iJRASET
International Journal For Research in
Applied Science and Engineering Technology

INTERNATIONAL JOURNAL FOR RESEARCH
IN APPLIED SCIENCE & ENGINEERING TECHNOLOGY

Volume: 10 Issue: IX Month of publication: September 2022

DOI: https://doi.org/10.22214/ijraset.2022.46894

International Journal for Research in Applied Science & Engineering Technology (IJRASET)
ISSN: 2321-9653; IC Value: 45.98; SJ Impact Factor: 7.538
Volume 10 Issue IX Sep 2022- Available at www.ijraset.com

Study the Behavior of Box Type Minor Bridge or Vehicular Under Pass When Subjected to Different Combination of Loads in Terms of Bending Moment and Shear Force Variations

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Abstract: Predicted Earth Pressure, Stresses, Moments, Shear forces under the action of load combinations at the location of VUP are presented for symmetrical and unsymmetrical live loading conditions. Furthermore, predicted bending moment distributions around the RCC single cell Box VUP are presented for various loading conditions. The design considerations, ULS and SLS check after the design structure analyses with excel calculations and as per IS and IRC codes. In additions, The shear force distributions around the RCC single cell Box VUP are presented for various loading conditions.
Keywords: RCC Box structure, RCC culvert, single cell, soil interaction, spring stiffness, Staad.pro.

I. INTRODUCTION

This present study is a part of contract package II of Four laning of Ahmednagar – Mirajgaon – Karmala - Tembhurni section of NH-561A [Package –II from design km 38.775 (Ghogargaon) to design km 80.390 (Ahmednagar-Solapur Border)] in the state of Maharashtra under Bharatmala Pariyojana on Hybrid Annuity Mode.. Specific details for the design are discussed below: The RCC Box cross section design of VUP (Chainage – 77+925) at the project Stretch for 1m strip is considered for analysis and the loads and load combinations are applied.

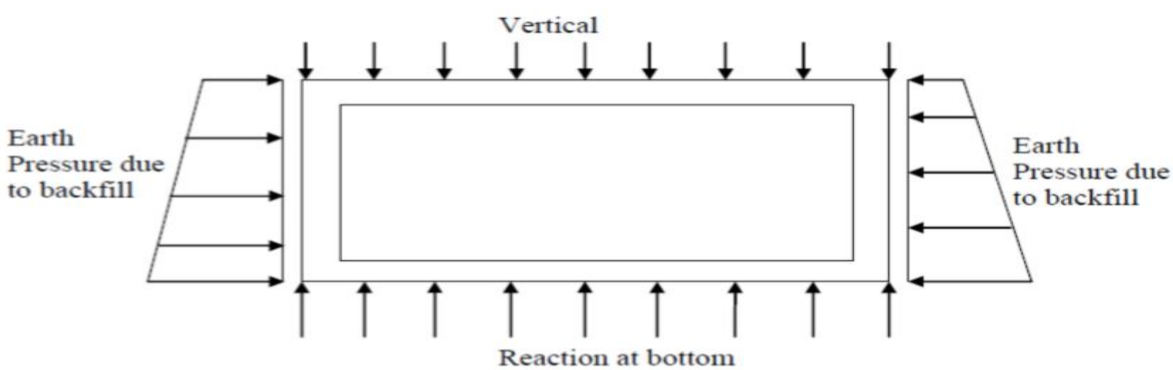

Figure **Error! No text of specified style in document.**. Model showing with loads and reaction

This study demonstrates the structural analysis and design of RCC Box type Vehicular Under Pass /Minor bridge using manual approach i.e. MDM method and by computational approaches (Staad-pro) using IS, IRC - CBC codes. The structural elements (i.e. top slab, bottom slab, side wall) were designed to withstand Ultimate Load criteria with respect to maximum bending moment and shear force -due to various loads (such as Dead Load, Live Load, SIDL, LL surcharge, DL surcharge) and serviceability criteria i.e. Crack width and a comparative study of the results obtained from the above two approach has been carried out to validate the correctness of the results. Further, it was also observed that the analysis using manual calculation becomes very tedious and cumbersome and for a complex type of structure, thus it is quite a complex task to perform the analysis manually, so the use of computational method (Staad – pro and excel sheet) becomes the obvious choice for design. The results obtained using MDM method shows a good agreement with the results obtained from computational methods.

II. LITERATURE REVIEW

Shreedhar and Shreedhar (2017) The study was on designing factors for each case of box culverts, starting from single to dual box culverts, where the study included the moments and shear forces and their development in each axis, after which each case of force loading was studied for them.

