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Finite Element Analysis of Deck Girder Brdige under IRC class a and AASHTO HS-20 Loading using STAAD-PRO

Vidu Choubey
Gyan Ganga Institute of Technology and Sciences

Abstract: In this work a finite element analysis of deck Girder Bridge under IRC Class A and AASHTO HS-20 loading is done. A comparative study of Deck Bridge with AASHTO and IRC: 6 -2014 have been analysed. A simple deck bridge has been taken for analysis work. The live loads have been assigned to the bridge model according to the specifications provided in the code. The analysis of the bridge is done by the FEA Software STAAD pro. A simply supported RC Bridge deck of varying deck thickness 365mm to 815mm have been considered. The slab has length as 10m and constant width as 12m. Comparison of absolute structural response parameters of I section concrete girders in slab of thickness 365mm TO 815mm under IRC Class A and AASHTO HS-20 Loadings is performed.
Keywords: Moving loads, HS-20, IRC Class A loading, Staad Pro, AASHTO, LRFD

I. INTRODUCTION

The direct and concentrated pounding of truck wheels are the most primarily types of live load a bridge must withstand. The deck should distribute the forces in such a way that it does not damage the bridge and safely transfers it to the support element below. In comparison to the other components of the bridge the deck have high ratio of live to total stresses. The dynamic performance of the bridge is affected by the vehicle speed, road surface conditions and different types of vehicles. The evaluation of the deck slabs can be determinant by the effects of heavily loaded trucks. Usually for the live loads and self-weight of the bridge structure the analyses of the bridge deck is done

II. METHODOLOGY

In this work a virtual model of the bridge deck has been created by the help of the FEA Software Staad Pro and the results of bending moment have been obtained. With the help of the software an accurate analysis and proper modelling of the bridge deck for different parameters like types of loads and the loading type, type of structural element supporting the deck can be carried out with less errors.

III. PROBLEM FORMULATION

In this work a finite element model is presented. Finite element analysis of concrete deck bridge supported by the help of I section concrete girders for a varied range of deck thickness under IRC Class Loading and AASHTO HS-20 loading is carried out. A total of 480 plates have been created to represent the slab model and total number of nodes created by the FEA software is 525. The deck slab has constant length of 10m and width as 12m.

IV. FINITE ELEMENT MODE

Plates elements are used to represent the slab model. The plates shows the characteristics same as the concrete slab in whole and can withstand stresses individually. The slab model have 525 nodes.3150 degree of freedom and 480 plates. A sketch of the mesh of the finite element is shown in Figure 1. The constant width of the slab is 12m and the length is 10m.The plate element is discretized in finite element mesh having shell elements as quadrilateral size. The size of the quadrilateral shell is 0.5m x 0.5m. The standard beam elements are represented by the horizontal elements.

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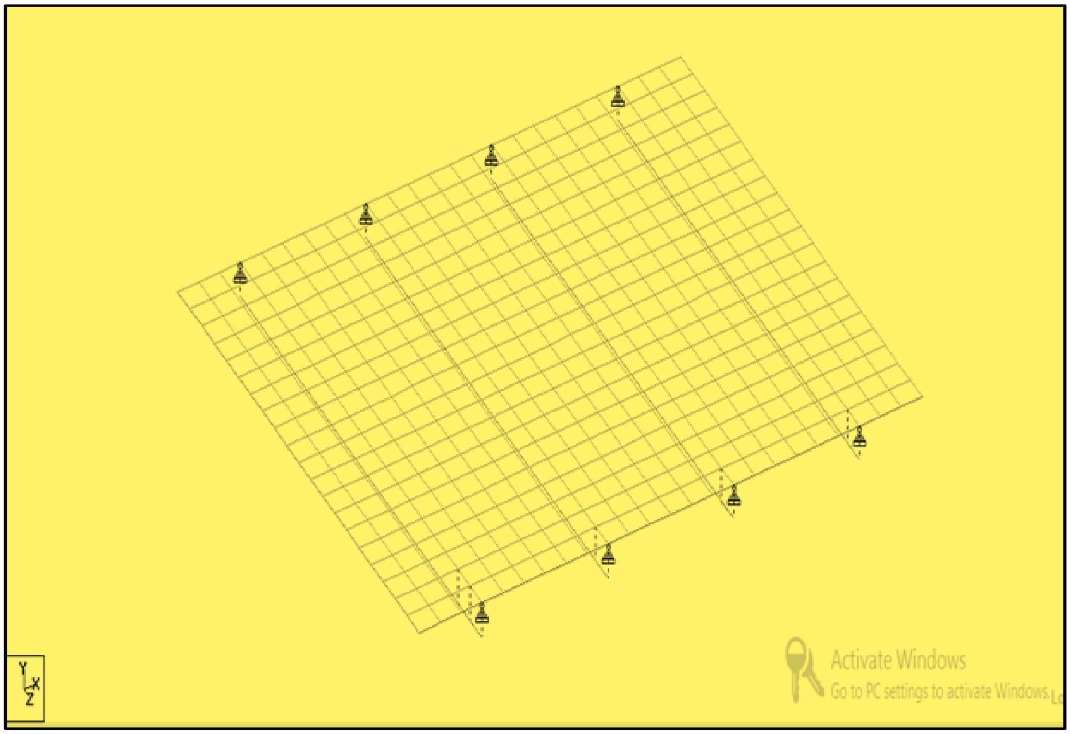

