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Comparative Analysis of Cable Stayed Bridge and Girder Bridge Considering Seismic Forces and I.R.C. Loading Using SAP2000 : A Review

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ABSTRACT

A bridge is a structure which is built over some physical obstacles such as a body of water, valley, road and railway, its purpose is to provide crossing over that obstacle. Numerous bridges are in exist namely Arch Bridge, Girder Bridge, Suspension bridge, Cable stayed Bridge, etc. Design of bridges varies depending on the function of the bridge, the nature of the terrain where the bridge is constructed and anchored, the funds available to build it. Structural analysis is a process to analyze a structural system to predict its responses and behaviour by using physical laws and mathematical equations.

In this study we are reviewing the literatures related to analysis of structures using analysis tool

Keywords : Structural Analysis, Bridge, seismic, vehicular load, sap2000

I. INTRODUCTION

A bridge is a structure built to span a physical obstacle, such as a body of water, valley, or road, without closing the way underneath. It is constructed for the purpose of providing passage over the obstacle, usually something that is otherwise difficult or impossible to cross. There are many different designs that each serve a particular purpose and apply to different situations. Designs of bridges vary depending on the function of the bridge, the nature of the terrain where the bridge is constructed and anchored, the material used to make it, and the funds available to build it. Khawaja Ali et.al (2021) the examination paper introduced a correlation of link remained and extradosed spans dependent on the security appraisal of their visit links completed on the wellbeing variables of stay links under exhaustion and extreme breaking point states by thinking about the impacts of different untoward and harming factors, for example, over-burdening, link misfortune, and erosion. The essential objective of the exploration was to depict the primary incongruities between the two kinds of extensions and assess their underlying redundancies by utilizing deterministic and non-deterministic strategies. To accomplish this objective, three-dimensional limited component models of the two extensions were created dependent on the current plan rules for stay links in Japan. After the reasonable conditions of the extension models were accomplished, static examinations were performed for

various wellbeing elements of stay links in a parametric way. At long last, the main request unwavering quality strategy and Monte Carlo technique were applied to decide the dependability list of stay links.

The investigation results show that link remained and extradosed spans display diverse primary redundancies for various security factors under similar stacking conditions. Additionally, a huge expansion in underlying excess happens with a steady expansion in the safety variables of stay cables.

Priyanka Rajput et.al (2020) the research paper conducted comparative study of cable stayed bridge using SAP2000 software and the material of deck girder of bridges was changed and comparison was done on the basis of shear force, bending moment, torsion, bending stress of girders with concrete and steel and prestressed girder of same span and same loading conditions. Economic aspect of cable stayed bridge with concrete steel and prestressed deck girder was even further investigated. Maximum stresses, shear forces, bending moment was compared for 120.0m span concrete, steel and prestressed bridge girder. Concrete deck girder M 60 grade of concrete was used in design of cable stayed bridge and for design of steel girder bridges FE 500 was used in design of cable stayed bridge. Different combination of dead, live, earthquake and prestressing are taken into account in all the models of cable stayed bridge design.

The results stated that forces in steel girder are lesser than prestressed and concrete deck girder in cable stayed bridge. The moment and shear for concrete are more than steel and prestressed deck girder cable stayed bridge. Svm of prestressed deck girder was more than steel and concrete deck girders and Torsion is also more in concrete deck bridges than steel and prestressed bridges. Hence, results concluded that steel girders are more efficient than prestressed and concrete deck girders for the same span and loading conditions which we analyze through sap software.

Puneet Garg and Rajesh Chaturvedi (2019) in the exploration paper, a cable-stayed connect for a longer span out length was examined on grounds of its conduct under static and vehicle stacking. Two unique sorts of primary model viz. The spine Model and Area Object Model are utilized for the examination of the link remained connect. Static examination and moving vehicle investigation have been done in which IRC Class A vehicle load was applied and their heap blend was considered for assessing the outcomes. M-35 evaluation of cement and Fe-415 evaluation of building up steel was utilized for individuals from the scaffold. Fe-345 evaluation steel for arch and ligaments are utilized as links. Versatile material properties of these materials were considered according to Indian Standard IS code.

