Original Article
International Journal of Scientific Research in Civil Engineering
Available online at : www.ijsrce.com
© 2023 | IJSRCE | Volume 7 | Issue 4 | ISSN : 2456-6667

Analysis of a Cable Stayed Suspension Hybrid Bridge Considering Vehicular Loading using CSI Bridge A Review

Vivek Saraf[1], Rahul Sathbhaiya[2]
P.G. Scholar[1], Assistant Professor[2]
Department of Civil Engineer, Infinity Management and Engineering College, Madhya Pradesh, India

ARTICLEINFO

Article History:

Accepted: 05 July 2023
Published: 22 July 2023

Publication Issue
Volume 7, Issue 4
July-August-2023

Page Number
84-90

ABSTRACT

Cable-stayed bridges are built for providing connectivity over obstacles such as rivers, mountains, flyovers over rotary squares and valleys for a long span. Cable stayed bridge provides ample stability and utilises structure material and further its advantages goes in for cheap maintenance and design. Design of the bridge is highly dependent on its function and purpose and the nature of terrain of the site.
A bridge type known as a suspension bridge has its deck suspended by vertical suspenders and suspension cables. The main structural elements of a suspension bridge system are stiffening girders/trusses, main suspension cables, main towers, and cable anchorages at each end of the bridge. Vertical suspenders sustain the weight of the deck and the traffic load, while the main cables are stretched between towers and eventually connect to the anchorage or the bridge itself. The superstructures of suspension bridges are constructed utilising the cable erection technique similarly to other cable-supported bridges.
In this paper presenting review of literature related to analysis of bridge structure.

Keywords : Cable Stayed Bridge (CSB); Suspension Bridge (SB); Cable Stayed Suspension Hybrid Bridge (CSSHB),Pylon, Seismic Analysis , CSi Bridge.

I. INTRODUCTION

Long span bridge are increasing day by day to facilitate the need of construction projects. Cable stayed bridges and suspension bridges are the systems used to achieve long span bridges. The spans of cable-supported bridges range from 200 to 2000 metres. The greatest span of a cable-supported bridge system is determined by the density, stiffness, and strength of the materials utilised. In the design and analysis of cable-stayed bridges and suspension bridges, high strength steel cables are a key component, which is superior for effective tension resistance. The advantages of a cable-supported bridge are in the way that the system uses the materials.

A suspension bridge is a form of bridge in which the deck is suspended on vertical suspenders from below suspension cables. In the early 1800s, the first examples of this kind of bridge were constructed in the modern era. In many hilly areas of the world, simple suspension bridges with no vertical suspenders have a long history.

Thousand years ago, people cross water bodies with the help of cable attached with wooden block. It was born of cable stayed and suspension bridge but mainly cable stayed bridge developed in 1595 and commonly used in 19th century. In early days, Cable Bridge was constructed with combination of suspension bridge and cable stayed bridge. In 1808 an American inventor named James give the born of modern cable bridge. Two cables are used over the top of many towers and anchoring this chain on the either side of bridge structure. Although suspension bridges and cable stayed bridges are quite similar, the main distinction between the two is how the deck force is transferred to the cable in a suspension bridge. In a cable stayed bridge, the cable is connected directly to the deck. Because of its low weight, improved aesthetics, and long span designs, cable stayed bridges have gained popularity. The primary purpose of a cable-stayed bridge is to handle its own weight and impending traffic loads safely while also being aesthetically beautiful and demonstrating excellent serviceability under any conceivable load scenario. Steel wire cable is used to suspend a cable stayed bridge deck. The top vertical towers are fixed with these cables, which transmit shear force to the vertical members, which then transform it into compression force.

In this study, three distinct cases—a suspension bridge, a cable-stayed bridge, and a hybrid cable-stayed suspension bridge—are largely examined. CSI Bridge's analytical application was used to model the data and conduct the analysis while accounting for seismic and vehicle loading.

