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REVIEW ON ANALYSIS AND BEHAVIOR INVESTIGATION OF BOX GIRDER BRIDGES

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Abstract - *This paper represents the various methods to understand the behavior of Box Girder Bridges. Bridges are the key Element in a transport system, they covers a gap by connecting two communities separated by streams, valley, rivers etc. To meet the traffic demands Box Girders are the most economical and widely constructed. The need of this study is to understand behavior of box girder bridges with the help of various analytical methods to understand the behavioral aspect.*

Key Words: Box Girder Bridges, Economical, Widely constructed, analytical method, Behavioural aspect.

1. INTRODUCTION

Bridges are the important assets generally used to connect two communities separated by rivers, valleys etc. Thus they cover this gap and also play a key role in our transport system. So it is necessary to build an efficient and long lasting bridge keeping economical aspects in mind. The main beam of Box Girder Bridge comprises girders in the shape of hollow box which is economical as well as long lasting solution. These are widely constructed for short and medium spans. Build to carry load in Shear and Flexural bending. Analysis and design of box-girder bridges are very complex because of its three dimensional behaviours consisting of torsion, distortion and bending in longitudinal and transverse directions.

Thus, it compels 'us- to carry a clear study and to understand the recent works on box-girder bridges.

2 LITERATURE REVIEW

As we know Box Girder Bridges are increasingly popular in modern highway systems. Significant researches have been executed on advanced analysis for many years to understand the behaviour of all types of box-girder bridges; however, the results of various research works are scattered and unevaluated.

Angel Lopez, Angel C. Aparicio [1] on Non linear behaviour of curved prestressed box girder bridges and the goal of his work was to study the response of prestressed concrete curved bridges under adding external loads. They developed a mathematical model for nonlinear analysis of reinforced and prestressed concrete structures which significantly dealt with the internal forces for bending, torsion and shear. A prestressed concrete curved bridge was studied with model under different loading condition.

Results presented were-

1 - The structural response under increasing loads of curved prestressed box girder bridges, supported over intermediate piers without torsional restrains, was highly nonlinear after cracks appeared.

2 - Due to progressive cracking and structural coupling between bending and torsion, internal forces were redistributed. Moreover, their interaction from a strength point of view showed the ultimate internal forces response.

3 - Hence, the type of failure were as per the load case considered: for instance, a centred live load produced a bending failure on the cross-sections located over the support piers; while exterior and interior load cases induced failure essentially due to torsion at the bridge ends.

4 - Significant variations in the post-cracking response were produced by transversal prestressing of the top and bottom slabs. If the transversal steel mechanical ratio remained constant, there were no noticeable influences on the ultimate load capacity.

Mayank Chourasia and Dr. Saleem Akhtar [2] gave a comparative study between four cell and single cell pre-stressed concrete box girder Cross-sections. The study showed that the single cell pre-stressed concrete box girder

were most suitable and economical cross-section for 2 lane Indian national highway bridges.

Table: 1 Comparison between the Results of 4 cells & single cell Box girder

Sr. No.	Parameters	Four cells	Single Cell
1	Bending Moment	10631.1kN.m	6276.96kN.m
2	Deflection	17.06 mm	7.189 mm
3	Concrete Consumption	249.3 m3	138.6 m3
4	Steel Consumption	26.272 MT	18.167 MT
5	Strand Consumption	450.619 m	180.285 m

Muthanna Abbu et. al. [3] presented the work on 3D FE modelling of composite box Girder Bridge. The conclusion was interaction between the two parts of the bridge in the ANSYS analysis model using rigid links to give full interaction between components. The thickness of precast concrete 15 cm was big to simulate using shell elements, so note worthy differences were observed (about 2 %) by using 3-D solid elements to model such thickness.
The value of the degree of freedom in coincident with the points to be coupled, was important thing effects on result of simulation of constrained point load, big difference appeared (15 %) when the loading simulated by Coupling to force a set of nodes to have the same DOF value.

P. V. Ramana [4] presented the work on FSM Analysis for Box Girder Bridges. The study comprised of the finite strip method for analysis of box girder bridges subjected to dead load and IRC live load. The impact factor was also considered for live load analysis. The analysis program used given the calculations of bending stresses, shear stresses, bending moments and torsion moments at the desired sections along the span and the results were concluded as under-

1. The deck slab must be divided into finer mesh compared to bottom slab due to the effect of concentrated load. In the web only, one strip is regarded as essential as it saves computer time without affecting accuracy.

2. It was observed from the deflection point of view, the trapezoidal shape of box girder gives lesser deflection as compared to rectangular section.

3. The eccentric loads were more evenly distributed over the box cross section and the variations in longitudinal stresses with different disposition of IRC loads in transverse direction were small.

A typical box girder bridge constructed in Delhi Metro Rail Project is shown in Figure (a),(b).