Results expressed that shear power in the space object model was 10% not exactly the spine model. The shear power delivered in the space object model is at the closures of the bridge which is more worthy than that created at the middle in the spine model. The most extreme positive second about a level hub for the two models was around something similar and no much deviation is noticed except for the greatest negative second about an even hub for the space object model is less when contrasted with the spine model. The decrease in twisting second is practically 17% in the space object model and most extreme diversion in the space object model is relatively more than the spine model. The expanding level of avoidance in the space object model is over 4%. Consequently increment of avoidance in the space object model is more satisfactory.

Henceforth, the outcomes inferred that for the displaying of link remained connect, the design model that gives satisfactory outcomes is the Area Object model.

II. Literature Survey

Kumudbandhu Poddar and Dr. T. Rahman (2015) the exploration paper managed the computational investigation of the link remained connect, engineered overpass and two sorts of composite kind extension. It likewise presents another composite scaffold model where the long range deck is upheld by stay links and suspension links at various segments along the entire longitudinal segment of the range. Static and dynamic impacts of burdens are contemplated for the investigation of these extensions. Examination has been performed with the assistance of MIDAS CIVIL Software.
Results show the progressions come in execution and reaction of different individuals from the extension because of the adjustment of balancing style of superstructure.

Heemika Upadhyay and Pradeep Pandey (2018) the research paper parametric study of Superstructure Extradosed Bridge, Cable Stayed Bridge and Box Girder Bridge. Analysis was done for all the Bridges for Span of 50m, 100m, 150m, 200m, 250m and 300m. Forces were compared and estimation was done from bridge geometry and member forces. Seismic zone Zone-V [IS 1893:2002], wind zone as per IS 875 : 1987 and vehicle loading as per IRC AA-Wheeled Loading [As Per IRC] was considered in the loading combination.
Results stated that Girder Bridge is preferable for the span up to 50m, while extradosed bridge is preferable for the span of 50m to 300m.

Mycherla Chaitanya et.al (2018) the research paper stated that the main objective of structural analysis was to determine internal forces, stresses and deformation of structure under various load effects where Girder Bridge and Cable stayed bridge was modelled and comparative analysis was carried out for dynamically loading conditions and further comparison was made between the bridges for dead load, live load and combined load. The modelling and analysis of the two cases was done using SAP 2000.

Results stated that Girder Bridge was giving minimum deformations than Cable stayed Bridge. Cable stayed Bridge provided minimum Shear force than Girder Bridge at the piers. Deformation values are decreased by 47.72% for Girder Bridge compared to Cable stayed Bridge and Shear force values increased by 70% for Girder Bridge compared to Cable stayed Bridge.

Sagar Maske and M. M. Magdum (2017) the objective of the research paper was to investigate the effect of linear static loading on cable-stayed bridge with various cable arrangement and comparison was made on axial cable forces and the deflection of girders under the progressive collapse mechanism to identify the most stable cable arrangement against the progressive collapse.
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. The axial forces in the cables start increasing in the adjacent of the lost cables up to the location of the pylon, after the pylon, the axial forces in cables starts decreasing. The cables which are in the vicinity of the pylon have very less axial forces, so they have very less possibility of cable loss. FAN cable arrangement with A-type Pylon can be considered as the best possible combination against the progressive collapse.

Pampana Geetha Ramesh and Dr. P. V. Surya Prakash (2018) in the research paper four different bridge girders are considered namely Rectangular Single and Double cell Box Girder (RSBG & RDBG), Trapezoidal Single and Double cell Box Girder (TSBG & TDBG) of spans 20 m, 30 m , 40m and 50m. Linear Static and

Modal Analysis was performed on all the considered bridge girders using SAP2000 bridge wizard. IRC Class AA Tracked Loading system was considered for the analysis and comparative report on dynamic characteristics was generated for all the considered bridge girders using SAP2000.

Results stated that for all considered spans Rectangular Double cell Box Girder (RDBG) having maximum stiffness when compared to all other considered girders. For all considered spans due to dead and moving load Rectangular Double cell Box Girder (RDBG) having minimum deflection when compared to all other considered girders.

Joseph Vianny X et.al (2020) the research paper investigated the response of asymmetric Cable stayed bridge under all condition of loads mainly in moving loads and the comparative study was carry out between conventional and asymmetric cable bridges. The model of long span conventional and asymmetric Cable stayed bridge for two cable plane and four cable plane arrangements was prepared using SAP2000 software.

