Analytical Study of Reinforced Concrete deck slab bridge with varying Span & Thickness Conceptual Review

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Abstract - *A bridge is a building that allows travel over an additional obstacle without blocking the approach at a lower point. The necessary passage may also be for a pipeline, a canal, a road, a railroad, pedestrians, or a railway. It may be necessary to cross a river, road, railway, or valley. The T-beam Bridge is by far the most widely used type for spans between ten and twenty-five meters. The structure is so named because the first longitudinal girders are constructed as T-beams that are monolithically joined to a portion of the deck block. Over thirty meters of simply supported T-beam span are uncommon because the loading is then too severe. The current study was created to analyze the investigation conducted by various researchers in the field of safe and cost-effective bridge design. The research project summarizes previous studies and concludes with a list of research gaps and the subject of further investigation.*

***Key Words*:** Span/Depth Ratio, Deck slab, IRC Loading, Staad pro.

1.INTRODUCTION

Over the past few decades, there has been an enormous increase in the volume of traffic on highways due to population growth and rapid urbanisation. Many new highways and flyovers are being built to ensure smooth traffic flow. The paramedic study aids in determining the economic factor during the planning and construction of the bridge because the study of Bridge Girder material, size, shape, and selection are based on engineering and economic criteria. The current study was created to analyse the investigation conducted by various researchers in the field of safe and cost-effective bridge design. The research project summarises previous studies and concludes with a list of research gaps and the subject of further investigation.

2. CONTRIBUTION OF RESEARCHERS IN FIELD OF DECK SLAB BRIDGE

This work begins with an overview of the condition assessment of the old bridge and explained reasons for demolishing of the bridge. Briefly presented the flexural analysis of two-stage post-tensioned prestressed concrete girder, which will replace the old (new bridge). Construction of I-girder and composite girder at the first stage and second stage prestressing respectively is explained with figures. Assessment of the load-caring capacity of the one span of the replacement bridge with simple supports using proof load test is presented which is mandatory according to Indian standards. Weighted sandbags were wont to load the bridge up to a preset service load with impact issue. Deflections of the I-girders of the bridge were measured at selected locations on and across the bridge span and compared with computed values. A linear response was observed during loading and unloading. Considering the load take a look at results, theoretical estimation and criteria as stipulated in codes of practice, it can be inferred that prestressed concrete I-girder bridge span has adequate capacity to carry the loads and hence, deemed to have passed the test. **Saibabu Sundru (2018)**

This paper describes the look of 4-lane concrete T-beam bridge considering IRC Class-AA tracked loading with span varied from twenty-five to 40m. After computing manually and STAAD Pro analysis software, it is observed that dead load bending moment with increasing span increases almost square of the span. **Neeraj Kumar (2017)**

In this study, the integral bridge with a various span length of 40m, 50m, 60m and 70m non-skew and skews angles of 15°, 30°, 45° and 60° were designed and modelled in SAP2000 software. The parameters investigated in this analytical study were the skew angle, span length and stress reduction methods. The geometric dimensions of the Integral Bridge and the loading used followed AASHTO commonplace specifications. Static analysis and dynamic nonlinear time history analysis were performed to assess the seismic performance of the integral bridge. The analysis results in terms of shears and bending stresses, axial force and deflection were checked by the allowable stress method. Extreme stresses that exceed allowable limit were reduced by using six different stress reduction methods. The propose of this study was to analyze the behaviour of integral, skew angle, and to reduce extreme stress of integral bridge under dynamic loading. In skew angle bridge, cross frame member stress increases greatly as the skew bridge tend to rotate during a seismic event, which can cause excessive transverse movement. MSE+HLAC method was the best stress reduction method for all non-skew and skew angle bridge. According to the analysis result, integral bridge maximum skew angle can be extended up to 60° and span length up to 60 m can be extended using stress reduction method under extreme seismic loading. **Haymanmyintmaung, (2017**

in 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 straightforward T- Beam Deck slab. In T-Beam Deck Slab consists of Slab with Longitudinal and Cross Girders. Girders have analyzed with three different Rational Methods (Courbon theory, Guyon-Massenet, Hendry Jaeger) 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 Textbook (Design of Bridges by N. Krishna Raju) for this Project and also taken some of the curves and Graphs. **Tangudupalli Mahesh Kumar, (2017)**

