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# Study and Analysis of Cable Stayed Bridges Using STAAD Pro

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***Abstract—****Long span Bridges are constructed to cross obstacles. Bridges are structures which are built to provide a passage over lake, river, valley, road or any other obstruction. During the past twenty years cable stayed bridged has occurred as the most structurally dominant system for the long spans. Long span bridge could be achieved with use of high strength materials and innovative techniques. Live load acting on the bridge is transferred to the bridge deck, which in turn both the dead load of the superstructure (self-weight of the bridge deck) and live load of the bridge is balanced by tension cables which is anchored to the tower. The tower of the bridge carries the total working load. Innovative efforts has been taken to reduce the depth of girders of large span bridges resulting in the development of cable stayed bridge decks in which the deck system is suspended by steel cables. The objective of this is to study and analysis in detail the cable stayed bridge which his continuously evolving as an efficient structure.*
***Keywords—****Bridges, Cable Stayed Bridges, Structures, STAAD Pro*

## I. Introduction

In the recent years cable stayed bridges have received more attention than any other bridge mainly, in the United States, Japan and Europe as well as in third-world counties due to their ability to cover large spans. Cable-stayed can cross almost 1000m (Tatara Bridge, Japan, Norman die Bridge, France) In India few of the cable stayed bridges are constructed and a couple of them are underway. Like Bandra-Worli sea link, Second Hoogly Bridge are the finest example of application of cable stayed bridge in India. Cable stayed bridges for road over bridge in Bangalore and Chennai have come up and a cable stayed road over bridge is proposed in various smaller emerging cities. There is still place for innovation in Cable-stayed bridge techniques.The achievement of man has been attributed to how large; long and tall he can create the structures around him. From the very beginning of the human race he has been trying to prove that he can create some very astonishing and amazing structures around him, like Pyramids of Egypt. After end of World War II there was shortage of construction materials like steel and cement thereby need to obtain optimum structural performance from these materials became necessary. New systems and technologies were evolved to meet these requirements.

Cable stayed bridges are constructed along a structural system which comprises of a deck and continuous girders which are supported by stays in the form of cables attached to tower located at the main piers. Stiffness of the overall structure can be provided by stiff towers or can be stiffened by taking backstays to individual or by employing intermediate tension piers or combination of the stiffness of the main span, the tower and the back span, credited to several advantages over suspension bridges, predominantly being associated with the relaxed foundation requirements, with the introduction of high-strength steel, development of welding technology and progress in structural analysis and new construction technique which is very much in vogue [10]. The development and application of computers opened up new and practically unlimited possibilities for the exact solution of these highly statically indeterminate systems and for precise statically analysis of their three-dimensional performance. This leads to economic benefits which can favors cable-stayed bridges in free spans of up to 1000m. In the twentieth century the development and research has take place enormously in the field of the bridge engineering to fulfill the need of the very long span bridges. With development of new materials and techniques for analysis of very long span cable supported structures came into practice. For very long span bridges the high strength steel cable are used as a structural load resisting elements. Some importance of cable supported bridges is illustrated here [6].

## II. Types Of Bridges

### 2.1.SUSPENSION BRIDGES.

Decks of suspension bridges is hanged by vertical hangers, which are connected to main suspension cater nary cables. The main cable is continuous, over saddles at the pylons or towers, from anchorage to anchorage. In a suspension bridge, a procedure to find the initial configuration under dead load is relatively simple as the main extremities are fixed at earth constraints.

As an outcome, optimization techniques are frequently employed with the purpose to identify the structural behavior of the bridge with respect more complex external loads such as aero elastic and seismic phenomena. However, most of the methodologies are typically concerned to evaluate optimum post-tensioning forces in the dead load configuration, without achieving the complete optimization of the geometry, the stiffness of the structural elements and thus cost of construction [2].

**Fig: 2.1.1.** A Typical Suspension Bridge

2.2. **CABLE-STAYED BRIDGES**

The cable-stays are directly connected to the bridge deck resulting in a much stiffer structure. A large number of closely spaced cable stays support the bridge deck throughout its length, reducing the required depth and bending stiffness of the longitudinal girder to allow the construction of relatively longer spans. The structural action is simple in concept; the cables carry the deck loads to the towers and from there to the foundation. The primary forces in the structure are tension in the cable-stays and axial compression in the towers and deck; the effect of bending and shear in deck is less influential. In cable-stayed bridges a cable-stays are making variable angles with horizontal axis, so the forces in the cable-stays are incompatible at different locations [1].

The requirement of incredible long span bridges is increased day by day with increase in inhabitants and their needs. To achieve a very long span bridge, use of high strength material along with novel structural system is essential. To achieve longer span bridges and good structural system the cable stayed bridges are used, in which the cable-stayed bridge has better structural stiffness than suspension bridges.

