A Comparative Study of Bridge Super Structure with & without Footpath of Two Lane by Varying Cross Girders

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Abstract— The unprecedented and rapid growth of bridge design practices & concrete construction in developed & developing countries is the driving force. Analysis & Design of Bridge Super Structure for Reinforced Concrete I-section has been carried out as per IRC 112-2011 "Concrete Road Bridges (Plain, Reinforced & Prestressed)" which is based on limit state method. Now-a-days the processing power & storage capacity of computers has increased by a factor of over 1000 & analysis software has improved greatly in sophistication and ease of use. Inspite of the increases in computing power, bridge deck analysis methods have not changed and Grillage Analysis remains the standard procedure for the most bridges deck. In this study has been carried for RCC I-girder for two lane carriageway width as per IRC specifications. The study also carried for the consideration of with & without footpath loads on bridge deck. Determination of quantity of materials for RCC super structure will be carried out. For the analysis, study is carried using STAAD Pro software and design excel sheets will be develop as per IRC recommendations.

Keywords: RCC I-Girder, STAAD Pro, IRC Recommendations, Limit State Method

I. INTRODUCTION

Carriageway Width	7.50m
Overall width	9.0m
Width of Crash Barrier	0.50m
Cross slope	2.5% (Both direction)
Thickness of wearing course	75mm (50mm asphaltic wearing with topping of 25mm mastic asphalt).
C/C of the Girder	2.85m

Table 1: Description of the Structure

S.No	Description	Dimensions
1.	Bridge length (c/c of expansion gap)	30.00m
2.	Span lengths (c/c of bearing)	29.60m
3.	Skew Angle	0 Deg

Table 2: Span Arrangement

II. STRUCTURAL ANALYSIS

A. Method of Analysis for Longitudinal Girders

The analysis of the RCC Girder for longitudinal flexure shall be carried out using Grillage model on STAAD Pro on the following basis.

- For the design of the longitudinal Girders stresses and moments shall be determined at an interval of every L/8.
- Members along the longitudinal Direction shall be along the longitudinal beams and at the ends.
- Transverse members of the grillage other than the Cross-diaphragm shall be modeled as slab elements.

B. Method of Analysis for Cross Girders

The analysis of the Cross Diaphragm shall be carried out using Grillage model on STAAD Pro on the following basis:

- The Intermediate cross girders shall be designed as a continuous beam supported on the longitudinal girders.
- The end cross girders shall be designed for the jack up position.

III. METHODOLOGY

The following steps are to be followed for the analysis of bridge deck using Grillage Analogy Method.

- Idealization of deck into equivalent grillage.
- Evaluation of equivalent elastic inertia of grillage members.
- Application and transfer of loads to various nodes of grillage.
- Determination of force responses and design envelopes.
- Interpretation of results.

IV. LOADS

A. Dead & Super Imposed Dead Load

Dead Load is the gravity loading due to components of structure and other permanently attached items to it. Dead Load or permanent load is calculated as the product of volume and density of material. The weight of superstructure is supported wholly or in part by the girder including its own weight is the Dead Load. Superimposed Dead Load (SIDL) is also the gravity load due to non-structural parts of the bridge which may be changed during the lifetime of the structure. SIDL is particularly prone to increase during the lifetime of bridge; this is a reason high load factor is applied.

B. Live Load

Road Bridges are designed in accordance with the IRC code of practice. IRC: 6-2000 code of practice gives the specifications for the various loads and stresses. For bridges, the design live loads consist of standard wheeled or tracked vehicles or trains of vehicles. There are three types of standard loadings for which the bridges are designed namely, IRC class AA loading, IRC class A loading and IRC class B loading.

