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Analysis & Design of Reinforced Concrete Solid Slab Bridge

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ABSTRACT

Structural planning and analysis is an art and science of designing with economy, elegance and sturdiness. Structural designing requires an in-depth structural analysis on which the planning is predicted, to compete within the ever-competitive market, the use of software can save many-man hours and efforts in structural analysis and an effort was made in the present study to achieve this objective. The purpose of this study is to analyze and design the solid deck slab bridge by STAAD-Pro and manual method under different loading conditions. And also, the analysis results in term of shear, bending moment, axial force and deflection were checked by STAAD-Pro which is passes through many different load combinations. The maximum design moments resulting from the combinations of various loading cases.

part 1 The study deals with the planning and analysis of Solid Deck Slab using Staad-Pro software. In this study solid deck slab having 8.2 m long span and the thickness of slab 0.65 m and the slab is simply supported. The drafting and detailing work was completed using AutoCAD software and thereafter the entire design work was completed using “Staad-Pro v8i ss6”.

Part 2 Manual analysis of load is compared preferably with the results of software and thus it's concluded that Staad-Pro is suitable tool that may save considerable time and gives sufficiently accurate results.

Part 3 Comparison of Manual Calculation and also the analysis results in term of shear, bending moment, axial force and deflection were checked by STAAD-Pro which is passes through many different load combinations. The maximum design moments resulting from the combinations of various loading cases.

KEYWORDS: *Planning, Analysis, Solid Deck Slab, STAAD-Pro, Shear forcr, Maximum design moments*

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I. INTRODUCTION

A bridge may be a structure which is built to produce a passage over an obstacle like river, valley, or road, etc. The first bridge made by humans was wooden bridge in which they use the cut wooden logs for a simple support. Growth and rapid urbanization, there has been a limitless growth in traffic volume on highways over the previous couple of decades. To make sure smooth flow of traffic, numerous new highways and flyovers are being constructed. Study of structure shape, material, size, and selection should have supported engineering and economic criteria hence its study helps to decide the economic aspect during the design & construction of the bridge. Present research work developed to research the investigation made by different researchers within the field of economic and safe bridge design. The research work presents the summary of assorted research work & concludes with identified gaps within the research moreover as identified the object of required work. The primary bridge made in 1840 by using trusses with wrought iron as tension vertical and timber planks for all other members.

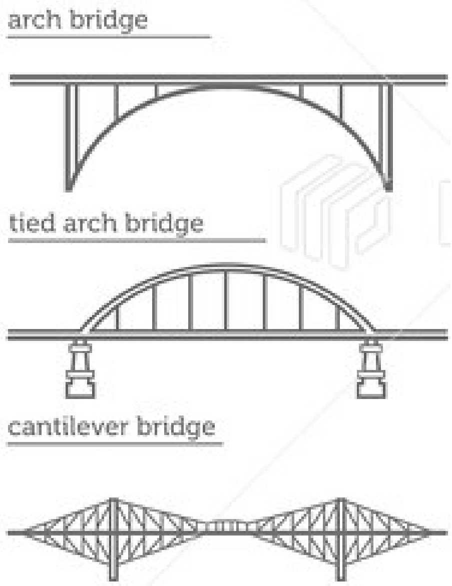


Fig-1 Classification of bridge

Concrete decks are the most commonly used type of deck in bridge construction, specifically because they are easy to prepare and place in various shapes and sizes. Concrete decks provide excellent durability and wear resistance, as well as traction control. Furthermore, drainage systems, reinforcement covers, skew of the bridges, and the thickness of slabs also have a significant impact on concrete deck durability. Concrete slabs deteriorate primarily due to corrosion of the reinforcement. A chloride attack usually results in corrosion (concentrations of chloride molecules seeping through cracks in decks).

Among the places where this loading is applicable are certain municipal limits, certain industrial areas, other areas, and certain highways. As certain conditions may result in heavier stresses under Class A Loading, bridges designed for Class AA Loading should be tested for Class A Loading as well.

