iJRASET
International Journal For Research in
Applied Science and Engineering Technology

INTERNATIONAL JOURNAL FOR RESEARCH

IN APPLIED SCIENCE & ENGINEERING TECHNOLOGY

Volume: 8 **Issue:** IX **Month of publication:** September 2020

DOI: https://doi.org/10.22214/ijraset.2020.31642

International Journal for Research in Applied Science & Engineering Technology (IJRASET)
ISSN: 2321-9653; IC Value: 45.98; SJ Impact Factor: 7.429
Volume 8 Issue IX Sep 2020- Available at www.ijraset.com

A Comparative Study of RC Deck Bridge and Rubberized Concrete Deck Bridge

Aakash Shrivastava[1], Dr. A. K. Jain[2]
[1]*(M.E. Scholar, NITTTR, Bhopal)*
[2]*(Professor & Head, Department of Civil &Environment Engineering NITTTR, Bhopal)*

Abstract: Due to ageing of bridges, a large number of bridges may not fulfill the requirements of the current scenario. Various structural deficiencies occur in the bridges due to the increased traffic which consequently results in failure of the bridges. Deficiency of bridge includes span and height issue, material quality and critical hogging and sagging moments , excessive displacements and frequency of structure. A suitable change of material can prove to be the solution of all these dificiencies. A typical model of a deck bridge structure is made on STAAD.PRO software and investigation of the same structure under two cases namely RC bridge and Rubberised concrete bridge are performed as per IRC guidelines. The impact of change of geometry is considered in terms of varying number of span , span length and pier height has been carried out under IRC conditions, then the above models are compared in terms of various parameters like displacements in x , y ,z directions , bending moment , shear force , frequency of structure .

Keywords: deck type bridge, rubberized concrete , IRC loadings, STAAD.pro, frequency , displacements

I. INTRODUCTION

The bridge structures are important component in highway, railway, and urban road and play important roles in economy, politics, culture, as well as national defense. Especially for medium span and larger span bridges, they are generally served as “lifeline” engineering due to their vital functions in the transportation network. Therefore, the bridge structures should be carefully planned and designed before the construction. A bridge is a structure built to span physical obstacles without closing the way underneath such as a body of water, valley, or road, for the purpose of providing passage over the obstacle, usually something that can be detrimental to cross otherwise. A bridge carries a large number of population every day, hence its design and construction are cautiously performed. In recent scenario various research are being conducted on the performance, behavior , serviceability , durability of these bridges . All these research helped us to realize that a lot of work can be done in the areas of failures of bridges.

Although, even after careful design, there are a lot of other factors which influences the behavior of the bridges. Due to ageing of bridges, a large number of bridges may not fulfill the requirements of the current scenario. Various structural deficiencies occur in the bridges due to the increased traffic which consequently results in failure of the bridges. Deficiency of bridge includes height issue, pier quality and critical hogging and sagging moments *[S.N.Krishna kanth 2015]*. Concrete bridge deck is subjected to premature cracking which is caused by self desiccation . Self desiccation is a process in which early age cracking is induced by means of autogenous shrinkage. This is main reason for the reduction in durability of the concrete *[Weiss J et. al 1999]*. One of the major reason of the failure of the bridges being the displacements occurring in longitudinal and transverse direction. The cause of these displacements was found to be the excessive dead load and the temperature change. Thus there is a need of some structural aid which can minimize the displacements and also withstand against temperature change. The other reason for bridge failure to be mentioned is the vibration occurring due to the moving load. Cement based concrete are brittle and of high rigidity . In application of traffic barriers , it is desirable for concrete to have high toughness and good impact resistance. Aggregate type has greatest influence on amount of thermal expansion and contraction. Coefficient of thermal expansion plays major role in joint faulting *[Sherry Sullivan 2012]*. Due to this reasons we need to think about some alternate materials which are good against vibrations and are also light in weight.

A technical solution of the unavoidable movements in bridge structure is the use of bridge bearing. A bridge bearing transfers the forces to the piers allowing movement free damping and attenuate vehicular traffic loads on piers. Bridge bearings are best suited to withstand against expansion and contraction occurring due to temperature change. Although the displacements occurring due to the dead weight of structure are still to be resolved as it is the only factor that can be reduced in the design. The search for the alternate material having lesser weight , resistant against temperature and vibration loading ends on rubberized concrete . A rubberized concrete shows good toughness and ductility. Also it decreases the vibration as it has reversible elastic property. Rubberized concrete has found applications in *[Fattuhi & Clarke 1996]* :

1) Vibration damping
2) Resisting impact loads
3) Resisting temperature change
4) Places where high strength is not crucial.

