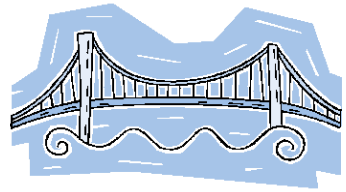
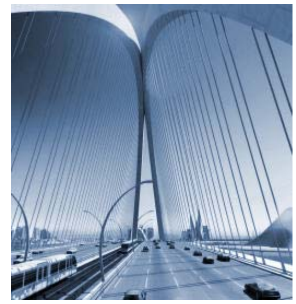
Popsicle Bridge



Student Resource: Types of Bridges

There are six main types of bridges: arch, beam, cable-stayed, cantilever, suspension, and truss.



◆Arch

Arch bridges are arch-shaped and have abutments at each end. The earliest known arch bridges were built by the Greeks and include the Arkadiko Bridge. The weight of the bridge is thrusted into the abutments at either side. The largest arch bridge in the world, scheduled for completion in 2012, is planned for the Sixth Crossing at Dubai Creek in Dubai, United Arab Emirates.

◆Beam

Beam bridges are horizontal beams supported at each end by piers. The earliest beam bridges were simple logs that sat across streams and similar simple structures. In modern times, beam bridges are large box steel girder bridges. Weight on top of the beam pushes straight down on the piers at either end of the bridge.

◆Cable-stayed

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.. The longest cable-stayed bridge is the Tatara Bridge in the Seto Inland Sea, Japan.

◆Cantilever

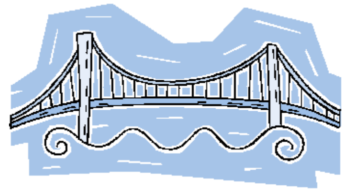
Cantilever bridges are built using cantilevers — horizontal beams that are supported on only one end. Most cantilever bridges use two cantilever arms extending from opposite sides of the obstacle to be crossed, meeting at the center. The largest cantilever bridge is the 549 m (1800 ft.) Quebec Bridge in Quebec, Canada.

◆Suspension

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. The longest suspension bridge in the world is the 3911 m (12,831ft.) Akashi Kaikyo Bridge in Japan.

◆ Truss

Truss bridges are composed of connected elements. They have a solid deck and a lattice of pin-jointed girders for the sides. Early truss bridges were made of wood, but modern truss bridges are made of metals such as wrought iron and steel. The Quebec Bridge, mentioned above as a cantilever bridge, is also the world's longest truss bridge.



Student Resource: Famous Bridges

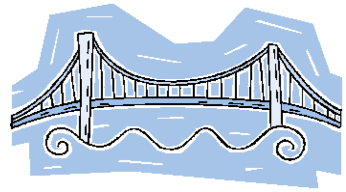
◆Firth of Forth Bridge, Scotland

The Forth Bridge is a cantilever, railway bridge over the Firth of Forth in the east of Scotland. The bridge is, even today, regarded as an engineering marvel. It is 2.5 km (1.5 miles) in length, and the double track is elevated 46 m (approx. 150 ft) above high tide. It consists of two main spans of 1,710 ft (520 m), two side spans of 675 ft, 15 approach spans of 168 ft (51 m), and five of 25 ft (7.6 m). Each main span comprises two 680 ft (210 m) cantilever arms supporting a central 350 ft (110 m) span girder bridge. The three great four-tower cantilever structures are 340 ft (104 m) tall, each 70 ft (21 m) diameter foot resting on a separate foundation. The southern group of foundations had to be constructed as caissons under compressed air, to a depth of 90 ft (27 m). At its peak, approximately 4,600 workers were employed in its construction.

◆ Sydney Harbour Bridge, Australia

The Sydney Harbour Bridge is a steel arch bridge across Sydney Harbour that carries trains, vehicles, and pedestrian traffic between the Sydney central business district and the North Shore area. The dramatic view of the bridge, the harbour, and the nearby Sydney Opera House is an iconic image of both Sydney and Australia. The bridge was designed and built by Dorman Long and Co Ltd, from Middlesbrough, Teesside, U.K., and was the city's tallest structure until 1967. According to Guinness World Records, it is the world's widest long-span bridge and its tallest steel arch bridge, measuring 134 metres (429.6 ft) from top to water level. It is also the fourth-longest spanning-arch bridge in the world. The arch is composed of two 28-panel arch trusses. Their heights vary from 18 m (55.8 ft) at the center of the arch to 57 m (176.7 ft) (beside the pylons).

Popsicle Bridge



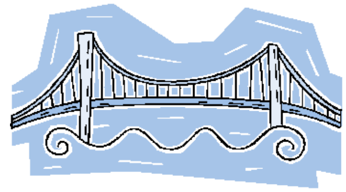
Student Worksheet: Design Your Own Bridge

You are part of a team of engineers who have been given the challenge to design a bridge out of up to 200 popsicle sticks and glue. Bridges must be able to hold a specific weight (your teacher will decide what the weight goal will be for your class). The bridge must span at least 14 inches in length. But, it must be longer than 14 inches because when it has been constructed, it will be placed between two chairs so it is at least one foot above the floor for a weight bearing test. In addition to meeting the structural and weight bearing requirements, the bridge will be judged on its aesthetics as well, so be creative! And, you are encouraged to use the fewest number of popsicles possible to achieve your goal.

◆ Planning Stage

Meet as a team and discuss the problem you need to solve. Then develop and agree on a design for your bridge. You'll need to determine how many popsicle sticks you will use (up to 200) -- and the steps you will take in the manufacturing process. Think about what patterns might be the strongest….but you are also being judged on the aesthetics of your bridge! Draw your design in the box below, and be sure to indicate the number of sticks you anticipate using. Present your design to the class. You may choose to revise your teams' plan after you receive feedback from class.

Number of popsicle sticks you anticipate using:



Student Worksheet (continued):

◆ Construction Phase

Build your bridge. During construction you may decide you need additional sticks (up to 200) or that your design needs to change. This is ok -- just make a new sketch and revise your materials list.

◆ Aesthetic Vote

Each student will cast a vote about the look of each bridge. The scale is 1 - 5 -- (1: not at all appealing; 2: not appealing; 3: neutral/average; 4: somewhat appealing; 5: very appealing). This number is averaged to generate a score for each bridge. This score is not based on how well the bridge might hold weight, but on how it looks.

◆ Testing Phase

Each team will test their bridge to see if it can withstand the required weight for at least one full minute. Be sure to watch the tests of the other teams and observe how their different designs worked.

◆ Evaluation Phase

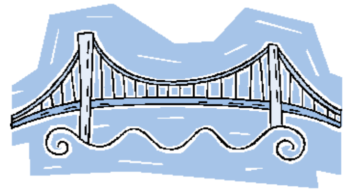
Evaluate your teams' results, complete the evaluation worksheet, and present your findings to the class.

Use this worksheet to evaluate your team's results:

1. Did you succeed in creating a bridge that held the required weight for a full minute? If not, why did it fail?

2. Did you decide to revise your original design while in the construction phase? Why?

3. How many popsicle sticks did you end up using? Did this number differ from your plan? If so, what changed?



4. What was the average aesthetic score for your bridge? How did this compare to the rest of the class? What design elements of other bridges did you like the best?

5. Do you think that engineers have to adapt their original plans during the construction of systems or products? Why might they?

6. If you had to do it all over again, how would your planned design change? Why?

7. What designs or methods did you see other teams try that you thought worked well?

8. Do you think you would have been able to complete this project easier if you were working alone? Explain…

9. What sort of trade-offs do you think engineers make between functionality, safety, and aesthetics when building a real bridge?