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Review of Design Procedure for Box Girder Bridges

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Abstract: This research focuses on the work of study and configuration of bridge deck and beam on software. A standard bridge model of a specific span and carriageway width is used, and the bridge is subjected to various IRC loadings such as IRC Class AA, IRC Class 70R tracked loading, and so on, in order to achieve the optimum bending moment and shear power. The research is used to analyse and comprehend the action of the bridge deck under various loading conditions, as well as to compare the results. New study on straight and curved box girder bridges has looked at the formulation of these complex structural systems to help understand their behaviour. The box girder bridge was also evaluated using a finite element method by the researchers.
Keywords: Box Bridge, Girder, Ansys FEM analysis, Loading, Literatures.

I. INTRODUCTION

Bridge is an urban and rural life line of the road network. Innovative cost-efficient structural systems, including T-Beam Girder System and Box Girder Bridge System, replaced the traditional bridge with quick technical development. In spite of the challenging design process and demanding function on form, box girders, because of their structural performance, increased reliability, serviceability, construction economics and artistic appearance in road and bridge structures, have gains wide recognition. The continued widening of the highway infrastructure worldwide is primarily the product of a substantial rise in traffic, population and extensive development in developed areas and metropolitan areas.

This extension has resulted in many improvements in bridge usage and growth. The bridge form is related to the optimum utility of materials and building methods for unique applications. With the growth of span, dead load is a rising factor. This occurs in the form of a box girder or of cellular systems, which may or may not be ignored, in order to minimise the deadload redundant material that is unused at its maximum potential.

The size length of piers for the box bridge girder is smaller than that for the T-beam Girder bridge, which implies a relatively small number of piers of the same depth of a gorge. When two web plates are connected with a standard flange at the top and at the bottom, a box girder is formed.

The shut cell has a much higher torsional rigidity, strength, which is the usual explanation for preferring a box girder structure than an open section. In houses, box girders (box columns are frequently used, but they are axially filled and not loaded in tilt) are seldom used.

It can be used under special situations, for example if the loads are eccentrically brought through the axis of the beam. From the point of view of load transport, box girders can be uniformly extended to the ignorance as to whether bending times are positive or negative and torsional rigidity.

II. BOX GIRDER BRIDGE DECK

A box girder bridge is a bridge with hollow box-shaped girders as the main radiators. The wrap typically consists of pre-stressed cement, structural steel or stainless steel and hybrid reinforced concrete. It is typically rectangular or trapezoidal in the cross section. Box girder bridges for highway flyovers and modern light-track rail systems are usually used. The box girder may also be part of the portal frame bridges, arch bridges, wires, etc.

Box girder panels are cast-in-service units which are designed so that direct, skewed and curved bridges of different types can be found in all desired alignment in the plan. The box girder is particularly appropriate for bridges with substantial curvature, due to its high torsional strength. Both static and static multi-stage lines can be studied by SAP2000. Certain types of load patterns are multi-step, since several different spatial load patterns are actually implemented. These include the form of load patterns for vehicles, live and wave. Calculating modes of vibration using Ritz or Eigen vectors, response continuum analysis and time-host analytics of both linear and nonlinear behaviour provide SAP2000.dynamic analysis capabilities.

Figure 1: Box Girder Bridge

III. COMPUTER MODELING USING ANSYS

The full bridge and then the ANSYS workbench model are a numerical way that can solve problems, which would otherwise be impossible to do. The numerical analyses were done using commercial ANSYS 14.5 tools. In the finite element analysis of civil science, modelling a dynamic behaviour of reinforced concrete, both non homogeneous and anisotropic. Where a special eight nodded isoperimetric solid element is formed, Solid 65 is. Solid 65. It models the nonlinear reaction of delicate materials and is based on a model of the triaxial comportement of concrete. Solid 65 permits the inclusion within each element of four distinct materials; one matrix material (e.g. concrete) and up to three separate reinforcement materials.

In addition to integrating plastic and creep actions the concrete material is able to break and crush the directional incorporation. The reinforcement (with creep and plasticity as well) has uniaxial rigidity. In the current analysis, ANSYS uses Solid 65 elements to achieve the ultimate ability of load transport and the comportment of the concrete bridge in duty load.

