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A Review on Collapse Behaviour of Cable Stayed Bridge

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Abstract- Cable stayed bridges have good stability, ultimate use of structural materials, aesthetic, tremendously low design and protection costs, and efficient structural traits. Therefore, this kind of bridges are becoming more and more famous and are generally preferred for lengthy span crossings as compared to suspension bridges. A cable-stayed bridge includes more than one tower with cables helping the bridge deck. In phrases of cable arrangements, the most not unusual forms of cable stayed bridges are fan, harp, and semi fan bridges. Because of their big length and nonlinear structural behaviour, the analysis of those kinds of bridges is greater complex than conventional bridges. However in these bridges, the cables are the principle supply of nonlinearity. An optimal design of a cable-stayed bridge with minimum cost with reaching power and serviceability necessities is a challenging project. Therefore a review on collapse behaviour of cable stayed bridge has been done.

Keywords- Collapse behaviour, cable stayed bridge, suspension bridge, conventional bridge.

I. INTRODUCTION

Cable stayed bridge works on the precept that deck of the bridge can be supported by way of the inclined individuals which might be stretched from the tower and acts as the tension members to carry the load coming over the bridge and transfer the load into the sub structure through the towers. The concept of cable stayed bridge was first posted by means of the french engineer navier inside the 12 months 1823. He has done lots of investigation regarding bridge deck supported by the wrought iron chains.

However wrought iron chains provide the further stiffness to the bridge deck. However navierwork continued as the paper work on account that no person applied it in instruction. In 1938 dischinger studied on cable stayed bridge wherein the outer a part of the bridge deck in longitudinal direction is attached by using the cable on the top of the tower analogous to navier's work. But he did a few adjustments inside the centre span of the bridge in which cables are connected between the towers and deck as the arrangement of suspension and cable stayed bridge. However it is noted that this system even not used for construction as this system had many structural behaviour discontinuity and even the discontinuity in the appearance of the bridge. So dischinger proposed a new system which can be known as because the pure cable stayed bridge system.

This system becomes adopted within the construction of the Stromsund Bridge as a result dischinger can be known as "the father of modern cable stayed bridge". In the 12 months 1955 creation of Stromsund Bridge finished consequently becoming the primary ever contemporary cable stayed bridge built. After Stromsund Bridge the subsequent current cable stayed bridge was built throughout the river rhine at dusseldorf and it turned into designed by the leonhardt. The bridge changed into named as Theodorheuss Bridge which changed into inaugurated aesthetically within the year 1957. These two bridges had been very stiff, appealing, reasonably-priced and comparatively easy to erect. The manner changed into open for in addition extensive and successful utility.

II. CABLE-STAYED BRIDGE

It is just like suspended bridge i.e. it has towers and a deck that is held by using cables, but its cables keep the deck through connecting it immediately to the towers as a substitute via suspender cables. It normally carries pedestrians, bicycles, cars, vans, and mild rail. It's far used in locations where spans want to be longer than cantilever bridge can gain (due to its weight), however the span is brief sufficient so a suspension bridge is not realistic there economically.

It has more than one tower also called pylons, through which cables guide the bridge deck. A one-of-a-kind feature is the cables which run immediately from the tower to the deck, generally forming a fan-like pattern or a chain of parallel strains. That is in evaluation to the modern-day suspension bridge, wherein the cables assisting the deck are suspended vertically from the principle cable, anchored at both ends of the bridge and running between the towers.

The cable-stayed bridge is most useful for spans longer than cantilever bridges and shorter than suspension bridges. However it is the range where cantilever bridges would hastily develop heavier if the span has been lengthened; at the same time as suspension bridge cabling

might not be more in economical aspect if the span had been shortened.

III. DESIGNS

Major designs with cable-stayed bridges are as follows:-

- First one is mono design; from its towers it uses a single cable. However it is not much used now days.
- Second one is harp also called parallel design, in this arrangement the cables are nearly parallel to each other so with parallelism it offers with the height of their attachment to the tower is directly proportional to the distance from the tower to their mounting on the deck.
- Within the fan layout, the cables all connect to or bypass over the top of the towers. The fan design is structurally advanced with a minimal second applied to the towers, however, for sensible reasons, the changed fan (also called the semi-fan) is desired, particularly where many cables are vital. Within the changed fan association, the cables terminate near to the top of the tower but are spaced from every different sufficiently to permit better termination, advanced environmental safety, and desirable get entry to person cables for protection.
- In the star layout, it is another rather rare design, the cables are spaced apart at the tower, like the harp layout, however connect to one point or a number of intently spaced points at the deck.

