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Analysis and Design of Minor Type Box Bridge

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ABSTRACT: A bridge is a structure providing passage over an obstacle without closing the way beneath. The required passage may be for a road, a railway, pedestrians, a canal or a pipeline. Now a days, bridge section of Box shapes are used widely. Most of the bridges constructed are of Box girders which is constructed to connect two points which are inaccessible due to depression /obstacles so for smooth, easy and safe moving of vehicles over a depression Minor type Box Bridge with 4m span with 8 cells along with different types of load such as Dead Load, Live Load, Super Imposed Dead Load, Wearing Coat Load, Earth pressure, Temperature load, Breaking Load and varying loads of vehicle such as Class "A" vehicle, 70R bogie vehicle, 70R Wheeled vehicle, 70R Tracked vehicle, as per IRC-6 2017 is analyse.

Also, various Load Combinations are applied to bridge structure such as limit state of collapse and limit state of serviceability, for accurate results of Bending Moment and Shear Force critical sections are marked. The aim and objective of the work is to analyse and design the sections for Indian Road Congress Code i.e. IRC 6. This has been done by analysing the structure by software i.e. STADD PRO. And validating with manual results by developing the Microsoft Excel Sheet.

.**KEYWORDS:** Minor type Box Bridge, Load Combination, Staad Pro., IRC-6 (2017), Excel Sheet. Bending Moment, Shear Force.

I. INTRODUCTION

Bridge construction nowadays has achieved a worldwide level of importance. With rapid technology growth the conventional bridge has been replaced by innovative cost effective structural system. The efficient dispersal of congested traffic, economic considerations, and aesthetic desirability has increased the popularity of box type bridges these days in modern highway systems, including urban interchanges. They are prominently used in freeway and bridge systems due to its structural efficiency, serviceability, better stability, pleasing aesthetics and economy of construction. They are efficient form of construction for bridges because it minimizes weight, while maximizing flexural stiffness and capacity. It has high torsion stiffness and strength, compared with an equivalent member of open cross section. Although significant research has been underway on advanced analysis for many years to better understand the behaviour of all types of box bridges, the results of these various research works are scattered and unevaluated. Hence, a transparent understanding of more recent work on straight and curved box bridges is highly desired which divulged the attention towards aiming a present study. The main objective is to provide a clear vision about the analysis and design of box type minor railway bridges. This study would enable bridge engineers to better understand the behaviour of box bridge outlining a different approach towards analysis and design.

Figure no. 1

Bridges are defined as structures which are provided a passage over a gap without closing way beneath. They may be needed for a passage of railway, roadway, footpath and even for carriage of fluid, bridge site should be so chosen that it gives maximum commercial and social benefits,

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efficiency, effectiveness and equality. Bridges are nation’s lifelines and backbones in the event of war. Bridges symbolize ideals and aspirations of humanity. They span barriers that divide, bring people, communities and nations into closer proximity.

II. AIM AND OBJECTIVE

- To study the behaviour of box type minor road bridge when subjected to different combination of loads in terms of bending moment and Shear force variations.
- To note the behaviour of bridge for moving loads of vehicle at the critical sections.
- To design safe and economical structure.
- The design was computed by limit state of collapse and serviceability.

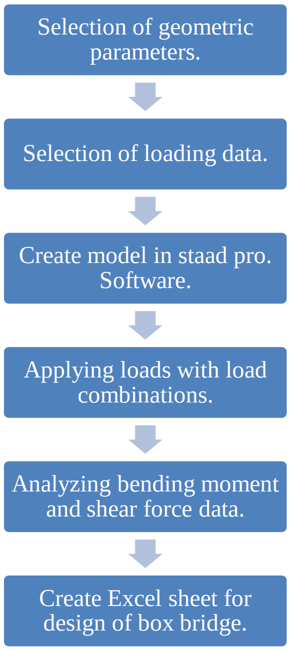
Figure no. 2

III. SUMMARY OF LITERATURE REVIEW

This study demonstrates the structural analysis and design of RCC box type minor bridge using manual approach [i.e. MDM method] and by computational approach [Staad-pro] using IRS - CBC codes. The structural elements [top slab, bottom slab, side wall] were designed to withstand Ultimate Load criteria [maximum bending moment and shear force] due to various loads [Dead Load, Live Load, SIDL, LL surcharge, DL surcharge] and serviceability criteria [Crack width] and a comparative study of the results obtained from the above two approach has been carried out to validate the correctness of the results. Further, it was also observed that the analysis using manual calculation becomes very tedious and cumbersome and for a complex type of structure, thus it is quite a complex task to perform the analysis manually, so the use of computational method [Staad – pro and excel sheet] becomes the obvious choice for design. The results obtained using MDM method shows a good agreement with the results obtained from computational methods.

