Building Bridges – VOCABULARY

Arch Bridges

- **Deck Arch**
  - ✓ Roadway is above the arch
  - ✓ Romans first used

- **Half Through Arch**
  - ✓ Roadway cuts through the arch

- **Through Arch**
  - ✓ Roadway is suspended from the arch

- **Bowstring**
  - ✓ Roadway ends are hung from the arch by tension wires

Beam Bridges

- **Girder**
  - ✓ Load carrying horizontal beam is supported at each end by footings
  - ✓ Boxed or arched girders are used for maximum strength

- **Cantilever**
  - ✓ Middle beam is supported by two outside beams
  - ✓ Divides the bending movement into two parts
  - ✓ Bridge whose two main spans extend toward each other and support a short suspended span, which bears fewer loads.

- **Truss**
  - ✓ Made from beams which are cross braced at regular intervals
  - ✓ Horizontal beams are necessary to prevent the truss from falling over
  - ✓ Truss may be above or below the deck

Tension Bridges

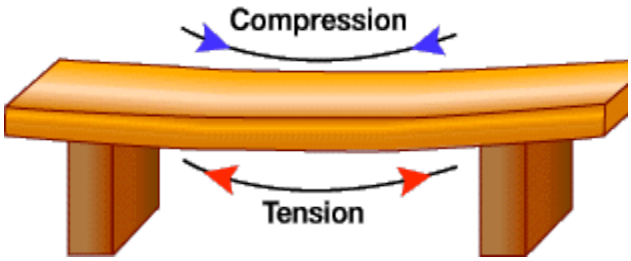
- **Suspension**
  - ✓ Deck is suspended by hangers from continuous steel cable
  - ✓ Cables are supported by towers and are anchored at each end of the structure
  - ✓ Load is carried in tension which is transmitted to the ground by each part

- **Cable Stayed**
  - ✓ Deck is supported by cable connected directly to one or two towers
  - ✓ Load is transferred directly to the towers

- **Strut**
  - ✓ That part of a structure which carries the load in compression

- **Thrust Lines**
  - ✓ Lines of force, caused by loads, transmitted through a structure to the ground
  - ✓ Must remain in the middle third of a structure of it will fall over
  - ✓ Is the limiting factor in the possible height of a structure

- **Compression**
  - ✓ The tendency for a materials forces to be applied inwards



- **Tension**
  - ✓ The tendency for a material to stretch or be pulled apart

- **Torque**
  - ✓ When a force is multiplied by the length of a lever arm
  - ✓ If a lever arm is doubled, the torque is also doubled.

- **Torsion**
  - ✓ The tendency of a material to be twisted

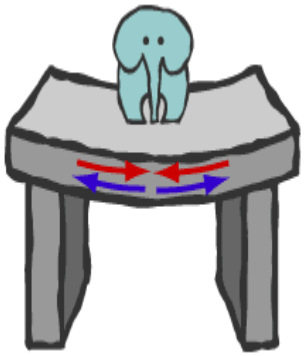
- **Weight**
  - ✓ The gravitational pull between two objects

We all rely on bridges for travelling over many of obstacles that get in the way of path to our many designations we need to go to each day. But do you know how they work? Or why some bridges are curved while others are straight? Engineers have to consider many things -- like the distance to be spanned, the types of materials available, and the needs and functions of the bridge; before determining the size, shape, and overall look of the bridge.

Since the earliest times, people have designed four major types of bridges:

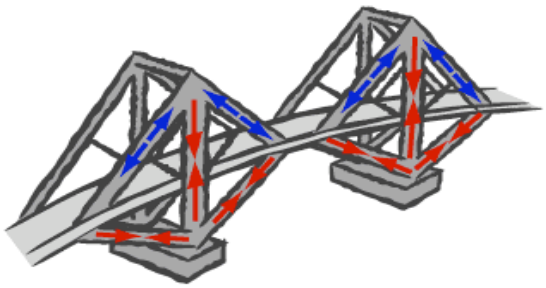
The Beam Bridge...

- A simple bridge that has horizontal beams supported by vertical posts
- Horizontal beams are supported at each end by piers. The weight of the beam pushes straight down on the piers.
- When something pushes down on the beam, the beam bends. Its top edge is pushed together, and its bottom edge is pulled apart.
- The farther apart its piers, the weaker the beam becomes. This is why beam bridges rarely span more than 250 feet.
- A continuous span bridge has the ability to span great distances because several beam bridges can be linked together.



The Truss Bridge...

- Truss bridge consists of an assembly of triangles; they are commonly made from a series of straight, steel bars.



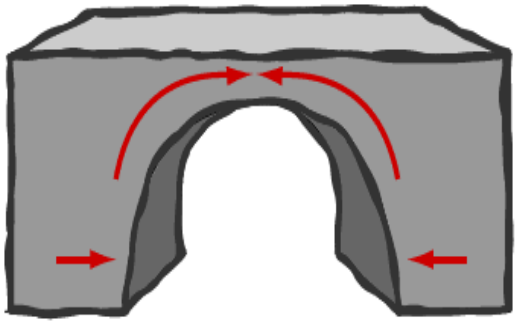
- Every bar in this cantilever bridge experiences either a pushing or pulling force. The bars rarely bend. This is why cantilever bridges can span farther than beam bridges.

The Arch Bridge...

