

Analysis of Girder Bridge with IRC and IRS Loadings – A Comparative Study

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ABSTRACT: I-girders have gained wide acceptance in freeway and bridge system due to their structural efficiency, better stability, serviceability, economy of construction and pleasing aesthetics. This paper deals with the comparative analysis of single span RCC Girder Bridge under IRC loadings and PSC Girder Bridge under IRS loadings. Analysis has been performed using MIDAS Civil software and STAAD-Pro software. Behaviour of Girder Bridge is discussed through the results obtained from analysis. This study further describes the percentage variation of bending moment and shear force from analysis results.

KEYWORDS: Girder Bridge, PSC, MIDAS Civil, STAAD Pro, IRC, IRS.

I. INTRODUCTION

Girder Bridges are widely adopted for short and medium spans. Deck and Girder usually act together to support the entire loads for highway and railway bridges to carry in Shear and Flexural bending. I-Girder Bridges are economical, simple to design and relatively straightforward to build. If the bridge contains any curves, the beams become subject to twisting forces, also known as torque, therefore they are best used to construct bridges that do not have any significant curves.

In Pre-stressed Concrete (PSC) internal stresses of suitable magnitude are introduced so that the stresses resulting from external loads are counteracted to a desired degree. Analysis of prestress I-Girder Bridge is very complex because of its three dimensional behaviour consisting of torsion, bending and shear. For Railway Bridges PSC I-Girders and for Highway Bridges RCC I-Girders with 4.8 m deck width and span of 19.76 m are adopted for this study.

The codal provisions used for standard loads in case of bridges are according to IRC and IRS. Highway Bridges have to be designed to withstand the live loads specified by the Indian Roads Congress (IRC). The standard IRC loads specified in IRC: 6-2014 are grouped under four categories as Class AA, Class 70R, Class A and Class B. As per IRC: 6-2014, one lane of Class A type of loading is recommended with Impact factor for 4.4 m carriageway width in this study.

The design guide lines of Railway Bridges in India shall be in accordance with the Indian Railway Standard (IRS) Code of Practice. The longitudinal loads for Broad Gauge standard loadings for all spans are 25t Loading-2008 and DFC loading (32.5t axle load) with a maximum axle load of 245.2 kN (25.0t) for the locomotives as per IRS. For this study, 25t Loading-2008 with five load combinations has been considered.

II. LITERATURE REVIEW

Praful N K and Balaso Hanumant analysed simply supported RC T-beam Bridge by rational method and finite element method using STAAD Pro. This study concluded that Courbon's Method gives the average result with respect Bending Moment values in the longitudinal girder has compared to Guyon Masssonet method whereas Guyon Masssonet method underestimates the Bending Moment values when compared with Courbon's method.

R.Shreedhar and Rashmi Kharde analysed the bridge deck by both grillage analogy as well as by finite element method. This study concluded that grillage analysis is easy to use and comprehend but analysis by finite element

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method gives more economical design when compared with the grillage analysis as finite element method gives lesser value in terms of bending moment compared with grillage model.

III. DIMENSIONS OF BRIDGE

The following provisions are considered for the modelling and analysis of I-Girders as per codal provisions

