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Study, Review and Analysis of Self-Anchored Suspension Bridge

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Abstract: ***A self-Anchored Suspension Bridge is a type of bridge in which the construction of anchored system is avoided and the cable is embedded into the deck system. In this work, the analysis and design of Self-Anchored Suspension Bridge is done by using CSi Bridge software with standard parameter and design loads which are mentioned in Indian codes. The details of Self-Anchored Suspension Bridge, design loads, deck, cables and pylon details, arrangements are included.***
Keywords: Anchored system, Cables, Bridge, CSI Software applies, review.

I. INTRODUCTION

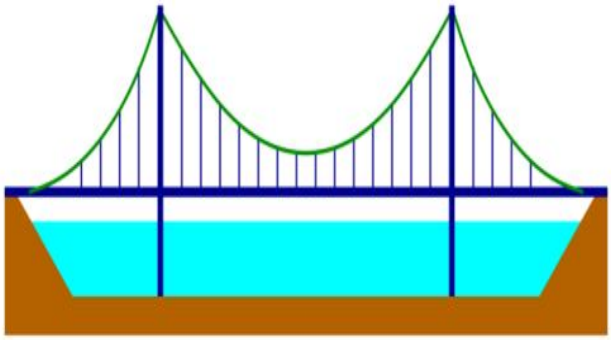
A bridge structure designing and erecting involve various stages which are planning, surveying tendering and execution. Also it contains after construction activities like maintenance and repairing. The major components used in self-anchored suspension bridge are pylon, suspenders, main cable, deck, beam, and footing. In this research paper we are using the dead load of the structure and IRC tracked load and their load combination for generating the results in form of bending moment, shear force and deflection. In case of normal suspension bridge the horizontal reaction are supported by anchored system and vertical reaction are balanced by pylon but in self-anchored suspension bridge the horizontal reaction are balanced by the deck system hence designing the deck system is the most crucial part.
CSI bridge software is a modern tool to design and analyses the various structural component and hence the designing of self-anchored suspension bridge is all done by CSI bridge software in this study.

II. OBJECTIVES

1) To create a modal of self-anchored suspension bridge using the CSi bridge software.
2) To study the deformation of the bridge and outcomes of the load on self-anchored suspension bridge.
3) To study shear force, axial force, bending moment in the bridge.

III. SELF-ANCHORED SUSPENSION BRIDGE

The evolution of bridge engineering has witnessed remarkable advancement during the timeline, among these advancement, self-anchored suspension bridge stand out as an innovative design and feasible with new engineering prowess. First self-anchored suspension bridge was designed in early 19th century but the challenges coming in the erecting process makes it less famous than normal suspension bridge. However self-anchored suspension bridge has more aesthetical advancement than the normal suspension bridge. Notable examples include the eastern span of the San Francisco-Oakland bay bridge. Location with challenging geological conditions or limited space for traditional anchorages and the soil condition are complex for erecting the anchorage structure, it may be more practical to design a bridge where the structure itself provide the necessary tension.



IV. LITERATURE REVIEW

Subeesh Nath S (2015) introduce Self anchored suspension bridge and take a simple modal of bridge and design it on SAP 2000 software. He takes response spectrum and time history load cases in consideration. After the analyzing bridge modal on SAP2000 with various parameter studies the result he states that the influence of deck bending stiffness decreases bending moment acting on girder also decreases. He also finds the influence of pylon bending stiffness on the girder which is negligible. He analyses cable stiffness by increasing its axial stiffness that result in decrement in bending moment and deflection in girder. Finally the sag effect is measured by decreasing it directly decreases the girder and bending moment in girder decreases.

Sachin Paul, Abhijith P S, Anjana Thambi, Anju Thomas and Merin Mathew (2022) perform a study on suspension bridge with help of MIDAS civil software. They study Inchathotty suspension bridge in Kerala. After the determining stages of construction they estimate the earthwork that required for the construction of the suspension bridge. Then they estimate the design cost which came to known a sum of Rs. 365 Cr. Finally they did 3D modeling of the suspension bridge using Revit Architecture.

