Review Paper on Comparative Analysis of T-Beam Along With Deckslab by Courbon's Method and Staad Pro

Ashwani Kumar Pandey[1] Mohd Zain[2] Rakesh Varma[3]
[1]M. Tech. Student [2]Assistant Professor [3]Professor
[1,2,3]Department of Civil Engineering
[1,2,3]Shri Ramswaroop Memorial University, Lucknow, India

Abstract— Bridge design is crucial because it entails a great deal of difficulty in terms of analyzing loads and load distribution on structural components. The new programme STAAD Pro V8i version was used to analyses a simple T-beam bridge using IRC loadings and the logical method approach. The main goal of this project is to study the T-beam of the bridge, as well as the deck slab, using Courbon's method and calculating the values of bending moment, shear force, and deflection and to compare the manual results with those obtained using the programme STAAD Pro V8i.

Keywords: T-Beam Along with Deck Slab, Courbon's Method, IRC Loadings, Logical Method Approach

I. INTRODUCTION

A bridge is a structure providing passage over an obstacle without closing the way beneath underneath such as a road, valley or body of water etc. A bridge is a critical component of every transportation system. Bridges of different types are used all over the world. Adair designed the first reinforced concrete bridge, a 15-meter span bridge over the Waveney in Homersfield, England, in 1871. In India, the use of reinforced concrete in the construction of road bridges is becoming more common. In the span range of 10 m to 25 m, T-beam bridges have been commonly used. Various components of a bridge that are taken into consideration by designers before execution on site are as follows: - Superstructure, Substructure and Foundation which are considered as a composite structure when casted monolithically all together called a bridge. Designing Bridge is a very complex problem, due to involvement of creativity and practicability, while satisfying the basic requirements of safety and economy.

However, Bridges are classified according to– function, material used in Construction, Inter span relations and span length. Also, The Indian Railway Standard (IRS) Code, as well as the specifications specified by the Indian Railway Research, Design and Standard Organization (RDSO), must be followed when designing a railway bridge.

A. Objective:

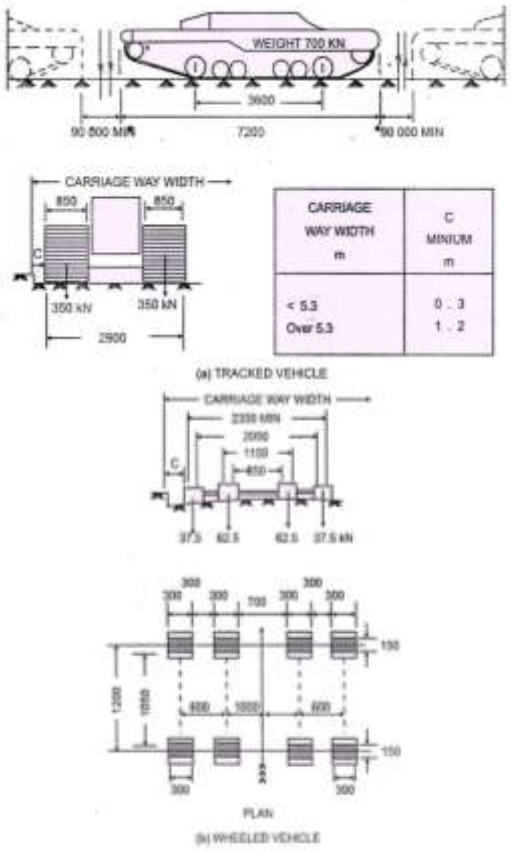
Courbon's approach was utilised in this research to analyse an RC T beam bridge in terms of moment and shear force under IRC loading. The study analyses the results of analytical modelling of an RC T beam bridge using Courbon's approach and STAAD Pro software. The scope of this research is limited to right bridges with no skew.

B. Scope of Study:

Maximum bending moment and shear force on T beam girders estimated using Courbon's approach based on IRC loadings. The max bending moment and shear force on the T beam girders according to IRC loadings calculated by software STAAD Pro 8Vi. Compare above both results.

