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ANALYSIS OF T-BEAM BRIDGE ALONG WITH DECK SLAB AT GOMTI RIVER BY COURBON'S METHOD

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ABSTRACT: Design of Bridge is most important as il involves major complexity, to analyse the loads and load distribution on the semidiurnal elements. Analysis of a simple T-beam bridge was by using IRC loadings using rational method approach and latest software STAAD Pro V8i version. The main aim of this project to analyse the T-beam of the bridge

STAAD Pro is a general-purpose structural analysis and design program with applications primarily in the building industry - commercial buildings, bridges and highway structures, industrial structures, chemical plant structures, dams, retaining walls, turbine foundations, culverts and other embedded structures etc. In software deck was analysed for moments in different directions as plate elements which were quadrilateral in shape and the loading was applied on the plate elements by assigning co-ordinates discussed here.

KEYWORDS: T-Beam, IRC Loading, FEM, STAAD Pro 8vi, Courbon's method etc.

I. INTRODUCTION

Designing Bridge is a very complex problem, due to involvement of 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.

Objective: In this project used of Courbon's method in analysis of RC T beam bridge with respect to moment and shear force under IRC Loading. The study is based on the analytical modeling of RC T-beam Bridge by Courbon's method and STAAD Pro software and compares its results. The scope of this study is applied on right bridge i.e., no skew bridge.

Courbon's method is used in this project to estimate the load distribution over the girder. For computation of bending moment due to live load in a girder and slab bridge, the live loads distribution among the longitudinal girders has to be determined. There are various methods to estimate load distribution. Among various methods of load distribution we had applied Courbon's method widely used because of its simplicity and also of its usefulness it is very popular. Courbon's method is constant for all spans due to load factor being obtained constant for all spans and this reveals that the effect of variation of span is not at all considered. Therefore it is proposed to study about Courbon's Method Application and also its effectiveness for various spans of bridge by varying number of longitudinal girders. A simple problem could be taken for ready reference from the text book (Essential of bridge engineering, by D J Victor) for solving the problem taken in our project for analysis.

Scope of Study: Maximum Bending moment and Shear Force on the T beam girders according to IRC loadings calculated by Courbon's method. The max bending moment and shear force on the T beam girders according to IRC loadings calculated by software STAAD Pro 8Vi.

IRC Class 70R Loading: This loading consists of a tracked vehicle of 700 KN or a wheeled vehicle of total load of 1000 KN. The wheeled vehicle is 15.22 m long and has seven axles with loads totaling to 1000 KN. In recent year, there is an increasing tendency to specify this loading in place of Class AA loading. All dimensions of the Class 70 R loading vehicles are shown in fig.

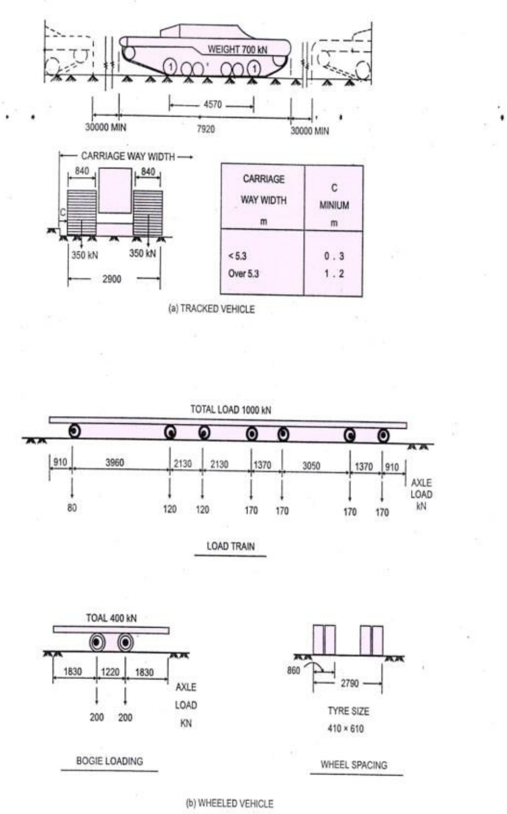


Fig. IRC Class 70R Loading.

IRC Class A Loading: Class A loading is a 554 KN train of wheeled vehicle on eight axles. Class A loading normally adopted on all roads on which permanent bridges and culvert are constructed.

IRC Class B Loading: Class B loading comprises a train wheeled load similar to that of Class A loading but smaller axle loads.