Figure 1: Ismoteric View of model of concrete slab with supporting I section concrete girder.

V. INVESTIGATIONS

The self-weight of the structure can be calculated and estimated by the geometry of the bridge section. The density of the concrete is 23.5 KN/m^3 and the Poisson's ratio is taken as 0.17. The standard vehicle loads considered are IRC Class A and the AASHTO HS-20 loadings. The bridge deck is supported by the four concrete girder. A total of 16 models were investigated. The Comparison of the absolute structural response parameters of concrete girders in slab of thickness 365mm TO 815mm under IRC Class A and AASHTO HS-20 Loadings are presented in tabulation form.

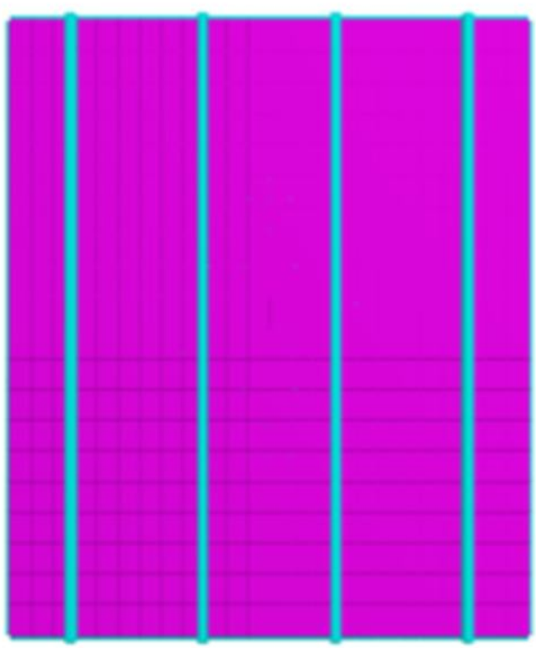

Figure 2: Plan View Of Concrete Slab With Supporting I Section Concrete Girders

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VI. ANALYSES RESULTS

A four I-section concrete girder is considered and the analysis is done as shown in the Table 1.The variation of bending moment in the girders with the increasing thickness of the deck can be observed in Figures below.

DECK THICKNESS (mm)	Girder 1		Girder 2		Girder 3		Girder 4	
	IRC	AASHTO	IRC	AASHTO	IRC	AASHTO	IRC	AASHTO
365	118.99	122.79	118.02	122.01	118.01	122.02	119	122.99
415	116.89	118.92	116.4	118.56	116.5	118.55	116.99	119.01
465	114.78	116.78	114.07	116.07	114.06	116.06	115.89	117.02
515	113.44	115.39	113.12	115.17	113.10	115.16	113.99	115.69
565	112.56	114.41	112.05	114.01	112.04	114.00	112.91	115.01
665	111.30	113.82	111.01	113.28	111.02	113.34	111.99	111.99
735	108.98	111.88	108.56	112.42	108.54	111.21	109.01	109.09
815	97.90	99.01	97.34	97.89	97.45	97.81	98.09	99.69

