A Study on Seismic Analysis of Straight Bridge and Skew Bridge Structure

Dr. C. P. Pise[1] Mr. Shinde Amol Bapu[2]
[1]Guide [2]Student
[1,2]SKN Sinhgad College of Engineering, Korti, Pandharpur-413304, Maharashtra, India

Abstract— This paper deals with the Non-Linear Dynamic Analysis of Skew Bridge using STAAD.Pro V8i software subjected to Earthquake loading. In present, construction of Skew Bridges short and medium spans for by-passing the traffic is extensively happening due to its easily load bearing properties. Therefore, it is a need to check its stability against strong earthquake. So the Non-Linear, Time history analysis of skew bridge modeled in STAAD.Pro is carried out in this reseskew. For Time History analysis the Bhuj-2001 Earthquake data is used & for Reference the Rudramata Bridge which was failed during Bhuj Earthquake is studied. This study mainly focuses on the study of displacement, Time-Velocity, Time-Acceleration result of Skew Bridge against lateral loads. And results show that displacement in all three directions for skew bridge is Less the that for Rudramata bridge.

Keywords: skew Bridge, STAAD.Pro V8i, Non-Linear Dynamic analysis, Time History, Rudramata, Bhuj, Displacement, Time-Velocity, Time- Acceleration

I. INTRODUCTION

The study of Skew Bridge's Behavior under the time history load is important for the areas which are prone to the earthquake. The STAAD.Pro V8i version software is also a leading software in the field of structural analysis analysis. Nonlinear analysis allows us to account changes in stiffness with application of load. Depending on the nature of the problem, the loads should be applied in steps while the stiffness is adjusted multiple times within a load step to arrive at a converged solution. The objectives of damages field inspection of the bridge structure are to evaluate the structural performance, to identify the actual and potential sources of damage at the earliest possible stage, to explain the member state weather is in safe or unsafe, to classify the damaged parts in bridge members, and to identify any maintenance, repair, and strengthening that needs to be carried out. The deterioration of a bridge structure often appears in visible signs of damage. A detailed investigation provides information about the damages. Various test may be used to complement of the results of the visual investigation. Testing techniques and equipment should be determined relative to the amount and type of the deterioration and the importance of structure.

The purpose of evaluating the bridge structure damage is not only to determine the effect of damage to its remaining service life and load-carrying capacity, but also to determine the causes of defects. Generally, the damages occur in concrete bridges under unacceptable loads can be classified into cracks beneath the beam and slab. Additional settlement of bridge slab, extra vibration due to upcoming loads, corrosion of reinforcement, and spalling of concrete.(Sadeghi and Fathali 2007). In the present study, Rudramata concrete bridge is inspected for the Lateral loading in terms of Time-History Analysis. The objectives of this study are to investigate is there any kind of reduction in displacement, and to compare the results of Bridge by considering the full span and Half span bridge models.

Fig. 1: Skew Bridge.

A. Aim and Objective:

Non-Linear Analysis of Skew Bridge Subjected to Ground Motion objective:

- To compare straight bridge for equivalent skew bridge for earthquake zone.
- To study effect of curvature on the structural response of bridge.
- To study non-linear analysis of skew bridge.
- To compare effect span of bridge and its radius of curvature subjected to specified ground motion.
- To validate the model with analytical results.

II. METHODOLOGY

Following Are Scheduled Work For Project:

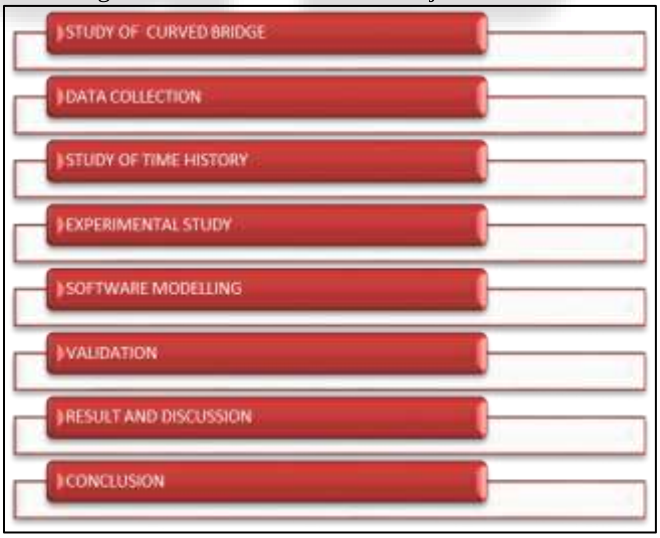


Fig. 2: Line up for future work.

