Traveling Programs

Paper Bridge Engineering

Whether going over a river, railroad or highway, bridges serve as useful structures to get from here to there. However, it takes a lot of planning and designing to make the best bridge for a specific location. Although bridge designs may vary around the world, all bridge engineers have to consider the materials needed for their plan, how the bridge will be used, and how the local climate will affect their idea. In this classic activity, students will design, test, and re-design their own paper bridges.

Materials

- 5x8 Index Cards
- Scissors
- Paper clips
- Pennies (the more, the better!)
- Stack of Books
- Paper Bridge Data Sheet (included below)

Directions

1) Have each student create a "valley" for their bridge by making two stacks of books and separating them so that the gap in-between measures approximately 7 inches.

2) Hand out seven index cards, a roll of pennies, a data sheet, and a pair of scissors to each student.

3) Ask each student to place one index card between the book stacks to act as a basic beam bridge. They should slowly place pennies on their bridge and count how many their bridge is able to hold before falling down.

4) Next, challenge the students to think of ways they can make their bridge stronger. How many pennies can their bridge hold if they fold a file card:

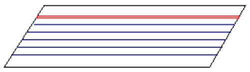
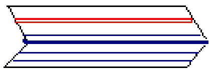
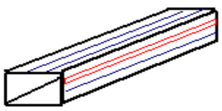
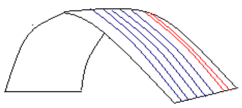
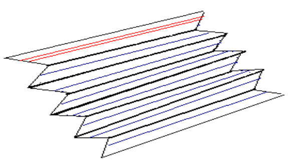
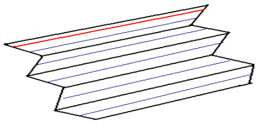
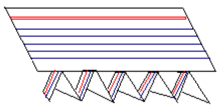
   - in half?
   - in the shape of a 4-sided beam?
   - in the shape of a curved arch?
   - into big triangle-shaped pleats?
   - into small triangle-shaped pleats?
   - in a combination of these folds?

5) Have each student record their results for each bridge on their data sheet.

Background Information

Although there are many types of bridges used around the globe, the four most common are the beam bridge, arch bridge, suspension bridge, and draw bridge. Each of these bridges work well for different locations and situations, and it is up to the local engineers to decide which bridge is the best fit. Beam bridges are the simplest design, and consist of a flat deck supported on the ends by abutments. They are great options for crossing over small spans, such as a foot bridge over a stream. Arch bridges are made up of a curved arch supported by abutments on either side. By combining multiple arches side-by-side, these bridges can be used for both shorter and longer spans. Suspension bridges have a deck that hangs below giant suspension cables supported by upright towers. These bridges are especially helpful for crossing great distances, while still leaving room for water traffic below. Seeing as suspension bridges can be very expensive to build, a draw bridge may be a good alternative to keep costs down. Draw bridges work best in low traffic areas, since pedestrians and vehicles must wait as the leaves of the bridge move upwards and downwards to give overhead clearance to passing boats and ships below.

By looking for the basic shapes that make up a bridge, bridge engineers can better understand how forces act on it. Rectangle shapes, such as those that are formed by beam bridges and the ground beneath them, tend to be the weakest of shapes. As weight is added to the top, the beam begins to sag in the middle, causing the top of the beam to undergo compression and the bottom of the beam to undergo tension. If too much weight is added, the beam will tear apart and fail. Arch shapes, found in arch bridges, are more stable than rectangle shapes. The more weight is applied to the top of the arch bridge, the more the arch experiences compression. This squishing force is transferred to the abutments, which pushes back on the arch and prevents it from spreading apart and collapsing. Triangles, such as those seen in suspension bridges, are the most stable of shapes. As weight is added to the deck, the cables experience tension, and this pulling force causes the towers to compress. The towers support most of the weight of the bridge and contribute greatly to its stability.

Bridge Design	Total # of Pennies Held
Plain Card 	
Half Fold 	
4 sided Beam 	
Arch 	
Little Triangles 	
Big Triangles 	
Combo 	
Your Own Design!	