Rubberized concrete have found to be useful in dealing with dynamic loading . It reduces density and compressive strength while increases flexural strength , water absorption and damping ratio . It also absorbs shock waves , induces ductility and impact resistance [Senin 2017]. Different methods which can be used for analysis and design of the bridges are AASHTO, Finite element method, Grillage and Finite strip method. In this dissertation finite element method is adopted for the design and analysis purpose.

II. METHODOLOGY

In this work, the analysis based on finite element method is used to investigate , A COMPARATIVE STUDY OF RC DECK BRIDGE AND RUBBERIZED CONCRETE DECK BRIDGE as per IRC- standards. In order to study the effect seismic force on Progressive Collapse Assessment zone II of India is considered.

A. *Material And Geometrical Properties*

Following materials and geometrical properties are considered in the modeling of the bridge:
Specific weight of RCC = 25KN/m^3
Percentage of rubber used in rubberized concrete 10%
Size of beams 600 X 1200 mm
Size of columns 600 X 1200 mm
Size of deck plate 800 mm.

B. *Loading Conditions*

1) *Dead Load:* The dead loads of each element is calculated automatically by the software STAAD.PRO
2) *Live Load :* As per IRC , the live load for bridge is takes as IRC 70 R LOADING which is also inbuilt in STAAD.PRO

The Deck is subjected to an additional load of 2kN/m^2as per IRC.
Cases of a bridge Models which has been considering the study are given below-

Table 1: Group *1 under consideration*

Software used	Configuration of Bridge	Span length	Number of span	Remarks
STAAD.PRO	Deck type with Varying the number of spans of both bridges	10m	a) 3 b)5 c)7	Stucture analysis of a) RC bridge b) Rubberized concrete bridge .

Table 2: Group *2 under consideration*

Software used	Configuration of Bridge	Span length	Number of span	Remarks
STAAD.PRO	Deck type with Varying the number of spans of both bridges	10m	a) 3 b)5 c)7	Stucture analysis of a) RC bridge b) Rubberized concrete bridge.

Table 3: Group *3 under consideration*

Software used	Configuration of Bridge	Span length	Number of span	Remarks
STAAD.PRO	Deck type with Varying the number of spans of both bridges	10m	a) 3 b)5 c)7	Stucture analysis of a) RC bridge b) Rubberized concrete bridge .

International Journal for Research in Applied Science & Engineering Technology (IJRASET)
ISSN: 2321-9653; IC Value: 45.98; SJ Impact Factor: 7.429
Volume 8 Issue IX Sep 2020- Available at www.ijraset.com

