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REVIEW STUDY ON THE ANALYSIS AND DESIGN OF PRESTRESSED CONCRETE BRIDGES.

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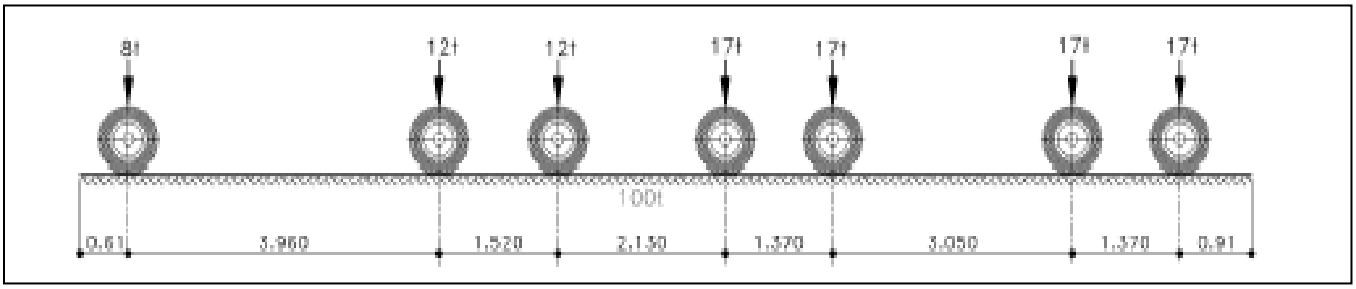
Abstract— Nowadays bridges are being constructed either of ordinary reinforced concrete or of prestressed concrete having longitudinal girders and transverse cross girders. The method that is used for the dynamic analysis of such bridges is FINITE ELEMENT METHOD and for the implementation we use the commercial software (SAP 2000N, CSI BRIDGE 2017). The bridges that we discussed was subjected to the several dynamic loads such as vehicular live load, seismic load and also the static loads such as deck slab load, footpath and crash barrier loads. The vehicular load distribution in the girder is a very complex phenomenon which was calculated by using Morice-Little load distribution method. For the study and the comparison purposes we vary the geometry and the number of longitudinal girders of the superstructure and the bending moment, shear force, and deflection was checked and compared.

Keywords— Finite Element Method, Load distribution, IRC, CSI BRIDGE 2017, Cross Girder.

I. INTRODUCTION

Due to efficient dissemination of congested traffic, economic considerations, and aesthetic desirability PSC girder bridges have become increasingly popular nowadays in modern highway systems. The bridge is subjected to the static as well as the dynamic loads. One of the aspects to be considered while assessing the dynamic response of bridges subjected to live loads is the problem of vibration. The passage of any load over a bridge causes the span to deflect from the equilibrium position, causing a series of oscillations. This phenomenon continues till either the structure comes back to its equilibrium position or is again activated by the passage of another load. Therefore, "dynamic behaviour of bridge deck" needs to be studied. According to the IRC:6-2017 the design live load shall consist of standard wheeled or tracked vehicles the vehicles that we consider are 70R (WHEELED VEHICLE), 70R (TRACKED) VEHICLE, Class 'A' Train of Vehicles, Class B Train of Vehicles, and the Special Multi-Axle Hydraulic Trailer Vehicle. After deciding the number of lanes which depends upon the carriageway width, we use the different combinations of the vehicle and the critical combination is used for the load distribution.

Fig.1 CLASS 70R (WHEELED)- LONGITUDINAL POSITION [10]



Calculation of the load distribution in the girders is the complex task so we use the methods such as Courbon's method, Hendry-Jaegar method, Morice and little version of Guyon and Massonnet method. After the load distribution, we can design the girders by using the Indian Road Congress publishes codes and specifications for the design. Usually, the concrete of grade M40 is used for post-tensioned prestressed girders. In the starting, they assume the design dimensions based on their experience. The design involves the calculation of the section properties, dead load moments, live load moments, magnitude and location of the prestressing force, the profile of the tendons, shear stresses at different sections finally the design of end block and cross beams.