II. Review of Literature Survey

Farhan Farid Reshi et al (2021) research paper conducted analysis and design part of the suspension bridge and Cable-stayed bridge. The designing and analysis of the model was done using analytical application STAAD.pro. The wind load analysis is provided 9 | P a g e to check the dynamic behaviour of suspension and Cable Stayed Bridge. The wind zones considered were zone 4 and zone 5 and the speed of wind is taken as 47 m/s and 50 m/s respectively. Conclusion stated that cable-stayed bridge is an innovative structure and is preferred to conventional steel suspension bridges for long spans mainly due to the reduction in moments in the stiffening girders resulting in smaller sections of the girders leading to economy in overall costs. This bridge type is useful for numerous traffic options, including automobiles, trucks, bicycles, and pedestrians. In some situations, a cablestayed bridge is suitable for light rail as well. Engineers use this option when a span must be longer than what a cantilever bridge can support because of its weight, yet it is also short enough so that suspension Cable-stayed bridges take less time to complete than other options.

Neel Shah et al (2021) research paper investigated the dynamic effect on different configuration of pylons of a cable stayed bridge. A pylon is inclined at 5o , 10o, 15o, 20o, 25o and 30o with vertical and horizontal axis both and compared with vertical pylon to study the dynamic response of bridge. The 3D bridge models was prepared on CSI BRIDGE software and bridge was analyzed seismically by Imperial Valley 1947, Earthquake. The bridge response in terms of Pylon, Girder and Cable axial force, moment and torsion was obtained. Results stated that minimum axial force was obtained at 10o in Cable at main span near pylon in X -Direction and Y - Direction both. Minimum axial force was obtained in girder at 10o at main span and side span both in X –Direction. Minimum axial force was obtained in pylon at 10o in X – Direction and at 15o for Y –Direction. Minimum moment in pylon was obtained at 10o and minimum torsion in pylon at 5o. Hence, it was stated that the different angle of the pylon has great influence in the seismic response of the cable-stayed bridge.

Priyanka Singh et.al (2021) The bridge design, model, and analysis for various types of pylons were reported in this research study utilizing STAAD Pro. H-type, A-type, and inverted Y-type pylons are the different types of pylons that are considered. The most efficient sort of pylon design was determined by comparing shear force and 10 | P a g e bending moment in terms of self weight for three scenarios. The results gained can be used to mitigate the disadvantages of other types of pylons. The highest deflection was found to be 172.5mm in pylon type H, followed by 149.8mm in inverted Y-type pylon design, and 76.9mm in A-type pylon design, indicating that A-type pylon is the most suitable and stable section in comparison.

Shubham Garg and Vinod Kumar Modi (2021) in the research paper, eight number of models of bridge with the variation of cable position were analyzed considering main span of bridge as 250m and side span as 125 m including two lanes each 3.5m wide and 1.5m wide pathway. The prepared geometry of the eight models of cable stayed bridge was analyzed in STAAD.Pro v8i series VI software for various structural properties. The wind zone-IV and seismic zone-V was selected for the detailed analysis. The bridge with the variation in cable position was design in STAAD.Pro software and analyzed for maximum horizontal shear force (Fx), maximum vertical shear force (Fy), maximum horizontal moment (Mx) and maximum vertical moment (My) for side span & main span along without bracing in pylon. The obtained results for different cable profiles were analyzed and compared to obtain optimum position. Results stated that the comparison of bracing model with unbracing model revealed that bracing are not so efficient in the reduction of shear force and bending moment of cables. The number of cables affects the design of cable because if the bridge is designed with a greater number of cables, the anchor failure can be managed easily. If a bridge is designed for a smaller number of cables, then it is difficult to manage anchor failure.

