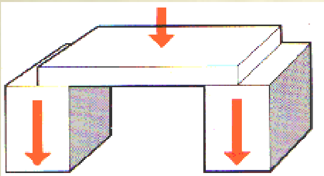
SUSPENSION BRIDGE

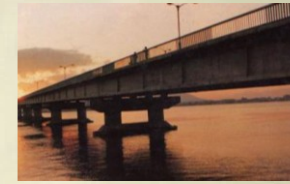
SUSPENSION BRIDGE

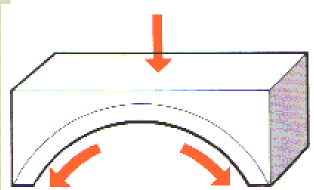
FOUR BASIC TYPES OF BRIDGES (ON THE BASIS OF LOAD TRANSFER)



BEAM BRIDGE

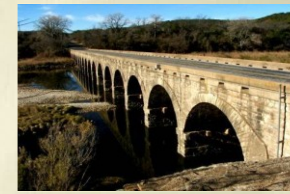
The beam type is the simplest type of bridge. The beam bridge could be anything as simple as a plank of wood to a complex structure. It is made of two or more supports which hold up a beam.

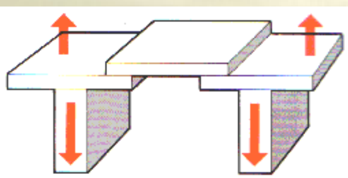




ARCH BRIDGE

In the arch type of bridge, weight is carried outward along two paths, curving toward the ground.





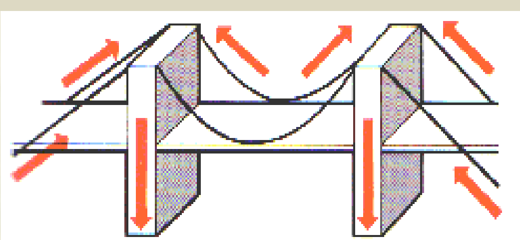
CANTILEVER BRIDGE

In the cantilever type of bridge, two beams support another beam, which is where the deck or traffic way is.

SUSPENSION BRIDGES

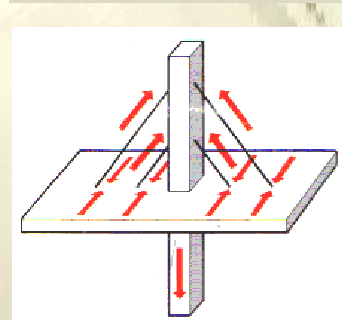
TYPICAL SUSPENSION BRIDGE

The deck (trafficway) of a suspension bridge is hung by suspender cables which hang from master cables (resting on the towers). The cables transfer the weight to the towers, which transfer the weight to the ground



CABLE STAYED BRIDGE

Cable-stayed bridges have towers, but cables from the towers go directly to the road deck, instead of spanning from tower to tower.

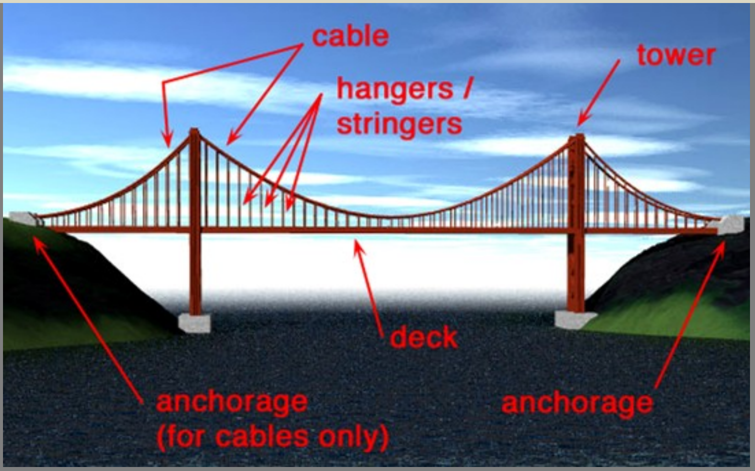


COMPONENTS OF SUSPENSION BRIDGES

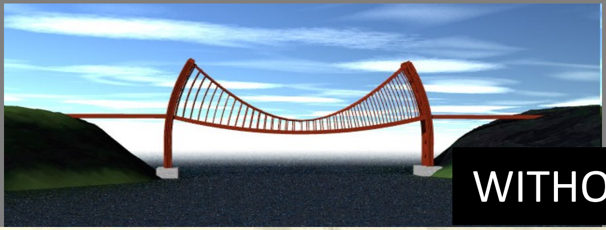
A suspension bridge is a type of bridge in which the deck (the load-bearing portion) is hung below suspension cables on vertical suspenders.

