DRISHTI
A Revolutionary Concept

BRIDGE DESIGNING

Team Members:

Mentors:-

Chirayu Kamble	(U16CE035)
Aditya Raj	(U16CE025)

2nd Year:-

Ram Rathi	(U17CE031)
Atul Maurya	(U17CE097)
Yash Mandwariya	(U17CE035)
Ashish Sinha	(U17CE044)
Tanmay Shivhare	(U17CE073)
Fateh Singh	(U17CE089)
Khushhali Solanki	(U17CE093)

Acknowledgment

We have taken efforts in this project. However, it would not have been possible without the kind support and help of many individuals and TEAM DRISHTI. I would like to extend my sincere thanks to all of them.

We are highly indebted to CHIRAYU KAMBLE and ADITYA RAJ for their guidance and constant supervision as well as for providing necessary information regarding the project & also, for their support in completing the project. We would also like to appreciate all type of support that was given by all the individual and the members of TEAM DRISHTI.

Abstract

The idea was to design a cable-stayed bridge on the Chambal river in Kota, and its analysis performed using SAP2000. A prototype of the same was built, and it could carry a static load of 2200kg.

Table of Contents

1. DEFINITIONS

1.1 BRIDGE

Bridges are built to connect two points separated by a naturally occurring
A region like a valley, river, sea or any other water bodies, etc. They are usually lengthy, depending upon the width of the river.

1.2 FLYOVER

It is a structure which joins two or more points which are separated by an
Accessible route/s or a human-made structure to cut the traffic for a faster mode of travel. They are usually made over road junctions, roads, streets, etc. The name itself suggests that you are flying over a traffic zone.

1.3 CULVERT

A Culvert is a structure that allows water to flow under a road, railroad, trail, or similar obstruction from one side to the other side. Typically embedded to be surrounded by soil, a conduit may be made from a pipe, reinforced concrete, or other material. They are smaller or equal to 6m in length.2. Parts of Bridge

2.1 Foundation:

It is the lowest part of the building or the civil structure that is in direct contact with the soil, which transfers loads from the structure to the earth safely. Generally, the foundation can be classified into two, namely **shallow foundation** and **deep foundation.**

A deep foundation used in bridge. Generally, pile foundation, Caissons foundation, well foundation. Typically, M50 and M60 grade concrete used, steel bars used as reinforcement.

2.2 Abutment:

Bridge abutments connect the deck, or surface of the bridge, to the ground and help support its weight both horizontally and vertically.it is capable of standing with the high level of horizontal force. Brick or stone masonry, mass concrete, or reinforced concrete may be used in the design of abutments.

2.3 Piers:

Pier supports the spans of the bridge and should be strong enough to take both vertical and horizontal loads. Its primary function is to transfer the load from the bridge superstructure foundation below it. They subjected to substantial axial loads and biaxial moments and shear forces in the transverse and longitudinal direction. Said that pier is usually compression elements of a bridge. Piers are referred to as Bents as well. The generally used materials used for the construction of these types of piers are bricks, stone masonry, mass concrete, or RCC.

2.4 Pier Cap:

Pier Cap is the component that transfers loads from the superstructure to the piers. Pier cap provides sufficient seating for the Bridge girders and disperses the loads from the bearings to the Piers.

2.5 Bearing:

A bridge bearing is a component of a bridge which typically provides a resting surface between bridge pier cap and the girders. The purpose of bearings is to allow controlled translational and rotational movement and thereby reduce the stresses involved. The most common type of bearing used is elastomeric bearing.

2.6 Deck:

A bridge deck or roadbed is the roadway, or the pedestrian walkway, the surface of a bridge, and one is a structural element of the superstructure of a bridge. The deck may be constructed of concrete, steel, wood. Sometimes the deck is covered with asphalt concrete or other pavement.

2.7 Girders:

A girder is a support beam used in construction. It is the primary horizontal support of a structure which supports smaller beams. Girders often have an I-beam cross-section composed of two load-bearing flanges separated by a stabilizing web, but may also have a box shape, Z shape, or other forms. Girders, in turn, placed on piers and abutments, which supports the span of the bridge. They are made from iron and steel.