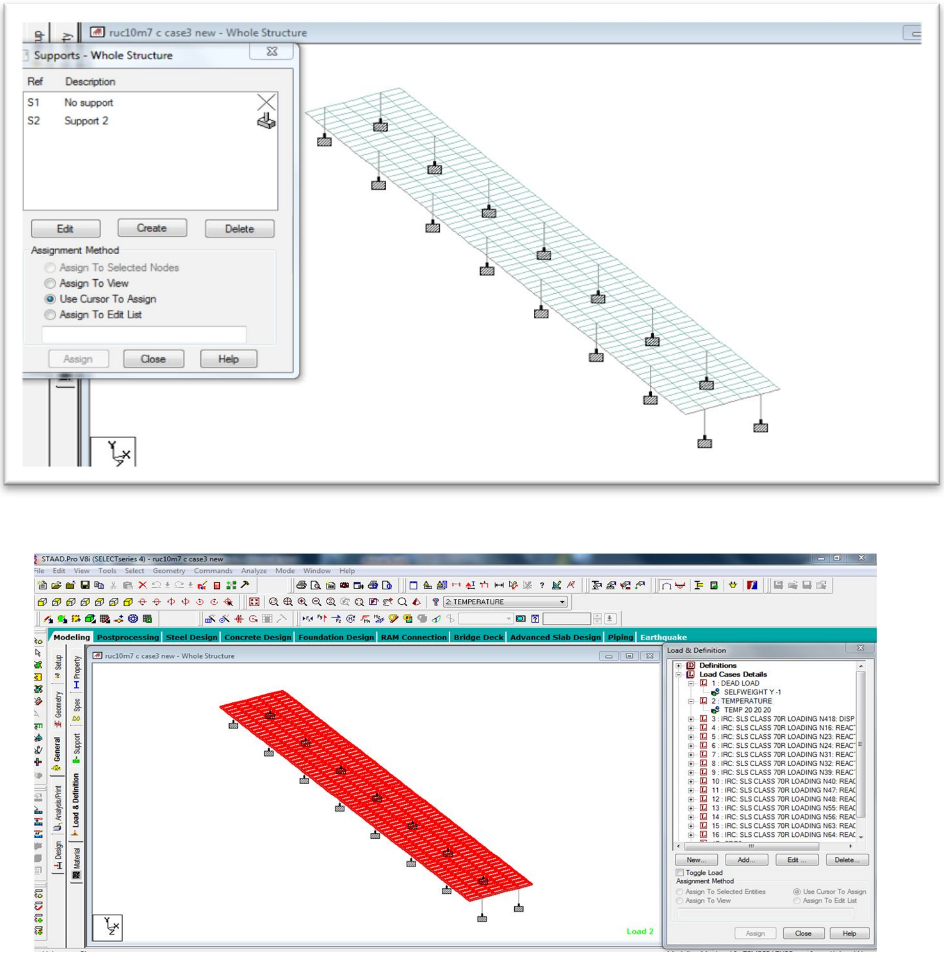


Figure 1: *General view of bridge on STAA.PRO*

III. RESULTS AND DISCUSSIONS

In this section concrete bridges and Rubberized concrete bridges are compared with each other for maximum values of displacements , bending moments in beam , shear force in beam and frequency .

1) *Group 1:* In this group concrete bridge and Rubberized concrete bridges are compared with respect to variation of number of span of the deck .

Table 4.7: Comparison of bridges of three number of spans.

S.no	Parameters	Concrete bridge	Rubberized concrete bridge
1.	Max. displacement(in mm)		
	i. X- direction	8.062	5.378
	ii. Y-direction	3.149	2.727
	iii. Z- direction	3.249	2.374
2.	Max. bending moment : Mz (in kNm)	2120.5	1471.81
3.	Max. shear force : fy (in kN)	1377.85	911.416
4	Max. frequency (in Hz)	87.64	77.424

Table 4.8: Comparison of bridges of five number of span.

S.no	Parameters	Concrete bridge	Rubberized concrete bridge
1.	Max. displacement(in mm)		
	i. X- direction	9.152	6.721
	ii. Y-direction	3.239	2.890
	iii. Z- direction	4.772	2.805
2.	Max. bending moment : Mz (in kNm)	2402.731	2023.12
3.	Max. shear force : fy (in kN)	1558.353	1310.41
4.	Max. frequency (in Hz)	73.58	62.215

Table 4.9: Comparison of bridges of seven number of span.

S.no	Parameters	Concrete bridge	Rubberized concrete bridge
1.	Max. displacement(in mm)		
	i. X- direction	10.103	7.839
	ii. Y-direction	3.396	3.05
	iii. Z- direction	6.174	3.424
2.	Max. bending moment : Mz (in kNm)	2654.82	2216.83
3.	Max. shear force : fy (in kN)	1719.9	1375.09
4.	Max. frequency (in Hz)	62.14	50.94