Farhan Farid Reshi, Priyanka Singh, Shivangi, Ravinder Kumar Tomar and S K Singh (2021) study various type of cable which is used in various type of suspension bridge. After that they study the type of pylon and anchorage system that is used in suspension bridge. And then they create a modal on software in which the only load effect they include is wind effect in 4 directions. The conclusions were drawn from the analysis of the Cable stayed and suspension bridge is that the cable stayed bridge is innovative structure and preferred to cable suspension bridge due to the reduction in moments in the stiffening girders resulting in smaller section hence less cost. They conclude that the strength of cable-stayed bridge is more than cable suspension bridge.

Govardhan Polepally, Venkata Dilip Kumar Pasupuleti and Archanaa Dongre (2020) Study various type of pylon shapes on the seismeic response of the cable stayed bridge. They include A type, H type and inverted Y type shapes of pylon. Heights of the pylon remain constant in all scenarios. They use the software SAP 2000 in their study and analyze the three earthquake ground motions Bhuj 2001, Loma Prieta 1989 and El Centro earthquake 1940. In their analysis they determine that A shaped pylon have a less time period although other pylon shapes, H shape and inverted Y shape have a larger time period. The other thing this paper conclude that different type of shape has different response for various ground motion.

Priyanka Singh, Mirza Jahangir Baig, Bhumika Pandey and Kartik Papreja used STAAD PRO software to model the shape of pylon in cable stayed bridge. The goal of this study is to analyze the forces and stresses on the various type of pylon shape and hence obtain which design is most efficient. There is most important factor of choosing the correct design is how much it affects the other component of the bridge and the cost of the structure. There are three different design of pylon is studied in this research which is A type, H type and inverted Y type. The software analyzed the data of shear force, bending moment and deflection. In this research the final conclusion is that the A shaped pylon has less deflection and bending moment. It can be inferred that the most suitable and stable section is A- type pylon design.

Viktor Hermansson & Jonas Holma (2015) focused on the Study of Suspended bridges for isolated community. They mentioned following points in their thesis:

1) History of suspension bridge started with the access the inaccessible area for isolated community hence this study focuses on determining the primitive bridges and how the bridge behave in a load condition.

2) The stress- strain behavior of the cable is non-linear in a load condition and hence the deformation happened in the cable. This generates the basic equation of the cable.

3) Wind load can affect a bridge in different ways that they mentioned in their thesis. Some of the effects are written below:
   1. Buffeting 2. Flutter 3. Vortex 4. Shedding 5. Galloping

4) The next findings are analysis of single cable and hence evaluation of sag is done in case of natural frequency which varies along the length of the cable.

5) Finally it concluded that when determining the lateral dynamic response from wind loads,a modal dynamics analysis gives a good approximation of the behavior of the bridge.

T.Subramani, J.Karthick rajan, V.R.Perumal, A.Palani, P.Kesavan (2019) designed a finite element model with the help of SAP 2000 software and hence determine the bending moment and shear force and create a model of it. Finding of this research paper are imposing the damping instrument to mitigate the vibration of the cable and hence concluded how much the damper is effective by comparing the result data of the previous.

Drashti Vadhel, Sameer Malgundkar, Zainab Bohra, Javed Shaikh (2021) used TPA (temporary pylon anchor) technology in their research. The goal of this study is to propose TPA technology for the designed PSC box girder. They used MIDAS CIVIL software in their research. In conclusion they stated that the pre stressed box girder is most suitable for self-anchored suspension bridge. The technology is new; hence its applicability should be tested.

Nakul V. Kharde, Prof. Dr. V. R. Rathi (2021) create a model of suspension bridge and Tied arch Bridge using the software SAP2000. The goal of this paper is to study how suspension bridge and tied arch bridge behave under the condition of the imposed loads and seismic load.