Sanjay Tiwari (2017) Cellular steel section composite with concrete the deck is one in every of the foremost appropriate superstructures in resisting torsional and warp effects elicited by route loading. This type of structure has inherently created new style issues for engineers in estimating its load distribution once subjected to moving vehicles. Indian Codes of observe doesn't offer any specific pointers for the planning of straight composite concrete deck–steel multi-cell bridges. To meet the sensible needs arising throughout the planning method, a simple design method is needed for straight composite multi-cell bridges in the form of load distribution factors for moment and shear. This work presents load distribution characteristics of straight composite multi-cell box beam bridges underneath IRC trains of masses.

Yogita Gupta (2017) The shallow foundation is generally provided on non-erodible strata or where scour depth is less. It is conjointly desirable for low perennial flow or standing water condition. In the present case study, the shallow foundation is adopted for box type bridge. The total length of the bridge is 132.98 m, consisting of eight units of RCC box. Each unit is composed of three cell boxes. The bottom slab of the box unit is acted as raft foundation, founded 500 mm below ground level. River bed protection work is provided on both the upstream and downstream side along the whole length of the bridge as it is founded above scour level. The bridge collapsed during the monsoon just after two years of service. The present paper explains the cause of failure. This study on the failure of the bridge illustrates the importance of bridge review before and when the monsoon amount and therefore the importance of timely maintenance. Standard specifications of Indian Road Congress for the stream bed protection work also are enclosed.

Tanmay Gupta (2017) Usually, the design moments in the simply supported bridges are obtained because the total of moments because of dead masses and super load wherever the super load moments are calculated victimization the rolling load conception neglecting the result of dead loads. For the merely supported bridges, uniformly distributed dead load produces maximum moment at midspan while the absolute maximum bending moment due to multi-axle vehicles occur under a wheel which usually does not lie at mid-span. Since the location of the absolute maximum bending moment due to the multi-axle vehicle does not coincide with the location of the maximum moment due to dead loads occurring at mid-span, the design moment may not be obtained by simply superimposing the effect of dead load and live load. Moreover, just in case of Class-A and Class-70R wheeled conveyance live masses, which consists of several axels, the number of axels to be considered over the bridge of given span and their location is tedious to find out and needs several trials. The aim of this study is to search out the quantity of wheels for Class-A and Class-70R wheeled vehicles and their precise location to provide absolute most moment in the bridge considering the result of dead masses and impact issue. Finally, so as to modify the designers, the planning moments because of Class-70R wheeled and Class-A loading are conferred in tabular type for the spans from ten to 50 m.

Pragya Soni(2017) In this paper studied Due to population growth and rapid urbanization, there has been an enormous growth in traffic volume on highways over the last few decades. In order to ensure smooth flow of traffic, numerous new highways and flyovers are being constructed. The use of box-girders has proven to be a very efficient structural solution for highway bridges and flyovers due to its high tensional rigidity, serviceability, economy, aesthetics and the ability to efficiently distribute the eccentric vehicular live load among the webs of the box-girder. For the multi-lane bridges, multi-spine/cell box-girders are most commonly adopted in order to limit the local deformations in the top slab of the box. Many studies are available on the suitability of box girder bridges for various spans and effect of stresses for skewed box girder bridge. The curvilinear nature of box girder bridges along with their complex deformation patterns and stress fields have led designers to adopt approximate and conservative methods for their analyses and design. Recent literature on straight and falcate beam bridges has restrained analytical formulations to raised perceive the behaviour of those advanced structural systems. It was found that researchers have used the finite element method for the analysis of box girder bridge. However, not many studies are available for the design of the box girder bridge. Hence, this study emphasized on the design and analysis of box girder structure. The literature also indicates that the various researchers have used ANSYS, MIDAS and Stadd-Pro for the analysis of Pre-stressed Concrete Structures using FEM.

