JETIR.ORG ISSN: 2349-5162 | ESTD Year : 2014 | Monthly Issue
JOURNAL OF EMERGING TECHNOLOGIES AND INNOVATIVE RESEARCH (JETIR)
An International Scholarly Open Access, Peer-reviewed, Refereed Journal

Analysis of Slab Bridge and T-Beam Bridge : A Case Study

[1]Kamlesh Sanodiya, [2]Dr. N.R. Dhamge,

[1]PG Student, [2]Professor,
[1]Civil Engineering Department,
[1]K. D. K. COLLEGE OF ENGINEERING, NAGPUR , MAHARASHTRA, INDIA.

Abstract : Designing a bridge is an important stage in the life of a bridge. In India, there are various codes used to design the bridges. Each code has different design provisions and methods. In this study, IRC codes are used to design slab bridge and T-beam bridge based on the limit state method. In this study, a T-beam bridge with three single spans of 10m & 15m length is designed as per IRC codes and analysed with STAAD pro software for moving load & Seismic loads. The IRC Class 70R & Class A loading are considered for applying the moving load whereas the seismic load is considered for different zones with different soil type. It has been observed that with the increase in span the results also gets increased when there is a change in loading from Class A to Class 70 R.

***IndexTerms* - T-beam Bridge, Slab Bridge, Class A Loading, Class 70R, STAAD pro**

I. INTRODUCTION

Highway bridges have been designed and built since the advent of the wagon, and the general structure types used and described in this chapter are not likely to change. There are many areas where these structure types can be improved—hence the need for future research. The research needs for highway bridges (and for that matter, bridges of all uses) fall into five general areas:

1. To optimize structural systems
2. To develop ways to extend service life
3. To develop systems to monitor bridge conditions
4. To develop details and methods to accelerate bridge construction
5. To develop a full life cycle approach to bridge data management

1.1 SLAB BRIDGES

Slab bridges are generally the simplest bridge cross section. It can be used for single span and multi-span bridges with span length up to 12m. For short spans, one solid reinforced concrete slab spans between two abutments with no intermediate supports. Simple reinforcement design is enough to carry the load. For longer spans, care needs to be taken to mitigate the extra self-weight introduced by the thicker slab. This can be achieved by adding pre-stressing bars to control the crack and deflection, and/or introducing “voids” into the slab to reduce its deadweight.

Figure 1:- Slab bridge

1.2 T-BEAM BRIDGE

T- beam bridges have cast-in-place, reinforced concrete beams with integral deck sections to either side of the tops of the beams. In cross section the beams are deeper than their deck sections, which produces the T-shape that gives them their names. The primary reinforcing steel is placed longitudinally in the bottom of the beam to resist the tension (the forces that would pull apart) on the beam. The deck that forms the top part of the T-shape is subject to compression (forces that squeeze or push it together). As concrete resists compression, it is concentrated in the deck along with less substantial reinforcing steel laid across the width of the bridge.

Figure 2:- T-Beam Bridge

1.3 Need for Research

The construction of bridges is done with the help of different IRC codes which are published with different design philosophy. In this study, T-beam and slab beam bridge superstructure has been analysed, designed and then comparison is made between these designs in order to determine which design methodology is most preferable design method or code for these RCC bridges.

1. Objectives

The objectives of the present study are-

- To study the comparison of Slab bridge and T-Beam bridge.
- Modelling of Slab Bridge and T-Beam Bridge using Staad Pro.
- Analysis of Slab bridge and T-Beam Bridge using Staad Pro.
- To carry out study by comparing the results of the Slab bridge and T-Beam Bridge.

2. Methodology

Following methodology has been adopted for the analysis of Slab bridge and T-Beam bridge

- Literature Review: Conduct a complete literature study to acquire essential information on the behaviour of bridge structures under various loads. This stage aids in understanding the available research, methodology, and design approaches pertinent to the analysis.
- Bridge Selection: Select relevant bridge for the analysis. Consider bridges with various spans, structural systems and

compare a range of reactions.

- Data Collection: Collect all relevant data on the chosen bridges, such as drawings, structural plans, material qualities, and site-specific information. This data will provide the foundation for the analysis and modelling.
- Structural Modeling: Using appropriate structural analysis tools, create three-dimensional (3D) models of the chosen bridges. Represent the shape, mass distribution, and connections of the construction components precisely.
- Comparative Evaluation: Compare the reactions and performance of the selected bridges. Examine parameters such as maximum Bending moments, Shear force, reactions, and overall bridge behavior.