The results stated that maximum deck displacement of conventional cable bridge for two cable plane is 0.44 m and maximum deck displcament of asymmetric cable bridge is 0.59 m. The maximum deck shear force of conventional cable bridge for two cable plane is 2059.395 kN and maximum deck shear force of asymmetric cable bridge is 2078.805 kN. The maximum deck bending moment of conventional cable bridge for two cable plane is 3.41x105 kNm as a negative value and maximum deck bending moment of asymmetric cable bridge is 3.49x105 kNm as a negative value. Hence results concluded that the percentage of reinforcements in pylon for conventional and asymmetric cable bridge was changed. The change in percentage of reinforcemnt was due to reduced in number of cables. The numbers of cables are partially reduced in asymmetric cable bridge than conventional cable bridge. Therefore the weights of the cables are greatly reduced along the length of the bridge. Hence in order to construct asymmetric cable bridge instead of conventional cable bridge because of its behavior similar to conventional cable bridge and aesthetic improvisation.

P. Padmaja and V. Bhargavi (2019) in the research paper, three bridge models were considered box Girder Bridge, suspension bridge T girder bridge of lengths 100m, 120m and 140m consisting of two lane road network and the materials considered were M60 and Fe550 for concrete and steel and the structures modeled in CSIBRIDGE structural analysis and design software by considering various loads and load combinations such as dead load, live load, wind and seismic loads. The results were compared between displacements due to dead and live loads, shear and bending moments in the sections and support reactions.

Results stated that displacement due to dead load was higher than live load and seismic loads and Suspension bridges shown economic results when compared to box and T girder bridges for spans of range 100m, 120m and 140m.

M.C.Swami et.al (2018) the purpose of the research was to investigate the behaviour of extra-dosed bridge and compare the structural parameters with pre-stressed girder bridge. The extra-dosed bridge stability analysis was done by using STADD-PRO software. For The case study, Pre-stressed Girder Bridge was considered under constructed at Mundhwa, Pune.

The comparison stated that the load carrying capacity of extra-dosed bride was more than pre-stressed girder bridge and using stay cable in bridge structure play lead role in carrying vehicle load over the bridge deck. The superiority of extra-dosed bridge is much more than traditional bridge. The height of pylon (25-30m) and span length (100-120) was efficient as compare to pre-stressed girder bridge span length (30-40m). Deflection in girder is less as compare to pre-

stressed girder bridge as its life span was more. By using software, results concluded that the structural aspects of Extra-Dosed bridge are more effective than pre-stressed girder bridge.

Ismatullah Amiri and Shunichi Nakamura (2015) the research paper investigated static and seismic practices of a multi-range link that remained connect with three unique kinds of the tower, RC and steel/substantial mixture and steel tower. The steel/substantial crossover tower comprises a sandwich-type twofold steel box segment loaded up with concrete, the RC tower has a rectangular empty area, and the steel tower has a steel box segment. In the first place, static investigation was directed with various live burden designs. Size and material strength are first expected, which was approved by the cutoff states plan. Second, versatile and plastic seismic examination is directed for the three pinnacles utilizing fiber components. Three distinctive help conditions to associate the brace to the pinnacle were considered: portable, straight and bilinear spring associations. Medium-solid and super solid quakes as indicated by the Japanese Seismic Codes for Highway Bridges were embraced. Dynamic reactions of twisting and sectional powers were gotten and thought about. The restorability of the pinnacles was checked in the occasions of the seismic tremor.

Results presumed that each of the three sorts of the pinnacle were achievable for a multi-length link remained connect from static and seismic perspectives. In static investigation, RC tower had triple less uprooting and a few times bigger bowing second contrasted and steel and crossover towers. Steel tower had the biggest relocation however the most un-twisting second. In seismic investigation, bilinear spring (BLS) association is extremely viable in lessening the unique reaction of the multitude of pinnacles. The reaction of steel tower is especially diminished with BLS. At last, RC and crossover tower showed excellent static highlights and the energy disseminating conduct during a quake. Bilinear spring was successful in lessening the unique reaction of the multitude of pinnacles particularly the steel tower.