Khan (2017) the study of problems involved during execution of Railway under bridge using box pushing technique and its remedies: This paper gives attention towards problems that arises during execution of RUB using box pushing technique and its remedies. It also explains about the methodology involving in application in subway construction.

Mahto et al. (2018) A Review on Bridge Construction Technology: This paper describes the details about the bridge construction technology. This paper also review the existing various types of bridges with the history of worldwide bridges and their classification based on materials used in the performance.

Maora and Patil (2019) have presented a complete study of Slab Culvert by using computational methods such as Grillage analysis and Finite element method. Grillage analysis is versatile in nature and can be applied to verity of bridge decks having both simple and complex configurations with ease and confidence. Grillage analysis has done by most commonly using softwre STAAD Pro. Their main objective was to know the behaviour of Slab Culvert and variation of stresses in terms of Shear force and bending moment values. Patil and Galatage (2020): had done analysis physically. The design and analysis issues of Slab were done with mitigating and without cushioning. The maximum bending moment in each and every loading were determined. The result is the load combination to be found very critical for all aspect ratio bending moments for different ratio or aspect is varying or constant for with and without cushion. Tiwari et al. (2021): Researched on the underpass RCC Bridge design and analyses for the study is to determine the load combination and to examine the behavior of box culvert without cushion loads. The results were analysed by staad.pro which passes through different load combinations in terms of shear, bending moments, axial forces and deflection.

III.DESCRIPTION

The analysis of RCC Box/VUP structure has been done considering a slice of unit width. The RCC Box has been analyzed for all applicable loads vis a vis self weight, superimposed dead load (due to wearing coat and crash barrier), earth pressure, braking load, temperature load, live load. The RCC Box structure is analyzed using STAAD Pro. The soil beneath the bottom raft is modeled as spring supports as per available literature and practice and the spring constant is calculated on the basis of modulus of subgrade reaction of the soil. For earth pressure modeling, two cases -earth pressure at rest and active earth pressure with coefficient of earth pressure having the following values:

Coefficient of Earth Pressure as 0.50 when soil at rest & Density of Earth as 2.0 t/m3 for no traffic flow

Coefficient of Active Earth Pressure as 0.279 & Density of Earth as 2.0 t/m3 for traffic flow conditions

Analysis for Live Load for Class 70R tracked, Class 70R wheeled & Boggie load have been done using STAAD Pro. Live Load positions are identified for maximum bending moments at different sections and corresponding load intensities per meter width are evaluated as per effective width method as explained in Annexure B-3 of IRC 112: 2011.

The RCC Box has also been checked for temperature loads as per Clause 215 of IRC 6:2014.

A. Load Combination

The following load combinations are considered for the analysis:

1) DL+ SIDL+ EP
2) DL+ SIDL+ EP+ LL
3) DL+ SIDL+ EP+ Temp.
4) DL+ SIDL+ EP+ TEMP+ LL

The RCC Box is checked for all ULS and SLS cases as per partial load factors specified in IRC 6:2014 and permissible limits as specified in IRC 112:2011.

IV. SELECTION OF MODEL

It has been considered to analyses the position of vehicles under the basic load according to the Indian Road Congress and analyses it with Staad pro professional programming for the investigation of a 7m clear span RCC Bridge. The proposed steps are as follows:

1) *Step 1:* Choose the type of structure you would like to make in staad before you map it. Modelling Geometry of the structure can be selected by using the coordinate system in Staad Pro or by Plotting over the AUTO CAD, which can be imported into Staad-Pro according to the box Dimensions, such as the span, height, wall thickness, and number of boxes. Below you will find a sketch of the box structure.

2) *Step 2:* Whenever you start a project, the first step is to set up model data, such as name, storage, place, units, etc.

