

A Review on Design and Analysis of Prestressed Concrete Bridges

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ABSTRACT: A bridge is a structure providing passage over an obstacle without closing the way beneath. The required passage may be for a road, a railway, pedestrians, a canal or a pipeline. Now a days, bridge deck section of Box shapes are used widely. Most of the bridges constructed are of Box girders. Method of post-tensioning in the construction of bridges is very common today. Most of the bridges are of prestressed types (mostly post-tensioned). In this work an attempt for a comparative study for different types of prestressed bridges are by changing the different parameters of the bridge is done.

KEYWORDS: Prestressing, Box-girders, Cable profile, moving load.

I. INTRODUCTION

Bridge construction today has achieved a worldwide level of importance. Bridges are the key elements in any road network and use of pre-stress girder type bridges gaining popularity in bridge engineering fraternity because of its better stability, serviceability, economy, durability, aesthetic appearance and structural efficiency. There are semi-integral, integral and simply supported bridges.

Normally the common support conditions used in the bridges are simply supported which has expansion joints on end of each spans and for the integral type there will not be any expansion joints and are connected by an integral diaphragm. For the semi integral type the expansion joints are provided only in the abutments. Due to the expansion joints in the bridges there will be an increase in the deflection while comparing the integral bridge. The study is based on changing the parameters on the substructure and comparing the moments, shear force and other results from it.

II. LITERATURE REVIEW

Shubham Landge et al (2018), has performed an analytical study in which prestressed I girder is analysed using STAAD Pro for a bridge of span 28m and total width of 10.25 m. Finite 3-D modelling is done for the deck slab and bending moments, shear forces are calculated from Pagenaud's curve and Courbon's method is used for the design of sections. The analysis of the structure resulted deflections and stresses within permissible limits compared with the ordinary deck slab configuration. It was concluded that, use of precast PSC girders provides convenient maintenance.

Prakash and Bhavikatti (2017) proposed a method to develop an economical section for PSC I-Girder bridges. In this objective a precast PSC I-Girder bridge of span 30 m and road width of 7.5 m is analysed and designed using sequential linear programming. It was concluded that, cost ratio between 50-100, it does not influence the design variables and proper grade of concrete was recommended for the sections. Also, from the analysis results, width to depth ratio of different span conditions was recommended.

Phani Kumar and Adithya (2016) has conducted analysis of box girder bridge and designed the sections as per IRC 112 specifications. The method of analysis of PSC box girder bridge was explained for a span of 30m and carriageway width of 7.5m using SAP 2000. various span to depth ratios were adopted and results showed that deflections, stresses are in safe permissible limits. Also, it was concluded that, when the depth of girder decreases, the number of prestressing strands and prestressing force was decreased. Since the prestressing force is decreased, more strength of concrete is utilized and governing the serviceability criteria.

Shreedhar and Rashmi (2013) have conducted an analytical study stating that, among the various methods available for analysing the bridge deck, Finite element method and grillage analogy are mostly used methods. In this article, both the methods were briefly explained. It was concluded that, FEM analysis give lesser value of bending

moments which results in economic sections but grillage analogy is the simpler method of analysis for a bridge deck slab.

Siva Sankara (2007) has reported a method of analysing a deck slab using Grillage analogy. This method is suitable for bridge decks having complicated features like skew, edge stiffening and isolated supports. A simply supported deck with box girders is analysed using STAAD Pro software by grillage analogy method. Equations were formulated to find the flexural and torsional stiffness of the grillage beams of the slab. This method provides better design of reinforcements resulting in the most economical sections. It was concluded that, moments in the slab increases with increase in the span.

Han and Hwan (2003) have performed study to achieve more economical PSC girders. In this article it has been stated that, Prestressed concrete (PSC) I-type girders are generally restricted for short and medium span bridges and girder depths are increased for long span bridges. So, in order to reduce the girder depth, for any span given, method of multistage prestressing for different loading cases is introduced. From the experimental results and studies, it was concluded that, the developed girders have shown the satisfactory behaviour for the strength and ductility and it can be used as an economical alternative to other types of PSC girders for long-span bridges.

Khaled and John (2002), studied various literature articles for analysis of straight and curved box girder bridges for different cross sections. This study also deals with the elastic analysis and elastic response of box girders. Calculation of longitudinal and transverse bending moment was done as per grillage analogy and results were compared with that of 3-D analysis using finite strip method. It was concluded that, finite element method is the most suitable, comprehensive method for static and dynamic analysis.

C&CA/CIRIA Recommendations (1973) provides standard procedure to perform analysis and design using grillage model. It provides appropriate layout of the grillage beams which represents the actual structure and methods to calculate the structural parameters. It defines the grillage geometry and parameter evaluation for different type of deck structures like grid structures (I beam deck and inverted T beam deck), box beam structures, slab structures and pseudo slab structures. It provides equations for calculating the torsional inertia for different beam conditions and different grillage layouts are suggested for typical forms of construction.