Kartikay Nayak and Hitesh Kodwani et.al (2019) the research paper investigated the performance of the Cable Stayed Bridge with four types of common arrangement of cables i.e., fan type arrangement, star arrangement, radial arrangement and harp arrangement with different arrangement of pylon “A” shape, “Y” shape, “H” shape. The comparison was made for the arrangement types with respect to shear force, bending moment, axial force, plate stresses and displacement. The analysis was done using STAAD Pro BEAVA software. The considered bridge had span of 500 m, deck width of 10 m and height of bridge was 70 m. The load considered were dead load, Imposed Loads and I.R.C. 70-R Load.

In H shape tower, results indicated that the harp arrangement is more efficient than harp, radial and star cable arrangement. In case of A shape tower, results indicated that the radial arrangement was more efficient than three other arrangement and in case of Y shape tower, the radial arrangement was more effective in comparison to other considered cable arrangements.

Umang A. Koyani and Kaushik C. Koradia (2016) the essential goal of the examination paper was to explore the static conduct of link remained spans and the impact of different boundary on link remained to connect. To do a similar investigation of link remained spans. The scaffold with a three-length, two planes link remained to connect with a case brace deck with stacking condition IRC class AA. The investigation was completed with the assistance of MIDAS CIVIL programming thinking about different boundaries as side range to principle length proportion, upper swagger stature, link framework, number of links per plane and link distance across.

The outcomes were dissected on greatest brace second, diversion, shear power, pivotal power in the support.

Results expressed that with the expansion inside to primary range proportion, most extreme second reduction up to as far as possible and afterwards increments. With the expansion in the quantity of links greatest second in the brace diminishes. Henceforth, results presumed that the greatest second in the brace was decreased for proportion 0.5 by 12.53% when contrasted with side range to principle length proportion 0.35. It was tracked down that the greatest second in the support diminishes with an expansion in the number of links. It diminishes by 47.74% for 20 links for each plane in contrast with 8 links for every plane. There was no critical change in the most extreme second in the support with an increment in cable firmness.

G.E Valdebenito et.al (2012) the research paper introduced a mathematical relative seismic investigation of the reaction of link remained spans for various stay link game plans with the principle objective to propose the best primary designs from a seismic perspective. Initially, eight symmetric cement hypothetical link remained connect models dependent on the notable Walther's Bridges were characterized thinking about varieties of the link plan, deck level and stay dividing. Nonlinear static investigation was performed for every one of the cases to process the fundamental mathematical nonlinearities associated with the general change in the scaffold calculation, nonlinear link droop impact and hub force bending moment connection in pinnacles and supports. The powerful portrayal of the models was done through a modular examination considering the changed firmness lattice acquired from the nonlinear static investigation. To analyze the greatest seismic reactions as an element of the fundamental varieties considered, a reaction range investigation was performed for every one of the designs considering solid ground movements as indicated by Eurocode 8.

The application of the response spectrum method shows that the best solution to reduce seismic displacements corresponds to fan pattern bridges with low deck level and short stay spacing. To reduce both internal forces and displacements, the harp pattern seems to be an efficient solution. The modal analysis shows that first vibration modes correspond to deck modes (longitudinal and transverse oscillations, depending on the bridge configuration). They are followed by cable or tower modes, depending on the geometric layout.

Manjiang Tan et.al (2015) the research paper presented structural performance of extra-large-span cable-stayed bridge under different section forms, with the engineering background of a 800m main-span cable-stayed bridge with steel truss girder, the cable-stayed bridge with steel box girder was designed according to the current bridge regulations when two bridges are designed in an ultimate state of the carrying capacity, so the maximum stress and minimum stress of the stress envelope diagram are substantially the same. A comprehensive comparison was presented to two types of bridge on the aspect of static force, natural vibration frequency, stability and economic performance.

After the comparison of natural vibration frequency and the comparison of deflection of auto live load, based on the vertical stiffness of the cable-stayed bridge with steel box girder designed by the same stress indicator, its lateral stiffness and torsional stiffness was smaller than that of the cable-stayed bridge with steel truss girder. Buckling analysis shows that the steel box girder was prone to overall bucking, while the steel truss girder is prone to local buckling. In the design, there was a need to pay more attention to overall buckling of the steel box girder and local

buckling of the steel truss girder of the cable bent tower due to too large pressure stress.

III. CONCLUSION

Understandings from the above writing survey recommend the utilization of limited component displaying of superstructure utilizing STAAD.pro to examine the extension structure considering the different forces which follow up on the structure to get them down to earth results.

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