Analysis of Steel Box Girder Culvert using Ansys

Miss Apurva J. Chavan[1] K. K. Tolani[2]
[1]M.E Student [2]Faculty
[1,2]Late G. N. Sapkal College of Engg, Nashik, India

Abstract— The design of a highway and railway bridges depends critically upon standards and criterias. Naturally, the importance 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 the design and analysis of box girder bridges can be handled by the use of the digital computer software in the design. The objective of this analysis is to modeling the box girder in an ANSYS FEM design. This task involves examining the stress patterns obtained using static three-dimensional finite element modelling.

Key words: Box Girder, Finite Element Method, ANSYS, Stress Patterns

I. Introduction

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. Bearings are not needed. It is convenient to extend the existing culvert in the event of widening of the carriageway at a later date as per future requirement, without any problem of design and/or construction.

II. Literature review

Nehakolate, Molly Mathew, Snehal Mali:-This paper deals with study of some of the design parameters of box culverts like angle of dispersion or effective width of live load, effect of earth pressure and depth of cushion provided on top slab of box culverts. 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 items. Box culvert is easy to add length in the event of widening of the road. Box is structurally very strong, rigid &safe. Box does not need any elaborate foundation and can easily be placed over soft foundation by increasing base slab projection to retain base pressure within safe bearing capacity of ground soil. Small variation in co-efficient of earth pressure has little influence on the design of box particularly without cushion.

D. Vamshee Krishna and B. Jagadish Chakravarthy:-In this paper, the analysisof the underpass RCC bridge is carried out. The analysis of this underpass RCC bridge is done by considering fixed end condition and the soil structure interactions at different sections are presented. Comparison of different forces with results at different sections of the model for fixed end condition is provided. In this study a 2D model can be effectively used for analysis purpose for the loading condition mentioned in IRC: 6, “Standard Specifications and Code of Practice Road Bridges” 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.

B.N. Sinha& R.P. Sharma: -This Paper deals with box culverts made of RCC, with and without cushion. The size, invert level, layout etc. Are decided by hydraulic considerations and site conditions. The cushion depends on road profile at the culvert location. The scope of this Paper has been further restricted to the structural design of box. 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. Box for cross drainage works across high embankments has many advantages compared to a slab culvert. It is easy to add length in the event of widening of the road. Box does not need any elaborate foundation and can easily be placed over soft foundation by increasing base slab projection to retain base pressure within safe bearing capacity of ground soil.

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".

III. Methodology

1) Extensive literature survey by referring books, technical papers is carried out.
2) Modeling of steel box culvert.
3) Analytical work is to be carried out.
4) Interpretation of result and conclusion.

IV. Modeling & analysis

– Size of box culvert 4m x 3.5m x 2.5m
– Size of box culvert 4m x 3.5m x 3m
– Size of box culvert 4m x 3.5m x 3.5m

Model Name	Description	Slab Thickness (mm)	Size (m)

M-1	With Water Pressure	50	4 x 3.5 x 2.5
M-2	With Water Pressure	55	4 x 3.5 x 2.5
M-3	With Water Pressure	60	4 x 3.5 x 2.5
M-4	Without Water Pressure	50	4 x 3.5 x 2.5
M-5	Without Water Pressure	55	4 x 3.5 x 2.5
M-6	Without Water Pressure	60	4 x 3.5 x 2.5
M-7	With Water Pressure	50	4 x 3.5 x 3
M-8	With Water Pressure	55	4 x 3.5 x 3
M-9	With Water Pressure	60	4 x 3.5 x 3
M-10	Without Water Pressure	50	4 x 3.5 x 3
M-11	Without Water Pressure	55	4 x 3.5 x 3
M-12	Without Water Pressure	60	4 x 3.5 x 3
M-13	With Water Pressure	50	4 x 3.5 x 3.5
M-14	With Water Pressure	55	4 x 3.5 x 3.5
M-15	With Water Pressure	60	4 x 3.5 x 3.5
M-16	Without Water Pressure	50	4 x 3.5 x 3.5
M-17	Without Water Pressure	55	4 x 3.5 x 3.5
M-18	Without Water Pressure	60	4 x 3.5 x 3.5

Table 1:

V. RESULTS & DISCUSSIONS

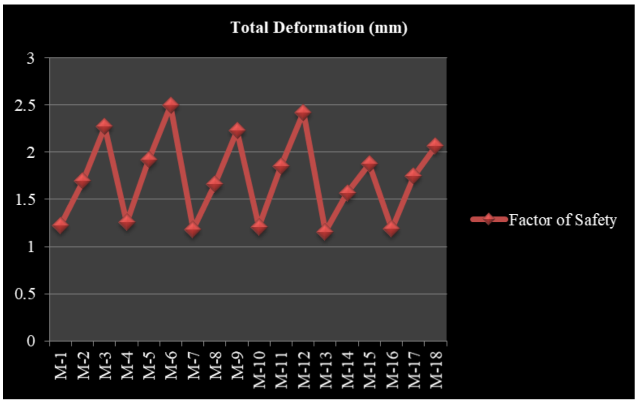


Fig. 1:

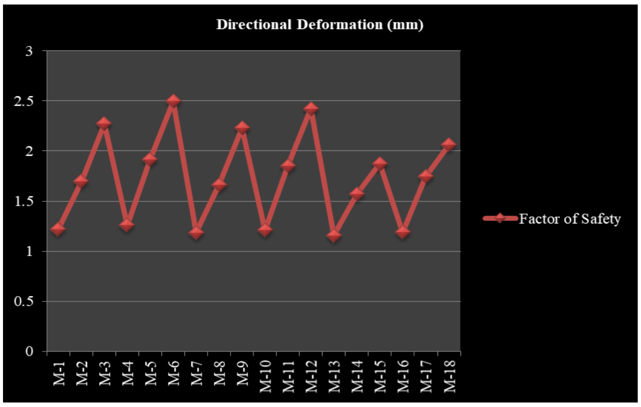
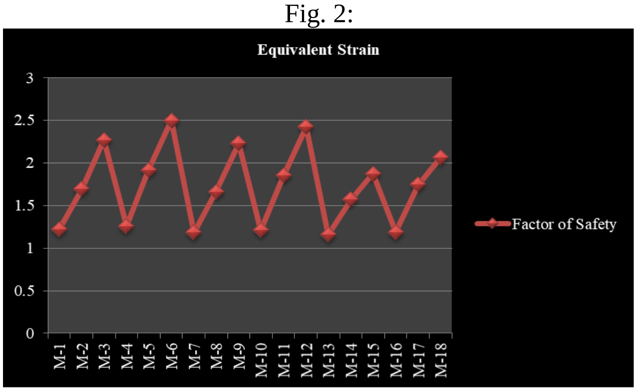


Fig. 2:



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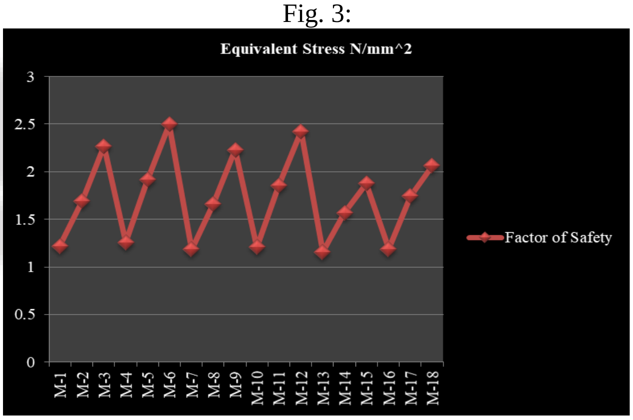

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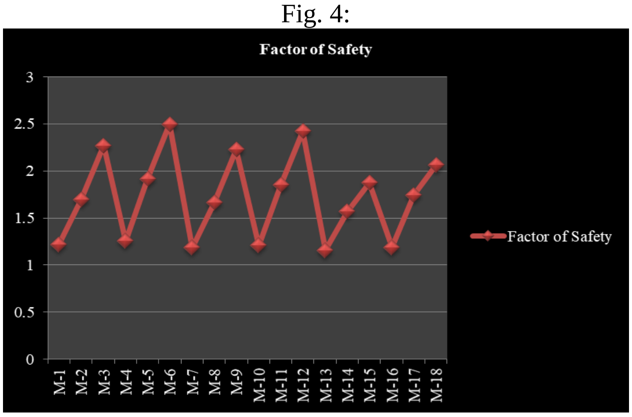

Fig. 5:

VI. CONCLUSION

As the thickness of the slab increases:

- Deformation of Top & Bottom Slab decreases.
- Deformation of vertical walls decreases.
- Safety factor increased as thickness increased.

- Equivalent stress that is developed goes on decreasing.
- Equivalent elastic strain also decreases with increase in the thickness.

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