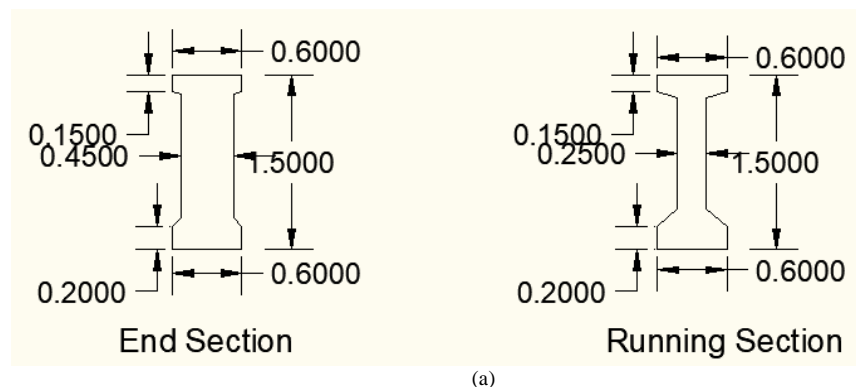
- The thickness of the web shall not be less than 200 mm plus diameter of duct hole. Where cables cross within the web, suitable increase in the thickness over the above value shall be made.
- The minimum thickness of deck slab including that at cantilever tips shall be 200 mm.
- In case of multi-beam arrangement, at least two cross girders, one at each support, shall be provided. The depth of the end cross girders shall be suitably adjusted to allow access for proper inspection of bearings and to facilitate positioning of jacks for future lifting up of the super structure.
- The thickness of cross girders shall not be less than the minimum web thickness of longitudinal girders.
- Haunches of 150 mm (H) x 150 mm (V) at top flange and 150 mm x 210 mm at bottom flange for PSC I-girder. For RCC I-girders haunches of 75 mm x 21 mm at top and 75 mm x 75 mm at bottom for End Section and haunches of 175 mm x 50 mm and 175 mm x 150 mm for running section.

The following parameters are considered for Girder Bridges

Span of the bridge	= 19.76 m
Effective span of the longitudinal girder (C/C of Girder)	= 18.0 m
Overall Deck width	= 4.80 m
19K13 strands are used for prestressing	
Ultimate tensile stress of High tensile steel	= 1860 N/mm ²
Maximum allowable jacking stress is 85% of 0.2% proof stress	= 1279 N/mm ²
Nominal steel area of each strand	= 128 mm ²

The following are the sectional dimensions of girder, End cross section, Middle cross section and loadings for Highway Bridge.

Fig.1 shows the sectional dimensions of the RCC I-Girder at End section and at running section, End cross section and Middle cross section of the Highway Girder Bridge and Loading for Highway Bridge for single lane as per IRC: 6-2014. The dimensions of the (a) End section and Middle section of Girder and (b) & (c) Cross sections of the bridge are in millimetres. In (d) spacing between the wheel loads are in metres and intensity of load in kN.



