A Review Paper on Analysis of T-Beam Along with Deck Slab by Courbon's Method

Shubham Kesarwani[1] Rohit Rai[2] Ravi P. Srivastava[3]
[1]M.Tech Student [2,3]Assistant Professor
[1,2,3]Department of Civil Engineering
[1]Maharishi University of Information Technology, Lucknow, India
[2,3]R.R. Institute of Modern Technology, Lucknow, India

Abstract— Bridge design is a complex problem, to analysis the loads and distribution of this load on the structural elements is the most important. A simple T-beam bridge was analysed by using IRC loadings using rational methods and software STAAD Pro V8i. The main aim of this paper to analysis the T-beam of the bridge and calculate the value of bending moment, shear force and deflection for span different range and compare with the software STAAD Pro V8i results. In this paper Carbon's method and other different methods were used to study the load distribution on the girder. In order to compute the bending moment due to live load in a girder and slab bridge, the distribution of the live loads among the longitudinal girders has to be determined. There are many methods to estimate load distribution.

Key words: T-Beam, Compressive Membrane Action, Punching Shear, Bridge Deck Slab

I. INTRODUCTION

A bridge is a structure built to span physical obstacles without closing the way underneath such as a road, valley or body of water etc. A bridge is an important elements in a transportation systems. The various type of bridges is used in all over word. The first reinforced concrete bridge was built by Adair in 1871 as a 15 m span bridge across the Waveney at Homers field, England. The use of reinforced concrete for road bridges has becomes popular in India. T-beam bridges have been used widely in the span range of 10 m to 25 m. Bridge design is a complex problem, calling for creativity and practicability, while satisfying the basic requirements of safety and economy. Specification and code of practice have been involved by the concerned government agencies and professionals institutions, based on years of observation, research and development. All highway bridges in India have to be built in accordance with the India Roads Congress (IRC) Code, specification prescribed by the Ministry of Road Transport and Highway, Government of India. The design of Railway Bridge should conform to Indian Railway Standard (IRS) Code, specification prescribed by the Research, Design and Standard Organization (RDSO) of the Indian railway.

II. LITERATURE REVIEW

David A.M Jawad (2010) this study investigates the dynamic behaviour of concrete T-beam bridge decks due to heavyweight vehicles. The three-dimensional model of an actual T-beam bridge deck design is implemented within the context of the finite element method, through use of the ANSYS 5.4 computer code. The deck is modeled with 20-node brick elements. Axle loads and configurations which correspond to the "permit vehicle" loading model are adopted for the vehicle model. The case study is considered for static, free vibration, and forced vibration analysis. The dynamic loading for forced vibration analysis is a harmonically (sinusoidal) varying load with magnitude equal to 10% of the axle load and a forcing frequency equal to the first(fundamental) frequency of the bridge deck, thus simulating a case of resonance. Dynamic amplification factors are evaluated at certain locations on the bridge deck for vertical displacement, normal stress in the longitudinal direction, and shear stress. Numerical results show a general trend for higher values than those specified by the AASHTO design code. It is also concluded that the values of dynamic amplification factors are response dependent, which suggests the use of different type of dynamic application factors for the analysis of bridge decks.

Praful N K (2015) The 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. T-beam bridge decks are one of the principal types of cast-in place concrete decks. T-beam bridge decks consist of a concrete slab integral with girders. The finite element method is a general method of structural analysis in which the solution of a problem in continuum mechanics is approximated by the analysis of an assemblage of finite elements which are interconnected at a finite number of nodal points and represent the solution domain of the problem. A simple span T-beam bridge was analyzed by using I.R.C. loadings as a one dimensional structure using rational methods. The same T-beam bridge is analysed as a three- dimensional structure using finite element plate for the deck slab and beam elements for the main beam using software STAAD ProV8i, three different span of 16m, 20m and 24m was analysed. Both FEM and 1D models where subjected to I.R.C. Loadings to produce maximum bending moment, Shear force and similarly deflection in structure was analysed. The results obtained from the finite element model are lesser than the results obtained from one dimensional analysis, which means that the results obtained from manual calculations subjected to IRC loadings are conservative.

Prof. Dr. Srikrishna Dhale (2018) a bridge is a structure providing passage over an obstacle without closing the way beneath. The required passage may be for road, railway, pedestrians, canal or pipeline. In present study our main concern is with T-Beam Girder Bridge and Box Girder Bridge. The aim and objective of the work is to analyze and design the sections for different Indian Road Congress Code i.e IRC 6 and IRC 21. This has been done by analyzing the structure by software i.e STADD PRO. & validating with manual results by developing the Microsoft Excel Sheets. We used piegurds curve for bending moment calculation for four different cases. We check shear force and bending moment for vehicular load. We check the depth then from that depth

we design the bridge in STAAD- pro then we analyze the bridge for results. It is found that the IRC 70R vehicle producing maximum effect on the sections. In the present work the comparison between the 'Tee Beam Girder' and 'Box Girder' is carried out. This is helpful when we have two kinds for girder which can be used for same span; in that case the most economical one is to be selected.

