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Review on "Box Girder Culvert Analysis Using Ansys"

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Abstract :- **Thedesign of a highway and railway bridges depends critically upon standards and criterias. Naturally, theimportance of highway bridges in a modern transportation system would imply a set of rigorous design specifications to ensure the safety, quality and overall cost of the project. The nature of complexity of box girder bridges makes it difficult to accurately predict the structural response of box girder under loading. However, this complexity and difficulty in thedesign and analysis of box girder bridges can be handled by the use of the digital computer software in the design. Now a days box girder iswidely used for the construction of the bridge. Box girder cross section smay take theform of single cell (one box), multi-spline (separate boxes) or multi-cell with a common bottom flange. The objective of this analysis is to modelling the box girder in an ANSYS FEM design. This task involves examining the stresspatterns obtained using static three-dimensional finite element modelling. ANSYS is developed by th eworld's largest ANSYS finite element analysis software company from United States. Itcan interface with most CAD software, sharing and exchange of data.**

Box girders provides better resistance to torsion, which is of benefit if he bridge deck is curved in plan. In thiscurrentstudy, non composite straight steel boxes are analyzed with beam and Shell elements using the three dimensional finite element analysis and their behaviour is investigated. Box girder bridge can be analyzed by usingn onlinear finite elemen tprogram ANSYS. In this research, a steel box girder is analyzed by ANSYS program. The objective of this analysis is to model the box girder in an ANSYS FEM design. This task involves examining the stress patterns obtained using static three-dimensional finite element modelling.

Keywords: **- Box Girder, Finite Element Method, ANSYS, Stress patterns**

I. INTRODUCTION

A culvert is a structure that allows water to flow under a road, railroad, trail, or similar obstruction from one side to the other side. Typically embedded so as to be surrounded by soil, a culvert may be made from a pipe, reinforced concrete or other material. It is well known that roads are generally constructed in embankments which come in the way of natural flow of storm water (from existing drainage channels). As such flow cannot be obstructed and some kind of cross drainage works are required to be provided to allow water to pass across the embankment.

Box culvert has many advantages compared to slab culvert or arch culvert. The box is structurally strong, stable and safe and easy to construct. The main advantage is, it can be placed at any elevation within the embankment with varying cushion which is not possible for other type of culverts. A multi cell box can cater for large discharge and can be accommodated within smaller height of embankment. It does not require separate elaborate foundation and can be placed on soft soil by providing suitable base slab projection to reduce base pressure within the safe bearing capacity of foundation soil.

The size of box and the invert level depend on the hydraulic requirements governed by hydraulic designs. The height of cushion is governed by the road profile at the location of the culvert.

The benefits of steel box culverts include Structural Capacity, Lightweight Construction, Easy Installation, Aesthetically pleasing, Maintenance free, Long service life and Design flexibility.

Ongoing culvert function without failure depends on proper design and engineering considerations being given to load and water capacities, surrounding soil analysis, backfill and bedding compaction, and erosion protection. Improperly designed backfill support around aluminium or plastic culverts can result in material collapse or failure from inadequate load support.

The study includes the study of effect of soil pressure on box girder and to analyse the performance of the steel box girder using finite element analysis.

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2. LITERATUREREVIEW

1. **Sandeep Kumar Ahirwar, Mohd. Afaque Khan, Abhishek Kumar (April-2016)** were tried to explain the various methods to understand the behavior of Box Girder Bridges. The study states that, the main beam of Box Girder Bridge is comprises of girders in the shape of hollow box which is economical and long lasting solution as well. These are widely constructed for medium and short spans. They are built to carry load in Shear and Flexural bending. Design and analysis of box-girder bridges are very complex because of its three dimensional behaviors which consists of torsion, distortion and bending in transverse and longitudinal directions. The need of this study is to understand the behavior of box girder bridges with the help of various analytical methods to understand the behavioral aspect.