3. Modelling of Slab bridge and T beam Bridge

STADD Pro. is the software used for modeling, analysis, and design of the structure. This software includes various country design standard it also includes Indian standard codes. it's a software where, modeling of structure, properties, and loading and load combination specification, applied analysis and design are carryout. The software has given the utilization ratio which shows the suitability of members as per codes.

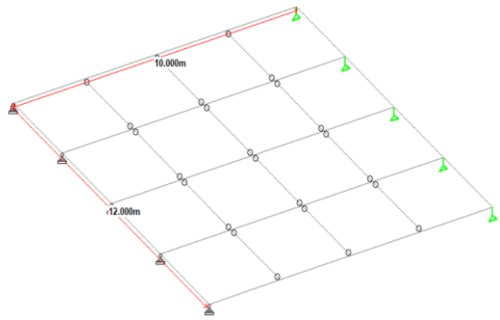


Figure 3:- T-beam bridge model

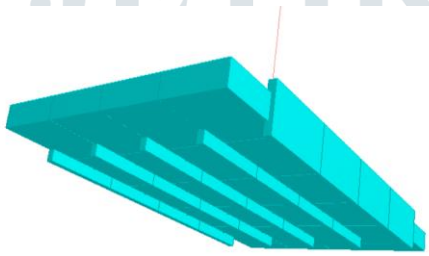


Figure 4:-3D Rendered model of T-Beam bridge in Staad Pro

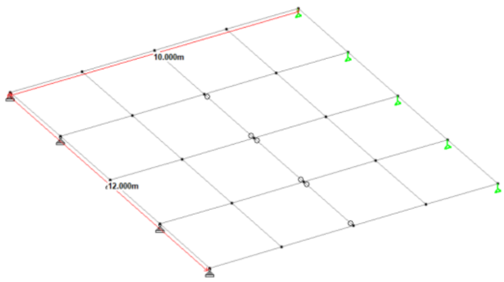


Figure 5:- Slab bridge Model

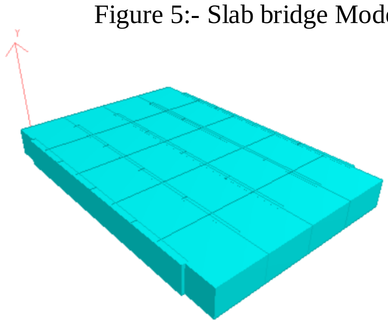


Figure 6:- 3D Rendered model of Slab Bridge in Staad Pro

4. Load Applied

The Loads applied on the structure is

- Dead Load:-

1. Selfweight
2. Crash Barrier Load:- 15.636 kN/m

- Moving Load:- Class 70R and Class A Loading

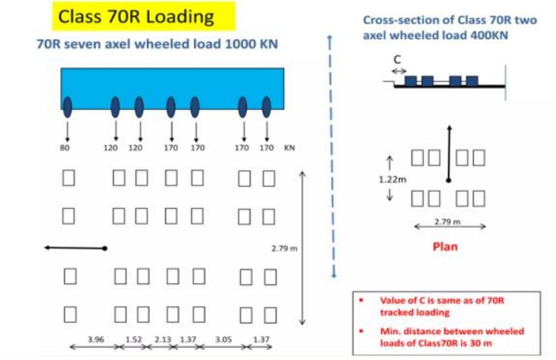