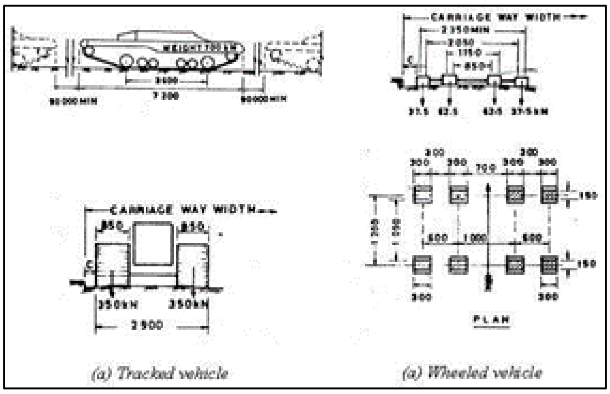

Fig. 1: Class AA vehicle load

IRC class AA loading consists of either a tracked vehicle of 70 tonnes or a wheeled vehicle of 40 tonnes with dimensions as shown in Fig. Sometimes Class 70R Wheeled and Tracked vehicles are used instead of Class AA loading. Class A loading consists of train wheel load and two trailers of specified axle spacing, adopted on all roads for permanent bridge. While Class B vehicle loading is adopted for bridges in specified areas.

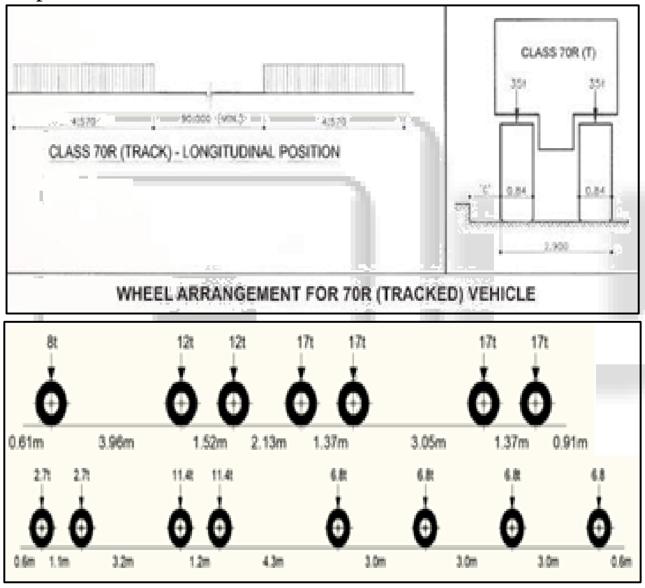

Fig. 2: Class 70R tracked & wheeled vehicle and Class A vehicle loads

V. RCC I-GIRDER

A. Design Procedure

- Create the structural model including member properties and support conditions.
- Go to the command menu and the vehicle loading.
- Define the position of the vehicle in load window.
- Then go for the analysis.
- Proceed with the same procedure to get the maximum support and span moments by changing the transverse and longitudinal position of vehicle.
- Proceed with analysis and post-processing in the normal way. STAAD Pro model has been created and illustrated in the following diagram.

