Comparative Study of PSC Box Girder Multi Cell (3-Cell) Bridge of Different Shapes

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Abstract— The present thesis work involves the modeling and analysis of different shapes of Multi Cell (3-Cell) Box Girder of post-tensioned type. "When tension flanges of longitudinal girders are connected together, the resulting structure is called a box girder bridge". Five different shapes of Multi Cell Box Girders (1) Exterior girder with maximum slopped, (2) Exterior girder with radius, (3) Exterior girder vertical, (4) Exterior girder slopped, and (5) Exterior girder clipped, are modeled and analyzed using CSI Bridge Software (v-2017). The vehicle loading of IRC Class A is applied on all different models.

Key words: PSC Multi Cell Box Girder, Post-tensioned, IRC Class A loading, CSI Bridge (V-2017)

I. INTRODUCTION

A box girder is formed when two web plates are joined by a common flange at both the top and the bottom. The closed cell which is formed has a much greater torsional stiffness and strength than an open section and it is this feature which is the usual reason for choosing a box girder configuration. Bridge construction constitutes an importance element in communication and is an important factor in progress of civilization. In the present work, Multi Cell Box Girder of different shapes are analyzed for a two-lane bridge. The design parameters were kept same for all of the cross-sections The general parameters are as follows,

- Lane width (carriage way) - 7.5 m
- Total width of deck slab - 11 m
- Span length - 35 m
- Grade of Concrete - M40
- Tendon profile - Perabolic
- moving load - IRC CLass A loading

II. MODELING OF DIFFERENT SHAPES OF BOX GIRDER

In the present thesis work, 5 different shapes of Multi Cell Box Girder are considered. Modeling is done using CSI Bridge Software (v-2017). This software is basically finite element method software and Finite element method is the most versatile method, which can easily handle structures of complicated shapes, and boundary conditions. It involves subdivision of the whole structure into number of small elements.