Figure 8:- CLASS 70R Loading Diagram as per IRC6 : 2017

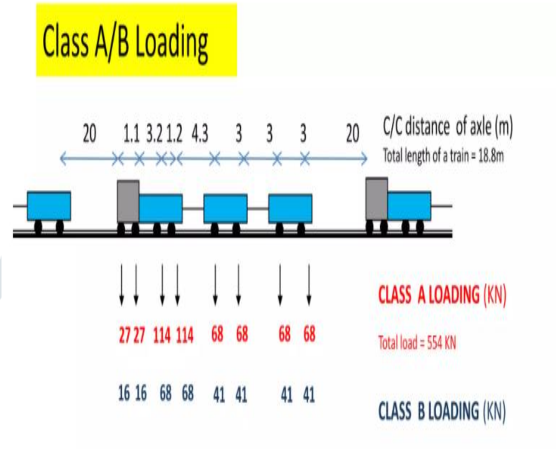
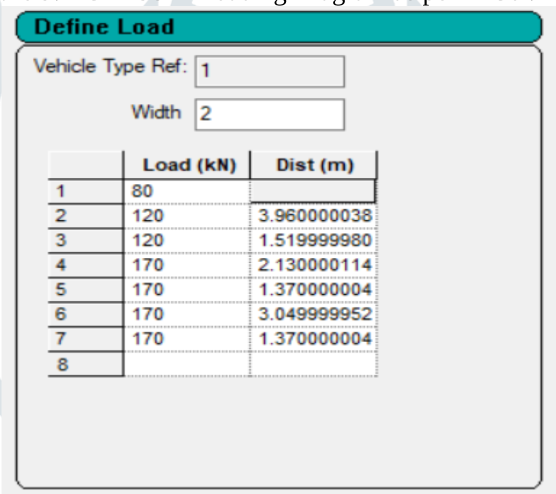


Figure 9:- CLASS A Loading Diagram as per IRC6 : 2017


Define Load

Vehicle Type Ref: 1

Width 2

	Load (kN)	Dist (m)
1	80	
2	120	3.960000038
3	120	1.519999980
4	170	2.130000114
5	170	1.370000004
6	170	3.049999952
7	170	1.370000004
8		

Figure 10:- IRC CLASS 70 Loading in STAAD Pro

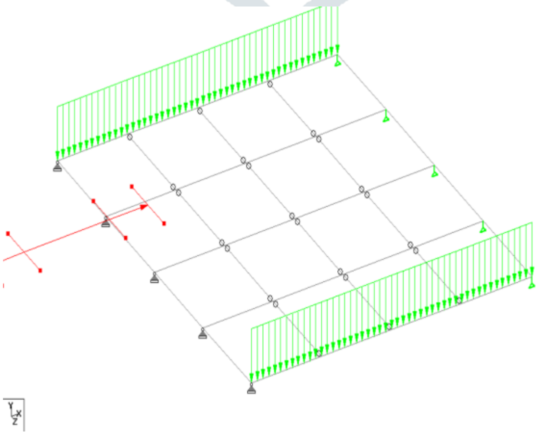
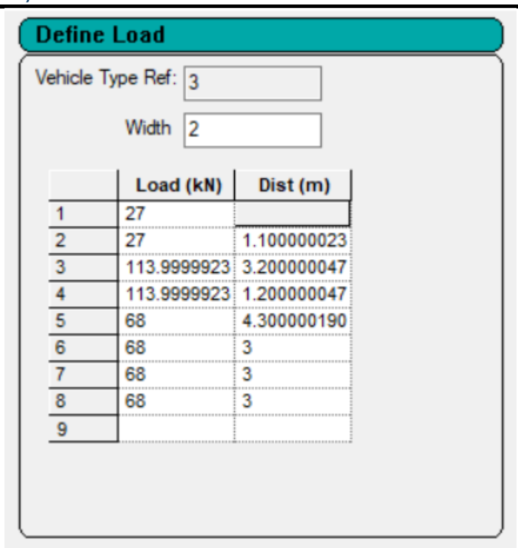


Figure 11:-IRC CLASS 70 Load applied in STAAD Pro



Define Load

Vehicle Type Ref: 3

Width 2

	Load (kN)	Dist (m)
1	27	
2	27	1.100000023
3	113.9999923	3.200000047
4	113.9999923	1.200000047
5	68	4.300000190
6	68	3
7	68	3
8	68	3
9		

Figure 12:- IRC CLASS A Loading in STAAD Pro

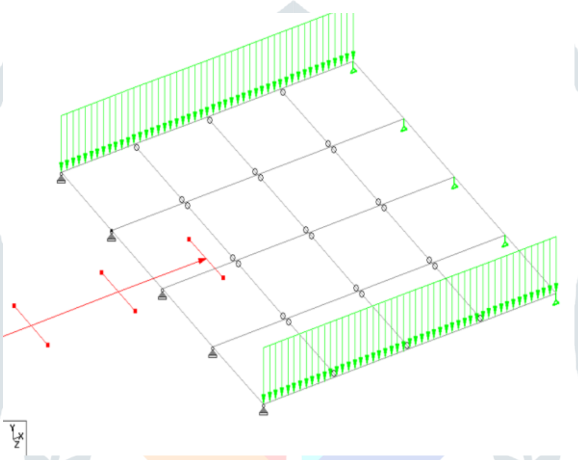


Figure 13:- IRC CLASS A Load applied in STAAD Pro

5. Results

From the analysis of the bridges the results are formulated for span 10m and 15m with vehicle load applied on it. The results are as follows.