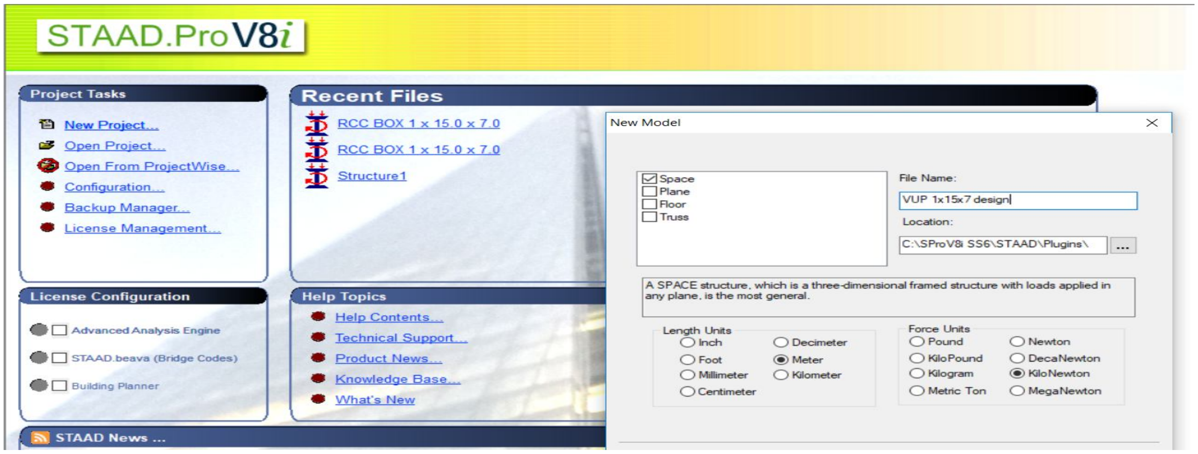

Figure 2 : Setup in STAAD Pro

3) *Step 3:* Once the units are set, we can create a model using the node/beam courser, or we Can provide co-ordinates to allow for

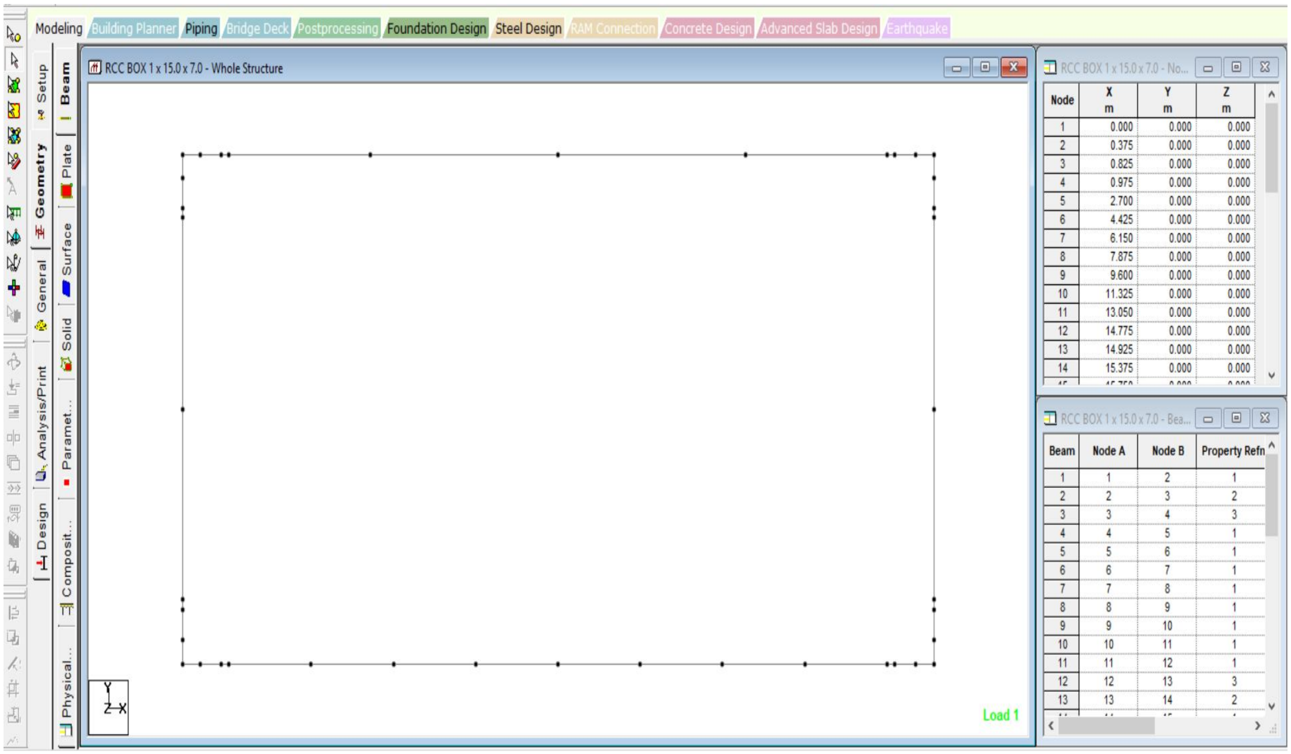

Figure **Error! No text of specified style in document.**. : Coordinates provided in STAAD Pro

V. CONCLUSIONS

The present study shows that there is significant contribution to positive normal thrust at centre of vertical wall (section E4) due to superimposed dead load & live load and weight of side walls. The present study shows that the multi celled RCC Boxes are more economical for larger spans compared to single cell RCC Box as the maximum bending moment and shear force values decreases considerably, thus requiring thinner sections.