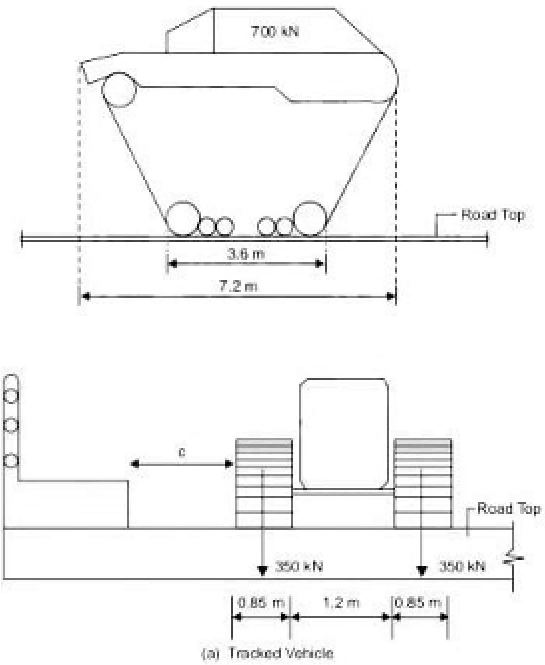


Fig-2 Class AA Loading

II. LITRATURE REVIEW:

For the correct functioning of our project I have undergone various national and international papers published. The summary of some important papers skillful are as below. The design aspects of various journals and theses were studied. Variable parameters such as Depth of Slab, Length of Slab and width of Slab are the variable parameters considered during the design of Solid Slab Bridge. RCC Slab bridge is designed as per the Limit state method using the, IRC: 06-2017, IRC: 112-2011 and analyzed by STAAD Pro V8i.

Shreedar and Mamadapur (2012) The bridge deck of the T-beam bridges constructed with girders has to be studied. Using the Finite Element Method, they analyzed the T-beam deck slab, applying an IRC loading to it. Comparing 3-D model results with 1-dimensional model results, they found that Finite Element Method results are less than that of one dimensional model. They used 70R and IRC loading methods for Class A and Class AA. An IRC study was conducted on a one-dimensional version of a simple span T-beam bridge. For both the bridge deck slab and the main beam, a three-dimensional analysis is conducted using finite element software STAAD ProV8i. Loading is simulated to produce maximum bending moments for both models. Due to the lower accuracy of finite element analysis than one-dimensional analysis, manual calculations based on IRC loadings typically produce conservative results.

Gaur and Pal (2019) We have learned from the research that there is a gap in the research and objectives of the research in the field of the slab deck structure system. They provide a new perspective on the RC deck sab problem. It is possible to enhance the economic aspect of a deck slab bridge by evaluating its performance with different thicknesses. This will guide the design of a stronger, safer, and more economical bridge.

Kanathe and Kushwaha (2019) Precast concrete decks with prestressed surface conform to greater range of forces, moments, and displacements than plain beam decks. The Finite Element Method involves assigning a finite element number to each part of the structure so it can be analysed separately. A nodal intersection is when two elements intersect. This has been taken into account when analysing a bridge with the same IRC loading and span of 30 meters for critical loads. The results of analysing these critical loads will then be compared to determine the most stable and economical section based on all factors, including forces, deflection, weight, and cost. Prestressed concrete deck slabs experience fewer variations than plain beam decks in terms of forces, moments, and displacements.

Roopa (2020) An analysis of the static and vibrational responses of bridge deck slabs. At the two edges of bridges, the most important structures are the bridge deck slabs. This structure is typically orthogonal to the route of traffic. They may, however, occasionally not be orthogonal to a traffic route for a variety of reasons. This type of bridge deck is called a skew bridge deck. Despite the growing interest in skew slab bridges, very few studies have been conducted on either static or vibration behaviour. Hence, finite element analysis was utilized to analyse the behaviour of skew slab bridge decks using a static and vibration analysis. Static analysis is performed for different skew angles and for different aspect ratios, for multiple loading scenarios including dead load, for IRC class A loading, for the case of slab slabs without and with edge stiffening beams. Parametric studies were also carried out to evaluate the effect of area stiffening and bearing flexibility at the static level on bridge decks with 30° skew angles and aspect ratios of 0.4. Simple skew slab bridges of different skew angles and aspect ratios were analysed for vibration.