COMPONENTS

- Cables-suspend the roadway(deck) via hangers
- Towers- stabilize wire cables (offer little support)
- Anchorages- key to the structure, mass that keeps cables tight, gives the bridge structure

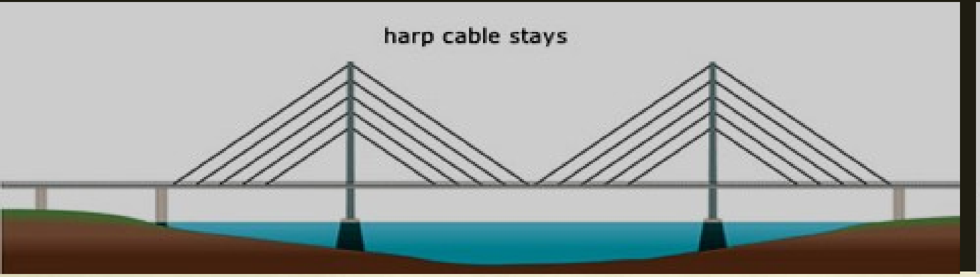


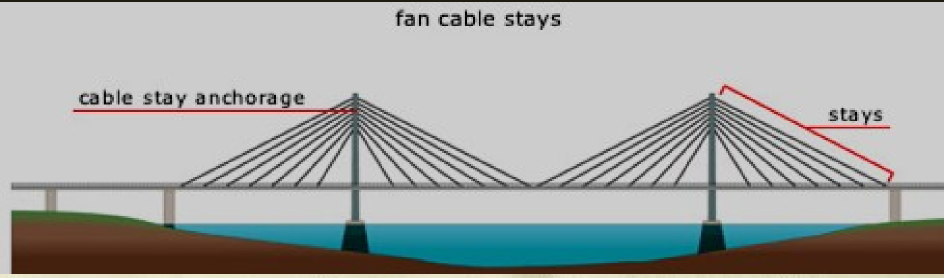
WITH ANCHORAGE



WITHOUT ANCHORAGE

IN CASE OF CABLE STAYED BRIDGE CABLES DIRECTLY CONNECT THE TOWER WITH THE DECK
THEY MAY BE OF TWO TYPES DEPENDING ON THE FIXING OF THE CABLES





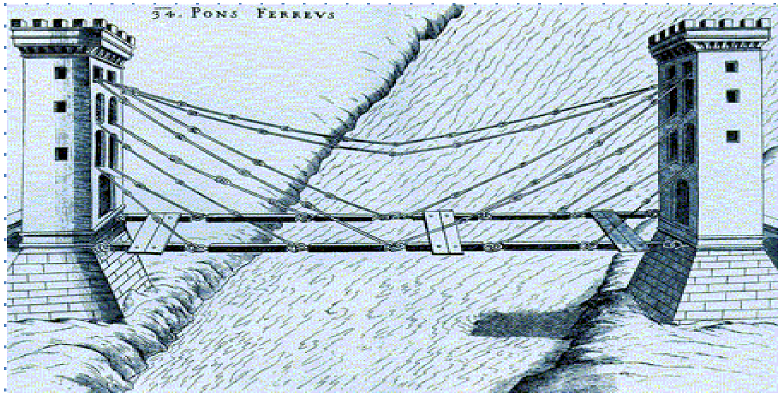
EVOLUTION OF SUSPENSION BRIDGES

Thousands of years ago people strung twisted vines attached to trees to cross over rivers and it gets many modified forms over the time.