2.8 Wing wall:

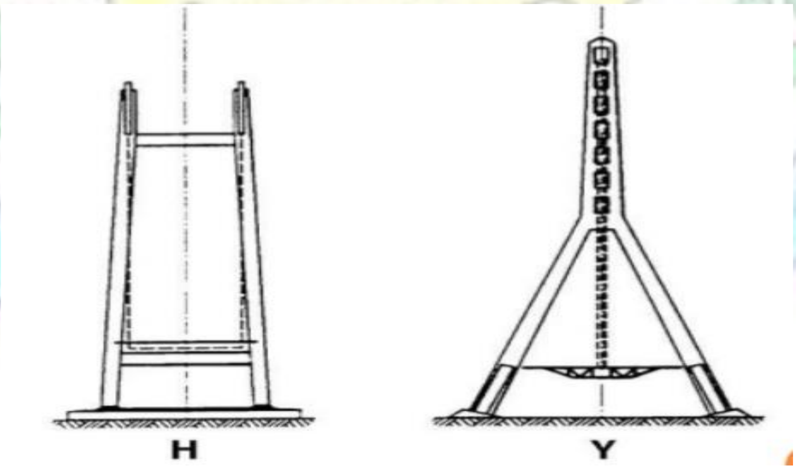
In a bridge, the wing walls are adjacent to the abutments and act as retaining walls. They are generally constructed of the same material as those of abutments. The wing walls can either be attached to the abutment or be independent of it.

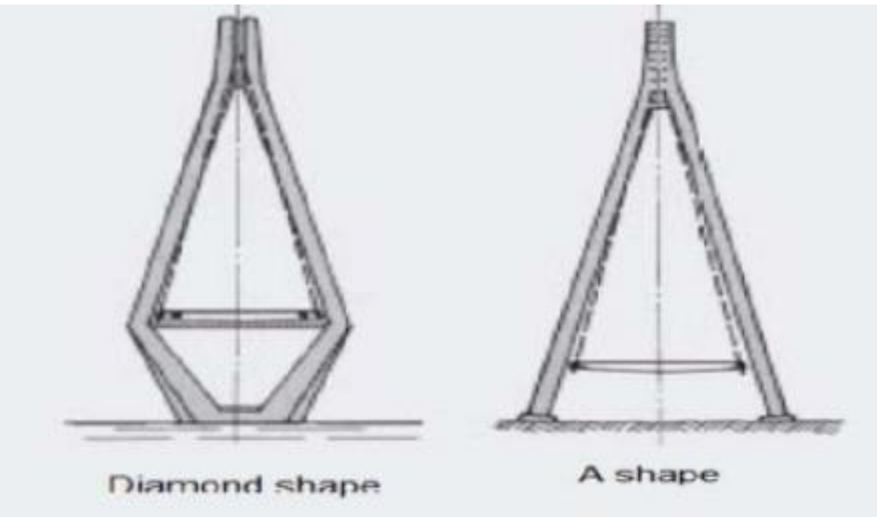
2.9 Railings:

Bridge railings serve both safety and aesthetic functions in bridge projects. They are designed to safely redirect vehicles to minimize injury and damage in the case of accidents, as well as to retain pedestrians and bicyclists. It is made of steel.

2.10 Pylon:

These are the towers from which the cable supports the bridge deck. There are many arrangements of a pylon, like - H-shaped, A-shaped, Inverted Y shaped, Diamond-shaped. We used an H-shaped pylon as in this, and the axial forces are more compared to any other pylon. Pylon generally made of concrete (M40) with steel reinforcements.





While designing a bridge, many things should be kept in mind, such as the width of the river, soil condition. So we decided to design the bridge for the Chambal River situated in Kota, Rajasthan.

3. About Chambal River Location

The Chambal river has a width of around 270 meters.

The test results on the Chambal river soil test are as follows:-

1. There was no presence of $CaCO_3$ present in the rocks.
2. The Compressive strength of the soil is about 100-300MPa, Its obtained from the UCS test (Unconfined Compressive Test).
3. The modulus of elasticity of the rock is-17500MPa.
4. Its Poisson's ratio is -0.21. The topography at a depth of 10 meters, a thin layer of soil is obtained, and at a depth of 13 meters presence, weak rocks are found.
5. Kota is located in seismic zone 2.

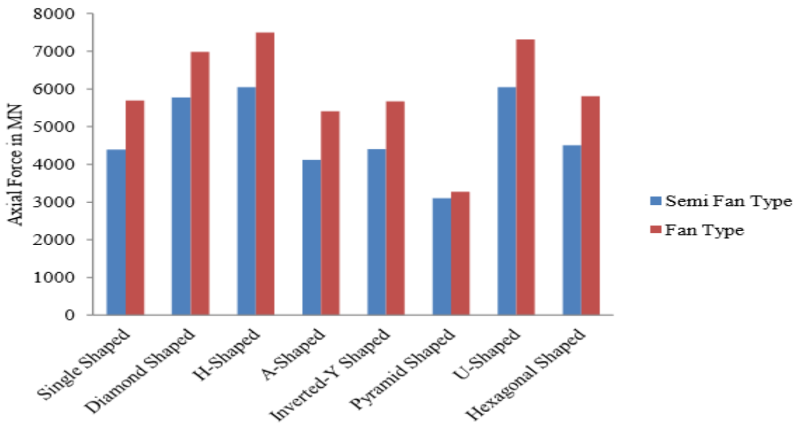
4. DESIGNING

4.1 PYLON

The shape of the pylon is H-shaped. As in this, the axial forces are more as compared to other forms.

