iJRASET
International Journal For Research in
Applied Science and Engineering Technology

INTERNATIONAL JOURNAL
FOR RESEARCH
IN APPLIED SCIENCE & ENGINEERING TECHNOLOGY

Volume: 5 **Issue:** XII **Month of publication:** December 2017

DOI:

A Study on Dynamic Response of Bridge Deck Slab under Moving Loads

Mr.Powar A.R. [1], Mr. Khurd. V.G [2]
[1]P.G. Student, Department of Civil Engineering, Sanjay Ghodawat group of institutes, Atigre, Kolhapur, Maharashtra, India[1]
[2]Assistant Professor, Department of Civil Engineering, Sanjay Ghodawat group of institutes, Atigre, Kolhapur, Maharashtra, India[2]

Abstract: Present study includes the modal and transient analysis of bridge deck slab subjected to moving load by using ANSYS software. The modal analysis results are compared with previous literature and close for solution. The parametric study is in form of deflection, stress and strain for variation of models dimension. The study reveals that Finite Element Method can be applicable and reliable tool for analysis of bridge deck slab.
Keywords: Bridge deck slab, Finite Element Method, Natural Frequency 3D-FE modelling, IRC loading

I. INTRODUCTION

Vibration of a bridge structure under the passage of vehicles is an important consideration in the design of bridges. The interaction between the vehicle and the bridge makes the dynamic response analysis very complex. To understand the phenomenon and to develop rational design procedures, a number of analytical and experimental investigations were carried out in the past by Jagmohan L. Humar. et. al [1]. The numerous analytical and experimental investigations have shown that the interaction between the vehicle and the bridge is a complex phenomenon governed by a large number of different parameters. The deformation of bridge subjected to vehicles with different velocities is very complicated, and some attention has been paid to it in engineering community. On the basis of typical theory on vibration analysis between bridge and vehicles, finite element model of bridge is established using ANSYS software. Through the numerical simulation analysis dynamic response characteristics of the bridge body are acquired when the vehicle passes over the bridge deck slab at different speeds and different load frequencies.

II. PROBLEM STATEMENT

There is limited work has been done on finding dynamic response of bridge. Vibration due to moving loads on bridge causes larger effect on deck slab. It is difficult to identify effect of the significant parameters that governs the response. Due to vibrations change in stresses, strains and deflection occurs. Hence finding dynamic behaviour of deck slab is very important. In this research we are finding these stresses, strains and deflection when velocity, span, depth and load frequency changesThe modal analysis is carried out in software. The vehicle load of IRC Class A and IRC Class B traveling along the deck in a direction parallel to span. Damping in both the bridge and the vehicle is ignored. The vehicle is assumed to remain in contact with the deck. So that it will become helpful in future for analysis of deck slab. The design of bridges arise the dynamic response is very much significant in bridge to obtain vibration free and disturb free bridge structure.

III.DECK SLAB DETAILS

Table 1 shows the dimension of deck slab for different spans and effective depths.

Span (m)	Width (m)	Depth (m)			
5	12	0.35	0.40	0.45	0.50
6	12	0.35	0.40	0.45	0.50
7	12	0.35	0.40	0.45	0.50
8	12	0.35	0.40	0.45	0.50

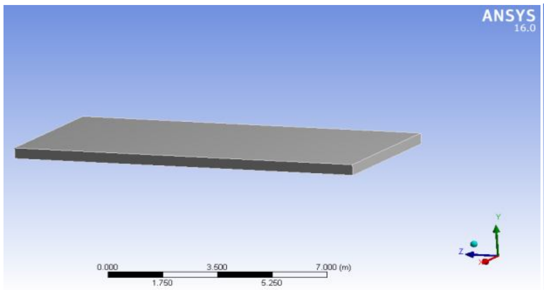
The following IRC loading have been applied for the deck slab

A. IRC Class A

B. IRC Class B

IV. 3D FE MODELLING IN ANSYS

Bridge Deck slab panels of size 12m X 5m, 12m X 6m, 12m X 7m, 12m X 8m with thickness 0.35m, 0.40m 0.45m and 0.50m are modeled in Ansys. Material properties of deck slab are Young's Modulus = 25 x 10^6 MPa, Poisons ratio = 0.15, Density = 25 kN/m^3. The width of slab is 12 m where as span and depth varies as 5m, 6m, 7m, 8m and 0.35m, 0.40m, 0.45m, 0.50m resp. Meshing is developed to slab for accuracy of results, boundary conditions are one end of slab is fixed and other having pinned support.