III. PROBLEM DEFINITION

A. Introduction

The Rudramata Bridge, built in 1966, is located on State Highway 45, 16 km north of Bhuj. The bridge is 7.3 m wide and is composed of 10 simple spans of 16.8 m each, with expansion joint at the piers. The superstructure comprises of two precast/prestressed braces with cast set up concrete is

All rights reserved by www.ijsrd.com

Elastomeric orientation bolster the prestressed supports at the two projections and at middle of the road docks. There were no longitudinal restrainers or transverse stops to control the superstructure movement on the piers. The substructures consist of reinforced concrete A-frame towers (Figure 19-17). These are each supported on a large diameter caisson. The main structure of the bridge performed relatively well during the earthquake, but the north end suffered approach damage, resulting in the closure of one lane of traffic.

B. Bridge Geometry & Model

Bridge Details		
Sr. No.	Description	
1	Span of Bridge	10m X 16.8
2	Width of Bridge	12 m
3	Lanes	2 Lanes
4	Number of Main Girders	4 No's
5	Total depth	20 m
6	Slab thickness (average)	0.3 m
7	Type of Loading	IRC class AA Train
8	Loads	DL+LL+IL+EQ (Time History)
9	Compressive Strength of Concrete (fck) (M30)	30000 KN/m²
10	Modulus of Elasticity E=5000√fck E=5000√30 = 27386.128 N/mm²	27386.128 N/mm²

Table 1: Bridge Details (Case Study)

Fig. 3: The Rudramata Bridge, the tallest in the region, supported on open-type reinforced concrete A-frame piers.

C. Input Data in Software:

The data is used in the analysis is given in Table 2

Input Data for Analysis		
Sl. No	Particulars	
1)	Density of Reinforced Concrete	25 KN/m³
2)	Grade of Concrete	M-30
3)	Type of live load	IRC Class AA Train
4)	Importance Factor (I)	1.2
5)	Response Reduction Factor (R)	3.0
6)	Poisson's Ratio of Concrete	0.18
7)	Seismic Zone	Zone III
8)	Seismic Zone Factor	0.16
9)	Soil Type	Type II

Table 2: Input Data in SOFTWARE

IV. RESULTS AND DISCUSSION

A. General:

MODEL NO.1	STRAIGHT BRIDGE 84m
MODEL NO.2	STRAIGHT BRIDGE 168m
MODEL NO.3	SKEW BRIDGE 84m
MODEL NO.4	SKEW BRIDGE 168m
MODEL NO.5	SKEW BRIDGE 20m deck span
MODEL NO.6	SKEW BRIDGE 30m deck span

