Bridges

There are more than half a million bridges in the United States, and you rely on them every day to cross obstacles like rivers, valleys, railroad tracks, and other open spaces. But do you know how they work, or why some bridges are curved while others are straight? Engineers must consider many things, like the distance to be spanned and the types of materials available, before determining the size, the shape, and the overall look.

Since ancient times, engineers have designed bridges of different types to withstand all forces of nature. There are numerous bridge designs, ranging from simple beam bridges, arch bridges, truss bridges, and suspension bridges to more complex variations. The key difference between these four bridge types comes down to the lengths they can cross in a single span (which is the distance between two bridge supports). Modern beam bridges are likely to span up to 250 feet, while modern arch bridges can safely cross up to 800 feet. Suspension bridges are capable of extending from 2,000 - 7,000 feet!

Regardless of the structure, every bridge must stand strong and be able to support weight.
Beam Bridges

The beam bridge is the most common bridge. It is usually used to span shorter distances and is commonly found on local roads. A beam bridge is made with large piers (supports) on the edges and a heavy beam (called a deck) crossing over water, a ditch, or other open space. Over the sturdy deck beam, there are boards, metal, or most commonly a layer of concrete. The bridge road surface is level with the road, making it very strong.

Beam bridges are used to span no more than 250 feet. The weight of the beam pushes straight down on the piers. The farther apart its piers, the weaker the beam becomes. This is why beam bridges rarely span more than 250 feet. When something pushes down on the beam, the beam bends. Its top edge is pushed together, and its bottom edge is pulled apart (as shown below).

A single beam bridge rarely spans more than 250 feet. But often times several beam bridges can be linked together, creating what is called a continuous span. The continuous span gives beam bridges the ability to span great distances.
Arch Bridges

Arch bridges are the oldest and most sturdy type of bridge. They do not have all the forces pushing down. In this type of bridge the weight is carried outward and distributed along two curving paths to the supports at each end. These end supports are called abutments, and they carry the load and keep the ends of the bridge from spreading out. The points where the arch reaches the ground keeps the bridge up by resisting the outward thrust. The roadway is located on top of the arch.

When supporting its own weight and the weight of crossing traffic, every part of the arch is under compression. For this reason, arch bridges must be made of materials that are strong under compression. 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 (like that of beam bridges), but arch bridges can span up to 800 feet.
Truss Bridges

The truss bridge is basically a fancy beam bridge which consists of an assembly of triangles. This triangular design is used for support to hold up more weight and span more distance. The triangular supports span across the top sides of the bridge, and sometimes trusses are part of the under structure of a truss bridge (as seen below).

Truss bridges are commonly made from a series of straight, steel bars. Rigid arms extend from both sides of two piers. Diagonal steel tubes, projecting from the top and bottom of each pier, hold the arms in place. The arms that project toward the middle are only supported on one side, like really strong diving boards. These "diving boards," called cantilever arms, support a third, central span. Every bar in this bridge experiences either a pushing or pulling force. The bars rarely bend. This is why these bridges can span farther than beam bridges.
Cantilever Bridges

The cantilever bridge is a bridge formed by two projecting beams or trusses that are joined in the center by a connecting member and are supported on piers that are anchored by balancing members. In other words, there are two beams with a tower that holds them together in the middle, and there are weights on each end to balance it. In the cantilever type of bridge, two beams support another beam, which is where the deck or roadway is. The two beams must be anchored, and this must be done well.

Cantilever bridges depend on counterbalances. Counterbalances are weights used to balance another weight. They consist of two or more arms that equally balance each other, almost like a perfectly balanced see-saw.

Often the part of the bridge that leads to the first cantilever is just a beam bridge. Cantilever bridges are built in a way similar to beam and arch bridges, depending on how the bridge is designed.
Suspension Bridges

The suspension bridge is used to span long distances. Most suspension bridges can span lengths of 2,000 to 7,000 feet -- way farther than any other type of bridge! Suspension bridges suspend the road from huge main cables which extend from one end of the bridge to the other. These cables rest atop high towers and are secured into solid concrete blocks at each end called anchorages. The towers enable engineers to stretch the main cables over long distances.

The cables carry most of the bridge’s weight to the anchorages, which are embedded in either solid rock or massive concrete blocks. Inside the anchorages, the cables are spread over a large area to evenly distribute the load and to prevent the cables from breaking free. The cables transfer the weight to the towers, which transfer the weight to the ground. Most suspension bridges have a truss system beneath the roadway to prevent it from bending and twisting.

In all suspension bridges, the roadway hangs from massive steel cables. The cars push down on the roadway, but because the roadway is suspended, the cables transfer the load into compression in the two towers. The two towers support most of the bridge's weight.