International Journal of Technical Innovation In Modern Engineering & Science (IJTIMES),(UGC APPROVED)
Impact Factor: 5.22 (SJIF-2017),e-Issn:2455-2585
"Recent Trends in Structural Engineering" (RTSE-2018)
Volume 4, Special Issue 01, Sept.-2018

A REVIEW ON COMPARATIVE STUDY OF BRIDGE SUPER STRUCTURE WITH REFERENCE TO IRC AND AASHTO STANDARDS

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Abstract—Bridge design varies broadly around the world. Many standards are presently deals with Limit State Method. The design of various components of bridges is now done in most countries almost invariably with the use of computers. Designers are going in for longer and longer spans and adopt different forms and geometry in alignment. In recent years, single or multi-cell reinforced concrete box Girder Bridge have been proposed and widely used as economic aesthetic solution for the over crossings, under crossings, grade separation structures and viaducts found in modern highway system. The very large Torsional rigidity of the box girder's closed cellular section provides structures beneath is more aesthetically pleasing than open-web type system. In India, IRC had published IRC: 112 – 2011 that combines the provision for the both RCC & Prestress Concrete Structures. The present paper focus on comparative design of a box Girder bridge under IRC: 112 – 2011 and AASHTO LRFD Bridge Design Specification. This paper addresses the differences in calculation procedure, and the resulting design. This review paper consists of evaluate the Limit State Method of IRC: 112 and AASHTO-LRFD Bridge Design Specification. The main aim is to study the similarities and differences between the design procedures of IRC: 112 and AASHTO-LRFD. For that the past papers related to comparison of bridge super structure design with reference to IRC and AASHTO standards.

Keywords— IRC: 112-2011, AASHTO- LRFD, Box girder, Bridge super structure

I. INTRODUCTION

A box girder bridge is a bridge in which the main beams comprise girders in the shape a hollow box. Now a day box girder bridges are commonly used for highway flyovers and modern elevated structures of light rail transport because of its high torsional stiffness and strength as compared to an equivalent member of open cross section. It has gained wide acceptance in freeway and bridge systems due to its structural efficiency, better stability, serviceability and economy of construction. Maintenance of box girder can be easier, because the interior space can be made directly accessible.

Box girders can be universally applied from the point of view of load carrying, to their indifference as to whether the bending moments are positive or negative and to their torsional stiffness from the point of view of economy. Box girders are more suitable for larger spans and wider decks, box girders are to be suitable cross-section. They are elegant and slender. Economy and aesthetics further lead to evolution of cantilevers in top flanges and inclined webs in external cells of box girder. The dimension of cell could be controlled by prestressing. Any eccentric load will cause high torsional stresses which will be counter acted by the box section. The analysis of such sections are more complicated due combination of flexure, shear, torsion, distortion. But it is more efficient cross-section. The main aim is to compare the design of a box Girder bridge under IRC and AASHTO LRFD Bridge Design Specification.

II. LITERATURE REVIEW

[A] Epuri Pavan Kumar, Arepally Naresh, Sri Ramoju Praveen Kumar, Amgoth Ashok "Comparative Study Of Precast I-Girder Bridge By Using The IRC And AASHTO Codes", International Journal of Research in Engineering & Advanced Technology (IJREAT), April-May, 2015

Epuri Pavan Kumar, Arepally Naresh, Sri Ramoju Praveen Kumar, Amgoth Ashok carried out research work on three span continuous bridges of fixed width of 14.8 m and each span of 40 m. In this exercise, the writers has done the comparision of axial force, shear force, torsion, longitudinal stress and bending moment at various position in I girder section generated using two codes namely IRC: 21(2000) and AASHTO(2007). Analysis and Design is done by using CSI Bridge 17.0 version software. The live loads assigned for bridge model is class AA and class A from IRC: 6(2000) and HL- 93K and HL-93M from AASHTO. The conclusion made that the all forces generated from IRC is large compared to AASHTO because IRC code specifically imply the large vehicular load compared to AASHTO. Hence, for Precast Section is more stable when it is design through IRC rather than AASHTO.