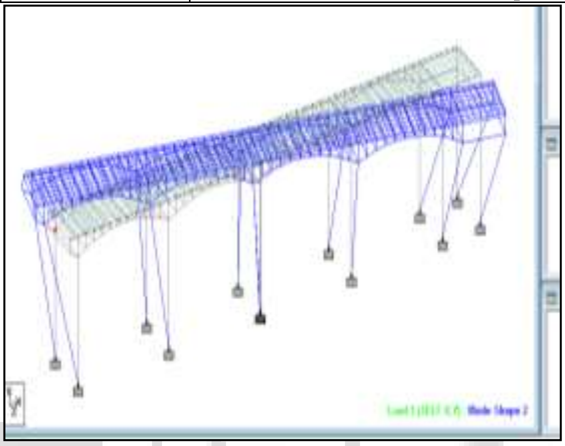


Fig. 4: MODE SHAPES NO.1

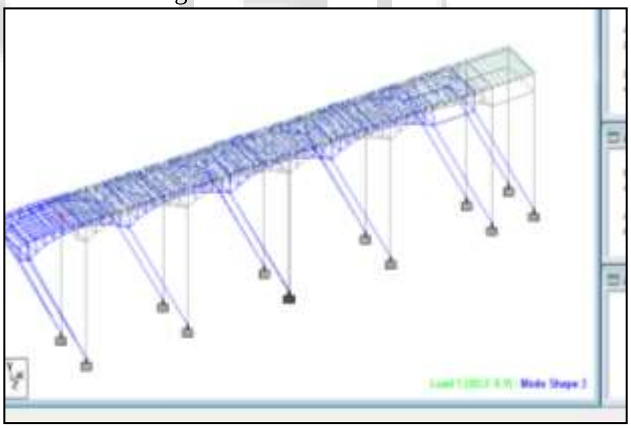


Fig. 5: MODE SHAPES NO.2

All rights reserved by *www.ijsrd.com*

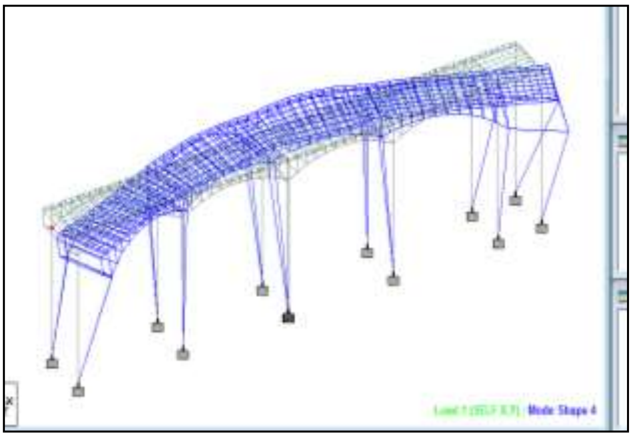


Fig. 6: MODE SHAPES NO.3

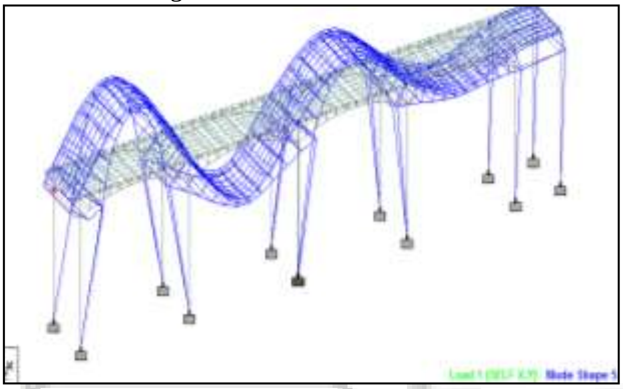


Fig. 7: MODE SHAPES NO.4

