International Journal For Technological Research In Engineering
Volume 9, Issue 11, July-2022 ISSN (Online): 2347 - 4718

STUDY OF A CABLE STAYED BRIDGE CONSIDERING DIFFERENT ARRANGEMENTS OF PYLON CONSIDERING I.R.C.

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Abstract: Bridge is an important structure required for the transportation network. Now a day with the fast innovation in technology the conventional bridges have been replaced by the cost effective structured system. For analysis and design of these bridges the most efficient methods are available. Different methods which can be used for analysis and design are AASHTO, Finite element method, Grillage and Finite strip method.

In this Project work, live project of Raja Bhoj Setu, Bhopal is considered. It is located at V.I.P. road. It has been designed, constructed considering details and hydraulic data as per site. In this study analysis of different types of pylon in cable stay bridge i.e. H-type, A-type and Y-type is presented to determine the most suitable type and compare it with the executed H-type pylon.

It is concluded through this study that A-type pylon is comparatively more stable, economical and efficient in bearing load whereas H-type is second best and Y-type is third in comparison. On the basis of various parameters considered.

Keywords: Staad, Analysis, Cable stay, Pylon, Finite element analysis, IRC loading, Deflection, Bending, Forces.

1. BACK GROUND OF STUDY

Vehicle load capacity analysis of a bridge superstructure is required as per I.R.C. and manual for standards and specifications for Indian road congress norms. Its main purpose is to assure, that bridge is safe for the user or public. By the load capacity analysis, a bridge might be found to be incapable of securely conveying some legal loads. Furthermore, when the loads are beyond the range of permit loads need to be utilizing a particular structure, load limit analysis can give answer about which loads are securely satisfactory. STAAD.Pro is efficient and accurate software used for concrete and steel bridge analysis and design. The advantage of the software is that it incorporates this provision of Indian Road Congress (IRC) bridge design specifications and railway specifications. STAAD.Pro is a general purpose structural analysis and design tool with applications chiefly in the building industry - commercial buildings, bridges and highway constructions, industrial constructions, chemical plant structures, dams, retaining walls, foundations, culverts and other embedded structures, etc. STAAD. Pro is basically based on Finite Element Analysis for carrying out the computations for Analysis and Design of a Structure.

Bridge failures

The collapse of the Tacoma Narrows Bridge is perhaps the best recorded and documented bridge failure in the bridge engineering history. The spectacular and prolonged failure process was captured on extensive live footage, giving a unique document for the investigation committee as well as for the engineering society at large. The footage has since then been used in civil engineering classes all around the world for educational purposes. Consequences of neglecting dynamic forces in the construction of suspension bridges can be clearly observed.

The flexibility of the bridge decks (i.e. their lack of stiffness) can cause not only problems with vibration and swaying during wind loading, but also, when marching troops are passing. Through the combined effect of heavy wind and the steps interlocking with the Eigen frequency of the bridge, a large troop of marching soldiers in 1850 set the suspension bridge over the river Maine at Angers in France in violent vibrations. The bridge collapsed and 226 soldiers lost their lives.

2. OBJECTIVES

The main objectives of the present study are as follows: -

- Study of Cable Stay Bridge with different pylon types under Dynamic Loading Condition.
- To determine the most suitable type of pylon for cable stay bridge located at V.I.P. Bhopal.
- To determine the effect of pylon on deck of bridge.
- To calculate vehicular load as per I.R.C. 70R.

Now a day this software is very much friendly for the analysis of different type of structures and to calculate the result at every node & element wise. Analysis for the bridge members, prepared the conceptual dimension geometry of the superstructure which are shown in figure 4.1 –

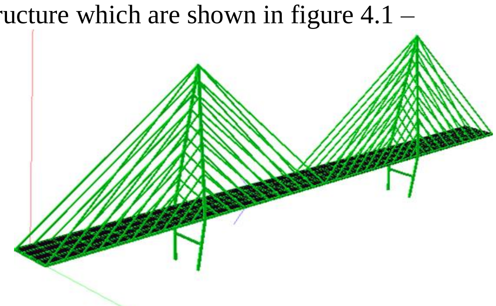

Fig: 1 Bridge model

Here R.C.C. bridge frame is modeled in analysis tool staad pro in which deck bridge is analyzed and optimized, and I.R.C. loading is considered as class 70R+A loading, dead load as per 875 part-1 and superimposed live load as per 875 part-2 is calculated and applied.

