International Journal of Scientific Research in Civil Engineering
© 2018 IJSRCE | Volume 2 | Issue 5 | ISSN : 2456-6667

Analysis of a Cable Stayed Bridge with Different Pylon Types : A Review

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ABSTRACT
The study of the bridge section superstructure has analyzed using analysis software (STAAD.Pro) which is a traditional type use in bridges.we will discusse the advantages of the bridge in the construction point of view. Bridge sections is a simple, easy and fast construction type of structure and world wide it has using for span length 262 m. A literature review is an evaluative report of studies found in literature related to selected area. The literature related to selected area. The literature review should describe, summarize, evaluate, and clarify the literature. A literature review goes beyond the search for information and includes the identification and articulation of relationship between the literature and field of research. While the form of literature review might be vary with various types of studies. We have different literature review from papers, journals, websites and dissertation.

Keywords : Analysis, Bridge, Staad.Pro, Pylon, Cost Analysis, Forces, Deflection.

I. INTRODUCTION

A bridge is a structure built to span physical obstacles without closing the way underneath such as a body of water, valley, or road, for the purpose of providing passage over the obstacle. There are many different designs that each serve a particular purpose and apply to different situations. In engineering, a bridge is a structure that "consists of two-force members only, where the members are organized so that the assemblage as a whole behaves as a single object".

The Pylon transfers the forces developed in the cables to the foundation through vertical compression. The design of the bridge is figure out such that the static horizontal forces resulting from dead load are almost balanced to minimize the height of the pylon. Cable stayed-bridges have a low centre of gravity, which makes them capable in opposing the effects of earthquakes. Cable stayed bridges provide outstanding architectural display due to their small diameter of cables and exclusive upper part of structure. It can be constructed by cantilevering action from the tower i.e. the cables act both as temporary and permanent supports to the bridge deck. The advantage of cable stayed bridges is that it can be built with any number of towers.

II. LITERATURE REVIEW

Hussain Hararwala and Savita Maru (August 2017) Stated that the linear static analysis of Cable Stayed Bridges with different shapes of pylons under its own weight. The cable stayed bridge is one of the modern bridges which were built for the longer spans. Therefore, there is a need of study on the behaviour of the pylons before implementing it in actual practice. For this study, the different shapes of Pylons have been compared with the bridge span dimension and other parameters are kept unvarying. The

different shapes of Pylons considered for Cable Stayed Bridge are A type, H type, inverted Y type, Single pylon, Diamond shaped, Pyramid Shaped, U-Shaped & Hexagonal Shaped. The height of the pylon remains same for all the models of Cable Stayed Bridge with different shapes of Pylons. The modelling of bridge has been prepared using SAP 2000 software. For this study, the arrangement of cable stay has been taken as semi fan type as well as fan type. The study reveals the following points regarding to the behaviour of Pylons such as the Axial Force in Pylon, Bending Moment in Pylon, and Shear Force in Pylon & Deflection at the top of Pylon. This study will be helpful for make an appropriate choice for the shape of Pylon used for Cable Stayed Bridge in particular conditions.

Raut and Dubal (January 2015) Studied that finite element approach for the geometric nonlinear aerostatic analysis of self anchored cable-stayed bridges with different pylon configurations along with vehicular interaction. In the recent years cable stayed bridges have received more attention than any other bridge mainly due to Cable stayed bridge are the most flexible bridge and getting popularity because of its economy for longer spans and aesthetics. The results showed that these factors have significant influence on the aerostatic behavior and should be considered in the aerostatic analysis of long span cable stayed bridges. Analysis results will be useful for the designers to consider the shape of pylon at the initial stage of design. Again the results indicate the significant influence of pylon shapes on aerostatic behavior of such long span 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. A cable stayed bridge consists of one or more towers with cables supporting the bridge deck. In terms of cable arrangements, the most common type of cable stayed bridges are fan, harp, and semi fan bridges. Because of their large size and nonlinear structural behavior, the analysis of these types of bridges is more complicated than conventional bridges. In these bridges, the cables are the main source of nonlinearity. Obtaining the optimum distribution of post-tensioning cable forces is an important task and plays a major role in optimizing the design of cable stayed bridges. An optimum design of a cable-stayed bridge with minimum cost while achieving strength and serviceability requirements is a challenging task.

