MODELING AND LOAD ANALYSIS SLAB BRIDGE ON DIU LAKE BRIDGE

Submitted by

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DECLARATION

I'm pleased to declare that this thesis paper is authentic work and is not to be submitted anywhere else. And also, it was not submitted previously. My supervisor Ms. Mardia Mumtaz guided me throughout the writing of the thesis paper.

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CERTIFICATE

The study included under the name **"MODELING AND LOAD ANALYSIS SLAB BRIDGE ON DIU LAKE BRIDGE"** in the thesis is certified by this. At a partial fulfillment of the requirements for the award of the Bachelor of Science in Engineering, Daffodil International University, Department of Civil Engineering Comparative Study. I would like to say that the thesis paper on "Modeling and load analysis slab Bridge on DIU Lake Bridge" was written by **Md Alif Chowdhury Akash** with ID: **201-47-372**. His Project Paper is excellent work. To my knowledge, it is original. To the best of our knowledge, the last statement is true.

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The thesis entitled "**MODELING AND LOAD ANALYSIS SLAB BRIDGE ON DIU LAKE BRIDGE**" submitted by **Md Alif Chowdhury Akash**, ID No: **201-47-372**, Session: Fall 2023 has been accepted as satisfactory in partial fulfillment of the requirements for the degree of **Bachelor of Science in Civil Engineering** on 15th April 2024

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LIST OF ABBREVIATIONS

RCC	Reinforcement Concrete
AASHTO	American Association of State Highway and Transportation officials
DL	Dead Load
LL	Live Load
M	Bending Moment
Fy	Yield Strength
Fu	Ultimate Tensile Strength
PTFE	Polyethylene Terephthalate
LRFD	Load and Resistance Factor Design

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ABSTRACT

The increasing pace of urbanization and infrastructure growth is making complex transportation systems increasingly required. This condition along with additional constraints for aligning the bridges correctly are what allow an increasing number of slab bridges to be built. Slab bridges are commonly employed in rural planning when geometry makes it impossible to build the appropriate bridges. In this paper, the behavioral properties of slab bridges are analyzed and compared with straight bridges using CSI-Bridge Analysis software. At critical places where the slab bridge has an influence, the maximum bending moment, maximum shear force, maximum torsional moment, maximum deflection from dead load, and maximum deflection from live load are all shown. IRC Class Hsn-44 live load Tracked Vehicle and Moving load VECL1 Load case define vehicle class HL-93S, HL-93K, HL-93M, all load case use AASHTO code 2014.The highest tensile forces and sheer are found at the ends and lower portion of slab bridges, where reinforcing steel rods are twisted or roughened. Slab bridges are made up of a single, flat concrete beam known as a slab. The amount of steel and depth are chosen based on the length and live-load capacity of the slab. Powerful Simply supported bridges are made up of horizontal beams connected across a single span, and continuous slab bridges are made up of beams connected over two or more spans. Substructure modules provide support for slab bridges at both ends.

KEYWORDS: Torsional moment, CSI-Bridge analysis, IRC loading, and slab bridge

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CHAPTER I
INTRODUCTION

1.1 General

In Bangladesh concrete is utilized to create the majority of buildings and bridges. It is sometimes referred to be the foundation of the country's infrastructural growth. For building medium and long-span bridges concrete is the perfect material. A bridge is a building designed to allow traffic to cross over a barrier without blocking traffic below. For pedestrians, roadways, railroad tracks etc. A passageway may be necessary. The road, railroad, river, deep valley with or without water etc. Might be the obstacle that needs to be traversed. Bridges play a significant role in the nation's transportation network which supports the growth of the economy, industry and culture. Bridges are vital conduits for traffic and the backbone of our communities.

1.2 Project Description

Daffodil International University Bridge (DIU Bridge) is located at the junction of two village’s dattapara-changao of birulia union under Ashulia police station of savar upazila of Dhaka district. The bridge is very old. This bridge is popularly known as London Bridge. Ashulia's changao-dattapara, kumkumari bazar's industrial factories, living residential areas use water. Rain water flows through this canal and gets mixed with the Turag River through the Nalkandi Bridge.

Due to a lack of regulation the river was filled with waste from many factories. Since Daffodil International University started work on the permanent campus. The bridge has further improved people's transportation. Daffodil International University has done its version of the lake. Currently the bridge is named as daffodil international university bridge. The bridge has undergone some modifications which have made the lake look much more beautiful.

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Fig. 1.1 Location of the DIU bridge google view

Fig. 1.2 View of the DIU lake bridge

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Fig. 1.3 DIU lake bridge east side

Fig. 1.4 DIU lake bridge west side

1.3 Aim

The aim of the study was to investigate and compare current methods in the analysis of Slab bridge structures. DIU Lake Bridge is a very old bridge. We have modeling the bridge in a new way with the exact dimensions of this bridge and tried to do the load analysis.

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1.4 Objectives

This study aims to examine the behavior of cars carrying a moving load while utilizing a concrete slab bridge by analyzing it using CSI Bridge software. A parametric investigation is then conducted on the created bridge model, and its moving load is assessed.

1.5 Scope of Study

The current work focuses on the behavior of slab bridges. The slab length and variable radius of curvatures are the only parameters covered in this study. The bridge's cross section can only be the size of a multicellular rectangular form. Slab bridges are taken into account. Super elevation is not taken into account during modeling. It is examined how many reactions occur, including shear force, bending moment about horizontal axis, bending moment about vertical axis, torsion, deflection, longitudinal stresses, and fundamental frequencies.

The structural modeling and analysis of the slab concrete bridge in this study is conducted using the CSI Bridge 2024 assessment program. This application uses the matrix displacement technique of analysis based on finite element idealization and is commercially accessible to analyze a broad range of bridges. Analysis, both static and dynamic, is included in this tool.

In the final limit state, the bridges modeled in the thesis are exposed to a simplified combination of loads. These loads consist of

- Self-weight and surfacing
- Bridge Railings
- Shrinkage
- Pedestrian Loads
- Earth pressure, including earth pressure increases due to horizontal loading
- Vehicle Loads
- Traffic loads, load models etc.

1.6 Computers and Structures

CSI is a structural and seismic building programming corporation that was founded in 1975 and is based in Walnut Creek, California, with additional offices in New York. SAP2000, CSI-Bridge, ETABS, SAFE, PERFORM-3D, and CSI COL are all included in the fundamental analysis and design programming that CSC offers. As its name implies, CSI-Bridge v24.2.0 is designed for structural analysis and design of several types of bridges, including prestressed i-girder, box girder, and steel girder, curve, and slab bridges.

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1.7 Components of Bridge

The components of the bridge structure are as follows

1. Superstructure: also known as decking this comprises trusses, girders, slabs, etc. This supports the weight that is applied to it and transfers the forces generated by that weight to the substructures.
2. Bearings: These are designed to distribute the load uniformly over the substructure, which might not have enough bearing strength to directly support the load from the superstructure. They transfer the load from the decking to the substructure.
3. Substructure: This includes their foundation; wing walls or returns and piers and abutments.
4. Piers and Abutments: These are the vertical supports for a deck or bearing that are used to transfer the load through the foundation to the bed or earth.
5. Wing walls and Returns: These serve as an extension of the abutments maintaining the approach bank's natural angle of repose in the earth.
6. Foundation: This is intended to transfer the weight from the piers, abutments, wings, or returns and distribute it equally across the strata. This needs to be placed deep enough to prevent it from being undermined and damaged by the scour brought on by the river's flow. Guard rails or curbs are placed over the decking to prevent vehicles or users from falling into the stream and to separate traffic streams, even though the previously mentioned parts are structurally functional.

1.8 Advantages of slab System Bridge

- Cost-effective
- Slab system depth is reduced
- Less concrete and reinforcement are used
- Layout flexibility is enhanced.
- Lower story elevation.
- Quick and simple construction

1.9 Disadvantages of the Slab System Bridge

- The flat slab system has several benefits, but there are also some places nowhere caution and vigilance are required.
- Critical deflection typically occurs in the middle of the slab or middle strip during design. So, it's important to be as certain as possible about the expected deflection when planning the structure's layout.

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- In general brittle (masonry) partitions should not be supported by flat slab systems as this puts them at risk during seismic activity.
- It may also be necessary to take into account the possibility of drop panels interfering with larger mechanical ducting.
- In the vicinity of columns vertical penetrations should be avoided.
- It is necessary to prevent vertical penetrations in the vicinity of columns.

1.10 Problem Statement

Slab bridge for 2 lane urban highway bridge, with the data below
Type of support: simply supported
Length: 21 ft.
Carriageway width: 14 ft.
Concrete grade: 4000 Psi
Materials type: concrete 4000 Psi
Weight per volume: .15 kip
Frame Properties: Concrete 4000 Psi

1.11 Outline of the Thesis

Chapter Ⅰ, I begin by outlining the purpose and theoretical background for load-bearing structure structural analysis. The chapter covers the principles of flat slab bridges. Place and specifics of the slab.
Chapter II includes the design of bridges based on a review of the literature on slab bridges.
Chapter Ⅲ explains modeling and the issues that have been brought up in the literature when creating structural analysis models using CSI Bridge. There is also a brief presentation of issues related to element selection in this chapter.
Chapter Ⅳ describes the analysis and outcomes of various modeling techniques for a flat slab bridge. This chapter covers modeling from a practical perspective, highlighting the variations in structural analysis models and their effects on sectional forces and design. Additionally, succinct analyses of the findings are provided.
Chapter Ⅴ presents discussions and a summary of the findings, along with suggestions for more research.

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CHAPTER-II
LITERATURE REVIEW

(Miriam Guadalupe, 2016) This study examines the suitability of a simplified modeling approach based on grillage modeling strategies for dynamic analysis of simple-span slab-girder skewed bridges. In order to assess the practicality of this method, skew angles between 0° and 60° are examined. Grillage models' capacity to represent vibration modes is contrasted with shell and frame elements in three-dimensional (3-d) finite element (fe) models. The impact of the skew angle on the accuracy of the grillage model related to the orientation of the transverse grillage members (tgms) and the grillage modeling technique of the bridge's deck are examined. The grillage modeling technique reduces the number of degrees of freedom and computational time in the bridge model by eliminating shell elements to model the slab. Despite its simplicity, the technique shows good ability to capture the vibration modes. [6]

(Pravin Jaiswal, 2022) The length of bridges ranges from a few meters to several kilometers. These are some of the most significant buildings that humans have ever created. There are strict requirements for both layout and materials. A bridge must be strong enough to support both the weight of the people and vehicles using it in addition to its own weight. In addition, the shape needs to withstand a variety of natural events, such as strong winds, earthquakes, and temperature fluctuations. Many bridges have an asphalt or concrete path that is used for vehicle and pedestrian traffic, as well as a framework made of concrete, steel, or wood. By adjusting the span of 10 meters, 15 meters, and 18 meters, as well as the span/depth ratio and the number of longitudinal and cross girders, the analysis of a three-span lane T-beam bridge is completed using the software Staad Pro v8i. Bridge styles are subject to the IRC magnificence AA in order to obtain the maximum response, second on the guide, most stresses in the slab, and the most bending and shear force in the girder. Following the loading device, it was determined that the girder's bending moment, deflection, and shear force would all increase along with the slab's stress levels. [9]

(R. A. Miller, 1994) An abandoned skew RC slab bridge was the subject of a destructive test. The upper mat reinforcing bars were visible in the badly deteriorated shoulder sections of this bridge. A single-lane entry for an HS-20-44 truck was replicated through the arrangement of hydraulic cylinders on the test bridge. The findings suggest that the geometry of the bridge and its boundary conditions have a major impact on the behavior of the bridge. Throughout the test, the load path shifted twice as a result of