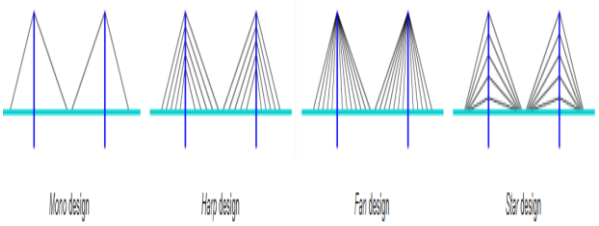

Fig 1. Different types of bridges.

In bridges, the cables are always the main source of nonlinearity. Hence a most efficient design of a cable-stayed bridge with minimum cost with attaining power and serviceability requirements is always a challenging work.

IV. CABLES

We can say that cables are wire-like arrangementsand it has no bending stiffness, hence they can carry only axial tension force. But even if it fully flexible against bending, then the shape of a cable is find out by the external forces that are acting on the cable.

Cables are commonly made from a couple of strands of cold-drawn high-strength steel wires twisted together. Normally, they have got strength 4 to five instances that of structural steel and practically inextensible underneath working loading situations. Given that cables bring only axial tension, complete capacity of the cable go-section can be applied in transferring forces. Therefore, cables are capable of convey the equal quantity of force with a much smaller cross-section compared to different structural systems.

However excessive strength -to-weight ratio makes cables very beneficial wherein light-weight systems are needed. Then again, a beam over a totally long span could require a very large (and deep) pass-section, and most of its ability may be utilized in sporting internal forces because of its personal weight. If we use cables replacing this beam or in mixture with a beam rather, a lighter shape may be required, who's self-weight will no longer add appreciably to load outcomes.

The number one drawback with cables is because of their flexible geometry. Because the loading on a cable machine modifications (as in the case of shifting hundreds on a bridge) there can also be huge change in the cable geometry, and sooner or later on forces appearing in the cable. Surprising forces may additionally destabilize a cable system, causing immoderate deformations. A designer must be very careful on this regard while designing a cable system, at the side of other issues which include, large forces at the anchors, massive oscillations, and so on.

V. LITERATURE REVIEW

Mycherla Chaitanya (2018) modelled Girder Bridge and Cable stayed bridge and investigate its performance underdynamic loading conditions.They consider dead load, live load and combined load for analysis purposes. At last author made comparative analysis with reference to internal forces, stresses and deformation of structure under various load effects.

KrunaliMavani (2017) performed the modelling of Cable Stayed Bridges with different pylon arrangement. Author realised that there is a need of examination ofdynamic response on the effect of shape of pylon.Also in there research work the bridge specifications and other performance parameters were kept constant and the only variation is he made changes in pylon shape with variation in height of the pylon for assessment purpose.

Pravin Malwiya (2017) did linear static and nonlinear static analysis using this software SAP2000. He also investigates cable tension, deck deflection, and base shear and made comparison for the study of behaviour of cable-stayed bridge.

Pawan Patidar and Sunil Harne (2017) checked the economic status of Plate Girder Bridge (Railway) on various spans keeping one parameter constant and other parameters varying.

Praveen kumar M et al (2017) calculated the displacements of the cable stayed bridge deck and pylonwith the traffic loads and seismic loads.Later this load is transferred to the foundationbelow the pylons. Author also selects the shape of the pylons and arrangement of cables carefully in such a way that they carryall the different types of loads.

Poornima and Bharath (2017) have done research work on analysis of cable stayed bridge with different cable configuration.Author considered the different shapes of pylon and estimates the most appropriate configuration of the cable and the tower by using FEM software. The pylons shape are "A" shape, "Y" shape, "H" shape and one axial layer of stays i.e. circular shape pylon.All pylon have different cross sectional area and shape. Author in his investigation take different cable configurations are mainly of four types which are based on the connection of cables to the deck and the tower.