Tangudupalli Mahesh Kumar (2017) Before Design of Any Structure we should know what the structural components in the structure, should know the specifications of the components, what are the loads to be considered in the design of structure and should know the analytical concepts. So this thesis gives the brief idea about the meaning of bridge and its classification, loads to be considered and the different methods to be adopted for the analysis of T-Beam deck Slab Bridge (only deck Slab with girders). This project Analyze the simple T- Beam Deck Slab. In T-Beam Deck Slab consists Slab with Longitudinal and Cross Girders? Girders have analyzed with three different Rational Methods (Courbon theory, Guyon-Massonet, Hendry Jaegar) for four IRC Loadings (Class-AA, Class-A, Class-B, Class-70R) and three Different country Loadings which are AASHTO Loading, British Standard Loading, Saudi Arabia Loading. Also this project Compare the All the Loadings and All the Methods which are mentioned above and the same bridge is analyzed as a three- dimensional structure using software STAAD ProV8i. Analysis of girders in the Bridge means Calculation of Moments and Shear forces induced in the longitudinal and cross girders at different positions for above mentioned loadings. Also analyzed the Moments induced in the Slab due to IRC Loadings Only. A simple example problem could be taken from the Text book (Design of Bridges by N. Krishna Raju) for this Project and also taken some of the curves and Graphs.

R.Shreedhar (2015) T-beam Bridge is composite concrete structure which is composed of slab panel, longitudinal girder and cross girder. Present study is mainly focusses on design of longitudinal girder by IRC: 112-2011 and IRC: 21-2000. In India, till now girders are designed and constructed according to Indian road congress guidelines as per IRC: 21-2000 code in which working stress method is used. Recently Indian road congress has introduced another code IRC: 112-2011 for design of prestress and RCC bridges using limit state method. In regards to this, present study has been performed to know how design of IRC-112differs from IRC-21 and an attempt is made to study undefined parameters of IRC: 112-2011 such as span to depth (L/d) ratio. Present study is performed on design of longitudinal girder using "working stress method" using IRC: 21-2000 and limit state method using IRC: 112-2011 code specifications. It is observed that L/d ratio of 10 in working stress method and L/d ratio of 14 in limit state method is most preferable. Quantity of materials required in limit state method is compared with quantity of material required in working stress method and it is found that concrete can be saved up to 25 to 30% using limit state method.

Y. Kamala Raju (2018) The present study on Practices in civil engineering for sustainable community development to meet four out of total eight Millennium Development Goals of United Nations have been taken up to improve the quality of life of Global Community by creating awareness in all concerned. This study is also relevant during the United Nations Decade of sustainable development. The four goals related to Civil Engineering are effective irrigation water management, providing safe drinking water, ensuring environmental sustainability and sustainable transportation system. As an inspiration of these goals, this paper is on the study of Reinforced Cement Concrete bridge deck design and its dynamic response to urban development in transport systems. A Reinforced Cement Concrete bridge deck is designed using the Indian Roads Congress (IRC) Bridge Code: IRC 21-1987. The bridge deck is designed for IRC Class AA loading tracked vehicle. The design curves by M. Pigeaud, are used to get Moment Coefficients in two directions for the deck slab. The longitudinal girders are designed by Courbon's method. The dynamic response of bridge deck for moving loads is analyzed as per British Standard Code of Practice BSCP-117 Part-II – 1967. This is based on Lenzen's criteria relating the Natural Frequency and Vibration Amplitude. A computer program in C language is developed to design interior slab panels of the Reinforced concrete bridge deck to arrive at the reinforcements and depths for a specified length of the width of slab panel and thickness of the wearing coat with Grade of concrete M-25 and Grade of steel Fe-415 High Yield Strength Deformed (HYSD) bars. The possible Global Partnership for overall development with universities, consulting organizations, government organizations and nongovernmental organizations is also to be discussed.

L.P.Huang (2017) Load distribution factor (LDF) is an important index for evaluating the performance of existing bridges. However, few researchers have studied the change of transverse load distribution coefficients of beams before and after the widening and reinforcement of existing bridges. To work out such problem, a reinforcement method for widening longitudinal and cross beam was proposed. A Finite element (FE) model was built to simulate the widening reinforcement of existing bridge, Load distribution factor for all girders were analyzed in the cases of different position, quantity and stiffness of cross beam, different added width of girder, different existing bridge stiffness and different connection system. Results show that the LDF of side beams decreases by 63.92% to the highest extent after bridge reinforcement, which significantly improves load-carrying condition of girder. However, the LDF at fulcrum increases by 30% after reinforcement. Therefore, some strengthening measures are necessary in these positions. The quantity, position and dimension of cross beam have not much influence on the LDF of each girder. The LDF of beams are smaller when the widened girders are connected rigidly to the old girders than that hinge connected to. The LDF of each girder shows not much difference when the main beams are connected to widened girders with rigid or hinged connection, respectively. This study is meaningful for the development of widening and reinforcement design of existing bridges.