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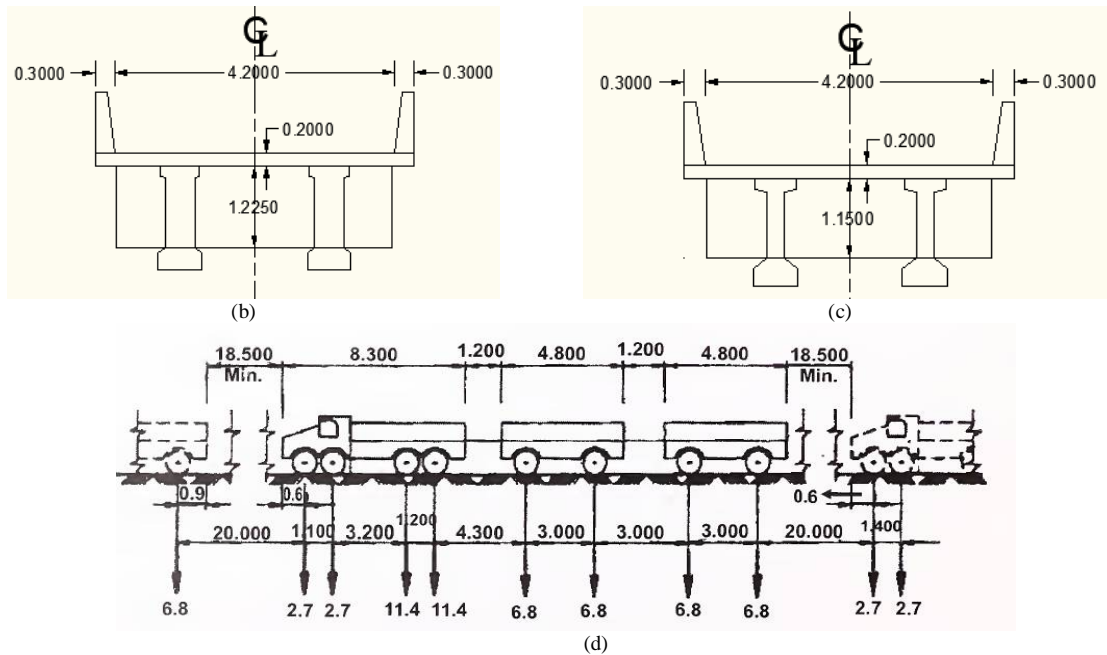
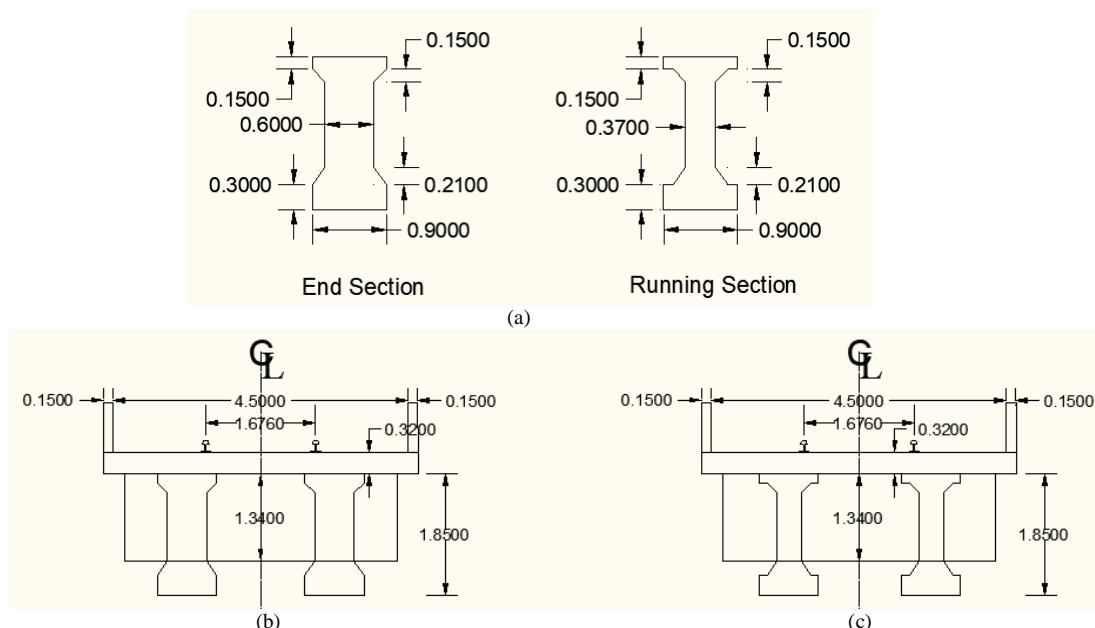


Fig.1. Highway Girder Bridge (a) Sectional Dimensions of Girder (b) End Cross Section (c) Middle Cross Section (d) Class A type of Vehicular Load as per IRC:6-2014

The following are the sectional dimensions of girder, End cross section, Middle cross section and loadings for Railway Bridge.

Fig.2 shows the sectional dimensions of the PSC I-Girder at End section and at running section, End cross section and Middle cross section of the Railway Girder Bridge are as per RDSO and Load combinations of 25t Loading-2008 as per IRS. The dimensions of the (a) End section and Middle section of Girder and (b) & (c) Cross sections of the bridge are in millimetres. In (d) to (h) spacing between the wheel loads are in millimetres and load intensity in kN.



