Study on Interfacial Shear Properties of Concrete Reinforced Stone Arch Bridges Using Staad.pro

Tirangini Hanwate[1], Sandeep Gupta[2], Supriya Jain[3]

P.G. Scholar[1], Assistant Professor[2], Assistant Professor[3]

Department of Civil Engineering, S.I.R.T.E. Bhopal, Madhya Pradesh, India

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ABSTRACT

Bridges are the structural components that are required for the efficient movement of Trains and locomotives and under earth embankment for crossing of water course like streams across the embankment as road embankment cannot be allowed to obstruct the natural water way. Bridges can be of different shapes such as arch, slab and box. These can be constructed with different material such as masonry (brick, stone etc.) or reinforced cement concrete. Since bridge pass through the earthen embankment, these are subjected to same traffic loads as the road carries and therefore, required to be designed for such loads. The cushion depends on rail profile at the bridge location. For analysis relevant IRCs are required to be referred. The structural elements are required to be designed to withstand maximum bending moment and shear force.

This study provides comparative analysis of a Arch shape stone-concrete (RCC) & General RCC bridge considering IRC loading using analysis tool staad.pro. To determine shear performance of the bridge under vehicular loading.

Keywords : Analysis, bridge, staad.pro, IRC, structure, forces, displacement, stone masonry.

I. INTRODUCTION

Bridges are an important component of all type of modem transport system. In the half of the past decade technical knowledge of earthquake engineering increased considerably. Performances of bridges have vital importance before and after an earthquake event. Hence it must remain functional even after dissipation of seismic event to endure relief as well as security purpose. Substructure of the bridge is more susceptible to damage and its performance must be good during ground motion because substructure connect superstructure to the foundation. Hence failure of substructure leads to collapse of entire bridge which may turn m to disaster. There are many design codes and guidelines available worldwide for the seismic design of bridges. These guidelines are helpful for improving the seismic capacity of the bridges. Despite of many advances made in design of earthquake Resistance Bridge some gaps still remain in many areas due to unpredictable nature of ground motion. For the analysis of bridges under seismic excitation simplified method (response spectrum method) or time history analysis and pushover analysis are used.

Fig 1 : Arch Bridge

II. LITERATURE REVIEW

Yutao Pang and Li Wu (2018) the research paper investigated the effect of aftershocks on seismic responses of multispan reinforced concrete (RC) bridges using the fragility based numerical approach. For that purpose, a continuous girder RC bridge class containing 8 bridges was selected based on the statistical analysis of the existing RC bridges in China. 75 recorded mainshock-aftershock seismic sequences from 10 well-known earthquakes were selected for the investigation. In order to account for the uncertainty of modeling parameters, uniform design method was applied as the sampling method for generating the samples for fragility analysis. Fragility curves were then developed using nonlinear time-history analysis in terms of the peak curvature of pier column and displacement of bearings. Finally, the system fragility curves were derived by implementing Monte Carlo simulation on multi-normal distribution of two components.

Results stated that for the RC continuous bridges, the influence of aftershocks can be harmful to both bridge components and system, which increases both the component fragility of the displacement of bearings and seismic curvature of pier sections and system fragility. Additionally, it is better to evaluate the vulnerability of bridge system, rather than only assess the effect of aftershock based on a single component.

Rahul Gangwar et.al (2020) This paper gives the comparative study of R.C.C.(Reinforced Cement Concrete) Girder and P.S.C.(Prestressed Concrete) Girder, which include the design and estimates of R.C.C. and P.S.C. Girder of various spans. The aim of this work is to study R.C.C .girder as well as P.S.C. girder and then compare the results. The idea is to succeed in a superior conclusion regarding the prevalence of the 2 techniques over each other. R.C.C members are commonly used for residential as well as commercial structures and are generally short span. In R.C.C. depth of girder increases with the increase in span due to deflection limitation. To surmise, R.C.C girder shall be suitable for small to medium span however the prevalence of prestressed concrete girder is undeniable for extended spans.