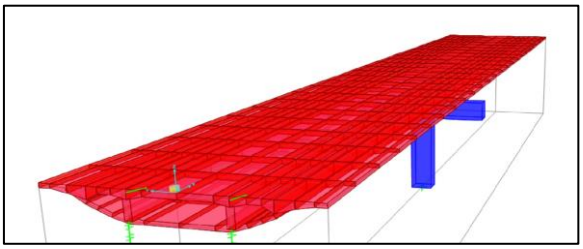

Fig. 1: Multi Cell Box Girder of Exterior Girders Slopped Maximum

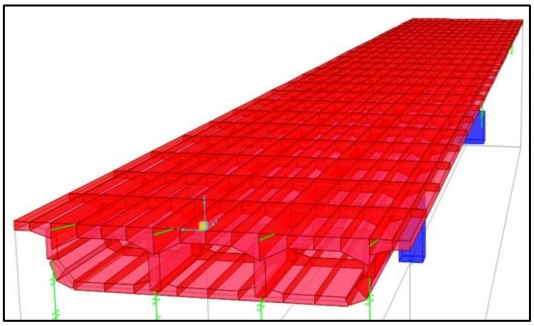

Fig. 2: Multi Cell Box Girder of Exterior Girders with Radius

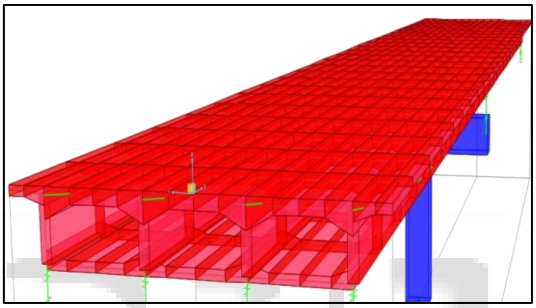

Fig. 3: Multi Cell Box Girder of Exterior Girders Vertical

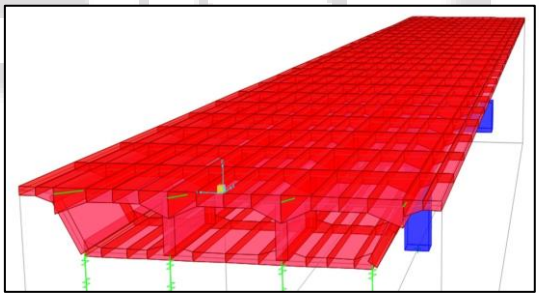

Fig. 4: Multi Cell Box Girder of Exterior Girders Slopped

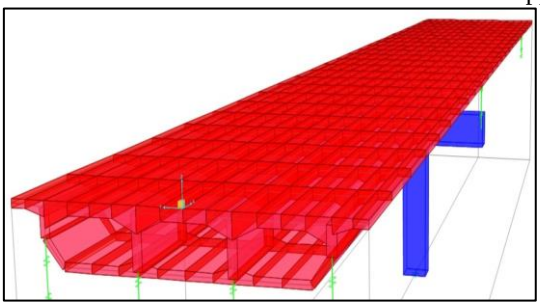

Fig. 5: Multi Cell Box Girder of Exterior Girders Clipped

III. MATERIAL SPECIFICATION

For Post tensioning work minimum grade of concrete as specified in IS-1343 is M35, while for Pre-tension prestressed work grade of concrete specified in IS-1343 is M40 (Clause 5.1 Table 1 IS-1343). In this work, concrete of grade M40 is used in post-tensioning and steel of grade Fe415.

A. Tendon Properties

- Prestress type - Post-tension
- Material - A722Gr150 TypeII
- Prestressing strand - 13mm (0.5" strand)
- Nominal diameter- ASTM 0.5mm
- Area of single strand - 98.7 mm^2
- Torsional constant - 6.625 KN/m^2
- Modulus of Elasticity: Eps = 2 X 108 KN/m2
- Shear area - 5.806 KN-m
- Tendon load (force) - 444.82 KN
- Jack from - Both ends
- Poisson μ - 0.3

IV. LOADING

IRC : 6-2000 (Standard Specifications And Code Of Practice For Road Bridges, Section - II Loads and Stresses) describes different types of loadings. IRC standard live loading are as follows

- IRC Class AA Tracked Vehicle
- IRC Class AA Wheeled Vehicle
- IRC Class 70R Tracked Vehicle
- IRC Class 70R Wheeled Vehicle
- IRC Class A Loading
- IRC Class B Loading

In the present work, vehicle loading of IRC Class A is considered for analysis of bridge deck.

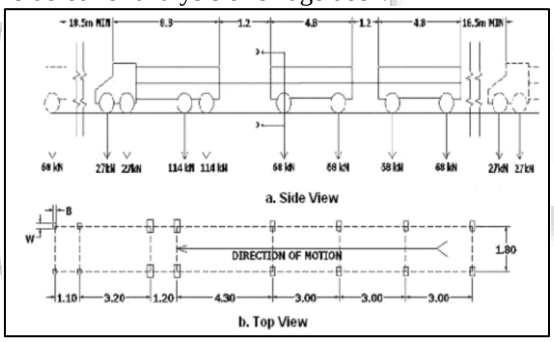

Fig. 6: Details Of IRC Class A Loading

V. RESULTS

A. Dead Load

Dead load on girder = Dead weight of deck slab+ Dead weight of wearing coat + Self weight of girder. All different models of Multi Cell Box Girders are analyzed, and the results obtained are compared as in terms of force (KN) due to dead load, Longitudinal stress (KN-m) induced in girder and displacement (mm) due to dead load.