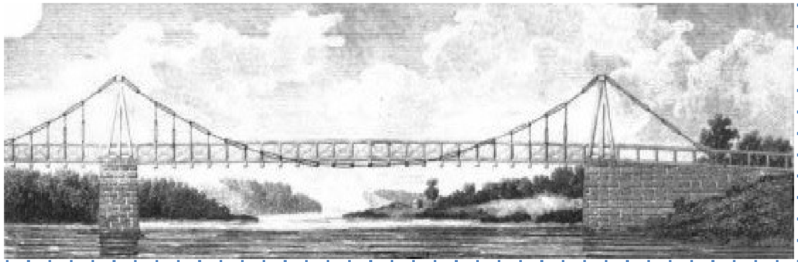
The Tibetan saint and bridge-builder Thangtong Gyalpo originated the use of iron chains in his version of early suspension bridges. In 1433, Gyalpo built eight bridges in eastern Bhutan. Gyalpo's iron chain bridges did not include a suspended deck bridge which is the standard on all modern suspension bridges today. Instead, both the railing and the walking layer of Gyalpo's bridges used wires.

EVOLUTION OF SUSPENSION BRIDGES

The first design for a bridge resembling the modern suspension bridge is attributed to Venetian engineer Fausto Veranzio, whose 1595 book *Machinae Novae* included drawings both for a timber and rope suspension bridge cable-stayed bridge using iron chains



However, the first suspension bridge actually built was by American engineer James Finley at Jacob's Creek, in, Pennsylvania, in 1801. Finley's bridge was the first to incorporate all of the necessary components of a suspension bridge



Dry burg bridge-1817-UK

Union bridge-1820 UK

Clifton bridge-1864 UK

AND SO ON………

STRUCTURAL ANALYSIS - LOADS

Three kinds of forces operate on any bridge: the dead load, the live load, and the dynamic load.

DEAD LOAD

Dead load refers to the weight of the bridge itself. Like any other structure, a bridge has a tendency to collapse simply because of the gravitational forces acting on the materials of which the bridge is made.

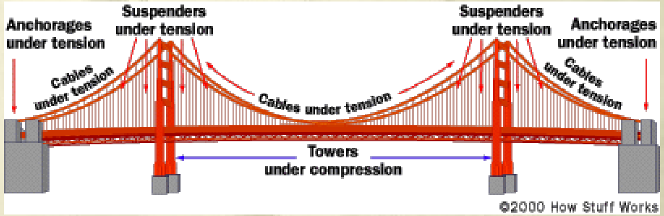
LIVE LOAD

Live load refers to traffic that moves across the bridge as well as normal environmental factors such as changes in temperature, precipitation, and winds

DYNAMIC LOAD

Dynamic load refers to environmental factors that go beyond normal weather conditions, factors such as sudden gusts of wind and earthquakes. All three factors must be taken into consideration when building a bridge.

BEHAVIOUR : THE MAIN FORCES IN A SUSPENSION BRIDGE OF ANY TYPE ARE TENSION IN THE CABLES AND COMPRESSION IN THE PILLARS.

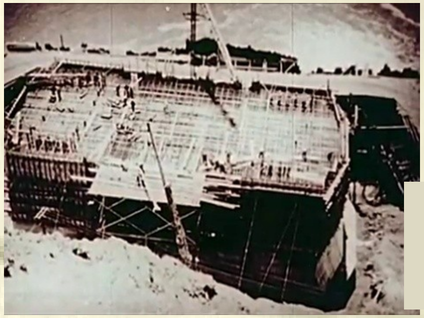


CONSTRUCTION SEQUENCE

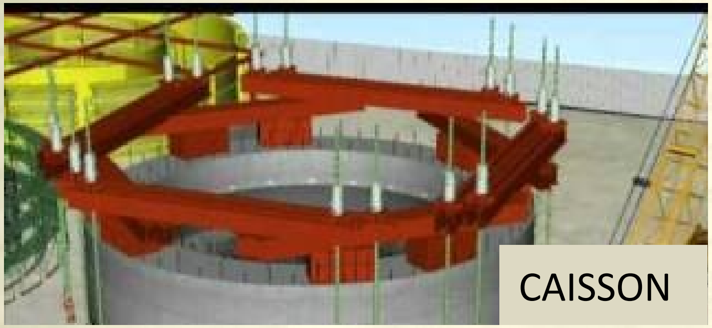
1. TOWERS`

Tower foundations are prepared by digging down to a sufficiently firm rock formation.

Some bridges are designed so that their towers are built on dry land, which makes construction easier.



