ISSN (Online) 2456-1290

International Journal of Engineering Research in Mechanical and Civil Engineering (IJERMCE)
Vol 4, Issue 6, June 2019

Parametric Study and Analysis of Box Type Minor Bridge on Small River

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***Abstract*—As we know that bridge is a structure which is built across the river, which facilitate to passage over an obstacle such as river, road, rail or valley etc. This is important for smooth flow of communication route for carrying moving loads or other traffic. Bridge can be built of different shape such as slab, arch and box. These bridges can be constructed with different material such as reinforced cement concrete or masonry like brick and stone etc. Culverts are required to be provided under earth embankment for crossing of water course like stream. In this study the structural analysis of RCC box type minor bridge using CSI bridge software is done. The paper provides full discussion on the provision in the codes. The structural elements are analysed to withstand maximum bending moment.**

***Keywords*—Minor Bridge, Box Culvert, Maximum Bending Moment**

1. INTRODUCTION

A bridge is a structure provided over an obstacle such as river, road, valley, railway etc. With the advancement in civil engineering several types of bridges are constructed like beam, truss, cantilever, cable stayed and suspension bridges. According to IRC the bridges have been classified in three types culvert, minor bridges and major bridges depending upon their length. For culvert the span length upto 6m, minor bridge length is above 6m and maximum upto 60m and major bridges the length is above 60m. The design of bridge constructed depending on the function of bridge, nature of terrain where bridge is constructed, the material used to make it and the funds available to build it. With the advancement in technology the conventional bridges has been replaced by cost effective sustainable structural system. These days in modern highway system the efficient dispersal of congested traffic, economic considerations as aesthetic desirability has increased the popularity of box type bridge. They are prominently used in freeway and bridges system due to its structural efficiency, serviceability, stability and economy of construction. They are efficient form of construction for bridges because it minimizes weight, while maximizing flexural stiffness and capacity.

The importance of minor bridge over small obstruction road, railway, small river or remarkable importance has increased about 15% to 30% cost of the project in this item. In this study the main objective is to understand the behaviour of the box type bridge outlining a different approach towards analysis.

Box type bridge is a structure which provides the flexibility for the designer to design it in a very easy way and easy to construct and design. Foundation requirement is very less.

2. MODELLING AND ANALYSIS

- Computational analysis has been done using CSI bridge software.
- Analysis of the box type minor bridge for empty box condition with dead loads and live loads on the top and earth pressure and surcharge at the side wall has been done using excel sheet and CSI bridge software. Load cases were formed based on IRC codal provisions [9] followed by several load conditions for bending moment. The variation of bending moment at top slab, side wall and bottom slab obtained by using CSI bridge software.

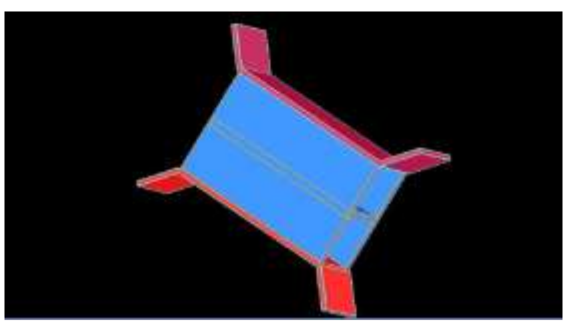

Fig. 1: 3D model of box type minor bridge

2.1 Structural Details of the Bridge

S.No.	SPECIFICATION	DIMENSIONS
1	Bridge type	Box type
2	Length of the bridge	15 metre
3	Deck width	7.5 metre
4	Clear height	5 metre
5	Thickness of slab	0.8 metre
6	Design Discharge	175 m^3/sec
7	Loading as per IRC 6:2017	Class 70R Tracked
8	Concrete	M30
9	Steel reinforcement	Fe500

3. ANALYSIS OF THE MODELS

Various cases adopted for analysis of box type minor bridge are:-

- **Case 1:** Analysis of box type bridge by considering the box as in empty condition, while no water pressure from inside and the dead load and live load acting from outside as well as due to earth pressure.
- **Case 2:** Analysing the box bridge by considering that it is half full, while water pressure acting from inside and the dead load and live load acting from outside as well as earth pressure.
- **Case 3:** Analysing the box bridge by considering that it is full, while the water pressure acting from inside and the dead load and live load acting from outside as well as earth pressure.