IV. LOADING REPRESENTATION

The simulated wheel load of the IRC Class A wheeled vehicle as described in IRC 6−2000 was used in nonlinear analysises of the bridge model. For a travelling load or vehicle, special methodology is used. This approach uses the temporary analysis of the ANSYS solution, putting loads at a time on a certain group of nodes. The programme, which splits axle weights by half, adds double-wheel loads to either side of the middle line of drive, proportional to half the width of the car. IRC Vehicle Train Type A is shown in Figure 1. For a fatigue safety assessment of current concrete bridges, accumulation of fatigue damage incurred by vehicles going by is important. Tiredness may also be manifested over a period of years. The total number of standard axles in design traffic is called.

According to IRC 37 (2001), the cumulation of regular axes is determined. The above was taken into account.

A. For the calculation of pressure according to the IRC – Class A piling, the axle loading is used.
B. In order to increase the number of cycles per engine, one cycle for each truck would be accepted.
C. The ADTT calculation was approved under 5228 trucks / day for regular day by day truck traffic.
D. For road transport in rural areas, the growth factor is agreed as 6-7,5 percent.

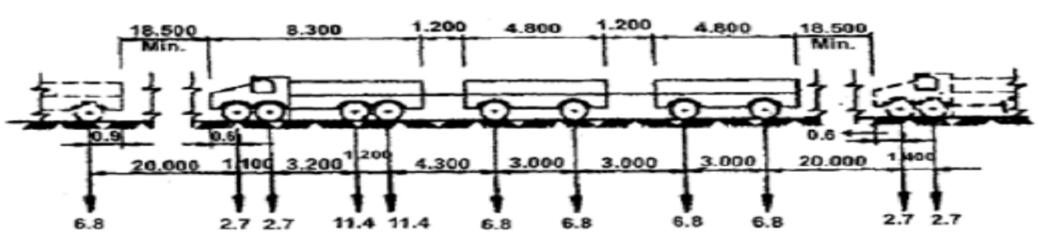

Figure 1: IRC-Class A Train of vehicle (Habeeba et. Al. 2015)

V. LITERATURE REVIEW

Sonia et. al. (2020) The paper examines four cross-sections of the same load. In designing the steel box Girder Bridge, which is subject to IRC class AA loading, IRC is used for the construction norm of India. The optimised cross section is analysed by four separate models. As a consequence, the bending time and tension effects can differ for multiple cross-sections. Also the most economical cross-section is the cross-section with a lower value bending time. This indicates that while loading and service requirements were held the same for all four main versions of the different cross section, the steel box girder is more expensive than the single cell box girder. Tekla structures are used to analyse and build.

Bharat Jeswani et. al.(2020) In this review, the staff pro programme can analyse the T-beam bridge. A T-beam bridge is a composite structure consisting of plate, longitudinal girder and cross girder in concrete framework. This research examines the study and creation of the software bridge deck and beam. Differs in IRC loads, such as IRC Class AA, IRC Class 70R loading etc. are used to achieve a maximal torquing moment and shear energy, in a given bridge model of the specific span and tracking distance. From the study, the action of the bridge deck with various loading conditions is observed and compared.

Ravikant et. al. (2019) The present research considers the construction of both longitudinal girders and cross girders for bridge girders. The span of the bridge is 25 m where girders are built. The scale is 2000x500 mm for longitudinal girders and 1500x250 mm for cross-girders. There are three vertical girders with a spacing of 2600 mm c / c and cross girders with a spacing of 5000 mm c / c are considered. Using STAAD Pro tools, the construction of girders is carried out. Three equivalent versions are prepared in the STAAD pro in this bridge girder modelling analysis Euro codes are taken from different loadings. The minimum value of deflection and bending time is acquired by the bridge girder design using IRC codes.