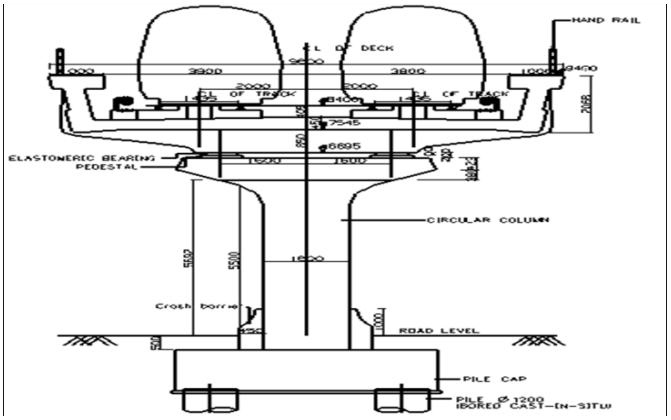


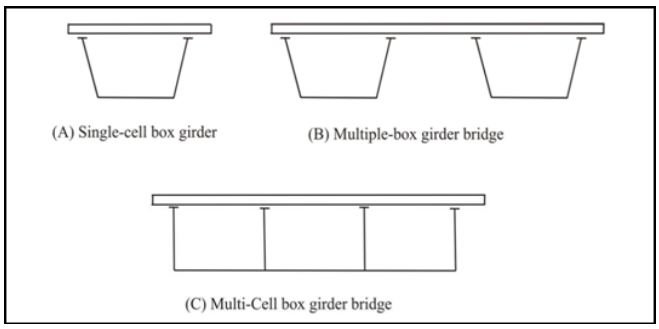
Fig (a): C/S of Viaduct

Fig (b): Viaduct

Patil Yashavant and Prof. Shinde Sangita [5] given a comparative analysis of Box Girder Bridge with two different codes which provided comparative analysis of concrete box girder that would help designer while considering different factors based on code at the beginning of the project. It also showed how to use MIDAS for the analysis of box girder. It gave result based on finite element modeling and concluded that Box girder shows better resistance to the torsion of superstructure.
Results of bending moment and stress for self weight and superimposed weight were same, but were different for the moving load consideration, IRC codes gave design for the heavy loading compared to the AASHTO codes.

In load combination, AASHTO codes have taken more factor of safety than IRC. Area of pre stressing steel required for AASHTO was less compared to IRC. Finally based on the comparative study AASHTO code were more economical than IRC.

P.K. Gupta et.al. [6] issued a technical note on parametric study on behavior of box-girder bridges using finite element method. It present study of box girder bridge cross-sections namely Rectangular, Trapezoidal and Circular has been carried out in the present investigation.



SAP-2000 has been used to carry out linear Analysis of these box girders. Three dimensional 4-noded shell elements have been employed to analyze the complex behavior of different box-girders. The linear analysis has been carried out for the Dead Load (Self Weight) and Live Load of Indian Road Congress Class 70R loading, for zero eccentricity as well as maximum eccentricity at mid-span. The paper presents a parametric study for deflections, longitudinal and transverse bending stresses and shear lag for these cross-sections. In the paper, results of linear analysis of three box girder bridge cross-sections namely Rectangular, Trapezoidal and Circular of varying depths have been presented.

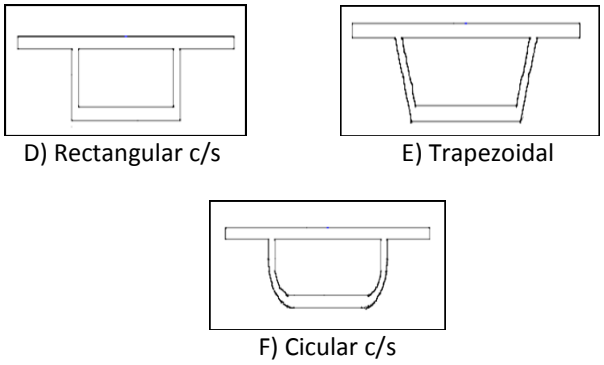


Fig (c): Different types of box girder bridges

J. Rimal et.al. [7] worked on the thermal behavior of a Composite Box-girder Railway Bridge, The behavior of a composite box-girder railway bridge subject to environmental thermal effect such as solar radiation, air temperature and wind speed, was presented. The temperature measure of temperatures was performed on the railway bridge in Kralovske Porici.

3. CONCLUSIONS

It can be concluded from the present study that the simple beam theory is a crude approximation for analysis of box sections and figures out the behavior of all types of box girder bridges. It can also be believed that the results presented in this paper will be of valuable guidance to the designers.
The further study focus on the analysis and behavior investigation of box girder bridges with the help of 3D modelling using FE analysis on ANSYS software.

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