The conclusion derived from the results stated that Reinforced concrete beams are generally heavy. They always need shear reinforcements besides the longitudinal reinforcement for flexure. Prestressed concrete beams are lighter. By providing the curved tendons and the pre-compression, a considerable part of the shear is resisted. In reinforced concrete beams, high strength concrete is not needed. But in prestressed concrete beams, high strength concrete and high strength steel are necessary. Reinforced concrete beams being massive and heavy are more suitable in situations where the weight is more desired than strength. Prestressed concrete beams are very suitable for heavy loads and longer spans. They are slender and artistic treatments can be easily provided. Cracks do not occur under working loads. Even if a minute crack occurs when overloaded, such crack gets closed when the overload is removed. The deflections of the prestressed concrete beams are small. Prestressed concrete sections are thinner and lighter than RCC sections, since high strength concrete and steel are used prestressed concrete.

Problem Identification

The literature review has suggested that use of a finite element modeling of the Arch Bridges with various material. So it has been decided to use STAAD.Pro for the Finite Element Modeling. With the help of this software study of bridge structure has been done considering Vehicular loading. STAAD.Pro also helps in Finite Element Modeling in view of that different type of forces can apply to get the actual results. In this literature review it is revealed that live project work to implement the same at site and to develop a relation between software and practical work implementation.

Objectives of the study

1. To Determine the stability of the structure with considering vehicular load IRC.
2. To Determine the variation in structural stability of a structure with stone and reinforced concrete in a arch type bridge geometry.
3. To Compare Stone lining RC structure with General RCC structure using analysis tool.

III. Methodology

Step-1: First step is to prepare a literature survey related to bridge, software implementation, vehicle load and structural analysis.

Step-2: second step is to select a geometry and model it in staad.pro.

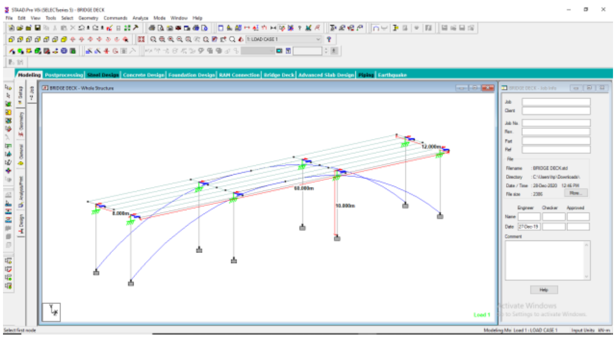


Fig 2 : Modelling of the bridge

Step-3 To assign section data (concrete and stone) and material properties.

Step-4 To Assign support conditions.

Step-5 To assign vehicle loading and hydraulic data as per provided toposheet.

Step-6: To perform finite element analysis.