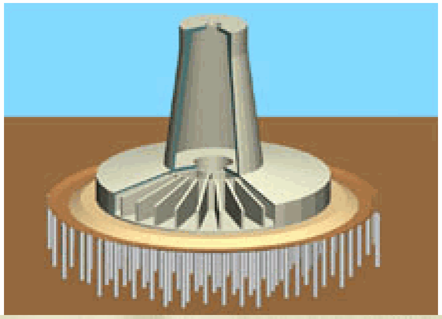
FOUNDATIONS ON DRYLAND



CAISSON

If a tower will stand in water, its construction begins with lowering a caisson (a steel and concrete cylinder that acts as a circular damn) to the ground beneath the water; removing the water from the caisson's interior allows workers to excavate a foundation without actually working in water.

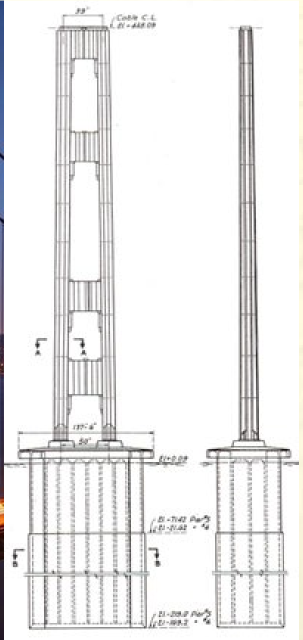
If the bedrock is too deep to be exposed by excavation or the sinking of a caisson, pilings are driven to the bedrock or into overlying hard soil, or a large concrete pad to distribute the weight over less resistant soil may be constructed, first preparing the surface with a bed of compacted gravel.

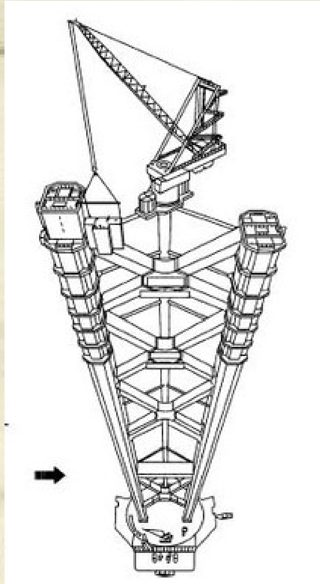


CONSTRUCTION SEQUENCE

1. TOWERS`

The piers are then extended above water level, where they are capped with pedestal bases for the towers. From where towers of single or multiple columns are erected using high-strength reinforced concrete, stonework, or steel. Concrete is used most frequently in modern suspension bridge construction due to the high cost of steel.



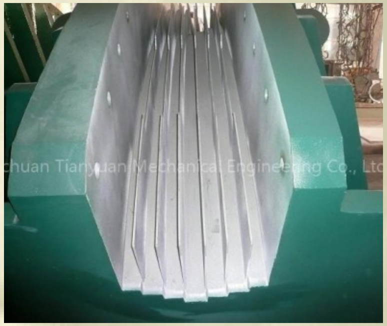


Towers are constructed on top of the steel caissons.

CONSTRUCTION SEQUENCE`

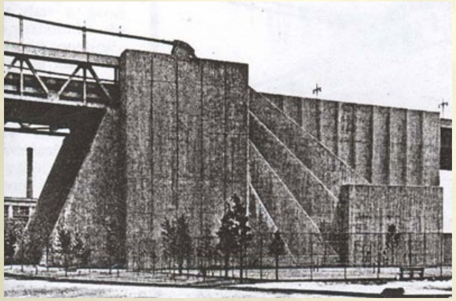
2. SADDLES

Large devices called *saddles*, which will carry the main suspension cables, are positioned atop the towers. Typically of cast steel, they can also be manufactured using riveted forms, and are equipped with rollers to allow the main cables to shift under construction and normal loads.



3.ANCHORAGE

Anchorages are the structures to which the ends of the bridge's cables are secured. They are massive concrete blocks securely attached to strong rock formations. During construction of the anchorages, strong eye bars (steel bars with a circular hole at one end) are embedded in the concrete.—each wire bundle will be secured to one of the anchorage's eye bars.