Mohb. Sadab, Deepak Bandewar, Rakesh Patel describe three major type of anchorage system which are gravity type, tunnel type and rock type anchorage system. Further in the study using the software SAP2000 they create a modal for the analysis and using two different load conditions they concluded that shear force in tunnel type is 478.098 KN and in gravity type it is 379.207 KN, Also the deflection they determine in tunnel type is 621.098 mm and in gravity type is 598.992 mm. Some other forces is determined during the study which are torsional value, support reaction and maximum moment. At the end it is stated that gravity type anchorage system is more suitable as compared to tunnel type anchorage system.

Gohel Pinkal, Patel Sweta, Pandey Vipul, Guide Prof. Nikunj Patel studied various type of suspension bridges and assumption which were taken into account when constructing a suspension bridge. Finally the authors include various types of loads that are taken into consideration (live load, dead load, pedestrian load, wind load and seismic load) while we analyze the bridge structure. IS 875 part-2 (2015) – live load, IS 875 part 1(2015) - dead load, IS 875 part -1 (2015) – wind load, IS 1893 (Part 1) 2002 – seismic load are used in the study.

V. GEOMETRY OF BRIDGE MODELLED IN CSI BRIDGE

TABLE 1: DETAILS OF BRIDGE

1	Main span	120 m
2	Side span	80 m
3	Total span	200 m
4	width	8.4 m
5	Height of the pylon	14 m
6	Height of the pylon below the deck	4 m
7	No. of Lanes	2
8	Deck	Box girder
9	Cable sag at centre span	2 m
10	No. of suspenders	32

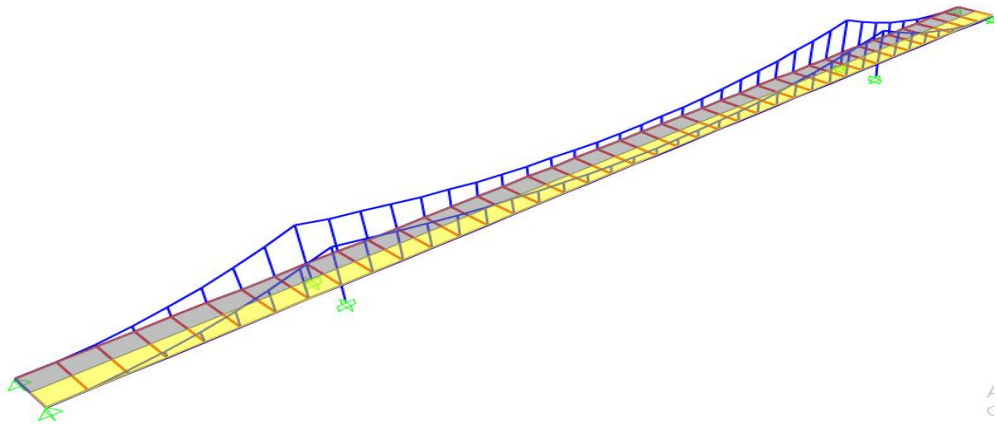


Fig 1. General view

VI. BRIDGE COMPONENT DETAILS MODELLED IN CSI BRIDGE

1) Deck of the Bridge –

We are choosing AASHTO – PCI – ASBI – Standard deck in the modelling.