Fig**: 2.2.1.** Cable Stayed Bridge

## III. Advantages Of Cable-Stayed Bridges

Cable stayed bridges have good stability, optimum use of structural materials, aesthetic, relatively low design and maintenance costs, and efficient structural characteristics. Therefore, this type of bridges are becoming more and more popular and are usually preferred for long span crossings compared to suspension bridges The Key advantages of cable-stayed bridges are as follows.

1) The cable-stayed bridge has much greater stiffness than the suspension bridges, so that deformations of the deck under live loads are reduced.
2) Theyarestrong as they have much greater stiffness than suspension design since the cables can handle more pressure. As a result, the deformations of the deck under live loads are reduced and the deck has more rigidity. And if compared to concrete bridges, they are also more resistant to environmental changes, such as earthquakes.
3) They take less time to build as Cable-stayed designs require fewer cables than suspension types and they don't require anchorages. This means construction time can significantly be reduced.
4) They are more economical as they require fewer materials and less building hours than a concrete structure, significant savings can be acquired.

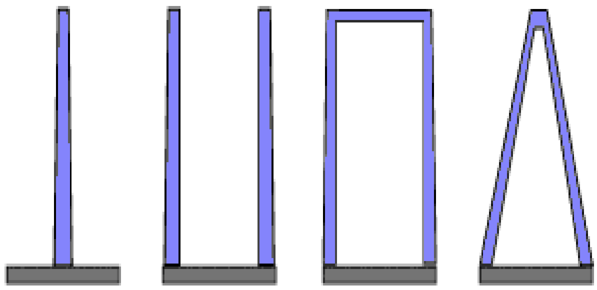
## IV. Components Of Cable Stayed Bridges

The various structural components of a cable stayed bridge are:

I. Towers
II. Types of cables
III. Cable arrangement

Typical different types of towers include:

a) Single
b) Double
c) Portal
d) A-shaped




In cable stayed bridges the cables are the most important element as it transfers the load from the super structure to the tower and to the anchorages. Different types of cables are as follows [3]:

(a) Helically wound galvanized strands
(b) Parallel wire strands
(c) Locked coil strands

In the construction of cable stayed bridges, the cables are chosen on the basis of high and constant value of modulus of elasticity, therefore the parallel wire strands is the most commonly used cable type. The arrangement of cables depends upon factors like clear span, tower height and level of roads. There are four types of cables used and they are classified as:

a) Mono type

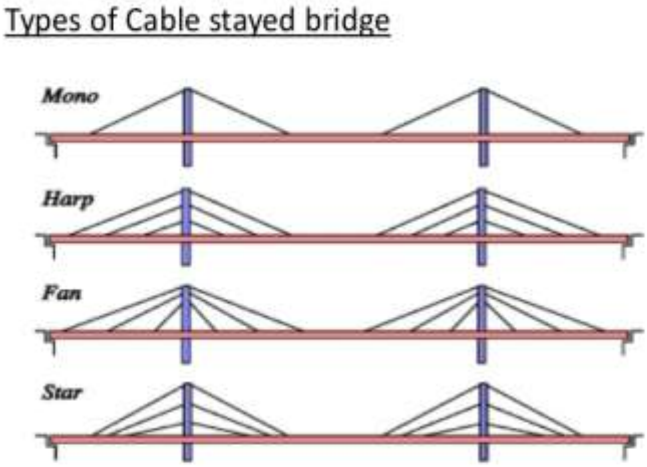
This type of system consists of bridges with one single stayed cable along the longitudinal axis of superstructure.

b) Harp type
c) In Harp type the cables are connected to the tower at different heights and are parallel to each other. The compression is higher in this kind of pattern.
d) Fan type

In this system, the cables are connected at the same distance from the top of the tower it is the most economical arrangement of cables.

e) Star type

In star type cables are connected to two opposite points on the pier.




## V. Analysis Using STAAD Pro

The following is the fundamental considerations for the effective use of STAAD-PRO (i.e. Structural Analysis & Design Program software) for the analysis of structures. It must be mentioned however that since STAAD is a computer program. It is therefore recommended that experience of continually using STAAD is obtained, and for important structures parallel hand calculations for the analysis of the structure be done as well [4].

## VI. Conclusion

1. The cable stayed bridges has much greater stiffness than the suspension bridges, so that deformation of deck are reduced.
2. Cable stayed bridges were highly statically indeterminate structures and in order to find out exact solution of these highly indeterminate systems and analyze the cable stayed bridge.
3. Cable stayed bridges have much greater stiffness since the cables can handle more pressure.
4. Here different cables, towers and cable arrangements are considered for the study.
5. The difference between cable stayed bridge and suspension bridge lies in how the cables are connected to the towers.
6. In cable stayed bridge cables are directly connected to an incline to bridge tower.
7. Loading is transmitted to the foundation in sequence as
a) To the deck
b) To the stay cable
c) To the bridge tower
d) And lastly to the foundation.
8. In suspension bridge the cable rides freely across the tower transmitting the load to the anchorages at either end.

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