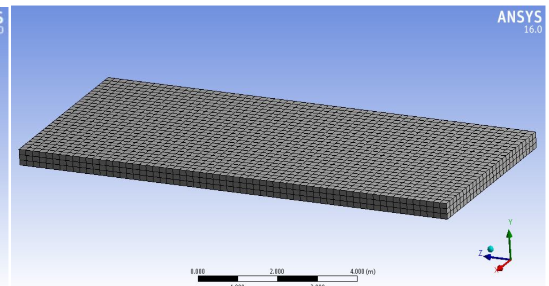


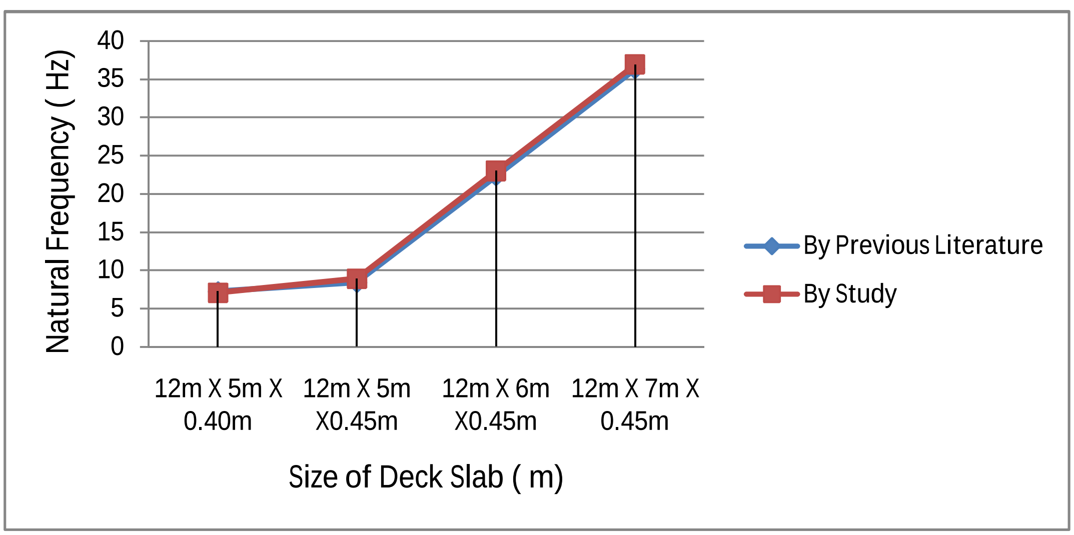
Fig 4.1 Model of Deck Slab 12m X 5m X 0.40m   Fig 4.2 Meshing of Model of size 12m X 5m X 0.40m

V. VALIDATION OF BRIDGE DECK SLAB

A validation of 3D-FE modelling of bridge deck slab is done with previous literature paper for modal analysis. For validation purpose size of models are 12m X 5m, 12m X 7m of thickness 0.40 m are used. In Modal analysis for six numbers of modes natural frequencies are found out, first frequency is approximately matched with previous paper.

Following Table shows the validated natural frequencies of deck slab models. The natural frequencies are approximately same with natural frequencies of deck slab model studied in previous literature.

Size of model	By Previous Literature	By Study	Variation
12m X 5m X 0.40m	7.26 Hz	7.1 Hz	+0.16 Hz
12m X 5m X0.45m	8.4 Hz	8.9 Hz	-0.5 Hz
12m X 6m X0.45m	22.3 Hz	23 Hz	-0.7 Hz
12m X 7m X 0.45m	36.3 Hz	36.9 Hz	-0.6 Hz



International Journal for Research in Applied Science & Engineering Technology (IJRASET)
ISSN: 2321-9653; IC Value: 45.98; SJ Impact Factor:6.887
Volume 5 Issue XII December 2017- Available at www.ijraset.com

Above graph shows values of natural frequencies which are approximately equal with previous literature.
(Refer Table No. 2)

VI. MODAL ANALYSIS

The modal analysis is carried out for different span lengths for varying depths. Table 3 shows natural Frequencies of the deck slab. The result shows that as the depth increases natural frequencies are also increases.

