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"A RESEARCH STUDY ON RCC T-BEAM BRIDGES"

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ABSTRACT

T-beam bridge decks is one of the principal types of cast-in place concrete decks. It consist of a RCC concrete slab integral with girders. A T-beam bridge was analyzed by using I.R.C. loadings as a one dimensional structure and also T-beam bridge is analysed as a 3-dimensional structure by using finite element plate for the deck slab and beam elements for the main beam using software .Both models are subjected to I.R.C. Loadings to produce maximum bending moment. We are study from this result the finite element model are lesser than the results obtained from one dimensional analysis by FEM Method, that means the results obtained from manual calculations subjected to IRC loadings are conservative.

Keyword*: FEM, RCC, IRC, T- beam, 3-dimensional*

I. INTRODUCTION

Reinforced concrete structures are largely employed in engineering practice in a variety of situations and applications. In most cases these structures are designed following simplified procedures based on experimental data. Although traditional empirical methods remain adequate for ordinary design of reinforced concrete members, the wide dissemination of computers and the development of the finite element method have provided means for analysis of much more complex systems in a much more realistic way. The main obstacle to finite element analysis of reinforced concrete structures is the difficulty in characterizing the material properties. Much effort has been spent in search of a realistic model to predict the behaviour of reinforced concrete structures. Due mainly to the complexity of the composite nature of the material, proper modelling of such structures is a challenging task. Despite the great advances achieved in the fields of plasticity, damage theory and fracture mechanics, among others, an unique and complete constitutive model for reinforced concrete is still lacking. The shear failures in reinforced concrete (RC) structures are highly brittle when compared with the flexural failures. The addition of chopped steel fibers in the concrete matrix is effective in mitigating the brittle failures of RC structures. The addition of fibers in the matrix improves the strength and post cracking tensile stiffness of the concrete. The chopped fibers induce confinement effect in concrete matrix, which contributes to the increase in the strength characteristics of concrete. The toughening mechanisms, such as, fiber pullout, fiber bridging or fiber fracture at crack interface improves the post cracking tensile stiffness of the matrix. Thus, the presence of fibers increases the strength and results in a relatively ductile type of failure of RC beams. In the literature, the modeling of various effects due to the addition of fibers in RC structures has not been attempted extensively .The present study addresses this lacunae and reports the details of the finite element analysis of eleven shear critical partially prestressed concrete T-beams having steel fibers over partial or full depth. The finite element (FE) analysis of the T-beams has been carried out in the 'ANSYS' program. The predicted results, namely, loads, deflections and cracking behavior using the 'ANSYS' model have been compared with the corresponding test data

T-beams are formed when reinforced concrete floor slabs, roofs, and decks are cast monolithically with their supporting

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beams. Generally, formworks are placed for the bottom and sides of the beams and soffit of slabs. Bent up bars and stirrups of the beam are extended up into the slab. After that, all the elements are cast at once, from the lowest point of the beam to the top of the slab.The part of the slab around the beam, called flange, would work with the beam and resist longitudinal compression force. Interior beams have flanges on both sides and are termed as T-beams, while edge beams have flanges on one side and are called L-beams. The part of the beam extending below the slab is called a stem or web. The design of the reinforced concrete T-beams is similar to that of a rectangular reinforced concrete beam except for flanges that need to be considered in the former type of beam.

Fig.1 Bridge actual photograph

II. LITERATURE REVIEW

Manohar R et al (2018) According to the study a T-beam bridge of varying slab size 3×2, 3.5×2.5, 4×3, 4.5×3.5, 5×4 and depths of deck (200,225,250,275,300) mm is analyzed using SAP 2000 software. The main bridge components are deck slab, cross girders, longitudinal girder. Here the different dimensions of cross girders and deck slab are selected. Many manual methods are used for the analysis. It is noted that Shear force, Bending moment and deflection in the girder increases with the increase in the span length.[1]

Abrar Ahmed et al (2017) The aim of the work is to find out the most suitable section for bridges of different spans. The purpose of the work is for designing and analyzing sections for different I.R.C vehicles. Analysis of structure is done by Csibridge software, the validation is done by using working stress method and Courbons theory. We can observe that I.R.C 70-R vehicle gives maximum impact. Till 30m span of bridge, T beam girder is suitable, and if span is higher makes it uneconomical. Box girder is suitable for higher spans.[2]

Sandesh Upadhyaya K et al (2016) This paper gives a comparative examination of a deck slab system of 20m, 24m, 28m span lengths. Conventional design was made using excel sheets. Shear force and bending moment values are studied. The live load assigned is of Class AA wheeled vehicle. Validation is done by checking between finite element method analysis and manual Courbons method. It shows T beam slab is more efficient than ordinary slab on girder.[3]