Mohaliya and Dashore (2021) The study of A Deflection Analysis of Deck Slabs. Researchers have studied a steel-free composite deck bridge system for the past two decades. It is an entirely new concept. The new structural system eliminates the need for steel reinforcement in concrete deck construction. Concrete decks of bridges are traditionally designed to withstand loads in flexion. Innovative bridges without steel decks develop internal compressive forces which result in shear failure by punching at loads many times higher than their designed flexural loads. The new composite bridge concept has been applied to five bridges in Canada.

III. EXPERIMENTAL PROGRAM:

Step 1: First, assign various attributes to your STAAD Pro project, such as a name, unit, storage location, etc.

Figure 3: Setting of units, location in STAAD Pro

Step 2: We can either provide structure coordinates or use the node and beam courser for generating the structure model.

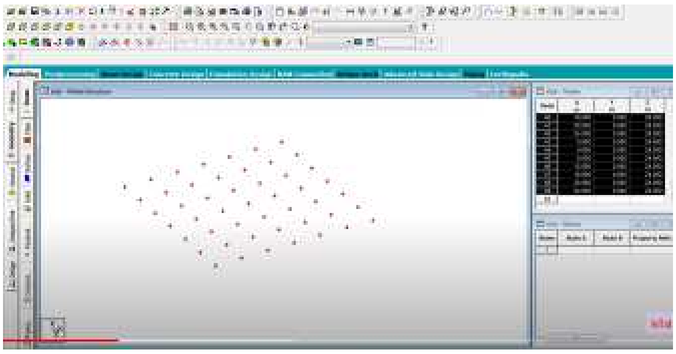


Figure 4: Provide coordinates in STAAD Pro

Step 3: After applying all the different types of load conditions, it is necessary to analyze the model to find the axial force, shear force, maximum displacement, and support reactions.

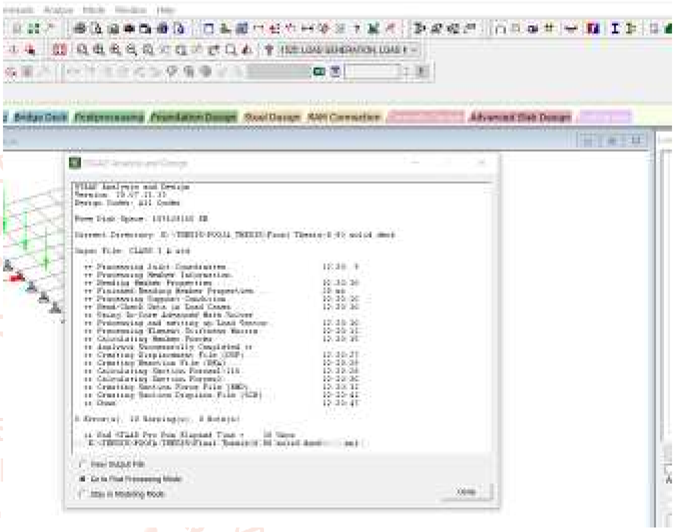


Figure 5 : Shows Maximum Bending and Shear in STAAD Pro

IV. METHODOLOGY:

To achieve the above-mentioned objectives our methodology is as follows:

1. Review the existing literature on topics of solid slab (bridge) structural for analysis.
2. Engineering properties of the materials (like modulus of elasticity, poisons ratio, ultimate tensile strength, etc.) to be used in analysis is inserted.
3. Modelling of the structure is done by using STAAD-Pro V8i software.
4. Generate beam geometry is done and element size is chosen in such a way that accuracy in analysis is ensured.
5. Provide slab thickness and material properties
6. Now the support condition is provided at edges of the slab, and the load is applied at top face of the slab.
7. Apply different type of load and load combination on the slab. (i.e., top face slab, bottom face slab).

