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RESEARCH ARTICLE

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PARAMETRIC STUDY OF HORIZONTALLY CURVED BRIDGE GIRDER

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ABSTRACT

Parametric study of a horizontally curved bridge girder is done using a finite element software. The bridge is simply supported. IRC Class AA type of moving load is simulated on two lanes on the beam of span 66m, having a trapezoidal box type cross-section. A parametric study is done by varying the radius of curvature of the beam from 50 m to 250 m with the interval of 50 m to check the response of the beam like bending moment, shear force, torsional moment and deflection. The effect of L/R ratio i.e. ratio of spanto radius of curvature is computed. From the results, it can be said that the responses of the bridge decrease with increase in the radius of curvature. Also, the responses of the beam increase with increase in the L/R ratio.

Keywords- Parametric study, horizontally curved bridge, finite element, moving load, Simply Supported, trapezoidal Box type, L/R ratio

1. INTRODUCTION

Box type bridges have extended their importance in various areas of civil engineering because of their characteristics like serviceability, stability, structural competence and construction economy. The analytical analysis of these is complex due to their three dimensional behaviours due to the fact that these may be subjected to moving loads, thrust loads, impact loads along with bending moments, shear forces and torsional moments. Thus, sometimes larger depths are needed to resist these high loads. Thus, there should be a proper and special care taken on order to analyse and design such structures which include the effect of all above parameters.

2. Modelling of Box Girder for Parametric Study

The geometry of Box Girder considered in the present work is extends 66 m in span length. The cross-section consists of a single cell trapezoidal box girder, with total width of 9.6 m at the top and overall depth of 2.31 m. The overall thickness of the beam is 381 mm. The details of the cross section considered for this study is given in Figure 1 and geometric cases considered for this study are presented in Table 1. The material properties of the girder is shown in Table 2.

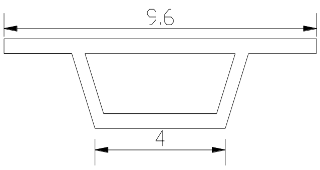

Fig.1Cross Section of Beam (Dimensions in m)

Table 1. Geometry of Bridges Girders used in Parametric Study

Radius (m)	L/R Ratio	Subtended Angle (Degrees)
50	0.62	35.523
100	0.31	17.762
150	0.21	11.841
200	0.16	8.881
250	0.12	7.105

Table 2. Material Properties used for modelling

Properties of Material	Value
Mass per unit volume	24 kN/m^3
Modulus of Elasticity (E)	32500 x 103 kN/m^2
Shear Modulus (G)	1.413 x 107 kN/m^2
Poisson's Ratio (υ)	0.15
Specific Concrete Compressive Strength (fc′)	45000 kN/m^2

3. Finite Element Modelling

Modeling of trapezoidal box Bridge Girder is carried out using SAP2000 software. Shell element is used to discretise the bridge cross section. The bridge is simply supported at both the ends. At each node, it has six degrees of freedom i.e. translations in the nodal x, y, and z directions and rotations about the nodal x, y, and z axes. A moving load is i.e. Live Load is applied in the form of IRC 6 Class AA (Tracked Vehicle) loading on two lanes which have width of 3.658 m. The responses of the trapezoidal box bridge girder i.e. shear forces, bending moments, torsional moments and deflection are calculated.

4. Results

The variation of responses of the trapezoidal box bridge girder is shown in the following figures.