Tangudupalli et al (2017) In this project comparison of all loadings and all methods and same bridge is analyzed using software STAAD Pro V8i. Analysis of the girder is done using the three rational methods (Hendry Jaegar, Guyon-Massonet, Courbons theory). The loadings assigned are IRC loadings Class A, Class AA, Class 70-R, Class-B). The different country loadings given are Saudi Arabia loading, AASHTO loading, and British Standard loading.[4]

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M.G Kalyanshetti et al (2013) Computation of Bending moment due to live load in slab and girders, the live load distribution in the longitudinal girders is done. The method used to determine load distribution is Courbons method. Here we study the effectiveness of Courbons theory by varying the spans of number of longitudinal girders. Bridge modeling is done in Staad Pro software and they are analyzed by grillage method. Study is done for 4 lanes of different spans 15m, 20m, 30m, 35m, by using IRC class A loading. Numbers of Longitudinal girders are also different. Study shows that Courbons method gives higher bending moment for exterior girders. Modified Courbons equation is used for determining the problem of over estimation of load on exterior girder.[5]

Amit Saxena et al (2013) This paper represents two types of bridge systems, i.e., simply supported reinforced cement concrete t-beam, box girder bridge, based on loadings and other various parameters. Calculation of material that is steel and concrete consumption in construction is calculated. The selection of type of bridge is carried out on the basis of important aspects of civil engineering such as economy, serviceability and safety. The analysis is carried out by using software STAAD Pro. After examining manually and by software, the economical one has been selected out of these two.[6]

Soumya S et al (2015) The main purpose of this study is to design superstructure of a RC T-beam bridge of different spans. T-beam bridge decks are cast-in-situ concrete deck. It comprises of a concrete slab attached with girders. The finite element method is a common technique for the analysis of complicated structure. A T beam bridge was analysed by I.R.C. loadings as a one dimensional model. It is then analysed as a three-dimensional structure using software SAP 2000, v14.2.2 Models are subjected to I.RC Loadings. The result obtained by Courbons method is more than that obtained from finite element model, which indicates that the result obtained is conservative.[7]

Praful N K et al (2015) Analysis by rational methods of a T beam bridge is done in this paper, where we use one dimensional structure. Use of various IRC loadings is studied. The three dimensional model is been analysed by Finite element method using the software Staad Pro. The models are been created for three spans of varying lengths that are 16m, 20m, 24m. The results obtained from software are thus compared with manual results. It shows that the results of software are lesser than that of the manual results. So we can come to a conclusion that the manual results are more conservative.[8]

Y Yadu Priya et al (2016) In his study, analysis of Pre stressed concrete bridge is done. The spans are varied by 25m, 30m, 35m, 40m where the width of the bridge is constant. The bridge deck system which comprises t-beam is been subjected to IRC loadings i.e., IRC class AA, IRC Class 70-R tracked vehicle. After the analysis we get the values of Shear Force and Bending Moment. They are then compared manually by Courbons method with that of Finite element method. The comparison shows that there is no much difference in comparison.[9]

Pavan D et al (2015) In this paper a Finite element method (FEM) simulation were conducted to evaluate effect of the variation of cushion depth, coefficient of earth pressure, width or angle of dispersion on the structural behavior of the three dimensional box culvert and to examine the accuracy of FEM by comparing the FEM results with IS Code methods. It guides us in evaluating box culvert behavior under different cushion depths, the bx culvert need not be reconstructed during widening of roads.[10]

Priyanka Dilip P et al 2017] A box girder bridge is an evident bridge sector in which main longitudinal girders are provided in the hollow box shape. The box girder are constructed using steel or the concrete after prestressing or they are also constructed in the form of composite or reinforced concrete section. The typical cross section of box girder is rectangular, square and trapezoidal. In this paper, the analysis and design of 240m span of two Lane Bridge is carried out. A trapezoidal crosssection of post tensioned box girder bridge with two cells is analysed using different design loads using the IRC code for loads and load combinations i.e. IRC:6-2014 which includes different loads such as Super imposed dead load, Dead loads, moving loads, Prestresssing force. SAP 2000 is used to analysed the post tensioned box girder bridge using v 19 software.[11]

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Phani Kumar et al [2016] Bridge are used for connecting highway, roadways and railway in the whole world has high level of importance in construction sector. Prestress girder bridges are extremely popular in bridge engineering field as they are more stable, serviceable, economical and structurally efficient and gives aesthetic appearance. In this thesis, prestressed concrete T-Girder and Box Girder bridges analysis and design are carried out. IRC:112-2011 is used for analyzing the bridges. IRC:112 is a new generation code. The design provisions given in new code differs from previous codes. The previous codes are IRC:18 for prestressed concrete structures and IRC:21 for reinforced concrete structures. IRC:112 based on limit state method and IRC:21 and IRC:18 are based on working stress method which is the main difference between IRC:21 and IRC:112-2011. [12]