2. **Ms. Patil M.B. 1, C.M. Deshmukh2 , Dr.C.P.Pise3 , Y .P . Pawar2 , S .S .Kadam , D .D .Mohite2, S.V. Lale2 (March-2016)** explained in their study that the behavior of the composite structure is heavily influenced by the properties of its component materials. The use of a concrete slab on a steel girder uses the strength of concrete in compression and the high tensile strength of steel. Stronger, stiffer materials like steel attract proportionally more load than materials such as concrete. If there is no connection then the materials will behave independently, omitting the positive effects, but if adequately connected the materials act as one whole structure. In this study they determined three girders which can be effective to the composite bridges and their analysis is made using software.

3. **P.Sachithanantham, D.Ebenezar Anburaj (June-2015)** addressed examination utilizing shell and pillar component models of the straight and bended box brace span. This undertaking includes analyzing the anxiety examples which acquired utilization of static three-dimensional limited component demonstrating. Examinations are made between the straight and bended box brace spans, from the shell component model and pillar component model for each. At the end, the parametric examinations are performed on the bended steel box model to assess the impacts of a few critical parameters on the conduct of the support. This paper states that the longitudinal bending stress distribution in wide flange girders is distributed non-uniformly throughout the width. It remains maximum at the edge and reduces towards the centre, and usually it cannot be obtained accurately from elementary beam theory.

4. **Zhang Kai Yuan (June-2015)** In this research, a steel box girder was analyzed in ANSYS program with the Monte Carlo simulation direct sampling probabilistic method. The objective of this analysis is to make a model of the box girder in an ANSYS FEM design, check the frame structure of box girder in moments and force, bending + axial and stress and strain graph and to compare the result based on difference graph. In this research, Finite Element Methods (FEM) models were used to stimulate the characteristic behavior of the concrete, steel and reinforcement steel structure using ANSYS+CIVILFEM 12.0 program. In order to validate the requirements to meet the alignment, driving comfort, people's aesthetic and other requirements, this study test have been taken on the box girder by load through ANSYS+CIVILFEM software. This research is applied on different size and type of box girder, which generated different result by application of different loading on box girder.

5. **Muthanna Abbu, Talha Ekmekyapar, Mustafa Özakça (May-2013)** proved that although three dimensional Finite Element (FE) modelling is probably the most critical and time consuming, it is still the most comprehensive and effective technique for static as well as dynamic analyses, which captures all aspects affecting the structural response. The other methods proved their adequacy but are limited in scope and applicability. In this study, three-dimensional solid FE model was created using ANSYS for the study of thermal loadings. By taking into consideration, longitudinal strains, modal analysis, and deformations, this model simulated a three span, 220-meter concrete bridge which is built to replace an existing six span concrete bridge across the Kealakaha Stream. A major interest in this paper is to perform three-dimensional FE analyses of composite box girder bridge to replicate the actual bridge behaviour. In this, attention is focused on development of representative numerical models for a composite box girder bridge. To achieve this purpose several FE models of a laboratory specimen are developed using different approaches available within ANSYS software.

6. **Zakia Begum, MS, (2010)** explained that the box girders offer better resistance to torsion, which is particularly of benefit if the bridge deck is curved

in plan. Due to the high torsional stiffness of the box girders as the cross section is closed, it often ranges from 100 to 1000 times larger than the torsional stiffness of comparable I-shaped sections, the torsional moment induced by the curvature of the girder can be resisted by the I-shaped girders with much more transverse bracing than that of the box girder. The fabrication of the I-shaped girder is more economical as compared to the Box shaped girder, but this additional cost in box girder is usually balanced by the reduction in substructure that need to construct. This study is to develop the three-dimensional finite element beam and shell models of curved and straight box girders using the commercially available finite element computer program "ANSYS".

7. **Kritee Chhetri1, Rajendra.S and Kavitha.N** made a study which showed the 3D analysis and dynamic vehicular analysis result is compared to a simplified static analysis by analysing span to height ratio of the culvert. A parametric study is made on the behaviour of a multi cell box culvert when subjected to dead loads and IRC wheel loadings. The effective width method is used to model the box culverts using SAP 2000 software. For the analysis and design of culvertsIRC 70R loading is used. The results of the study revealed that their issignificant influence on the result of the dynamic analysis and it is necessarily and carefully considered for analysis and design. The alteration in the relative stiffness of various members in a culvert is observed by changing in span to height and hence affects the internal forces in the members. Also, considerable variations in the results of bending moments can be seen with varying span to height ratio of culverts. Analysis of Vehicular dynamics revealed that the maximum bending moment occurs for the dynamic vehicular load case.