Step-7 Assigning Lanes of Deck

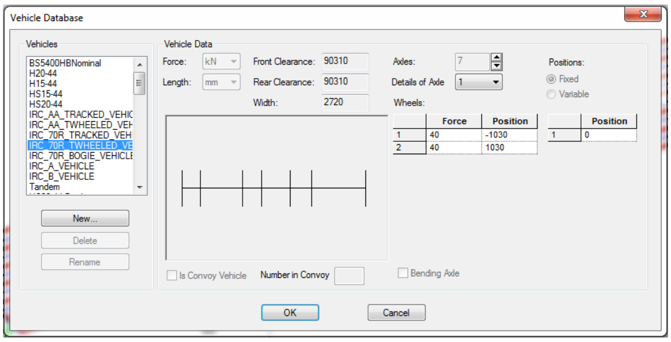


Fig 3 : Vehicular Loading

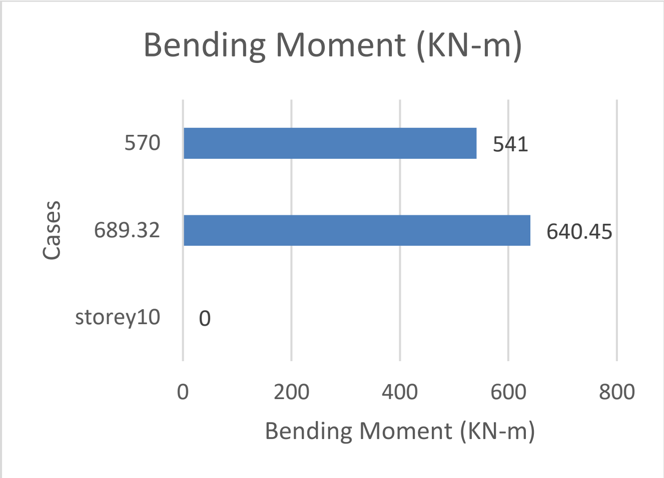
Table 1 : Loading Conditions

S. No.	Loading Type	Standard
1	Dead Load	I.S. 875-I
2	Live Load	I.S. 875-II
3	Vehicle Load	I.R.C. 70R Class Loading
4	Combination 1	1.5 DL + LL
5	Combination 2	1.2 DL + LL + Vehicular load
6	Combination 3	0.9 DL+1.2 LL+1.2 Vehicular load

IV. Analysis Results

Table 2 : Bending Moment (KN-m)

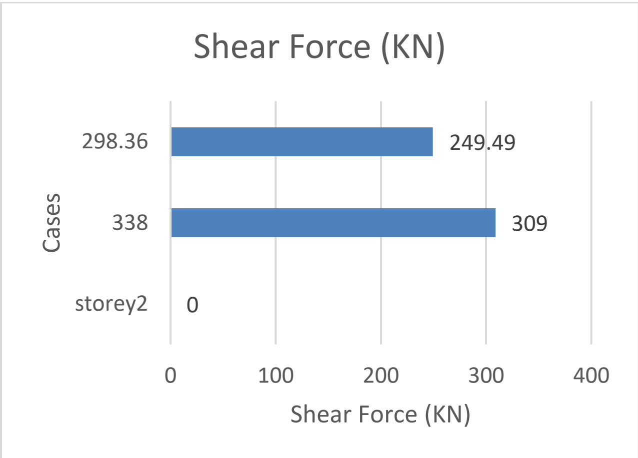
Bending moment kN-m		
General Bridge	**Arch Bridge**	**Arch Bridge (Brick Lining)**
507.76	490.45	448.21



Graph 1: Bending Moment

Table 3: Shear Force (KN)

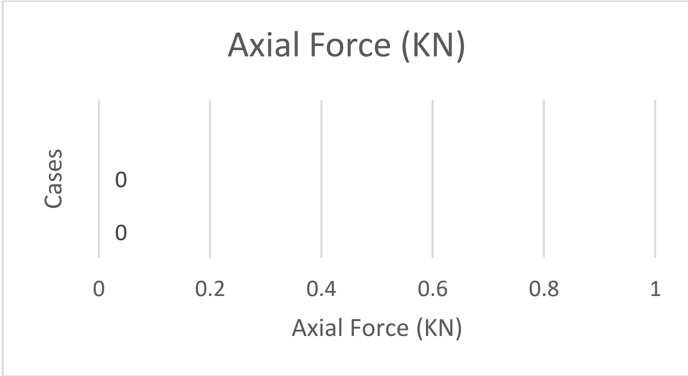
Shear Force kN		
General Bridge	**Arch Bridge**	**Arch Bridge (Brick Lining)**
705.87	689.4	654.87



Graph 2: Shear Force (KN)

Table 4: Axial Force (KN)

Axial Force kN		
General Bridge	**Arch Bridge**	**Arch Bridge (Brick Lining)**
2008.09	**1996.78**	1980.55



Graph 3: Axial Force (KN)

V. CONCLUSION

Following are the salient conclusions of this study-

Shear Force

Shear force in known as the unbalance force observed due to transmission of load from beam to column, in our study it is observed that with Arch Bridge it can be minimized in all the cases considered for study.

Axial Force

Axial force is known as the vertical force observe in piers, this force is meant to distribute load from pier to earth. It is observed in the results that with Arch Bridge Distribution of vertical forces can be processed easily.