Sanket Patel et al [2016] The bridges are used for different purposes from the very beginning of human civilization. Innumerable bridges of various kinds and of various materials have been built from times immemorial. Design of medium span highway bridge system requires careful selection of structural element in preliminary stage. The motive behind present study is to prepare some useful interface for preliminary design of bridge system. The most economical design can only be found by comparing few different designs. Particular set of conditions can be used to find the most economic design. Economy can be achieved by separately or simultaneously considering one or more of the following factors: span, superstructure cross section, cost of prestressing steel and concrete consumption. The present study includes parametric study on prestressed concrete girder bridge superstructure.[13]

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Jagdish Chand et al,[2019] the way may have barrier or obstacles in the form of river or valley. So, without changing the alignment, a pathway or passage is provided over the barrier or obstacles. Both longitudinal girders and cross girders have been considered in this study of design of bridge girders. Girders are constructed for the individual span of the bridge which is taken as 25m. The size for longitudinal girders and cross girders are taken as2000x500 mm is 1500x250 mm respectively. The spacing between the three longitudinal girders is taken as 2600 mm c/c and between cross girders as 5000mm c/c. Software STAAD Pro is used to carry out the design of girders. For analysis bridge girder, Three same models are prepared in the STAAD pro and IRC codes, Euro codes and AASHTO loadings are applied. Shear force, bending moment and area of steel is determined from the models according to these different loadings from both longitudinal girder as well as cross girder. The whole analysis is carried out in STAAD Pro and tables and graphs are used to compare the results. [15]

Prashant Pundlik et al [2022] A bridge is a structure erected across a road, river, or railway to allow people and vehicles to go from one side to the other. Comparative studies are undertaken to select the most suitable section in bridges of various span lengths. The major goal of this work is to use software and manual approaches to investigate the impacts of T beam and Box girder bridges of varied spans under shifting loads. The analytical and design methods used are determined. The bridges are intended to withstand various IRC vehicle loads, and the TBeam deck and box girder systems are investigated. The software's results are compared to those obtained using manual techniques. The parametric analysis is carried out on parameters like Bending Moments and Shear Forces. [16]

Min Sun,Jiapeng et al [2017] Research on mechanical property of SFRC was done through experiments of two SFRC T-beams and one concrete T-beam, while the influences of different volume fractions of steel fibers on integral rigidity, ultimate shear capacity, and the crack distribution characteristics were analyzed. ANSYS finite element software was used to simulate the tests and it was found that there was good conformation between the results of ANSYS simulation and tests. The test results and finite element software simulation both showed that the incorporation of steel fibers in

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the concrete can increase the integral rigidity and ultimate shear capacity, while partially reducing the propagation of cracks effectively. It was also proved that it is reliable to simulate SFRC T-beam by ANSYS software[17]

III. RESEARCH GAP

Many research work on T RCC beam by using strip insert in beam, different material used in beam . but no body used different geometry of beam. Here my research curvature effect provide in beam modeling.

IV. RESULT

The finite element method is a well known tool for the solution of complicated structural engineering problems, as it is capable of accommodating many complexities in the solution. In this method, the actual continuum is replaced by an equivalent idealized structure composed of discrete elements, referred to as finite elements, connected together at a number of nodes. Thus the finite element method may be seen to be very general in application and it is sometimes the only valid form of analysis for difficult deck problems. The finite element method is a numerical method with powerful technique for solution of complicated structural engineering problems. It is mostly accurately predicted the bridge ehavior under the truck axle loading. The finite element method involves subdividing the actual structure into a suitable number of sub-regions that are called finite elements. These elements can be in the form of line elements, two dimensional elements and threedimensional elements to represent the structure. The intersection between the elements is called nodal points in one dimensional problem where in two and three-dimensional problems are called nodal lines and nodal planes respectively. At the nodes, degrees of freedom (which are usually in the form of the nodal displacement and or their derivatives, stresses, or combinations of these) are assigned.

V. CONCLUSION

After the review of previous researches, it becomes clear that Bending Moment and Shear force results were analyzed and it was found that the results obtained from the finite element model are lesser than the results obtained from FEM method, which means that the results obtained from one of the rational method i.e. FEM method is conservative and from FEM using ANSYS provides reasonable design of bridge deck & more economical design method for transverse reinforcement in concrete bridge deck slab is obtained in Finite element Method.

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