II. LITERATURE REVIEW

Paval (2016) aimed for the analysis of PSC box girder type bridge. The researcher performed the analysis to study how the variations in basic geometry of the superstructure and the member properties affect the equilibrium of the structure. Time history analysis with the different boundary conditions has been used to check its effect on the structure. The live load or vehicular load that is assumed for the deck was the combination of three moving vehicle loads moving in the two lanes. A finite element method-based software SAP 2000N has been used to model the structure and generate different

loads. For the modelling of the superstructure in the software different types of elements (Beam Element, Frame element, Plate element, Shell element, Solid element) based on their principle structural actions were used to get the correct results. The researcher compared the different load-deformation curves and also stability was compared by varying the overhang part and by increasing the thickness of joints.

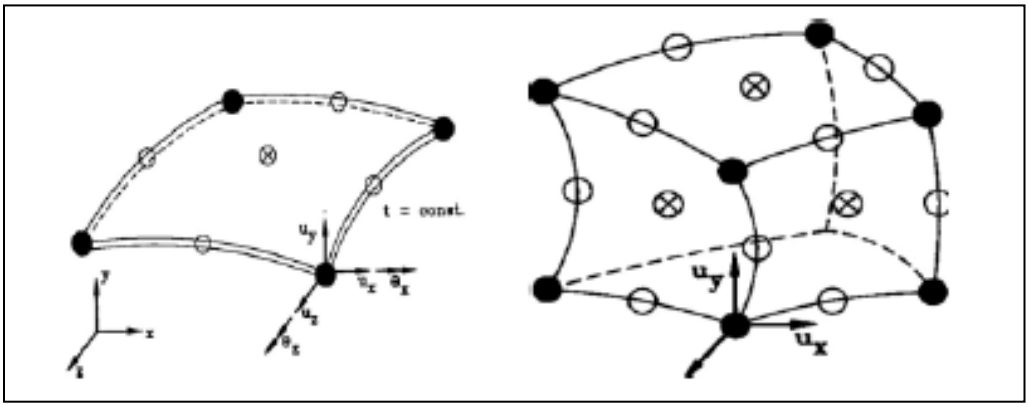


Fig.2 Shell and Solid Elements [1]

Madda et al. (2013) used the T- beam bridge superstructure which is subjected to the dynamic loading. For the comparison, they used the various span of bridges by varying no. of longitudinal girders. The dynamic analysis was carried out for bridge, having two lanes and four lanes of spans 15m, 20m, 25m, 30m, 35m. The bridge deck was subjected to the IRC class A loading.
Dynamic parameters such as natural frequency and the time period of the structure were obtained with the help of SAP2000 software. They did the dynamic analysis by using the Response Spectrum Method and used the outputs of the computer model to check the resonance criteria. They considered a frequency range between 3-5 Hz for the vehicles and examined that 25m and 30m bridge was subjected to the vibration related problems.

Peera, et al. (2014). They studied the design of prestressed girder elements by assuming the overall depth of girder as 75-85mm for every meter of span and computed the dead load and live load moments. They also discussed the available load distribution methods like Pieguard's method, Hendry-Jaegar method but mainly focused on the Morice-Little method of load distribution in girders and calculated the load distribution on to the longitudinal and cross girders by this method only.

Naik, et al. (2015). In their work they analysed and designed a PSC box girder type bridge by using two different types of sheathing that is HDPE and corrugated Bright metal pipes. Superstructure having a total length of 35.0m and overall width of 16.6m with 4 lanes loading of 70R wheeled vehicle was analysed by using the FEM based software called CSI bridge 2017 and later designed by using their self-developed spreadsheets. The variation of bending moment, shear force and deflection were checked and after assuming all the losses like elastic shortening, Creep, shrinkage, friction and wobble loss it was concluded that HDPE pipes are found to be more viable than corrugated bright metal pipes since the loss of pre-stress is much less in case of HDPE pipes.