4. RESULTS AND DISCUSSIONS

Table 1: B.M and Direct Force Result for Top Slab, Side Wall and Bottom Slab

Elements	Case	B.M at Centre (kN-m)	B.M at end (kN-m)	Direct Force (for depth hd) (kN)
Top slab	i	637.641	95.057	149.721
	ii	81.911	302.879	491.08
	iii	505.731	267.421	11.948
Side Wall	i	-172.456	109.264	449.121
	ii	268.224	345.887	270.175
	iii	338.026	267.421	269.875
Bottom Slab	i	712.176	109.624	185.498
	ii	98.409	345.887	66.090
	iii	554.178	267.421	29.452

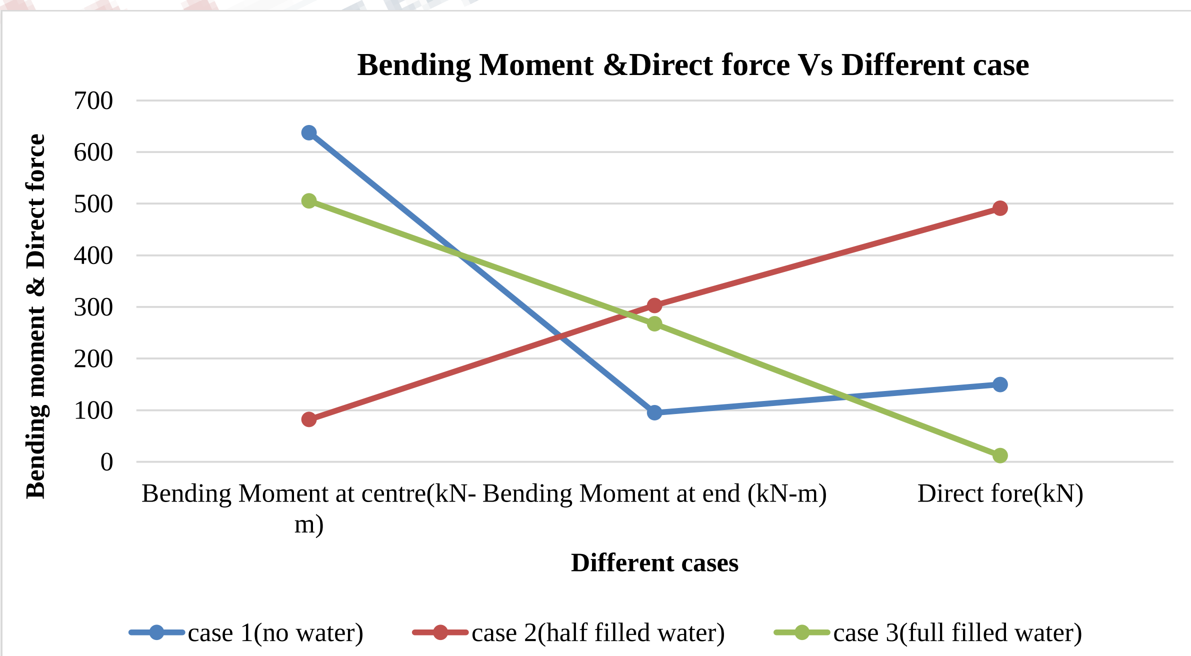

Fig. 2: Bending Moment and direct force result for top slab.