Junichiro Niwa(2016) An experimental study of the interface shear transfer between otherwise aged concrete (old and new deck slabs) has been performed. The recent and new deck slabs elements were crossed by steel bars and subjected to the external prestressing force. The tests were applied to be representative of a projected technique used for widening prestressed concrete (PC) main road decks. The experimental program comprised 9 specimens checked below double-shear test by taking the initial prestressing levels, connection methods between steel bars, reinforcement magnitude relation and surface roughness as parameters. The experimental results indicated that the failure behaviour of the interface was greatly affected by the initial prestressing level, reinforcement ratio and surface roughness of the interface. Finally, a comparison of

the experimental shear strength with those given by JSCE customary Specification, AASHTO and fib Model Code 2010 showed a conservative result for low and high prestressing levels, low reinforcement ratio and smooth surface.

Job Thomas S. Ramadass(2016)studied Fibre Reinforced Polymer (FRP) bars are being widely used as internal reinforcement in structural elements in the last decade. The corrosion resistance of FRP bars qualifies its use in severe and marine exposure conditions in structures. A total of eight concrete beams longitudinally reinforced with FRP bars were cast and tested over the shear span to depth ratio of 0.5 and 1.75. The shear strength test data of 188 beams published in various works of literature were also used. The model originally planned by Indian customary Code of follow for the prediction of shear strength of concrete beams strengthened with steel bars IS:456 (Plain and concrete, code of practice, fourth revision. Bureau of Indian Standards, New Delhi, 2000) is considered and a modification to account for the influence of the FRP bars is proposed based on regression analysis. Out of the 196-test data, 110 test data is used for the regression analysis and 86 test data is used for the validation of the model. In addition, the shear strength of 86 test data accounted for the validation is assessed using eleven models proposed by various researchers. The planned model accounts for compressive strength of concrete (fck), modulus of elasticity of FRP rebar (Ef), longitudinal reinforcement ratio (qf), shear span to depth ratio (a/d) and size effect of beams. The predicted shear strength of beams exploitation the planned model and eleven models planned by alternative researchers is compared with the corresponding experimental results. The mean of foretold shear strength to the experimental shear strength for the eighty-six beams accounted for the validation of the planned model is found to be zero.93. The result of the statistical analysis indicates that the prediction based on the proposed model corroborates with the corresponding experimental data**.**

Kearthi.S (2016) In this paper studied structures are subjected to two types of load: static and dynamic. However, most civil engineering structures are designed with the assumption that all applied loads are static. The effect of the dynamic load is not considered because the structure is rarely subjected to dynamic loads; more so, its consideration in analysis makes the solution more complicated and time-consuming. This feature of neglecting the dynamic forces may sometimes become the causes of the disaster, particularly in the case of an earthquake. Therefore, it is proposed to do “dynamic analysis of bridge deck” for the various span of the bridge by varying number of longitudinal girders. The detailed study is carried out for “T-Beam Bridge”, for various span 16m, 20m, 24m and 28m under IRC class AA loading condition**.**

Sandesh Upadhyay K (2016)T-beam bridges are one among the foremost usually used forms of bridge and thence it's necessary to perpetually study, update analysis techniques and design methodology. Structurally they are simple to construct and maintain. Hence, they're most well-liked over alternative forms of bridges once it involves providing property at intervals short distances. The aim of our study was to work out the variation and quality of 2 completely different configurations of those bridges, namely ordinary deck slab supported on girders and T- beam configuration of the deck slab. In this study, we have considered span lengths of 20m, 24m and 28m. The deck block has been conventionally analyzed for IRC category AA loading victimization Courbon’s technique. This study also considers all other components of a T- beam bridge such as cantilever slab, girders and cross beams. A complete FEM analysis of T-beam bridge with standard deck block supported on girders was performed analysis was valid conventionally exploitation Courbon’s technique analysis for both the configurations of T- beam bridges were extensively studied based on results of maximum Shear Force, maximum Bending moments and maximum deflection values. From the study, the T-beam configuration of deck slab proves to be effective than ordinary deck slab supported on girders

Y. Yadu Priya (2016) The analysis is carried out using IRC code 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 the 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, 40m where the width is kept constant. The bridge models are subjected to the IRC category AA and IRC 70R tracked loading system so as to get most bending moment and shear force. From the analysis, it is observed that with the increase in the span, shear force and bending moment in the girder increases. It is also observed that the results of bending moments and shear forces obtained from both courbon’s method and finite element method have no significant variation.