Blesson and Thakkar (November 2011) Studied that the dynamic and aerostatic effect on different shapes of pylons of a cable stayed bridge. The different shapes of pylons considered here are H type, A type, Inverted Y type, Diamond type and Delta type. The central span of the cable stayed bridge is also varied as 100m, 200m, 300m, 400m to study the combined effects due to shape and span. The study is carried out by taking live load according to IRC 6:2000, IRC Class A and Class 70R vehicle load along with Aerostatic wind loads was undertaken. A Dynamic analysis in the form of Linear Time-history is also carried out using El-Centro ground motion and various response quantities such as Bending-moment, Shearforce, Torsion and Axial force are represented.

T.Pramod Kumar, G.Phani Ram (July 2015) This research's objective was to estimate the economic importance of the railway cum road bridge. This paper was carried out to find out the reduction in cost of construction by providing single bridge for both road as well as railways. The analysis and design phase of the project was done utilizing STAAD PRO V8i. It was observed that the construction of a single bridge reduced the cost of two separate bridges for road and railways, also land acquisition problem is reduced to some extent.

R.Shreedhar, Spurti Mamadapur (September 2012) Analysed a simple span T-beam bridge by using I.R.C. specifications and Loading (dead load and live load)

as a 1-D (one dimensional) structure. Finite Element Method analysis of a three-dimensional structure was carried out using STAAD. Pro software Both models were subjected to I.R.C. Loadings to produce maximum bending moment. The results were analyzed and it was found that the results obtained from the finite element model are lesser than the results carried from 1-D (one dimensional) analysis, which states that the results obtained from I.R.C. loadings are conservative and FEM gives economical design.

Rajesh F. Kale, N.G.Gore, P.J.Salunke (January 2014) Studied the cost efficient approach of reinforce cement concrete T-beam girder. His main objective function was to reduce the total cost in the design process of the bridge system considering the cost of materials. The cost of each structural component such as material, man power, cost for reinforcement, concrete and formwork. For each and every bridge its girder length, width of bridge, deck slab depth, width of web of girder and girder depth are considered for the cost minimization of the bridge system, the structure is modeled and analyzed using the direct design methods. Cost efficient problem is formulated in NLPP (non-linear programming problem) by Sequential Unconstrained Minimization Technique. The model is analyzed and designed for an optimization purpose by using Mathematical lab (Matlab) Software with SUMT, and it is capable of indicating precisely with high probability of minimum design variables. Optimization for reinforced cement concrete T-beam girder system is illustrated and the results of the optimum and conventional design procedures are compared. Observed that Significant savings in cost over the normal design can be achieved by the optimization. However the exact saving obtained from optimum design of reinforce cement concrete T-beam girder depend upon the span of slab and grade of material. The cost of girder is directly proportional to grade of concrete.

Georgios Michas (2012) discussed various non-ballasted concepts and some considerations are made in relation to life cycle cost for high speed track. It is concluded that slab track is in a long-term perspective, more economically efficient as observed. Even though the slab track construction costs are 30 % to 50 % higher than the standard ballasted track, the maintenance costs for slab track are one-fourth of those for ballasted track.

Mulesh K. Pathak (January-2014) studies various behaviors like bending, shear, axial & torsion for horizontally curved reinforce cement concrete box bridges considering three dimension FEM using SAP software. This approach simplifies analysis & the preliminary design of curved bridge section. The increase in the torsion for any set of graph is comparatively increases than that of bending moments, shear forces and axial forces which indicate that box section is having high torsional stiffness and is nonlinearly vary with degree of curvature. From the study it is observed that various span, the multiplication factor for variable degree of curvature is varying linearly for axial force & bending moment, which is about 1.20 to 1.30 for 90° curvature. Multiplication factor for torsion moment is varying nonlinearly having 1.80 to 1.90 for 90° curvature, while there is not necessary to apply multiplication factor for shear force.

Amit Saxena, Dr. Savita Maru (April-May, 2013) discussed the variation and cost difference in T beam girder and two cell box girder in terms of concrete quantity and conclude that cost of concrete for T-Beam Girder is not as much of two cell Box Girder as quantity required by T-beam Girder, Quantity of steel for T-beam Girder is less so budget of steel in T-Beam is less as compared to two cells Box Girder Bridge T-Beam Girder is economical for span length is not more than 25m but if span is more than 25 m, so Box Girder is always suitable. This type of bridge structure lies in the high torsional rigidity because of closed box section.

Stanislovas kalantal, Juozas, et al, in their paper, considered the optimal design problems of the elastic and elastic-plastic bars. The mathematical models of the problems, including the structural requirements of the strength, stiffness and stability, are formulated in the terms of finite elements method. The stated nonlinear optimization problems are solved by the iterative method, structures These problems are formulated as nonlinear discrete optimization problems.