IV. METHODOLOGY

The methodology used in this project is described briefly in points mentioned below:



3.1 Geometric parameters

Number of cells	=	8
Clear span of box bridge	=	4 m
Clear depth of box bridge	=	4 m
Overall width of bridge	=	12 m
Total length of bridge	=	35.6 m
C/C length of bridge	=	35.2 m
Top slab	=	0.4 m
Side wall	=	0.4 m
Bottom slab	=	0.45 m

Table no. 1

3.2 Loading data

S.No.	Load cases considered	Abbreviation	Limit state of collapse	Limit state of serviceability
1	Dead load	DL	1.35	1
2	Superimposed dead load.	SIDL	1.35	1
3	Wearing coat	WC	1.75	1
4	Earth	EP	1.5	1

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	pressure.			
5	Live load surcharge -one	LLS-One Side	1.2	1
6	Live load surcharge -both side.	LLS-Both Side	1.2	1
7	Temperature rise	TR	1	1
8	Temperature fall	TF	1	1
9	Breaking force - class A	BF-Class A	1.5	1
10	Breaking force - 70R tracked	BF-70RT	1.5	1
11	Breaking force - 70R wheeled	BF-70RW	1.5	1
12	Breaking force - 70R bogie	BF-70RB	1.5	1
13	Temperature gradient-rise case	TG-Rise	1	1
14	Temperature gradient-fall case	TG-Fall	1	1

Table no. 2

3.3 Staad Model of box bridge

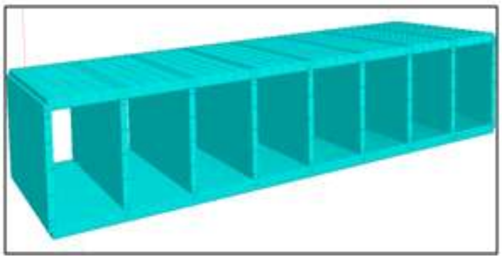


Figure no. 3

3.4 Impact factor

a) For 70R tracked vehicles	=	25%
b) For 70R wheeled vehicles	=	25%
c) For 70R bogie vehicles	=	25%
d) For class A vehicles	=	41.66%

Table no. 3

3.5 Calculations of Effective width of dispersion

beff=αa(1-(a/l) +b1

V. RESULTS

The analysis is done by staad pro. Software and design was computed in excel sheet. The result is computed in terms of Bending Moment and Shear Force. As we marked the sections to find bending moment and shear force at that point so by seeing the result values we saw that the bending moment in top and bottom slab is maximum at the corners and in external and internal wall it is maximum at the bottom and minimum at the top. In terms of graphs it is shown below.

Also values of BM & SF by varying load of vehicle is been shown in graphs.

L/C. NO.	Ultimate bending moment results at critical sections in KN				
	1	2	3	4	5
201	121	95	44	102	154
202	134	111	64	112	151
203	157	124	72	121	147
204	161	131	81	110	145
205	125	114	82	89	138
206	136	130	90	154	130
207	166	134	76	146	124
208	161	154	112	152	119
209	130	125	68	95	125
210	135	115	69	114	145
211	148	120	89	131	150
212	134	126	95	154	123
213	136	131	74	158	131
214	124	132	68	125	138
215	146	142	98	139	154
216	163	157	115	136	158
MAX.	166	157	115	158	158

Table no. 4

L/C NO.	Top Slab			Bottom Slab		
	Exteriour Support	Mid Span	Interiour Support	Exteriour Support	Mid Span	Interiour Support
201	96	39	89	119	63	126
202	85	33	76	114	60	113
203	74	28	69	109	52	120
204	65	24	61	99	46	118
205	116	47	96	132	75	135
206	91	38	81	128	68	129

207	82	36	66	116	59	121
208	76	39	68	104	39	107
209	126	51	102	147	81	142
210	95	49	92	132	71	87
211	98	45	72	126	62	74
212	88	49	76	121	54	68
213	121	49	96	131	71	128
214	89	44	83	109	60	111
215	93	42	70	108	53	98
216	79	43	73	95	42	79
Max. SF	126	51	102	147	81	142

