Comparative Analysis and Design of Solid Deck Slab of Minor Bridge by Effective Width Method and Finite Element Method

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***Abstract*—As we know bridge is a structure which is important to facilitate a communication route for carrying road traffic or other moving loads. There are various types of bridges but the most simplest type of bridge is single-span beam or slab which is supported on its end. Various methods can be used for analyzing and designing the superstructure of bridge which is deck. In this project the comparative analysis is make for different span with different load condition for analysis and design of deck slab.**

I. INTRODUCTION

A bridge is a structure which is built to provide a passage over an obstacle such as river, valley, or road, etc. In a past the first bridge made by humans was wooden bridge in which the span of cut wooden logs or planks and eventually stones, using for a simple support. The first bridge made in 1840 by using trusses with wrought iron as tension vertical and timber planks for all other members.

There are six basic modern bridge formed : beam, truss, arch, cantilever and the cable-stay and suspension . The horizontal beam which is supported on its end is called as beam bridge. The bridge having an arch-shaped and supported on the both ends is introduced as an arch bridge. Just like that another type is depend on suspension cables, therefore that called as suspension bridge. The bridges are classified on the basis of how their forces of tension, compression, bending, torsion or shear are distributed.

As we know the bridge is very important factor of our daily transportation need. Our society has always depends on transportation to survive. When man walk on earth first he relied on himself for transportation. After some time he relied that he can used the wild animal for transportation purpose, and finally after some long time he created machine to take him places he could not reach on his own or with the animals. The minor deck bridge is one of the types of bridge. The bridge which having its length up to 60m is generally called as minor bridge. The deck bridge can be made of concrete, wooden planks which in turn may be curved with asphalt or other pavement. The deck of bridge of two types first it may be integral part of bridge structure or second it based on I-section or steel girders. The deck of bridge is depends on the material used for their construction or the material of deck is fitted in which matter. On the basis of material used some deck are classified as concrete deck, wooden deck, reinforced concrete deck, girder deck, etc.As we know concrete is a material that will break under overburdening pressure. So we can provide steel beams to provide flexibility and strength to the concrete deck. In Reinforced concrete deck we can provide a thick layer of concrete for making roadway and solid steel sheet laid beneath the weight as well as we can provide a steel bars to sustained the tensile and compressive forced on it.

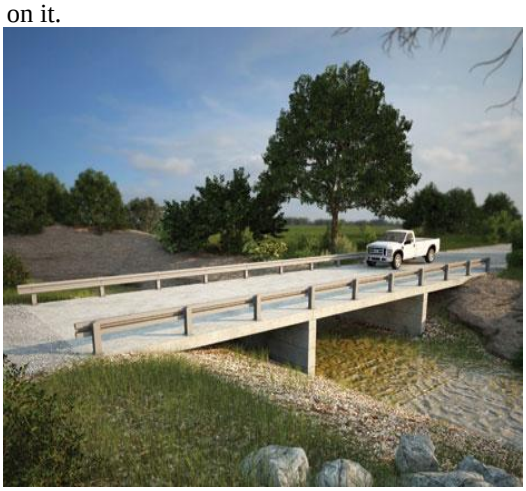


Fig 1: Minor deck Bridge

II. LIERATURE REVIEW

For the proper functioning of our project I have undergone various national and international papers published. The summary of some important papers gone through are as below.

Singh Shailendra[1] he has done a study on simply supported and continuous R.C.C. slab he was compare the behavior of continuous bridge with simply supported bridges. To study the comparison with simply supported bridges, the bending moments developed in continuous bridges are considerably less and consequently small sections can be adopted resulting in economy of steel and concrete. He used the effective width method of IRC for design and analysis consideration, he also used FEM method by STAAD-PRO, etc. At the end result show the provision of continuous spans of single span causes considerable reduction in dead load, live load and design moments.

Hemalatha A.[2] she has to be done a study on bridge decks with different loadings using Finite Element Method. In her project she used a different standard loading which are act on reinforced concrete bridge decks. They

investigated aspect ratio (span/width). They analyzed on two lane slab bridge of span 5m to 9.5m and two lane T-beam decks of span 7.5m to 20m. They used IRC Class A Loading and 70R Loading for calculating deflection, longitudinal bending moments, transverse moments, shear force, and torsional moments. They used Finite Element Method, T-beam bridge decks, and concrete deck slab.

R Shreedar[3] has to be done a study on T-beam bridge deck which are constructed with girders. They analyzed the T-beam deck slab with Finite Element Method , they applied a IRC loading on that section. They compared result of 3-D model with one dimensional model and they get a result as a Finite Element Method result are lesser than one dimensional model result. They used IRC loading of Class A, Class AA Loading and 70R Loading.

Indrajit Barua[4] has to be done a study on deck slab of R.C.C. bridges. The design of R.C.C. deck slab for road bridges in India is dictated by consideration of load bearing, even though the failure mode of such slabs under concentrated or wheel loads is due to punching shear. So they present some facts about shear in concrete deck slab and urges the revision of the IRC code to prescribe design for punching shear so that large saving in reinforcement needed for deck slabs may be effective.

Wije Ariyaratne[5] he has done a study on simple methods for reinforced concrete slab bridges. The main purpose of his study is to developed a quick and a simple method to determine the rating of the reinforced concrete slab bridges. In his paper he discusses three different assessment methods used for a typical concrete slab bridge. The results obtained from these methods are compared with the rating obtained from the proof load testing of this bridge.