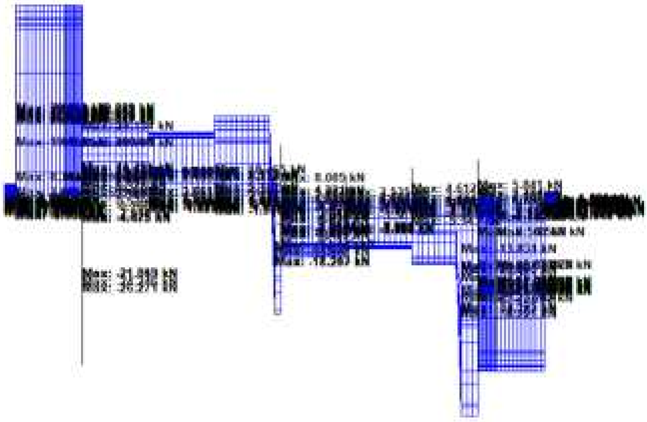


Fig-6 Generation of Shear Force

This study finds the bending moment and shear force under various types of load combinations using a manual approach. As the slab width is 12m, we consider this structure to be a 3 lane structure. So, we apply the loading according to IRC 3 lane structure.

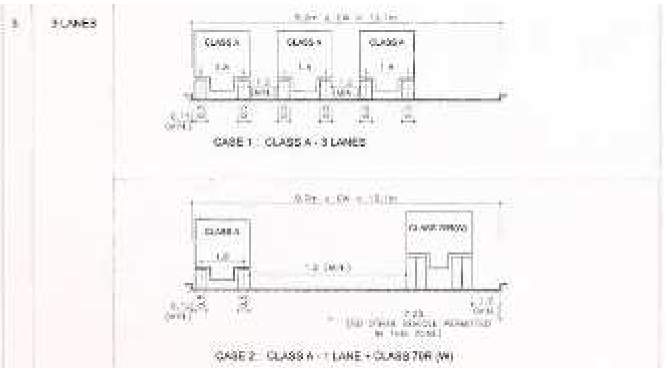
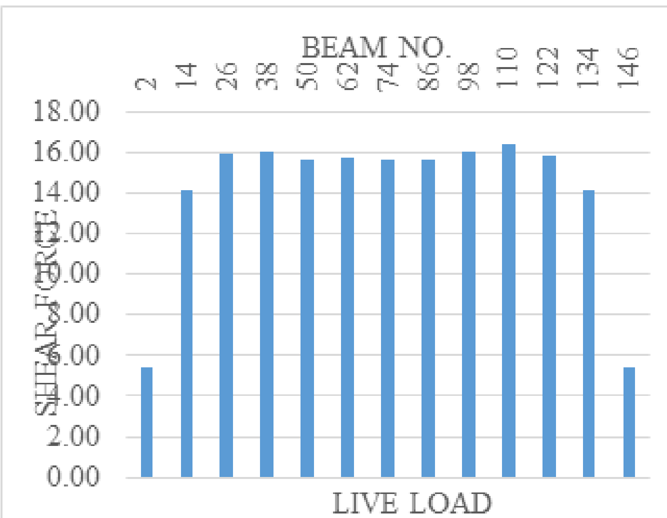