Dimension (m)	Depth (m)	Natural Frequencies (Hz)					
		Mode 1	Mode 2	Mode 3	Mode 4	Mode 5	Mode 6
12 X 5	0.35	6.254	15.39	20.205	34.05	41.929	58.059
	0.40	7.193	17.455	22.978	38.565	47.526	59.989
	0.45	8.0264	19.609	25.848	43.301	53.400	60.009
	0.50	8.9082	21.681	28.681	47.819	59.008	60.011
12 X 6	0.35	6.230	13.371	20.228	30.574	41.973	43.733
	0.40	7.135	15.184	23.003	34.669	47.571	49.6
	0.45	11.428	23.207	36.877	53.775	76.268	78.947
	0.50	12.68	25.677	40.834	59.404	84.209	87.164
12 X 7	0.35	6.265	11.958	20.245	28.238	34.240	42.002
	0.40	2.603	13.987	14.669	31.539	34.261	39.212
	0.45	11.453	20.873	36.964	50.019	61.735	76.425
	0.50	8.924	16.923	28.692	39.828	48.212	59.113
12 X 8	0.35	6.270	10.926	20.26	26.602	28.03	42.03
	0.40	7.16	12.456	23.1	30.295	31.909	47.82
	0.45	8.046	13.975	25.919	33.95	39.745	55.53
	0.50	12.737	21.239	41.024	52.416	55.815	84.549

VII. TRANSIENT ANALYSIS

The transient analysis is carried out for different span lengths for varying depths under moving loads. The loading is applied in form of IRC type loading. As load moves on slab deflection, stress and strain develops in it.