Guru prasad D (2016) made assessment of two bridges and author find out the most economical and suitability of bridge for the six traffic lanes. He noticed that three plane cable configuration of cable stayed bridge is more economical with more width as compared to that of two plane cable configuration.

Shivanshi and Pinaki (2016) considered most common arrangements such as fan type, semi fan type and harp type cable. Author designed the bridge and analysed by using these cables arrangement on STAAD Pro software. After that author suggest theutmosteffective arrangement after analysis of all bridge models. The results indicated that the fan arrangement is more efficient then two other arrangement.

Savaliya (2015) performed the nonlinear static and modal time history analysis of cable-stayed suspension Hybrid Bridge. Author also validates stheir results. All the analysis was carried out in SAP2000 software. After analysis the time period of bridge for different mode shape is obtainable to associate the result of research paper with Sap 2000 software.

Deep Gupta et al (2016) in their research work author design a bridge at the intersection of NH-58 and Kaliyar road. Author said that it will eliminate completely traffic jamming and delay at the highway and also eliminate clashes between pedestrians and motor vehicles. In recent years, the interest in solar energy has risen due to environmental concern and also to support green building initiative of College, a solar power generation system also incorporates in the design.

Mohammed Yakub Ali &Gugulothu Swarna (2016) designed bridge because at aurora's engineering college where students and other people cross the road and heavyjams and also for the elimination of conflicts between pedestrians and motor vehicles. He found that vehicles in front of aurora are engineering college where students and other people cross the road, an average hourly traffic of more than 2500 vehicles. With this high average hourly traffic value, crossing the road by foot can not only be challenging, but can be dangerous too. With regard to this, he designs bridge at the intersection of roads in front of college building. This will minimize traffic jams and delay at the highway as well as eliminate engagements between pedestrians and motor vehicles.

Nikhil R (2017) provided a seismic analysis on cable stayed bridges.The modelling of bridge was done on SAP 2000 software and the effect non-linear time history analysis was done. The parameters which were considered for the comparison are Base shear, Mid-Span displacement and Tower Head displacement. At last he suggests that the fan type cable arrangement and H-shape pylon are found to be effective in earthquake prone areas.

Hussain Hararwala (2016)have done research work on analysis of cable stayed bridge with different cable configuration.Author considered the different shapes of pylon and estimates the most appropriate configuration of the cable and the tower by using FEM software. The pylons shape are "A" shape, "Y" shape, "H" shape and one axial layer of stays i.e. circular shape pylon.All pylon have different cross sectional area and shape. Author in his investigation take different cable configurations are mainly of four types which are based on the connection of cables to the deck and the tower.

Kumar and G. Phani Ram (2015) proposed a design of bridge having road at the top and railway track at lower level. This proposed system is for between Mahanadu road of Sithanagaram and P.N.Bus station, Vijayawada. Author considered it is constructed by steel truss because it has to carry two railway tracks at lower level and roadway traffic of three lane at upper level. Also author matches the span length with that of existing Railway Bridge. Analyses have been done using STAAD Pro. Author design the structural members of the bridge according to Indian railway standard code and Indian roads congress code.

Aye Nyein Thu (2014) modelled a long span cable-stayed bridge having H-shaped tower 2400 ft by using SAP 2000 software. Author deliver the results with respect to cable tension forces, axial forces, vertical shear and horizontal shear, vertical moment and horizontal moment, torsion, truss girder displacement, support reactions and so on. Necessary design and checking are done according to the specifications of AASHTO.

VI. CONCLUSION

Bridges is the lifeline and important structure for any nation. Cable-stayed bridges are one of the most popular long-span bridge types due to its structural efficiency and

pleasing aesthetics. Stays of cable-stayed bridges are critical structural elements which are subjected to corrosion, abrasion, wind, vehicle impact and malicious actions and these extreme loading scenarios may lead to severe damage and loss of cable which demands the progressive collapse analysis. Progressive collapse is a continuous spread and enlargement of initial local failure of structures, which is characterized by a disproportion between the initial failure and its resulting widespread collapse.

Several bridge accidents occurred in recent years have demonstrated that the consequences of progressive collapse may be unpredictable and serious. It has been found that the ability to resist the collapse is determined not only by structural load-bearing capacity, but also by other structural attributes. Although great efforts have been contributed to the progressive collapse of building structures, comparably small attention have been paid in the same problem about bridge structures.

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