[B] Amit Saxena, Dr. Savita Maru, "Comparative Study of the Analysis and Design of T-Beam Girder and Box Girder Superstructure", International Journal of Research in Engineering & Advanced Technology (IJREAT), April-May, 2013

Amit Saxena, Dr. Savita Maru described the cost optimization between T- girder and Box girder. For this exercise, writers investigated a bridge of span 25 m only for both types. Here in this study, simply supported two lane RCC T-beam Girder and simply supported two lane RCC Box Girder was analyzed for dead load and live loads as per IRC: 21(2000). Analysis and design is done by STAAD Pro Software. The conclusion made that service load bending moments and shear force for T girder are lesser compared to Box girder, also T-girder has more capacity of moment of resistance of steel and shear force resistance for span 25 m compared to BOX Girder, also quantity of steel and concrete required more in Box Girder compared to T-girder. But one advantage of Box girder is that it has higher torsion rigidity though it found costly. But for span more than 25 m box girder is convenient for RCC Type Bridge.

[C] Harish M K, Chethan V R, Ashwini B T, "ANALYSIS OF BOX GIRDER BRIDGES UNDER IRC LOADING", International Journal of Scientific Development and Research (IJSDR), September 2017

Harish M K, Chethan V R, Ashwini B T studied the parametric behaviour of a single cell and four cell box girder bridges. And also compared the results for IRC class AA loading conditions and corresponding bending moments with respect to different prototype models. In this study consider simply supported 2 lane box girder bridge with the span of 30 m. The formulation of problem for this research work regarding single cell and four cell girder bridge subjected to IRC class AA loading. Writers described the features of CSi bridge software used in analysis, bridge configurations, loading cases and analysis and interpretation of results. According to results obtained, the bending moment was found to be maximum for the Single cell box girder while compared with Four cell girder. Results of bending moment and stress for self-weight and superimposed weight are same, however those are totally different for the moving load, as a result of IRC codes offers style for the significant loading. Finally supported this comparative study it was clear that Single cell girder bridge is economical than Four cell girder bridge.

[D] Phani Kumar.Ch, 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), 2016

Phani Kumar.Ch, S.V.V.K.Babu, D.Aditya Sai Ram worked on analysis and design of prestressed concrete bridges (Deck Slab, T-Girder and Box Girder) are carried out using IRC:112-2011. A post tensioned deck type box girder bridge of clear span 30 m and width of roadway is 7.5 m is considered for the analysis. Live loads are taken as per IRC:6. Cross section of box girder is shown in Figure 1 and mathematical modelling is done using SAP2000 and is shown in Figure 2. Material properties used are M50 grade of concrete and Fe415 grade steel. The tendon profile considered is parabolic in nature. The Bridge analysis for different span to depth ratios (L/d) ratio starting from 15 to 19 and different span to depth ratios (L/d) are considered as follows.

Table 1 Cases of different span to depth ratio

Case	Span/Depth (L/d)	Depth (d)
1	15	2.0
2	16	1.9
3	17	1.8
4	18	1.7
5	19	1.6

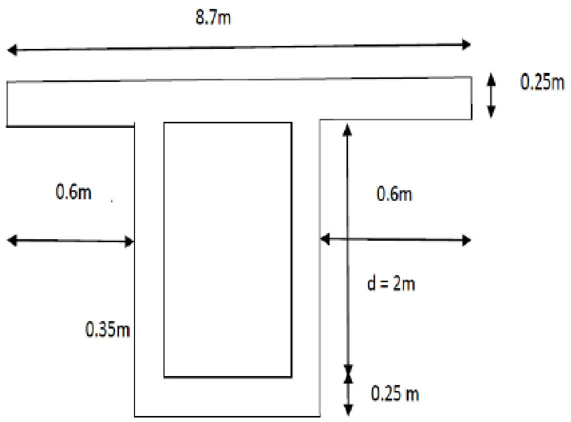

Figure 1 Cross section of box girder

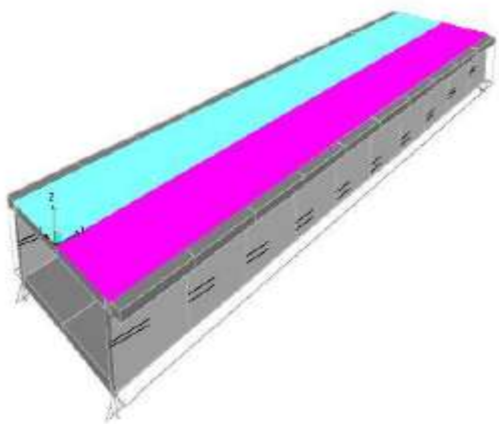

Figure 2 Modelling of box girder bridge

The various span to depth ratio were taken for the analysis of box girder bridges, and for all the cases, deflection and stresses are within the permissible limits. The comparison of prestress force, deflection and stresses values are obtained for various span/depth ratios for box girder bridge as shown in Table 2.