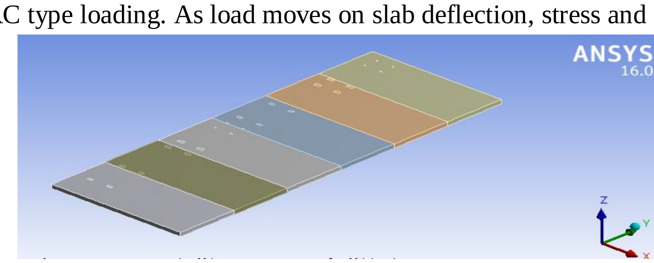


Fig 6.1, Model for transient analysis, size 12 X 5 X 0.40

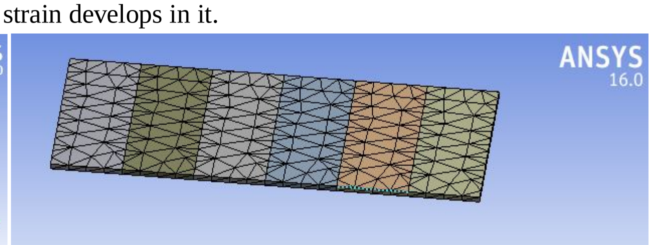


Fig 6.2, Meshing of model, size 12 X 5 X 0.40

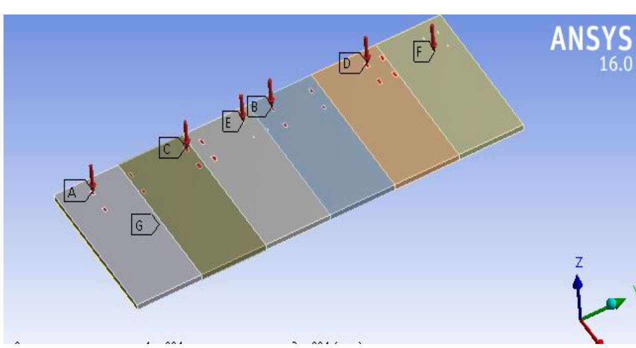


Fig 6.3, Application of load on slab models, IRC Class A loading

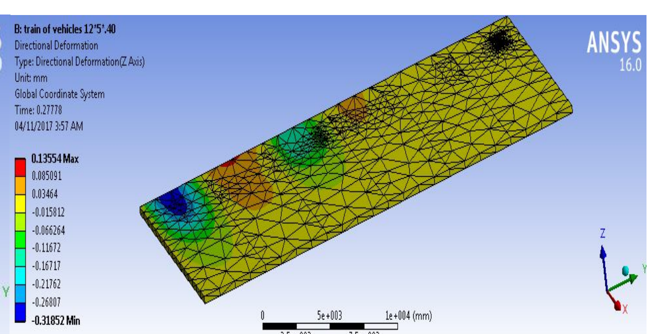


Fig.6.4Deflection of slab of size 12 X 5 X 0.40 m, IRC Class A loading

International Journal for Research in Applied Science & Engineering Technology (IJRASET)
ISSN: 2321-9653; IC Value: 45.98; SJ Impact Factor:6.887
Volume 5 Issue XII December 2017- Available at www.ijraset.com

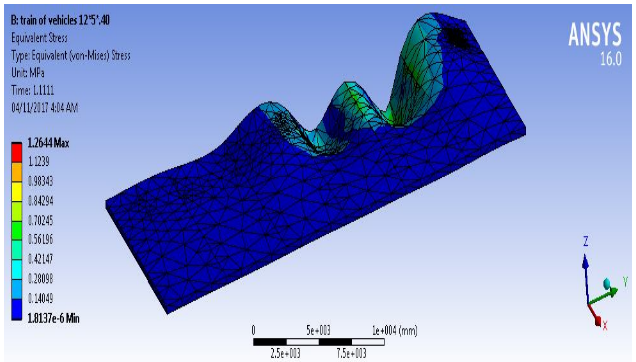


Fig 6.5, Stress in slab of size 12 X 5 X 0.40 m, IRC Class A loading

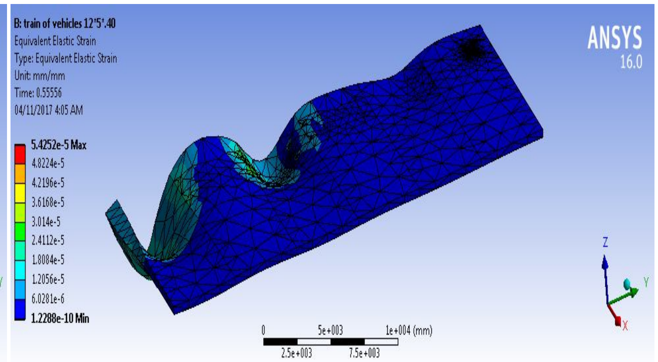


Fig.6.6, Strain in slab of size 12 X 5 X 0.40 m, IRC Class A loading

VIII. RESULT & DISCUSSION

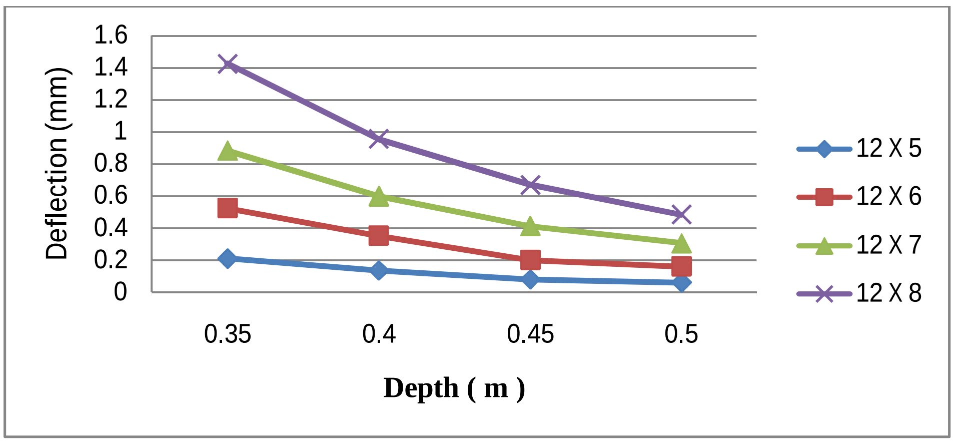


Fig.7.1 Effect of Class A loading on Distribution of Deflection in deck slab

As depth increases changes occur in deck slab that is deflection is decreases. For span 5m, maximum deflection is 1.4252 mm when depth is 0.35m. For span 6 m, maximum deflection is 0.8833 mm when depth is 0.35m. For span 7m maximum deflection is 0.5252 mm when depth is 0.35m. For span 8m maximum deflection is 0.2098 mm when depth is 0.35m.