Praful N K(2015) In this paper studied bridge is a structure providing passage over an obstacle without closing the way beneath. The required passage could also be for a road, a railway, pedestrians, a canal or a pipeline. T-beam bridge decks are one among the principal forms of cast-in-place concrete decks. T-beam bridge decks carry with it a concrete slab integral with girders. The finite element technique could be a general technique of structural Analysis during which the answer of a haul in time mechanics is approximated by the analysis of an assemblage of finite parts that are interconnected at a finite variety of nodal points and represent the solution domain of the matter. A simple span T-beam bridge was analyzed by I.R.C. loadings as a one-dimensional structure using rational methods. The same T-beam bridge is analyzed as a three-dimensional structure mistreatment finite component plate for the deck slab and beam parts for the most beam using software package STAAD ProV8i, three different spans of 16m, 20m and 24m was analyzed. Both FEM and 1D models wherever subjected to I.R.C.

Loadings to produce a maximum bending moment, Shear force and similar deflection in the structure were analyzed. The results obtained from the finite component model are lesser than the results obtained from the one-dimensional analysis, which suggests that the results obtained from manual calculations subjected to IRC loadings are conservative.

Kalpana Mohan (2015) In this paper studied Bridge girder material, size, shape and selection are based on engineering and economic criteria. Steel concrete composite construction has gained wide acceptance as an alternative to pure steel and pure concrete construction, there is no need for formwork because the steel beam is able to sustain the self-weight of steel and concrete with few temporary props. In this paper, we present analysis and results of steel and steel reinforce bridge girders, based on STAAD Pro analysis and manual analysis.8 combos of bridge girders are taken and compared.

Vikas Gandhe(2014) Bridges are highly investment structures and important landmarks in any country besides being vital links in the transportation system. Strength, safety and economy are the three key features that cannot be neglected before the finalization of types of bridges. While deciding the types of bridge, spans and other parameters are to be studied carefully to meet out the need of suitability to site conditions. The scope of this paper is to confine to the design aspect related to variable parameters. Depth of web, the thickness of the web, the width of flange and span of bridges are the variable parameters considered during the design of plate Girder Bridge. The graphical representation is showing the relations between different parameters to conclude for cost effectiveness with respect to spans. Broad gauge mainline loading is adapted to carry out design calculations. Bending and shear stresses are plotted against the spans to check the stability of the structure. The results summarized in this paper will be a guideline to field and budding engineers

Ibrahim S. I. Harba(2011) In this paper studied T-beam bridge is a common choice among the designers for small and medium span bridges. In order to cater to larger speed and a lot of safety of contemporary traffic, the modern high ways are to be straight as far as possible. This requirement, along with other requirements for fixing alignment of the bridges, is mainly responsible for the provision of an increasing number of skew bridges. The presence of skew in an exceedingly bridge makes the analysis and style of bridge decks complex. For the T-beam bridges with little skew angle, it's oft thought of safe to ignore the angle of skew and analyze the bridge as a right bridge with a span equal to the skew span. However, T-beam bridges with an oversized angle of skew will have a substantial impact on the behaviour of the bridge particularly within the short to medium vary of spans. In this paper, an analytical study using three-dimensional finite element methods was performed to investigate the effect of skew angle on the behaviour of simply supported reinforced concrete T-beam bridge decks. The parameters investigated during this analytical study were the span lengths and skew angle. The finite part analysis (FEA) results for inclined bridges were compared to the reference straight bridges (nonskewed). The geometric dimensions of the T-beam bridge decks and also the loading used are in compliance with AASHTO customary specifications. The FEA results and comparison of the skewed bridge with a straight bridge indicate that max. Live load bending moments and deflections decreases in T- beams for inclined bridges, while max. shear, torsion and supports reactions increases in some T-beams for skewed bridges for all considered span lengths (12, 16, 20 and 24m). This study disagreement with the AASHTO standard specifications as well as the LRFD in recommending that bridges with a skew angle less than or equal 20° be designed as straight (non-skewed) bridges additionally it suggested that engineers are higher to perform three-dimensional finite part analysis for inclined T-beam bridge decks.