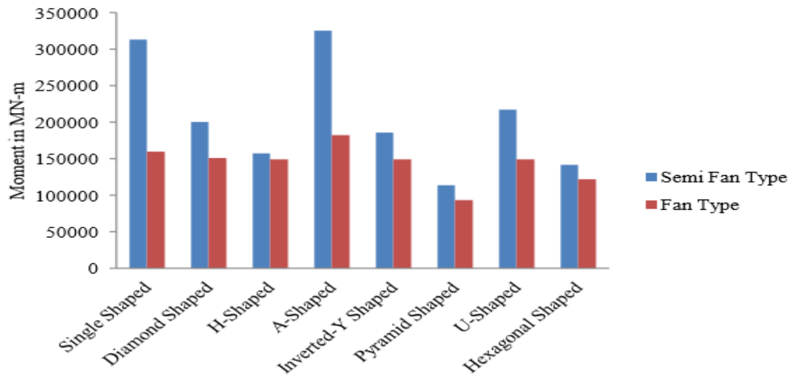
- Rectangular Concrete Pylon:

  a) For Axial Force:



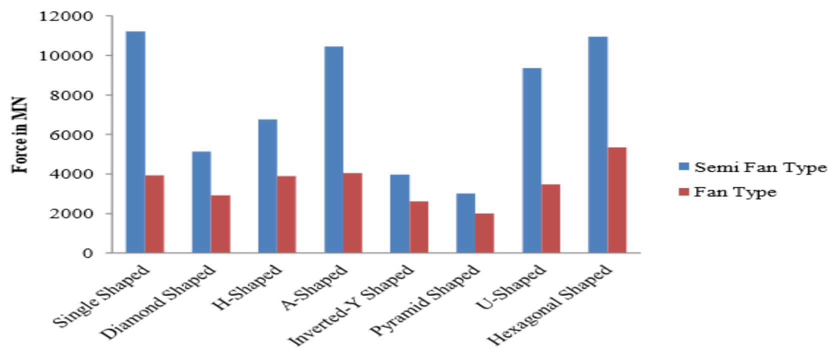
Graph 3.1. Comparison of axial forces for different shapes of rectangular concrete pylons

b) For Bending Moment:



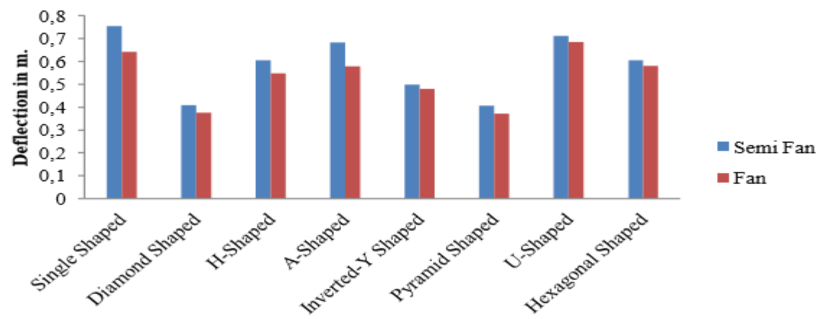
Graph 3.2. Comparison of bending moments for different shapes of rectangular concrete pylons

c) <u>For Shear Force:</u>



Graph 3.3. Comparison of shear force for different shapes of rectangular concrete pylons

d) <u>For Deflection at the top of Pylon:</u>

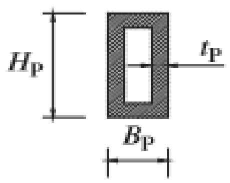


Graph 3.4. Comparison of deflections for different shapes of rectangular concrete pylons

So, the purpose of choosing an H-shaped pylon is clear from the above graphs- as it has more axial forces, less bending moment, less shear force, and less deflection at the top.

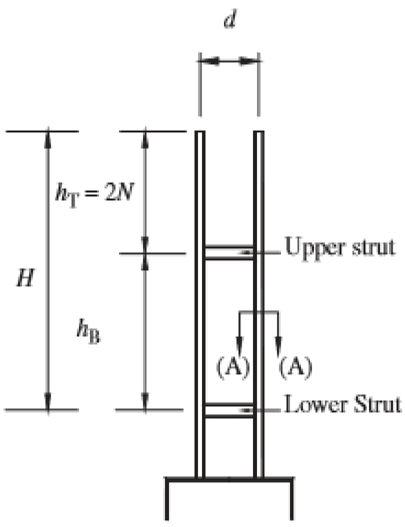
The width of the river is 300m, and the distance between pylons is 350m to avoid the water currents and to protect wildlife such as crocodiles living in the river.

The pylon of the bridge has a following cross-section.



