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Study of Structural Behaviour of Box Girder Bridges

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Abstract: ***Bridges are key element in any road network. In this paper, study of structural behaviour of curved box girder is presented by using previous literature. Also validation of software by comparing results with previous literature. IRC6:2014, IRC112:2011 are used for analysis. From the proposed work it is observed that results from previous literature and present study nearly same. So, software used for present study (Midas Civil) is valide.***
Keywords: Structural behaviour, IRC6:2014, IRC 112:2011, Midas Civil.

I. INTRODUCTION

Box girders , have gained wide acceptance in freeway and bridge systems due to their structural efficiency, better stability, serviceability, economy of construction and pleasing aesthetics. The box girders are single cell, multi-cell or multi-spine with rectangular or trapezoidal cross-section. Curved bridges play an important role in urban and crowded areas where there is lack of adequate space and complex road alignment. These bridges are economical and preferable. Horizontal curved bridges respond to loads differentally than to straight bridges because of the torsional forces induced by the curvature of the longitudinal axis. These are used to construct large and complex highway to avoid traffic congestion and to increase the aesthetics of structure. Post-tensioned curved box girder bridges have been popular in modern bridge construction because of their aesthetic apperance. Post-tensioning forces enhance the control of cracking in concrete girder. Prestressed concrete T-beam bridges can be used for spans upto 50m while prestressed concrete box girder bridges can be used for spans up to about 80m. Curved bridges provided with different cross sections like box girder, T-girder, I-girder etc.

II. ADVANTAGES OF BOX GIRDER

A. The maintenance of box girder is easier in interior space is directly accessible without use of scaffolding.
B. It has high structural efficiency which minimizes the prestressing force required to resist a given bending moment. Its great torsional strength with the capacity this gives to recentre eccentric live loads, minimizing the prestress required to carry them.
C. They can be cast in smaller segments and could be integrated into one unit by prestressing to achieve longer span.

III. METHODOLOGY

A. Study of structural behaviour of curved box girder.
B. Validation of trapezoidal box girder section by comparing the obtaining results using MIDAS Civil finite element software with Csi bridge software results example from the previous literature R.S. Patil is consider.

IV. PREVIOUS STUDY

A. Cheung et al. (1988), "Curved Box Girder Bridges."

The authors studied box girder bridges with circular and non-circular cross sections. The Finite Strip Method had been used to analyze the bridge deck. The homogeneous differential equations in curvilinear coordinate system were used to derive the stiffness and mass matrix for every element. Each node of strip consists four degree of freedom. The top and bottom flanges are treated as flat plates in which the membrane and bending action will be uncoupled. The webs are treated as thin shells in which the membrane and bending action are coupled. Authors investigate three examples of curved box girder bridges to demonstrate the accuracy and versatility of finite strip method the results are compared with those obtained by exact solution. Author conclude that, there is a significant reduction in the total number of variables involved in the analysis and thus savings in the computer time and effort as compared to the other methods of analysis.[1]

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B. Anurag Deshpande et al. (2017), "Parametric study on curved bridges subjected to seismic loading."

This paper aims at infrastructure developement such as bridges. In this paper bridges subjected to seismic loads and its behaviour. When the bridge is curved horizontally at deck section and skewed at column. Or pier section is dealt. The box girder bridge and I-girder bridge are compared with horizontal curvature and column skewness with variation. The software used for the study is CSI bridge 2016 v18 subjected to seismic load subjected to code of 1893 2002 & IRC 6 for vehicle loading from the result they can concluded that the box girder bridge is more stable and sustainable compared to I-girder bridge.[5]

C. Dongzhou Huang (2001), "Dynamic Analysis of Steel Curved Box Girder Bridges."

The author studied the impact on three span single box girder bridge with span length ranging from 76.2 to 213.36 due to vehicle moving across rough bridge deck. The beam element is used for modeling and loading is applied as per American Association of State Highway and Transportation Official specification (AASHTO). Author evaluates impact on single cell box girder due to multivehicle loading (side by side) moving over a rough deck. For analysis HS20- 44 truck including AASTO specification was used. Author also calculates effect of changing radius for moving load. According to study, when radius of curvature increases then natural frequencies of curved box girder bridges also increases. Also, maximum impact factor reduces as reduction in radius. Because of effect of curvature, normal stresses in outer and inner edge are different.[2]

V. STRUCTURAL BEHAVIOUR

Structural actions of box girder under loading consists of four principle modes bending, torsion, distortion and shear lag.