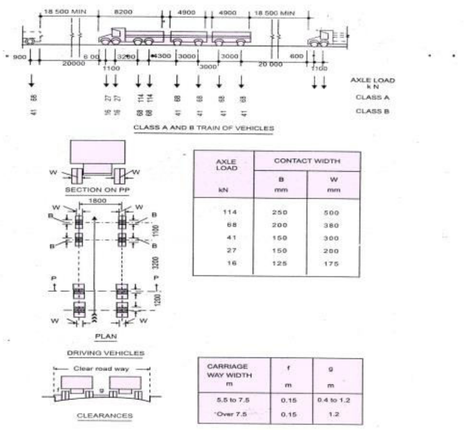


Fig. IRC Class A and B Loadings

IMPACT EFFECT: The impact allowance is expressed as a fraction or percentage of the applied live load; For IRC Class A and B Loading;

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.

For IRC Class AA or 70 R Loading;

•For span less than 9m,

For tracked vehicle: 25% for span up to 5 m linearly reducing to 10 % for span of 9 m. For wheeled vehicle: 25%

•For span of 9m and more,

For tracked vehicle : R.C. Bridges, 10% upto span of 40 m and in accordance with fig for span exceeding 40 m.

For wheeled vehicle : R.C. Bridges 25% for spans upto 12m and in accordance with fig span exceeding 12m.

II. LITERATURE REVIEW

According to M.G. Kalyanshetti and R.P. Shriram "Study of Effectiveness of Courbon's Theory in the Analysis of T-beam Bridges" in the International Journal of Scientific & Engineering Research, 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.

David A.M Jawad (2010) this study investigates the dynamic behavior 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.

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.

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.

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).

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.

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.

III. DESIGN AND ANALYSIS OF T-BEAM-Courbon’s method-

Among these methods, Courbon’s method is the simplest and is applicable when the following conditions are satisfied: -

a) The ratio of span to width of deck is greater than 2 but less than4.

b) The longitudinal girders are interconnected by at least five symmetrically spaced cross girders

c)The cross girder extends to a depth of at least 0.75 times the depth of the longitudinal girders.

Courbon’s method is popular due to the simplicity of computations as detailed below:-

$$R_x = \frac{\sum W}{n}\left[1 + \frac{\sum I \times d_x e}{\sum d_x^2 I}\right]$$

When the live loads are positioned nearer to the kerb the centre of gravity of live load acts eccentrically with the centre of gravity of the girder system. Due to this eccentricity, the load shared by each girder is increased or decreased depending upon the position of the girders.

This is calculated by Courbon’s theory by a reaction factor given by, Where,

Rx= Reaction factor for the girder under consideration. I = Moment of Inertia of each longitudinal girder.

dx= distance of the girder under consideration from the central axis of the bridge. W = Total concentrated live load.

n = number of longitudinal girders.

e = Eccentricity of live load with respect to the axis of the bridge.

STAAD pro analysis engines for performing linear elastic and pdelta analysis, finite element analysis, frequency extraction, and dynamic response (spectrum, time history, steady state, etc.). The programming in STAAD pro consists of mainly three parts.

1.Modelling

2.Analysis

3.Post processing.

1.Modelling:- In modelling there are various ways by which we can create in model .For current model we included in space structure category.

Step1-First and foremost we have to select the plane of our modelling for this structure we have selected XZ plane.

Step 2-Second step involves creating of nodes which needed to be done in very judiciously because once the nodes are created then only, we can do surface meshing properly.

Step 3-Thirdly we go to run structure wizard to create curved girders for that radius of the curve and angle of curvature is required.

Step 4-Fourth step involves creating of straight beams which is done joining the nodes at the required position.

Step 5-Fifth step is doing surface meshing which can be done in two-way polygonal meshing and quadrilateral meshing. If all the four nodes of a quadrilateral element do not lie on one plane, it is advisable to model them as triangular elements. The thickness of the element may be different from one node to another. While assigning nodes to an element in the input data, it is essential that the nodes be specified either clockwise or counter clockwise. For better efficiency, similar elements should be numbered sequentially.

Step 6-Sixth in this the property of curved beams, straight beams and plate elements is assigned.

Step 7- Assigning the supports to the right nodes. Assigning depends upon the end conditions.

Step 8-Eight step is applying the loads to our model it depends on our requirement which type of load we want in STAAD we have automatic load combination calculation which can be set according to Indian code, so our load assigning is over.

By following above step a curved deck model is created with our required properties and loading conditions modelling is completed.