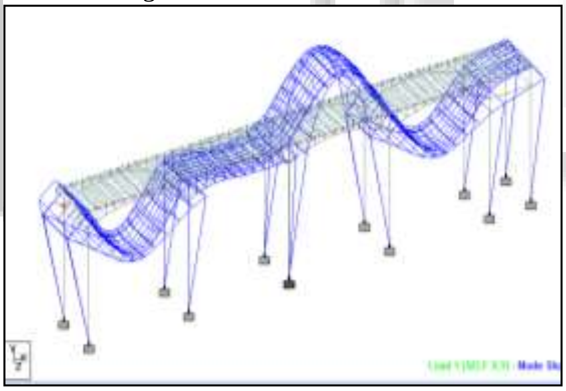


Fig. 8: MODE SHAPES NO.5

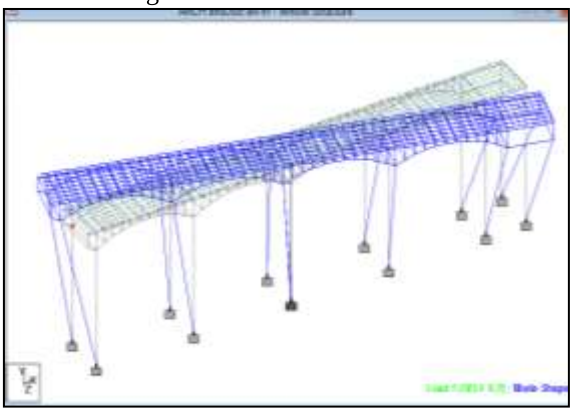


Fig. 9: MODE SHAPES NO.6

V. TIME HISTORY RESULTS:

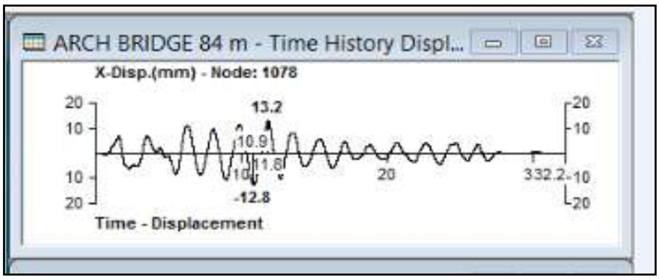


Fig. 10: SKEW BRIDGE 84m

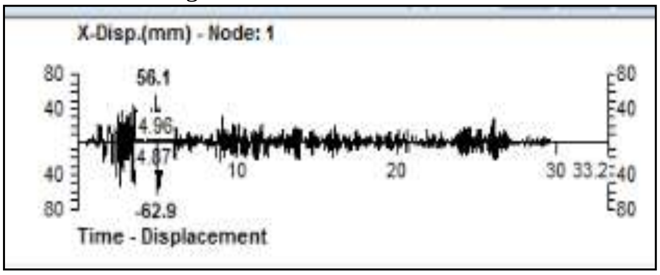
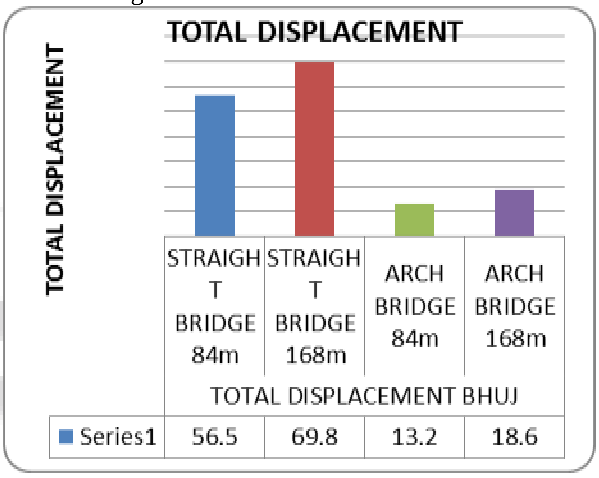
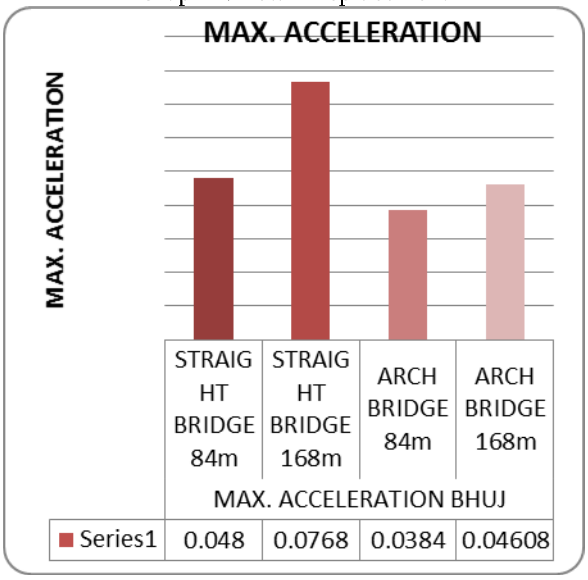