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shifting boundary conditions and reinforcing bar yielding. A load of 3,200 KN (720 kips), or the axle load of 22 HS-20-44 trucks, caused the slab to fail due to punching shear. The deterioration reduced the punching-shear capacity significantly, but did not appear to affect flexural behavior. Research shows that straightforward modeling techniques, like strip models, overestimate structural demand and underestimate structural supply because they fail to appropriately take slab action and other additional load-carrying mechanisms into account. [10]

(Jun Li, 2015) It is crucial to understand how concrete structures behave dynamically under blast loading conditions because these loads can cause serious structural damage, such as flexural, shear, and concrete spall damage, which can endanger the people and equipment the reinforced concrete structure is meant to protect Ultra-High-Performance-Concrete (UHPC) is a new concrete substance that is being widely explored and used to mitigate blast impacts on civil constructions. UHPC material is well recognized for its excellent workability, high energy absorption capacity, high compressive and tensile strength, and anti-abrasion qualities. A previous research examined the performance of the UHPC slab under blast loads using free air explosion testing. The ability of UHPC to withstand blasts was demonstrated by comparing it with concrete of typical strength. The current study explores and compares the dynamic performance of a UHPC slab under contact charge explosion with that of a regular strength concrete slab under the same loading scenario. Numerical replication is used for both the present contact explosion test and the earlier free air explosion test. In particular, the contact blast tests are simulated by merging the finite element approach with the smoothed particle hydrodynamics (SPH) method, while a finite element model is created to mimic the free air explosion test. Comparing the numerical findings with the experimental data validates the numerical model's correctness and viability. [4]

(Weijian Zhao, 2023) This study uses contact explosion tests with different TNT charge quality to assess the anti-explosive performance of UR50 ultra-early-strength cement-based self-compacting high-strength concrete slabs (URCS). Three types of ultra-early-strength cement-based reinforced concrete slabs with different reinforcing ratios were used in the experiment, with a normal concrete slab (NRCS) serving as the control specimen. The URCS and NRCS require 28 days and 24 hours, respectively, to cure. The results of the study show that URCS prevents explosions more successfully than NRCS. The reinforced concrete slab collapses in a contact explosion, bursting in front forming a crater and spalling in the rear. As the charge increased, the explosive punching and explosive penetration modes of the reinforced concrete slab eventually took over. Based on the trial results, URCS may reach its anti-blast performance 28

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days after 24 hours of curing, and anti-blast performance is not significantly impacted by reinforcement ratio. An empirical formula was created using this data to forecast the crater's width, spalling, and the damage characteristics of the URCS for different healing durations. [14]

(Sandesh Upadhyaya k., 2016) Since T-beam bridges are among the most often used types of bridges, it is essential to continuously research, update, and apply new design and analysis methodologies. They are easy to build and maintain structurally. Because of this, they are chosen over other kinds of bridges for short-distance connectivity. Our study's objective was to ascertain the differences and suitability of two distinct deck slab configurations for these bridges: the standard deck slab supported by girder and the T-beam deck slab configuration. The study has taken into account span lengths of 10, 15, and 20 meters. Conventionally, the deck slab has been examined for IRC class AA loading. Zone III seismic load is applied to the structure. The structure was analyzed using STAAD Pro to determine the maximum bending moment, shear force, and deflection values resulting from the dead load, live load, vehicle load, and seismic load. This allowed for a faster processing time. The final results give us the optimal configuration between the two options for the different span that the study looked at. According to this research, a deck slab with a T-beam configuration is more effective than one with a regular girder support. [13]

(Omkar Velhal, 2016) The need for sophisticated transportation systems has grown along with the rate of urbanization and the quick expansion of infrastructure. The provision of an increasing number of skew bridges is mostly due to this requirement, along with other requirements for correcting the alignment of the bridges. When geometry prevents the design of right bridges, skew bridges are frequently encountered in highway architecture. In this paper, we use Finite Element Analysis software to study and compare the behavioral aspects of skew T-beam bridges with straight bridges. At crucial points, the maximum bending moment, maximum shear force, maximum torsional moment, and maximum deflection from dead load and live load are all impacted by the skew angle. The IRC 6:2000 guidelines are followed when applying Live Load for "IRC Class AA Tracked Vehicle." This study demonstrates that the torsional moment of a longitudinal girder is significantly impacted by the skew angle, indicating that torsional moment should be taken into account when designing skew bridges. [7]

(Rao Jang Sher, July 2020) Due to their capacity to spur national development, bridges rank as the most significant element of any nation's transportation network. A bridge's design is heavily influenced by its intended use, the type of soil strata on which it is

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built, and the materials used in its construction. The use and development of various types of bridges undergo numerous changes due to the substantial increase in both population and traffic. The most often used superstructure for bridges is made up of box and T-beam girders. In order to determine the most appropriate type of bridge superstructure, SAP2000 was used in this research project to analyze and design box and T beam girders. This study's primary goals are to compare the structural behavior, material optimization for each component, and cost comparison of box and T beam girder bridges. While earlier studies in this area used the working stress method, the present study uses a limit state design. In terms of structural stability and cost-effectiveness, a thorough comparison reveals that box girders are preferable to T beam girders, even for shorter spans. [11]

(Saha, 2017) The longitudinal girder of a reinforced concrete T-beam bridge is examined structurally using a novel three-dimensional finite element model that is tested under a two-point loading system. The longitudinal girder is reinforced with steel and shape memory alloy bars, respectively. Super elastic S.M.A. bars replace 25% of the steel bars in the second girder. The ANSYS 11.0 program is used to carry out finite element analysis. A steel reinforced girder model was cast experimentally, and ANSYS prediction was used to verify the model's load deflection responses. The load carrying capacities of the steel reinforced concrete girder and the girder reinforced with S.M.A. and steel are also compared for the model. [12]

(Pavankumar M Naik, 2023) Skew effects can usually be ignored in simple supported bridges up to 15 degrees, at which point the bridge can be built as a right-angled bridge. Because the behavior of skew slab bridges with more than 15 degrees of skewness is complex, research on the behavior of skew-bridge slabs under IRC vehicle loading is done. Using skew angles ranging from 0° to 50° in increments of 10°, approximately 70 distinct deck slab models with widths ranging from 1 to 4 lanes and span lengths of 7.5 and 12 meters are examined in STAAD Pro software. The IRC-6:2017 standard specifications are followed for vehicle loads and placement. The bending moment and deflection in near-edge beams decrease as the skew angle increases, according to the results. In a farer edge beam, the bending moment increases up to a 30° skew, and then the deflection increases. As the skew angle increases, the longitudinal bending moment decreases. The transverse bending moments are more noticeable close to the corners than in the middle. Slabs with a large span and a small width are more concerned with torsion moments. With an increase in skew, deflection diminishes throughout the slab. The slab's maximum deflection moves in the direction of the obtuse corners. [9]

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CHAPTER-III
METHODOLOGY

3.1 Introduction

For parametric studies modeling in CSI Bridge v24.2.0. The first model is a 3d modeling. Slab measuring 21 feet in length. After that various reactions are examined including shear force, bending moments about horizontal and vertical axes, torsion, deflection, longitudinal stresses, and fundamental frequencies.

3.2 Shear Failures

The design shear force needs to be determined conservatively because the shear mode of failure in a bent column or pile will most likely cause the bridge to collapse completely or partially. Plastic hinge locations must be taken into account when calculating the bent shear force of a column. These can appear at both the top and bottom of flared columns. Unless the wall is structurally isolated from the column. The plastic hinges for multiple column bents with a partial-height wall will most likely be located at the top of the wall. The plastic hinge for deeply embedded foundation columns may be located above the pile cap or foundation. The plastic hinge for pile bents might appear above the estimated point of fixity. It is advised to use conservatism when locating potential plastic hinges in order to compute the largest potential shear force for design using the smallest potential column length and the plastic moments due to the consequences of a shear failure.

3.3 Shear Keys

A shear key is a shaped joint made of two prefabricated parts that because of the way the joint is geometrically constructed, can withstand shear. Sections of a flat slab have shear keys available. They fulfill two purposes. When the segments are erected, the first step is to align them. During construction, the second is to transfer the shear force between segments.

3.4 Diaphragms

There is some disagreement regarding the necessity of lateral bracing across bridge girders on straight, precast concrete beam bridges but a diaphragm is one structural component that can do so.

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3.5 Bearing

A bridge bearing is a part that transfers the weights from the deck to the substructure. Allowing for controlled movement in response to changes in temperature or seismic activity and lowering associated stresses. The line separating the superstructure from the substructure is called a bearing.

3.6 Fixed Bearing

Fixed bearings allow rotational movement while blocking longitudinal movement functioning as hinges. The fixed bearing keeps the superstructure from moving away from the substructure units longitudinally.

3.7 Free Bearing

Free pot bearing sliding. Pot bearing with free sliding capability is movable in every direction. A bearing assembly that permits horizontal movement in any direction is created by the addition of PTFE and stainless-steel sliding surfaces between the piston and the sole plate.

3.8 Abutment

The substructure supporting the superstructure at the ends of a bridge span or dam is called abutment. Each end of a single-span bridge has an abutment that supports the span both vertically and laterally. It also serves as a retaining wall to prevent the earthen fill of the bridge approach from moving laterally. The ends of spans on multi-span bridges that are not supported by abutments must be supported by piers.

3.9 Increase in Concrete Strength

The specified 28-day compression strength a low estimate of the strength anticipated in the field is the definition of concrete strength. Conservative concrete batch designs typically produce 28-day strengths that are 20-25 percent higher than expected. As its age's concrete will also get stronger. Experiments conducted on cores extracted from older California bridges constructed during the 1950s and 1960s have consistently produced compression strengths greater than 1.5 f′c. The potential confinement that the transverse reinforcement offers further improves the compression strength of the concrete. Rapid loading brought on by seismic forces may also cause a notable increase in strength or strain rate effect. Considering everything mentioned above the concrete's actual strength during a seismic event is probably going to be much higher than the 28-day strength that was specified. In order to calculate the column over strength resistance it is possible to assume an increased concrete strength of 1.5 f′c.

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3.10 Increase in Reinforcement Strength

The yield strength of almost all reinforcing bars will be greater than the minimum value required sometimes by up to 30% with an average increase of 12%. When computing the column over strength it is reasonable to assume an increased yield strength of 1.25 fy combining this increase with the effect of strain hardening.

3.11 AASHTO LRFD

The AASHTO lrfd suggests classifying vehicle loads into three categories design truck, design tandem, and design lane load. These loads fall into the live load category. These loads are adaptable to fit different design contexts. Along with vehicle loads a uniformly distributed load is applied and carried for pedestrian loads. The aforementioned loads must be correctly combined to get the best results, unlike the Euro code which does not have groups of vehicle loads.

3.12 Line Load

A line load is a hypothetical load that is applied with a line to a model. Forces and moments can be added as line loads to the model. In addition to being defined as a concentrated line load of the line at any point they are typically entered as a force per unit length (e.g. kn/m).

3.13 Carriageways

One can refer to the design lane width and number of lanes planned by the road planning department as bridges are frequently included in road projects. On the other hand, the design standard offers an equation that uses the total road width and the design lane width to calculate the total number of lanes.