Bending Moment

In terms of bending moment it is observed that minimum bending is Arch Bridge, which is resulting in comparatively most economical in comparison as bending moment is directly proportional to reinforcement requirement.

VI. REFERENCES

[1]. Yutao Pang and Li Wu, [Seismic Fragility Analysis of Multispan Reinforced Concrete Bridges Using Mainshock-Aftershock Sequences], Hindawi Mathematical Problems in Engineering, Volume 2018, Article ID 1537301, 12 pages.

[2]. Luca Pelà, Alessandra Aprile and Andrea Benedetti, [Seismic assessment of masonry arch bridges], Engineering Structures 31 (2009) 1777_1788.

[3]. RAHUL GANGWAR, ANKUR PRATAP SINGH and T.N.PANDEY, [Comparative Study of RCC and PSC Girder], International Research Journal of Engineering and Technology (IRJET), Volume: 07 Issue: 04 | Apr 2020.

[4]. Melika Naderi and Mehdi Zekavati, [Assessment of seismic behavior stone bridge using a finite element method and discrete element method], Earthquakes and Structures, Vol. 14, No. 4 (2018) 297-303.

[5]. Wei-Xin Ren, Cong-Cong Su and Wang-Ji Yan, [Dynamic Modeling and Analysis of Arch Bridges Using Beam-Arch Segment Assembly], CMES, vol.70, no.1, pp.67-92, 2010.

[6]. Hayder Ala'a Hasan, Ammar A. Abdul Rahman and Hani Aziz Ameen, [Finite element analysis of reinforced concrete bridge pier subjected to seismic loading], AMERICAN JOURNAL OF SCIENTIFIC AND INDUSTRIAL RESEARCH, 2012, 3(2): 94-98.

[7]. L. Di Sarno, G. Della Corte, R. De Risi, M. Erdik , C. Yenidogan, A. Marioni, M. Sartori, F. Taucer, P. Pegon and R. Ceravolo, [Seismic analysis and retrofitting of an existing R.C.highway bridge: investigation through pseudo-dynamic], 15 WCEE Lisboa 2012.

[8]. Lina Ding, Hong Hao, Yong Xia and Andrew J. Deeks, [Evaluation of Bridge Load Carrying Capacity Using Updated Finite Element Model and Nonlinear Analysis], Advances in Structural Engineering,Volume 15 No. 10 2012.

[9]. Ravikant and Jagdish Chand, [Design and Analysis of Bridge Girders using Different Codes], International Journal of Engineering Research & Technology (IJERT), ISSN: 2278-0181, Vol. 8 Issue 07, July-2019.

[10]. Alessandro Rasulo, Angelo Pelle, Davide Lavorato, Gabriele Fiorentino, Camillo Nuti and Bruno Briseghella, [Finite Element Analysis of Reinforced Concrete Bridge Piers Including a Flexure-Shear Interaction Model], Appl. Sci. 2020, 10, 2209; doi:10.3390/app10072209.

[11]. S.Basilahamed and A.R.R.Kalaiyarrasi, [COMPARATIVE ANALYSIS AND DESIGN OF T-BEAM BRIDGE DECK BY RATIONAL METHOD AND FINITE ELEMENT METHOD, Proceedings of National Conference on Sustainable Construction Materials, March 27-28, 2018.

[12]. B. Ozden Caglayan, Kadir Ozakgul and Ovunc Tezer, [Assessment of a concrete arch bridge using static and dynamic load tests], Structural Engineering and Mechanics, Vol. 41, No. 1 (2012) 83-94.

[13]. J. Kiyono, A. Furukawa and K. Toki, [Seismic Assessment of Stone Arched Bridges], 15 WCEE LISBOA 2012.

[14]. S. De Santis and G.de Felice, [Seismic Analysis of Masonry Arches], 15 WCEE LISBOA 2012.

[15]. Xiaoke Li, Lixin Liu, Shiming Liu and Shunbo Zhao, [Static Analysis of Reinforced Concrete Arch-deck Bridge with Archaized Connective Corridors], Applied Mechanics and Materials Vol. 238 (2012) pp 738-742.

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