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Study the Effect of Different Load Combination that will Lead to the Failure of the Structure and Hence Design for the Critical Combination of Load

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ABSTRACT

The box type bridge is designed for same span i.e., 6m but different height varying from 3m to 8m. The thickness of top slab; bottom slab and wall are kept same for all the span arrangements. The box type bridge is then modelled in STAAD.pro, considering 1m width of strip. Once modeling is done, the results i.e., shear force and bending moment is obtained. Maximum bending moment and shear force shall be considered for the design and hence taken further calculations in Excel. A culvert is a structure having an overall length not greater than 6m e.g., Hume Pipe Culvert, Box Culvert, and Slab Culvert. A bridge is called as a minor bridge when the overall span is greater than 6m and less than or equal to 60m.

KEYWORDS: *Bridge, thickness, bending moment, shear force, Box Culvert, Slab Culvert*

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I. INTRODUCTION

Numerous Box culverts are the cross drainage structures constructed below highways and railways to provide access to the natural flow across them. The opening of culvert determined based on the waterway required to pass the design flood. Box culvert is suitable CD structure where hydraulic head is limited. This paper deals with study of limit state method for box culvert constructed in reinforced concrete with cushion and without cushion on top slab. The thickness of the culvert section is designed on the basis of vehicular loading as per IRC applied and their combination produce worst effect of loading for safe structure. The structural elements and requirement of steel are to be designed to withstand maximum bending moment and shear force which obtained with analysis by using STAAD Pro. In this study it is observed that the bending moment and shear force is greater when cushion considered over the box as compared to box without cushion. Their corresponding results like maximum bending moment, shear force with impact for ULS combination and SLS combination are obtained according to provision given in codes. Area of steel indices is studied for both conditions which are shown by graph in result analysis. The required area of steel is greater for overburden structure so the depth adopted for sections box culvert without cushion is not suitable for box with cushion. Structure can be failed or unsafe to carry the stress in concrete while designing. So the adopted depth of section for overburden box culvert is more than no cushion condition for safety purpose.

II. OBJECTIVES OF THE PRESENT STUDY

- Provide guidance to the individuals involved in the design of box type minor bridges. This can help choose a certain dimension that is best suited for their research project which is ultimately economical and durable.
- To study the behaviour of box type bridge with different height and same width for the IRC loadings.
- To study the effect of different load combination that will lead to the failure of the structure and hence design for the critical combination of load.
- To design and analyse all the span arrangement and compare the results so obtained and prepare conclusion accordingly.

III. LITERATURE SURVEY

Patil and Galatage (2016) Box culverts are the structures constructed below highways and railways to provide access to the natural drainage across them. The opening of the culvert is determined based on the waterway required to pass the design flood, whereas the thickness of the culvert section is designed based on the loads applied on the culvert. Culverts and bridges often serve the same purpose; however, they differ on the size of the structure. Box culverts are ideal for flows where hydraulic head is limited. For an equivalent waterway area to circular pipes, box culverts can be configured to have less impact on upstream water levels and downstream flow velocities than equivalent pipe structures. This report devotes to the box culverts constructed in reinforced concrete having different aspect ratios. The box culverts are analyzed for varying cushion and no cushion loading. The main emphasis is given to the behavior of the structure under the types of loading as per IRC codes and their combinations top produce worst effect of loading for safe structure. Comparison and conclusion are made on the basis of maximum bending moments shown for different loading cases.