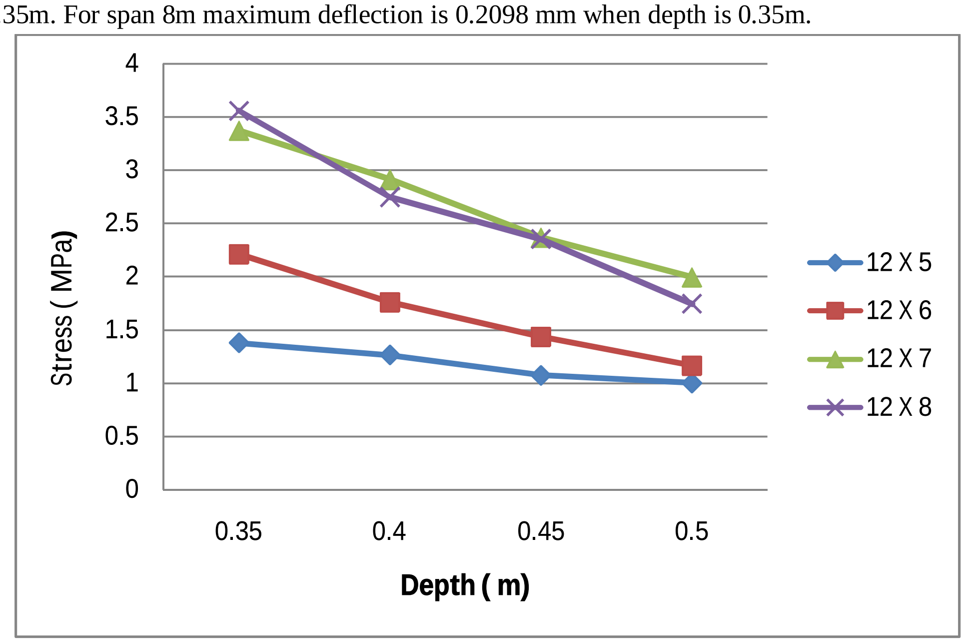


Fig.7.1 Effect of Class A loading on Distribution of Stress in deck slab

For 5m width span maximum stress is 1.3776 MPa, for 6m width span stress is 2.2106 MPa, for 7m width span stress is 3.3707 MPa and for 8m width span stress is 3.5583 MPa for IRC Class A loading when depth is 0.35m. As depth increases stress decreases.

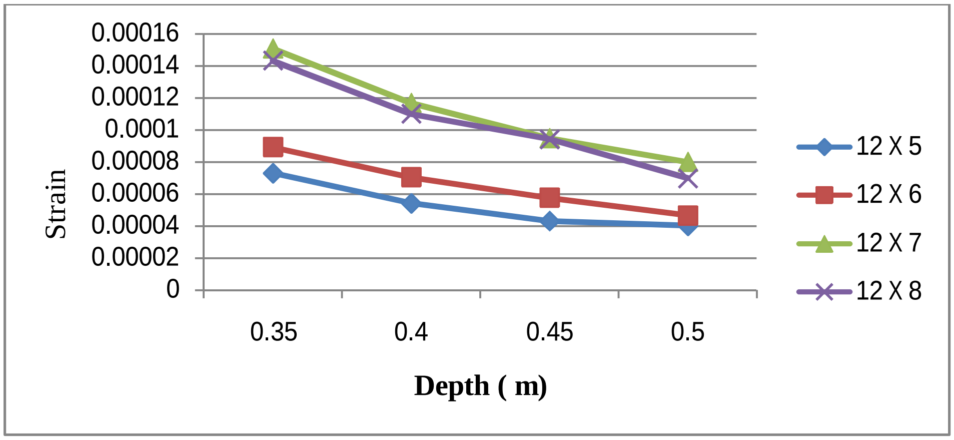


Fig.7.1 Effect of Class A loading on Distribution of Strain in deck slab

Maximum strain developed for 5m width deck slab span is 0.000073, for 6m width deck slab span 0.0000892, for 7m width deck slab span 0.00015, 8m width deck slab span 0.00014 for IRC Class A loading.