Sec. (A–A)

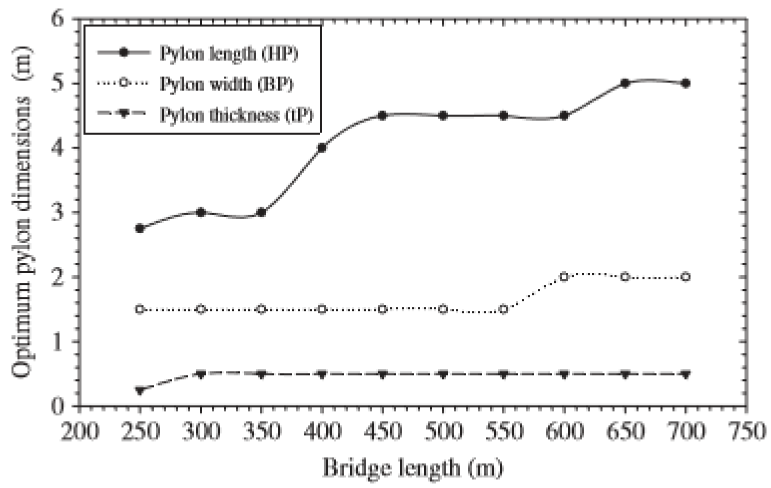
(c) Pylon cross-section.



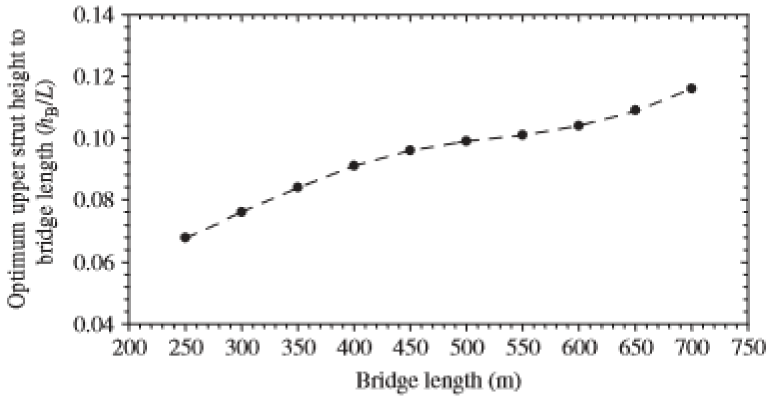
(d) Pylon elevation.

The cross-section of the pylon, according to the graph, is 5x2(m) (above the deck) and 5.6x2.6 (m) (below the deck).

The thickness of the pylon is 0.4m.



(b) Case (2) 'four lanes'.

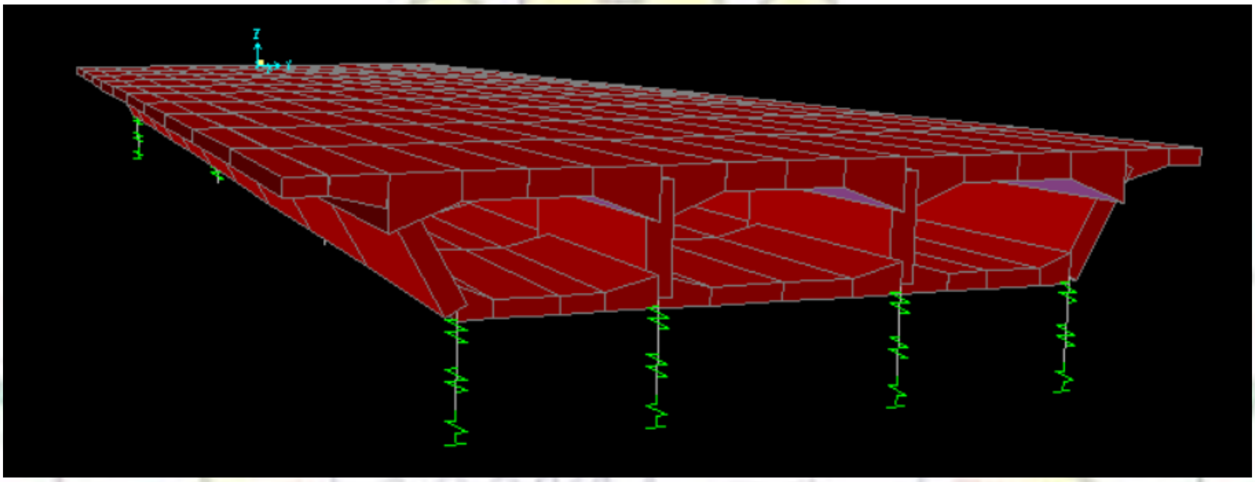


(b) Case (2) 'four lanes'.

So, the height of the upper strut is 70m. The lower strut will be just below the deck to support it.