Table 2 Comparison of prestress force and deflection for various span to depth ratio

Span/Depth	Prestressing Force (kN)	Eccentricity (mm)	Deflection (mm)		
			DL+SIDL	DL+SIDL+PRE	DL+LL+PRE+SIDL
15	5428	850	14	11	18
16	5370	800	16	12	20
17	5309	750	17	13	23
18	5251	700	19	16	26
19	5194	650	22	18	29

The comparison of stresses at transfer and working stage for various span to depth ratios for box girder bridge as shown in Table 3.

Table 3 Comparison of stresses for various span to depth ratio

Span/Depth	15	16	17	18	19	Units
		At transfer stage				
Stress at Top	1.52	1.51	1.50	1.49	1.48	Mpa
Stress at Bottom	0.87	0.87	0.87	0.87	0.88	Mpa
		At working stage				Mpa
Stress at Top	1.41	0.43	0.43	0.42	0.41	Mpa
Stress at Bottom	0.48	-0.48	-0.47	-0.46	-0.45	Mpa

As the depth of box girder decreases, the prestressing force decreases and no of cables decreases. Because of prestressing, more strength of concrete is utilized and also well governs serviceability. For the same cross section and same applied moment, steel difference is quite noticeable compare to WSM, LSM consumes less steel than WSM and its better to change grade of steel rather increasing grade of concrete for more %age steel difference.

III. CONCLUDING REMARKS

From the study of above research papers it can be concluded that,

- The T – beam girder is obvious choice for designer for 25 m span. It has two advantage, they didn't need more sophisticated formwork as well as it is economically sounded.
- Box girder is always suitable for span more than 25 m.
- Box girder shows better resistance to the torsion of superstructure.
- As the depth of box girder decreases, the prestressing force decreases and no of cables decreases. Because of prestressing, more strength of concrete is utilized and also well governs serviceability.
- IRC:112 (2011) requires increased cover for pre tensioned strands as well as post tensioned ducts, which will lead to increased thickness of webs and deck slab / soffit slabs for PSC girders / PSC box girder bridges.

IV. SCOPE OF WORK

In this review paper, the analysis and design procedure of Box girder using different codes and different loading condition have been discussed. But the implementation of the same with respect to design and analysis can be developed for different types of loads. And the performance can be compared for various cross sections of box girder and optimize the economical section.

REFERENCES

[1] Amit Saxena, Dr. Savita Maru, "Comparative Study of the Analysis and Design of T-Beam Girder and Box Girder Superstructure", International Journal of Research in Engineering & Advanced Technology (IJREAT), April-May, 2013.

[2] Angel Lopez, Angel C. Aparicio "Review on Analysis and Behaviour Investigation of Box Girder Bridges", Volume: 03 Issue:04 | Apr-2016.

[3] Epuri Pavan Kumar, Arepally Naresh, Sri Ramoju Praveen Kumar, Amgoth Ashok "Comparative Study Of Precast I-Girder Bridge By Using The IRC And AASHTO Codes", International Journal of Research in Engineering & Advanced Technology (IJREAT), April-May, 2015.

[4] Harish M K, Chethan V R, Ashwini B T, "ANALYSIS OF BOX GIRDER BRIDGES UNDER IRC LOADING", International Journal of Scientific Development and Research (IJSDR), September 2017.

[5] Ms. Patil M.B., C.M. Deshmukh, Dr. C. P. Pise, Y. P. Pawar, S. S. Kadam, D. D. Mohite, S. V. Lale, "Comparative Study of Girders for Bridge by Using Software", Ms. Patil M.B.et al. Int. Journal of Engineering Research and Applications, March 2016.

[6] Phani Kumar.Ch, 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), 2016.