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Analysis of Two Span and Three Span Box Culvert using Staad Pro: A Review

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Abstract: *In present days the box culverts are useful for providing natural drainage and access to pedestrians around them. These culverts play an important role in the transportation network as they provide a very effective cost structures compared to the major bridge.*

Culverts are almost similar to the bridges that allow vehicles and pedestrians to cross over the waterway. These are generally preferred where limited hydraulic head is available. The shapes of culverts are slab type, arch type, and box type. These are made of many materials such as bricks, stone and RCC. In this paper various authors review and their ideas are shown in design and then analyze the box culvert made of RCC and consider different aspect ratio. In the analysis of these type of culverts the review papers consider all the relevant codes of roads and bridges (IRC-6-2000 and IS 21-2000) and provision of standards in the design and analysis of the box culvert using Staad pro software. The structural elements of box culvert are compared to the shear force and bending moments of the respective elements of the structure.

Keyword: *Box culvert, aspect ratio, Staad pro, IRC codes.*

I. INTRODUCTION

Culverts are classified as cross drainage structures and with large utility in highways drainage. In fact, more than 75% of the cross drainage structures are culverts. Box culverts is the best choice among other culverts such as slab culvert and arch culvert. They can be used with great strength in soft soil conditions. These box culverts can be used in highways, railways, and also to provide access to natural drainage and pedestrians around them. The opening size of box culvert depends on the design flood in the area concerned and the thickness of wall depends on the load applied to the culvert. Box culverts are structurally strong, safe and stable and also easy to construct.

Box culverts do not require separate foundation for this and they can be built on any soil conditions with the required strength. Box culvert has bottom slab and top slab connected monolithic to its vertical walls but in slab culverts the top slab is supported over the vertical walls but there is no monolithic connection between them. These are usually made up of R.C.C materials and are also manufactured with precast R.C.C materials. These are economical because they are cast monolithically and provide greater rigidity and do not require separate foundations and the bottom slab rests directly on the soil therefore it serves as a raft slab foundation for the culvert. For small discharges, a single cell box culvert can be used but for the large discharge of water we will adopt two cell or multi cell.

II. COMPONENTS OF BOX CULVERT

The main parts of the box culvert are as given below :-

- A. Leveling course
- B. Bottom slab
- C. Top slab
- D. Side walls
- E. Wing walls
- F. Haunch
- G. Apron

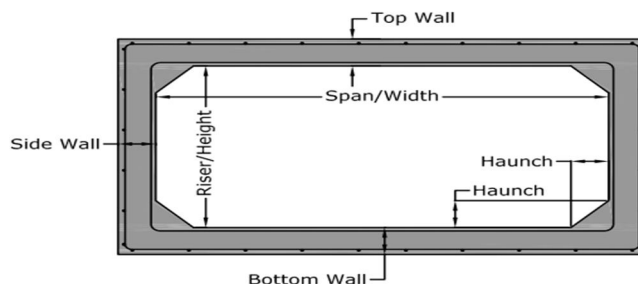


Fig. 1 Components of box culvert

III. ADVANTAGES OF BOX CULVERT

There are various useful applications of box culverts that are discussed as below :-

- A. It is economical and provides better strength.
- B. No additional treatment is required to improve the performance of the structure.
- C. It is very easy to construct and provides great rigidity to the structure.
- D. It can be used in weak soil conditions.
- E. It can prevent erosion and flooding.
- F. Bottom slab act as a raft foundation, so it will reduce the pressure on the soil.

IV. LITERATURE REVIEW

Several works have been presented on the analysis of box culvert using software and in this review paper we briefly discuss various researchers and scholars.

Sujata Shreedhar¹, R.Shreedhar² (2013) In this study multi cell box culvert analysis is considered for different L/H ratio and compares the the shear force and moments. The manual approach is adopted to determines the forces and moments.

Neha Kolate¹, Molly Mathew², Snehal Mali³ (2014) This paper deals with study of design parameters such as the angle of depression, the effect of the cushion on the top slab of the culvert and effect of earth pressure and depth of cushion and angle of dispersion for live loads on box culvert with or without cushion for structural deformations.