3.14 Dead Loads and Live Loads

A bridge's main purpose is to support trains, automobiles, and large trucks. Traffic loading needs to be estimated by engineers. The maximum possible load may be carried over short spans. That is four heavy trucks may cross simultaneously two in each direction on spans shorter than thirty meters (100 feet). The maximum possible load on longer spans of a thousand meters or more is so unlikely that it would be unjustifiable to design for it. As a result, engineers base their designs on likely loads.

3.15 Dead Load

The self-weight of the bridge's components is all that makes up the dead load. The deck slab, coat rails, parapet, stiffeners, and other utilities are among the various components of a bridge. It is the first design load that must be determined when designing a bridge.

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3.16 Live Load

The bridge's live load is the load that moves over its whole length vehicles, pedestrians, and other moving loads are present. But choosing one or more vehicles to include in the design of a safe bridge can be challenging. Thus, the IRC suggested using a few fictitious vehicles as live loads in order to provide safe outcomes when dealing with any kind of vehicle that moves across the bridge.

3.17 Vehicle Loads

According to each nation's unique design requirements different vehicle loads are suggested for highway bridge designs. First of all, there are numerous kinds of cars that come in a variety of sizes and shapes. For this reason, the load on the real vehicle is applied as a Design load but is modeled as a notional load. The term "design truck load" refers to a model that represents the impact of a single vehicle (or another vehicle load). The modeling effect when these vehicles are carried is called a design lane load even though the load is less than the design truck load. Whereas a lane load is expressed as a uniformly distributed load a truck load is primarily expressed as a concentrated load acting on each wheel.

AASHTO code HS-20-44 refers to a highway semi-trailer truck with a total nominal tonnage of 20 tons.

3.18 Pedestrian Loads

A pedestrian load is equal to one person's weight. Another name for it is crowd load. Because of the features of an individual's gait loads are transmitted not only vertically but also transversely. Although the load is not as heavy as it would be on a car or train. Care must be taken when a large number of people are up on a bridge. The reason for this is that a resonance phenomenon takes place when a person's gait and the natural frequency of a bridge coincide greatly vibrating the bridge.

3.19 Bridge Railings

The most popular material for building bridges is concrete. To build a robust vehicle barrier concrete railing are fastened to the deck slab of the bridge. For urban areas or bridges that are frequently subjected to large truck loads concrete railings are the ideal option. The initial cost of building concrete railings is relatively high. In certain cases, large concrete railings can obstruct a view of an open road. In these circumstances a tubular railing system can be coupled with highly durable concrete railings.

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3.20 Main and Typical Parts of Bridges

This section aims to give a clear picture of the major components and typical components of a bridge structure. It is essential for a deeper comprehension of the following section which discusses the characteristics of the bridge. The definition of bridge elements is identifiable portions of a bridge made of the same material having a similar role in the performance of the bridge and expected to deteriorate in a similar fashion.

The four primary components of a bridge structure are the superstructure, substructure, foundation and other basic elements. One of the three main sections may contain elements from the fourth part, other fundamental components.

1. Superstructure: "Superstructure comprises girders a deck and a slab and is the portion of the structure that supports traffic." A superstructure is made up of all the components of the bridge that are supported by a system.
2. Substructure: "substructure" refers to the portion of the structure such as piers and abutments that support the superstructure and transmit the structural load to the foundations.
3. The foundation: This part is responsible for moving loads from the substructure to the bearing strata. The bearing strata's geotechnical properties determine whether shallow or profound foundations should be used. Usually piles and well foundations are used for bridge foundations.
4. Additional fundamental components “The Bridge’s deck is directly assisting traffic loads." The way that the deck distributes weight to the girders depends on the kind of decking that is being used.
5. Span: "The dividing in the form of columns, towers as well as a ravine wall among the two bridges helps"
6. Beam: Beam refers to "A rigid part of construction that's generally straight."
7. Beam/ Girder: A beam or girder constitutes a superstructure element that runs the length of its span. The load-bearing section keeps the deck in place.
8. Bearings: "Bearings are used to move loads from the girders onto the pier caps."
9. Pier: "A straight structure that provides support including a pillar."
10. Headstock/pier cap" What moves weight through the superstructure to its piers is called the pier cap or headstock. The pier caps provide sufficient seating for the bridge girders.
11. Pile cap and Piles: "Pile foundation is the most widely used foundation system for crossings. A pile is a small, load-bearing piece of compression goods that is shaped or driven to the ground. A pile cap is a reinforced concrete mass that is placed over the top of a group of piles to ensure that they act as a unit and forward the load among themselves.

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3.21 Problem formulation

21 ft. long concrete slab bridge
Carriageway width: 14 ft. wide
Slab depth 6 in
Total Lane 2

Lane 1: 7ft off set 3.5 ft. lane width 7 ft.
Lane 2: 7ft off set 3.5 ft. lane width 7 ft.

(To facilitate the operation of the software)
Materials Properties: 4000 psi
Materials Type: Concrete
Frame Properties: Concrete, Rectangular section

3.21.1 Abutment Properties

The abutments consist of rectangular concrete pieces that are 1.28 feet wide and 14 feet deep. The bearings sustain the Beam length of 14 feet at the abutment, and they also rest over the foundation springs.

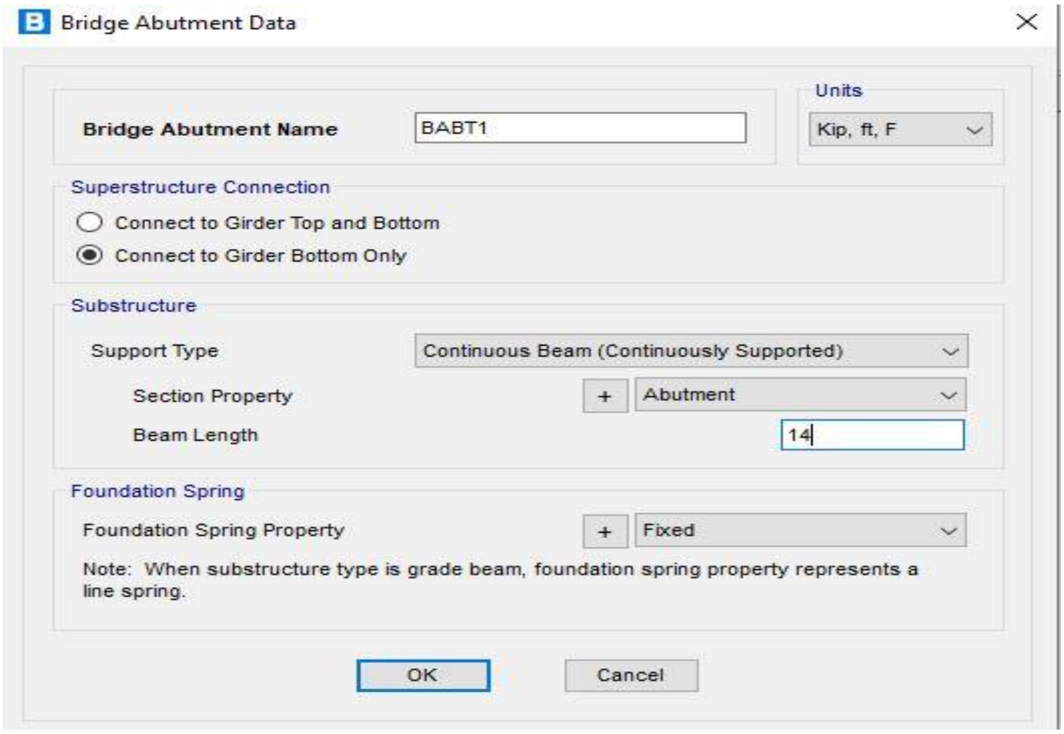

Fig. 3.1 Abutment properties

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3.21.2 Section Properties

Bearings: The abutments at the extremities of the bridge have them positioned beneath the girder top. All other directions are free for movement, with the exception of the vertical and normal transition to the layout line.