4.2 DECK

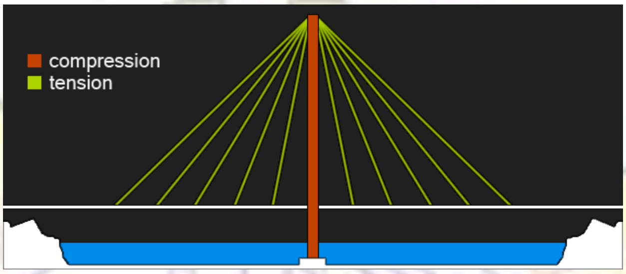
The length of the deck is 750m. It is made of precast concrete box girders that are aerodynamic in shape. It's an advantage being that it has high torsional stiffness and strength, giving greater suitability for horizontally curved bridges, greater aerodynamic stability, and reduced susceptibility to lateral buckling of flanges (in lateral-torsional or distortional buckling modes).



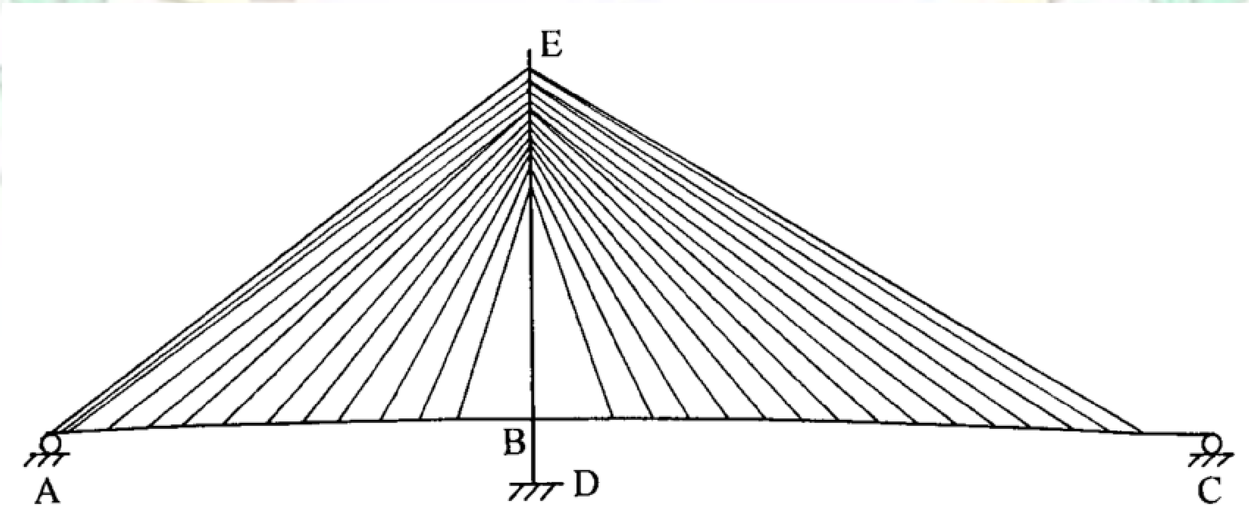
4.3 CABLES

There are mainly four types of arrangement of cables-

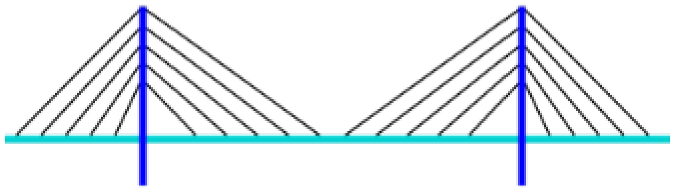
1. Fan arrangement- All cables are connected at a single point on the top of the pylon.



2. Semi fan arrangement- The distance between the cables attached to the pylon is less than the distance between the cables attached to the deck.

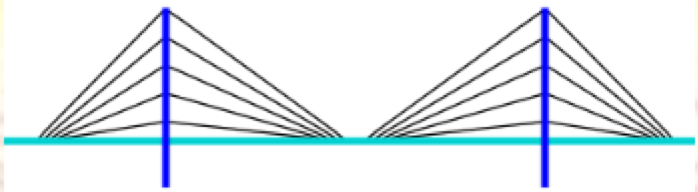


3. Harp arrangement- The cables are arranged parallel to each other



Harp design

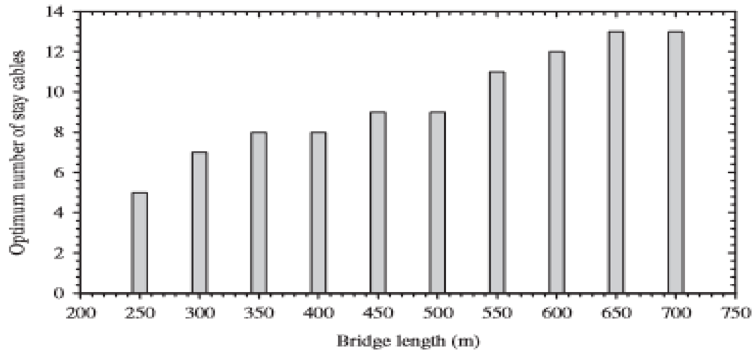
4. Star arrangement- The distance between cables attached to pylon is more than the distance between the cables attached to the deck.