1. Comparison of Maximum bending Moment

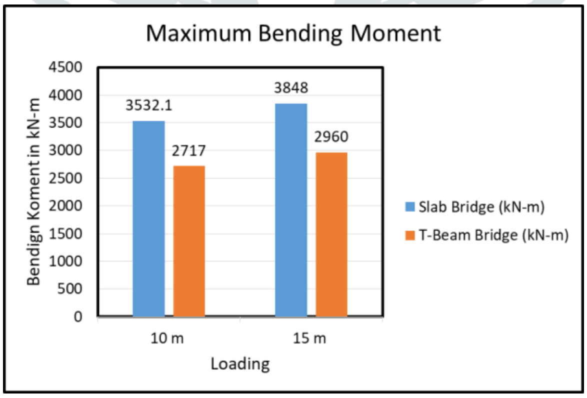


Figure 14:- Maximum Bending Moment in Slab and T-beam of 10m and 15m span

The above graph shows the result of maximum bending moment for Span 10m and 15m. In this the bending moment is directly proportional to the length and main reinforcement i.e. Ast. The main reinforcement required for the slab should be 1% of the area of member and for T-Beam its 2% for Area of the member. As the Area of the slab is more as compared to the size of T-beam thus the bending moment is more for slab bridge.

2. Comparison of Maximum Shear force.

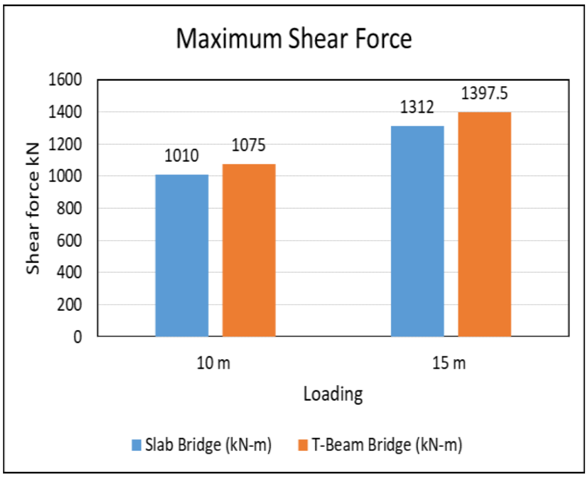


Figure 15:- Maximum Shear Force in Slab and T-beam of 10m and 15m span

The above graph shows the result of maximum shear force for Span for10m and 15m. In this the shear force is directly proportional to the stirrups and distributing bars i.e. Ast. In slab there are both distribution bars and stirrups where as in T-beam has only stirrups. Shear force is also related to cracks, the slab is more prone to shear failure.

3. Comparison of Deflection

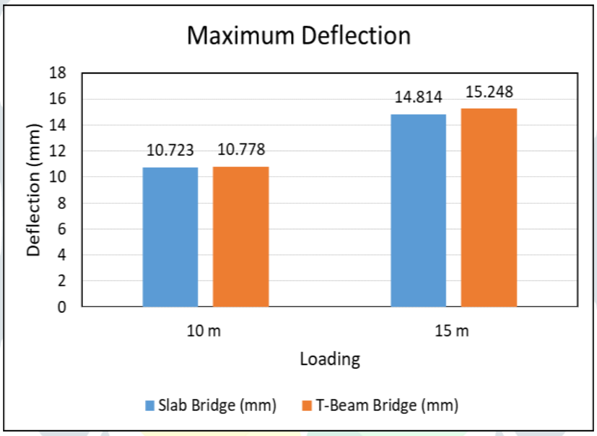


Figure 16:- Maximum Deflection in Slab and T-beam of 10m and 15m span

The above graph shows the result of maximum Deflection for Span for 10m and 15m. In this the Deflection in slab is less than the beam deflection as the depth of slab is more than the width of T-beam which gives more support and resistance to deflection to slab.