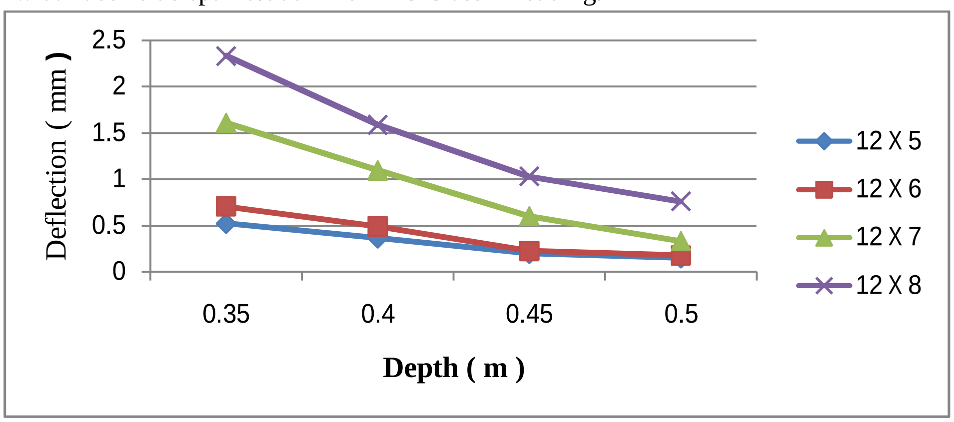


Fig.7.1 Effect of Class B loading on Distribution of Deflection in deck slab

For span 5m, maximum deflection is 0.5235 mm when depth is 0.35m. For span 6 m, maximum deflection is 0.7082 mm when depth is 0.35m. For span 7m maximum deflection is 1.6107 mm when depth is 0.35m. For span 8m maximum deflection is 2.3299 mm when depth is 0.35m for IRC Class B loading.

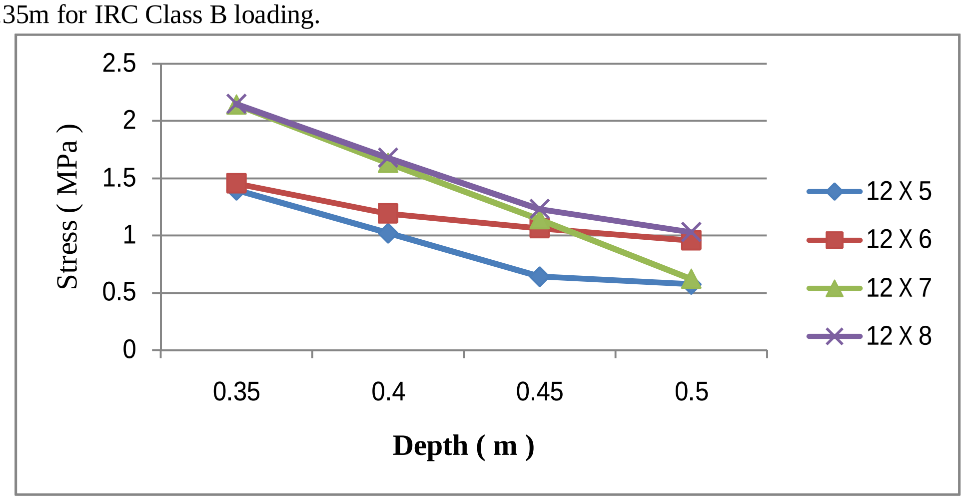


Fig.7.1 Effect of Class B loading on Distribution of Stress in deck slab

For 5m width span maximum stress is 1.3955 MPa, for 6m width span stress is 1.4534 MPa, for 7m width span stress is 2.1424 MPa and for 8m width span stress is 2.1461 MPa for IRC Class A loading when depth is 0.35m. As depth increases stress decreases.