Star design

Out of these, we have used a semi-fan arrangement of cables. If all the cables anchored at the top of the tower, the structural system is called a fan-shaped configuration. Unfortunately, the concentration of anchorages causes structural difficulties when the number of cables is large. Therefore, it is preferable to distribute the anchorages over a certain length of the tower head and get a semi-fan arrangement. The harp system requires more steel for the cables, gives more compression in the deck, and produces bending moments in the tower, so the semi-fan arrangement is considered.

The total number of cables are decided by the following graph for H-shaped pylon-



(b) Case (2) 'four lanes'.

The total cables used are 108 (13 on either side of the pylon).
The diameter of the cable used is 0.24m.

5. Materials used: -

1. Plywood (18mm)
2. Aluminum box section (2”X1” & 0.75”X0.75”)
3. Stainless steel cables(3mm)
4. U clamps (cast iron)

5. Hollow steel shaft (Internal diameter 6mm and outer diameter 8mm)
6. Turnbuckle

6. PROCESS

The manufacturing process began from the deck, for which a 3m long, 0.45m wide, 18 mm thick plywood was used in two segments of 113 and 187 cm long.
Girders were placed along the width of the deck for which the padded aluminum box section (0.75" X0.75") was used.

The initial design consists of girders under each cable, but later on, girders were placed at alternate cables and box section of length 10.29cm placed longitudinally under the remaining cables between the two lateral girders on which loops made with cables are passed and then clamped.

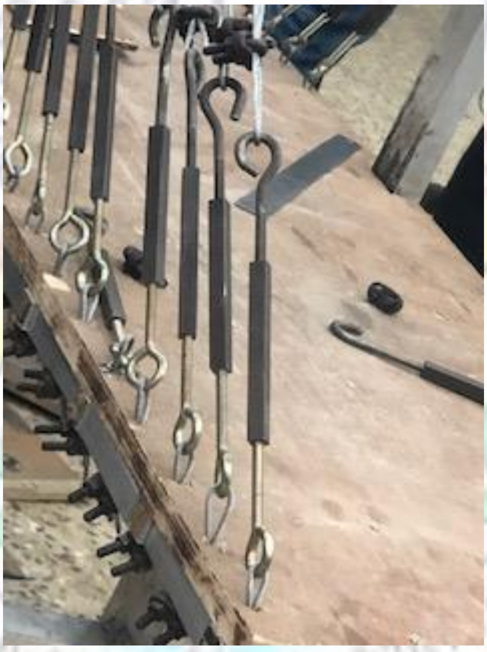
The loops are made at a distance of 6.1cm, the first one being at a distance of 20cm from the pylon.
Box sections (0.75”X0.75” & 2”X1”) are joined to the deck below the girders, to prevent sagging of the deck from the Centre span and hogging on side span.

Box section (2”X1”) is used at the Centre for more strength (as it is the joining point for 2 parts of deck).


Cables can sustain a weight up to 340kg.
testing as done in our engineering mechanics lab on universal testing machine (UTM).

The right-hand I-bolt is connected through the loops with the deck.

The left-hand hooks are connected to the M.S bar (1cmX1cm) which is then connected to the I-bolts.



Now the cable is passed through the pylon and then attached to the left-hand hook with the help of loops.
Hollow steel shafts were used in pylon to pass the cable through them from both the ends smoothly, tightened by U clamps at both ends.

6.1 PYLONS

1. The total height of pylon is 130 cm, out of which 70 cm is above the deck and 60 cm below it.

2. It is made up of an aluminum box-section (2" X1").

3. Below the deck, four aluminum box sections are brazed together according to the design.

4. The lower end of the pylon is connected to the plywood through L-clamps, which is brazed to the pylon and an 18mm plywood through Allen bolts.

5. In the upper end of the pylon, ten holes each of 6.5mm are made at a distance of 3 cm from each other. The first hole is at a distance of 28 cm above the deck.

6. The upper strut of the pylon is brazed at a distance of 50cm above the deck, and the lower strut is 49.5cm below the deck, and there is one strut just below the deck.