Fig. 11: STRAIGHT BRIDGE 84m

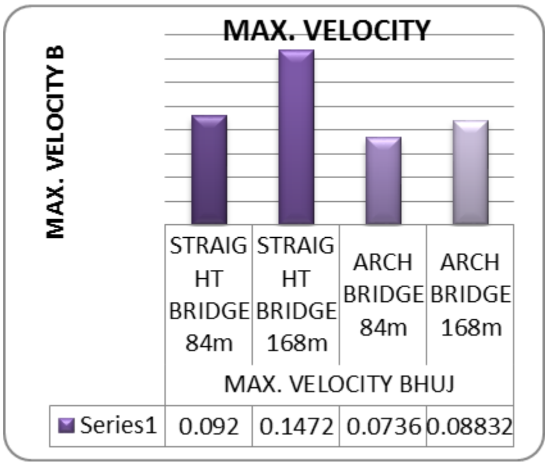


Graph 1: Total Displacement



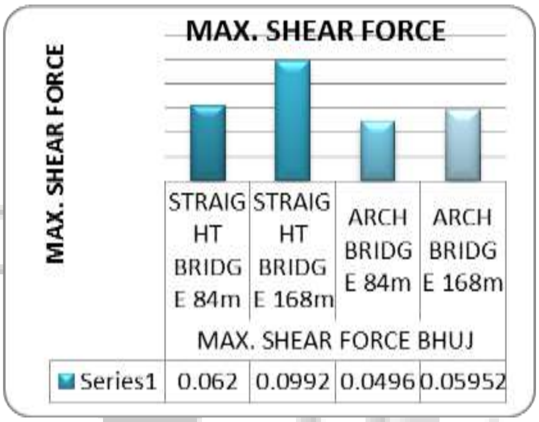
Graph 2: Max. Acceleration

This graph shows maximum acceleration. X axis shows series of straight bridge and y axis shows maximum acceleration.



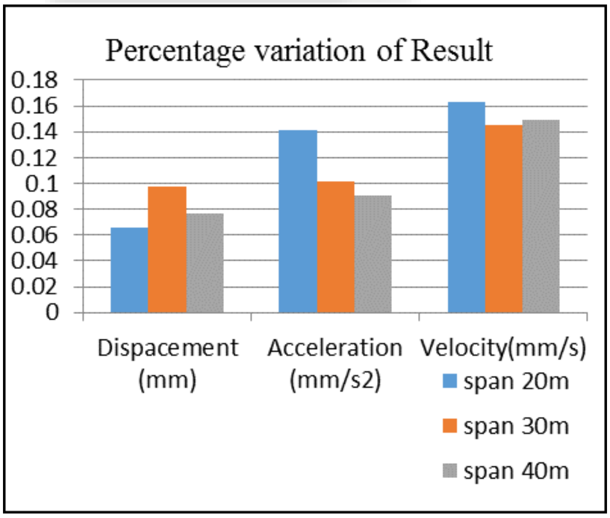
Graph 3: Max. Velocity

This graph shows maximum velocity. X axis shows series of straight bridge and y axis shows maximum velocity B.



Graph 4: Max. Shear Force.

This graph shows maximum shear force. X axis shows series of straight bridge and y axis shows maximum shear force.



Graph 5: Comparative presentation of percentage results with various span of Skew bridge

VI. Conclusion

The results obtained in this study are representing that the Skew bridge is having more stability if used with proper geometry. The models used in this study gives response for the given time history analysis proves that Skew bridge is having more rigidity under dynamic loading condition.

1) After studying the bridge models for the results of the displacement it can be found that for given loading the straight bridge of 168m span shows the displacement in x-direction as 21.8mm, and the same result for equivalent Skew bridge is found to be 13.8mm which shows that Skew bridge is having more stability under earthquake loading than that for straight bridge.
2) For the various span of Skew bridge it can be stated that as the span of bridge increases the values of displacement, velocity and acceleration also increases with respect to span in percentage that have been shown in graph 5.
3) It can be noted that from graph 5, the smaller span size will have more stability regarding displacement, velocity and acceleration response of the structure.

Reference

[1] Ali Fadhi lNaser, Wang Zonglin, "Field Investigation of Damages and Performance Evaluation of Longtan Truss-Skew Concrete Bridge in China" The Twelfth East Asia-Pacific Conference on Structural Engineering and Construction(2011) pp-2323–2332. B.K. Lee & J.F. Wilson, "Free Vibrations Of Skewes WithVariable Curvature", Journal of Sound and Vibrarion (1989) 136(l), 75-89.

[2] Dai Yu-wena, Wang You-yuana, "A Reseskew to Cable Force Optimizing Calculation of Cablestayed Skew Bridge", The Second SREE Conference on Engineering Modelling and Simulation (CEMS 2012), pp-155-160.

[3] T.E. Ford, C.E. Augarde and S.S. Tuxford, School of Engineering,"Modelling masonry skew bridges using commercial finite element software", 9th International Conference on Civil and Structural Engineering Computing, Egmondaan Zee, The Netherlands, 2-4 September 2003.

