Arch Bridge

Arch bridges are one of the oldest types of bridges and have great natural strength. Instead of pushing straight down, the weight of an arch bridge is carried outward along the curve of the arch to the supports at each end. These supports, called the abutments, carry the load and keep the ends of the bridge from spreading out

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 Romans used stones. One of the most famous examples of their handiwork is the Pont du Gard aqueduct near Nîmes, France. Built before the birth of Christ, the bridge is held together by mortar only in its top tier; the stones in the rest of the structure stay together by the sheer force of their own weight.

Today materials like steel and pre-stressed concrete have made it possible to build longer and more elegant arches, including a spectacular 1700 foot span in New River Gorge, West Virginia. (More typically, modern arch bridges span between 200-800 feet.)

Constructing an arch bridge can be tricky, since the structure is completely unstable until the two spans meet in the middle. One technique is to build elaborate scaffolding, or "centering," below the spans to support them until they meet. A newer method supports the spans using cables anchored to the ground on either side of the bridge. In situations where there is an active water or road way below, this method allows contractors to build without disrupting traffic.

One of the most revolutionary arch bridges in recent years is the Natchez Trace Bridge in Franklin, Tennessee, which was opened to traffic in 1994. It's the first American arch bridge to be constructed from segments of pre-cast concrete, a highly economical material. Two graceful arches support the roadway above. Usually arch bridges employ vertical supports called "spandrels" to distribute the weight of the roadway to the arch below, but the Natchez Trace Bridge was designed without spandrels to create a more open and aesthetically pleasing appearance. As a result, most of the **live load** is resting on the crowns of the two arches, which have been slightly flattened to better carry it. Already the winner of many awards, the bridge is expected to influence bridge design for years to come.

Beam Bridge

A beam or "girder" bridge is the simplest and most inexpensive kind of bridge. According to Craig Finley of Finley/McNary Engineering, "they're basically the vanillas of the bridge world."

In its most basic form, a beam bridge consists of a horizontal beam that is supported at each end by piers. The weight of the beam pushes straight down on the piers. The beam itself must be strong so that it doesn't bend under its own weight and the added weight of crossing traffic. When a load pushes down on the beam, the beam's top edge is pushed together (compression) while the bottom edge is stretched (tension).

Pre-stressed concrete is an ideal material for beam bridge construction; the concrete withstands the forces of compression well and the steel rods imbedded within resist the forces of tension. Pre-stressed concrete also tends to be one of the least expensive materials in construction. But even the best materials can't compensate for the beam bridge's biggest limitation: its length.

The farther apart its supports, the weaker a beam bridge gets. As a result, beam bridges rarely span more than 250 feet. This doesn't mean beam bridges aren't used to cross great distances -- it only means that they must be daisy-chained together, creating what's known in the bridge world as a "continuous span."

In fact, the world's longest bridge is a continuous span beam bridge. Almost 24 miles long, the Lake Ponchartrain Causeway consists of two, two-lane sections that run parallel to one another. The Southbound Lane, completed in 1956, is made up of 2243 separate spans, while the Northbound Lane, completed in 1969, is pieced together from 1500 longer spans. Seven cross-over lanes connect the two main sections and function as pull-over bays in emergencies. Although impressive, the Lake Ponchartrain Causeway bridge underscores the drawback of continuous spans: they are not well suited for locations that require unobstructed clearance below.

Suspension Bridge

Aesthetic, light, and strong, suspension bridges can span distances from 2,000 to 7,000 feet—far longer than any other kind of bridge. They also tend to be the most expensive to build. True to its name, a suspension bridge **suspends** the roadway from huge main cables, which extend from one end of the bridge to the other. These cables rest on top of high towers and are secured at each end by anchorages.

The towers enable the main cables to be draped over long distances. Most of the weight of the bridge is carried by the cables to the anchorages, which are imbedded 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.