II. LOAD ACTING

1) LOADS: While designing the bridge for the road importance of following loads should be considered: -
2) DEAD LOAD- Structural Dead load: Structural dead loads are loads imposed on a member by its own weight and the weight of other structural elements that it supports including rail, sidewalks, slab and beam.
3) Superimposed dead loads: In addition to the structure Dead load, members should be designed to support the weight of superimposed dead load including footpath, wearing course, ballast, signs architectural ornamentation, pipes, cables and any other immovable appurtenances installed on the structures.
4) LIVE LOAD- The application of the normal live load is taken parallel to the supports. The Indian Road Congress (IRC) specified four classes of loads, designated as Class AA, Class 70 R, Class A, and Class B for In India, the design of permanent bridges is strictly adhered to.
5) IRC Class AA Loading: This Loading is made up of either a 700 KN tracked vehicle or a 400 KN wheeled vehicle with the dimensions stated in fig. The tracked vehicle is modelled after an army combat tank, with a ground contact length of 3.6 meters.



6) IMPACT EFFECT- for IRC Class A and B Loading, the impact allowance is given as a fraction or percentage of the imposed live load.

$$I = A/B+L$$

Where
I = Impact factor fraction
A = Constant of value 4.5 for reinforced concrete bridges and 9 for steel bridges B = Constant of value 6 for reinforced concrete bridges and 13.5 for steel
bridges
L = Span in meter

Impact factor fraction may be determined from the curve given in figure.

III. LITERATURE REVIEW

David A.M Jawad (2010): This research looks at how heavyweight vehicles affect the dynamic behavior of concrete T-beam bridge decks. The ANSYS 5.4 computer code is used to create a three-dimensional model of a real T-beam bridge deck design in the context of the finite element approach. Twenty-node brick elements are used to model the deck. The vehicle model uses axle loads and combinations that match to the "permit vehicle" loading model. For static, free vibration, and forced vibration analysis, the case study is used. For forced vibration analysis, the dynamic loading is a harmonically (sinusoidal) changing load with a magnitude equal to 10% of the axle load and a forcing frequency equal to the bridge deck's first (fundamental) frequency, imitating a situation of resonance. For vertical displacement, normal stress in the longitudinal direction, and shear stress, dynamic amplification factors are measured at specific places on the bridge deck. The numerical data demonstrate a general trend toward higher values than the AASHTO design code specifies. The values of dynamic amplification factors are also found to be response dependent, implying that different types of dynamic application factors should be used for bridge deck analysis.

R. Shreedhar (2012): 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 limited component technique is an overall strategy for underlying examination where the arrangement of an issue in continuum mechanics is approximated by the investigation of a gathering of limited components which are interconnected at a limited number of nodal focuses and address the arrangement space of the issue. A basic range T-bar connect was broke down by utilizing I.R.C. loadings as a one-dimensional design. A similar T-shaft connect is investigated as a three-dimensional design utilizing limited component plate for the deck piece and pillar components for the fundamental bar utilizing programming STAAD ProV8i. The two models are exposed to I.R.C. Loadings to create greatest twisting second. The outcomes acquired from the limited component model are lesser than the outcomes gotten from one dimensional examination, which implies that the outcomes got from manual computations exposed to IRC loadings are traditionalist.