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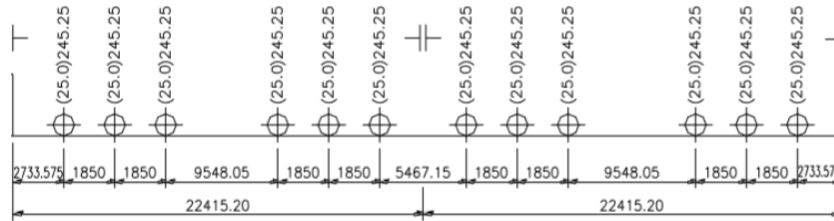
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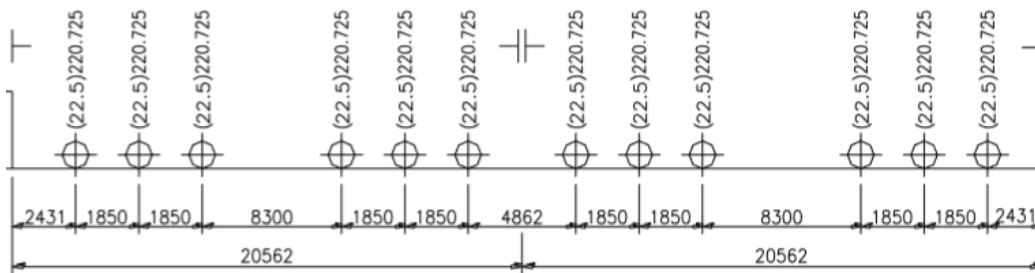
Note: Source for sectional properties of Railway Bridge is as per RDSO

COMBINATION-1: DOUBLE HEADED DIESEL LOCO



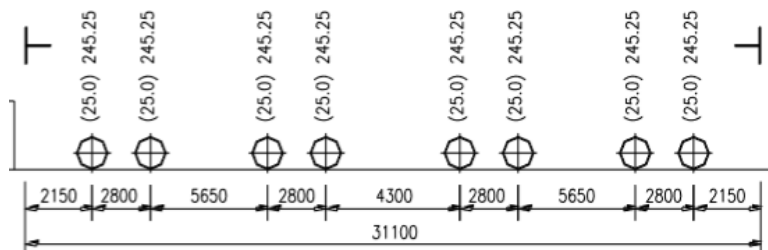
(d)

COMBINATION-2: DOUBLE HEADED ELECTRIC LOCO (2 WAG9H)



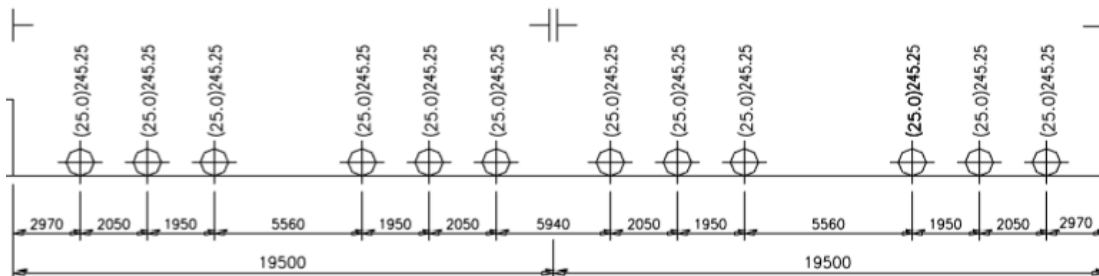
(e)

COMBINATION-3: ELECTRIC LOCO [(Bo-Bo)+(Bo-Bo)]



(f)

COMBINATION-4: WITH DOUBLE HEADED 25t LOCO



(g)

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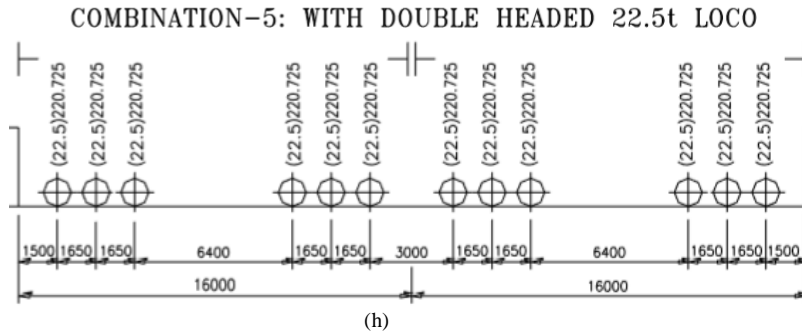


Fig. 2 Railway Girder Bridge (a) sectional dimensions of girder (b) End Cross Section (c) Middle Cross Section (d) to (h) five Load Combinations of 25t Loading-2008 as per IRS

The bridge is modelled by these cross sections and the loadings as per IRC and IRS are run on the deck of Highway Bridge and Railway Bridge which are modelled in the MIDAS Civil and STAAD Pro.