8. **PatilYashavant S.1, Prof. ShindeSangita B.:-** The comparative analysis of two standards namely AASHTO and IRC followed in construction of superstructure of bridge accounting load of heavy vehicles is presented in this paper.The aim of this study is to find the optimized Design, to apply the variety of checks and exercising them. As a result, it is found that results of stresses and bending moment due to self-weight and superimposed loads remains same, but varies under moving load considerations.This is due to the fact that IRC codes accounts for the design for the heavy loading conditions as compared to the AASHTO codes. The results revealed that the IRC codes are costly i.e. less economic because of the number of reinforcement bars in the pile cap and piles is more, than those with AASHTO code with the same dimensions. With the help of ANSYS Software of finite elements base modeling,displacement analysis is carried out. It shows that the chances of settlement increases with the increasing displacement intensity.

9. **C. Lande, S. K. Kamane, S. A. Mahadik.:-** In the present study, analysis of a RCC box culvert is presented using finite element method. 3D configuration of the space is considered and computer code is developed to find the bending moments, support reactions and member forces due tolateral soil pressuresand equivalent traffic load. With the help of excel programming, member forces Equivalent moments and support reactions are calculated. It concludes that Culvert Box full with water and live load surcharge on top of slab then there is increase in bending moments at centre and end of the top. On the contrary, Empty Box Culvert, live load surcharge on top slab, vertical wall bending moment at centre and end is increased.

10. **SurabhiTiwari, A.M.Gharad and P.D.Pachpor**:- In the present study, one RCC Underpass railway bridge carrying fly ash flow and consisting of piping system is considered. Using finite element analysis software package ANSYS 12, Two models; box-bridge hinged at base and subjected to static live load and soil pressure and same is surrounded by soil springs on faces of two vertical walls and one bottom face of it and top face with live load were analysed and compared. to study the effect of soilstructure interaction on RCC Underpass box-bridge the parametric study has been carried out. As the stiffness of adjoining soil increases the shear force and bending moment values also increases, whereas, for the other two vertical faces of the box culvert theshear force and bending moment values were in fair agreement. It can be stated thatsoil structure interaction analysis is essential for accurate results for2D analysis of RCC Underpass box culvert whencomes under different loading conditions i.e.from the adjoining soil, bottom strata and various live loads

3. RESULTS AND DISCUSSIONS

The above literature studied about design and analysis of RCC box culvert under different loading conditions. It can be noted that, the effect of Depth of

cushion, coefficient of earth pressure for lateral pressures on walls, width or angle of dispersion for live loads on box without cushion and with cushion for structural deformations are important. Box culvert full with water, live load surcharge on top slab of box condition then the bending moments at centre and end of the top and bottom slab are increased. The code IRC:6, Standard specifications and Code of practice Road Bridges can be referred for different loading conditions and specifications. The Indian Roads Congress and Directorate of bridges & structures (2004), "Code of practice for the design of substructures and foundations of bridges" Indian Railway Standard can also be used during design and analysis of box culvert. The structural design involves consideration of load cases and factors like live load, effective width, braking force, dispersal of load through fill, impact factor, co-efficient of earth pressure etc. Vehicular dynamic analysis has revealed that the maximum bending moment occurs for the dynamic vehicular load case.

IV. CONCLUSION

From the study of above literature, it can be concluded that the performance of box culvert is considerably dependent upon the Live load, effective width, impact factor coefficient of earth pressure, depth of cushion and flow of water through it. All the above literature shows the study of RCC box culvert, Hence the interest arises to design and analyse the box culvert by changing the material. Steel box culvert may be the next choice for further studies. A number of different specific elements will appear for each general category. Each element has its own set of DOFs, which are the degrees of freedom for which ANSYS will find a solution.

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