[4] E.C. Kandemira, T. Mazda, H. Nurui, H. Miyamoto,"Seismic Retrofit of an Existing Steel Skew Bridge UsingViscous Damper",The Twelfth East Asia-Pacific Conference on Structural Engineering and Construction, (2011), pp- 2301–2306.

[5] Raina, V. K. "Concrete Bridge: Inspection, Repair, Strengthening, Testing, Load Capacity, and Evaluation",USA (1996) ISBN 0-07-462349-4.Sadeghi, J. M. and Fathali, M., 2007, "Determination Analysis of Concrete Bridges Under Inadmissible Loads From theFatigue Point of View", J. ScientiaIranica, 14(3), :185-192.

[6] José de Jesús and Ángel Carlos, "Non-Linear Seimic Response Of An Skew BridgeWith Fluid Viscous Dampers",13th World Conference on Earthquake EngineeringVancouver, B.C., CanadaAugust 1-6, 2004, Paper No. 1858

[7] Mehmet F. Yılmaz1,2 , Barlas. Ö. ÇaglayanSeismic Assessment Of Multi-Span Steel Railway Bridge In Turkey Base On The Nonlinear Time History Analyses.

[8] IS 1893:2002, Indian Standard Criteria for Earthquake Resistant Designof Structures, Bureau of Indian Standards, New Delhi.

All rights reserved by *www.ijsrd.com*

[9] I.R.C: 6- 2000, Standard Specifications and code of Practice for Road Bridges, Section II, Loads and Stresses(Fourth Revision), Indian Roads Congress,2000, pp. 1-61.
[10] P.K. Chatterjee, T.K.Datta, "Dynamic Analysis Of Skew Bridges UnderTravelling Loads", International Journal Of Solids And Structures, 32(11):1585-1594, June 1995.
[11] Seung-Eock Kim et.al., "Performance based design of steel skew bridgesusing practical inelastic nonlinear analysis", Journal of Constructional Steel Reseskew 59 (2003) 91–108.
[12] S.N. Krishnakanth et.al. , "Design And Analysis Of Bridge Design Using Staad Pro", International Journal of Reseskew Sciences and Advanced Engineering [IJRSAE] Volume 2 , Issue 12, PP: 211 - 224 , OCT - DEC ' 2015.
[13] Joan R. Casas, Climent Molins, "Assessment of the Magarola skew bridge. Acase study", Transactions on the Built Environment vol 39 © 1999 WIT Press, ISSN 1743-3509.
[14] Elisabeth Scheibmeir, "Nonlinear seismic analysis of a masonry skew bridge", Masters Thesis at University at Politècnica de Catalunya, 2012.
[15] Yong Deng, Ph.D, PE, "Non-Linear Time History Analysis of A Highly Horizontally Curved Bridge onYerba Buena Island (YBI) WB On-Ramps, Bay Bridge, San Francisco, CA", Structures Congress 2013 at ASCE 2013, pp.502-513.
[16] Marin Franetović, Ana MandićIvanković, Jure Radić, "Seismic assessment of existing reinforced-concrete skew bridges", GRADEVINAR 66 (2014) 8, 691-703.
[17] Kiyofumi NAKAGAWA, et al, "Seismic Design Of Skew Bridges During Strong Earthquake", 12 WCEE 2000, pp1996.
[18] David B. McCallen, et al, "The Seismic Response Of Concrete Skew BridgesWith Focus On The Bixby Creek BridgeCarmel, California", UCRL - ID – 134419, June 1999.
[19] Kazuhiko KAWASHIMA, et al. "Seismic Response of a Reinforced Concrete Skew Bridge", 12 WCEE 2000, pp1824.
[20] F. Fanous, et al. "Simplified Analytical Model of a Covered Burr-Skew-Truss Timber Bridge".
[21] Ramesh Kumar Dhaka, PradeepK.Goyal, "Structural Analysis of Skew Bridge with a Span of 350m Using STAAD.Pro:A Case Study", International Journal of Advance Engineering and ReseskewDevelopment, Volume 4, Issue 11, November -2017.
[22] LUO Chaozhuan, et al. "Multimodal Response Spectrum Method Analysis ofIntegral Abutment Curved Box Girder Bridge" Project ofShanghai Municipal Education Commission, Project Number: J51502.

IJSRD