Najla yas et. al. (2018) This analysis focuses on the Composite Box Girder 's responses. It is a comparative analysis of Rectangular and Trapezoidal Composite Box Girder results. Concrete and Loading Research Properties are as per Irc 18-2000 and Irc 21-2000. A 70r class load was given. Responses were contrasted between deformation, equal stress, normal stress, shear stress, and moment response. After the review of the data, selection of a better segment between rectangular and trapezoidal was performed. In this research, a percentage variance of the best one is also given. We may infer that deformation is 7 percent less in trapezoidal compared to rectangular, moment reaction is 35 percent less in trapezoidal compared to rectangular, natural stress is 55 percent less in trapezoidal compared to rectangular. After performance review of composite box girder Compared with rectangular, comparable stress is 40 percent less in Trapezoidal. Compared to rectangular, Shear Stress is 1 degree higher in Trapezoidal.

Harish et. al. (2017) Following superstructures subjected to heavy vehicle loading using the 2015 version of CSI Bridge software, the Box girder bridge analysis under IRC loading of two distinct types Single1cell and Multi cell with IRC standard codes are discussed to understand its structural behaviour and determine which standard code is better when comparing the findings in evaluating the economic segment in all aspects f The analysis takes single and multi-cell box girder bridges into consideration. Under IRC class AA, models were exposed to loading conditions and subsequent bending moments and object response stress values were compared. Bent moment and strain effects are the same for self-weight and superimposed weight, but those are totally different for moving load thinking, as a result of IRC codes having considerable loading style.

Jayakrishnan et. al. (2017) This thesis summarised the investigate effort on the analysis of seismic activity of composite bridges without cross girders with ANSYS. In the fields of aerospace, civil engineering and manufacturing, composite structures have many useful uses. The seismic activity of composite bridges is analysed using the system of reaction range. The structure 's response based on the system's geometry, material, configuration, response spectrum chosen, and construction information. In this article, the ANSYS Workbench finite element instrument is utilized for the study of composite bridge seismic behaviour. In both bridges, the equivalent stresses are found to be below the allowable limit.

Arshad et. al. (2017) In this analysis, an effort is made to examine a concrete box girder section with and without pre-stress power. In the results of this comparative analysis, pre-stress force is considered to be an important parameter for fluctuation. ASBI has followed the concrete box girder portion and the considered loading class is CLASS A from IRC 006-2014. In the concrete box girder section, the pre- stress force caused is determined using the method of load balancing. For this analysis, a Finite Element model was built using the ANSYS software kit. For parameters like deflection, stress under the impact of moving vehicle load, this model is then evaluated, with and without pre-stress force. The basis devised for this analysis is to compare all the findings to provide the best performance for a concrete box girder section. The nature of deflection found without prestress is 0.182 mm sagging, whereas 12.9 mm hogging is the nature of deflection with prestress power. The negative deflection was due to the prestress force caused during its service life, which would be resolved. It is inferred from manual measurements and the comparison of software findings that the stresses in the top and bottom fibre do not surpass the allowable maximum in the case of prestressing power.

B. Paval et. al. (2016) The aim of this research is to construct a pre-stressed concrete box girder bridge and to explain the linear, non-linear and time history study of this concrete spread box girder superstructure when the traffic impact is simulated by different loads. In the base case, the prestressed concrete box girder bridge superstructure studied consists of two single-span concrete box girders. Using the structural analysis programme SAP2000v15, the behaviour of the bridge superstructure is analysed. For each variation in the properties of the bridge, load deformation curves are plotted and the ultimate load handling capacities are compared to those of the original bridge configuration. Owing to the various loading, the deflected form of the bridge model indicates that the value of deflection rises slightly and different time span periods are also increased. The result obtained by each analytical approach indicates strong consensus, it is noted.

Patil M.B. et. al. (2016) According to numerous research papers, composite bridge has been found to provide optimum strength relative to other bridges, and by using different tools for composite bridge construction for girder, the design and study of different girders for steel and concrete. In this research, efforts will be made to validate the girder analysis using SAP2000 tools. Therefore, three girders that can be efficient for composite bridges are described in this project. In compliance with the load carrying capacity, each segment has its own meaning. Due to this I section, the I section has single we band double flanges that helps to counteract the bending moment and bending pressures. Two webs and two flanges make the box section tougher against torsion, but not so much in flexure. Whereas only one flange and web is in the T segment, leading to low torsion resistance.

