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"COMPARATIVE STUDY AND ANALYSIS OF BOX BRIDGE"

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ABSTRACT

This study deals with the computational analysis of Box Bridge. It introduces a conventional concept of multispan bridge where the multispan span deck is supported by Pier/shearwall and mat beaneath along the whole longitudinal section of span. It includes comparative studies among two types of box bridges. To observe structural response parameter at different location of bridge intersecting deck, slab, pier and optimum & more efficient type of bridge between two types of Box Bridge. The geometries bridges are same besides of some necessary structural components. For the comparison of analysis of these bridge models structural symmetries are considered. The structural elements are required to be designed to withstand maximum bending moment and shear force, static and vehicle loads as per IRC are taken into consideration for the analysis of these bridges. Analysis has been performed with the help of SAP2000v14 software. Deflection pattern of deck slab, pier and shearwall are taken as study parameter of this research.

KEYWORDS: *Pier, Shear Wall, Box Bridge, SAP2000v14.*

INTRODUCTION

This Study carried out at the analysis of Box Bridge with the objective of gaining knowledge about the technical practices in a structural analysis, design of the Bridge. A bridge is a structure that connects the stream, river, gorge, and valley. It is used for the Railroad track, roadway, waterway etc. as box culverts serves with multi span. The traffic that uses the bridge is Pedestrian or cycle traffic, Vehicle or rail traffic.RCC box minor bridge comprising of top slab, base slab and stem are cast monolithically to carry live load, embankment load, water pressure and lateral earth pressure in a better way. The top of the box may be at road level or it may at a depth below the road level if the road is in embankment. The required height and number of boxes depends on hydraulic and other requirements at the site such as road level, nalla bed level, scour depth etc. The barrel of the box culvert should be of sufficient length to accommodate the carriageway and the kerbs [1].Box bridge consisting of two horizontal and two or more vertical slabs built monolithically are economical due to their rigidity and monolithic action and separate foundations are not required since the bottom slab resting directly on the soil, serves as raft

slab[2]. This types of bridge have non-linear structural behavior but they have their own structural limits, efficiencies, deficiencies and different ranges of limit of serviceability and durability for a particular geometry, loading and natural conditions. Bridges are classified as Nepal Bridge Standard 2067 as per the criteria given below:

- Culvert – length upto 6m
- Minor Bridge– When length ≤ 50m (with span ≤ 25 m)
- Major Bridge– Major Bridge : When span >25 m or length >50 m(with smaller spans)
- Special Bridge– Bridges that require special design considerations, whose construction features (e.g. concrete girder bridges with >50m span, steel trusses > 100m span, arch bridges, suspension bridges, cable-stayed bridges and other nonstandard bridges).

RESEARCH METHODOLOGY

This would enable bridge engineers to better understand the behaviour of Box Bridge outlining a different approach towards analysis and design. The structural elements were designed to withstand maximum bending moment and shear force. The purpose of this study is to determine the most economical and preferable design among both frame bridges and Shear wall box bridges.Some detail of Box Bridge:

Framed Structure Box Bridge

It's a box bridge model where the analysis is performed using frame structure for individual pier. There after the beaneath piers is analysed manually and using software. The main criteria punching Shear on the both deck slab and mat are consider.

Framed Structure Box Bridge

It's a box bridge model where the analysis is performed using Shear wall structure for individual shearwall. There after the mat beaneath shearwall is analysed manually and using software. The main criteria punching Shear and bending moment are on the both deck slab and mat are consider.

The geomatric section of the box bridge for the study is taken as follow:

TABLE I DIMENSION OF BRIDGE

S.N.	***Description***	***Dimension***
1	Deck Slab thickness	500 mm
2	Bottom Slab thickness	500 mm
3	End wall thickness	500 mm
4	No. of end wall	2 nos
5	Side wall thickness	0.5 m
6	No. of side wall	3 nos
7	No. of boxes	4 nos
8	Size of box	

i	Clear length	6 m
ii	Clear height	5 m
9	Total length of bridge	26.5 m
10	Effective Span	6.5 m
11	Effective height	5.75 m
12	Carriageway	5 m
13	No. of footpath	0 nos
14	Width of bridge	5 m

The following procedure used to study of the Bridge:

i. Collect experience from inspection and literal review of Box Bridge.

ii. Selection type of Box Bridge and its span, selection of material, component of bridge and its cross section.

iii. Modeling of different box bridge is done in Finite element method software SAP2000v14.

iv. Computational analyze maximum deflection and stresses in deck slab, piers and maximum force in component of Box Bridge.