V Raju, Devdas Menon (2010) The thought of formed bridge beam is currently being more and more adopted in urban railway system rail comes and for replacement recent bridges wherever there's a constraint on vertical clearance. These bridge decks are ordinarily designed in apply exploitation simplified strategies that assume beam action of the webs within the longitudinal direction and similar flexural action of the deck slab in the transverse direction. However, such assumptions can lead to errors. This paper tries to assess the extent of error within the simplified analysis, by examination the results with a lot of rigorous three-dimensional finite part analysis (3DFEA). A typical model railway bridge beam has been taken as a case study. The results of the 3DFEA, in terms of load-deflection plots, have been validated by field testing.

O'Brien, Eugene. (1998) For block bridge decks with wide thwart wise cantilevers, the plane grillage associate logy is shown to be an inaccurate methodology of linear elastic analysis because of variations within the vertical position of the neutral axis. The upstand grillage analogy is also shown to give inaccurate results, this time due to inappropriate modelling of in-plane distortions. A new methodology, known as upstand finite element analysis, is proposed which is sufficiently simple to be used on an everyday basis in the design office. The method is shown to give much better agreement than the others when compared with an elaborate three-dimensional solid finite element model. Single- and two-span bridge decks with solid and voided sections are thought-about for each longitudinal and thwart wise bending stresses.

Budi Ryanto Widjaja(1997) In this thesis studied cold-formed steel decks are employed in just about each steel-framed structure for composite block systems, efforts to develop more efficient composite floor systems continues. Efficient composite floor systems will be obtained by optimally utilizing the materials, which includes the possibility of developing long span composite slab systems. For this purpose, new deck profiles that can have a longer span and better interaction with the concrete

slab are investigated. Two new mechanical based methods for predicting composite slab strength and behaviour are introduced. They are referred to as the iterative and direct methods. These methods, which accurately account for the contribution of parameters affecting the composite action, are used to predict the strength and behaviour of composite slabs. Application of the methods in the analytical and experimental study of strength and behaviour of composite slabs, in general, reveals that more accurate predictions are obtained by these methods compared to those of a modified version of the Steel Deck Institute method (SDI-M). A nonlinear finite element model is also developed to provide an additional reference. These methods, which are supported by elemental tests of shear bond and end anchorages, offer an alternative solution to performing many full-scale tests as required for the traditional m-k method. Results from twenty-seven composite block tests are compared with the analytical ways. Four long span composite slab specimens of 20 ft span length, using two different types of deck profiles, were built and tested experimentally. Without significantly increasing the slab depth and weight compared to those of composite slabs with the typical span, it was found that these long span slabs showed good performance under the load tests. Some problems with the vibration behaviour were encountered, which are thought to be due to the relatively thin layer of concrete cover above the deck rib. Further study on the use of deeper concrete cover to improve the vibrational behaviour is suggested.

3. GAP IN RESEARCH REVIEW AND OBJECTIVE OF NEW RESEARCH

Based on the survey of available literature following gaps in the research are identifying.

1. There is very limited research which focuses on varying Span/Depth ratio of RC deck slab bridge with different span.
2. There is almost Nil research available for span/depth ratio with considering span/width ratio of deck slab bridge.

Based on above-mentioned gaps following the objectives of the research are being investigated

1. To evaluate the performance of the RC deck slab with varying depth/span ratio.
2. To compare stresses on girders and piers of the bridge with varying the thickness of the deck slab to optimize the performance of the bridge with safe and economic aspects.

4.CONCLUSION

From the research we understand about the contribution of different research in the field of the deck slab structure system, a gap in the research and objective of the research to be conducted. These contributions help to visualize the problem faced by RC deck sab from a new perspective. By evaluating the performance of deck slab bridge with different thicknesses its enhanced economic aspect may be achieved, which shall lead to the direction of the design of safe stronger and more economical bridge.

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