2.Analysis:-After modelling is over we go for analysis which can be done with the help of Graphic user interface and using analysis button in this we can perform various analysis at one time. It can do the following types of analysis.

1.Elastic. Traditional first-order including iterative one-way analysis.

2.P-Delta. Both large and small P-Delta including stress-stiffening effects

3.Cable. Account for the changing stiffness of cables due to loading

4.Imperfection. Account for imperfections in structural geometry

5.Dynamic. Modal analysis including stress-stiffening Eigen solution and steady-state options, Time History and Response Spectrums

6.Buckling. Identify the Eigen buckling factor

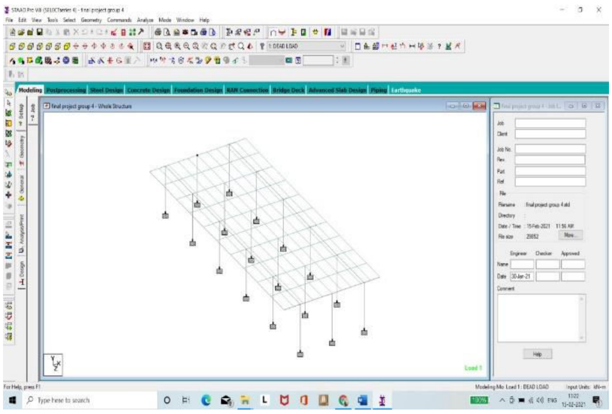
7.Pushover. A solution to the requirements outlined in FEMA356:2000

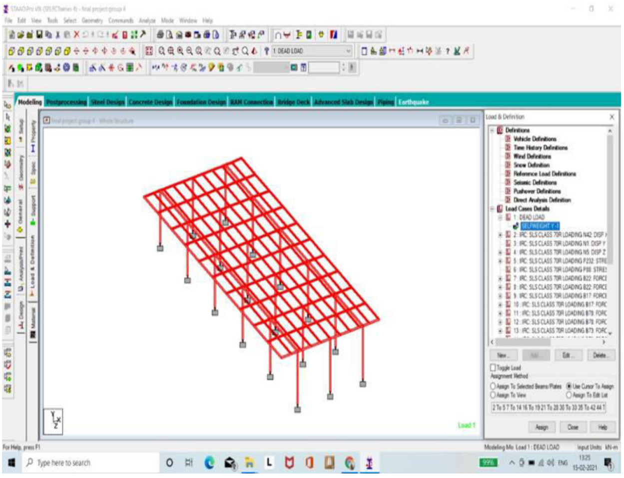
Second step is going to preprint analysis in this we include the desired things which we want as our results in stadd pro we have various data which we want to get material property, joint coordinate, problem statics, and member information

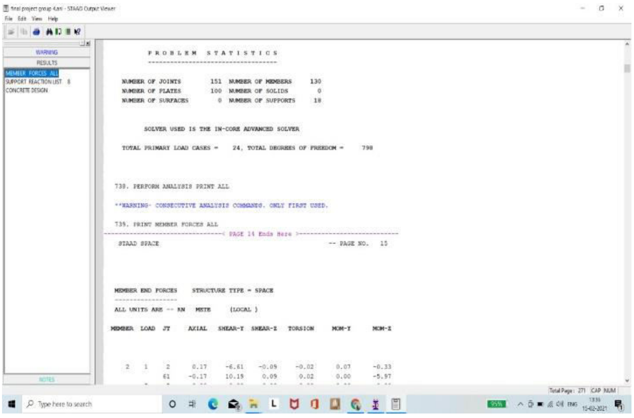
Third step in analysis is post print step which also included in the tab next to analysis button in this we can select any tool which we want not in our reports but these things get included in post processing these include member stress, load list, section, joint displacements, member forces, support reactions. This completes our analysis section.

3.Post processing: -It is basically a result set up which is used to view our result which we have got by proper modelling and doing the analysis which we want to do. In this we can get the complete information for animation, reports, plate, beam and nodes.

STAAD ANALYSIS







IV. CONCLUSION

The analysis and design of Deck slab and T-Beam of a Bridge has been carried out manually as per IRC guidelines and the following results have been noted.

1.Live Load due to Class AA Wheeled Vehicle produces the severest effect.

2.Shear Force due to Class AA Wheeled Vehicle is very high.

3.Bending Moment in the Inner girder is lesser than the Outer girder hence lesser reinforcement in inner girder when compared to outer girder.

4.The design of the deck slab and T- beam has been manually done keeping in view the above results.

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