Finite Element Method (FEM)

It is necessary for the intermediate and final stages of the design to obtain a reasonably accurate estimate of the structure deflections and member forces. With the wide availability of structural analysis programs and powerful computers, it is now possible to solve very large and complex structural models. Computer software SAP2000 v14 was used for finite element modeling of those bridges. After a three-dimensional finite-element model is constructed, and modal analysis is performed.

i. The bridge co-ordinate data was defined to facilitate the geometry of the bridge and then the sectional and material properties are defined in SAP2000v14.

ii. All the structural components are placed in the grid data system.

iii. Various loads and load combinations are defined as per codal specifications.

ANALYSIS AND INTERPRETATION OF DATA

The overall goal in completing this study of bridge analysis is to come up with a framework or model of a bridge that is structured in order to meet the objective of the study and analysis of the bridge is done Member Force Comparison.

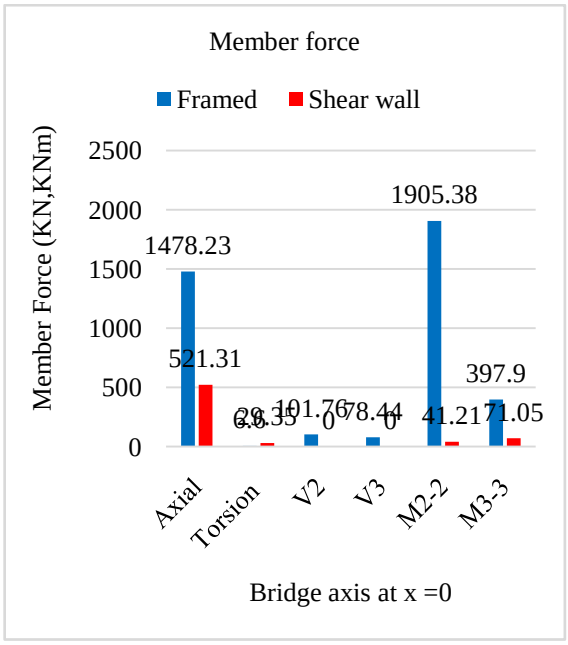

Fig 1. Member force of bridge at bridge axis x=0.

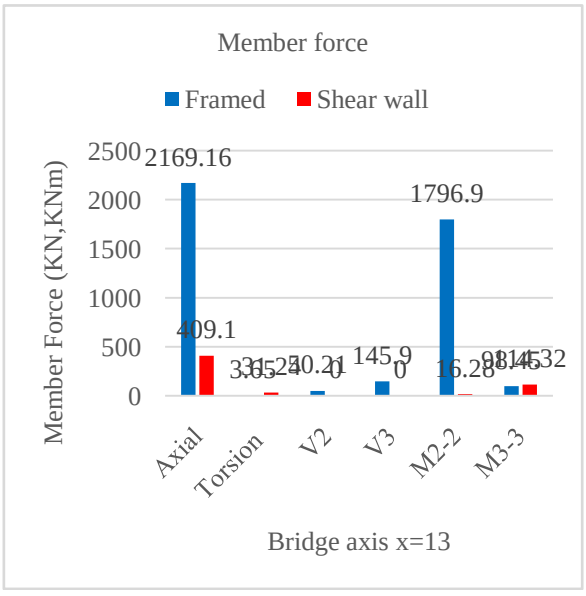

Fig 2. Member force of bridge at bridge axis x=13.

The value of all member force Axil, Shear and Moment force value is higher in case of frame structure then the shear wall structure bridge.

Pier Displacement Comparison

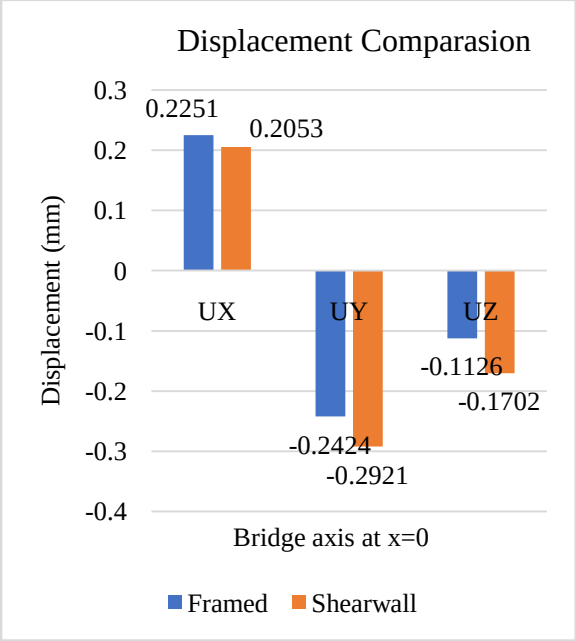

Fig 3. Pier displacement bridge at bridge axis x=0.