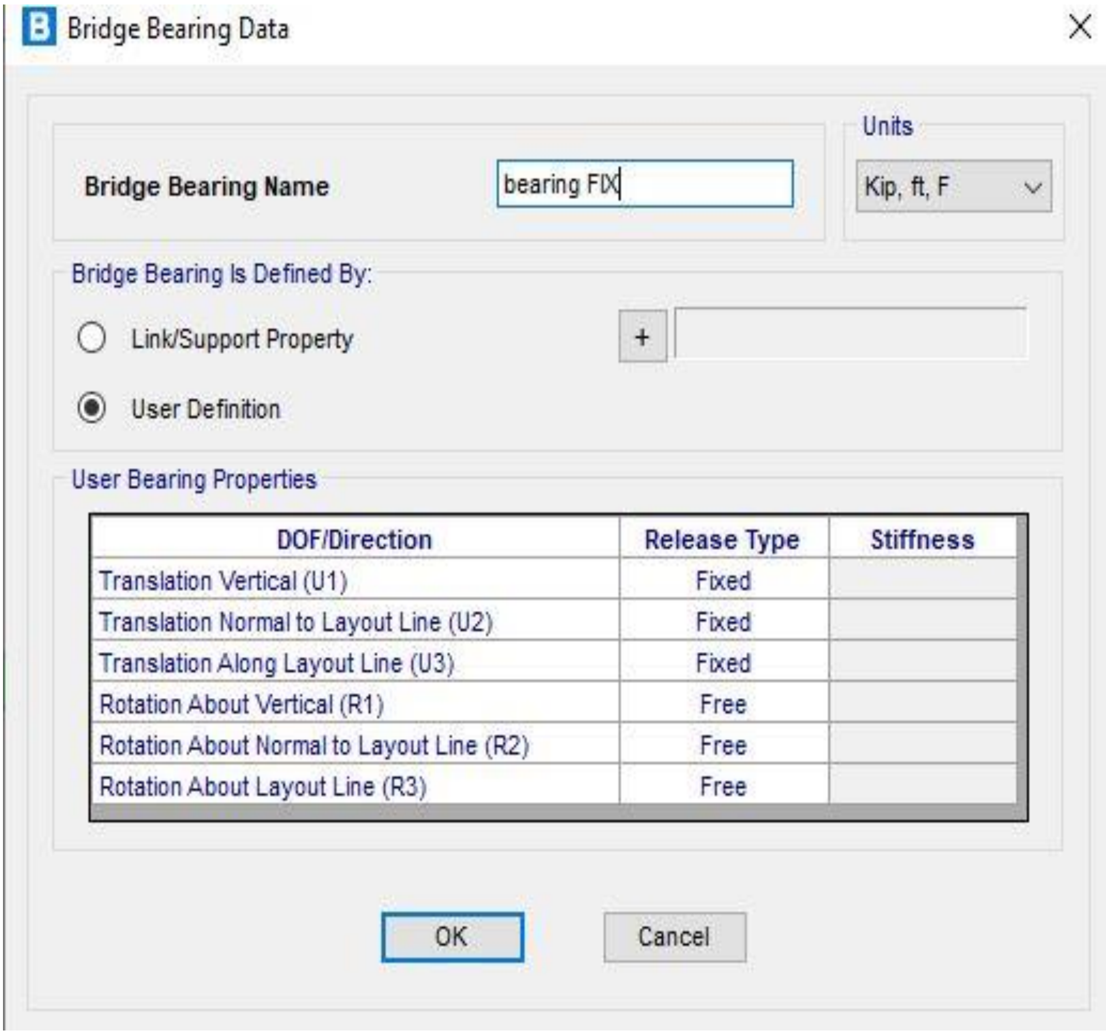

Fig. 3:2 Bearing fix

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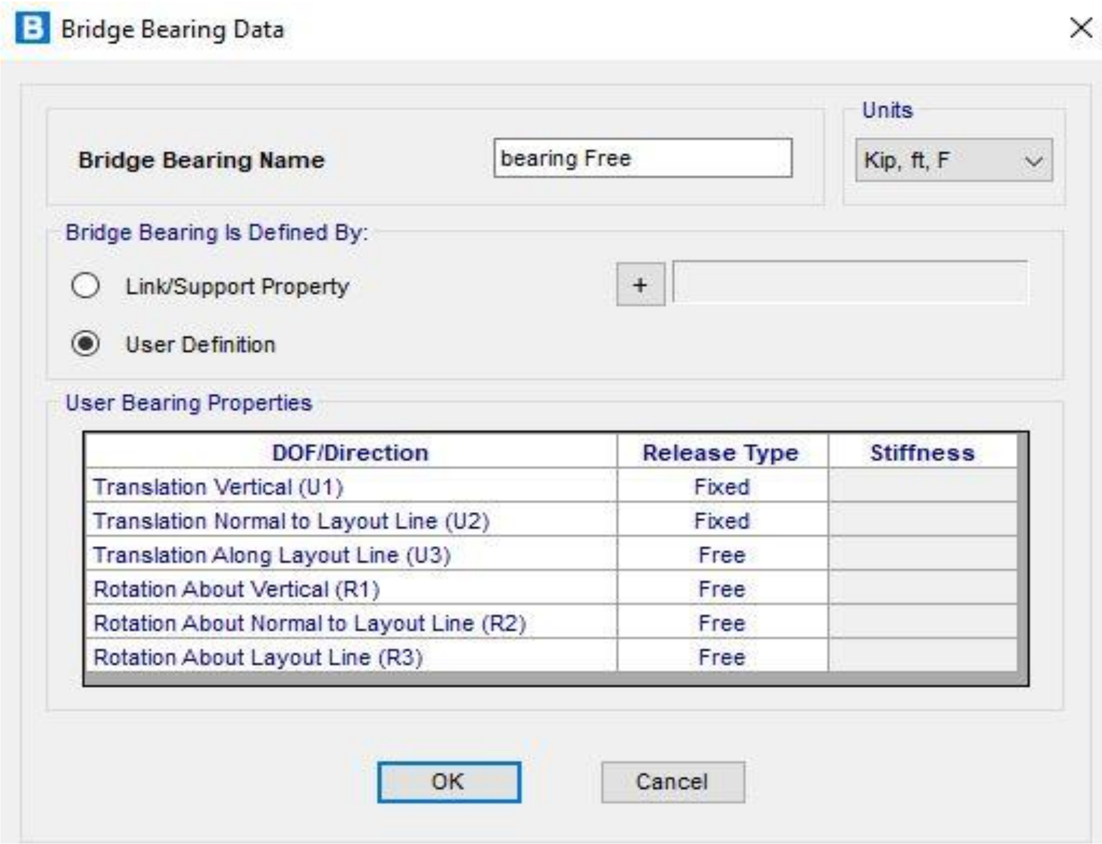

Fig. 3.3 Bearing free

Foundation springs: They are fixed in all 6 degree of freedom.

3.21.3 Material Properties

Table 3.1 Material properties

Material	Unit Weight (kcf)
Lightweight	0.110
Sand-Lightweight	0.120
Normal Weight with $f'c \leq 5.0$ ksi	0.145
Normal Weight with $5.0 < f'c \leq 15.0$ ksi	$0.140 + 0.001 f'c$
Loose Sand, Silt, or Gravel	0.100
Soft Clay	0.100
Steel	0.490

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Stone Masonry		0.170
Water	Fresh	0.0624
	Salt	0.0640

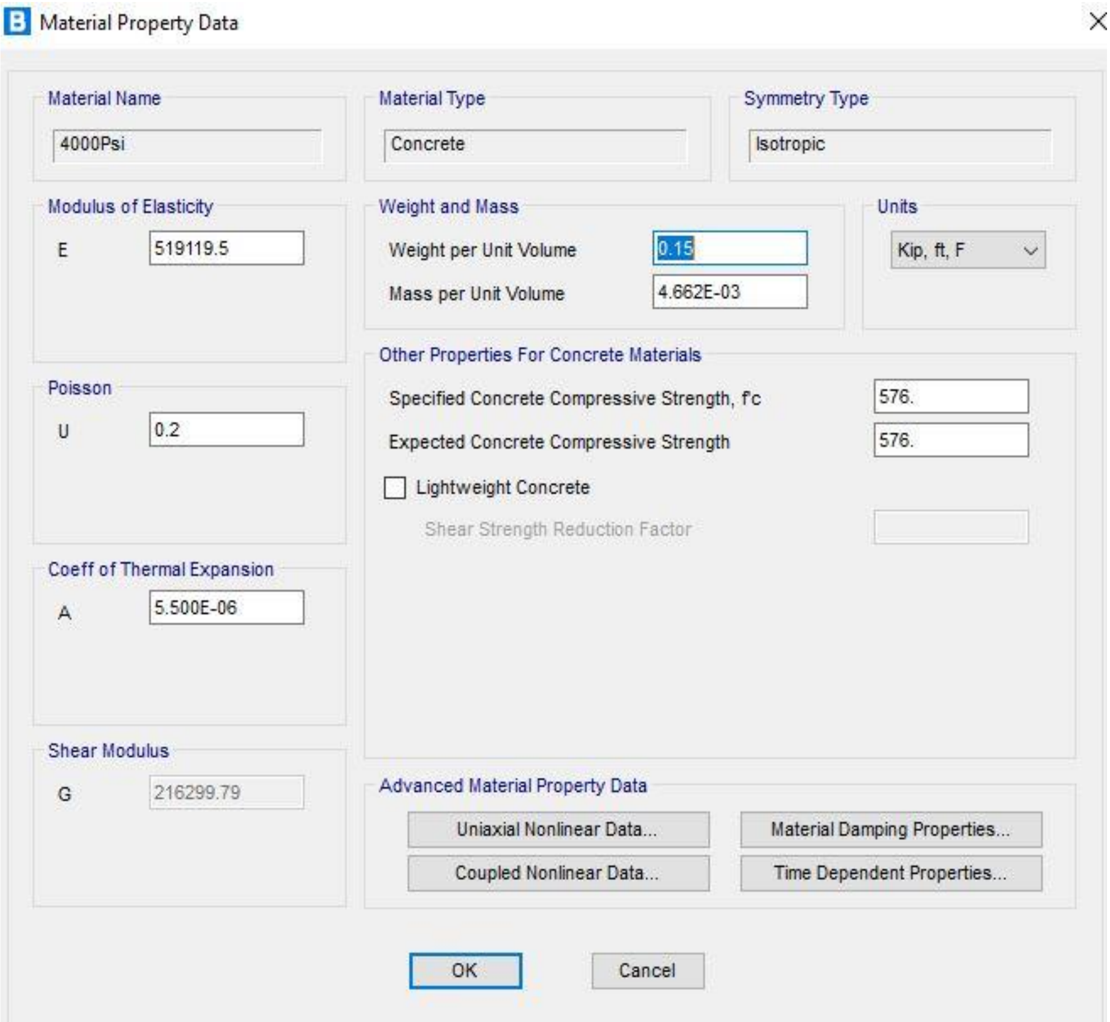

Fig. 3.4 Materials property data

3.22 Modelling of Bridge using CSI-Bridge Software

CSI Bridge v24.2.0 software is used for the bridge's modeling and analysis. The following lists the steps that went into making the model.

3.22.1 Bridge Window

A bridge window will appear when you click on the "CSI-Bridge v24.2.0" icon. To generate a window, open a new file. A variety of pre-set bridge models will show up

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when create a new template from the file menu. To design the bridge model, pick a blank page and the units Kip, ft., and F.

3.22.2 Reference Line

The configuration of lanes and bridge objects is specified by reference lines. Super elevations and skews are taken into consideration while defining the plan in terms of stations, bearings and grades.

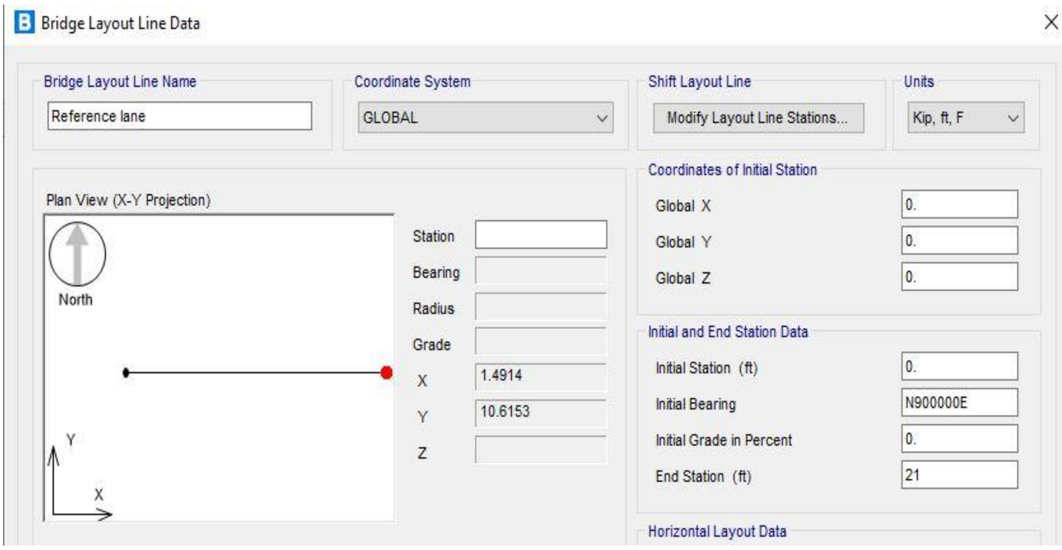

Fig. 3.5 Reference line

3.22.3 Layout Lines

Layout lines, or line objects and lanes, are the initial stage in defining a bridge object. The horizontal alignment of different stations is defined by the layout line, an orientation line. At twenty-one feet, we shall choose our endpoint.