Sreerag S Kallingal and Priyanka Singh (2021) research paper dealt with the investigation of dynamic analysis of cable-stayed bridges with different pylon arrangements. The cable transmits the reaction forces of the deck to pylon and pylon transmits the load of the cable to the foundation. The pylons ‘H’ shape, ‘Inverted Y’ shape, ‘Diamond’ shape & ‘Needle’ shape arrangement were considered and MIDAS CIVIL software was used to model and analysis of the cable stayed bridge with various pylon arrangements. The materials and section properties of all four bridges were kept the same and the moving load was provided as per IRC:6-2000 loading. In the part of seismic analysis, the time history analysis was done and data of 1940 El Centro earthquake so the nonlinear dynamic behaviour of four bridges was investigated on parameter like, axial forces, displacement and bending moment are analyzed. Results stated that inverted Y shape and diamond shape pylon cable stayed bridge shows high values of axial force, shear force and bending moment in both pylon and girder. As well as the Inverted Y shape shows high frequency compared to others. The H shape pylon cable stayed bridge shows more stable feature in dynamic response compare to others.

Abhishek Pandey and Nitesh Kushwah (2020) the research paper dealt with the design and analysis for different cables arrangement with the different shapes of pylon using STAAD Pro. Cable-stayed bridge was designed with overall span of 200 m and width of both the bridge's deck was 10 m. In building, edge beams were only erected and instead preceded through crossbeams on either the deck slab. A bridge's overall height reaches 65 m. A pylon with various shapes were used with arrangement of fans, radial arrangement, organization of stars or arrangement of harps. The four cable-stayed bride configurations like star, fan, radial or harp arrangements of specific tower shapes were compared. Results stated that the circular or the H shape pylon can have a small amount of sag and moment in the cables or the deck among all of the pylons (i.e. one axial layer of stay and two lateral of stays) also because greater number with joints wasn't homogeneous such that the composition with pressure and anxiety carrying capacity of both the cables wasn't really efficient towards the other parts of both the cable which might lead with sec, in comparison with a circular with a homogeneous member.

Kuihua Mei et al (2020) The Chengdong Hanjiang Bridge in Ankang City is a multispan continuous beam-arch combination system bridge of (75+2×125+160+2×125+75) m, and its site is located in the earthquake zone. Calculation model based on Midas / Civil finite element software process analysis method is applied to seismic response analysis using power. At the same time, in order to influence the travelling wave effect and the seismic isolation system on the internal force of the bridge structure, corresponding finite element models were established and calculated with time history analysis. The finite element model under non-uniform excitation uses the "Large Mass Method" (LMM) for analysis and calculation under different wave velocity multi-point excitations. The results show that after considering the traveling wave effect, the displacement and bending moment of the control section of each hole increase, and the internal force of the fixed pier increases. When the wave velocity is 600m/s, the traveling wave effect strengthens the seismic response of the structure the most. With the increase of the wave velocity, the seismic response of the structure gradually approaches the seismic response under uniform excitation. After the friction pendulum seismic isolation support is used, it is fixed. The bending moment of Pier No.32 has been reduced by 80%, the stiffness of the whole bridge is more balanced, the forces of each pier are relatively close, and the isolation effect is good.

Mayur G. Dangle and Girish Joshi (2020) in the research paper, linear static analysis loading was considered as per the Post Tensioning Institute (2001) recommendations and GSA (2003) progressive collapse guidelines.

Alternate path (AP) method was used for progressive collapse analysis of the cable stayed bridge modeled in SAP 2000 with various cable arrangements and investigated the deflection of girder under static loading condition. Progressive collapse analysis along with blast load was conducted for the cable stayed bridge having different cable arrangements and pylon geometry and compared the absolute displacements of girder and axial cable forces under progressive collapse mechanisms. When only Cable arrangement was considered the maximum deflection obtained is 0.4714m in HARP cable arrangement with H-type pylon whereas the FAN cable arrangement with A-type pylon gives least deflection 0.3317m. In case of cable arrangement with pylon geometry, the FAN cable arrangement with A type pylon gives best results against progressive collapse. HARP cable arrangement with H-type pylon gives worst results progressive collapse.

J H Gabra and A. K. Desai (2019) research paper endeavored dynamic investigation to inspect impact of pylon geometry (shape) on Modal Time Period(s) for different time history analysis using SAP2000.

1400 m span CSSHB has been used for the same. Fan type arrangement of cables was considered in research. On analyzing the effect of Pylon 13 | P a g e shapes of the dynamic analysis (Time History) carried out on CSSHB, with 7 different pylon shapes. Results stated that hexagonal shaped pylon exhibits greatest flexibility followed by H, whereas double diamond shape, Inverted Y and A shaped pylons exhibit greater stiffness.