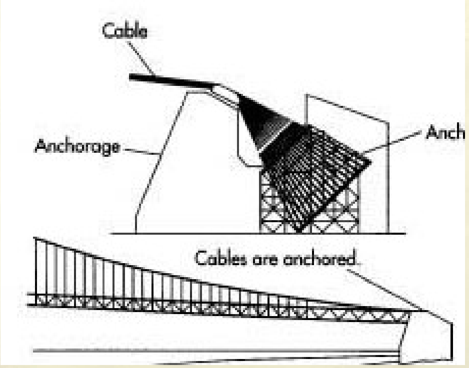


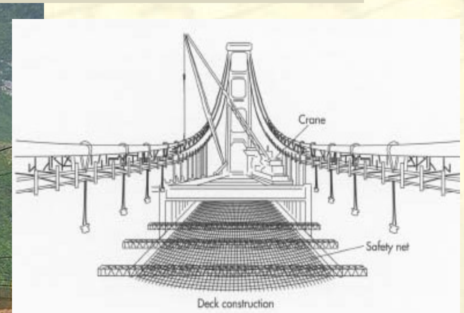
Fig. 31 Anchorage 4A of *Akashi-Kaikyo* bridge.

CONSTRUCTION SEQUENCE`

4.CATWALKS

Temporary suspended walkways, called *catwalks*, are then erected using a set of guide wires hoisted into place via winches positioned atop the towers. These catwalks follow the curve set by bridge designers for the main cables. Typical catwalks are usually between eight and ten feet wide, and are constructed using wire grate and wood slats.

Gantries are placed upon the catwalks, which will support the main cable spinning reels.



SUSPENSION BRIDGE

CONSTRUCTION SEQUENCE`

5.CABLE SPINNING

SPINNING

BUNDLE

COMPACTION

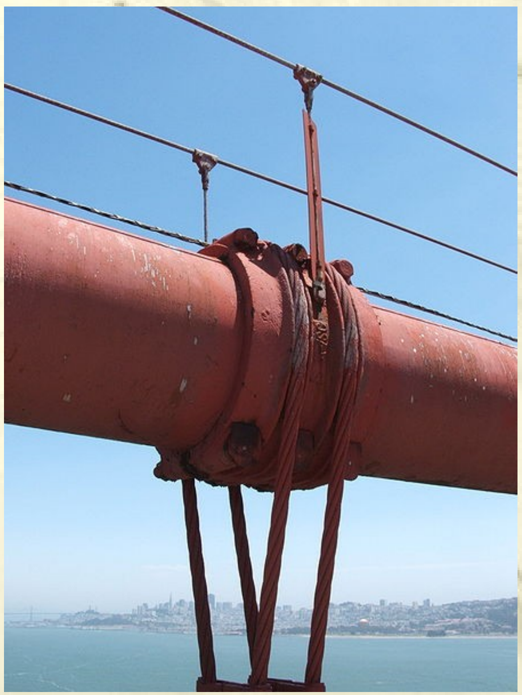
High strength wire (typically 4 or 6 gauge galvanized steel wire), is pulled in a loop by pulleys on the traveler, with one end affixed at an anchorage. When the traveler reaches the opposite anchorage the loop is placed over an open anchor eye bar. Along the catwalk, workers also pull the cable wires to their desired tension. This continues until a bundle, called a "cable strand" is completed, and temporarily bundled using stainless steel wire.

Then it is brought to shape with compactor

CONSTRUCTION SEQUENCE`

6.HANGERS / VERTICAL CABLES

At specific points along the main cable devices called "cable bands“(clamps) are installed to carry steel wire ropes called *Suspender cables.* Each suspender cable is engineered and cut to precise lengths, and are looped over the cable bands. In some bridges, where the towers are close to or on the shore, the suspender cables may be applied only to the central span.