1) *Bending:* Bending is to force from straight from into a curved or angular one or from curved or angular form into some different form. Bending is occuring in the longitudinal and transverse direction in the box girder. When structure is symmetrically loaded then torsion does not occur in the box section. This is applicable for horizontally straight in plan bridges only. If top and bottom flanges of box section connected ny shear webs and both flanges bend in transverse direction then it called transverse direction of box section.
2) *Torsion:* Torsion is the action of twisting something. The axel loads of live load vehicle are mostly eccentrically placed on the bridge deck. Torsion is due to the curvature of bridge horizontal in plane. Under the torsional loading, forces are applied on plate element tend to deform cross-section. This will cause formation of distortional stresses in transverse direction and warping stresses in longitudinal direction.
3) *Distortion:* Distortion is twists, changes and makes something quite different from what it actually is. Distortion of box section is occuring, when vertical shear force across a cell causes the slab and webs to flex independently out of plane. The distortion cannot be uniform along the span of the deck. It is minimum or zero at the location of diaphragm.

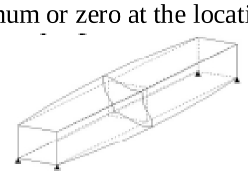

Fig.1: Distortion effect in box girder

4) *Shear Lag:* Shear lag is used to account for uneven stress distribution in connected members where some but not all of their elements (flange, web, leg etc.) are connected. In case of girder with wide flange experienced increase in bending stresses near the web called as positive shear lag. If bending stresses are away from the flange is increases and reduces near the web is called as negative shear lag.

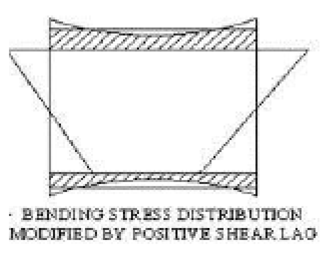

Fig.2 : Positive shear lag effect

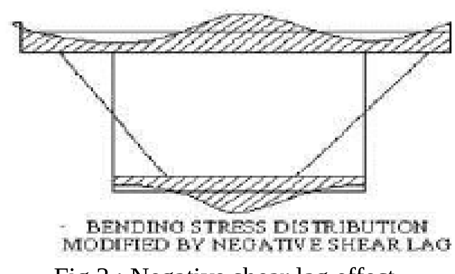

Fig.3 : Negative shear lag effect

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VI. MODEL VALIDATION

Finite element method software is used for validation. Example from previous literature R.S.Patil (2019)[6] is considered for validation of software. In that literature Csi bridge software is used for analysis. For current paper MIDAS Civil software is used. Validation of software is done by comparing results of both the software. The dimensions of box girder used for validation is shown in fig. The details of box girder is shown as below

Span length = 45m
width of deck = 8.5m
Live load = IRC Class A
Grade of concrete = M30
Grade of steel = Fe 500