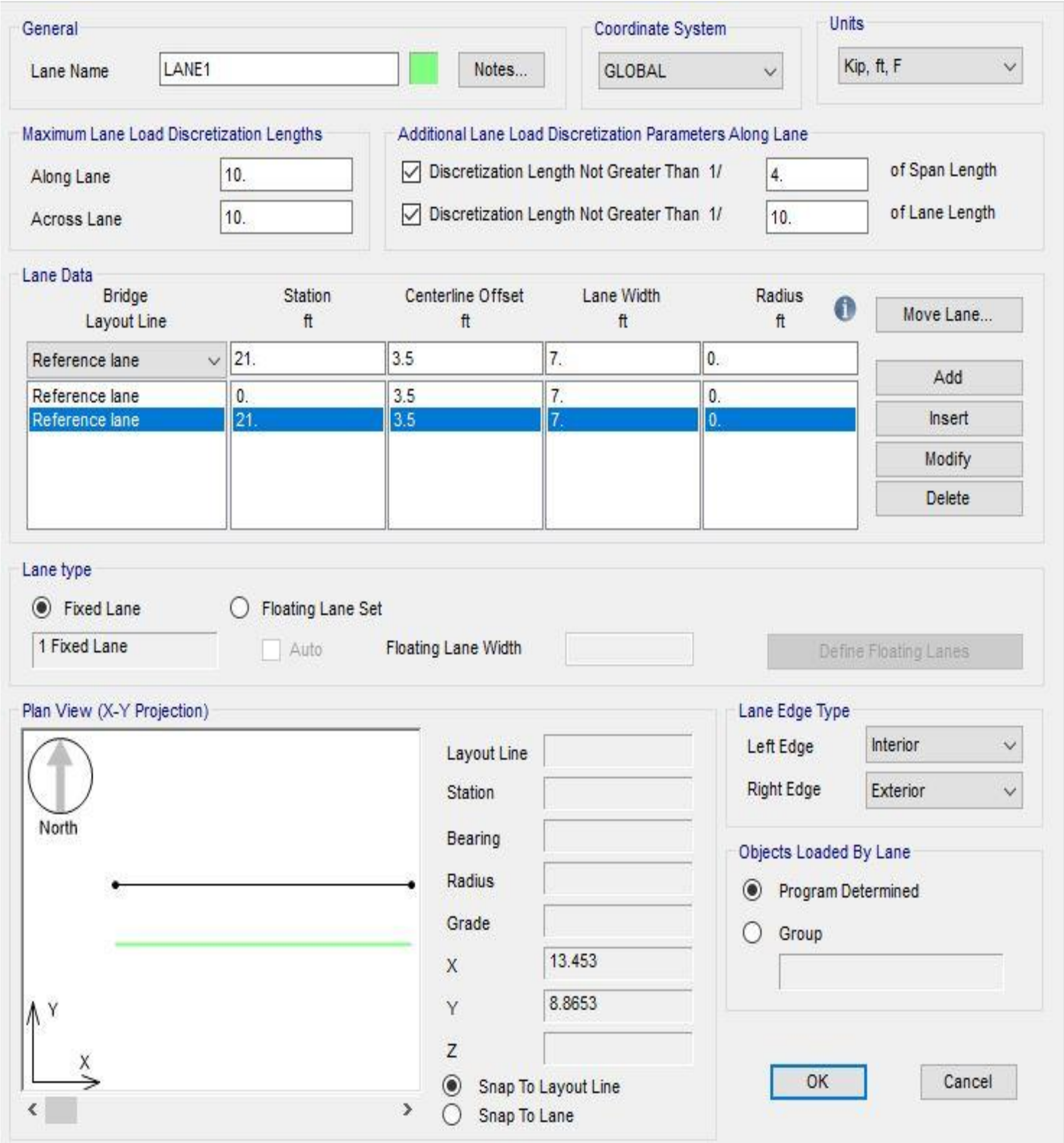
General
Lane Name
LANE1
Notes...
Coordinate System
GLOBAL
Units
Kip, ft, F
Maximum Lane Load Discretization Lengths
Along Lane
10.
Across Lane
10.
Additional Lane Load Discretization Parameters Along Lane
Discretization Length Not Greater Than 1/
4.
of Span Length
Discretization Length Not Greater Than 1/
10.
of Lane Length
Lane Data
Bridge Layout Line
Station ft
Centerline Offset ft
Lane Width ft
Radius ft
Move Lane...
Reference lane
21.
3.5
7.
0.
Reference lane
0.
3.5
7.
0.
Reference lane
21.
3.5
7.
0.
Add
Insert
Modify
Delete
Lane type
Fixed Lane
Floating Lane Set
1 Fixed Lane
Auto
Floating Lane Width
Define Floating Lanes
Plan View (X-Y Projection)
North
Y
X
Layout Line
Station
Bearing
Radius
Grade
X
13.453
Y
8.8653
Z
Snap To Layout Line
Snap To Lane
Lane Edge Type
Left Edge
Interior
Right Edge
Exterior
Objects Loaded By Lane
Program Determined
Group
OK
Cancel

Fig. 3.6 line 1

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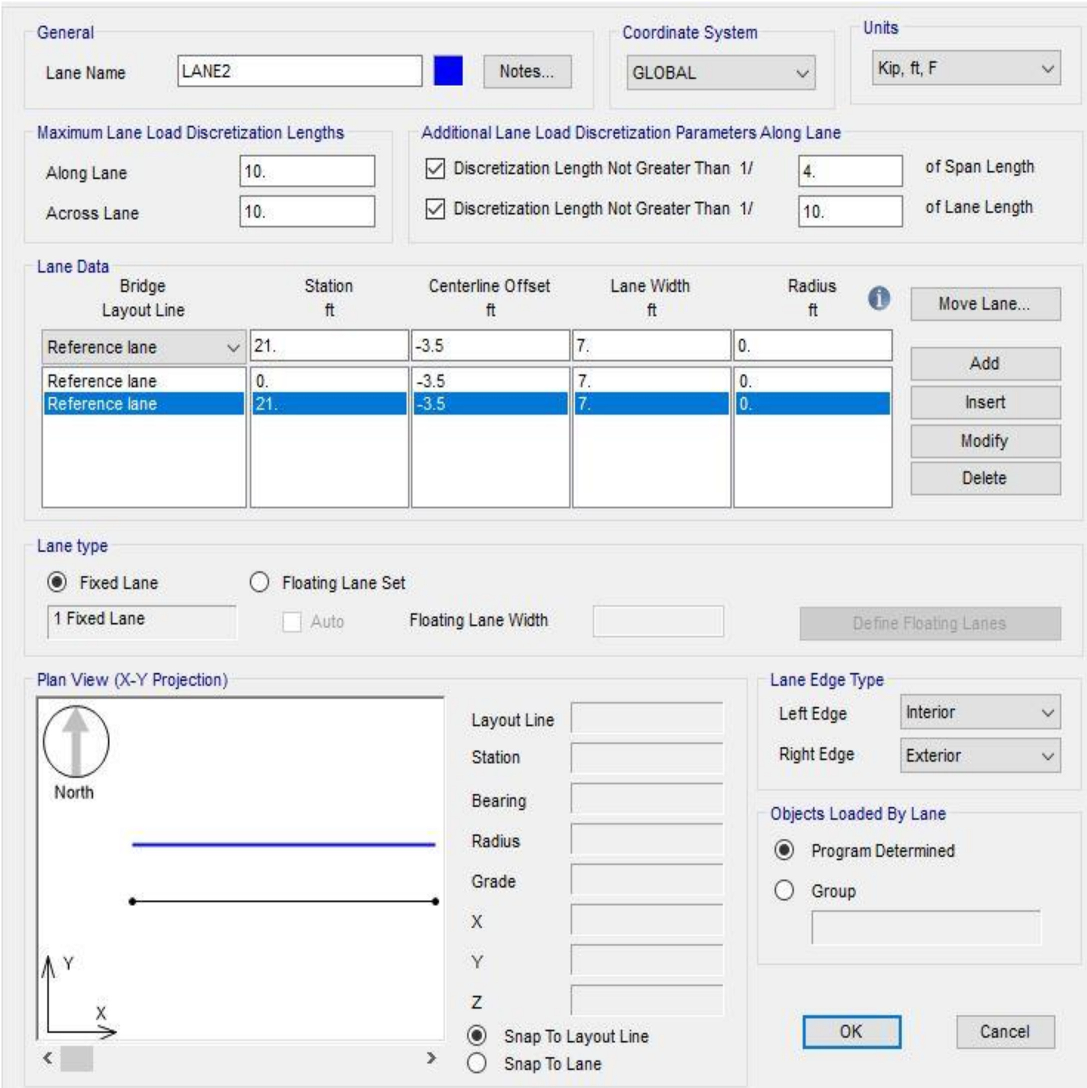

Fig. 3.7-line 2

3.22.4 Number of Design Lanes

Compute the integer part of the ratio w/12, as is commonly advised. Where w is the clear width of the road, measured in feet, between obstacles and curbs. To calculate how many design lanes are needed. The operational or structural clear highway width of the bridge may change in the future; thus, this should be considered.

When the width of the traffic lane is less than 12.0 feet, the number of design lanes should equal the number of traffic lanes, and the width of the design lane should be the same as the width of the traffic lane. For convenience of use, we created two lanes. (AASHTO, 2012)

Table 3.2 Multiple Presence Factors

Number of Loaded Lanes	Multiple Presence Factors, m
1	1.20
2	1.00
3	0.85
>3	0.65

(AASHTO, 2012)

3.22.5 Bridge Component

The superstructure and substructure material properties are what make up the bridge components in the bridge wizard option. It lets us choose the kind of material that will be used for the bridge. Deck sections can be measured in accordance with our blueprint. It also includes bents, foundation springs, bearings, actuators, and diaphragms, among other things. We will gradually add more information to the component section.

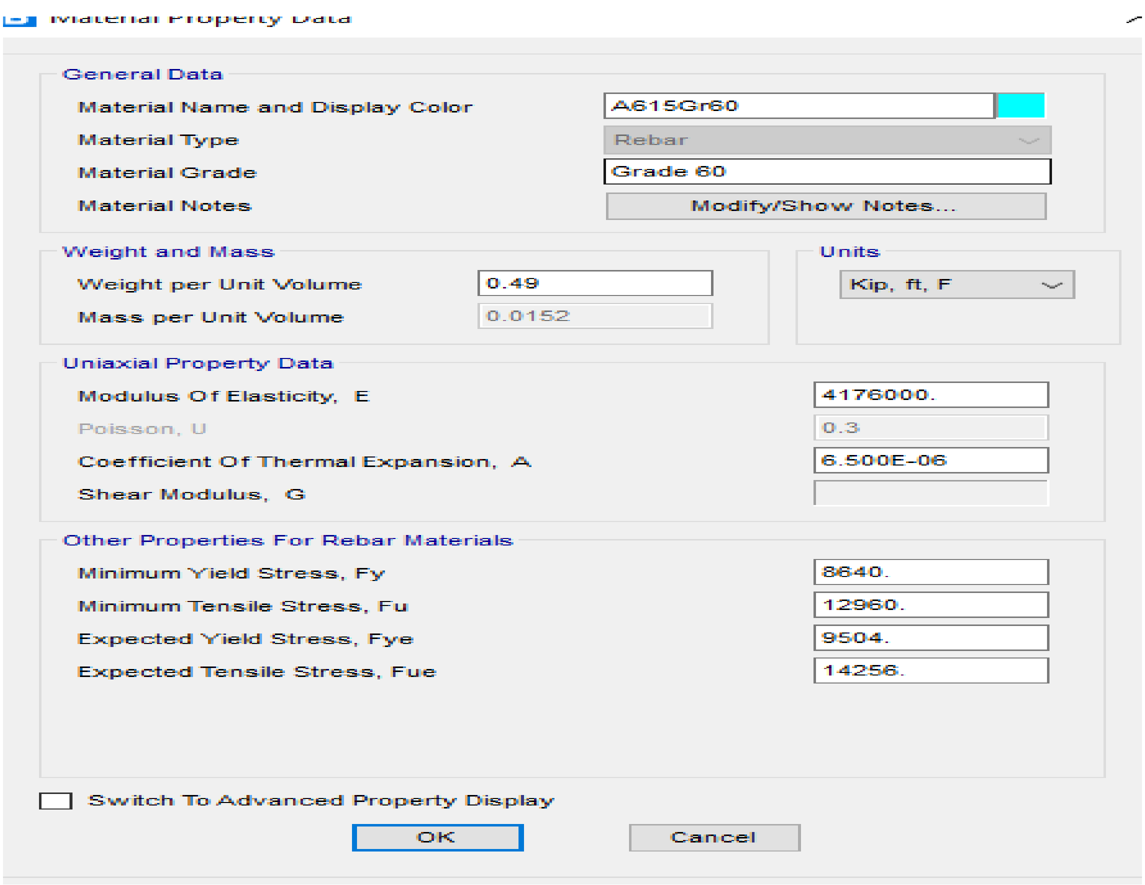

Fig. 3.8 Materials properties

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3.22.6 Bridge Objects

It is the last stage in building a model of a bridge. It includes specifying the section the abutment orientation the number of cross-sections and other information. We must click the update button and choose "Update as Area model" after finishing this menu. This will display all of the data entered in the tabs in the bridge.