M.G. Kalyanshetti (2013) "In "Study of the Effectiveness of Courbon's Theory in the Analysis of T-beam Bridges," published in the International Journal of Scientific & Engineering Research, the distribution of live loads among longitudinal girders must be calculated in order to compute the bending moment due to live load in a girder and slab bridge. Estimating load distribution can be done in a variety of ways. Courbon's method is utilised to estimate the load distribution in this project because it is very popular and frequently used due to its simplicity. However, the load factor generated by Courbon's technique is constant for all spans, indicating that the influence of span fluctuation is not taken into account. As a result, it is proposed to investigate the "efficacy of Courbon's hypothesis" for various bridge spans with different numbers of longitudinal girders. STAAD software is used in this project to analyses bridge models using the grillage approach. Finally, the load factors derived from the grillage analogy are compared to Courbon's load factors to determine the difference and derive a new equation. The detailed research is carried out for four and six lane bridges with spans of 15 meters, 20 meters, 35 meters, 30 meters, and 35 meters, employing IRC class A loading and a variety of longitudinal girders. The research also demonstrates that Courbon's theory predicts higher bending moments for outside girders. As a result, utilizing Modified Courbon's equation, the problem of overestimation of load on the outer girder is solved.

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 analyzed 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 spans of 16m, 20m and 24m was analyzed. 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 analyzed. 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.

Y. Yadu Priya (2016): In modern days in the field of bridge engineering, the enhancement of pre-stressed concrete bridge decks has been increased due to its better ability to carry live loads. IRC code clauses are used to conduct the analysis. T-beam bridge decks, which are made up of a concrete slab and girders, are one of the most common types of cast in-situ concrete decks. In STAAD Pro, the problem in continuum mechanics is approximated using FEM (finite element technique), This is a way of structural analysis in general. A single span two-lane t-beam bridge is evaluated in this study by modifying the span of 25m, 30m, 35m, and 40m while keeping the width constant. To get the maximum

bending moment and shear force, the bridge models are subjected to the IRC class AA and IRC 70R tracked loading system. From the analysis it is observed that with the increase in the span, shear force and bending moment in the girder increases. The findings of bending moments and shear forces obtained using both the courbon's approach and the finite element method show no major differences.

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 examination is likewise applicable during the United Nations Decade of economical turn of events. The four objectives identified with Civil Engineering are powerful water system water the board, giving safe drinking water, guaranteeing natural maintainability and manageable transportation framework. As a motivation of these objectives, this paper is on the investigation of Reinforced Cement Concrete extension deck plan and its dynamic reaction to metropolitan improvement in transport frameworks. A Reinforced Cement Concrete scaffold deck is planned utilizing the Indian Roads Congress (IRC) Bridge Code: IRC 21-1987. The extension deck is intended for IRC Class AA stacking followed vehicle.

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.

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. In this 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.

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 meters for which the Reinforced concrete sections are uneconomical. The aim and objective of the work is to analyze and design the sections for different Indian Road Congress, IRC vehicles. This has been done by analyzing 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.

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.

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.

S.Basilahamed (2018): In modern days in the field of bridge engineering, the enhancement of prestressed concrete bridge decks have been increased due to its better ability to carry live loads. The analysis is carried out using IRC codal provisions. T-beam bridge decks are one of the major types of cast in situ concrete decks which consist of a concrete slab integral with girders. The problem in continuum mechanics is approximated by FEM (finite element method) in STAAD Pro, which is general method of structural analysis. In this study a single span two lane t-beam bridge is analyzed by varying the span of 25m, 30m, 35m and 40m where the width is kept constant. The bridge models are subjected to the IRC class AA and IRC class 70Rtracked loading system in order to obtain maximum bending moment and shear force. From the analysis it is observed that with the increase in the span, Courbon's method and finite element method have no significant variation.

Abhishek Gaur (2019): A Bridge could be a structure providing passage over an associate obstacle while not closing the approach at a lower place. The required passage could also be for a road, a railway, pedestrians, a canal or a pipeline. The obstacle to be crossed may be a river, a road, railway or a valley. The T-beam Bridge is far and away the foremost unremarkably adopted kind within the span vary of ten to twenty-five Meter. The structure is thus named because of the foremost longitudinal girders are designed as T-beams integral with an area of the deck block, that is formed monolithically with the girders. Simply supported T-beam span of over thirty Meter are rare because the loading then becomes too serious. Present research work developed to analyze the investigation made by different researchers in the field of economic and safe bridge design. The research work presents the summary of different research work & concludes with identified gaps in the research as well as identified the object of required work.

