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Seismic Performance of T-Beam Short Span Bridge

Aysha Afeeza[1], Shaik Kabeer Ahmed[2], Dr. G.P. Chandradhara[3]
[1]*P.G Student,* [2]*Assitant Professor, Department of Civil Engineering, NMAM Institution of Technology, Nitte, Udupi, India*
[3]*Professor, Department of Civil Engineering, Sri Jayachamarajendra College of Engineering, Mysore, India*

Abstract: The This paper deals with modeling a single span and two span bridge in CSi bridge software, which contains the same length, and doing their analytical comparaison by seeing into parameters like displacement, shear force, time period etc.
Keywords: Static analysis; Shear force; Displacement; Top and bottom stresses ; T beam bridge ;CSi bridge software.

I. INTRODUCTION

Buildings structure have higher degree of redundancy generally inbuilt in their structural system, which mobilizes load paths, where bridges have higher or lower redundancy. Earthquake can find structural weaknesses easily and imply more damage to it. The failure of one structural component or connection between the elements in bridges is more likely to cause collapse of the bridge structure unlike in buildings. In present study, The static analysis is performed on the bridge structure to determine response of the structure on changing span. The introduction of this paper will explain the nature of the problem, previous work, purpose, and the contribution of the paper. And the contents of all section may be provided to understand easily about the paper.

A. Type of Analysis

1) *Nonlinear Static Analysis*: This analysis used to find out the strength of the structure, drift capacity of already built structure and the seismic demand of the new or existing structure subjected to selected earthquake and also used for checking the feasibility of new structural design as well. The lateral load is increased gradually with the distribution pattern with the translational direction of new or existing Structure. It is displaced till target displacement is reached or structure collapses. Once the elastic limit is reached the structure is further loaded which results in formation of cracks, plastic hinge and failure of the structural components. The relation between base shear VS displacement is plotted. This curve is also called as pushover curve or capacity curve. The main objective behind plotting of capacity curve is to determine performance point for a desired seismic demand

2) *Non linear Dynamic Analysis:* The time-history analysis presents the precise response of a structure as a function of time, and is determined by using a step by step numerical integration of the equation of motion. The high response can be obtained from the maximum value of the response-history plot.

3) *Response Spectra:* Response spectra is plotted between maximum response of SDOF system subjected to earthquake ground motion and frequency. It can also seen as the maximum response of SDOF system for a given damping ratio. And it also helps in finding out the peak structural response under linear range, which is used for obtaining lateral forces developed in structure due to the earthquake thus facilitates in earthquake – resistant design of structures.

B. Literature Review

The study of Nasim shatarat and Adel Assaf says that ,a response spectrum analysis and Time history analysis is done, for a bridge in Washington to checkout its service life and also to suggest some retrofitting techniques. The results shows that, some of its cross beams needs to be retrofitted. [1]

The paper made by Amit saxena and Dr.Savita Maru compares T-beam bridge and Box girder bridge interms of their serviceability. Which finally proves, T- beam bridge more serviceable ,economical and efficient. [2]

A study has been done by Rajeev Sharma, In which he has analyzed an existing bridge from Ghaziabad on hindon river. This area is very much vulnerable to earthquake. After the study it is concluded that the bridge structure under seismic vibrations is safe. [3]

C. Objectives

1) To find out shear performance of single span and double span bridge and to determine the more feasible one.

2) To find out displacements in both the bridges and to understand which is more flexible.

3) To explore, how stress factor is changing with change in span.

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II. METHODOLOGY

Two models of T Beam Bridge of 12m span are made by using CSi bridge; one is with a single span and another one is with double span. Static analysis is performed on both the models and they are checked and compared for the parameters like displacement, time period, shear force and top and bottom stresses etc.