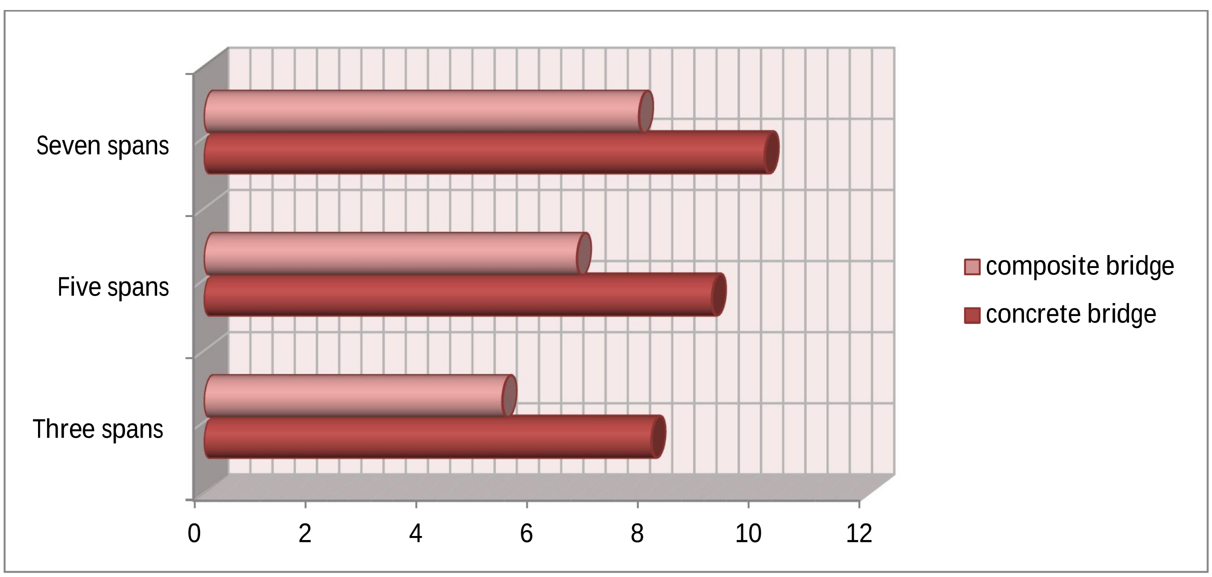


Fig 4.1 : Comparison of displacement in x-direction (in mm) for group 1

In group 1 , it is observed that as the number of spans are increasing the displacement in x direction is also increasing for both concrete and Rubberized concrete bridges , but the displacement in Rubberized concrete bridges are lesser than that in concrete bridges.

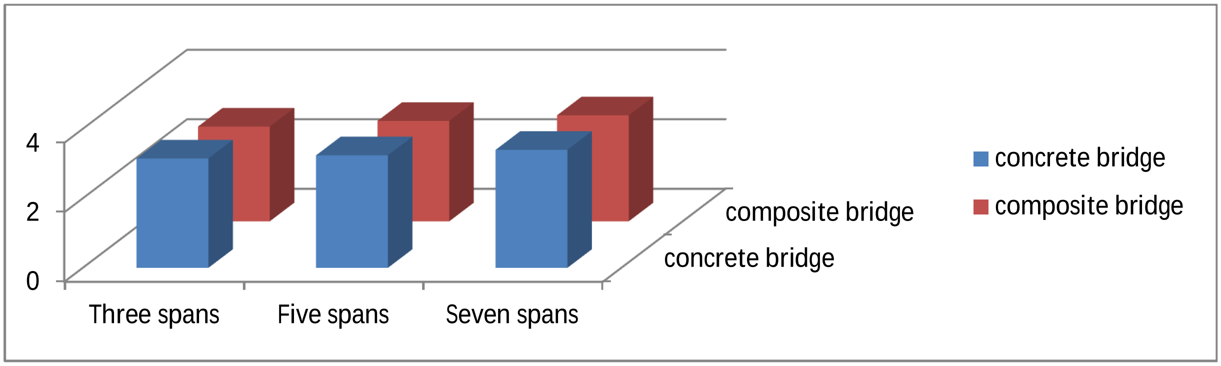


Fig 4.2 : Comparison of displacement in y-direction (in mm) for group 1

In group 1 , it is observed that as the number of spans are increasing the displacement in y direction is also increasing for both concrete and Rubberized concrete bridges , but the displacement in Rubberized concrete bridges are lesser than that in concrete bridges.

