A Review Paper on Analysis and design of Different Bridge Components

Akanksha yadav[1], Vijay Kumar Shukla[2], Dr. R. N. Khare[3]
[1]*MTech Scholar (Structural Engineering),VEC Ambikapur, , C.G., India*
[2]*Assitant Professor, Department of Civil Engineering, VEC Ambikapur, , C.G., India*
[3]*Principal, VEC Ambikapur, C.G., India*

ABSTRACT

In this study the RCC T-beam bridge and girder bridge is to be analysis by conventional method [Coruban Method] and FEM by different software i.e stadd pro,CSI bridge software. This project looks on the work of analysis and design of bridge deck and beam on software, the specific bridge model is taken of a particular span and carriageway width, the bridge is subjected to different IRC loadings like IRC Class AA, IRC Class 70R tracked loading ,Loading etc. in order to obtain maximum bending moment and shear force. From the analysis it is observed and understand the behavior of bridge deck under different loading condition and comparing the result.The different Codes of design will be use in this project such as IRC codes and AASHTO-LRFD etc.

Keywords: RCC-T Beam Bridge, Girder Bridge, STAAD.Pro software, IRC Codes i.e. Class AA and 70R,Coruban method ,FEM Analysis.

INTRODUCTION

A bridge is a construction built to cross physical barriers such as a body of water, valley, or highway, so as to provide a passage over the barrier. The design of the bridge varies depending on the function of the bridge, the nature of the land on which the bridge is constructed, the materials used for construction and the money available to build it. A bridge has three main elements. First, the substructure (foundation) transfers the load weight of the bridge to the ground; It is made up of components such as columns (also called columns).Second, the bridge superstructure is the horizontal platform that spans the space between the columns. Finally, the bridge deck. . The T-beam Bridge is best suited when the span ranged is between 10 to 25 m. T-beam are so called because the longitudinal girders and deck slabs are cast simultaneously to form a T shaped structure.A girder Bridge is a type of bridge that has main girders that supports deck slabs and transfer the load directly to the foundation. Girder bridge is classified as box-type girder or a plate-type girder system, respectively. The box girder system is beneficial in torsion and durability, but is detrimental in terms of construction costs. The plate type girder system is detrimental in terms of construction durability and capacity.

LITERATURE REVIEW

(Li, 2024) [1], To explore the vulnerability of a reinforced concrete girder bridge and reinforced concrete building during an earthquake, and to compare the difference in the seismic capacity of the two types of engineering structures, the nonlinear vulnerability numerical and probabilistic model analysis methods were combined. Overall, 1069 reinforced concrete girder bridges and 949 reinforced concrete buildings damaged in the Wenchuan earthquake of May 12, 2008 were selected for vulnerability analysis. The vulnerability grades of damaged samples were evaluated according to the Chinese seismic intensity scale (CSIS-08),and the vulnerability matrix of reinforced concrete girder bridges and reinforced concrete buildings in multiple intensity regions was established. The results obtained were in good agreement with the actual earthquake damage investigation results, which verifies the accuracy of the comparison model (GFRM, EQRM, vulnerability matrix, function, and curve model based on SN, FR, and EP, MDI parameter matrix model) to a certain extent, and can be extended to the vulnerability rating and prediction of reinforced concrete girder bridges and reinforced concrete buildings in the future.

(Network et al., 2023)[2], This study focuses on the design of I-bridge girders, specifically longitudinal and cross girders. The bridge in question has a span of 22m, and the girders are constructed accordingly. The longitudinal girders have dimensions of 1800 * 1000 mm, while the cross girders measure 1800x1000 mm. The bridge consists of four longitudinal girders spaced at 3000 mm c/c, and four cross girders. The design of these girders is carried out using the CSI Bridge software. Two identical models are created in CSI Bridge for the purpose of this study, with loadings adjusted to comply with IRC codes and AASHTO-LRFD specifications, respectively. By applying these different loadings, the shear force, bending moment, and average rotation in both the longitudinal and cross girders are determined.

In terms of loading and design methods, IRC codes demonstrate a superior combination when compared to AASTHO specifications. Total main reinforcement required for Bending in I-girder (as per IRC code) = 13215 mm and Total main reinforcement required for Bending in I-girder (as per AASHTO-LRFD) = 14448 mm . The results show that IRC codal provisions produced a maximum shear force across the longitudinal girder at the beginning of the span . Hence among the two codes IRC code produced maximum shear vertical force.The utilization of IRC codes for the design of bridge girders results in minimal deflection and bending moment, making IRC class AA and 70R loading the most cost-effective and optimal choice for bridge girder design in India.