A. Material And Geometrical Parameters

Table.1 Material and geometrical parameters

Span	12	m
Carriage way width	3.5	m
Pedestrian width	1	m
Width of crash barrier	0.6	m
Live load	IRC AA Wheel	
Thickness of wearing coat	80	mm
l/d ratio	As per IS 456 2000 clause 23.2.1	
Abutment size	4m deep 2m wide	
Concrete	40	MPa
Steel Fe	500	MPa

B. Models

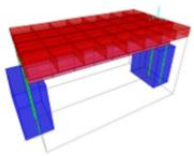

Fig. 1 single span T Beam Bridge

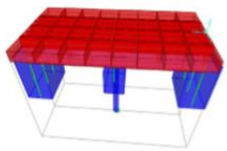

Fig. 2 Two span T beam Bridge

III. RESULTS AND DISCUSSIONS

Table.2 Moments and displacements

Outputs	Values	Dead load			Moving load		
		Single	Double	% Diff	Single	Double	% Diff
Moments (kNm)	Maximum	1908.52	1640	14.06	730.5	587.03	19.64
	Minimum	-1180.7	5.65	100.47	-328.70	-5.094	98.45
Displacement (mm) x10^{-4}	Maximum	-0.544	-0.316	41.91	-0.0236	0.324	1472
	Minimum	7.24	-6.82	194.2	-2.68	-2.21	17.53

A. Displacement Verses Time period

1) Dead load Case

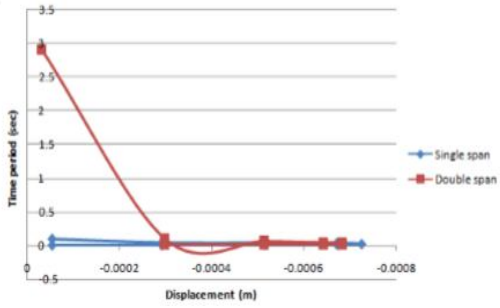

Fig 3 dead load case Time period verses Displacement

For dead load case Time period verses Displacement curve illustrates that (Fig 3), Single span bridge Displaces more when compared with double span bridge but the displacement is negligible
If we look into time period parameter, Double span bridge shows more flexibility when compared with single span bridge.

2) Moving Load Case

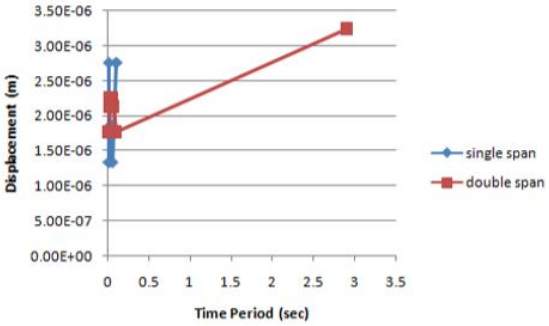

Fig. 4 Displacement verses Time period (Moving load)

In moving load case (Fig 4), Performance of double span bridge is much better when compared with single span bridge. Double span bridge imparts good flexibility and stiffness property.

B. Shear force Verses Displacement

1) Dead Load Case

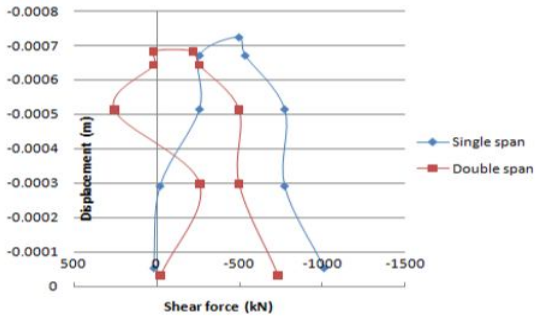

Fig. 5 Shear force verses Displacement (Dead load)

In Dead load case (Fig 5), both single span bridge and double span bridge performs well. Comparatively, single span bridge carries higher shear force.