Some of the earliest suspension bridge cables were made from twisted grass. In the early nineteenth century, suspension bridges used iron chains for cables. Today, the cables are made of thousands of individual steel wires bound tightly together. Steel, which is very strong under tension, is an ideal material for cables; a single steel wire, only 0.1 inch thick, can support over half a ton without breaking

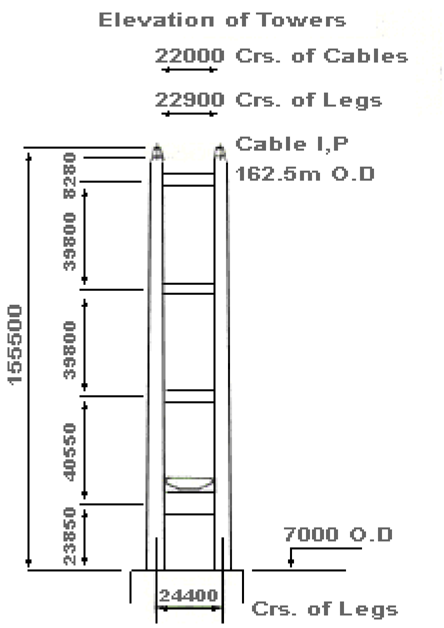
Currently, the Humber bridge in England has world's longest center span—measuring 4,624 feet. But this record won't stand for long. In 1998, the Japanese will unveil the $7.6 billion Akashi Kaikyo Bridge, linking the islands of Honshu and Shikoku. The bridge's center section stretches a staggering 6,527 feet. To keep the structure stable, engineers have added pendulum-like devices on the towers to keep them from swaying and a stabilizing fin beneath the center deck to resist typhoon-strength winds. Because suspension bridges are light and flexible, wind is always a serious concern—as the residents of Tacoma, Washington can surely attest

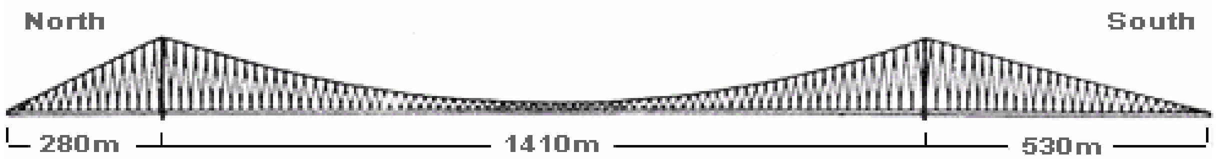
The Humber Bridge : more facts

The Humber Bridge is a suspension bridge with the north tower sited on the high water line and the south tower founded in shallow water 500*m* from the shore.

On the north bank, a hard well-jointed bed of chalk comes close to the surface and is covered by a tough layer of glacially deposited chalky boulder clay. The chalk has provided good foundations for both the anchorage and tower on this bank, on the south side, soft alluvium is underlain by beds of boulder clay, sand and gravel. Below these beds, at a depth of 30*m*, there is a deep bed of stiff, heavily fissured kimmeridge clay, on which the tower and anchorage have been founded.

Designed to cross the last major unbridged estuary in Britain, the bridge comprises reinforced concrete towers aerial-spun catenary cables and a continuously-welded, closed – box road deck supported by inclined hanger cables.





Cable-Stayed Bridge

Cable-stayed bridges may look similar to suspensions bridges—both have roadways that hang from cables and both have towers. But the two bridges support the load of the roadway in very different ways. The difference lies in how the cables are connected to the towers. In suspension bridges, the cables ride freely across the towers, transmitting the load to the anchorages at either end. In cable-stayed bridges, the cables are attached to the towers, which alone bear the load.

The cables can be attached to the roadway in a variety of ways. In a radial pattern, cables extend from several points on the road to a single point at the top of the tower. In a parallel pattern, cables are attached at different heights along the tower, running parallel to one other.

Even though cable-stayed bridges look futuristic, the idea for them goes back a long way. The first known sketch of a cable-stayed bridge appears in a book called *Machinae Novae* published in 1595, but it wasn't until this century that engineers began to use them. In post-World War II Europe, where steel was scarce, the design was perfect for rebuilding bombed out bridges that still had standing foundations. Cable stay bridges have begun to be erected in the United States only recently, but the response has been passionate

For medium length spans (those between 500 and 2,800 feet), cable-stayeds are fast becoming the bridge of choice. Compared to suspension bridges, cable-stayeds require less cable, can be constructed out of identical pre-cast concrete sections, and are faster to build. The result is a cost-effective bridge that is undeniably beautiful.

In 1988, the Sunshine Skyway bridge in Tampa, Florida won the prestigious Presidential Design Award from the National Endowment for the Arts. Painted yellow to contrast with its marine surroundings, the Sunshine Skyway is one of the first cable-stayed bridges to attach cables to the center of its roadway as opposed to the outer edges, allowing commuters an unobstructed view of the magnificent bay. Recently, in Boston, Massachusetts, a cable-stayed design was selected for a new bridge across the Charles River—even though cheaper options were proposed. City officials simply liked the way it looked.