclusion:



The ***top*** of a beam experiences __compression__.

The ***bottom*** of a beam experiences __tension__.

Engineering for bridges: Type of Bridges

Fixed

- Beam bridge
- Truss bridge
- Continuous truss
- Arch bridge
- Cantilever
- Suspension
- Cable-Stayed

Moveable

- Swing bridge
- Bascule bridge
- Vertical lift bridge

Other

- Bailey bridge
- Pontoon bridge

Type of Bridges: Fixed

Beam Bridges

- Two parallel beams with flooring supported by piers
- Used for highway over and underpasses or small stream crossings

Truss Bridges

- Beam bridge strengthened by trusses
  - A truss is a structure joined to form triangles with tie rods
- Lighter than ordinary beam sections of equal length
- Useful for longer bridges

Type of Bridges: Fixed

Continuous Truss Bridges

Simple Truss Bridges

Type of Bridges: Fixed

Arch Bridges

- One or more arches
- Masonry, reinforced concrete or steel
- Roadway on top of arches or suspended by cables
- Spans can be longer than beam or truss

Aqueduct

Type of Bridges: Fixed

Cantilever Bridges

- Double-ended brackets supporting a center span
- Shore end of each cantilever firmly anchored
- Center supported by pier

Suspension Bridges

- Roadway hangs from vertical cables supported by overhead cables chained between two or more towers
- Longest spans, costly and challenging to design
- Highly susceptible to winds and swaying
- Cables can be up to three feet in diameter

Type of Bridges: Fixed

Cable-Stayed Bridges

- Suspended by cables that run directly down to roadway from central towers
- Less costly than suspension
- Quickly constructible
- Spans must be limited in length

Type of Bridges: Moveable

Swing

- Central span turned 90 degrees on pivot pier placed in the middle of the water way

Bascule

- One or two sections are not supported by piers
- Balanced on one end by counterweights
- Section jack-knifes up to allow passage of ships
- Most common type of highway drawbridge

Vertical Lift

- Central span extends between two towers
- Balanced by counterweights

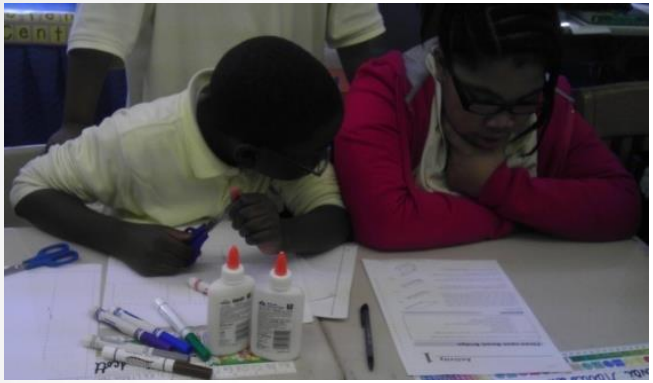
Let's start building our bridges:

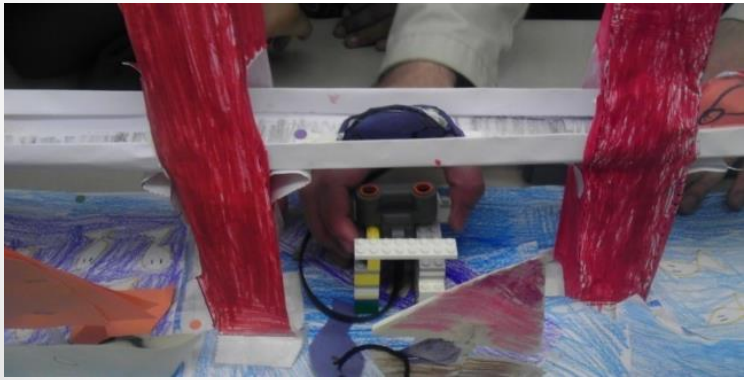
Two Designs:

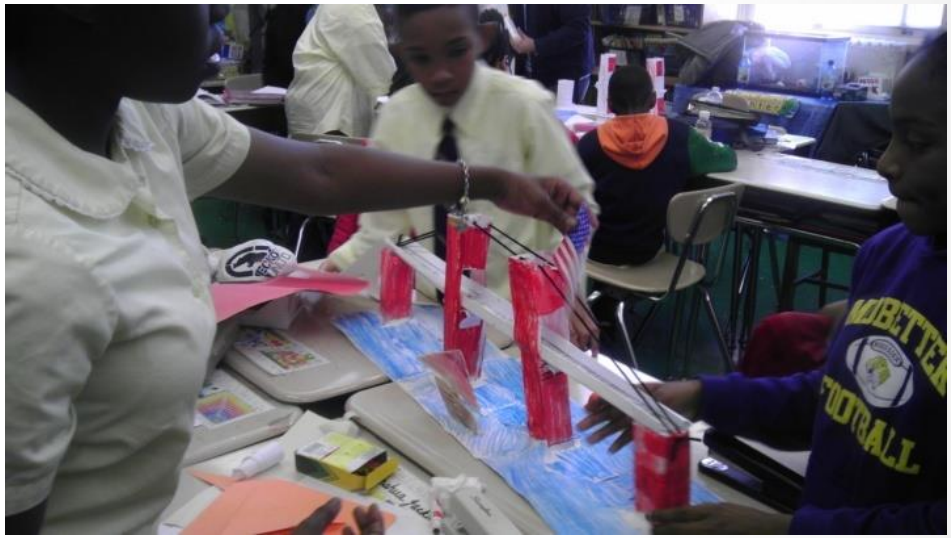
a. A three-span beam bridge made with paper

b. A simple truss bridge made of spaghetti (recommended) or any other design is also welcome

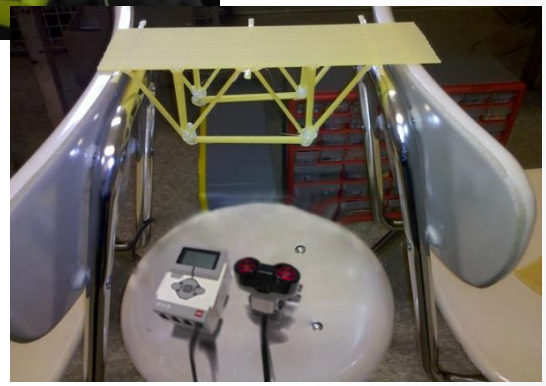
Paper Bridge:







Spaghetti Bridge:



1. Identify tension and compression forces
2. Learn how to strengthen a single beam bridge
3. Measure deflection using a LEGO MINDSTORMS EV3 ultrasonic sensor

THANK YOU !