Table 1- Variation of Bending Moments In Concrete Girders

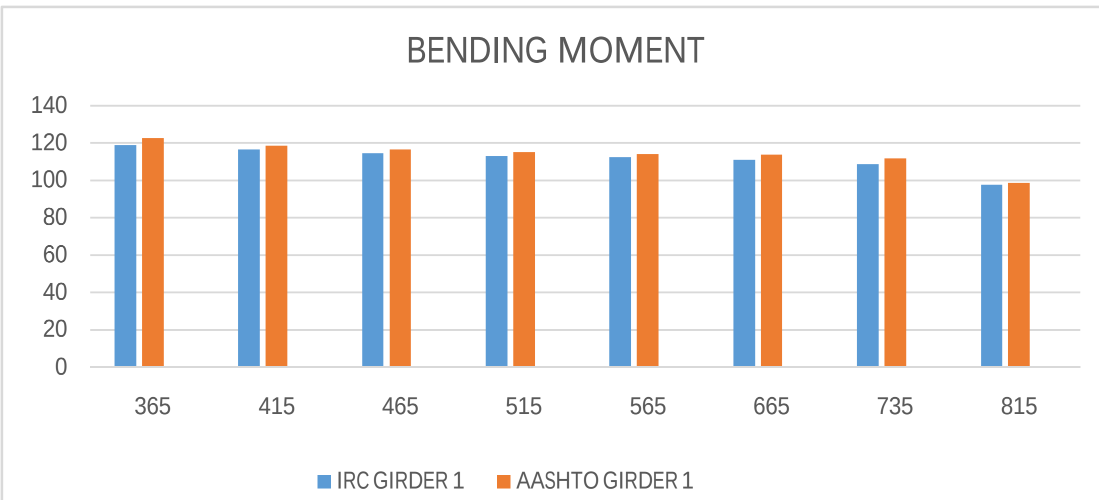

Figure 3: Bending Moment For Girder 1 Under Irc Class A And Hs-20 Loadings

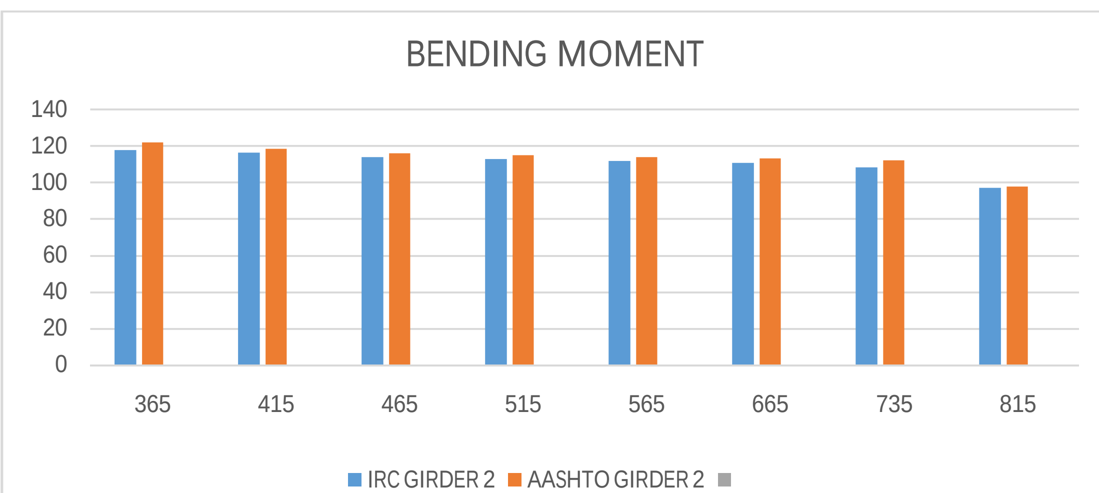

Figure 4: Bending Moment For Girder 2 Under Irc Class A And Hs-20 Loadings

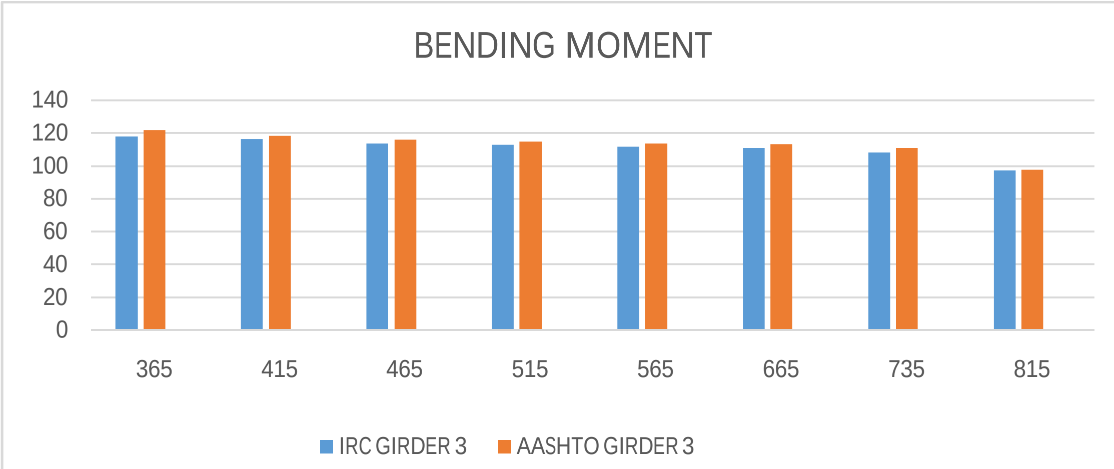

Figure 5: Bending Moment For Girder 3 Under Irc Class A And Hs-20 Loadings

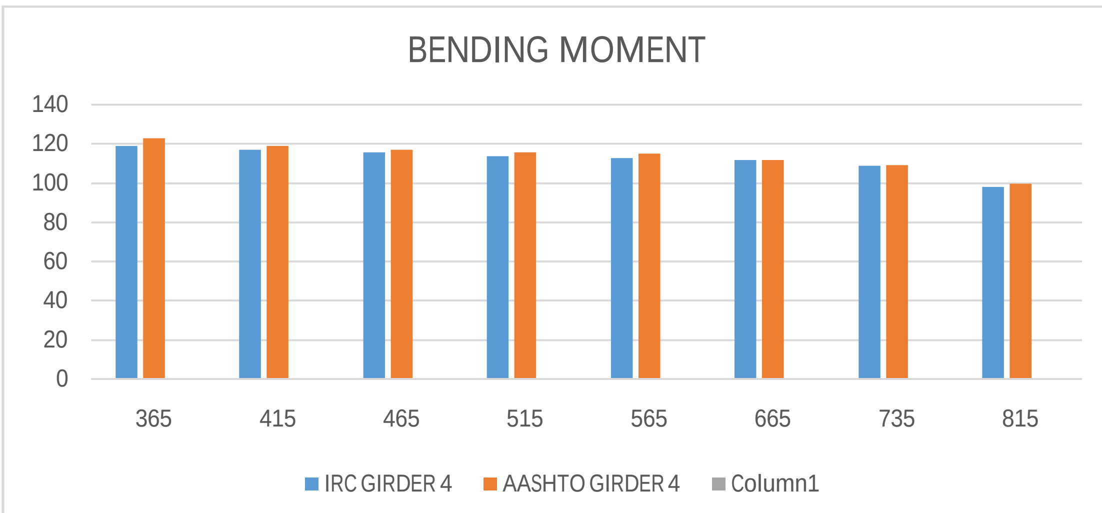

Figure 6: Bending Moment For Girder 3 Under Irc Class A And Hs-20 Loadings

VII. CONCLUSION

Based on the investigation done the following results can be obtained. The maximum bending moment values caused by the IRC Class A and AASHTO HS-20 loadings do not differ by 3.4%, this is mainly due to the variation in the wheel configuration AASHTO HS-20 and IRC Class A loadings. Also it can be concluded with the increase in the deck thickness the cracking propensity tends to decrease. AASHTO HS-20 Loading have 3.4% more bending moment as compared with IRC Class A loadings. It is concluded that there is the need of a more simplified and more realistic standard loads for the future.

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