B. STAAD models for 3 & 5 Cross Girders with Footpath

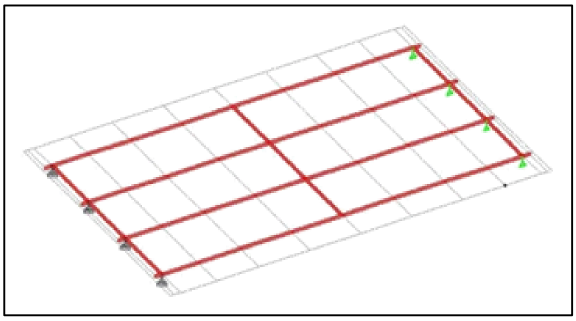

Fig. 3: STAAD model for 3-Cross Girders

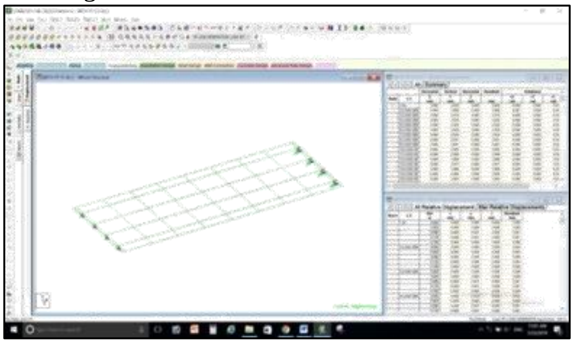

Fig. 4: STAAD model for 5-Cross Girders

No of girders	at centre
3-Cross Girders	110.07
5-Cross Girders	53.706

Table 3: Deflection

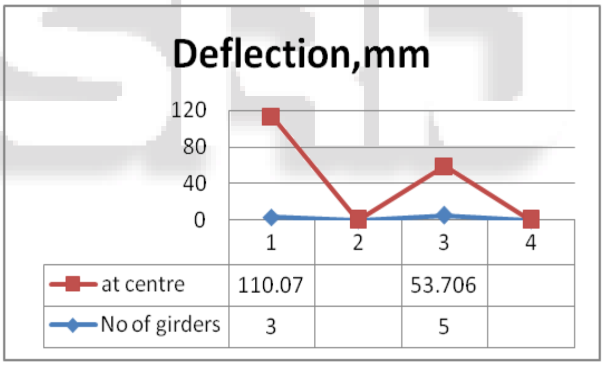

Fig. 5: Deflection diagram for 3 & 5 cross girders with footpath

No of girders	at centre
3-Cross Girders	8365.2
5-Cross Girders	8289.9

Table 4: Bending Moment

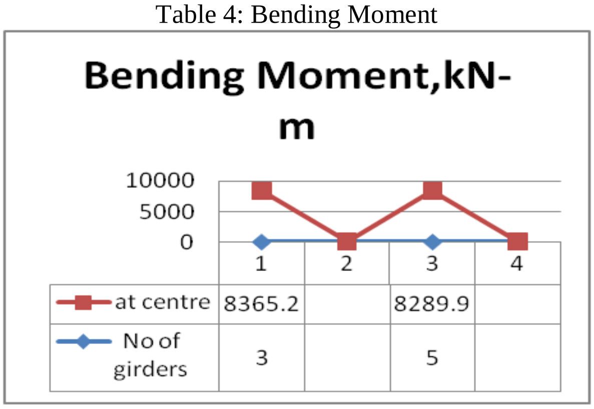

Fig. 6: Bending Moment diagram for 3 & 5 cross girders with footpath

No of girders	at centre
3-Cross Girders	716.8
5-Cross Girders	1342.1

Table 5: Shear Force

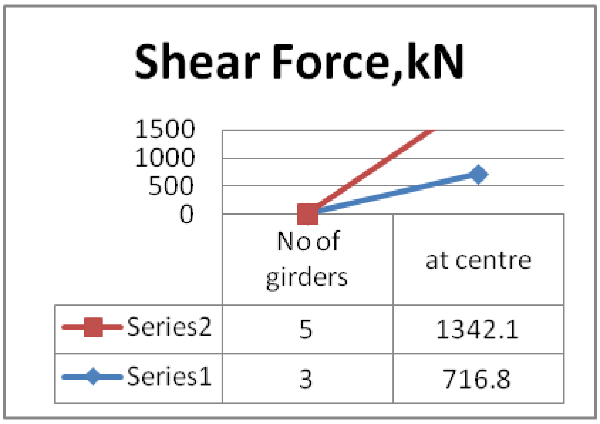

Fig. 7: Shear Force diagram for 3 & 5 cross girders with footpath

No of girders	at centre
3-Cross Girders	36.05
5-Cross Girders	18.84

Table 6: Torsion

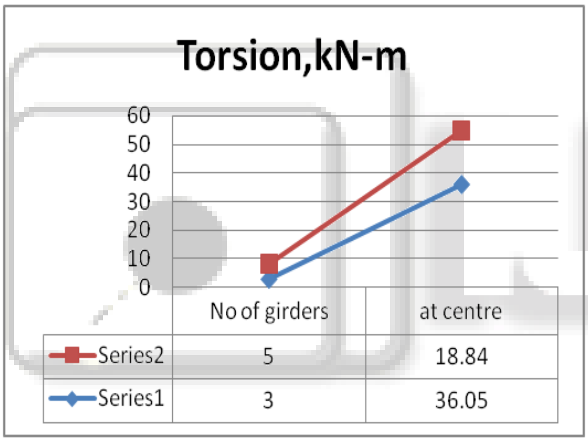

Fig. 8: Torsion diagram for 3 & 5 cross girders with footpath

C. STAAD models for 3 & 5 Cross Girders without Footpath