Fig. 3.9 bridge deck section type

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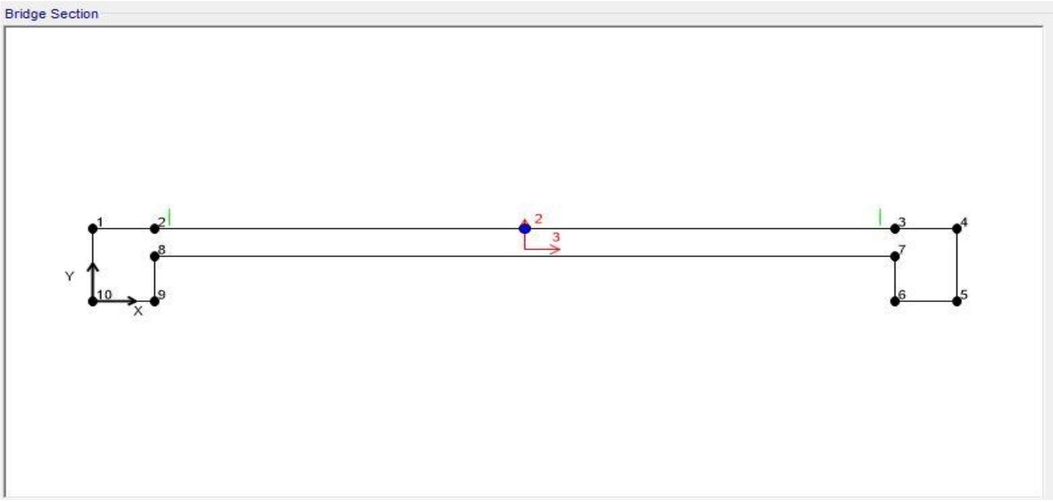

Fig. 3.10 bridge section

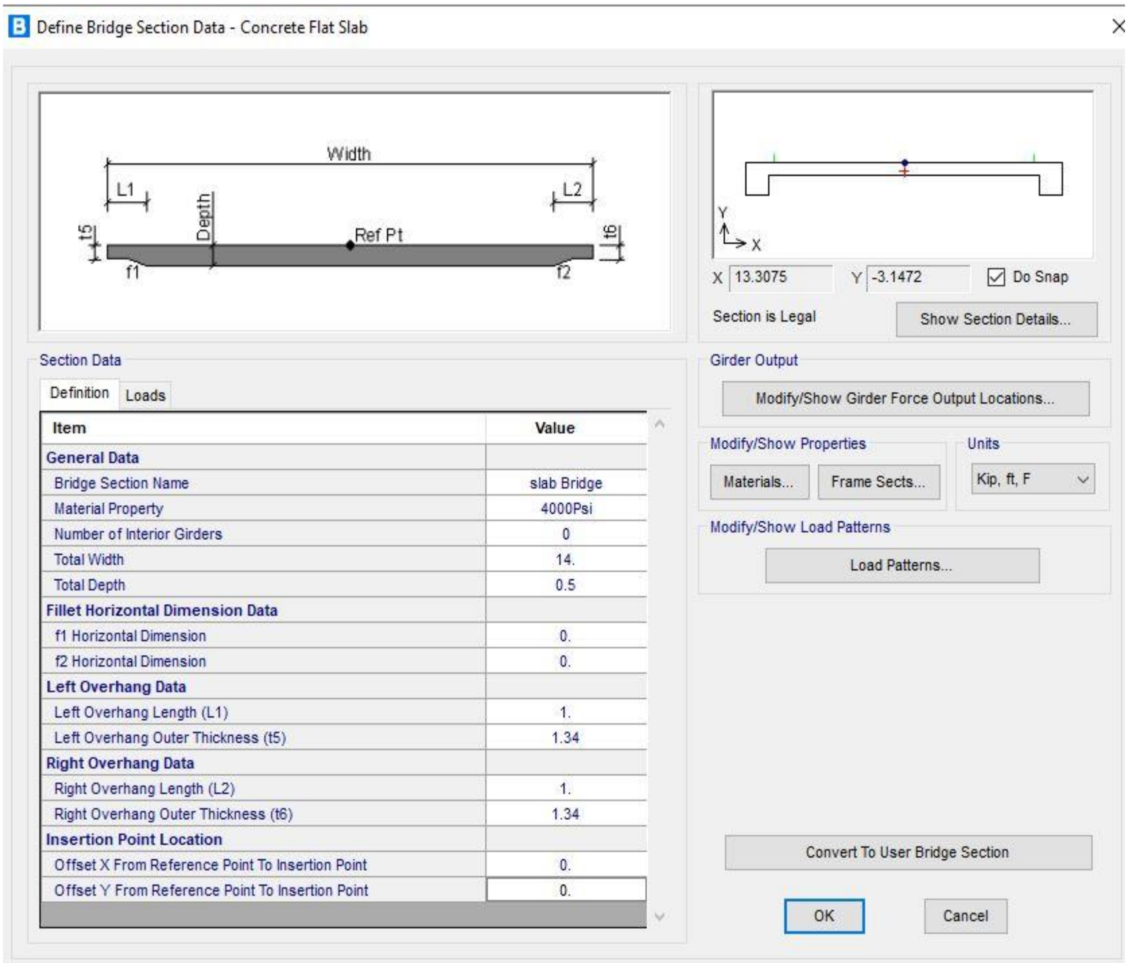

Fig. 3.11 Slab section properties of the bridge

Table 3.3 Slab section properties of the bridge

Items	Value
Bridge section name	Slab bridge
Material property	4000 psi
Total width	14
Total depth	.5
Fillet horizontal dimension data	
F1 horizontal dimension	0
F2 horizontal dimension	0
Left overhang data	
Left overhang length L1	1
Left overhang outer thickness T5	1.34
Right overhang data	
Right overhang length L2	1
Right overhang outer thickness T6	1.34

3.22.7 Loads

This section includes the addition of loads and load patterns. A vehicle class related to HSn-44 categories must be imported first. Also included in this tab dead loads. Both the left and right sides of the deck require the addition of line loads.

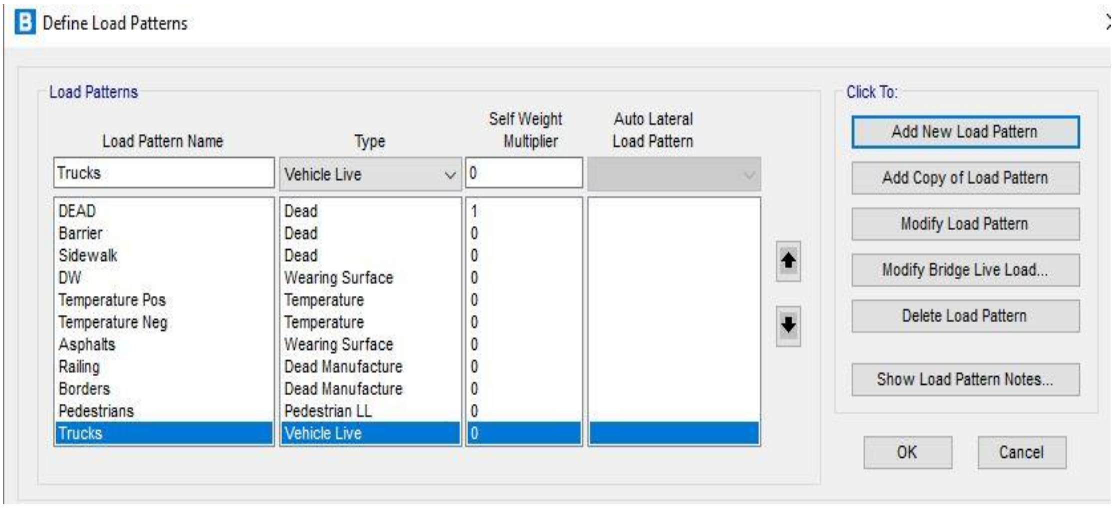

Fig. 3.12 Load pattern

3.22.8 Modeling of Slab Bridge

Fig. 3.14 3D view of slab Bridge , Fig. 3.15 3D YZ view plan 225 deg Elevation 35 deg, aperture30 deg of slab Bridge, Fig. 3.16 3D XY view plan 225 deg Elevation 35 deg, aperture30 deg of slab Bridge, Fig. 3.17 3D XZ view plan 225 deg Elevation

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35 deg, aperture 30 deg of slab Bridge, Fig. 3.18 3D YZ view plan 225 deg Elevation 35 deg, aperture30 deg of slab Bridge

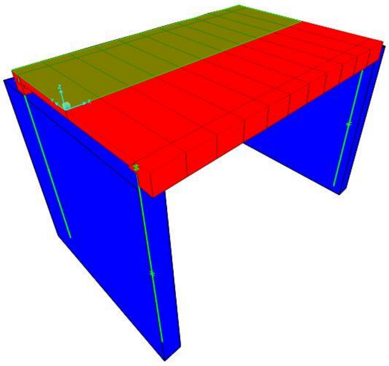

Fig. 3.13 3D view

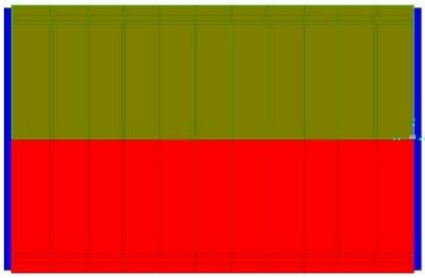

Fig. 3.14 3D YZ view

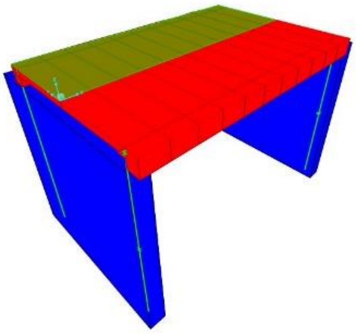

Fig. 3.15 3D XY view

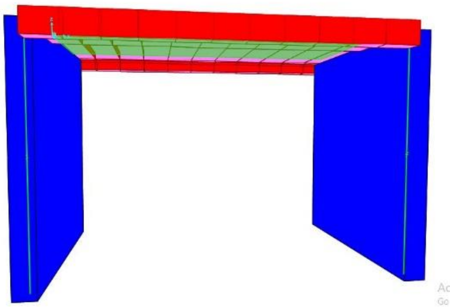

Fig. 3.16 3D XZ

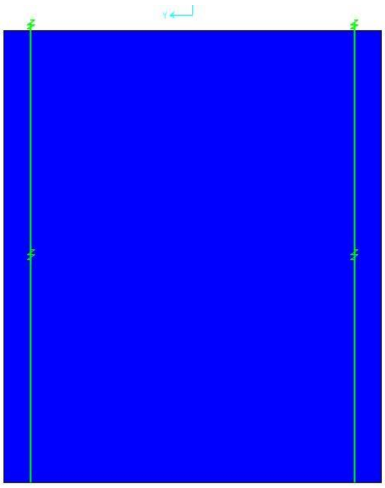

Fig. 3.17 3D YZ view

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CHAPTER-IV
ANALYSIS OF RESULTS AND DISCUSSION

4.1 Introduction

AASHTO code dead load and moving load analyses are performed on the slab bridge models. The following results were obtained during analysis Torsion (T), Axial Force (P), Shear Force Vertical (V2), Shear Force Horizontal (V3), Moment about Vertical Axis (M2), Moment about Horizontal Axis (M3), and Torsion (V) (respectively for AASHTO)

4.2 Analysis

The analyzing the concrete slab bridge the following load cases will be taken into account.