R B Khadiranaikar et. al. (2016) Two-cell, three-cell and four-cell rectangular box girder bridge study is performed. Using SAP 2000 tools, the simulation and research is completed. The reactions such as the moment of bending, shear force and deflection are contrasted. Results show that, relative to three and four-cell box girder bridges, the two-cell box girder is successful. The rest of the analysis focuses only on varying the span and depth of the box girder bridge. The influence of the number of cells is taken into account in the present analysis. It takes into account a clearly assisted single-span four-cell box girder bridge with a span to depth ratio of 25. The self-weight of the box girder bridge increases with increasing the number of cells due to which the deflection is raised by 11% and 5% in four and three-cell box girder compared to two-cell box girder for combined load event. For the two-cell box girder, the longitudinal stresses at the bottom are raised by 67% and 28% relative to the four-cell and three-cell box girder bridge. This indicates that there is more compression on the two-cell box girder bridge.

Jefeena Sali et. al. (2016) In this investigation, a comparative review has been performed of straight and curved girder box bridges with a trapezoidal cross-section. The analysis is conducted under dead charge, superposed dead load, live load and pre-stressed IRC Class A tracked vehicle. This paper concentrates on parametric analysis by maintaining the constant range, sectional structure, and material properties of box girders of distinct curvature radius. The parametrical studies on curved box girders help to assess the effect of differences in the curvature radius on the behaviour of the box girders. This analysis will allow the engineers of bridge bridges with straight and curved panel girder bridges to understand better. For bridge designer, the results of this study will be helpful.

Bobade et. al. (2016) In the present analysis, for IRC loadings, the results of adjusting the skew angle with the standard bridge are carried out. The longitudinal box girders can be made of steel or concrete in the direction of the roadway and joined across their tops and bottoms by a thin continuous structural stab. In current research, the single span concrete bridge deck backed by Simple is introduced. Several variables, like natural or manmade barriers, complex intersections, space limits, or mountainous terrain, can result in skew in a bridge. Whenever a bridge construction has a certain skew angle, the bridge must be evaluated for different IRC loading types and for the mixture of loads. It can be inferred from several previous experiments that the deflection, bending moment, shear force, torsional moment and support reaction differ with regard to the angle of skew.

Shah et. al. (2016) Parametric analysis of curved span PSC box girder bridges was conducted. For economic and architectural purposes, the building of curved span girder bridges at interchanges of the modern highway system has become increasingly common in many countries around the world. Such curved alignment bridges have been used especially in India, particularly in growing cities, in the architecture of crowded urban areas where multilevel interchanges must be constructed with inflexible geometric constraints. Owing to the addition of curvature, curved box girder bridges are considerably more complex in nature and layout than straight bridges. The Parametric Research on Curved Span Box Girder Bridges is conducted with this purpose, taking into account the curved geometry for review and IRC: 112 Code of Practice for Concrete Road Bridges for the construction. The findings are taken from the results obtained at the end of the study and configuration of the 35 m stretch with 2 Lane & 3 Lane width for 100 mt radius, 75 mt radius, 50 mt radius curvature degree & straight span. With an improvement in the curve for the 35 m span, it is observed that the necessary amount of pre-stressing steel is increased. With an improvement in the curve for the 35 m span, the average cost of Prestressing Steel and Concrete has increased.

VI. CONCLUSION

In this article, we examined several literature papers on girder boxes in order to determine their power. After reviewing the most recent RCC box girder analysis literature, it was discovered that several researchers studied the contrast between different parts of the box girder bridge and discovered that the rectangular box girder section is economical and has strong torsional and warping stress strength. There isn't any literature on the design of the Box girder bridge. This study aims to model and compare two distinct box girder bridge cross-sections, as well as evaluate them using a finite element methodology and related software methods such as ANSYS, SAP 2000, Staad pro, and MIDAS. Many of the tests for various bridge skew angles were carried out using Staad Pro. The findings are compared for various skew angles, period lengths, and girder box sizes.

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