Md tauheed reyaz, et al (2018), This work discusses the comparative analysis of 2 standards specifically AASHTO and IRC followed in construction of bridge superstructures subjected to load of serious vehicles for 2 sorts of examples specifically, beam with single cell and 4 cell and comparison has been given.. The look customary of Bharat, IRC was followed in style of Box girder superstructures subjected to IRC category AA loading in load combination, AASHTO codes have taken additional issue of safety than IRC. Analysis is disbursed victimization the Csi Bridge. The parameters thought-about to gift the responses of beam bridges specifically, longitudinal stresses at the highest and bottom, shear, torsion, moment, deflection and first harmonic of 2 sorts of beam bridges. Shear, torsion, moment impact on beam owing to IRC loading is additional as compared to AASHTO loading, i.e., vehicle load thought in IRC as compared to AASHTO It means that thought of impact think about AASHTO is additional compared to IRC. Finally supported this comparative study it's clear that AASHTO code is additional economical than IRC..

Prakash D. Mantur, et al (2017), Bridge is a structure providing passage over an obstacle without closing the way beneath. Bridges are mainly categorized based how the forces are distributed through the structure, purpose and material availability etc. PSC bridges are adopted for spans between 20m to 40m. The various parameters like selection of design vehicle, position of vehicle and load combination is decided as per IRC:6-2014, deck slab is designed with reference to IRC:21-2000 and the girder is designed with reference to IRC:112-2011, IS:6006- 1983, IS:12468 & IS:1343-2012. Parabolic tendon profile is adopted. A computer program is developed in C-programming language to design the deck slab and PSC I-girder. Optimization is carried out by using improved move limit method of sequential linear programming. For any cost ratio between 50-100, Cost ratio does not influence much on the design variables. It is recommended to use M30 or M40 grade concrete for 20m to 30m span & M40 for 30m to 40m span, and M50 or M60 for 40m to 50m span.

Shubham Landge, et al (2018), Bridge construction today has achieved a worldwide level of importance. Bridges are the key elements in any road network and use of pre-stress girder type bridges gaining popularity in bridge engineering fraternity because of its better stability, serviceability, economy, aesthetic appearance and structural efficiency. I-beam bridges are one of the most commonly used types of bridge and it is necessary to constantly study, update analysis techniques and design methodology. Structurally they are simple to construct. Hence they are preferred over other types of bridges when it comes to connecting between short distances. This present paper describes the analysis and design of longitudinal girder bridge. In this case analysis is done using STAAD- Pro software. To obtain

even better working results the precast pre-stressed concrete girder configuration deck slab can be subjected to pre/post tensioning. The pre-stressing force can be applied more easily and calculation of required jacking force is also simple. This however is not the case in ordinary configuration as it is required to come up with a composite design in case prestressing is considered in the design/construction phase.

Yuqian Zhao et al (2016), Due to their graceful cross-section form, favourable static and dynamic property, light self-weight and short construction period, prestressed concrete continuous box girders have been widely applied in high-speed railway bridges. In this paper, the prestressed concrete single-box single-chamber equal-height continuous box girder was taken as the research object. Based on the spatial separation finite element model of box girder, the overall deformation and key cross-section stress condition of the box girder were analyzed, with the deformation behavior and key cross-section stress state of box girder under prestress obtained. The stress state of the separation prestressed concrete box girder is analyzed using ANSYS. A finite element model is constructed, with the simulation of prestress in solid elements achieved using the equivalent load method and overall cooling method. The box girder overall deformation condition and control cross-section stress state under prestress are obtained. The girder stress and deformation meet the requirements of design regulation. The load-displacement curves also can reflect the stress state features of prestressed concrete box girders during the whole process from loading to fracturing. By combining information including the stress state of key cross-sections, overall deformation conditions, and engineering practice, the stress monitor control cross-sections are selected.

Phani Kumar.Ch et al (2016), Bridge construction today has achieved a worldwide level of importance. In this thesis analysis and design of prestressed concrete bridges (Deck Slab, T-Girder and Box Girder) are carried out using IRC: 112-2011. The unified concrete code (IRC:112) published by the Indian Road Congress in November 2011 combining the code for reinforced concrete and prestressed concrete structures represents a new generation code, which is significantly different as compared to previous codes (i.e. IRC:21 for RCC structures and IRC:18 for PSC structures). IRC: 21 and IRC: 18 standards withdrawn, with the publication of IRC: 112. As the depth of box girder decreases, the prestressing force decreases and no of cables decreases. Because of prestressing, more strength of concrete is utilized and also well governs serviceability.

From this study it is concluded that many type of analysis has be done on the pretressed concrete bridges for different section, different cable profile and also using different methods.

III.CONCLUSION

The literature deals with,

- [1] The comparative study of different sections like I-girder, box-girder, etc. for different sections and cable profile. They have also used different materials for prestressing for construction. They have used different codes for the analysis and also different softwares like CSI Bridge, STADD Pro.
- [2] They have done the analysis of the bridge using different models like creating a 3D finite element model using different software and design has been done.
- [3] Behavioural strength, ductility and other properties has also been checked or the economical section and for an alternative section.
- [4] By changing the depth of the section, point of stressing an analysis has been done to find the economical mode of construction.

This review paper deals with the different construction methods, different cable profiles and how to obtain the economical section for a prestressed concrete bridge.

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