Tarek Hassan[6] has to be done a study on analysis of minor deck bridge by using a glass fiber reinforced polymer and carbon fiber reinforced polymer as alternative solution for increased life of deck. They make a testing on two full-scale models of a concrete bridge deck slab. In result they found that the failure of loads of full-scale bridge deck slab are more than seven times the service loads specified by AASHO code (1996).

III. METHODOLOGY

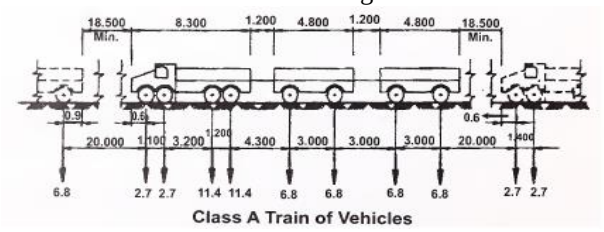
In a past days the bridges are design by using working state methods. But now a days according to government of India the bridge should be design on the basis of limit state method. For analysis purpose of bridge deck the Effective Width Method of IRC 112:2011 Iis used and Finite Element Method is used which is software basis.

If we use IRC method for design of minor deck bridge we have to make two models first of plate elements and second one is beam element. If we go for software basis we have to make a 3-D modeling. For plate element we have to make grid frame and for beam element 3-nodel and 4-nodel element.

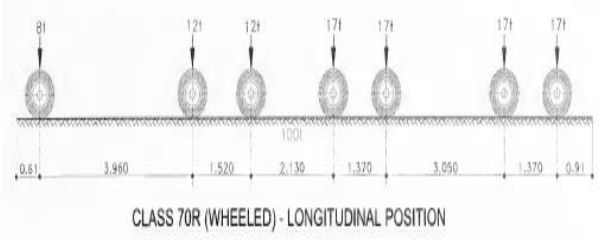
Some important points which are taken by IRC code are as below:

IRC -5-1998 Standard Specification and code of practice for road bridge (Section : I) General features of design.
Information about bridge superstructure
Bridge Aesthetics
Bearing and Joints
Utilities

IRC-6-2010 Standard Specification and code of practice for road bridge (Section : II) Loads and Stresses.
Types of loads
Classification of IRC class loading



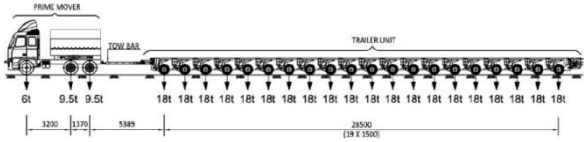
IRC-21-2000 Standard Specification and code of practice for road bridge (Section : III) Cement concrete (plain and reinforced)
Materials
General design requirement



IRC- 112-2011 Code of practice for Concrete Road Bridges.
Basic design
Material properties and their design values

IRC-6-2014 Code Standard Specification and code of practice for road bridge (Section : II) Loads and Stresses.

1) Types of loads
2) Classification of IRC class loading



EFFECTIVE WIDTH METHOD

For analyzing the Concrete solid deck slab we can used the effective width method in which the bending moment per unit width of slab caused by concentrated loads on solid slabs spanning in one directions or on cantilever slabs, may also be calculated by assessing the width of slab that may be taken as effective in resisting the bending moment due to the concentrated loads. The effective width may be calculated by formula.

$$b_{ef} = \alpha a\left(\frac{(1-a)}{l_0}\right) + b_1$$

b_{ef} = The effective width of slab
L_o = The effective span
a = The distance of the concrete of gravity of the concentrated load from near support
b_1 = The breadth of concentration area of the load

α = Constant having the following value depending upon the b/L0 ratio
b = width of slab

IV. CONCLUSION

The conclusion obtained from my research are the Effective Width Method specified in IRC is time consuming method as for each wheel we have to calculate area and for longer vehicle with number of axles it is more lengthy job, so it is better to go for alternate method which will provide the similar results with less efforts and time. From the all above papers we can understand that the Finite Element Methods are suitable for a long span design of a bridge. It gives a quick result as compared to analytical methods. The result obtained as as below.

TABLE NO:1
BENDING MOMENT CALCULATION FOR DIFFERENT SPAN

SR.NO	SPAN	DEAD LOAD (B.M.)	I.R.C.LOADING	LIVE LOAD (B.M.)
			70R TRACK LOADING	16.305tm/m width
1.	8M	23.63tm/m width	70R WHEEL LOADING	16.07tm/m width
			70R BOGGIE LOADING	13.104tm/m width
			CLASS A LOADING	10.25tm/m width
			70R TRACK LOADING	16.305tm/m width
2.	7M	8.42tm/m width	70R WHEEL LOADING	9.00tm/m width
			70R BOGGIE LOADING	14.792tm/m width
			CLASS A LOADING	10.25tm/m width
			70R TRACK LOADING	16.305tm/m width
3	10M	24.33tm/m width	70R WHEEL LOADING	16.07tm/ m width
			70R BOGGIE LOADING	13.104tm/ m width
			CLASS A LOADING	10.254tm/m width
			70R TRACK LOADING	8.3tm/m width
4	6M	5.28tm/m width	70R WHEEL LOADING	7.35tm/m width
			70R BOGGIE LOADING	8.04tm/m width
			CLASS A LOADING	6.77tm/m width

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