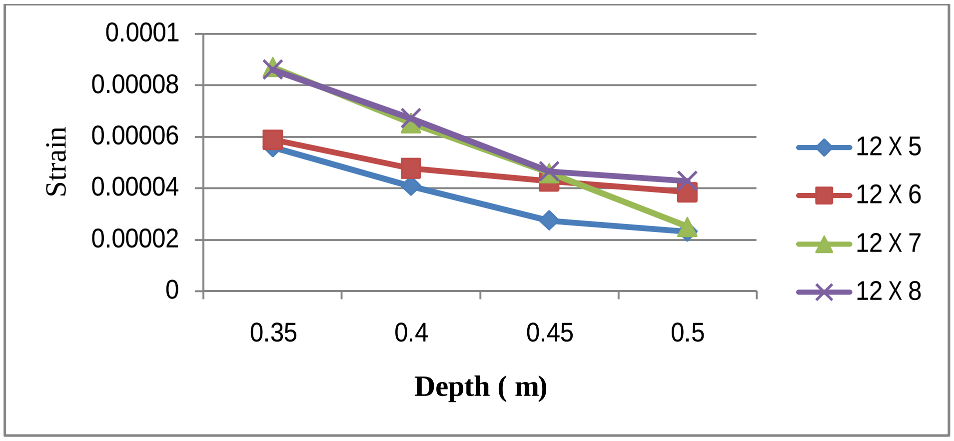


Fig.7.1 Effect of Class B loading on Distribution of Strain in deck slab

Maximum strain developed for 5m width deck slab span is 0.000056, for 6m width deck slab span 0.0000588, for 7m width deck slab span 0.000087, 8m width deck slab span 0.000086 for IRC Class A loading.

IX. CONCLUSION

The dynamic response of a bridge deck slab to moving vehicles was studied.. The dynamic response was measured in terms of the normalized deflection, stress and strain. Following conclusions were drawn on the basis of results obtained from this study of simplified models of the bridge and the vehicle.

A. Results of modal analysis obtained from 3D-FE analysis by using ANSYS are very close to previous literature. ANSYS software can be used for finding natural frequencies for deck slab analysis.

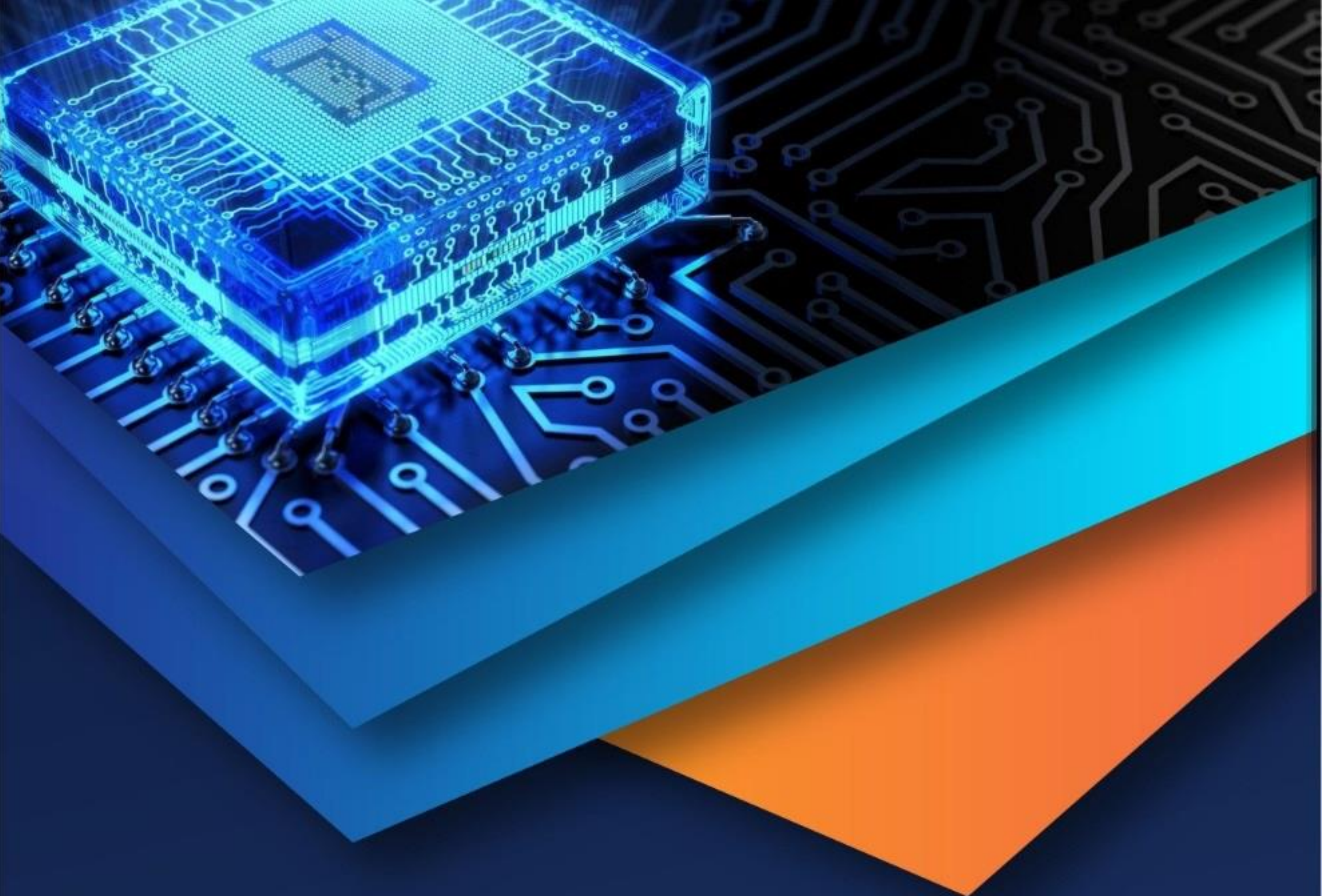
B. The modal analysis result shows that, as the depth increases, the natural frequencies are also increases.