Puneet Garg and Rajesh Chaturvedi (2019) For the examination of the cable stayed bridge, two different types of structural models, namely the Spine Model and the Area Object Model, are employed in the research work. Static and moving vehicle analyses have been carried out, with IRC Class A vehicle loads applied and their load combinations taken into account when evaluating the outcomes. The analysis was carried out in CSi Bridge, and the results were compared to tables and graphs to determine which structure model was suitable for study. The wires are organised in a mixed or fan configuration, with a single pylon inserted into the deck construction to sustain them. The steel pylon was 50 mm thick, with a diameter ranging from 1.2 m at the bottom to 0.6 m at the top. Its overall height is 55 m, with 45 m above deck. The pylon is connected to 36 cables with a diameter of 60 mm, with a maximum height of 42 m and a minimum height of 18 m, spaced at 3 m intervals on the pylon and 10 m intervals on the deck. The maximum positive moment about the horizontal axis for both models was roughly the same, with no significant divergence, but the maximum negative moment about the horizontal axis for the area object model was less than the spine model. In the area object model, the bending moment is reduced by nearly 17%. In comparison to the spine model, the maximum deflection in the area object model is higher. The percentage of deflection in the area object model is increasing by more than 4%. As a result, increasing the deflection in the area object model is more appropriate.

Ali L. Abass et al (2018) in the research paper, a cable-stayed bridge was modelled and analysed using the finite element method on Ansys. The damping effect was investigated in the vertical and inclined directions as an earthquake effect was applied on the cable-stayed bridge in the longitudinal and lateral directions with changes to the number, direction, and value of the damping coefficient (c) of the dampers. 14 | P a g e The results show that increments in the number of dampers and damping coefficient in inclined dampers were more effective than changes to vertical dampers in longitudinal and lateral earthquakes.

Amrendra kumar Sahani et.al (2018) The dead load analysis of a Suspension Bridge and a Cable-Stayed Bridge was described in this research study using the same parameters as the main span, side span, pylon height, bridge deck, and material properties. The optimum sag for suspension bridge at which the smallest value of deflection was determined through analysis. Then, using the optimum sag value, the diameters of the major cables were modified, and the resulting deflection of the bridge deck was calculated. The optimum value is the diameter for which the minimal amount of deck deflection is obtained. The amount of steel required for the optimum sag and diameter was calculated, and a similar process of adjusting the diameter of the cable on a Cable-Stayed Bridge was carried out, with the optimum diameter and bridges being modelled in the CSI-Bridge Software. When comparing a cable stayed bridge to a suspension bridge of the same length, the result demonstrates that the cable stayed bridge consumes less steel and has a lower deflection. In comparison to suspension bridges, cable-stayed bridges use 21.8 percent less steel and have less deck deflection.

Almas M A and Rajesh A K (2017) research paper focused on the effect of shape of pylon on the seismic response of cable stayed bridge. The bridge span dimension and other parameters were kept constant, and only the pylon shape was varied viz. A type, H shape and inverted Y shape. The height of the pylon was kept constant for all the shapes for comparison purposes and the 3D bridge model was prepared on ANSYS software and bridge was analyzed seismically. Straight and curved cable stayed bridges was analysed to study the seismic behaviour and effect of pylon shape of both. Results stated that the base shear values for inverted Y pylon system was less than the values for A pylon and H pylon. The curved cable stayed bridge with inverted Y shape pylon gives lesser value of displacement compared to other two bridges. As the pylon height increases the displacement value reduces for all the three models. Results further concluded that inverted Y shape pylon gives most suitable configuration for both curved and straight cable stayed bridges

III.CONCLUSION

Various authors studied the analysis part of different segments of bridge structure and its utilization using analysis tools.