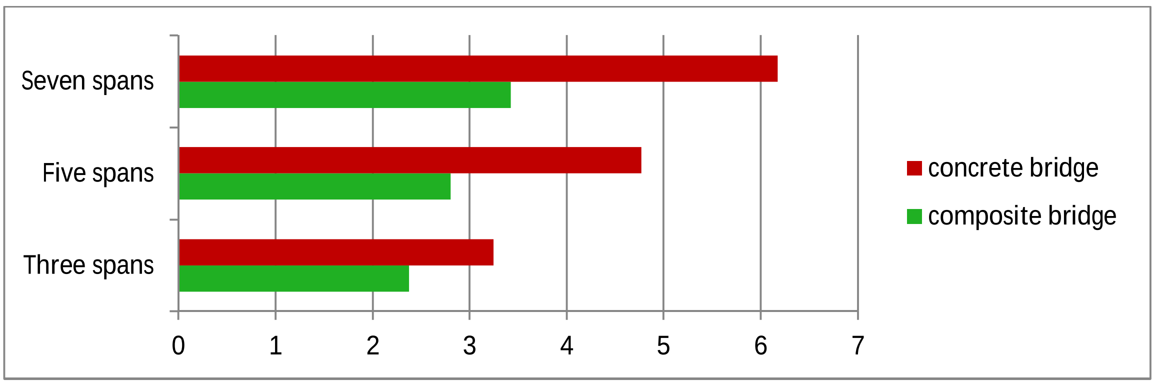


Fig 4.3: Comparison of displacement in z-direction (in mm) for group 1

In group 1 , it is observed that as the number of spans are increasing the displacement in z direction is also increasing for both concrete and Rubberized concrete bridges , but the displacement in Rubberized concrete bridges are lesser than that in concrete bridges.

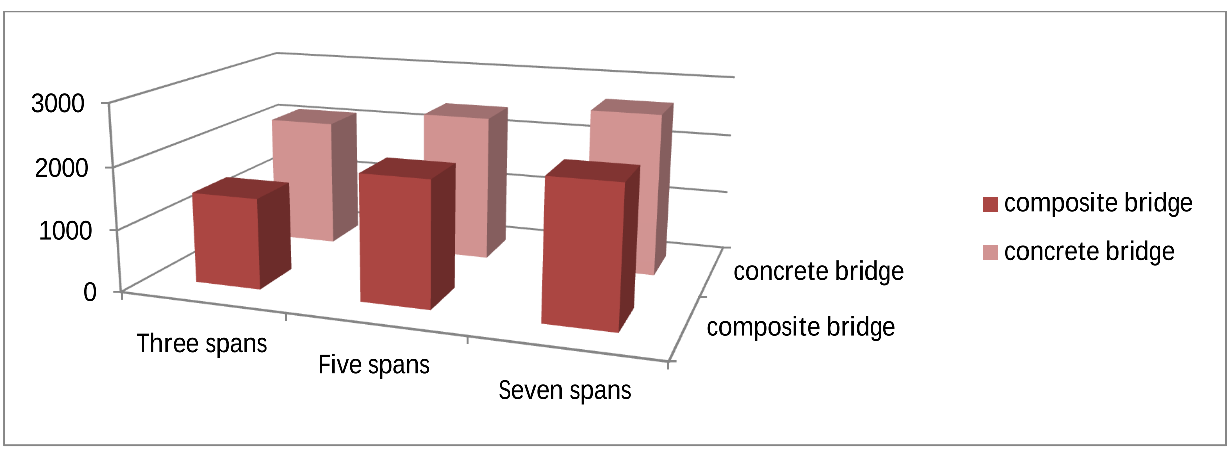


Fig 4.4 : Comparison of bending moment in beam (in kNm) for group 1

In group 1 , it is observed that as the number of spans are increasing the max. bending moment in beam is also increasing for both concrete and Rubberized concrete bridges , but max. bending moments in Rubberized concrete bridges are lesser than that in concrete bridges.

