

Reading: Bridges

There's something about bridges that I love. From simple stepping stones across a stream to giant overpasses linking continents, they have always been important to civilisation. And since the first Bronze Age river crossings, the objective of bridge building hasn't changed: to get to the other side. It's as simple as that. They're a natural part of everyday life. Bridges are used to cross a variety of obstacles whether a river, a sea, a valley, a road, or a railway line. My most memorable holidays are always associated with bridges: seeing San Francisco's Golden Gate swathed in fog, walking from Zimbabwe across the mighty Zambezi to Zambia, negotiating rickety bamboo bridges in Asia, the Sydney Harbour Bridge, and the wonderful Friendship Bridge connecting Thailand and Laos over the Mekong River. There are three main types of bridges: the beam, the arch and the suspension bridge.



Which bridge when?

Choosing the design of a bridge primarily depends on how wide the obstacle is – is it a small road or an enormous river? The main difference between the three main types of bridges is the distances they can cross in a single span. This means the distance between one vertical support to another. Some bridges can cross an obstacle in a single span, while others need many. If an enormous river is to be crossed, a bridge is needed that doesn't need too many supports. Another consideration of course is the types of material available to be used as well as the overall look of the bridge.

The beam bridge

The beam bridge is basically a rigid horizontal structure that rests on two piers (or supports), one at each end. The weight of the beam pushes straight down on the piers. The further apart the piers, the weaker the beam becomes. Next time you're on a journey, look out for these bridges crossing motorways. They're usually made of concrete or steel. Beam bridges rarely span more than 60m.

The arch bridge

It is the shape of the structure that gives the arch bridge its strength; they're a natural form of bridge. That's why they're so beautiful. An arch bridge doesn't need any additional supports or cables. In fact, an arch bridge made of stone doesn't even need mortar. Imagine that! There are still many arch bridges built by the Romans 2,000 years ago, without mortar, which are still standing today, real proof of the natural effectiveness of an arch as a bridge structure. Modern arch bridges can span up to 300m.

The suspension bridge

But surely the most elegant and sophisticated of all bridges is the suspension bridge. Modern suspension bridges usually have two tall towers (the supports) joined by cables

(or ropes or chains). The bridges hang from these cables. This means it is the towers that are supporting the majority of the bridge's weight. These bridges can have the longest spans – up to 2,000m. The main span of the incredible Akashi-Kaikyo Bridge is 1,991m.

Resonance

However beautiful the design or sophisticated the technology, bridges still fall down. Resonant vibrations, for example, can be fatal to a bridge. In 1940 a 65kph wind hit the Tacoma Narrows Bridge in Washington, USA, the third longest suspension bridge in the world at the time. This was just the right speed of wind hitting the bridge at just the right angle to cause the bridge to start vibrating. The vibrations caused waves which grew so large and violent that the bridge broke apart.

When an army marches across a bridge, the soldiers are often asked to 'break step'. This is to prevent their rhythmic marching from starting resonant vibrations that could cause the bridge to sway and undulate until it collapsed.

A recent case was the so-called 'wobbly bridge' in London. Some 80,000 people crossed the bridge on its opening day and those on the southern and central spans detected vibrations. The bridge began to sway and twist in regular oscillations. The pedestrians then altered their walking so as to be in step with the swaying and this made matters worse. The adjusted footsteps magnified the motion - just like when four people all stand up in a small boat at the same time. The bridge was then closed for several months for repairs. The bridge uses "lateral suspension", an engineering innovation that allows suspension bridges to be built without tall supporting columns.

The weather

This is the last battle for bridge designers. Although the latest designs and materials can produce state of the art bridges the weather can still cause problems. Cases of weather-related failures, for example windstorms, far outnumber those of design-related failures. As yet there is no effective solution either in terms of a specific construction material or in bridge design. And I like that: the idea that we can build the most wonderfully sophisticated buildings but Mother Nature still has the upper hand.