4. Comparison of Maximum Reaction

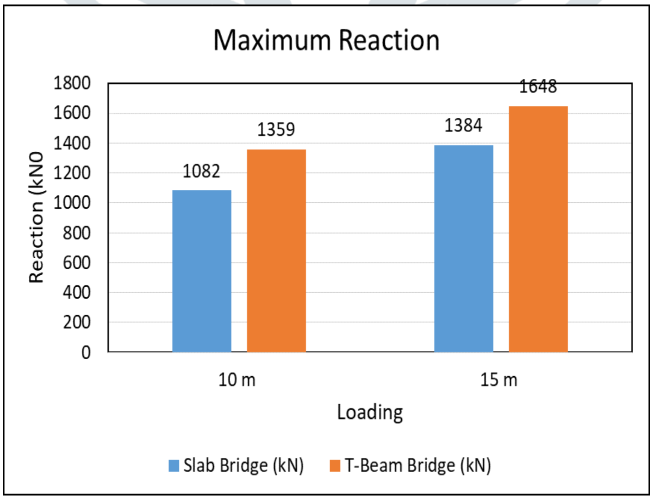


Figure 17:- Maximum Reaction in Slab and T-beam of 10m and 15m span

The above graph shows the result of maximum reaction for Span for 10m and 15m. As the weight of the slab bridge is more the overall reaction tends to be increased. While the T-beam bridge has less deck slab thickness and less weight as compared to the slab bridge thus the overall weight of T-beam bridge is also less. The reaction increases with increase in length of the bridge.

6. Conclusion

From the analysis of the bridges on STAAD Pro following conclusions are carried out

1. The result for Bending Moment & Shear Force shows the T-beam bridge has effective results as compared to Slab Bridge
2. The result of Maximum Deflection shows a slight change in the behavior as the slab bridge has les deflection than T-beam bridge
3. The maximum reaction at the support of the bridge have difference of more than 26 %
4. Comparing the span of 10m to 15m the result values gets increased by almost more than 20% overall
5. The Structural performance of the T-beam bridge is better than the slab bridge depending upon the loading parameters for Class 70R+70R+ClassA loading conditions.
6. The slab bridge is good for lower spans but the T-beam bridge is better for longer span.
7. The overall amount of reinforcement required for slab bridge will be significantly more than the T-beam bridge, thus the cost of construction also gets increases.
8. Overall the results shows the T-Beam bridge is 25-30% less values as compared to Slab Bridge.
9. Hence the T-beam bridge which is widely used for construction purpose shows better results than the Slab bridge.

References

[1] Fahad P. P. , Priyanka Dilip P, " Analysis and Design of Post Tensioned Box Girder Bridge Using SAP 2000," IJSRSET , Volume 3 , Issue 2 , Print ISSN: 2395-1990, Online ISSN : 2394-4099,2017.

[2] Phani Kumar, S.V.V.K.Babu, D.Aditya Sai Ram, "Analysis and Design of Prestressed Box Girder Bridge by IRC: 112-2011," International Journal of Constructive Research in Civil Engineering (IJCRCE) Volume 2, Issue 2, PP 1-10 ISSN 2454-8693, 2016.

[3] Sanket Patel, Umang Parekh, "Comparative Study of PSC. Tee Girder and PSC.Box Girder," IJSTE - International Journal of Science Technology & Engineering , Volume 2 , Issue 11 , May 2016.

[4] Pragya Soni, Dr. P.S. Bokare, "Review of Design Procedure for Box Girder Bridges," International Journal for Research in Applied Science & Engineering Technology (IJRASET) ISSN: 2321-9653; Volume 5 Issue IX, September 2017.

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

[6] R.Shreedhar, Spurti Mamadapur, "Analysis of T-beam Bridge Using Finite Element Method", International Journal of Engineering and Innovative Technology (IJEIT), Issue 3, Volume 2, September 2012.

[7] T. Sujatha ,Y. Yadu Priya , "Comparative Analysis of Post Tensioned T-Beam Bridge Deck by Rational Method and Finite Element Method," International Journal of Research in IT, Management and Engineering, ISSN 2249-1619, Issue 09,Volume 06, September 2016.

[8] Sharu.E ,Nivedhitha M and Gowtham Raja M , "design of RCC t-beam bridge considering overloading due to congestion," Indian J.Sci.Res. 17(2): 211 - 216, 2018.

[9] Prof. R.B. Lokhande ,Abrar Ahmed,"comparative analysis and design of t-beam and box girders," International Research Journal of Engineering and Technology (IRJET) Volume: 04 Issue: 07 , e-ISSN: 2395-0056 | July -2017.