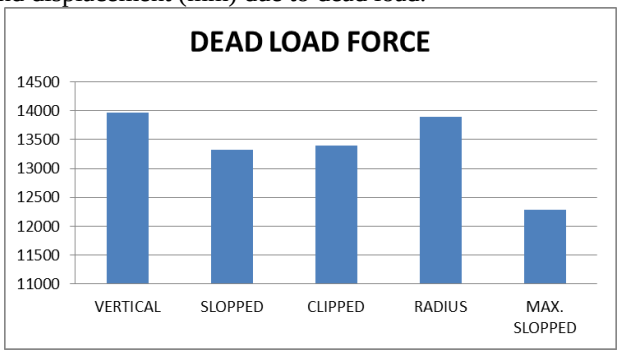

Fig. 6: Dead Load Force

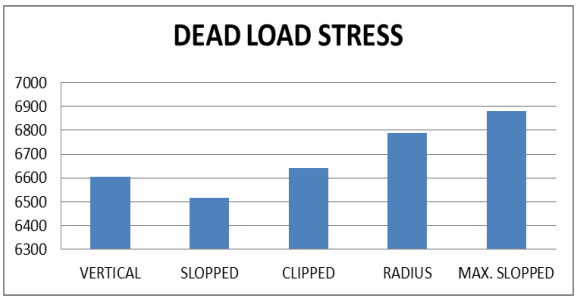

Fig. 7: Dead Load Stress

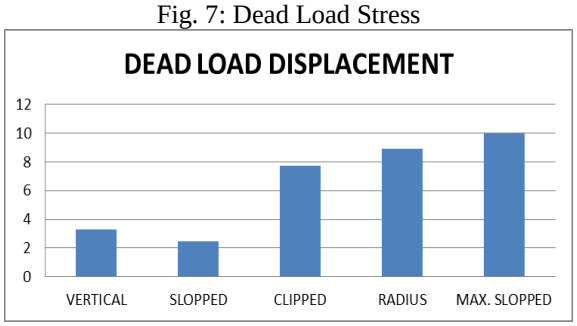

Fig. 8: Dead Load Displcement

B. Moving Load

A moving vehicle load of IRC Class A is applied on all different models. The results obtained are as follows:

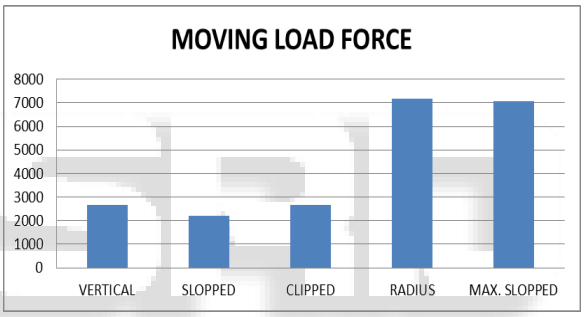

Fig. 9: Moving Load Force

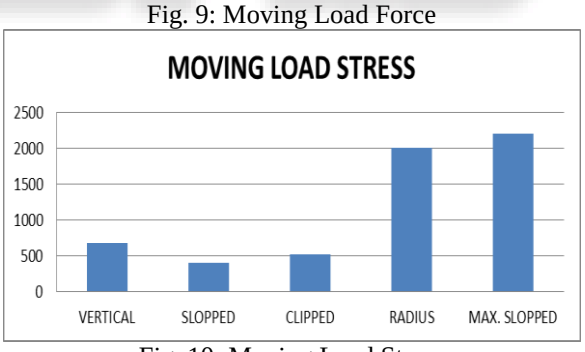

Fig. 10: Moving Load Stress

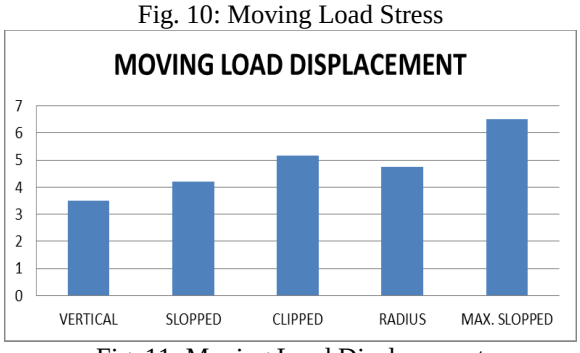

Fig. 11: Moving Load Displacement

C. Load Combination

1.25 Dead Load (DL) + 1.75 Moving Load (ML) + 1.0 prestress, and 0.9 Dead Load (DL) + 1.3 Moving Load (ML) + 1.0 prestress