CONSTRUCTION SEQUENCE`

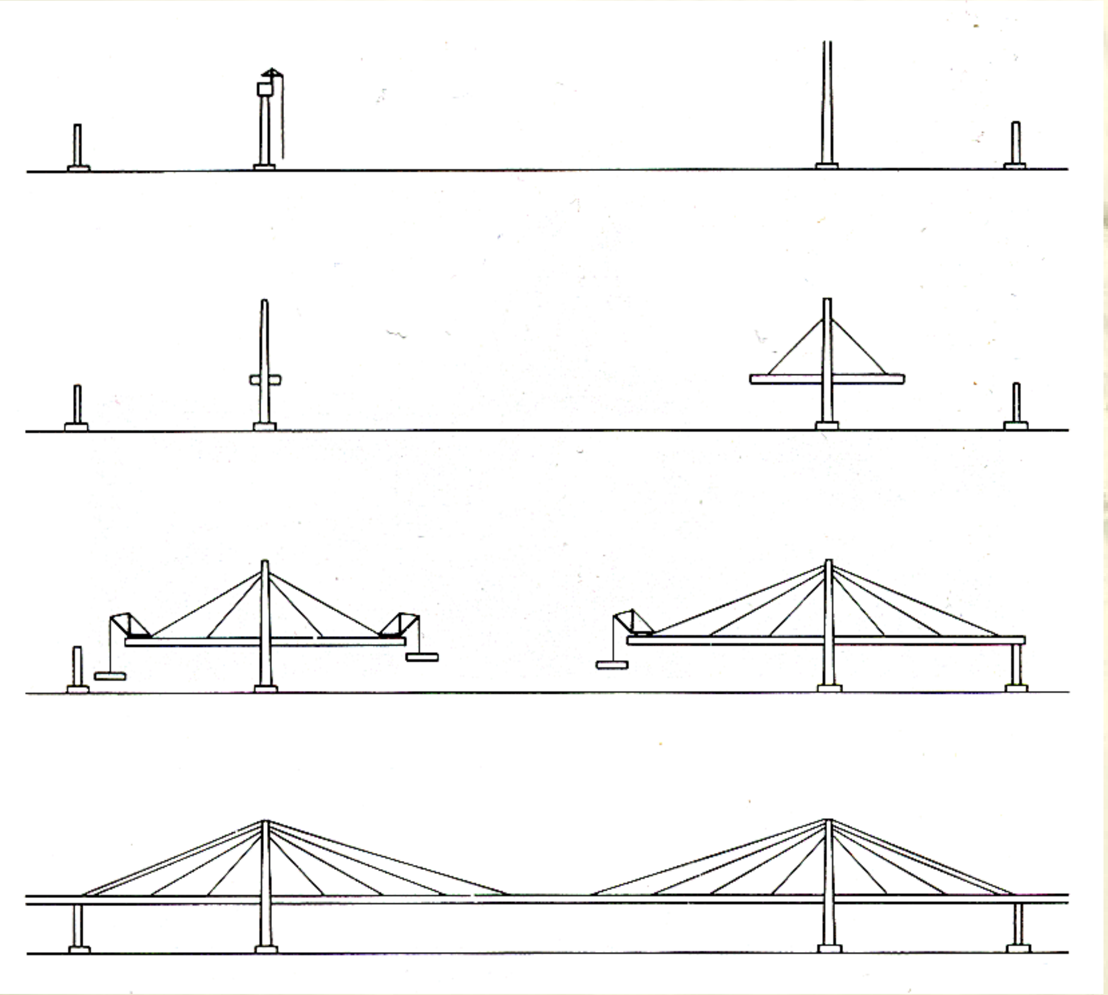
7.DECK

After vertical cables are attached to the main support cable, the deck structure can be started. The structure must be built in both directions from the support towers at the correct rate in order to keep the forces on the towers balanced at all times. In one technique, a moving crane that rolls atop the main suspension cable lifts deck sections into place, where workers attach them to previously placed sections and to the vertical cables that hang from the main suspension cables, extending the completed length. Alternatively, the crane may rest directly on the deck and move forward as each section is placed.

Upon completion of the deck the added load will pull the main cables into an arc mathematically described as a parabola, while the arc of the deck will be as the designer intended

CASE OF CABLE STAYED BRIDGE

CONSTRUCTION



Stage 1: The pylon above the main piers are erected.

Stage 2: A balanced free cantilever is initiated by using derrick cranes which operate on the deck to lift up the girder segments. These are transported to the site on barges.

Stage 3: As the cantilevers grow, the stay cables are installed and tensioned to their initial forces to carry the weight of the newly erected segment.

Stage 4: The bridge is closed at mid span and the additional loading is applied.