Three cases has been considered for comparative analysis:

- First Cable stay bridge with H-type pylon.
- Second Cable stay bridge with A-type pylon.
- Third Cable stay bridge with Y-type pylon.

All these are prepared as per data for Raja Bhoj Setu bridge at V.I.P. road Bhopal with length 262 m.

The following three activities must be performed to achieve that goal -

a. Modeling of the frame using STAAD.Pro.
b. The calculations to decide the explanatory results.
c. Result check is all empowered by devices contained in the framework's graphical environment.

Analysis of R.C.C. bridge 262 m span expansion to expansion has been considered for the parametric analysis of vehicle critical load position as per Indian Road Congress 70R+A loading standard which are analysed with the help of staad pro software. proposed steps are as followings:

Step 1: Selection the geometry of superstructure by using coordinate system in STAAD Pro or plot over the AUTO CAD, which can be import in Staad-Pro as per dimension of girder, c/c distance of bearing, expansion to expansion distance and number of diaphragm etc. Schematic sketch of the superstructure are shown in below figures.

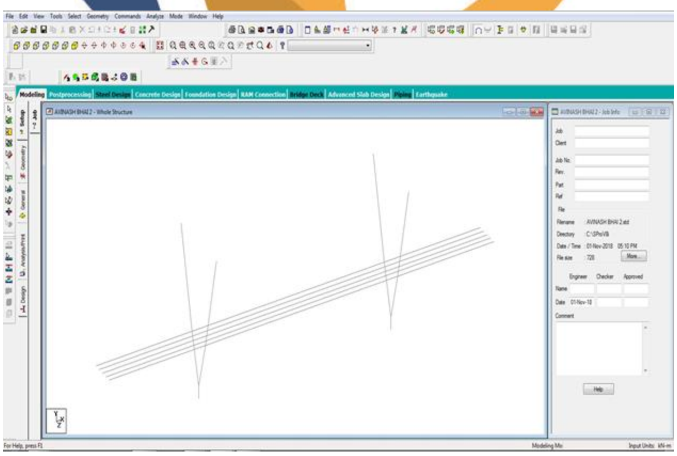

Fig: 2 R.C.C Bridge Type

Step 2: With different type of pylon in cable stay bridge models are prepared of same dimension and same loadings as per Indian standards. finite element modelling of the model considering the above parameters. It is considered that R.C.C. bridge with three different type of pylon such as H-type, A-type and Y-type geometry of superstructure define the dimensions like 262 length, 15.9 meter wide, which include in the girder property and steel material property of the structure as per Indian sections.

Different types of bridge sections considered are as follows:
A. A-type pylon bridge:

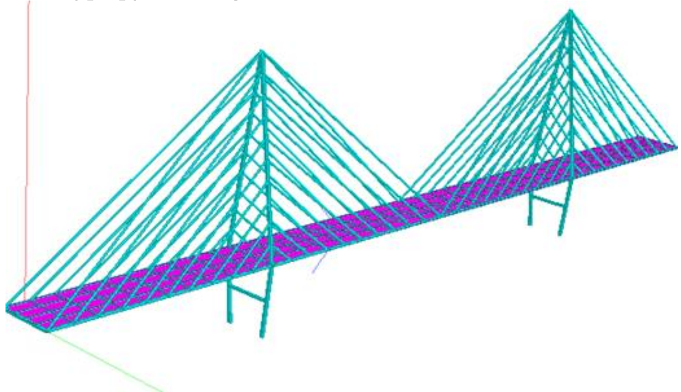

Fig: 3 A-type pylon cable stay Bridge

B. H-type Cable Stay Bridge:

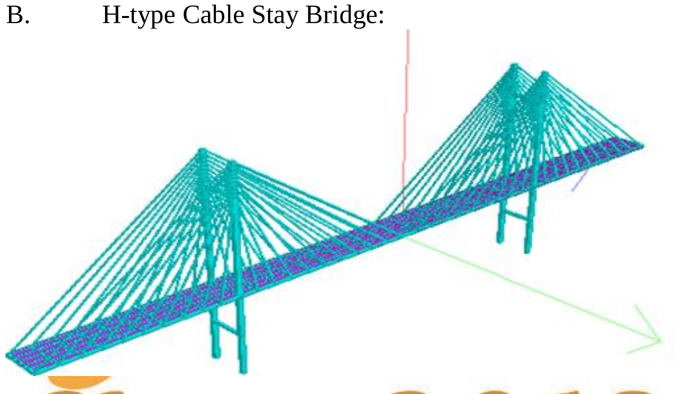

Fig: 4 H-type Cable Stay Bridge

C. Y-type Cable Stay bridge

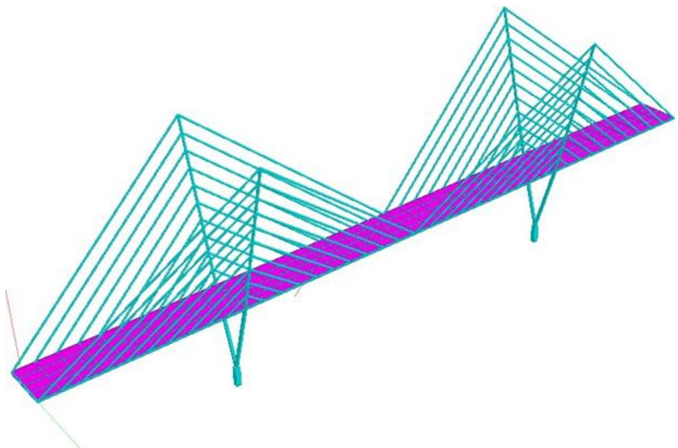

Fig: 5 Y-type Cable Stay Bridge

Step 3: Apply the material property as shown in above figures, after that support condition has been considered at the bearing locations of the superstructure which is fixed support as shown in below figure.

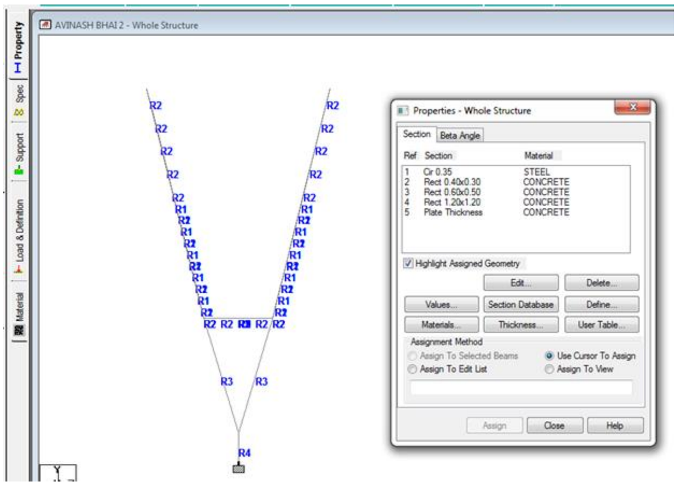

Fig: 4.6 Support condition

Step 4: After apply the support condition, now the next step to be considered for the Deal Load of the superstructure i.e. “self-weight”.

Step 5: After apply the Dead Load, now the next step to be considered for the Equivalent Uniformly Distributed Loads (EUDL) load.

3. CONCLUSION

As the aim of this study is to compare these three types of pylon for a live project. It is determined that A type pylon is most suitable, stable and resistible whereas H-type pylon is second best and Y type is observed as third best.

Following are the salient conclusions of this study-

Shear Force

Shear force in known as the unbalance force observed due to transmission of load from beam to column, in our study maximum value is observed in Y-type pylon i.e. 357.12 kN, whereas minimum in A-type pylon i.e. 345.34 kN.

Axial Force

Axial force is known as the vertical force observe in piers, this force is meant to distribute load from pier to earth. In our study maximum axial force is observed in Y-type i.e. 1376.19 kN, whereas minimum in A-type pylon i.e. 1024.15 kN, thus A-type pylon requires minimum cross sectional piers for load distribution.

Bending Moment

In terms of bending moment, it is observed that maximum bending is in Y-type pylon i.e.
148.93 kN-m, whereas minimum is observed in A-type pylon i.e. 138.04 kN-m which shows that A-type pylon is comparatively most economical in comparison as bending moment is directly proportional to reinforcement requirement.

Deflection

In case of deflection we observed in above chapter that maximum deflection is obtained in Y-type pylon 52.33 mm whereas least is observed in A-type pylon 45.20 mm, which concludes that A-type pylon is most suitable and stable section in comparison.

Deck Analysis

In deck analysis using Finite element method it can be observed that analysis is resulting in small nodal distribution of slab for proper analysis, in which number of nodal are resulting forces out of which maximum value is considered. It is observed in fig. 5.5 that resultants are minimum in A type pylon case whereas maximum in Y-type pylon case.

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