1. The structure's load is known as the dead load case.
2. After the vehicle class is created moving load case is applied to all lanes with a factor of one.
3. Modal load case is taken into account later on in the analysis, but for now
4. In additional research.
5. Truck or vehicle load case

4.3 Modeling and Load Apply

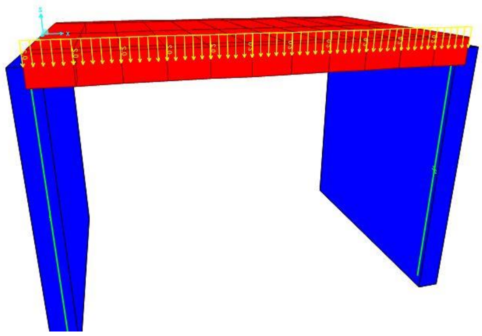

Fig. 4.1 Side walk load

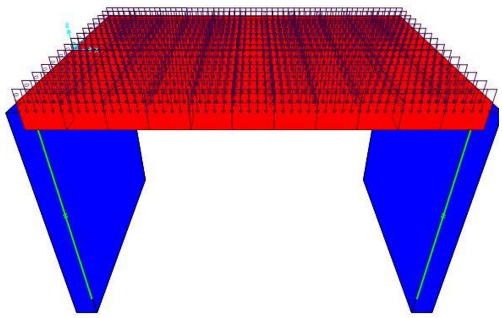

Fig. 4.2 Pedestrians load

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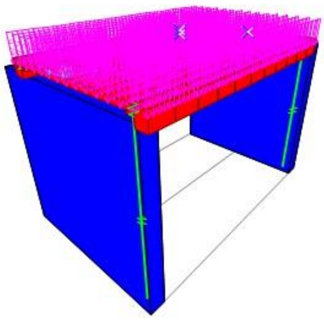

Fig. 4.3 Asphalts load

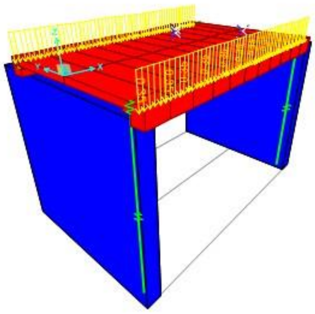

Fig. 4.4 Barrier load

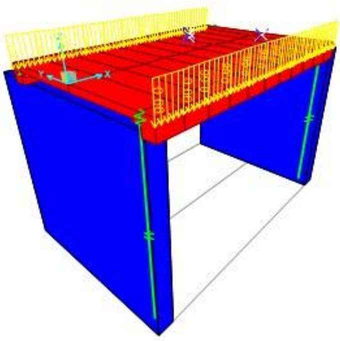

Fig. 4.5 Railing load

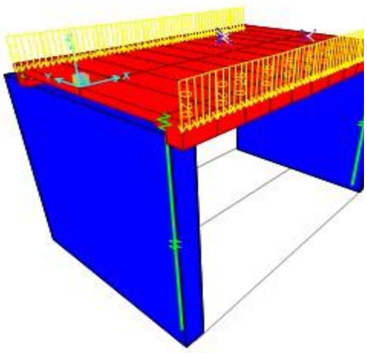

Fig. 4.6 Border load

4.4 Result of analysis

4.4.1 Response display to Moving load (AASHTO)

Axial Force (P), Shear force vertical (V2), Shear force Horizontal (V3), Moment About Vertical Axis (M2) , Moment About Horizontal Axis (M3) Torsion (T) obtained during analysis (respectively for AASHTO)
Generated by software CSI-Bridge

Table 4.1 Moving load

Layout Line Distance	Item Type	P	V2	V3	T	M2	M3
ft.		Kip	Kip	Kip	Kip-ft.	Kip-ft.	Kip-ft.
0	Max	0	0	21.666	285.2096	4.46E-08	2.69E-07
0	Min	0	-120.524	-16.934	-222.7678	-9.05E-09	-6.24E-09
1.9	Max	0	0	21.666	285.2096	32.175	228.9956

`

1.9	Min	0	-120.524	-16.934	-222.7678	-41.166	-4.94E-09
1.9	Max	0	7.921	21.666	252.0362	32.175	228.9956
1.9	Min	0	-106.279	-16.934	-195.9953	-41.166	-4.94E-09
3.8	Max	0	7.921	21.666	252.0362	64.35	407.6437
3.8	Min	0	-106.279	-16.934	-195.9953	-82.3321	-3.74E-09
3.8	Max	0	16.063	21.666	220.0249	64.35	407.6437
3.8	Min	0	-92.253	-16.934	-178.345	-82.3321	-3.74E-09
5.7	Max	0	16.063	21.666	220.0249	96.525	535.9444
5.7	Min	0	-92.253	-16.934	-178.345	-123.4981	-3.51E-09
5.7	Max	0	24.754	21.666	196.3334	96.525	535.9444
5.7	Min	0	-78.448	-16.934	-173.9628	-123.4981	-3.51E-09
7.6	Max	0	24.754	21.666	196.3334	128.6999	613.8976
7.6	Min	0	-78.448	-16.934	-173.9628	-164.6641	-3.09E-09
7.6	Max	0	37.667	21.666	187.9677	128.6999	613.8976
7.6	Min	0	-64.863	-16.934	-176.0946	-164.6641	-3.09E-09
9.5	Max	0	37.667	21.666	187.9677	160.8749	641.5033
9.5	Min	0	-64.863	-16.934	-176.0946	-205.8302	-2.64E-09
9.5	Max	0	50.801	21.666	182.3798	160.8749	641.5033
9.5	Min	0	-51.498	-16.934	-180.9893	-205.8302	-2.64E-09
11.4	Max	0	50.801	21.666	182.3798	193.0499	641.5616
11.4	Min	0	-51.498	-16.934	-180.9893	-246.9962	-2.57E-09
11.4	Max	0	64.154	21.666	176.5013	193.0499	641.5616
11.4	Min	0	-38.353	-16.934	-185.6579	-246.9962	-2.57E-09
13.3	Max	0	64.154	21.666	176.5013	225.2249	616.6057
13.3	Min	0	-38.353	-16.934	-185.6579	-288.1622	-1.74E-09
13.3	Max	0	77.728	21.666	172.3327	225.2249	616.6057
13.3	Min	0	-25.428	-16.934	-192.488	-288.1622	-1.74E-09
15.2	Max	0	77.728	21.666	172.3327	257.3999	541.3024
15.2	Min	0	-25.428	-16.934	-192.488	-329.3283	-3.51E-09
15.2	Max	0	91.521	21.666	176.1834	257.3999	541.3024
15.2	Min	0	-16.497	-16.934	-212.2077	-329.3283	-3.51E-09
17.1	Max	0	91.521	21.666	176.1834	289.5749	415.6516
17.1	Min	0	-16.497	-16.934	-212.2077	-370.4943	-4.33E-09
17.1	Max	0	105.535	21.666	190.2694	289.5749	415.6516
17.1	Min	0	-8.344	-16.934	-244.7713	-370.4943	-4.33E-09
19	Max	0	105.535	21.666	190.2694	321.7498	239.6533
19	Min	0	-8.344	-16.934	-244.7713	-411.6603	-5.46E-09
19	Max	0	119.827	21.666	217.9365	321.7498	239.6533
19	Min	0	0	-16.934	-279.0718	-411.6603	-5.46E-09
21	Max	0	119.827	21.666	217.9365	355.6182	2.21E-07
21	Min	0	0	-16.934	-279.0718	-454.993	-5.94E-08

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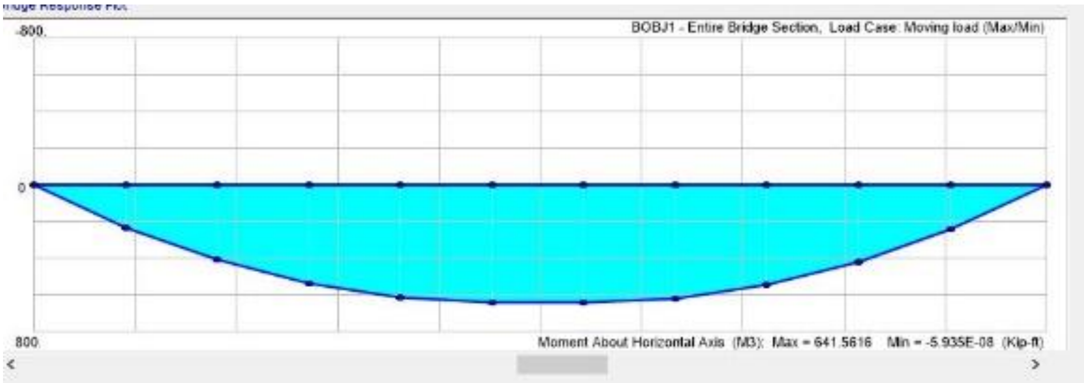