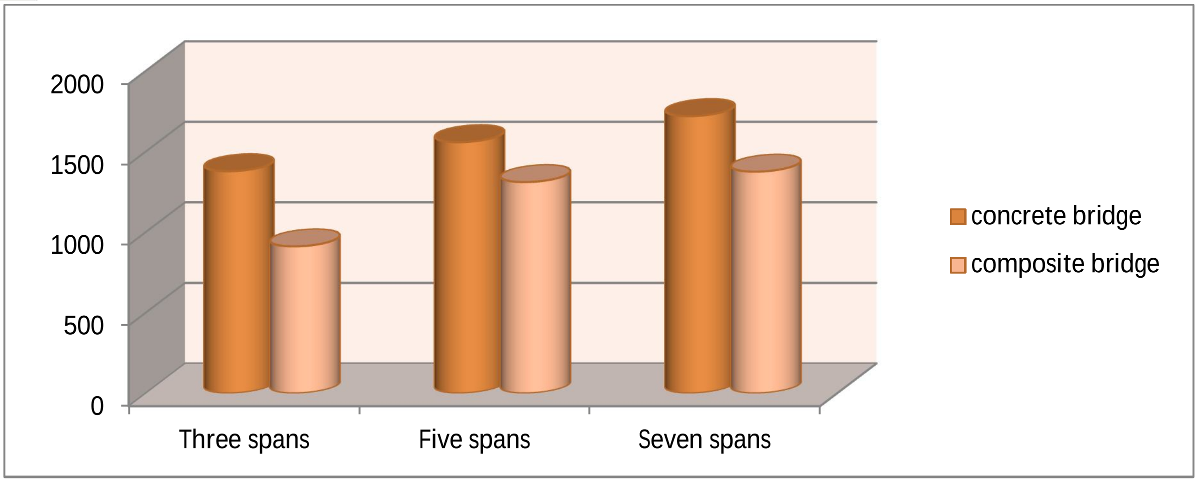


Fig 4.5 : Comparison of shear force in beam (in kN) for group 1

In group 1 , it is observed that as the number of spans are increasing the max. shear force in beam is also increasing for both concrete and Rubberized concrete bridges , but max. shear force in Rubberized concrete bridges are lesser than that in concrete bridges.

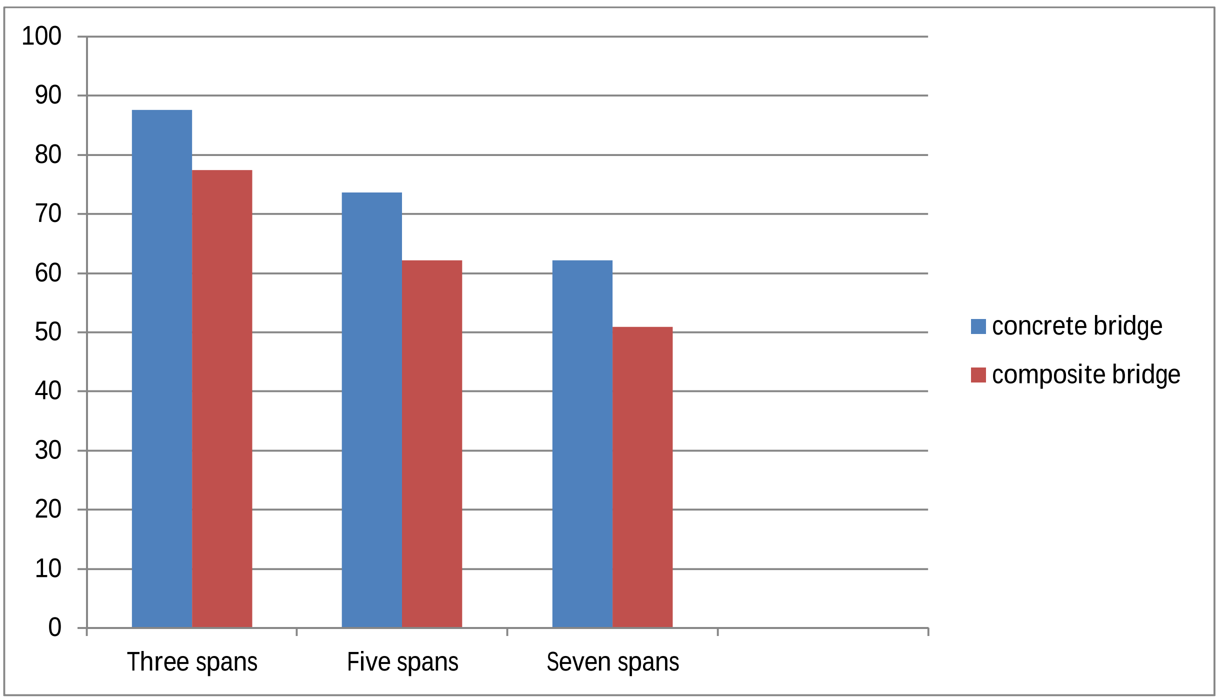


Fig 4.6 : Comparison of frequency (in Hz)for group 1

In group 1 , it is observed that as heights of piers are increasing the max.frequency in the structure is decreasing for both concrete and Rubberized concrete bridges , but max. frequency in Rubberized concrete bridges are lesser than that in concrete bridges.

IV. CONCLUSION

In this study "A COMPARATIVE STUDY OF RC DECK BRIDGE AND RUBBERIZED CONCRETE DECK BRIDGE" was performed using STAAD PRO software. On the basis of various cases considered the structures were analyzed.

Firstly concrete bridges were analysed using finite element method. And all the models were found to be safe.The important design parameters were noted .Secondly Rubberized concrete bridges were analyzed . And all the models were found to be safe which concludes that Rubberized concrete ia a suitable material for bridge construction. And again important design parameters were noted.And then comparative study of the results were done.