(Suwal & Sharma, 2020)[3], Nonlinear static (Pushover) analysis was used to determine the capacity of the bridge pier and seismic demand of the pier was determined from Nonlinear time history analysis. In the time history analysis seismic inputs are given in the form of earthquake time history data. Four numbers of time history data recorded in peer strong motion database has been used in this study.Damage on the pier was determined by using the output of Nonlinear time history analysis and Nonlinear static(Pushover) analysis.The probability of reaching or exceeding the different defined damage states with respect to the input ground motion was determined and the fragility curves are also developed by using the First Order Second Order method(FOSM).The acceptable PGA for target 5% probability of failure for bridge pier are found to be 0.18g, 0.37g, 0.45g and 1.1g for slight, moderate, extensive and complete damage respectively. Using this fragility curves, it is concluded that there is no shear and flexural failure occured in the bridge pier rather than shear crackings at PGA of 0.4g which is assumed as design PGA in this study for the seismic hazard level of 10% of probability of exceedence in 50 years(475 years return period).

(Yadav et al., 2019)[4], 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 ,width of two lane carriage way is 6m, depth of deck is 220mm, ,3 longitudinal girders is used of depth 1500 mm,1800mm,2000mm and thickness of 400mm, Spacing of cross girders 2.5m c/c ,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.
Comparison of Dead load bending moments using FEM analysis and Courbon's method, the Bending moment for both ways' analysis give much more accuracy (less than 1% variation) . Comparison of live load bending moments on outer girder,bending moment (FEM analysis) has reduced up to 5.4% as compared to courbon's method . Comparison of live load bending moments on inner girder ,Bending moment (FEM analysis) has reduced less than 5% with courbon's method .The maximum bending moment results obtained from finite element model are lesser than Courbon's method which looks more conservative.

(Jangid, 2018)[5], The present article shows the linear dynamic behaviour of T-beam girder and Trapezoidal box girder bridge deck and compares static as well as dynamic behaviour. Response spectrum analysis has been performed by using FEM based software in order to check the resonance criteria of bridge and to determine most favourable option from above two. The results show that response parameters for trapezoidal box girder such as bending moment, shear forces, deflection, time period, base reaction, longitudinal stresses and shear stresses are increases as the span length increases while fundamental frequency decreases.

The bending moment in T-beam girder is 18% more compared to trapezoidal box girder for combined load case. The shear forces in T-beam girder is 13% more compared to trapezoidal box girder for combined load case. The longitudinal stresses at top are 19% more in T-beam girder compared to trapezoidal box girder. The shear stresses are 15% more in trapezoidal box girder but the stresses are within the limit. This shows that the trapezoidal section is in more compression. The overall trapezoidal box girder shows the better performance.From the study it is finalized that trapezoidal box girder is the conservative solution as compared to T-beam girder bridge superstructure.

(Patil & Tallapragada, 2017)[6],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.
Maximum bending moment for both IRC class A loading and IRC class AA cases increases in MS Excel result up to 18 m when compared to STAAD.pro results. Beyond 18 m bending moment values decreases in MS Excel results when

compared to STAAD.pro results. The maximum deflection values are more for IRC class A loading case when compared to IRC class AA loading case . The maximum deflection for 20 m span is nearly same for both IRC Class loading cases. As per IRC guide lines T-beam section should be safe for both IRC class AA loading and class A loading.

(Anilkumar, 2017)[7], 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. the variation in cost with l/d ratio for different spans. bridges with span ranging from 12m to 24m are selected. Loading is IRC class AA tracked and grade of steel is Fe 415.It can be seen that cost decrease as l/d ratio increases up to a certain l/d ratio then it starts increasing. There is a point for each span curve at which the cost is minimum and it can be called as optimum l/d ratio .From this graph optimum l/d ratio for different spans can be obtained.

The optimal l/d ratio for the economical design of longitudinal girder using LSM is obtained as 14. Cost of girder increases gradually with increase in grade of concrete. Stress intensity decreases gradually with increase in thickness of deck slab. It is preferable to keep the thickness in between 170mm and 200 mm.

(Husain & Uddin, 2016)[8], A simple span T-beam bridge was analyzed by using I.R.C. loadings as a one dimensional structure. 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. Both models are subjected to I.R.C. Loadings to produce maximum bending moment. 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.