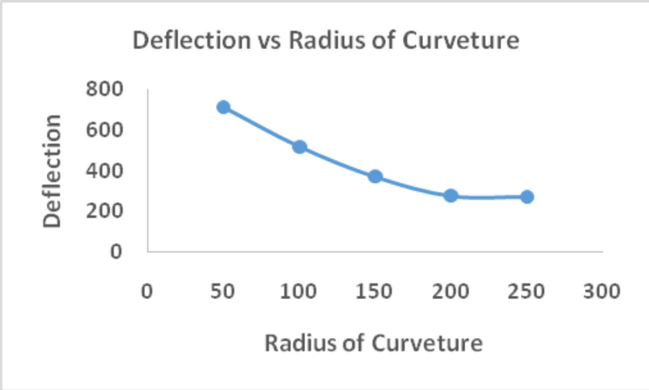

Fig. 2 Deflection vs. Radius of Curvature

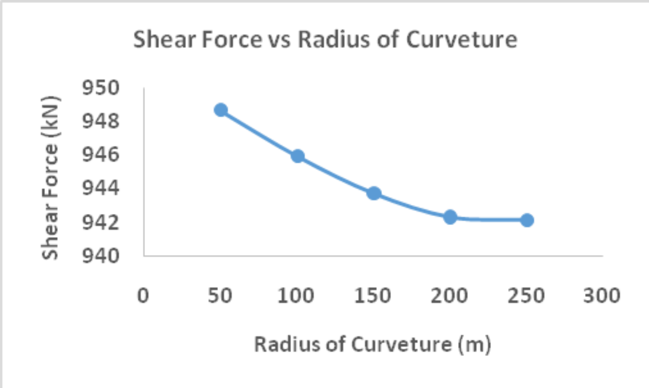

Fig. 3 Variation of Shear Force with Radius of Curvature

The above fig.3 shows that shear force of box bridge girder decrease as the radius of curvature increase.

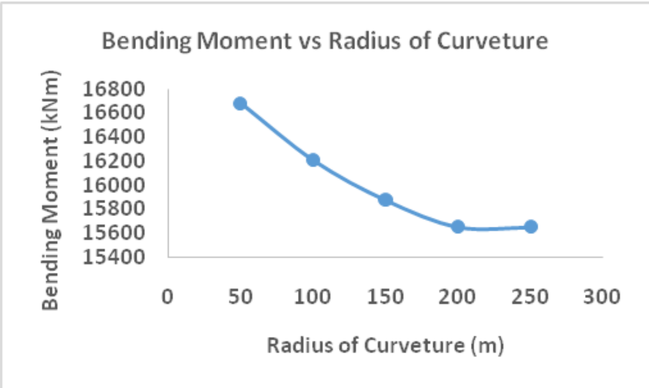

Fig. 4 Variation of Bending Moment with Radius of Curvature

The above fig.4 shows that bending moment of box bridge girder decrease as the radius of curvature increase.

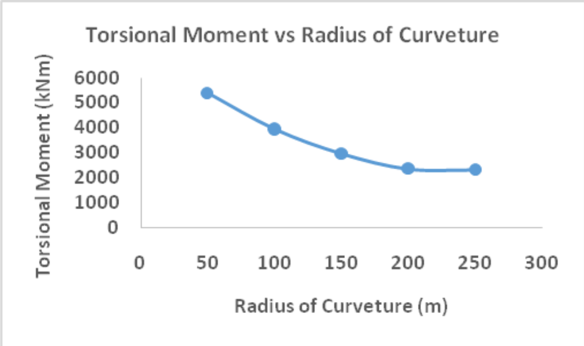

Fig. 5 Variation of Torsional Moment with Radius of Curvature

The above fig.5 shows that torsional moment of box bridge girder decrease as the radius of curvature increase.

5. Variation of the Responses with L/R Ratio for Moving Load

The responses of the trapezoidal box bridge girder is investigated with the influence of span length to radius of curvature (L/R) ratio. The following graphs show the impact of L/R ratio on the responses of curved box bridge girder i.e. the deflection, shear force, bending moment and torsional moment.

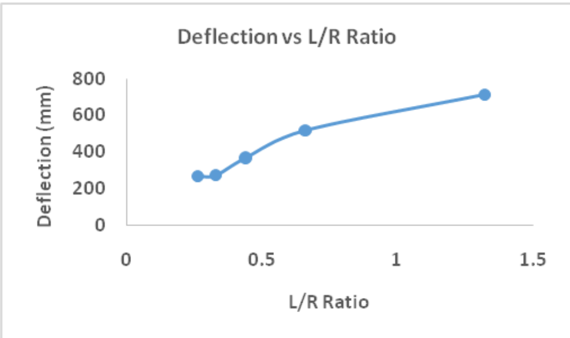

Fig. 6 Variation of deflection with L/R ratio

The above fig. 6 shows that maximum vertical deflection at the centre of box bridge girder increase as the L/R ratio increase.