IV. REFERENCES

[1]. Bilcilintan Patel, Amit Baghel, Nikhil Kumar and Pankaj Kumar Singh, [A STUDY ON VIBRATION CONTROLLER AND SEISMIC RESISTANT CABLE STAYED BRIDGE WITH MODEL], International Journal of Advance research in Science and Engineering, Vol no. 6, Issue no. 4, April 2017.

[2]. Neel Shah, Prashant Kanzariya and Dr. Bimal Shah, [PARAMETRIC STUDY OF CABLE STAYED BRIDGE USING DIFFERENT PYLON CONFIGURATION], International Journal of Engineering Applied Sciences and Technology, 2021 Vol. 5, Issue 10, ISSN No. 2455-2143, Pages 342-348.

[3]. Junjun Guo, Jian Zhong, Xinzhi Dang and Wancheng Yuan, [Seismic Responses of a Cable-Stayed Bridge with Consideration of Uniform Temperature Load], Appl. Sci. 2016.

[4]. J H Gabra and A. K. Desai, [Influence of Pylon's Geometry on response of Cable Stayed Suspension Hybrid Bridge (CSSHB)], International Journal of Recent Technology and Engineering (IJRTE) ISSN: 2277-3878, Volume-8 Issue-3, September 2019.

[5]. Shubham Garg and Vinod Kumar Modi, [DESIGN AND ANALYSIS OF CABLE STAYED BRIDGE CONSIDERATION WITH SEISMIC AND WIND LOAD BY CHANGING THE CABLE POSITION], International Advanced Research Journal in Science, Engineering and Technology Vol. 8, Issue 11, November 2021.

[6]. Sreerag S Kallingal and Priyanka Singh, [Dynamic analysis of cable stayed bridge with various patterns of pylon], E3S Web of Conferences 304, 02005 (2021).

[7]. Kuihua Mei, Wangwang Fu and Jufeng Su, [Seismic Analysis of Hybrid System Bridge of Multi-Span Continuous Girder and Arches], E3S Web of Conferences 165, 04032 (2020).

[8]. Praveen kumar M, Dr. M Rame gowda and Arjun B, [ANALYSIS OF CABLE STAYED BRIDGE UNDER THE ACTION OF VEHICULAR AND SEISMIC LOADS], International Journal of Scientific Development and Research (IJSDR), October 2017 IJSDR | Volume 2, Issue 10, ISSN: 2455-2631.

[9]. Abhishek Pandey and Nitesh Kushwah, [Seismic Analysis and Design of Cable Stayed Bridge with Different Cable Arrangements], International Research Journal of Engineering

and Technology (IRJET), Volume: 07 Issue: 12 | Dec 2020.

[10]. Almas M A and Rajesh A K, [Effect of Pylon Shape on the Seismic Response of Curved and Straight Cable Stayed Bridges], International Research Journal of Advanced Engineering and Science, Volume 2, Issue 2, pp. 267-271, 2017.

[11]. Mayur G. Dangle and Girish Joshi, [Research Paper on Progressive Collapse of Cable Stayed Bridge Using Sap2000], International Journal of Advances in Engineering and Management (IJAEM), Volume 2, Issue 3, pp: 01-04, ISSN: 2395-5252, 2020.

[12]. Farhan Farid Reshi, Priyanka Singh, Shivangi, Ravinder Kumar Tomar and S K Singh, [Analysis and Design of Cable Stayed and Suspension Bridge Subjected to Wind Loading], IOP Conf. Series: Earth and Environmental Science 889 (2021) 012059.

[13]. Ali L. Abass, Zaid S. Hammoudi and Haneen A. Mahmood, [Seismic Analysis of a Cable-Stayed Bridge Using the Finite Element Method.], IOP Conf. Series: Materials Science and Engineering, 2018.

Cite this article as :

Vivek Saraf, Rahul Sathbhaiya, "Analysis of a Cable Stayed Suspension Hybrid Bridge Considering Vehicular Loading using CSI Bridge A Review", International Journal of Scientific Research in Civil Engineering (IJSRCE), ISSN : 2456-6667, Volume 7, Issue 4, pp.84-90, July-August.2023
URL : https://ijsrce.com/IJSRCE23749