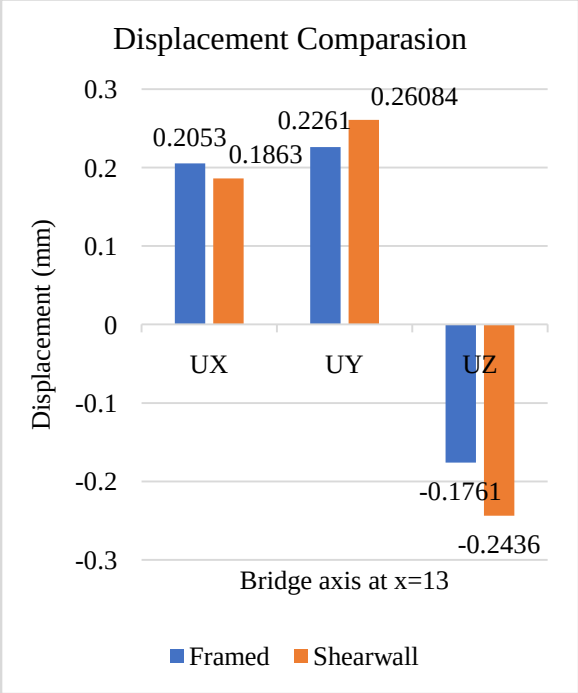

Fig 4. Pier displacement bridge at bridge axis x=13.

The observation that influence of structural displacement in x-axis or along the vehicle movement direction is more in frame Structure Bridge then Shearwall Bridge but in y-axis and z-axis are less displacement in the framed structure Box Bridge then shearwall Structure Bridge in

all location of bridge axis.

CONCLUSION AND RECOMMNEDATION

After analysis and compare the result displacement in deck slab, pier, axial force, moment and shear force in different structural component, as well joint reaction and all influence of structural parameter of box bridge conclusion are summarized below.

i. From displacement analysis there is seen pier in frame structure have more displacement along vehicle movement axis ie x-axis while less deflection in other two direction then shear wall structure in all location of bridge.

ii. The maximum member forces axial, Shear and Moment are observed highly deflected using method of analysis so the analysis of monolithic shear wall structure should be implemented as the box bridge is seemed less acting then monolithic pier connecting top deck slab and bottom mat slab.

iii. From analysis of Moment, shear and axial force in deck slab all parameter have the higher value in frame structure then the monolithic shear wall structure in all supported location of bridge.

Different analysis result of conventional box bridge we should follow different ways of analysis to get optimum solution of structural parameters among this the shear wall structure bridge is preferable for box bridge design.

REFERENCES

1. I. Journal, C. Civil, and S. Engineering, “Design coefficients for single and two cell box culvert,” no. July, 2017, doi: 10.6088/ijcser.201203013044.

2. A. Tiwari and S. S. Bhadouria, “Comparative Cost Evaluation of RCC Box and Solid Slab,” IJSRD-International J. Sci. Res. Dev., vol. 5, no. 08, pp. 2321–0613, 2017.

3. P. leela Krishna and K. rajasekhar, “Analysis and Design of RCC Box Culvert,” Int. J. Sci. Technol. Eng., vol. 4, no. 10, pp. 141–156, 2014.

4. M. B. Khan and M. P. Alam, “Hydraulic Design of Box Culvert for,” no. 9, pp. 31–40, 2015.

5. M. Afzal and H. Sharif, “Analysis and Design of Railway Box Bridge and Comparison Between Staad Software and Mdm Results,” Int. J. Sci. Dev. Res., vol. 1, no. 8, pp. 1–8, 2016.

6. K. S. Kattimani and R. Shreedhar, “Parametric Studies of Box Culverts,” vol. 1, no. 1, pp. 58–65, 2013.

7. A. Galatage, A. D. Patil, and A. A. Galatage, “Analysis of Box Culvert under Cushion Loading,” Int. Adv. Res. J. Sci. Eng. Technol., vol. 3, no. September, 2016, doi: 10.17148/IARJSET.2016.3631.