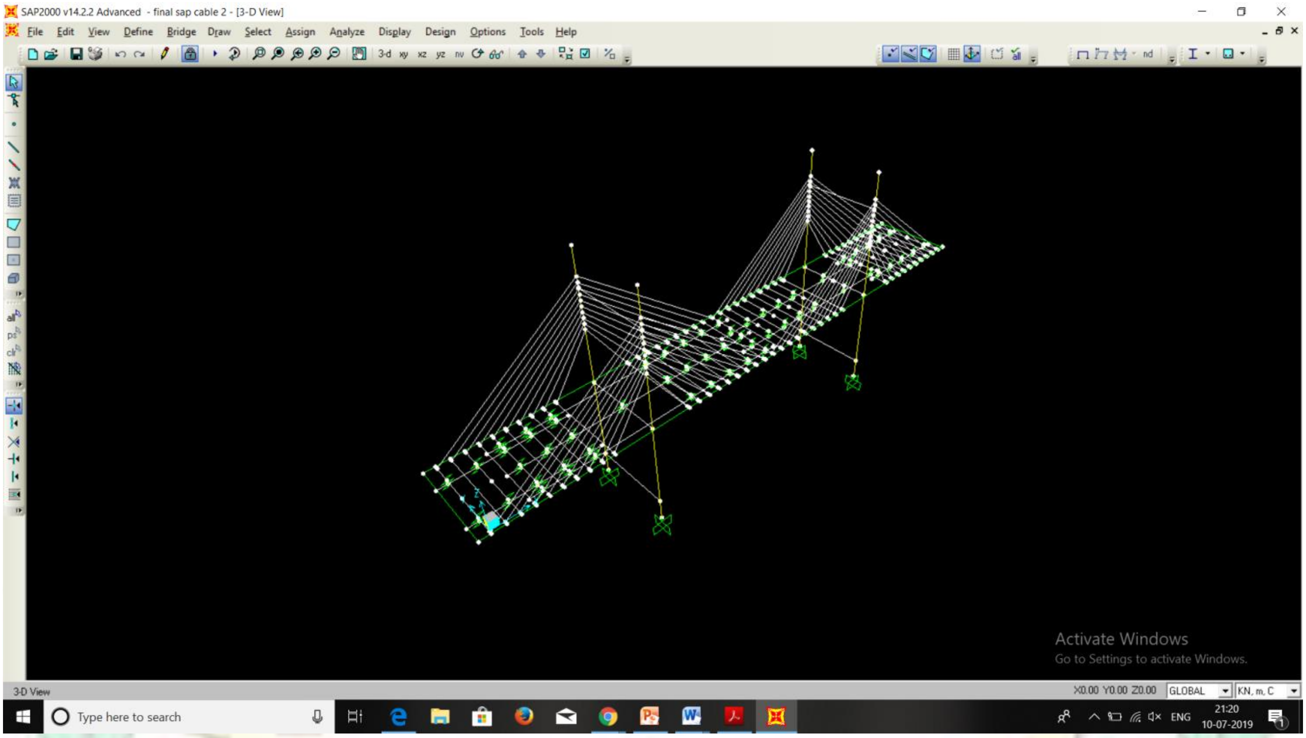
7. Hollow steel shafts (internal diameter 6mm) are inserted into these holes. These shafts are inserted to ensure a smooth curve in cables (avoiding sharp edges), and also, the cables and pylon don't cut each other.