Seo et al. (2017) Tens of thousands of aging, bridge-class, RC box culverts are in service in the United States. Within the context of establishing load rating for in-service RC box culverts, this paper introduces, calibrates, and applies a system-level pavement-stiffness model to a production-simplified, soil–structure interaction model used for calculating load demands. The proposed pavement-stiffness model uses system-level pavement data to account for the additional stiffness provided by the pavement structure to attenuate live load. The full cover-soil depth is modeled using linear-elastic finite elements per the production-simplified soil–structure interaction model, and the additional stiffness provided by the pavement structure is modeled using beam elements across the top row of finite-element nodes. Equivalent beam-modulus values for the system-level pavement-stiffness model were calibrated against results from a research-intensive, full-pavement model for various pavement types. A parametric study using the proposed model showed that the inclusion of pavement stiffness could increase the load ratings for both asphalt pavements with an intermediate thickness and concrete pavements, for both direct-traffic and low-fill RC box culverts. The effects of the system-level pavement-stiffness model on predicted live-load moment response were further evaluated using measured live-load moments from field live-load tests on in-service culverts. From these comparisons, the system-level pavement-stiffness model showed improved accuracy and precision of the live-load demand prediction. Finally, load-rating analyses performed for an illustrative sample of 24 in-service Texas RC box culverts under various pavement types showed improved rating factors from the system-level pavement-stiffness model compared to the production-oriented soil–structure interaction model without pavement stiffness and the AASHTO-recommended structural-frame model. The inclusion of the pavement stiffness when modeling in-plane live-load attenuation improves the RC box culvert load-rating results and can be implemented for system wide infra-structure management.

Alam and Patel (2018) SAP-2000 was used to analyze slab and box culverts under heavy traffic loads.. According to site, this study considers two distinct kinds of courses under substantial activity streams and water powered streams. In future working conditions, this examination work will assist in executing a more stable, practical and comparable execution.

Vasu et al. (2018) At the time of construction of roads, highways a structure is placed (commonly used) to transfer the traffic, rain water, drainage from one side to another of the road is called a culvert placed beneath the road. Due to the structural use, multiple loads are placed on the box causing various types of stress which occurs on it. The paper tries to reduce the stress occurred in the box by flaring the box partially. Culvert is an underpass provided beneath the high way which under goes various types of loading. It helps to facilities the flow of water, provide cross drainage, roadways or railways, to take electrical or other cables from one side of road to another side of the road. due construction of these high load bearing components various stress and shear gets generated in very high values the paper objects to reduce the values of the stress which have been generated for various cases.

Patel and Jamle (2019) Box culverts are the monolithic structure made to pass across a roadway, railway lines etc. Embankments are used to balance the flood water on both sides. Box takes various types of loads generated by water, traffic, cushion, soil etc. This work deals with complete design of box culvert manually and study the design parameters such as effect of earth pressure, depth of cushion at the top slab of culvert, factor such as braking force, Impact load, Live load, Dispersal of load through tracked or wheeled vehicle, effective width etc. In this work, study of culvert with and without cushion analyzed for different classes of IRC loadings and conclusions made on the basis of bending moments and shear forces with and without cushioning cases. This paper provides full discussion of provisions provided by Indian Standards, their justifications and considerations are taken into the account for design purpose. For box culvert which is without cushion braking force is required to consider for s mall spans. It is easy to widen the box length when required.

Patel and Jamle (2019) Box culverts are the structures which are used when the path of water in the natural stream crosses roads, railway lines, flyovers etc. They are normally cheaper than bridges, which make them the natural stream passes through channels. In this work, the review of various authors and their views in the design and analysis of box culvert with software approach and comparison between software and manual approach has shown. The IS standard requirements in the design manual for roads and bridges (IRC-6-2000, IS 21-2000) is used in the structural designing of concrete box culverts. In this paper study about the different classes of IRC loadings and their effect on without and with cushioning conditions imposed on box culvert. The pressure cases are then checked for both with cushioning and without cushioning loading cases. The structure designing includes the considerations of pressure cases (Box empty, Full, surcharge load) and factors such as Impact load, Braking force, Dispersal of load through fill, Effective width, Coefficients of earth pressure, Live load etc. The structural elements are designed to withstand the maximum bending moments and shear forces respectively. In the present study, this paper provides full discussion on the provisions in the codes, considerations and justifications of all the above aspects of design.