Okonkwo V. O. (2019): In this paper, three models of slab on beam (T-beam) bridge with varying number of girders and varying spans lengths were loaded with Load Model 1 (LM1) according to Euro code 1 Part 2 (EN 1991-2), and analysed using Finite Element Analysis, Grillage Analogy, and Courbon's method. The width of the carriageway is 7.2m, and with Euro code specifications, two notional lanes (3m wide each) and a remaining area 1.2m wide was produced for all the models. The bridge was analysed for LM1 only, with the load arrangement maximised for worst effect on the exterior girder. In the results obtained, finite element analysis gave the most economical results for longitudinal bending moment and shear forces, followed closely by grillage analogy. However, a calibration factor was proposed for the results from Courbon's method as a function of the bridge span length, which will enable Courbon's method to be used as a quick check for verification of results from computer methods, since it is a very easy and quick manual method to apply, thereby ameliorating the limitations in the use of the method.

Preeti Ban (2019): T-beam bridge decks is one of the principal types of cast-in place concrete decks. It consists of a 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 threedimensional 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 Courbon's Method, that means the results obtained from manual calculations subjected to IRC loadings are conservative.

Raghabendra Yadav (2019): The most commonly and popular type of bridge used in Nepal is T beam bridge due to it's simple in design, construction and maintenance than other types. T-beam Bridge comprises of a concrete slab integral with girders. This type of bridges is more preferred when it comes to connectivity to short distances. So, it is necessary to update the analysis and design methods. Here, in this paper, there is an attempt to study the comparison of maximum bending moment due to live load in a girder and slab bridge for varying span length as 15m, 20m and 25m respectively of T Beam bridge using conventional method. The same bridge is analyzed as a three-dimensional model in finite element software as SAP2000, apply the same loading done for conventional methods and compared the results. The maximum bending moment results obtained from finite element model are lesser than Courbon's method which looks more conservative.

Rajendra N. Khapre (2020):: In this paper parametric study of Reinforced Cement Concrete (RCC) girder and Prestressed Concrete (PSC) girder of various different spans is presented. PSC and RCC Girders are modeled and analyzed using STAAD.pro for different spans. Dead load, thermal load, wind load and live loads by IRC of Class A and Class 70R with different combinations depending on the width of the carriageway are considered for

the analysis. Stresses are check for compressive stress in concrete, tensile stress in concrete and tensile stress in steel. The conclusions are drawn by comparing various aspects like stresses at different levels. Study concludes that PSC girders are suitable over RCC girders for larger spans.

Shubham Sirse (2020): Bridge is the structure which is used for carrying the traffic over the valley or river by connecting highways or railways. There are types of bridges which are T-beam bridges and box girder bridges where the T-beams are effective in resisting bending providing ductility to the bridges. While box girders give high torsional stiffness providing ductility, stability and also aesthetics. Different codes with varying design philosophy are used for designing these bridges such as IRC:21-2000 and IRC:112-2011. Hence the purpose of this paper is to compare the results of analysis and design of different papers performed using these codes for both the types of bridges i.e., T-beam and box girder bridge. Various researchers' studies are available on the design and analysis of T beam bridge and box girder bridge using IRC:112-2011 and IRC:21-2000. The purpose of this study is to determine the most economical and preferable design code for both T-beam bridges and box girder bridges.

IV. Conclusion

The comparison was done using STAAD Pro and analytical modelling of a simply supported prestressed T-beam bridge deck using the rational technique and the finite element method. The bridge deck is studied in this study utilizing Courbon's method and STAAD Pro by altering the span of the bridge deck, the spans. Based on this study Courbon's method gives the average result with respect BM values in the longitudinal girder as compared to Courbon's method. The findings were studied, and it was discovered that the results produced from the finite element model were smaller than those obtained from one-dimensional analysis, implying that the results acquired from I.R.C. loadings are conservative and that FEM provides cost-effective design.

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