M.G. Kalyanshetti , S.A. Gosavi (2014) The main objective in this study is to achieve economical design of box culvert. This is achieved by reducing the wall thickness by adopting multi cell culvert for different aspect ratios. It is done by stiffness matrix method and a computer program in C language for the cost evaluation. The percentage reduction in single cell, double cell and triple cell costs is presented here based on optimal thickness.

Y. Vinod Kumar^{*1}, Dr. Chava Srinivas² (2015) It shows the study of design of box culvert and determines the stresses such as shear force and bending moment of the structure under railway loading conditions and these stresses have been determined by computational methods as well as conventional methods and compares the results. All the design parameters have been determined as per Indian railway standards.

A. D. Patil¹, A. A. Galatage² (2016) It deals with the different aspect ratios of the box culvert and compares the bending moments of different aspect ratios, respectively. It also considers the effect of varying cushion and without cushion condition on box culvert structures and determines the result on the basis of bending moments for different loading conditions.

Zaman Abbas Kazmi, Ashhad Imam, Vikas Srivastava (2017) This paper deals with the comparison of results between the manual approach and the computational approach (staad pro). In this study, it was also observed that manual calculation are very tedious and complex so it is better to solve it by computational method.

I. Siva Rama Krishna , Ch. Hanumantha Rao (2017) It serves to identify the behaviour of box culvert with interaction of soil and without interaction of soil. It analyze the structure with finite element method for soil interaction and stiffness method for without soil interaction. It determines the shear forces and bending moments from finite element method and stiffness method.

Mahesh D. Kakade¹, Rajkuwar A. Dubal² (2017) This paper deals with the soil interaction of box culvert structure with box full and box empty conditions using the finite element analysis tool ANSYS. It also consider the design parameters such as effect of earth pressures and depth of cushion varies on the top slab of the culvert. It also compares the various cases of box culvert with or without cushion.

Vasu Shekhar Tanwar¹, Dr. M. P. Verma², Sagar Jamle³ (2018) It is related to reducing the stress on the box culvert due to various types of loading and different conditions. Therefore in this study, it reduces the stress on the box culvert structure by flaring the box partially.

P. Leela Krishna, Dr. K. Rajasekhar (2018) In this paper the box culvert is analyzed with manual calculations and with the help of software. The shear force and bending moments of both manual calculation and computational approach have been compared and the results of manual calculations are almost identical to the computational approach. It uses the software for analysis of box culvert is staad pro.

Pooja Shende¹, Prof. Manish Chudare² (2018) This is related to the analysis of box culverts for different L/H ratio with different angle of friction. It also determines the moments, shear force and thrust for the rigid frame of box culvert for different types of loading conditions.

Ankita Kumara^{*}, Sunil Kumar Ahirwar^b, J. N. Mandal^c (2019) In this study, the main objective is to optimize the thickness of box culvert with the use of EPS geofoam as a backfill material. To achieve this result, finite element analysis has been performed using PLAXIS 3D. In this result we observed that the lateral deformation on the face of the box culvert is less than that of the traditional backfill materials. So it is useful in reducing the thickness of box culvert which reduces the quantity of RCC materials and ultimately the overall cost of the project.

Prema S Bangari¹, Guruprasad T N², Dr T V Mallesh³, S R Ramesh⁴ (2019) In this study it is concerned with the analysis of box culvert structure manually and with software. It also considers the effect of various types of loading conditions. In last, compares the results of moments and shear force with staad pro and manual approach.

V. CONCLUSION

Box culverts are very rigid, sturdy and easy to construct. These structures do not required any separate foundation and can be used on soft soil conditions. These presented reviews include the stability and the rigidity of structure, and almost no maintenance. It can also be a two span and three span box structure and can be analyzed for different loading condition for different aspect ratios. It can also be analyzed for varying depth of cushion on the top slab of the culvert. So lastly, determine the forces and stresses in the structure for different aspect ratio that will be easy to adopt the aspect ratio at the site.

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