SUSPENSION BRIDGES THROUGHOUT THE WORLD

AKASHI KAIKYŌ BRIDGE - JAPAN
1991 M – SPAN

XIHOUMEN BRIDGE - CHINA
1650 M – SPAN

GOLDEN GATE BRIDGE – US
1280 M – SPAN

SIDU RIVER BRIDGE – CHINA
(1222 M SPAN)

BRIDGE TO RUSSKY ISLAND
RUSSIA - 1104 M SPAN

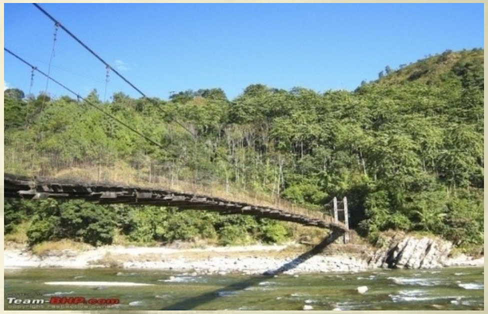
SUTONG BRIDGE - CHINA
1088 M SPAN

SUSPENSION BRIDGES THROUGHOUT INDIA

LAXMAN JHULA – RISHIKESH
150 M SPAN (FOOTBRIDGE)

KALLADA RIVER BRIDGE-
KERALA

BRIDGE ARUNACHAL PRADESH
FOOTBRIDGE



BANDRA WORLI SEA LINK
SPAN 40M (5.6 TOTAL LENGTH)

NIVEDITA SETU - KOLKATA
TOTAL LENGTH 880 M

VIDYASAGAR SETU KOLKATA
TOTAL LENGTH 822 KM SPAN 457 M

COMPARISION

Advantages over other bridge types

- Longer main spans
- Less material may be required than other bridge types, even at spans they can achieve, leading to a reduced construction cost
- Except for installation of the initial temporary cables, little or no access from below is required during construction, for example allowing a waterway to remain open while the bridge is built above
- A suspension bridge can be made out of simple materials such as wood and common wire rope.
- May be better to withstand earthquake movements than heavier and more rigid bridges

Disadvantages over other bridge types

- Considerable stiffness may be required to prevent the bridge deck vibrating under high winds
- The relatively low deck stiffness compared to other (non-suspension) types of bridges makes it more difficult to carry heavy rail traffic where high concentrated live loads occur

CASE STUDY – VIDYASAGAR SETU BRIDGE KOLKATA

INTRODUCTION

Vidyasagar Setu, also known as the Second Hooghly Bridge, is a bridge over the Hooghly River in West Bengal, India. It links the city of Kolkata to Howrah.

It was the second bridge to be built across the Hooghly River, after the Howrah Bridge (also known as Rabindra Setu) 12 kilometres (7.5 mi) to its north was built in 1943.

Design: Cable-stayed bridge

Total length: 822.96 metres (2,700 ft)

Width: 35 metres (115 ft)

Longest span: 457.2 metres (1,500 ft)

Clearance below: 26 metres (85 ft)

Designed by Schlaich Bergermann & Partner

Constructed by Gammon India Ltd

CASE STUDY – VIDYASAGAR SETU BRIDGE KOLKATA

FEATURES

- The bridge is a cable-stayed bridge (121 cables) with a fan arrangement
Built on steel pylons 127.62 metres (418.7 ft) in height.

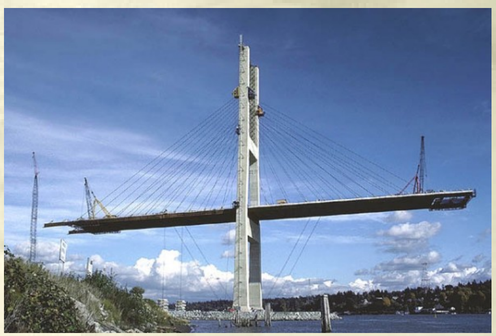
- It has a composite steel-reinforced concrete deck having two carriage ways with a total width of 35 metres, with 3 lanes each way and with a foot path of 1.2 metres on either side.

- The deck is over the main span of 457.20 metres (1,500.0 ft) length and two side spans of 182.88 metres (600.0 ft) each, supported by wire cables.

CASE STUDY – VIDYASAGAR SETU BRIDGE KOLKATA

CONSTRUCTION

TOWERS: made of 4×4 m steel boxes of riveted construction were raised on the two side spans of the bridge, one set on the Calcutta side and the other on the Howrah side pylons



DECK & CABLES: Construction of the main span of the bridge was to erect it from both ends, as cantilevers. A deck crane was used for this erection. Cables were erected from the four pylon heads with the help of hoist frames which were mounted on top of each pylon.