Anushia K Ajay (2017) the infrastructure available in a country judges the development of that country. Highway which allows the flow of human beings and material is a major part of infrastructure. Tee-beam bridges forms the major proportion of bridges constructed on the highways. IRC codes are developed and reused from time to time based on the research work carried out all over the world. IRC 112-

2011 replaces two codes of practice IRC 21-2000 and IRC 18-2000. Also IRC 112-2011 introduces limit state method of design of RCC bridges. Single span two lane bridge is subjected to IRC class AA tracked loading by varying the span is analyzed using software VB6.0. Inthis study parametric studies are conducted on various bridge super structural elements. The study is mainly focused on the economical depth of a longitudinal girder for different span. Nomograms are also developed which can be used as a handy tool in the design of T- Beam Bridge.

Sudarshan Prabhakar Patil (2017) Reinforced concrete bridges with different types of deck slab have been widely used for both road and railway bridges. The most common type is the slab deck used for short span bridges. For medium span in the ranges of 12 to 25 m T- Girder and slab deck is widely used. In the case of T Girder and deck slab type, the slab span in two directions since it is cast integrally with main girder and cross girder. The deck slab is generally designed for either by 70 R loading or class AA Tracked wheel loading. IRC recommends bridge designed for class AA loading should also be checked for IRC class A loading. However in conventional analysis many of the important considerations are ignored by the various designers, which proved out to be somewhat unrealistic during the pragmatic conditions. For an assessment of the load carrying capacity of a bridge, one needs to know the maximum bending moment and the shear force included in the beams or girders of the bridge by vehicular loads. These maximum design load effect can be calculated by the conventional method such as Courbon's method. The main objective of study is to analyse super structure for IRC Class AA loading (Tracked vehicle) and IRC Class A loading to compute the values of bending moment, shear force and deflection for span range from 16 to 24 m. The analysis of super structure of different sections and spans is carried out by Courbon's method using MS Excel and by using STAAD.pro software. The bending moment and shear force results obtained by STAAD.pro were less up to 18 m span when compared to results obtained by MS Excel and vice-versa as the span increased. The safe design section is obtained by deflection criteria.

Abrar Ahmed (2017) the development of the nation is mainly from agricultural and industrial activities, so, it is required to facilitate the proper transportation by providing the Flyovers and Bridges. For constructing the flyovers or the bridges we find many types of section among which T-beam and box type are very popular. In order to find out the most suitable section, this project looks on the work of analysis, design and cost comparison of T-Beam and Box girders for different spans. The purpose of this study is to identify the suitable section for bridges of different spans. The Prestressed concrete sections have been considered in this case as the spans designed are more than 25 metres for which the Reinforced concrete sections are uneconomical. The aim and objective of the work is to analyse and design the sections for different Indian Road Congress, IRC vehicles. This has been done by analysing the structure by CSI bridge software and validating with manual results by developing the Microsoft Excel Sheets using Working Stress Method and by adopting Courbon's theory. It is found that the IRC 70R vehicle producing maximum effect on the sections. Cost comparison has shown that the T-beam girder is suitable for spans up to 30metre, as we go for higher spans the depth of T-beam girder increases drastically which makes it uneconomical. Therefore for higher spans the box girder is suitable. The result of this analysis can be used to find the suitable section for respective spans. From the obtained results we can conclude that the software results are acceptable and can be adopted for the design of substructures also.

M.G. Kalyanshetti (2013) -In order to compute the bending moment due to live load in a girder and slab bridge, the distribution of the live loads among the longitudinal girders has to be determined. There are many methods to estimate load distribution. In this project Courbon's method is used to estimate the load distribution as it very popular and widely used because of its simplicity. But the Load factor obtained by Courbon's method is constant for all spans and this indicates the effect of variation of span is not at all considered. Therefore it is proposed to study "effectiveness of Courbon's theory" for various spans of bridge by varying number of longitudinal girders. In this project STAAD software is used in which bridge models are analyzed using grillage method. Finally load factor obtained from grillage analogy are compared with the Courbon's load factors to find out the difference and to obtain a new equation which considers the effect of span. The detailed study is carried out for four lane and six Lane bridges of spans 15m, 20m, 35m, 30m, 35m using IRC class A loading by varing a number of longitudinal girders. Also the study reveals that Courbon's theory gives higher values of bending moments for exterior girder. Therefore the problem of over estimation of load on exterior girder is solved by using Modified Courbon's equation.

III. Conclusion

With the advancement and recent development in bridge construction technologies now we have several options to select bridge from different types , different methods of analysis and also which full fills different parameters viz. economy, safety, stability and aesthetic view of sub-structure. Introduction and different types of bridges considered in this review and the selection of different type of bridges in construction technologies in civil engineering. Among all methods, Courbon's method is the simplest and is applicable when the conditions are satisfied.

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