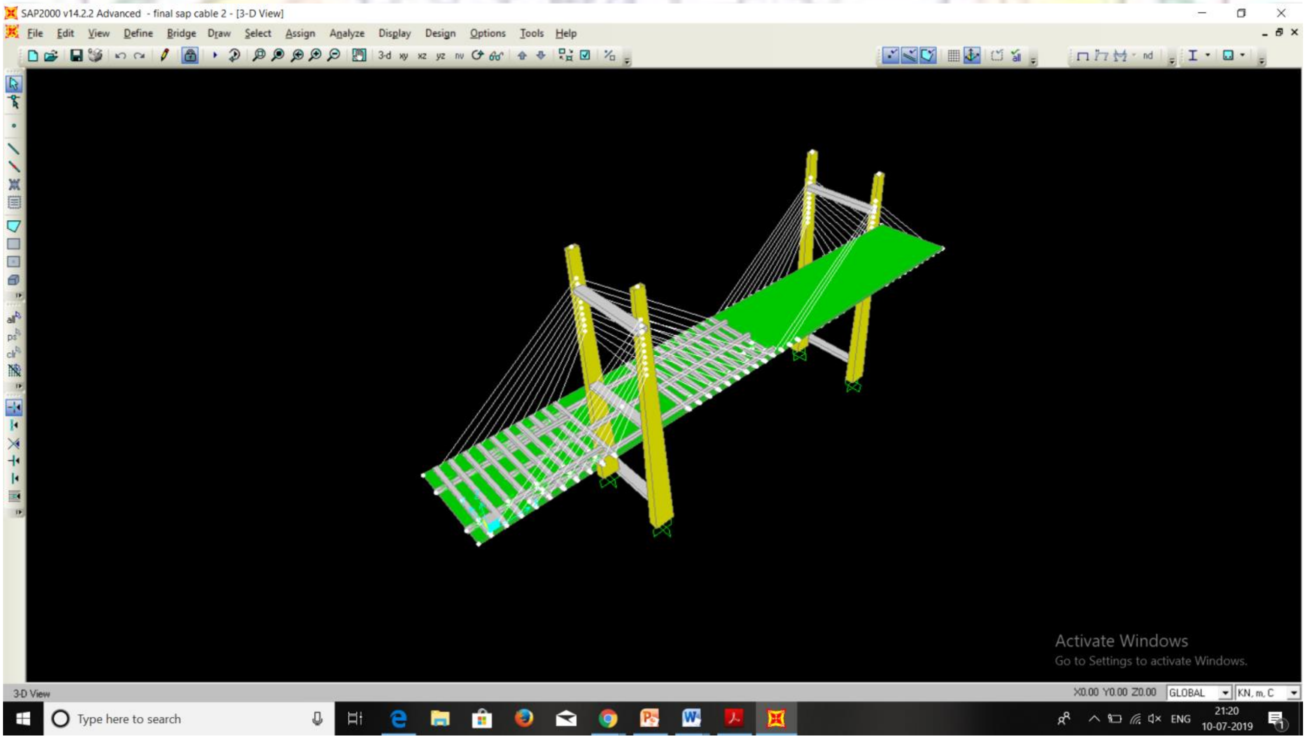
Load testing of the model

We tested our model by putting a load of app. 2000kg.

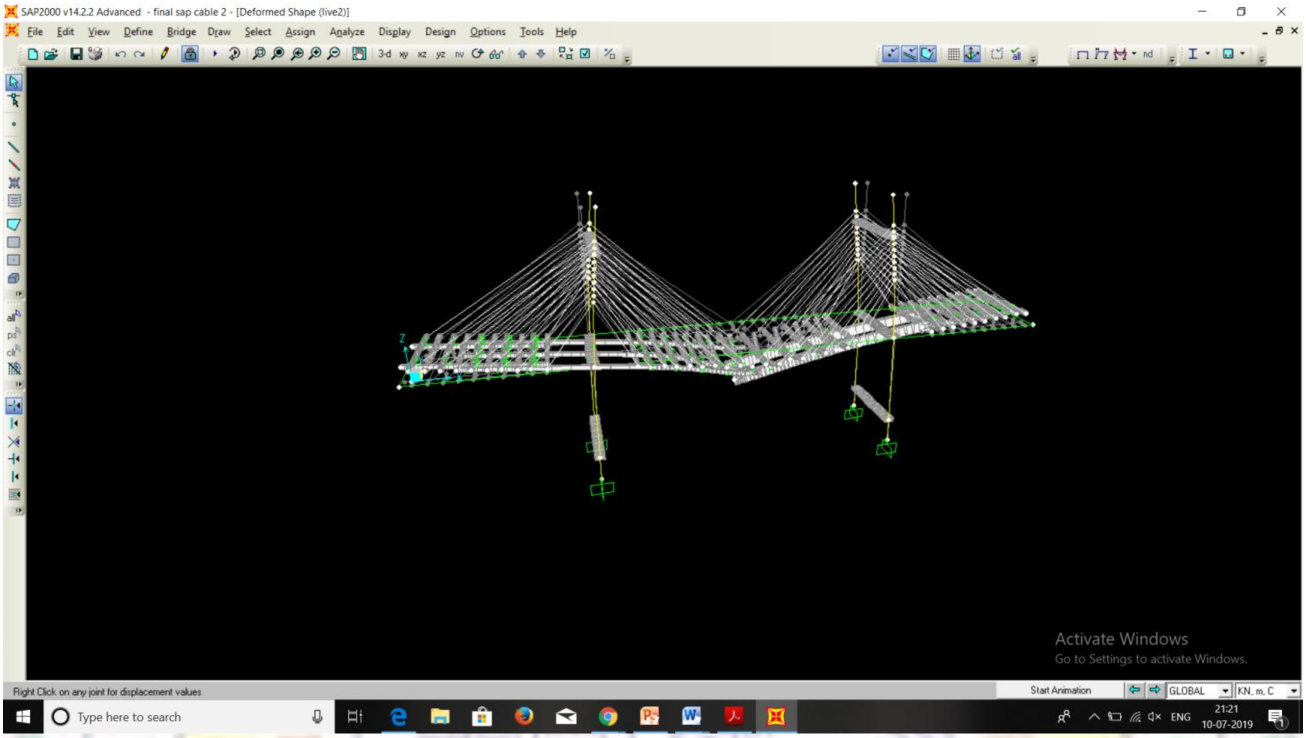
The failure points are that the loops getting loosen from the clamps and aluminum box sections below the deck also get bending. The side span also gets sagged due to extra tension in cables in the condition of no load.

7.Analysis on sap2000





3D View



Deformed Shape