Following notable conclusions can be drawn from the result obtained above

1) Under the defined loading conditions , the displacements in x direction in Rubberized concrete bridge is 0.7 times that of concrete bridge
2) Under the defined loading conditions , the displacements in y direction in Rubberized concrete bridge is 0.8 times that of concrete bridge
3) Under the defined loading conditions , the displacements in z direction in Rubberized concrete bridge is 0.66 times that of concrete bridge
4) The maximum bending moments in the Rubberized concrete bridge are 23% lesser than that of concrete bridge .
5) The maximum shear force in the Rubberized concrete bridge are 24% lesser than that of concrete bridge .
6) The maximum frequency in the Rubberized concrete bridge are 0.89 times that of concrete bridge .
7) It is also observed that the performance of Rubberized concrete bridge are better than concrete bridge on account of increasing number of spans.
8) It is also observed that Rubberized concrete bridge has lesser values of design parameters when the length of span is increasing in comparison to concrete bridge.
9) It is also seen that by Rubberized concrete bridges can be used to for greater height of piers than that of concrete bridges.

V. FUTURE SCOPE OF STUDY

Following noteworthy future scopes are suggested.

A. Seismic analysis of rubberized concrete bridge can be done.
B. Cost reduction analysis in rubberized concrete can be performed.
C. Analysis of rubberized concrete bridge by using different loading conditions can be performed.
D. Optimum span length , number of spans and height of peirs can be estimated by further study.