Index. 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 I.R.C. loadings are conservative and FEM gives economical design.

(., 2016)[9], The aim of this study was to determine the variation and suitability of two different configuration of these bridges, namely ordinary deck slab supported on girder and T-beam configuration of deck slab. In this study we have considered span length of 10m, 15m & 20m. The deck slab has been conventionally analysed for IRC class AA Loading. Seismic load of zone III is applied on structure. The process was to made faster by analysing the structure on STAAD Pro. and the results of maximum bending moment, shear force & deflection values arising from the dead load, live load, vehicle load & seismic load. The conclusive results provide us with the best option, out of the two configuration for the varying span considered in the study.

The result for Bending Moment & Shear Force shows that the T-beam bridge has effective results as compared to Slab Bridge.The result of Maximum Deflection shows a slight change in the behaviour as the slab bridge has less deflection than T-beam bridge . The maximum reaction at the support of the bridge have difference of more than 26 % . Overall the results shows the T-Beam bridge is 25-30% less values as compared to Slab Bridge. Hence the T-beam bridge which is widely used for construction purpose shows better results than the Slab bridge.

(Shailendra et al., 2015)[10], The object of the present work is to convert the simply supported bridges into continuous

bridges and then to compare the behavior of continuous bridges with that of simply supported bridges. For this purpose six cases of simply supported are considered. To study the comparison with simply supported bridges, the bending moments developed in continuous bridges are considerably less and consequently smaller sections can be adopted resulting in economy of steel and concrete. The ultimate moment capacity of continuous bridge deck is greater than that of simply supported decks due to the phenomenon of redistribution of moments in continuous structures. Observation shows that up to 6 m span dead load moments are @ 63% of live load moments and at 8 m span theses are almost equal. At 10 m and 12 m spans dead load moments are 1.50 times and 2.40 times of that of dead load moments respectively. Therefore from slab design view point it is better to go for continuous two or three spans in multiple of 4 m, 5 m and 6 m. Present work provides at least two continuous spans may be taken in place of single span when bridge length is more than 6 m.
Provision of continuous spans in place of single span causes considerable reduction in dead load, live load and design moments. Provision of two spans in place of one span results in reduction in moments from 80% to 90%. 4. Provision of three spans in place of one span results in reduction in moments about 92%..

(Jha et al., 2015)[11], This paper focuses on the methodology of design and analysis of Slab Bridge by working stress method and limit state method. Two models of slab bridges with different carriageway widths are analyzed using STAAD PRO V8i as per IRC standards. Grillage analogy is adopted for the analysis of the models which compares the change in economy by varying the carriageway widths.
maximum bending moment for carriageway widths 7.5m and 15m are almost same that is reinforcement detailing will be also almost same. Change in carriageway widths does not affect the detailing. .Class AA tracked vehicle gives maximum live load shear force for both models respectively. It is due to maximum UDL load with less contact length.
The thickness of slab was 500mm for WS M which was reduced to 400mm for both carriageways still there is about 20% saving in amount of concrete and 5-10% saving in amount of reinforcement for LSM that is LSM is considerably economical design compared to WSM.

(Manjeetkumar M Nagarmunnoli, 2014)[12], The aim of this dissertation is to study the effects of deck thickness of RCC T-Beam bridge on the properties like Arching action by varying the thickness of the bridge and keeping all the other parameters same. Linear analysis using SAP and nonlinear analysis of the structural element using ANSYS is carried out. Linear analysis is used for the identification of critical component. A single panel of the RCC T-Beam bridge has been chosen for detailed 3D nonlinear analysis. The Solid 65 element is used for modeling the concrete and Beam 188 element is used for modeling the reinforcement. The magnitude of the gravity loads are obtained from the linear analysis. From the present study, it is concluded that decrease in the deck slab thickness by a small value decreases the bending stiffness by about 40% to 50%. Analysis yields deck stresses far in excess of permissible stresses. The cracking propensity increases with decrease in the deck thickness by about 45%.

CONCLUSION

1. It helps to automate their task by eliminating the tedious and long procedures of manual method, this will help in saving the time.

2. The mistake done during the calculation of shear force, bending moment, and other parameters of design while calculating manually will be completed eliminated.

3. The software will be very helpful for constructing the economically structure.

4. we have witness the tremendous increase in the use of computer programs .The old method of has been completely replaced by modern methods of FE method and Grillage Method and among two the FE method is more reliable.

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