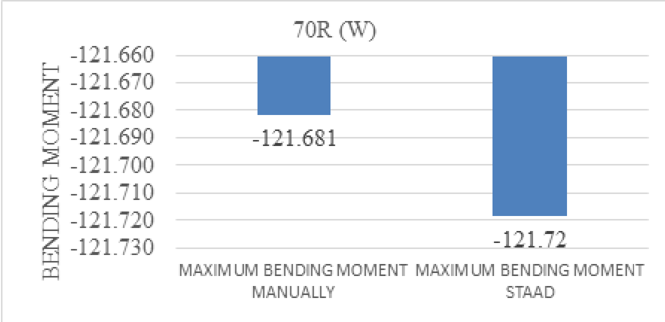
Fig-7 Lane criteria according to IRC

V. RESULT AND DISCUSSION:

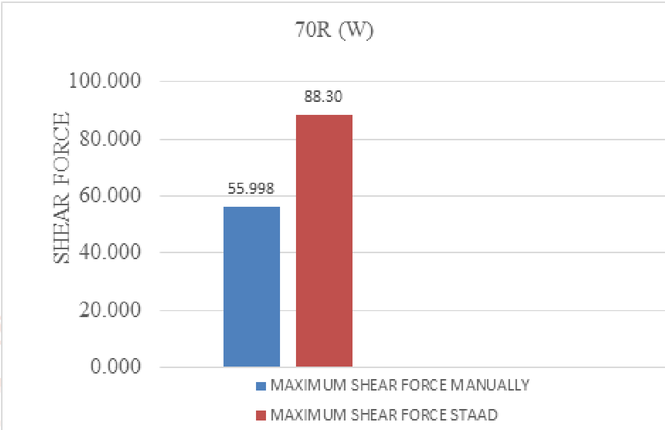
In this study solid deck slab bridge analyzes and design by STAAD-Pro under different loading conditions. And also the analysis results in term of shear, bending moment, axial force and deflection were checked by STAAD-Pro which is passes through many different load combinations. The maximum design moments resulting from the combinations of various loading cases.



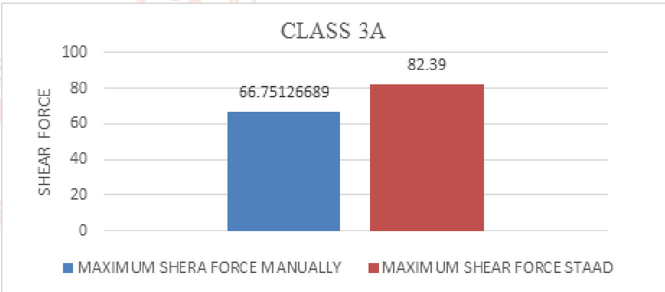
Graph-1 Consider Maximum Shear for Live Load



Graph-2 Comparison between Maximum Bending Moment under 70R



Graph-3 Comparison between Maximum Bending Moment under Class 70R (W)



Graph-4 Comparison between Maximum Bending Moment under Class Class 3A

VI. CONCLUSION:

In this study solid deck slab having 8.2 m long span and the thickness of slab 0.65 m and the slab is simply supported. The bridge analyzes and design by STAAD-Pro under different loading conditions. And also the analysis results in term of shear, bending moment, axial force and deflection were checked by STAAD-Pro which is passes through many different load combinations. The maximum design moments resulting from the combinations of various loading cases.

From the results obtained and graphs drawn for various loading variations it can be concluded that:

- ➢ Analysis and design of the Deck Slab Bridge as per IRC codes (here IRC 70R loading) can be easily done by STAAD. Pro. In connection with STAAD.vi8. Mechanism is well understood.

- The maximum and minimum values for beam maximum forces by section property are computed for axial, shear and bending.
- The effect of vertical loading for 6 traffic lanes showing width, front clearance, rear clearance, no. of axles, positon in x, and position in y with orientation can be determined. The orientation varies from 0 to 1.5708.
- Shear stress at a reference point vary with the variation in position of loads along the longitudinal edge.
- The maximum bending moment occur at center and decreases continuously from center to the edge of the beam
- The maximum shear force occurs at the edge of the beam and decreases continuously toward the center of beam
- Total deformation, bending moment and shear force at a reference point decreases with the reduction in size of beam.

SCOPE FOR FURTHER STUDY

Further research work can be done on this topic i.e., static structural analysis of RCC solid slab using STAAD Pro software such as:

A. Bending behavior and Shear behavior of different type of slab can be done by using STAAD Pro V8i.

B. Seismic or cyclic loading can be applied for the analysis of RCC solid slab using STAAD Pro software.

The analysis and design of consider slab in the study can also perform in another earthquake zone.

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