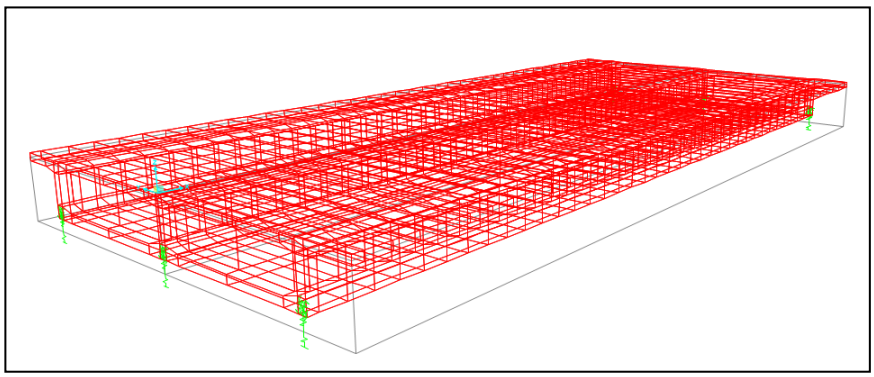


Fig.3 Frame element of Multi cell box girder [4]

Tande, et al. (2014) The researcher used the nonlinear analysis because it deals with the elastic range of the bridge and gives the exact parameters whereas the linear analysis deals with an elastic range of the structure where displacement and the forces are not exact and in this there is a chance of overestimation of the design. The CSI Bridge 2016 was used for the linear and nonlinear pushover analysis. The two-span superstructure having 20m span and 7.5m of carriageway width was used. The values obtained are base shear and displacement for the linear and nonlinear cases and further used to plot

the demand and capacity spectrum curves. The effective time period calculated by manual calculation was 1.1 seconds which was close to the software calculated time period of 1.35 seconds by linear static analysis.

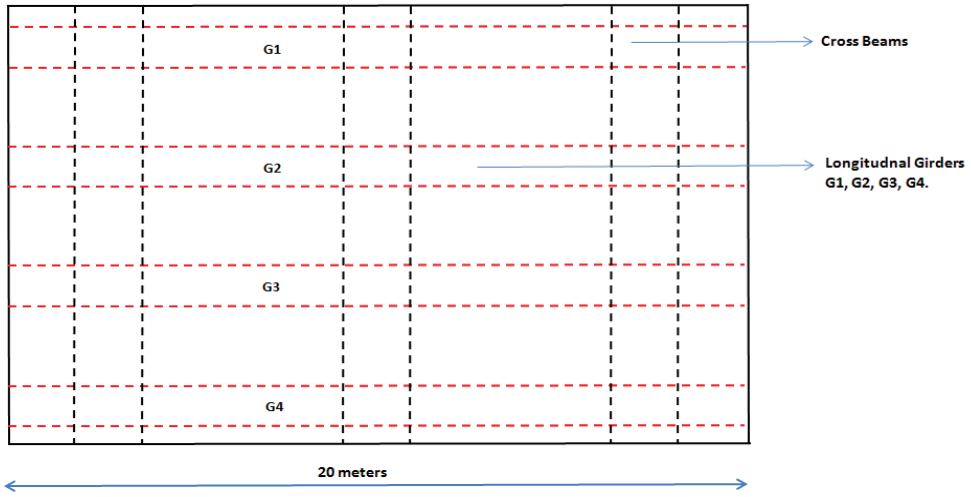


Fig.4 Plan view showing arrangement of cross beam and longitudinal girders [5]

III. CONCLUSIONS

Following conclusion have been made from the above literature review:

1. The prestressed concrete bridges (t-girder, box girder) are subjected to the static loads and dynamic loads and can be analyzed by using the FEM based software.

2. The linear and nonlinear analysis can be done by using the software and it is seen that the deflection changes up to 30-40% periodically. And also, it is clear that we get more accurate results by using non-linear analysis than linear analysis.

3. The vehicle vibration is also an important factor that affects the serviceability of the bridge and can also leads to the total collapse if the resonance happens.

4. Live load distribution in the girder needs to be calculated by using Pieguard's method, Hendry- Jaegar method, and Morice and little method.

5. The design has also been checked for Ultimate moment and Ultimate shear cases separately as per IRC:112-2011 guidelines and the design is found to be safe in all aspects.

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