Dimensions -

Depth	1.8 m
width	8.4 m
Material property	M30

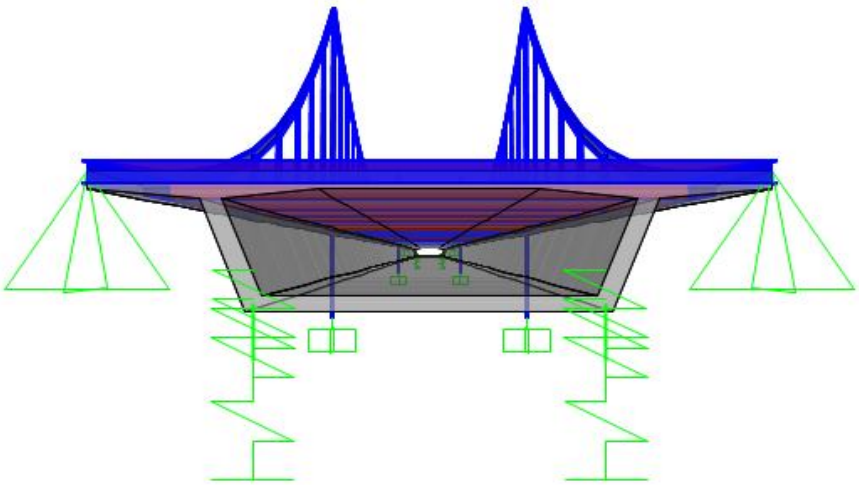


Fig 2. AASHTO – PCI – ASBI – Standard deck view

2) Cable and properties -

Diameter of the cable – 0.05 meter

Steel used - Fe250

3) Pylon- pylon is modelled as the frame section which is I girder.

4) The applied load is IRC AA tracked load and the dead load and live combinations.

VII. RESULT OF ANALYSIS

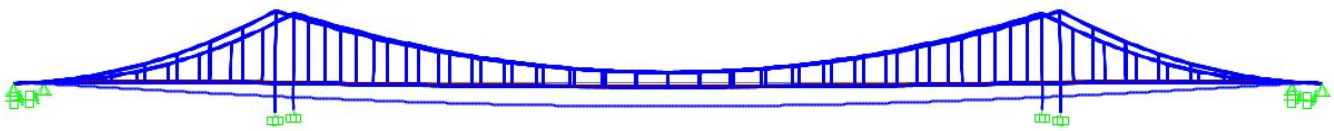


Fig 3. Deformed shape

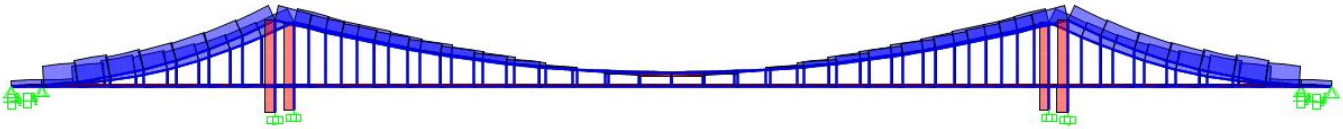


Fig 6. Axial force diagram of the cable

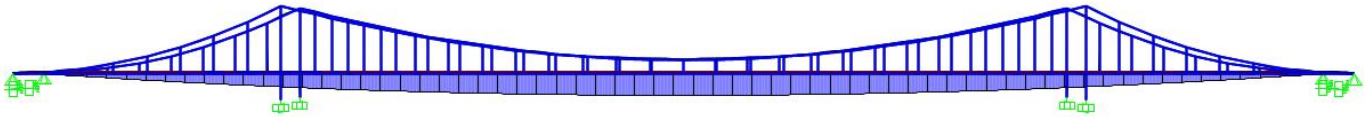


Fig 7. Bending Moment generated in the bridge

VIII. CONCLUSION

After investigating the result data of the analysis following point can be concluded.

1) The structural analysis of the self-anchored suspension bridge using (CSi bridge) maybe used to analysis many other suspension bridge.
2) The result of analysis which is based in adopting Indian and IRC specification standard for bridge loading.
3) Based on the analysis it can be stated that the box girder which is used is the most appropriate choice for the self-anchored suspension bridge and it can be used in other type of bridge form.

IX. FUTURE RECOMMENDATION

1) In self-anchored suspension bridge the condition of sway can be eliminate through the use of wind guy cable and reverse cable which is generally called hybrid structure.
2) Different type of variation can be done in choosing the type of cable material, deck section, pylon shape and material.