2) Moving load case

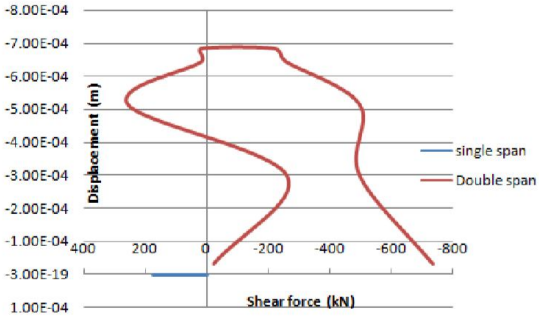

Fig. 6 Shear force verses Displacement (Moving load)

In case of moving load multispan bridge performs well, carrying higher shear force and higher displacement. (Fig 6)

C. Stress Verses Distance Along Span

1) *Dead Load Case:* Top stresses are more in single span bridge when compared with double span bridge (fig 7). Same is not valid for bottom stresses; they are more in double span bridge than single span bridge (Fig 8).
2) *Moving Load Case:* In moving load case also, top stresses are more in single span bridge and comparatively less in double span bridge (Fig 9). Here also, bottom stresses are more in double span bridge (Fig 10)

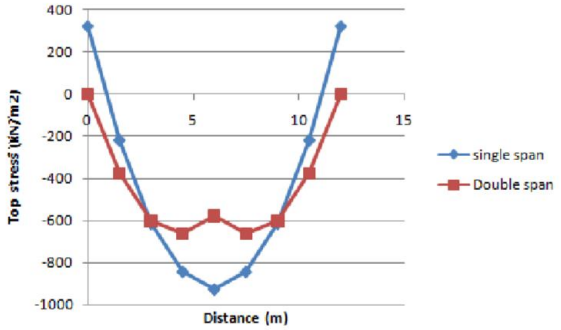

Fig. 7 Top stress verses distance along span (Dead load)

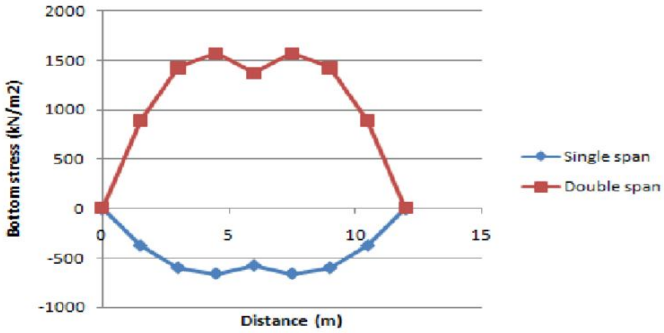

Fig. 8 Bottom stress verses distance along span (Dead load)

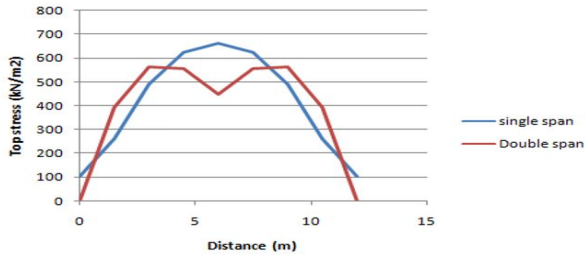

Fig. 9 Top verses distance along span (Moving load)

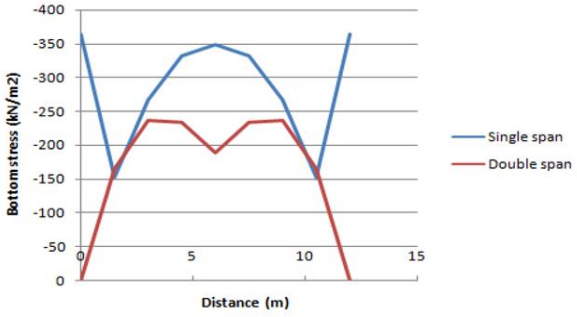

Fig. 10 Bottom stress verses distance along span (Moving load)

IV. CONCLUSION

A. Shear performance of double span bridge is better than single span bridge.
B. Double span bridge is more flexible since we are getting higher time period value.
C. Single span bridge displaces more than double span bridge.
D. Stresses in the top portion i.e., in the deck slab is the major concern, and for both dead and moving load combinations double span bridge shows lesser stresses than single span bridge.
E. Comparatively, Double span bridge performed well in all the areas of concern than single span bridge.