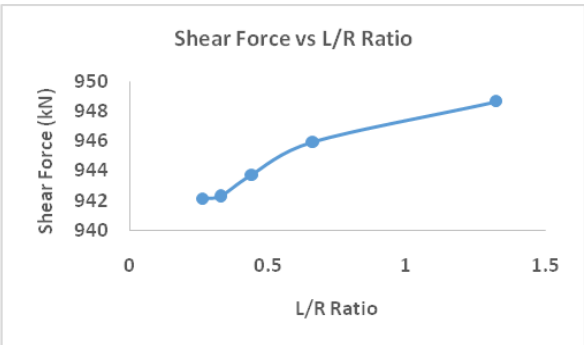

Fig. 7 Variation of shear force with L/R ratio

The above fig. 7 shows that shear force of box bridge girder increase as the L/R ratio increase.

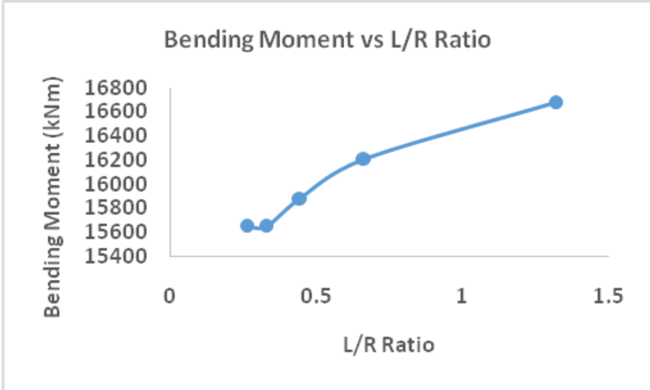

Fig. 8 Variation of bending moment with L/R ratio

The above fig. 8 shows that bending moment of box bridge girder increase as the L/R ratio increase.

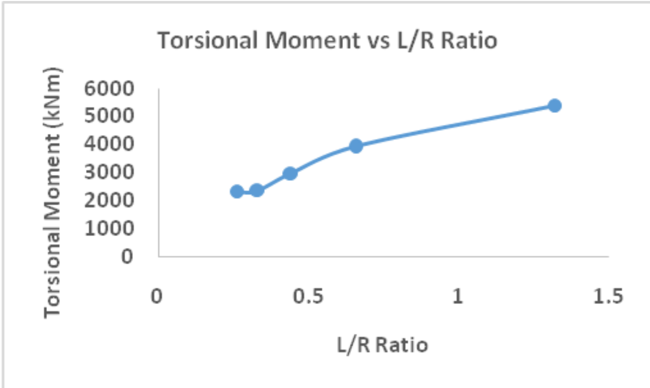

Fig. 9 Variation of L/R ratio with torsional moment

The above fig. 9 shows that torsional moment of box bridge girder increase as the L/R ratio increase.

6. Conclusion

From the analysis results, following conclusions were framed

Increasing the radius of curvature from 50m to 100m, the response of the bridge girder shows 27.19 % decrease in the mid-span vertical deflection.

Further increasing the radius of curvature upto 150 m, there is 28.72 % decrease in the mid-span deflection of the curved bridge girder.

When the radius of curvature is further increased from 150 m to 200 m, it shows there is 25.54 % decrease in the mid-span vertical deflection.

The Bending moment responses of curved box bridge girder show that there is no significant variation with increase in the radius of curvature of the beam. The responses decreases by 1.56% to every 50 m increase in the radius of curvature.

The Shear force response show that there is no significant variation with increase in the radius of curvature of the beam. The responses decrease with less than 1% for every 50m increase in the radius f curvature of the bridge girder.

The torsional moment of box bridge girder decreaseby26.76 % when the radius of curvature is increased from 50 m to 100 m.

Further the torsional moment decrease by 24.81% and 20.62% when the radius of curvature is increased to 150m and 200 m respectively.

When the radius of curvature of the girder is increased from 200m to 250m, the torsional moment decrease by 1.48%.

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