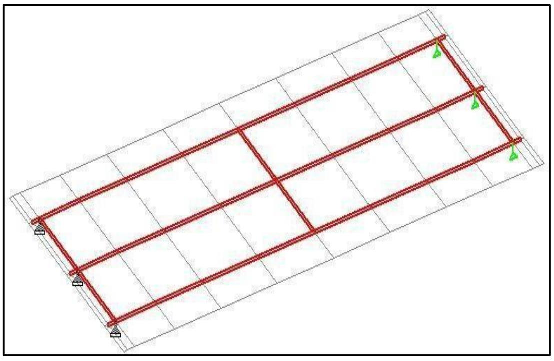

Fig.9 STAAD model for 3-Cross Girders

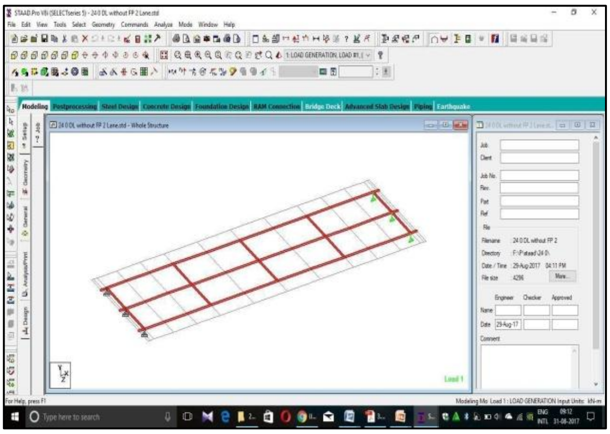

Fig. 10: STAAD model for 5-Cross Girders

No of girders	at centre
3-cross girders	27.87
5-cross girders	27.88

Table 7: Deflection

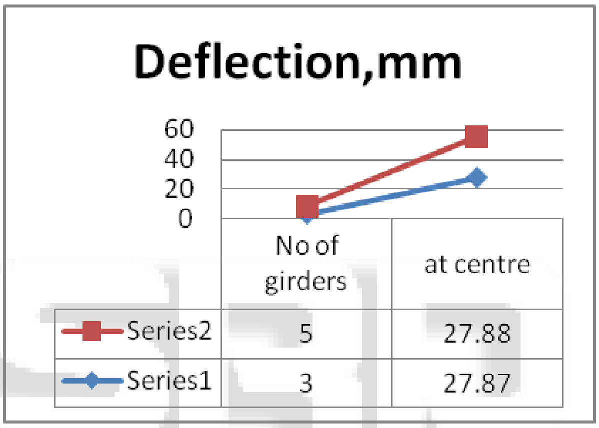

Fig. 11: Deflection diagram for 3 & 5 cross girders without footpath

No of girders	at centre
3-cross girders	8167.95
5-cross girders	6639.79

Table 8: Bending Moment

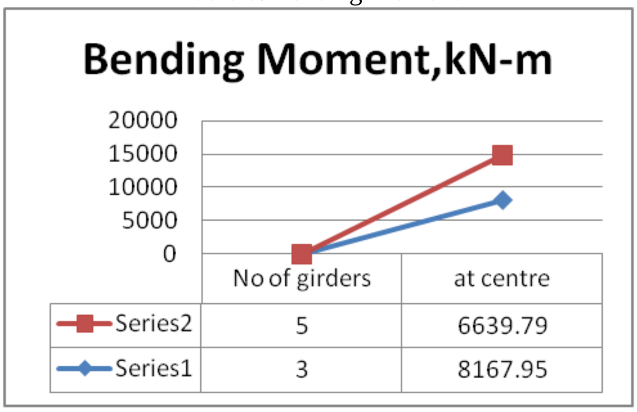

Fig. 12: Bending Moment diagram for 3 & 5 cross girders without footpath

No of girders	at centre
3-cross girders	195.5
5-cross girders	208.96

Table 9: Shear Force

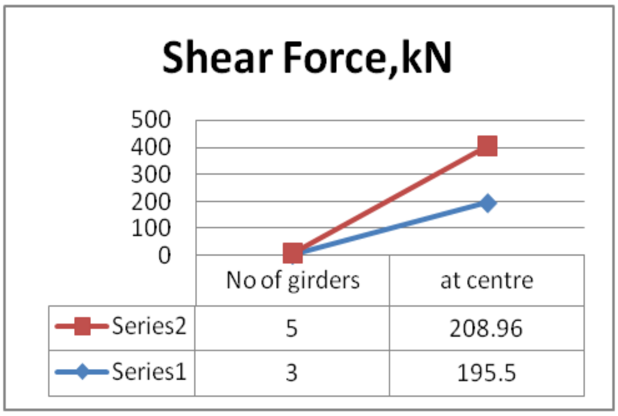

Fig. 13: Shear Force diagram for 3 & 5 cross girders without footpath

No of girders	at centre
3-cross girders	0
5-cross girders	0

Table 10: Torsion

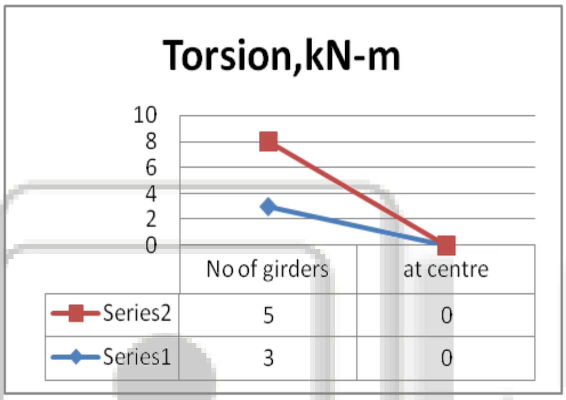

Fig. 13: Shear Force diagram for 3 & 5 cross girder without footpath

VI. Conclusions

A. Bridge Super Structure of Two Lane Carriageway Width with Footpath:

1) Deflection for 3-cross girders is 51.2% greater than 5-cross girders.
2) Bending Moment for 3-cross girders is 0.9% greater than 5-cross girders.
3) Shear Force for 3-cross girders is 87.2% lesser than 5-cross girders.
4) Torsion for 3-cross girders is 47.7% lesser than 5-cross girders.
5) In bridge super structure with footpath for 2-lane carriage way width 5-Cross Girders is more efficient than 3-Cross Girders.

B. Bridge Super Structure of Two Lane Carriageway Width Without Footpath:

1) Deflection for 3-cross girders is 0.03% lesser than 5-cross girders.
2) Bending Moment for 3-cross girders is 18.7% greater than 5-cross girders.
3) Shear Force for 3-cross girders is 6.8% lesser than 5-cross girders.
4) There is no Torsion value for 3 & 5 cross girders.
5) In bridge super structure without footpath for 2-lane carriage way width 5-Cross Girders is more efficient than 3-Cross Girders.

Hereby, we conclude that as the number of girders increases the efficiency of the bridge super structure increases.

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