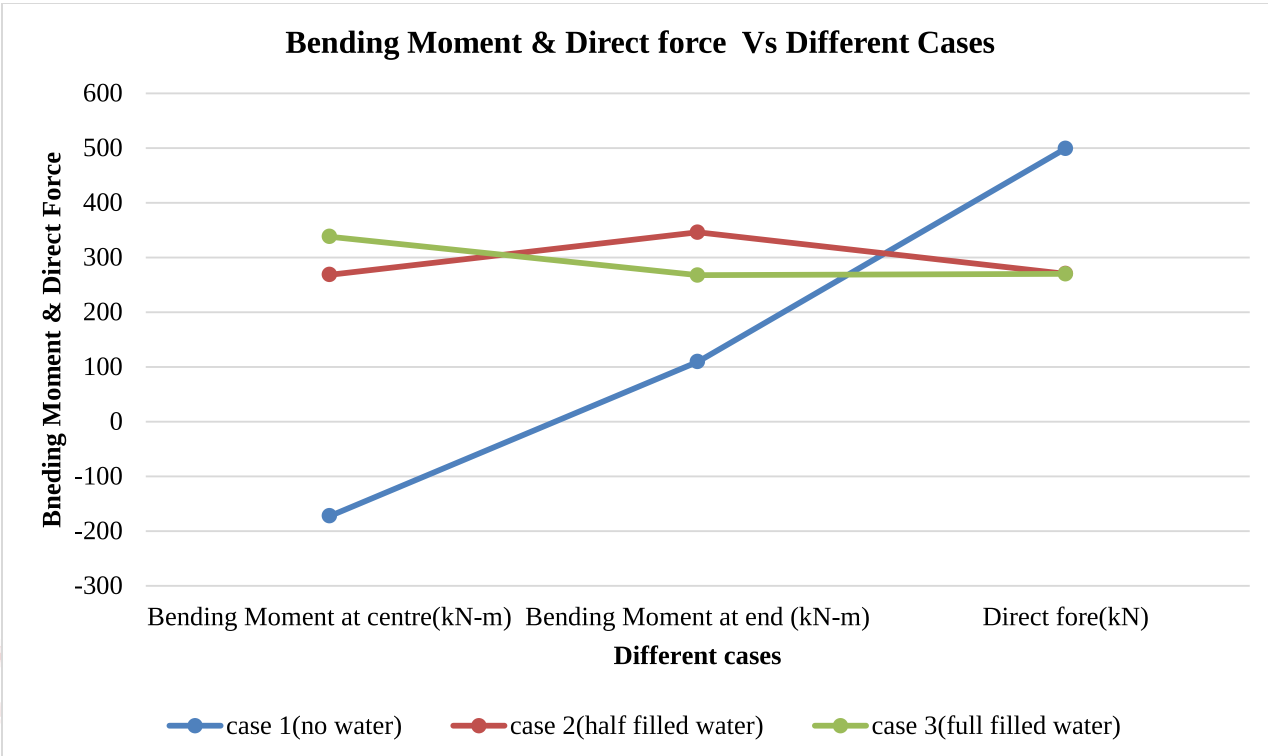

Fig. 3: Bending Moment and direct force result for side wall.

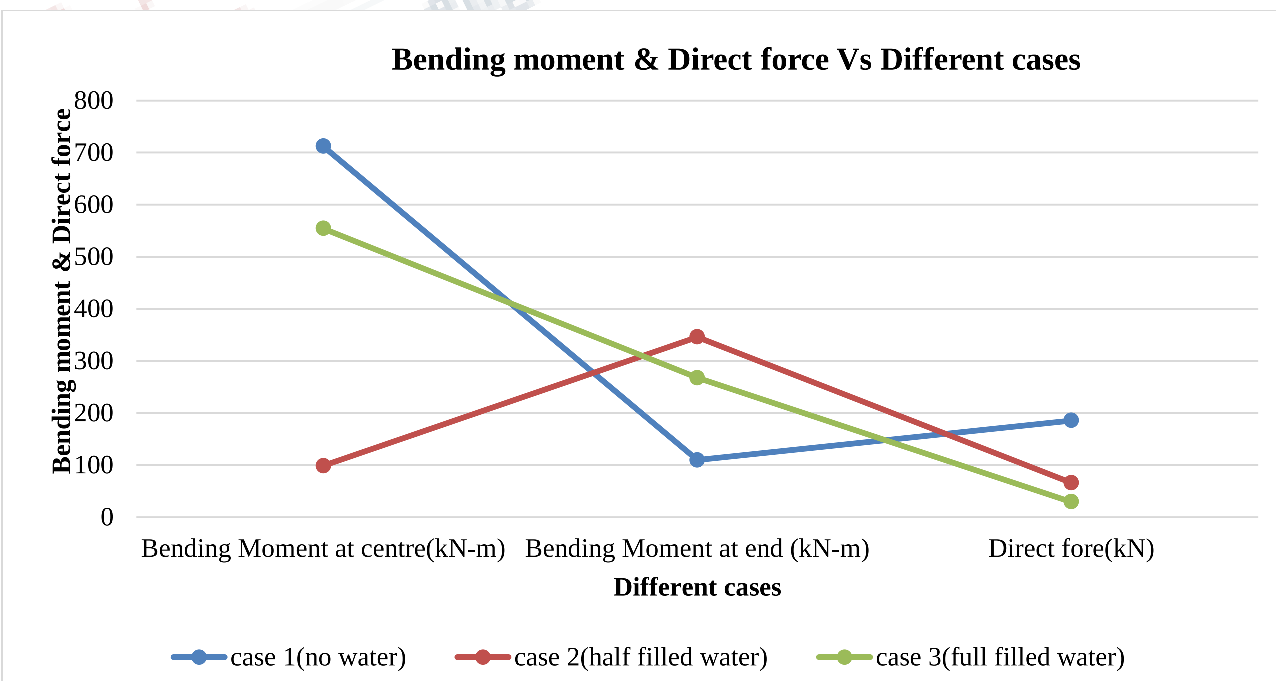

Fig. 4: Bending Moment and direct force result for bottom slab

5. CONCLUSIONS

The main objective of this project was to study the behaviour of box type minor bridge on small river when subjected to different combination of loads in terms of bending moment. The design was completed by using CSI bridge software. So from analysis we conclude that:-

1. The critical sections are the centre of span of top and bottom slab.
2. When the culvert is empty the maximum design forces developed at the top of slab is subjected to the dead load and live load and sidewall.
3. The maximum negative moment develop at the mid section of the top slab for the condition that the box is empty.
4. The maximum positive moment develop at the haunch section of the top slab for the condition that the box is empty.
5. The maximum positive moment develop at the mid section of the bottom slab for the condition that the box is empty.

The maximum negative moment develop at the haunch section of the bottom slab for the condition that the box is empty.

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