IV. MODELLING

Modelling is done in MIDAS Civil and STAAD Pro. For Highway Bridge, the analysis is carried under IRC Class A type of loading and for Railway Bridge, the analysis is carried under five combinations of 25t Loading-2008. Figures show the modelling of Highway Bridge and Railway Bridge in MIDAS Civil and STAAD Pro with IRC loading and IRS loading.

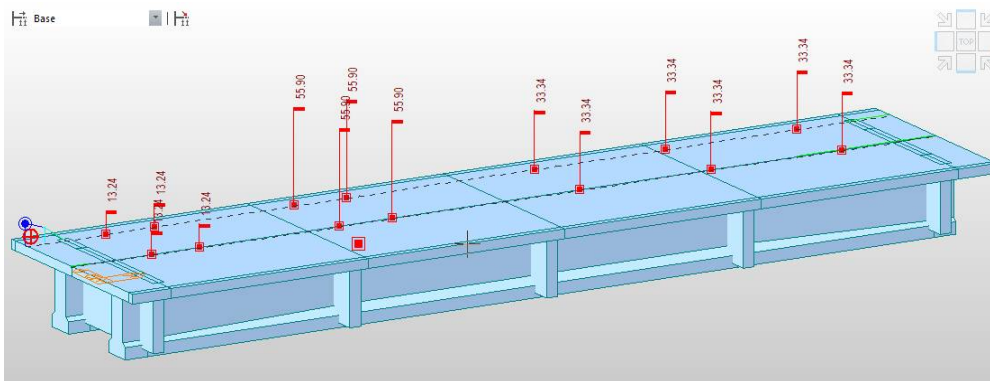


Fig.3 Longitudinal Position of IRC Class A vehicle in MIDAS Civil

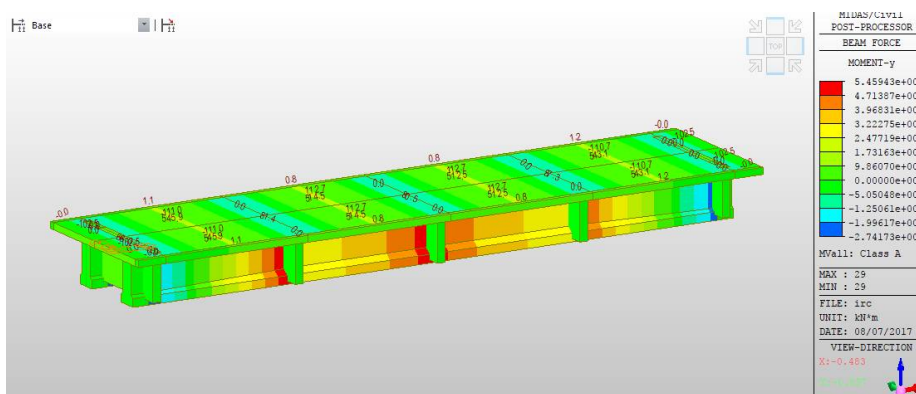


Fig.4 Bending Moment diagram for IRC Class A type loading in MIDAS Civil Software