Yasuyuki Nagano and T. Okamoto, et al, presented this paper; the purpose of this to show the practical applicability of a new optimum design method by the authors to an actual high-rise building structure with hysteretic dampers. They concluded that it possible to save structural cost and reduce computational cost than the conventional seismic resistant design methods, including iterative dynamic response analysis.

E. Kalkan and S.K. Kunnath (2004) revealed in their study that the suitability of using unique model combinations to determine lateral load confrigations that best approximate the inter-story depends in multi-story movement resisting frame buildings subjected to seismic loads.

Krishnan et. al. (2006) studied the responses of tall steel movement frame buildings in scenario magnitude 7.9 earthquakes on the southern San Andreas fault. This work used three-dimensional, nonlinear finite elements models of an existing eighteen-story moments frame building as it, and redesigned to satisfy the 1997 uniform building code. The authors found that the simulated responses of the original buildings indicate the potential for significant damage throughout the San Fernando and Los Angeles basins. The redesigned building fared better, but still showed significant deformation in some areas. The rupture on the southern San Andreas that propagated north-to-south induced much larger building responses that the rupture that propagated south-to-north.

Thomas Heaton, et al. (2007) simulates the response of 6 and 20-story steel movement- resisting frame buildings (US 1994. UBC) For ground motions recorded in the 2003 Tokachi-oki earthquake. They consider building with both perfect welds and also with brittle welds similar to those observed in 1994 Northridge earthquake. Their simulations show that the long- period ground motions recorded in the near-source regions of the 2003 Tokachi-oki earthquake would have caused large inter-story drifts in flexible steel moment – resisting frame buildings designed according to the US 1994, UBC.

Takanori OYA, takashi Fukazawa, et al (2009), in their paper introduced the application of a new type BRB to various structures. The brace has two buckling restraining parts (steel mortar planks), clipping a core plate being under axial forces. These parts are welded together and restrain the core plate of plastic behaviour , avoiding the out- of – plane deformation and the buckling.

Vaibhav B. Chavan et. al. (1990) This research's objective was to estimate the economic importance of the Hollow Sections in contrast with conventional sections. This paper was carried out to find out the percentage economy accomplished using Hollow Sections so as to understand the importance of cost efficiency. The technique used in order to reach the objective involves the comparison of various profiles for different combinations of height and material cross -section for given span and loading conditions. The analysis and design phase of the project was done utilizing STAAD PRO V8i. The results of STAAD analysis were validated with the results of Manual analysis.

Davison and Birkemoe (1982) determined that there are two residual stress gradients in the longitudinal direction, one across the tube face and around the cross section, denoted as membrane, and the other

perpendicular to the tube face through the material thickness, denoted as bending. "The perimeter (membrane) residual stress gradient represents the variation in the mean value of the longitudinal residual stress [and] the through thickness (bending) residual stress gradient is the deviation from this mean value normal to the perimeter through the material thickness".

Do dai thang et. al. (2009) presented a paper in which, optimum cost design of steel box girder bridge is carried out by varying of closed rectangular and open trapezoidal sections.

A joghataie and M. Takalloozadeh (2009), in their paper proposed new penalty function which have better convergence properties, as compared to the commonly used exterior and interior penalty function. They applied the old and new exterior and interior penalty function in conjuction with the steepest descent method to three-bar truss and ten-bar truss and compared the results. It was shown that the convergence speed and accuracy of the result were improved.

A Csebfalvi and G. Csebfalvi proposed a genetic algorithm for discrete weight design of steel planer frames with semi- rigid beam-to-column connections. It was revealed that the results of discrete minimal weight design are highly affected by the applied connection modelling method.

III. Review Result

The literature review has suggested that use of a finite element modeling of the superstructure. So it has been decided to use STAAD.Pro for the Finite Element Modeling. With the help of this software study of bridge structure has been done. STAAD.Pro also helps in Finite Element Modeling in view of that different type of forces can apply to get the actual results.

In the past researches it is determined that cable stayed bridge can be cast with different types of pylon, but in past none of the researcher implement the same in a live project with live data.

IV. CONCLUSION

Bridge span having 200 to 300 m span generally use as a superstructure for bridges. In this regards realistic analysis for bridge for different type of pylons are considered. In this modern time, such types of analysis is really important to find out the economical section which can be easily prepared in STAAD.Pro for modeling, analysis and design purpose. This motivation has lead to this study on this analysis of moving load as per Indian road congress that has to be placed at eccentric and concentric. Here proposed study can be considered for the position vehicle loading and carried out the critical case values of Bending and Shear Forces.

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