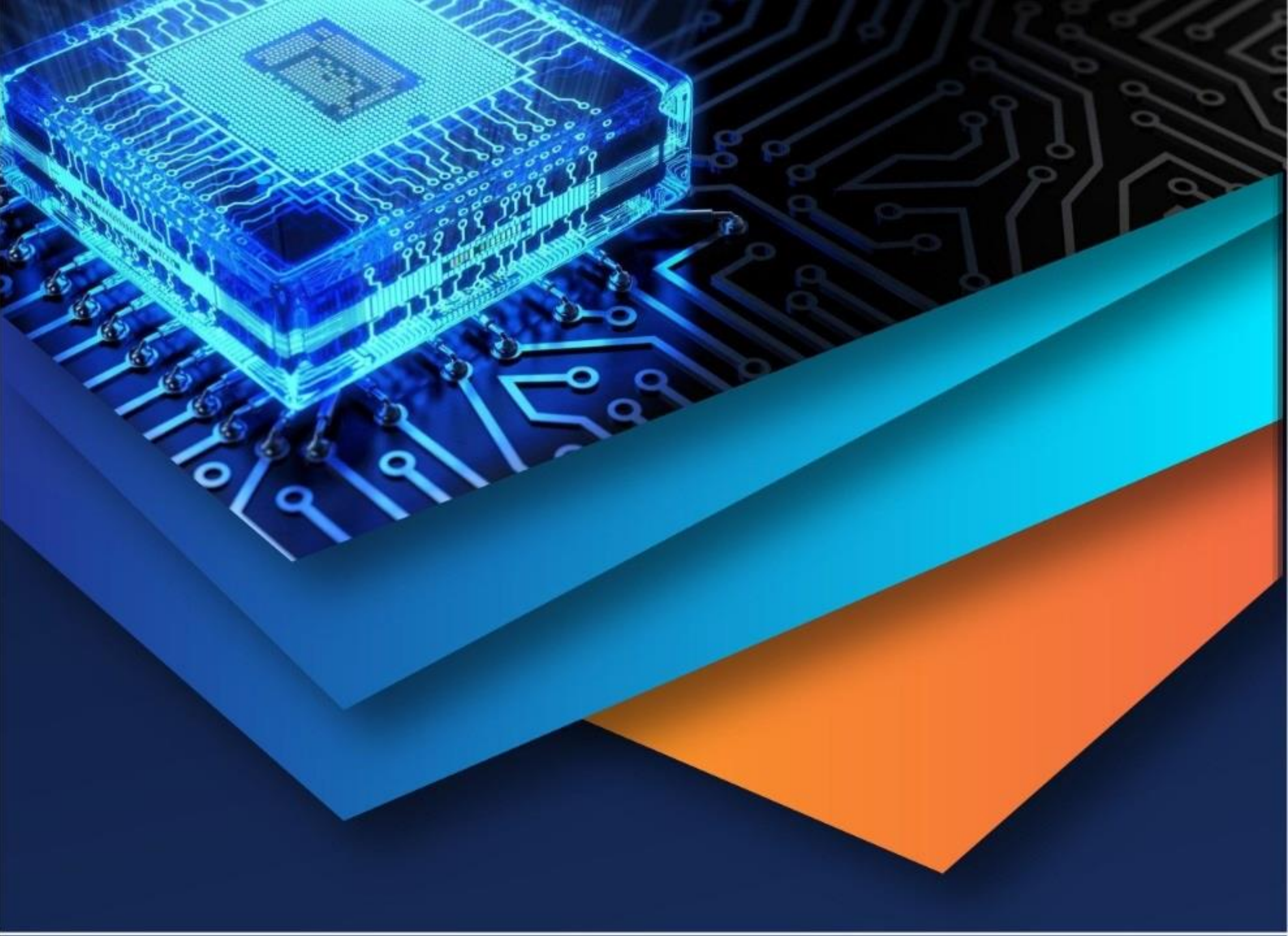
REFERENCES

Journal Papers

[1] Yue Li and Qiqi Wu , "Experimental Study on Friction Sliding Performance of Rubber Bearings in Bridges", Hindawi Advances in Materials Science and Engineering Volume April 2017, Article ID 5845149.
[2] Febymol K B and Rohini G Nair, "Finite element analysis of elastomeric bearing," International Research Journal of Advanced Engineering and Science, Volume 2, Issue 2, pp. 175-178, 2017.
[3] Mr. Kiranakumar V Arutagi, Prof. Ravichandra Honnalli, " A Comparative Study of Conventional RC Girder Bridge and Integral Bridge " International Journal of Advance Engineering and Research Development , june 2017.
[4] Imtiyaz Ahmad Parry, Dr. D. K. Kulkarni, Basavaraj Gudadappanavar, "Performance Evaluation of Elastomeric Pads as Bridge Bearings under Earthquake Loads", International Research Journal of Engineering and Technology , Volume 4, August 2017
[5] K.R.Dheepan, S.Saranya, S.Aswini , "Experimental Study on Bubble Deck Slab using Polypropylene balls", International journal of Engineering development and Research , Volume 5 ,2017
[6] Tejas N Rathi , " Comparative Study of Bearing and Integral Type Bridges as Per Indian Standards", International Journal of Science Technology & Engineering volume 1 , May 2015
[7] Nitin Chavan , Pranesh Murnal, "A Comparative Study on Seismic Response of Bridge with Elastomeric Bearing and Elastomeric Isolator", Journal of Civil Engineering and Environmental Technology , Volume 2, Number 10; April-June, 2015
[8] Ashwin Maru, "Construction of Bridge Decks with Pre-Cast, Pre-StressedConcrete Deck Planks", American Journal of Civil Engineering, july 2015
[9] Namdeo Hedaoo, Namdeo Raut, Laxmikant Gupta. Composite Concrete Slabs with Profiled Steel Decking: Comparison Between Experimental and Simulation Study. American Journal of Civil Engineering. Vol. 3, October 2015
[10] R.Z. Wang, S.-K. Chen, K.-Y. Liu, C.-Y. Wang, K.-C. Chang and S.-H. Chen , "Analytical Simulations of the Steel-Laminated Elastomeric Bridge Bearing", Journal of Mechanics / Volume 30 / Issue 04 / August 2014
[11] Shehata E. Abdel Raheem " Exploring Seismic Response of Bridges with Bidirectional Coupled Modelling of Base Isolation Bearings System " ARABIAN JOURNAL FOR SCIENCE AND ENGINEERING · October 2014
[12] Jaturong Sa-nguanmanasak, Taweep Chaisomphob and Eiki Yamaguchi, "Improvement on design analyses of composite steel-concrete bridges using elaborate finite element methods" ,Songklanakarin J. Sci. Technol. 32 (3), 289-297, May - Jun. 2010

Books

[1] D. Johnson Victor –" Essentials of Bridge Engineering" (sixth edition), 2019
[2] Donna Latham, Jenn Vaughn – "Bridges and Tunnels" , 2012
[3] N. Krishna Raju – " Design of bridge" (fifth edition), 2019
[4] M.K. Pant- "Elements of Bridge Engineering" (first Edition) January , 2014
[5] Duggal S. K., Earthquake-Resistant Design of Structures (Second Edition). 2014.



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