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[3] IRC:5-2015 code of standard specifications and code of practice for road bridges.
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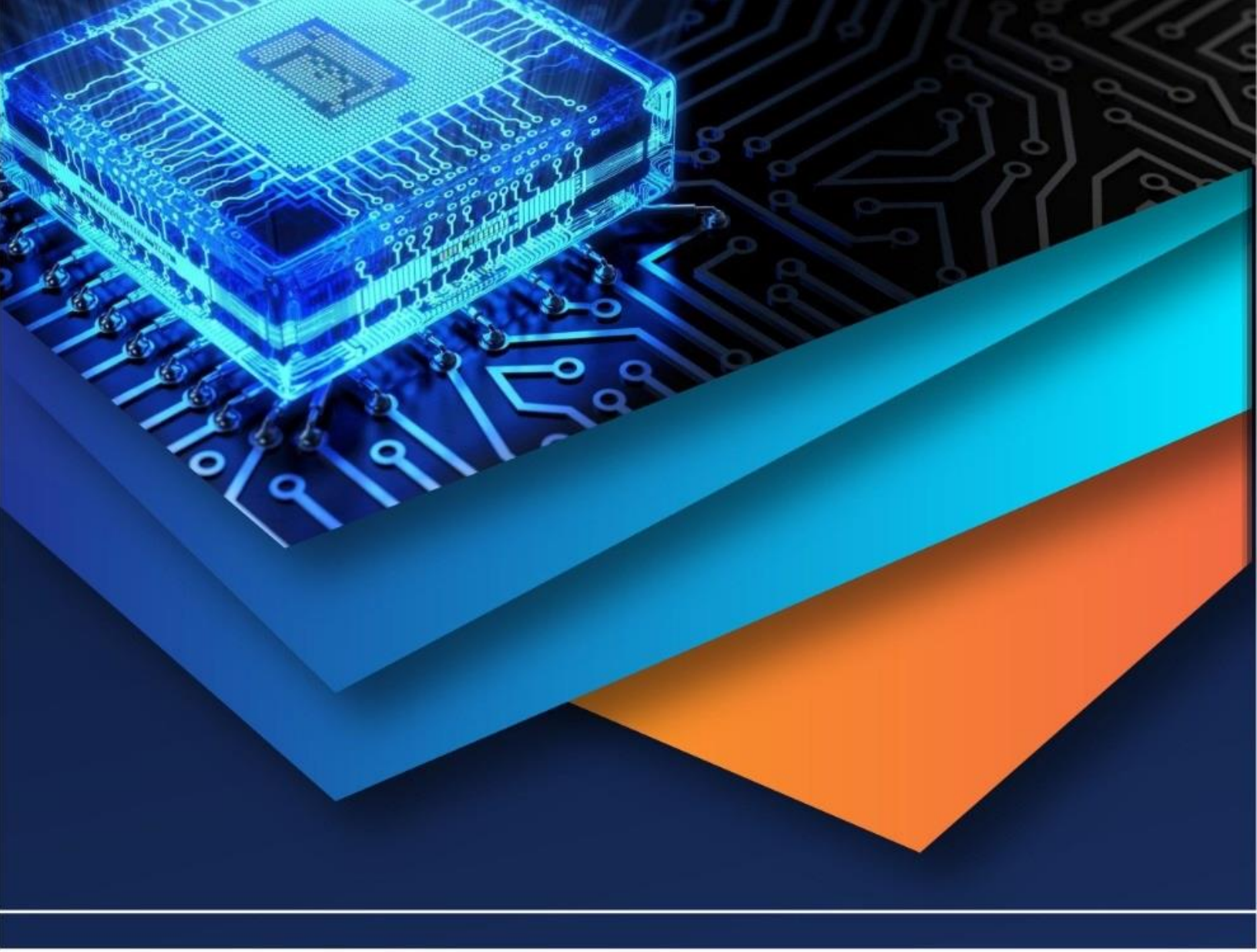
[5] Design of bridges by N. Krishna Raju Fourth edition.



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