Table no. 5

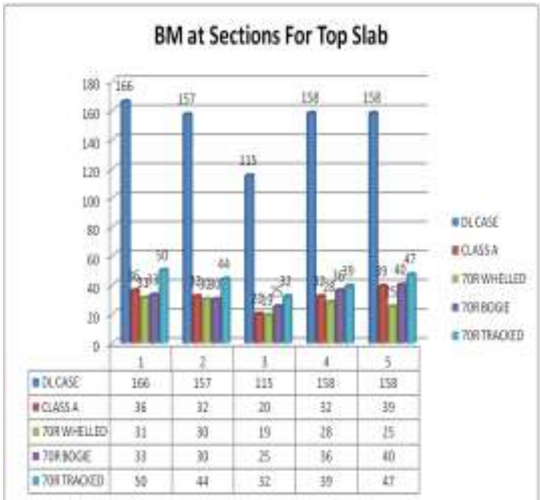


Chart no. 1

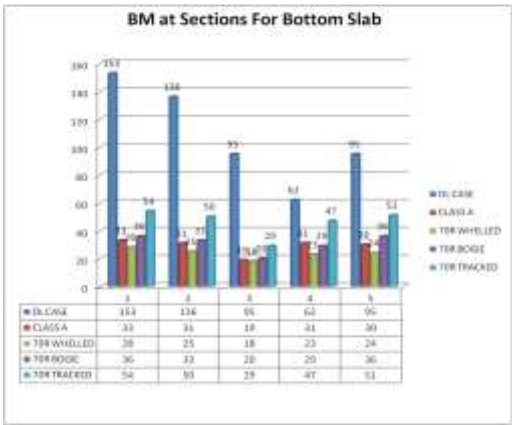
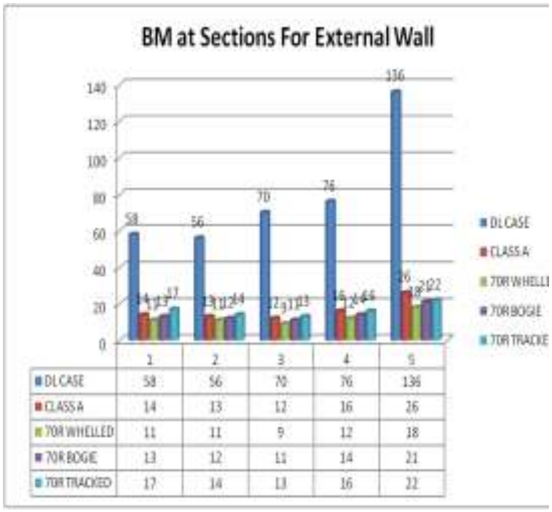


Chart no. 2



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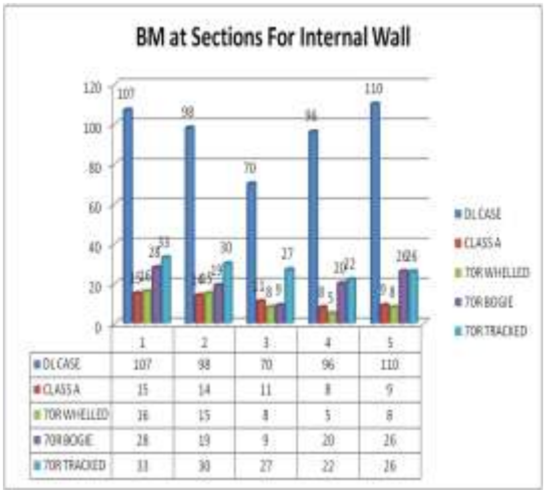

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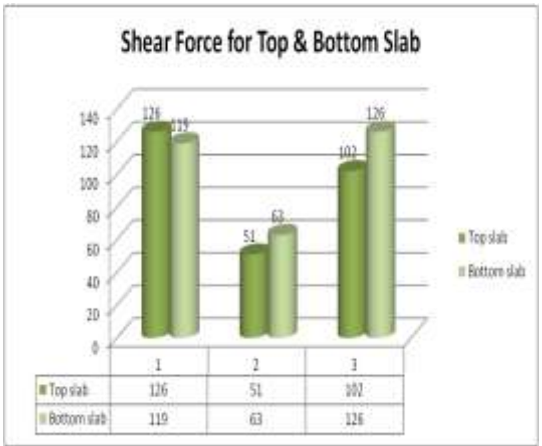

Chart no. 5

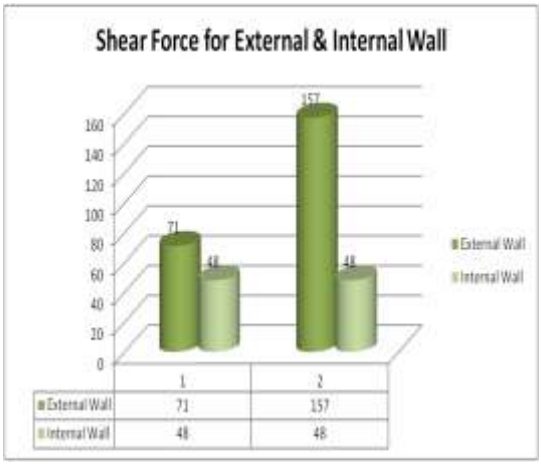

Chart no. 6

VI. CONCLUSION

The main objective of this project was to study the behaviour of box type minor road bridge when subjected to different combination of loads in terms of bending moment and Shear force variations. The design was completed by using Limit State method in case of Computational Approach (Staad Pro).So from analysis and design we concluded.

- The critical sections considered are the centre of span of top and bottom slabs and the haunch and at the centre and haunch of the vertical walls since the maximum design forces develop at these sections due to various combinations of loading patterns.
- The study shows that the maximum design forces developed for the loading condition when the top slab is subjected to the dead load and live load and sidewall is subjected to earth pressure and surcharges, and when the box is empty.
- The study shows that the temperature effect is severe in case of bridge design.
- The dimension of a bridge plays a governing role for the involvement of various loads and there cases for the designing purpose.
- It is found that for designing any railway bridge relevant IRS codes were to be very meticulously followed.

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