IV. METHODOLOGY

The methodology adopted for analysis and design is as follows:

- In STAAD.Pro, effective width method is used to model the box type bridge and hence effective width and height for one-metre strip is used for analysis.
- The geometry is prepared using nodes and beams.
- Relevant properties is given i.e., thickness, support (Spring Support), etc to the various structural element viz. top slab, wall and bottom slab.
- Apply loads to the structural members as per the IRC: 6-2017.Loads can be classified as shown in the following Figure1.5.
- Apply the Load Combinations as per the limit state design recommended in IRC: 6-2017 As shown in the Figure 1.3
- Obtain the results from Staad.Pro Analysis such as Shear Force and Bending Moment.
- Each Element like top slab, wall and bottom slab will behave differently for different load combination.
- Provide the required spacing and diameter of bars in manner such that each element sustains the critical combination of load as per the minimum conditions given in IRC: 112-2020 Chapter No. 16.
- Repeat the above process for all the span arrangements.
- Compare the results obtained.

V. CONCLUSIONS

- If all the models that is from 1x6x3 to 1x6x8 are carefully observed in the graphical representation of each result in Chapter 5 one can easily find out that there is sudden spike in the results of maximum bending moment, shear force, Quantity requirement after span **1x6x5**.
- In that case the span arrangement **1x6x5** which is rectangular in shape. As per the results obtained if 1x6x5 is selected found to be economical and durable as well when compared to the other span arrangements.

VI. References

[1] Nauraj Alam1 Rakesh Patel2 (2018). "Finite Element Analysis of Slab & Box Culvert under Heavy Traffic Loading using SAP-2000", *(IJSRD)International Journal for Scientific Research & Development*|, Vol. 6, Issue 08, 2018 | ISSN: 2321-0613.

[2] Osama S. Hussien, Effect of haunch on the stresses of box culvert, Peer-reviewed version available at AIMS Environmental Science 2020;

doi:10.3934/environsci.2020003,Preprints (www.preprints.org) | NOT PEER-REVIEWED | Posted: 29 August 2019 doi:10.20944/preprints201908.0310.v1

[3] Patil, Aniket & Galatage, Abhijeet. (2016). Analysis of Box Culvert under Cushion Loading. International Advanced Research Journal in Science, Engineering and Technology. 3. 163-166.

[4] Pavan D. Tikate and S.N. Tande (2015), "Design Based Parametric Study of Box Culvert using Finite Element Method ". p-ISSN: 2350-0077; e-ISSN: 2350-0255

[5] Pinoymathcomunity,http://www.mathalino.com /reviewer/strengthmaterials/moment-distribution-method

[6] Published: 2008 DOI: 10.1080/15732480802180791

[7] Rohitkados and Prof. B. V. Chavan (2022), "Comparative Structural Analysis of Different Types of Box Culvert" ISSN (Online) 2581-9429

[8] Roshan Patel, Sagar Jamle (2019), "Analysis and Design of Box Culvert: A Manual Approach". ISSN: 2349-6495(P) | 2456-1908(O).

[9] RoshanPatel, #SagarJamleAnalysis and Design of Box Culvert: A Review "International Journal for Research in Engineering Application & Management (IJREAM) ISSN: 2454-9150Vol-05, Issue-01, April 2019.

[10] Shweta Singh Baghel, Kapil Mandaloi (2021), "Comparative Analysis of Box Culvert with Cushion and Without Cushion Using Staad-Pro" e-ISSN: 2456 – 6470.

[11] Sudhir kushwaha, Tushar kesharwani, Umang shukla, Umesh kumar & Mr.Himanshoo verma (2020), "A Review Paper on Analysis and Design of Box Culvert using staad pro" ISSN: 2320-2882.

[12] Tanwar, Vasu & Verma, Dr & Jamle, Sagar. (2018). Analysis of Box Culvert to Reduce Stress Values. 5. 103-105. 10.22161/ijaers.5.5.14.

[13] Vinayak Demane and Prof. Swapnil Cholekar (2013). "Parametric Study on Underpass RCC Bridge with Soil Structure Interaction", *International Journal of Engineering Research & Technology (IJERT)*, Volume No.02, Issue No. 07, July 2013, ISSN: 2278 – 0181.