C. The transient analysis results shows that deflection, stress and strain decreases as depth increase .

D. As span increases deflection, stress and strain decreases.

REFERENCES

[1] Humar Jagmohan L. and. Kashif Ahmed H "dynamic response analysis of slab-type bridges", Journal of structural engineering, 1995.121:48
[2] Broquet Claude, Bailey Simon F., Mario Fafard, and Bru Eugen "Dynamic Behavior of Deck Slabs of Concrete Road Bridges", journal of bridge engineering, 2004-9
[3] Ayad Thabit Saeed Al-Ghabsha, Dr. Mohamad Najim "dynamic analysis of bridges subjected to moving vehicles", Al-Rafidain Engineering Vol.14 No.4 2006
[4] Ji Jing , Zhang Wenfu , Zhao Wenyan, Yuan , Chaoqing Yang, "Analysis and Comparison on Dynamic Characteristics of the Bridge Subjected to Moving Load Based on ANSYS " Journal of Convergence Information Technology(JCIT) Volume7, 2012
[5] Bhkari Norshariza Mohamad, Rahman Azlan Abd , Baderul Hisham Ahmad,"Modal Analysis of Concrete Bridge Decks Subjected to Free Vibration,
[6] Inbanathan Mahil J. and Wieland Martin "bridge vibrations due to vehicle moving over rough surface", Journal of Structural Eng. 1987.113:1994-2008
[7] Shwetha Siddesh "vibration response of deck slab", Proceedings of Twelveth IRF International Conference, 31st August 2014, Chennai, India, ISBN: 978-93-84209-48-3
[8] N. Munirudrappa and H. N. Dhruvaraja Iyenger "Dynamic Analysis of Continuous Span Highway Bridge ISET Journal of Earthquake Technology, paper no. 392, vol. 36, 1999
[9] Lai-Jun Liu, He-Xu Liu , Zi-Xue Lei "Simulation Analysis of Bridge's Dynamic Response Under Vehicular Load" ,
[10] International Conference on Future Computer Science and Education, EEE DOI 10.1109/ICFCSE.2011.15
[11] Standard specifications and code of practice for road bridges, IRC : 5-1998, IRC : 6-2000,IRC : 18-1985, IRC : 21-200 Ottawa, Canada, 20(2), 287-298
[12] Andre R. Barbosa, Tim Link, David Trejo, "Seismic Performance of High-Strength Steel RC Bridge Columns." Journal of bridge eng., ASCE.



10.22214/IJRASET

INDEX COPERNICUS 45.98

IMPACT FACTOR: 7.129

TOGETHER WE REACH THE GOAL

IMPACT FACTOR: 7.429

INTERNATIONAL JOURNAL FOR RESEARCH

IN APPLIED SCIENCE & ENGINEERING TECHNOLOGY