X. ACKNOWLEDGMENT

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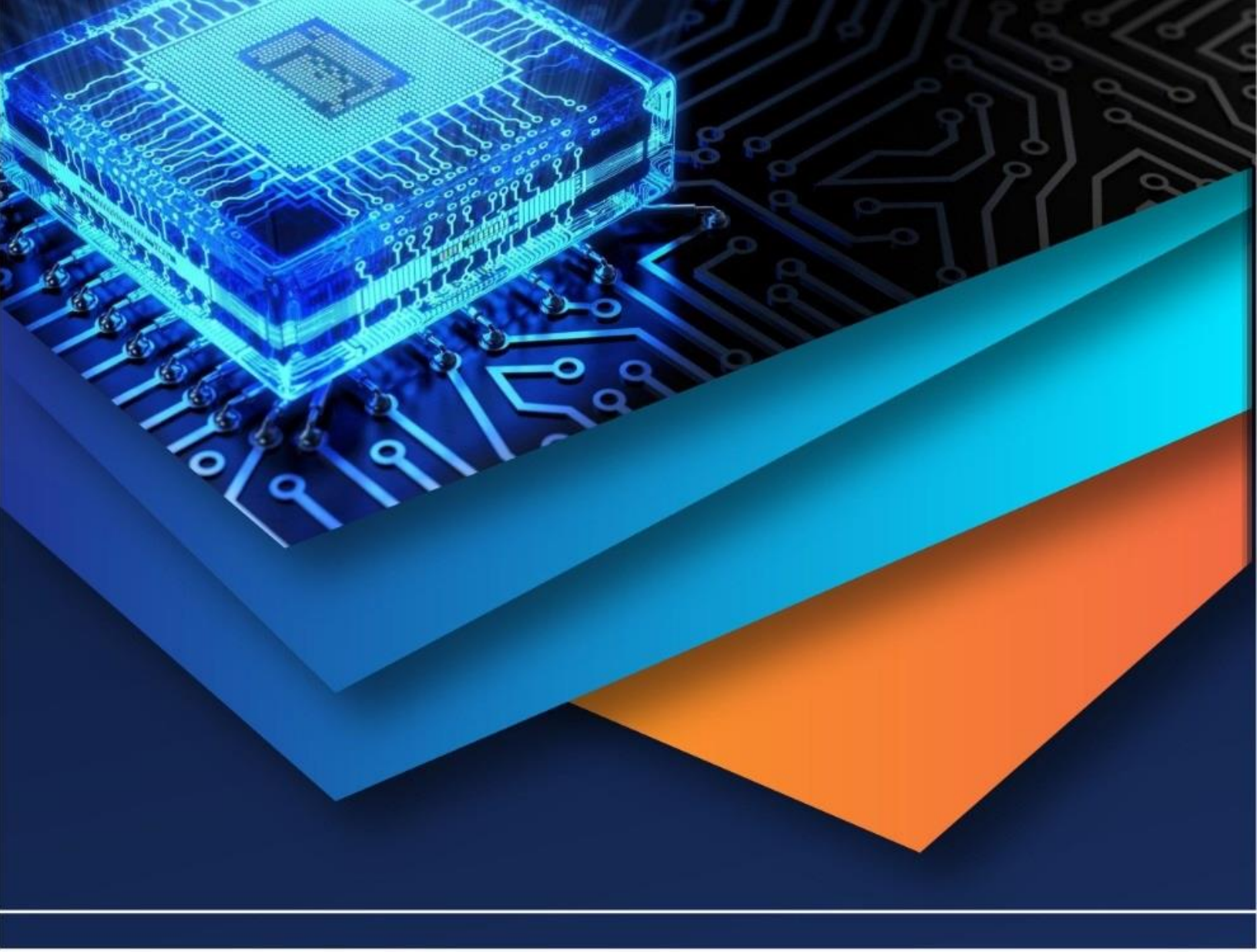

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