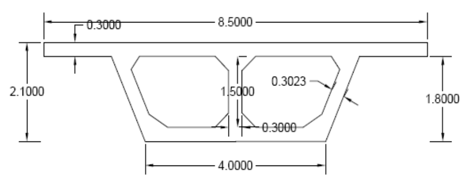

Fig.4 : Cross sectional details of the box girder

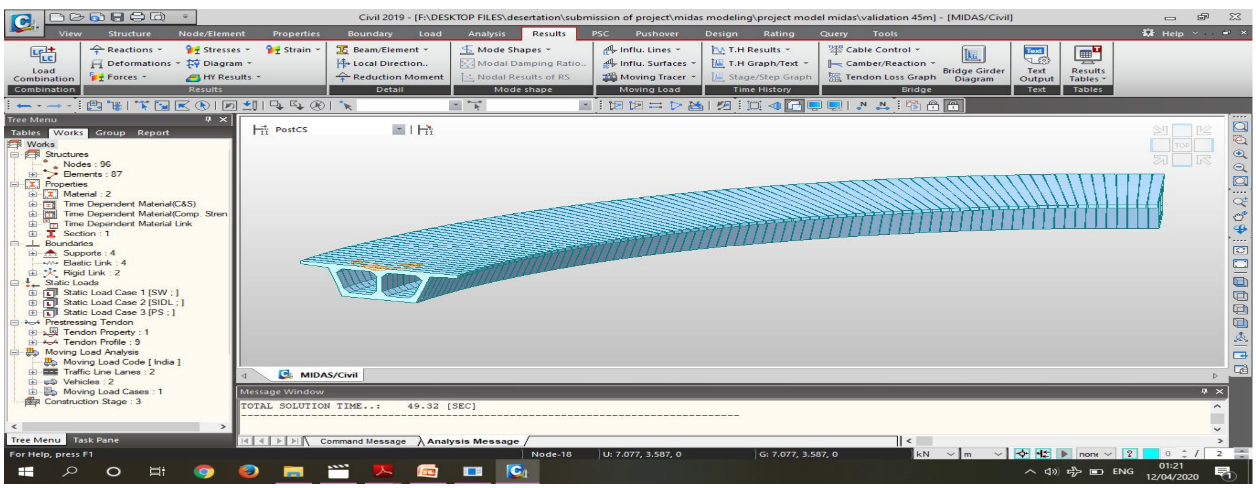

Fig.5: Modelling details of the box girder

Bending moment, displacement and shear force obtained by MIDAS Civil software are compared with the previous study of Csi Bridge software results shown in table 1

It can be observed from table 1 that the bending moment, displacement and shear force obtained from MIDAS Civil are nearest to results calculated by Csi bridge software, which validates box girder model developed in MIDAS Civil software.

TABLE I
Comparison of CSI bridge software with MIDAS Civil software results

Parameters	Present study (MIDAS Civil)	Previous study (Csi Bridge)	%Error
Bending moment	16065.22 KNm	15694.073 KNm	2.31%
Displacement	26.5 mm	25.2 mm	4.9%
Shear force	3246.47 KN	3363.4 KN	3.4%

VII. LOAD CONSIDERATION

The details of load considered for structure are as follows :

1. Self weight – Self weight command used to apply on structure.
2. Superimposed dead load
3. Prestressing force

   Load considerations as per specifications given in IRC6 :2016.

VIII. STEPS ADOPTED FOR ANALYSING BOX GIRDER MODEL IN MIADS CIVIL

1) Create nodes in node tool bar. Display node numbers.
2) Defining material and section properties in properties tool bar.
3) Preparing geometry of box girder using node numbers of elements and assigning predefined properties and cross sectional details.
4) Define creep and shrinkage and compressive strength also material links should be defined.
5) Define tendon properties in tendon profile generation tool bar.
6) Define rigid and elastic link for structure.
7) Applying dead load, prestressing load from load tool bar.
8) Selelecting loading standard of IRC6 .
9) Analyze box girder by selecting perform analysis.

A. References

Examples of reference items of different categories shown in the References section include: example of a journal article in [6]

IX. CONCLUSIONS

From the above proposed project work study of structural behaviour of box girder like bending, torsion, distortion etc. is done. Also the specifications of trapezoidal box girder studied with the referance of previous literatures and IRC codes of roads and bridges. The results from previous literature and present study nearly same. There is no more error in results. So, Midas Civil software is valid for further project work.