VI. ACKNOWLEDGMENT

This work was completed with the grants and facilities of Lakshmi Narain College Of Technology, Bhopal (M.P.). Authors are thankful to this institute and faculties for extending this cooperation.

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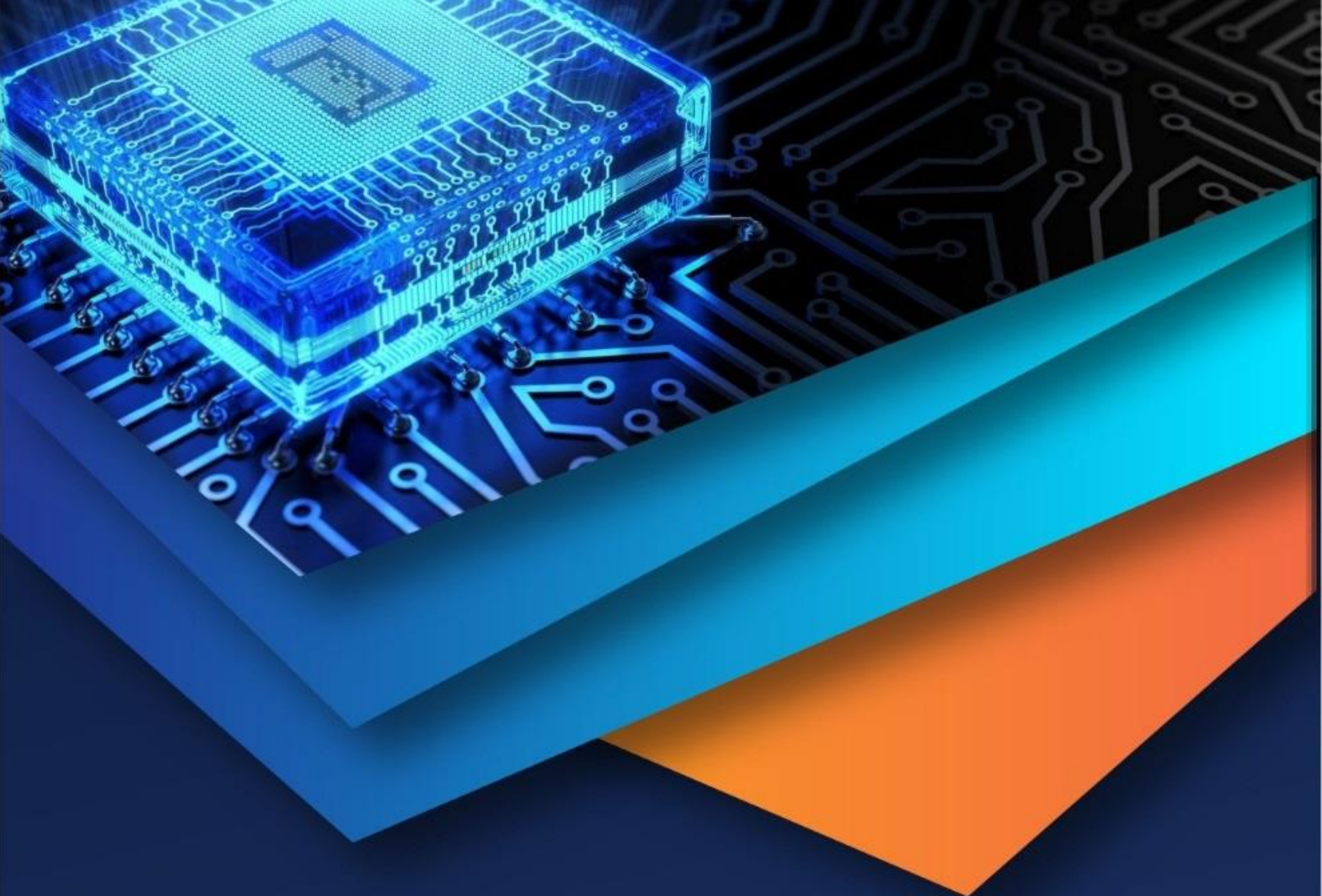

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