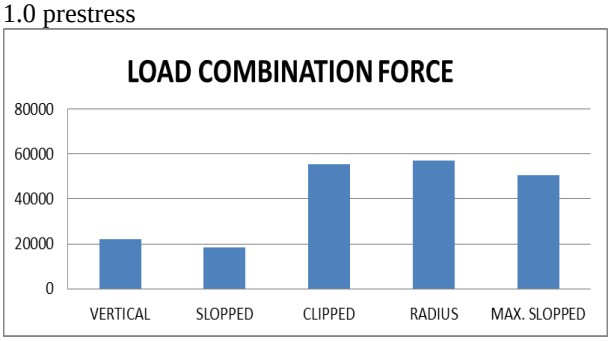

Fig. 12: Load Combination Force

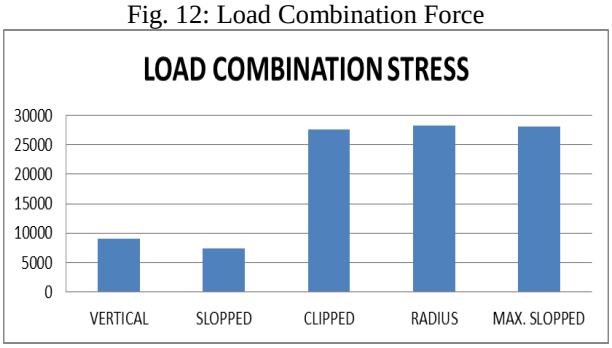

Fig. 13: Load Combination stress

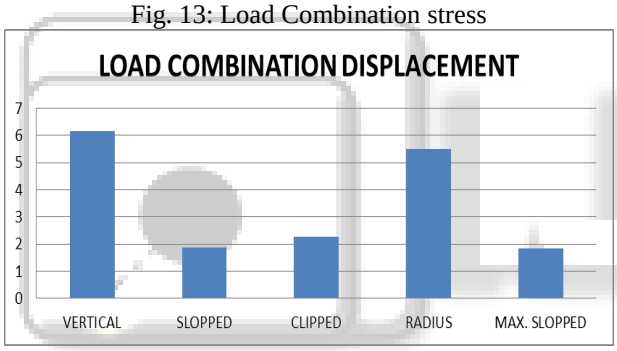

Fig. 14: Load Combination Displacement

VI. Conclusion

After analyzing all different shapes of PSC Multi Cell Box Girder, it is shown that Multi Cell Box Girder of exterior girder with slopped sides is showing better results among all the other shapes. Multi Cell Box Girder of exterior girder with slopped sides has less induced longitudinal stresses as compared with all others, it is also showing less displacement with respect to all other shapes.

References

[1] IRC: 112-2011, "CODE OF PRACTICE FOR CONCRETE ROAD BRIDGES", Indian road congress.
[2] IRC: 6- 2000, "Standard specifications and code of practice for road bridges" Indian road congress.
[3] IRC: 18 – 2000, "Design criteria for pre-stressed concrete road bridges (post – tensioned concrete)" Indian roads congress.
[4] IS: 1343 – 1980, "Code of practice for pre-stressed concrete" Indian standards.
[5] IRC: 21 –2000 "Standard specification and code of practice for road bridges (Plain and Reinforced)" Indian road congress.
[6] N. Krishna Raju, Text Book of Prestressed concrete, Fourth Edition
[7] D. Johnson Victor, Text Book Of 'Essential of bridge engineering', Sixth Edition
[8] Ajith Kumar R. , Dr. J. K. Dattatreya (2015) :- "Study on the Structural Behavior and Design of a Typical Single Cell Post Tensioned Concrete Box Girder Bridge".
[9] B. Paval (2015) :- "Analysis of Multi-Cell Prestressed Concrete Box-Girder Bridge".
[10] Chetan T Naik , Dr.M M Achar , K Lakshmi(2015) :- "Analysis and Design of Multi Cell Post-Tensioned PSC Box Girder".
[11] Jefeena Sali, Kashif Quamar Inqualabi, Reji P Mohan (2015):- "Parametric Study of Behaviour of Box Girder Bridges Under Different Radius of Curvature".
[12] Karthika Santhosh, Prof. P Asha Varma (2016) :- "Parametric Study on Behavior of Box Girder Bridges with Different Shape Based On Torsion".
[13] Mayank Chourasia , Dr. Saleem Akhtar (2015) :- "Design and Analysis of Prestressed Concrete Box Girder by Finite Element Method (4 Cells & 1 Cell)".
[14] Payoshni Mali, Shilpa Kewate , Savita Lokare (2015) :- "Comparison of Rectangular and Trapezoidal sections of Post Tensioned Box Girder"
[15] Phani Kumar.Ch, S.V.V.K.Babu (2016) :- "Analysis and Design of Prestressed Box Girder Bridge by IRC: 112-2011".
[16] Pranathi Reddy , Karuna S. (2015) :- "COMPARATIVE STUDY ON NORMAL AND SKEW BRIDGE OF PSC BOX GIRDER".
[17] Punil Kumar M P, Shilpa B S(2016) :- "Dynamic analysis of box girder bridges".
[18] Sanket Patel, Umang Parekh (2016) :- "Comparative Study of PSC. Tee Girder and PSC. Box Girder".