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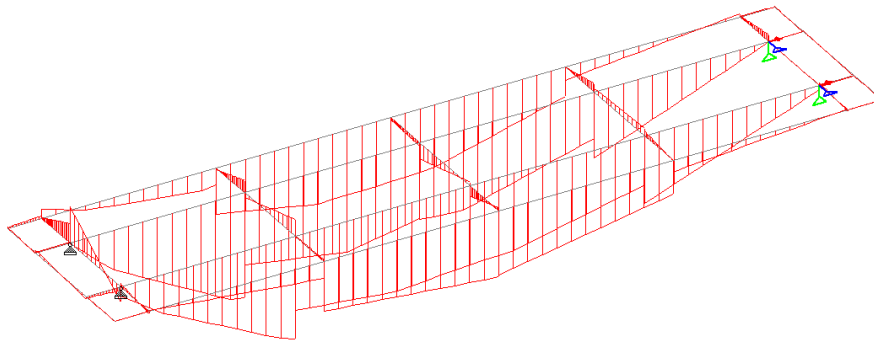


Fig.5 Bending Moment diagram for IRC Class A type loading in STAAD Pro software

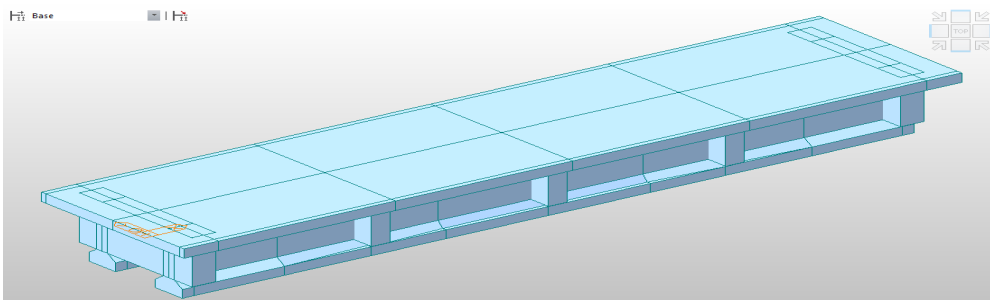


Fig.6 Modelling of Railway Bridge in MIDAS Civil for 19.76 m span

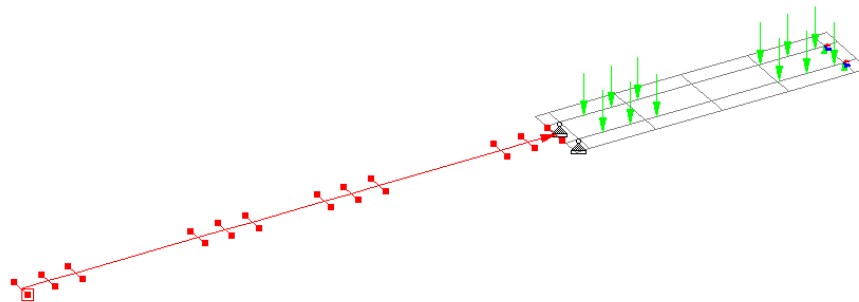


Fig.7 IRS 25t Loading Combination I in STAAD Pro

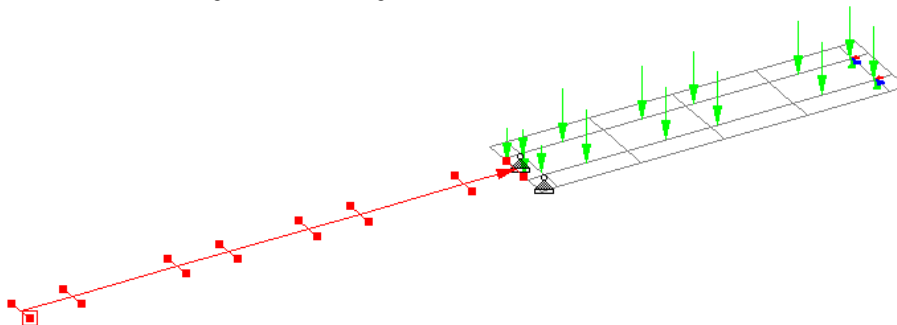


Fig.8 IRS 25t Loading Combination V in STAAD Pro

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The IRS loadings of five combinations of 25t loading-2008 are run on the deck for the Board Gauge with clearances as per IRS and the source for the sectional dimensions are as per RDSO. And the Class A load is run on the deck of Highway Bridge is as per guide lines of IRC: 6-2014.