[10] Sudip Jha, Cherukupally Rajesh, P.Srilakshmi, "Comparative Study of RCC Slab Bridge by Working Stress (IRC: 21-2000) and Limit State (IRC: 112-2011)," Volume No: 2, Issue No: 8 ISSN No: 2348-4845, August 2015.

[11] R.Shreedhar, Spurti Mamadapur, "Analysis of T-beam Bridge Using Finite Element Method," International Journal of Engineering and Innovative Technology (IJEIT) Volume 2; Issue 3; September 2012.

[12] Y. Yadu Priya , T. Sujatha, "Comparative Analysis of Post Tensioned T- Beam Bridge Deck by Rational Method and Finite Element Method," International Journal of Research in IT; management and Engineering, ISSN 2249-1619; Volume 06 Issue 09; September 2016.

[13] Nivedhitha M, Gowtham Raja M and Sharu.E, "design of RCC t-beam bridge considering overloading due to congestion," Indian J.Sci.Res. 17(2): 211 – 216; 2018.

[14] Abrar Ahmed, Prof. R.B. Lokhande,"comparative analysis and design of t-beam and box girders," International Research Journal of Engineering and Technology (IRJET) e-ISSN: 2395-0056 ; Volume: 04 ; Issue: 07; July -2017.

[15] Jagdish Chand, Ravikant, "Design and Analysis of Bridge Girders using Different Codes," International Journal of Engineering and Innovative Technology (IJEIT); ISSN: 2278-0181; Vol 8 Issue 07; July-2019.

[16] Anisha Chauhan, Dimple Desai and Bijal Chaudhri , "A Review On Comparative Study Of Bridge Super Structure With Reference To IRC And AASHTO Standards," International Journal of Technical Innovation In Modern Engineering & Science (IJTIMES); e-Issn:2455-2585; (RTSE-2018); Volume 4; Sept.2018.

[17] Kamde D. , John B. and Hulagabali A. , "Comparative Study for the Design of single span bridge using AASHTO LRFD and Indian Standard Method," IOSR Journal of Mechanical and Civil Engineering (IOSR-JMCE), e-ISSN: 2278-1684; p-ISSN: 2320-334X; PP 40-44.

[18] Hussein Yousif Aziz, Jianlin Ma,"Design and analysis of bridge foundation with different Codes," Journal of Civil Engineering and Construction Technology; ISSN 2141-2634; Vol. 2(5); pp.101-118; May 2011.

[19] Dr.Maher Qaqish, Dr.Eyad Fadda and Dr.Emad Akawwi, "Design Of T-Beam Bridge By Finite Element Method And Aashot Specification," KMITL Sci. J. ;Vol.8 No.1; January – June 2008.

[20] Sudip Jha, Cherukupally Rajesh, P.Srilakshmi, "Comparative Study of RCC Slab Bridge by Working Stress (IRC: 21-2000) and Limit State (IRC: 112-2011)," International Journal & Magazine of Engineering, Technology, Management and Research; ISSN No:2348-4845 ;Volume No: 2 ;Issue No: 8; August 2015.

[21] IRC: 112 – 2011, "Code of Practice for Concrete Road Bridges," Indian Roads Congress ; New Delhi ; India 2011. [12] IRC 6 – 2017, "Standard Specifications and Code of Practice for Road Bridges," Section II, Loads and Stresses; Indian Roads Congress; New Delhi; India; 2017.

[22] IRC: 21 – 2000, "Standard Specifications and Code of Practice for Road Bridges," Section III; Cement Concrete (Plain And Reinforced); Indian Roads Congress; New Delhi; India 2014.

[23] AASHTO-LRFD,"American Association of State Highway and Transportation Officials Load and Resistance Factor Design, "Sixth Edition; 2012.

[24] Rajan Patel, B.N. Kadia and Pooja Mistry, "Comparative Study of Live Load Condition on RCC Girder Span Bridge using IRC and AASHTO," Journal of Civil Engineering and Environmental Technology; p-ISSN: 2349-8404; e-ISSN: 2349-879X; Volume 3; Issue 4; pp. 280-286; January-March; 2016.

[25] IRC: 112-2011 Code of Practice for Concrete Road Bridges

[26] IRC: 6-2017 Standard Specifications and Code Of Practice For Road Bridges (section:ii) loads and load combinations (seventh revision)