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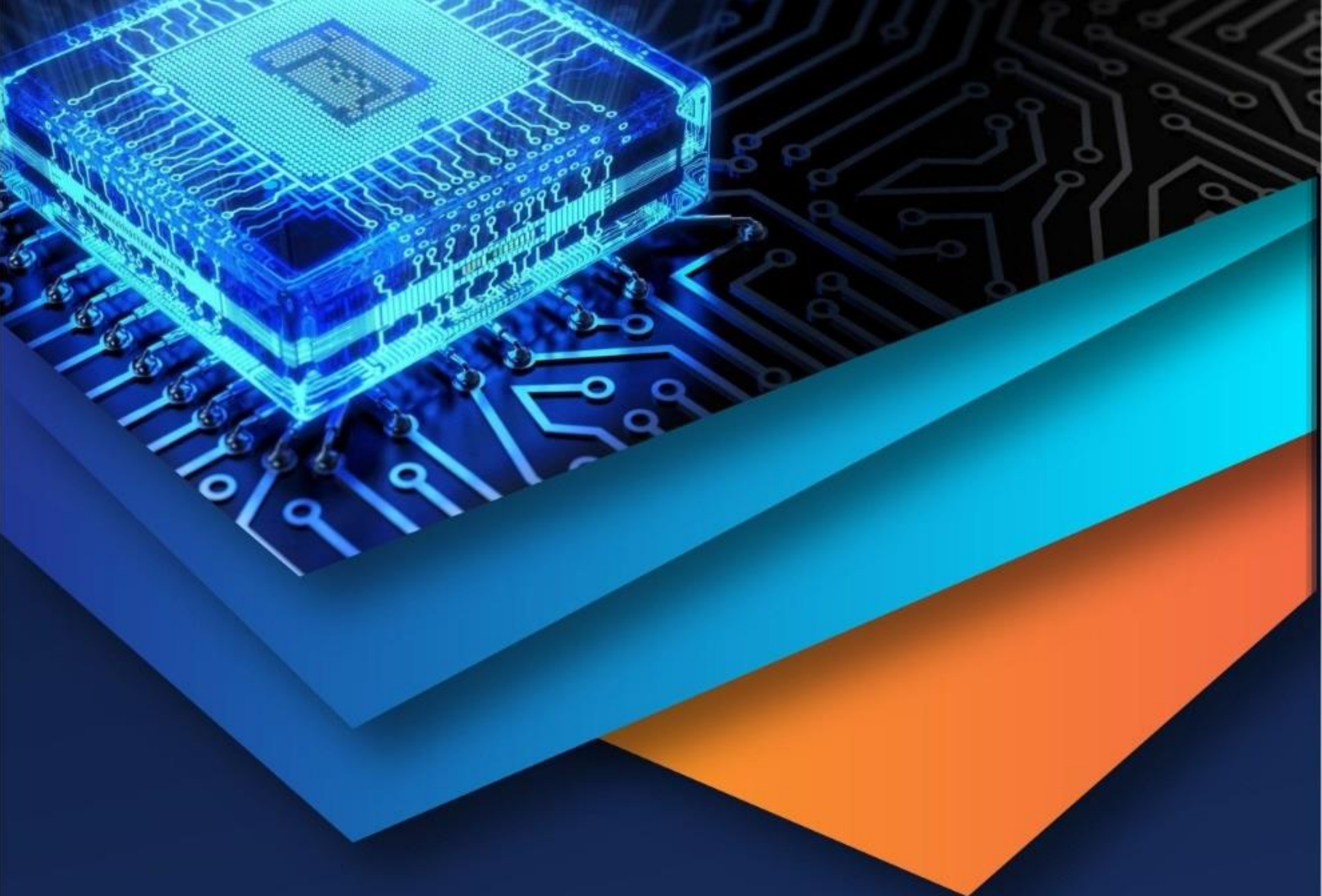
REFERENCES

[1] Cheung,W. Y. Li, Tham, "Curved Box Girder Bridges", ASCE, J. Structural Engineering, (1988), Vol. 114,pp-1324-1338.
[2] Dongzhou Huang, "Dynamic Analysis of Steel Curved Box Girder Bridges", ASCE, J. Bridge. Engineering, (2001), Vol. 6, pp-506-513.
[3] Magdy Samaan, John B. Kennedy, F.ASCE, and Khaled Sennah, M.ASCE, " Dynamic Analysis of curved Continuous Multiple-Box Girder Bridges, 10.1061/(ASCE)1084-0702(2007)12:2(184).
[4] J.Kent Hsiao and Alexander Y. Jiang , "Post-Tensioned Box Girder Bridge An anlysis approach using Equivalent Loads.", International Journal of Bridge Engineering (IJBE), Vol.4,No.1(2016),pp.27-55.
[5] Anurag Deshpande, H M Jagadisha, Aravind Galagali, "Parametric Study on Curved Bridges Subjected to Seismic Loading.", IRJET, Volume:04 Issue: 03|Mar-2017.
[6] Roshani Mehta, Prof. R.S.Patil, "Study of behaviour of Trapezoidal PSC Box Girder by using Single and Double cell with the help of IRC and AAShto Codes",IRJET, Volume : 06 Issue : 07|July 2019.
[7] Sali J., Mohan R.P., "Parametric Study of Single Cell Box Girder Bridge under Different Radii of Curvature", Applied Mechanics and Materials (2017), Vol. 857, pp-165-170.
[8] Yang W., Soleimani F., Desroches R., "The Effect of Superstructure Curvature on the Seismic Performance of Box Girder Bridges with In-Span Hinges", ASCE, J. Structural Engineering, (2017), Vol. 114, pp-469-480.
[9] Gupta Tanmay, Kumar Manoj, "Flexural Response of Skew-Curved Concrete Box-Girder Bridges", Elsevier Journal of Engineering Structures, (2018),vol. 163, pp. 358-372.
[10] Victor Johnson, "Essential of Bridge Engineering", (2007), Oxibh Publication House.
[11] IRC 6:2016 (Load and load combinations)
[12] IRC 112 : 2011(Code of practice for concrete road bridges)
[13] IRC 73 : 1980 (Geometric design standards for rural (non-urban) highways



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