- Has great natural strength. Thousands of years ago, Romans built arches out of stone. Today, most arch bridges are made of steel or concrete, and they can span up to 800 feet.

- The arch is squeezed together, and this squeezing force is carried along the curve to the supports at each end. The supports push back on the arch and prevent the ends of the arch from spreading apart.

How are arch bridges built?



- Building an arch bridge isn't easy, since the structure is completely unstable until the two spans meet in the middle.

- For years, engineers used a technique called centering, in which a wooden form supported both spans until they locked together at the top.

- A newer method supports the spans using cables anchored to the ground on either side of the bridge.

The Suspension Bridge...

- Can span 2,000 to 7,000 feet - much farther than any other type of bridge! Most suspension bridges have a truss system beneath the roadway to resist bending and twisting.

- The roadway hangs from massive steel cables, which are draped over two towers and secured into solid concrete blocks, called anchorages, on both ends of the bridge.
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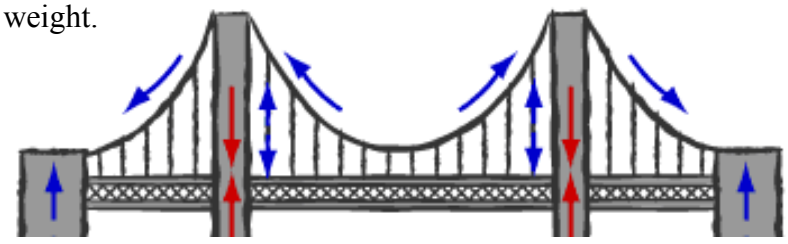
- The cars push down on the roadway, but because the roadway is suspended, the cables transfer the load into compression on the two towers. The towers support most of the weight.



Cable-Stayed Bridge

The cable-stayed bridge, like the suspension bridge, supports the roadway with massive steel cables, but in a different way. The cables run directly from the roadway up to a tower, forming a unique "A" shape.

Cable-stayed bridges, like the Alex Fraser Bridge in the lower mainland, require less cable and can be built much faster than suspension bridges. Cable-stayed bridges are becoming the most popular bridges for medium-length spans (between 500 and 3,000 feet).

Lower Mainland Bridges

1) Arthur Lang
2) Oak St
3) Knight St.
4) Queensborough
5) Alex Fraser
6) Pattullo
7) Port Mann
8) Second Narrows
9) Lions Gate

10) Cambie

11) Granville

12) Burrard

13) Pitt River

14) No. 2 Road

15) George Massey Tunnel

Lower Mainland Bridge Quiz

1) **What is another name for the Iron Workers Memorial Bridge?**
    a. Second Narrows
    b. Alex Fraser
    c. Lions Gate
    d. Port Mann

2) **What bridge runs from North Delta to Annacis Island?**
    a. Cambie
    b. Burrard St.
    c. Port Mann
    d. Alex Fraser

3) **I lead to the Alex Fraser bridge, who am I?**
    a. Knight St.
    b. Pattullo
    c. Queensborough
    d. Lions Gate

4) **What bridge carries traffic from highway 99 from Richmond to Vancouver?**
    a. Knight St.
    b. Burrard St.
    c. Oak St.
    d. Port Mann

5) **How many bridges tie the North Shore & West Vancouver to the rest of the Greater Vancouver?**
    a. Zero
    b. One
    c. Two
    d. Three

6) **Which bridge spans from Surrey to New Westminster?**
    a. Pattullo
    b. Arthur Lang
    c. Alex Fraser
    d. Granville St.

7) **What bridge goes from Sea Island to Vancouver**
    a. Cambie St.
    b. Queensborough
    c. Arthur Lang
    d. Lions Gate

8) **I am a large bridge that spans from Surrey to Coquitlam. Who am I?**
    a. Second Narrows
    b. Port Mann
    c. Lions Gate
    d. Knight St.

9) **I tie Vancouver to West Vancouver and North Vancouver, who am I?**
    a. Oak St.
    b. Granville St.
    c. Pattullo
    d. Lions Gate

10) **How many bridges tie Richmond to Vancouver**
    a. Zero
    b. One
    c. Two
    d. Three

Answer Key

1) Second Narrows
2) Alex Fraser
3) Queensborough
4) Oak St.
5) Two
6) Pattullo
7) Arthur Lang
8) Port Mann
9) Lions Gate
10) Three

Student Activities – Lesson Breakdowns

Day 1

- Unit breakdown
    - Talk about unit objectives
    - Talk about activities
    - Fun Quiz - Lower Mainland Bridges
- Vocabulary lesson
    - Handout of vocabulary and terms
- Student discussion questions
    - Handout of facts and information
    - Handout of discussion questions (Homework)
- Breakout into groups
    - Pick groups
    - Start preliminary design concepts
- Finish / Cleanup / Wrap-up
    - Finish vocabulary and discussion questions worksheets
    - Cleanup and setup classroom from group work

Day 2

- Pre-test
- Bridge Building Site – MEDIA COMPONENT
    - http://stephenjl.googlepages.com/bridgebuilding
    - Explore resource list
    - Play bridge builder game
    - Answer final questions (could be homework)
- Group work
- Cleanup lab and log off computers

Day 3

- Post test
- BUILDING YOUR NEWSPAPER BRIDGE!!!!!!
    - Get equipment
    - Build bridge
    - Return any unused resources
    - Test bridges
    - Awards ceremonies
    - Cleanup of room