V. RESULTS AND DISCUSSIONS

The following table.1 describes the variation of load per metre run for IRC Class A load and five load combinations of 25t Loading-2008 for Board Gauge as per IRS. Fig.10 shows the percentage variation of IRS loadings with respect to IRC load. Table.2 represents the Bending Moment and Shear Force values of five load combinations of 25t Loading-2008 as per IRS. Fig.11 shows the comparative results of Bending Moments (a) and Shear Forces (b) in MIDAS Civil and STAAD Pro for Railway Bridge subjected to five load combinations of 25t Loading-2008 as per IRS.

Table.1 Variation of load/metre for IRC and IRS

Type of loading	Load(kN)	Span(m)	Load/meter run(kN/m)
IRC Class A type Load	554	18.8	29.46
IRS Load Combination I	1471.5	16.95	86.82
IRS Load Combination II	1324.35	15.7	84.35
IRS Load Combination III	1962	26.8	73.21
IRS Load Combination IV	1471.5	13.56	108.52
IRS Load Combination V	1324.35	13	101.9

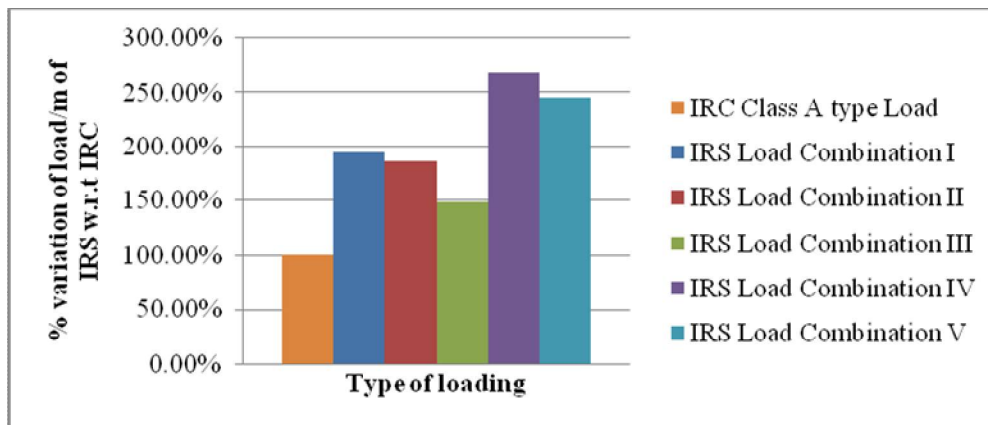


Fig. 9 Graph between % load variation and Type of loading

Table.2 Bending Moment and Shear Force values for 25t Loading-2008 combinations

Load Combination	Bending Moment, kNm		Shear Force, kN	
	MIDAS Civil	STAAD Pro	MIDAS Civil	STAAD Pro
Load Combination I	2389.7	2220.2	632	519.8
Load Combination II	2228.7	2132.53	573.34	483.75
Load Combination III	2001.6	1861.34	500.43	413.1
Load Combination IV	2330	2128.87	601.3	509.91
Load Combination V	2835	2633.88	621.22	546.9

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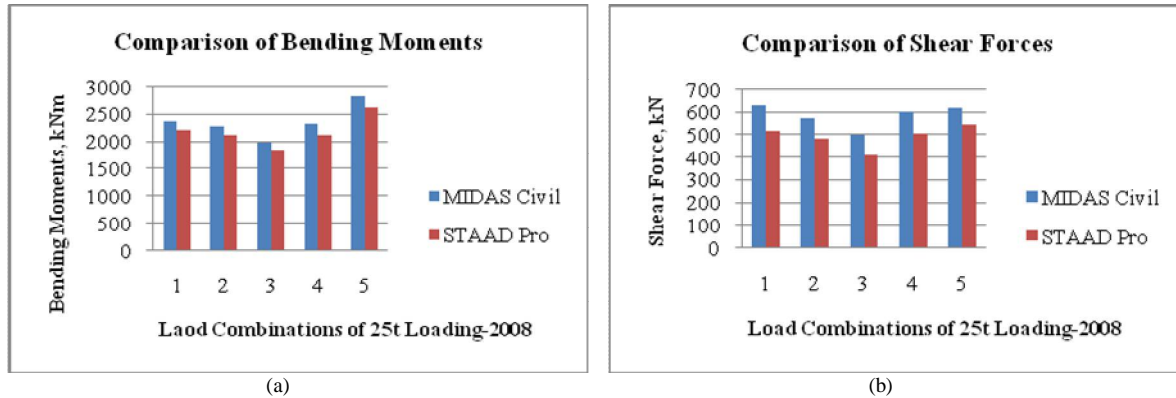


Fig.10 Railway Bridge (a) Comparison of Bending Moments (b) Comparison of Shear Forces

Table.3 Bending Moment and Shear Force values for Highway Bridge

	MIDAS Civil	STAAD Pro
Bending Moment, kNm	516.5	514.5
Shear Force, kN	227	182

The above table.3 shows the comparative results of Bending Moments and Shear Forces in MIDAS Civil and STAAD Pro for Highway Bridge subjected to IRC Class A type of loading as per IRC.

VI. CONCLUSIONS

It is found that the load per meter run of IRS loadings is increased by 210% compared to IRC. The Bending Moment due to IRS 25t Loading-2008 load combinations increased on an average of 4.6 times to the Bending Moment due to the IRC loading and Shear force due to IRS 25t Loading-2008 load combinations increased on an average of 3.2 times to the Shear force due to IRC load.

REFERENCES

- [1] K. Venkateswara Rao, G.RamaKrishna, Dr. M. Kameswara Rao, "A Comparative Design of RCC and Prestressed Concrete Flyover along with RCC Abutments", IJSRD - International Journal for Scientific Research & Development| Vol. 3, Issue 06, 2015.
- [2] Praful N K, Balaso Hanumant, "Comparative Analysis of T-Beam Bridge by Rational Method and STAAD Pro", International Journal of Engineering Sciences & Research Technology, ISSN: 2277-9655, 4(6): June, 2015.
- [3] Rajamoori Arun Kumar, B. Vamsi Krishna, "Design of Pre-Stressed Concrete T-Beam Bridges", International Journal of Bridge Engineering (IJBE), Vol. 2, No. 3,(2014).
- [4] Vishal U.Misal, N.G.Gore, P.J. Salunke, "Analysis and Design of Prestressed Concrete Girder", International Journal of Inventive Engineering and Sciences, ISSN: 2319-9598, Volume-2, Issue-2, January 2014
- [5] IRC: 6-2014 Standard Specifications for Code of Practice for Road Bridges.
- [6] R.Shreedhar, Rashmi Kharde, "Comparative Study of Grillage method and Finite Element Method of RCC Bridge Deck", International Journal of Scientific & Engineering Research Volume 4, Issue 2, February-2013.
- [7] IRC:112-2011 Code of practice for concrete road bridges
- [8] Wilast Amorn, Christopher Y. Tuan, and Maher K. Tadros, "Curved, precast, pretensioned concrete I-girder bridges", PCI Journal, November-December 2008.
- [9] IRC: 18-2000 Design Criteria for Pre-stressed Concrete Road Bridges (Post-Tensioned Concrete).
- [10] IRC: 21-2000 Standard Specifications and Code of Practice for Road Bridges.
- [11] Indian Railway Standard Code of Practice for Plain, Reinforced and Prestressed Concrete for General Bridge Construction (Concrete Bridge Code).
- [12] Grillage analogy in bridge deck analysis by C.S. Surana and R. Agarwal, Narosa Publishing House, ISBN: 978-81-7319-153-4, 1998.