Fig. 4.7 M3 max min

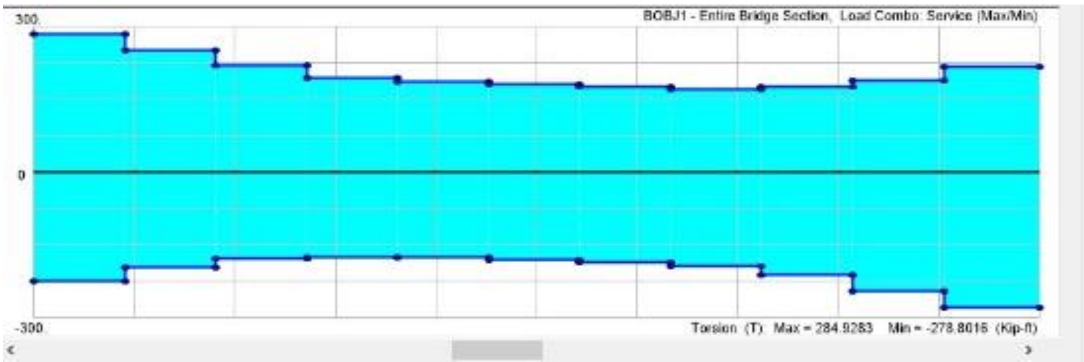

Fig. 4.8 Torson max min

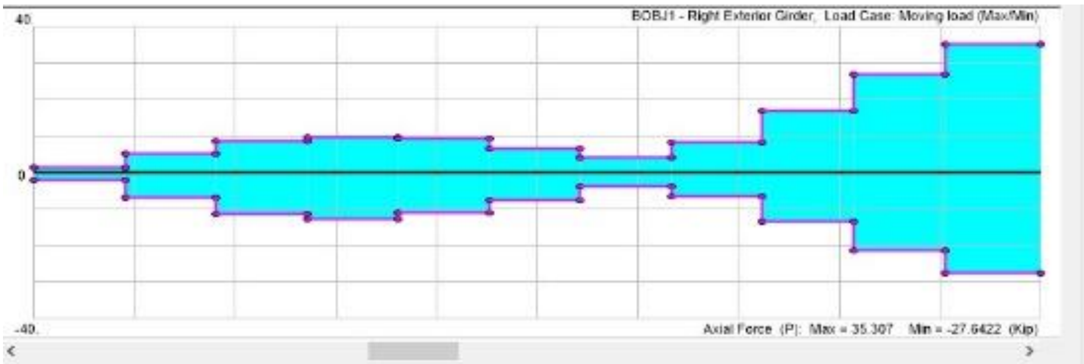

Fig. 4.9 Axial force max min

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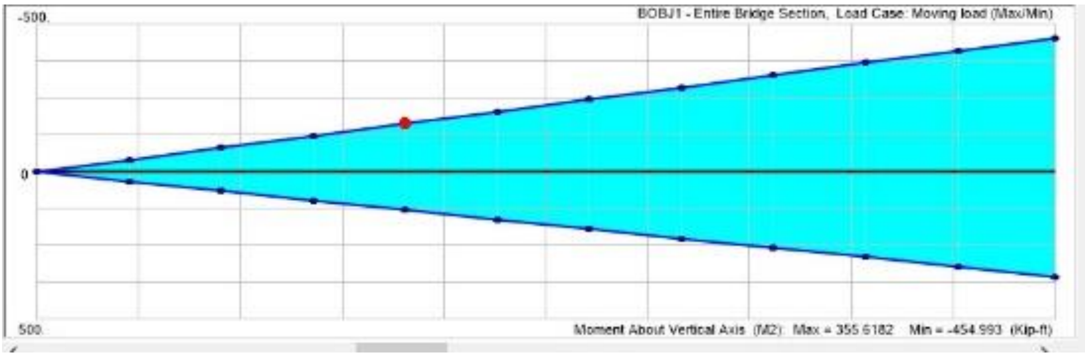

Fig. 4.10 M2 max min

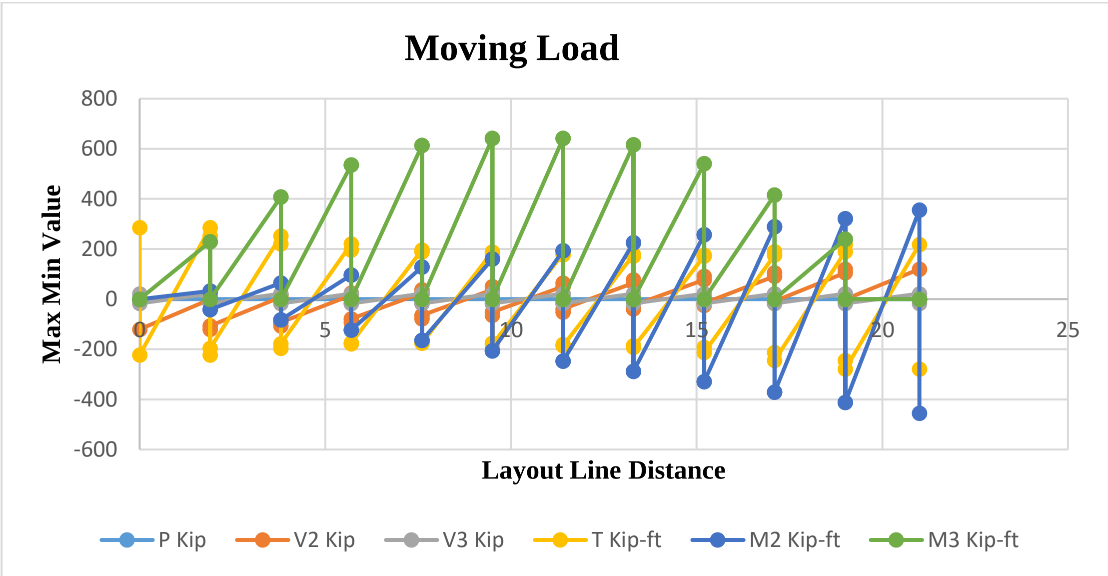

Fig. 4.11 Moving load

4.4.2 Response display to Resistance load (AASHTO)

Axial Force (P), Shear force vertical (V2), Shear force Horizontal (V3), Moment About Vertical Axis (M2) , Moment About Horizontal Axis (M3) Torsion (T) obtained during analysis (respectively for AASHTO)
Generated by software CSI-Bridge.

Table 4.2 Resistance load

Layout Line Distance	Item Type	P	V2	V3	T	M2	M3
ft.		Kip	Kip	Kip	Kip-ft.	Kip-ft.	Kip-ft.
0	Max	-3.83E-10	-72.317	37.87	498.6949	1.16E-07	6.74E-07

`

0	Min	-3.83E-10	-283.234	-29.681	-390.2656	2.23E-08	1.93E-07
1.9	Max	-3.83E-10	-72.317	37.87	498.6949	56.3937	538.1446
1.9	Min	-3.83E-10	-283.234	-29.681	-390.2656	-71.9531	137.4023
1.9	Max	-3.84E-10	-44.067	37.87	440.7239	56.3937	538.1446
1.9	Min	-3.84E-10	-243.917	-29.681	-343.3311	-71.9531	137.4023
3.8	Max	-3.84E-10	-44.067	37.87	440.7239	112.7875	960.8446
3.8	Min	-3.84E-10	-243.917	-29.681	-343.3311	-143.9061	247.4681
3.8	Max	-3.85E-10	-15.432	37.87	384.7867	112.7875	960.8446
3.8	Min	-3.85E-10	-204.985	-29.681	-312.3607	-143.9061	247.4681
5.7	Max	-3.83E-10	-15.432	37.87	384.7867	169.1812	1268.0999
5.7	Min	-3.83E-10	-204.985	-29.681	-312.3607	-215.8592	330.1972
5.7	Max	-3.82E-10	14.165	37.87	343.4091	169.1812	1268.0999
5.7	Min	-3.82E-10	-166.438	-29.681	-304.6093	-215.8592	330.1972
7.6	Max	-3.82E-10	14.165	37.87	343.4091	225.5749	1459.9106
7.6	Min	-3.82E-10	-166.438	-29.681	-304.6093	-287.8122	385.5898
7.6	Max	-3.80E-10	51.151	37.87	328.8516	225.5749	1459.9106
7.6	Min	-3.80E-10	-128.277	-29.681	-308.2575	-287.8122	385.5898
9.5	Max	-3.80E-10	51.151	37.87	328.8516	281.9686	1536.2766
9.5	Min	-3.80E-10	-128.277	-29.681	-308.2575	-359.7653	413.6458
9.5	Max	-3.79E-10	88.522	37.87	319.1553	281.9686	1536.2766
9.5	Min	-3.79E-10	-90.5	-29.681	-316.7406	-359.7653	413.6458
11.4	Max	-3.79E-10	88.522	37.87	319.1553	338.3624	1537.0979
11.4	Min	-3.79E-10	-90.5	-29.681	-316.7406	-431.7183	414.3651
11.4	Max	-3.82E-10	126.279	37.87	308.9504	338.3624	1537.0979
11.4	Min	-3.82E-10	-53.108	-29.681	-324.8282	-431.7183	414.3651
13.3	Max	-3.82E-10	126.279	37.87	308.9504	394.7561	1466.808
13.3	Min	-3.82E-10	-53.108	-29.681	-324.8282	-503.6714	387.7479
13.3	Max	-3.84E-10	164.42	37.87	301.7379	394.7561	1466.808
13.3	Min	-3.84E-10	-16.102	-29.681	-336.6984	-503.6714	387.7479
15.2	Max	-3.84E-10	164.42	37.87	301.7379	451.1498	1281.0733
15.2	Min	-3.84E-10	-16.102	-29.681	-336.6984	-575.6244	333.7941
15.2	Max	-3.83E-10	202.947	37.87	308.5592	451.1498	1281.0733
15.2	Min	-3.83E-10	13.914	-29.681	-371.1253	-575.6244	333.7941
17.1	Max	-3.84E-10	202.947	37.87	308.5592	507.5435	979.8941
17.1	Min	-3.84E-10	13.914	-29.681	-371.1253	-647.5775	252.5038
17.1	Max	-3.83E-10	241.858	37.87	333.2921	507.5435	979.8941
17.1	Min	-3.83E-10	42.569	-29.681	-428.029	-647.5775	252.5038

19	Max	-3.84E-10	241.858	37.87	333.2921	563.9373	563.2701
19	Min	-3.84E-10	42.569	-29.681	-428.029	-719.5306	143.8768
19	Max	-3.85E-10	281.635	37.87	381.7943	563.9373	563.2701
19	Min	-3.85E-10	71.938	-29.681	-487.9703	-719.5306	143.8768
21	Max	-3.86E-10	281.635	37.87	381.7943	623.2991	4.74E-07
21	Min	-3.86E-10	71.938	-29.681	-487.9703	-795.2706	-1.63E-08

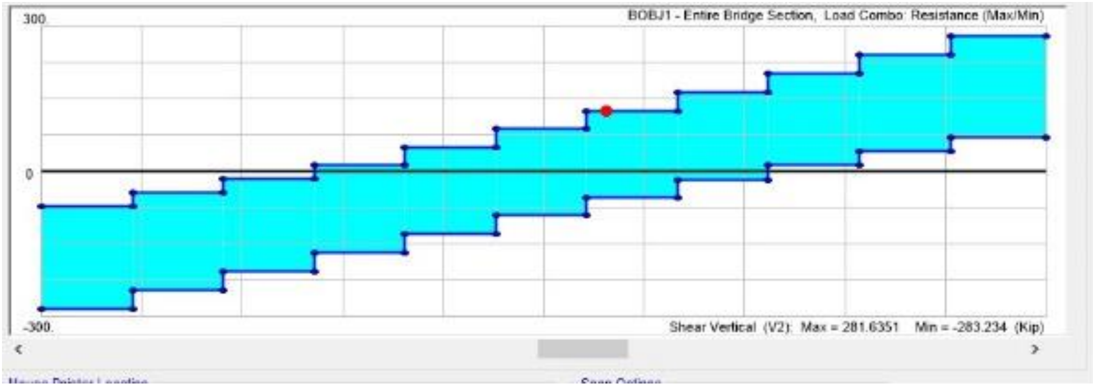

Fig. 4.12 V2 max min

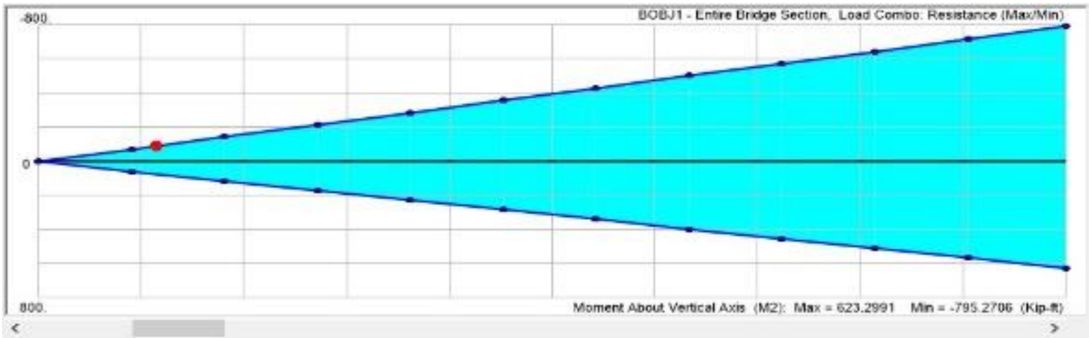

Fig. 4.13 M2 max min

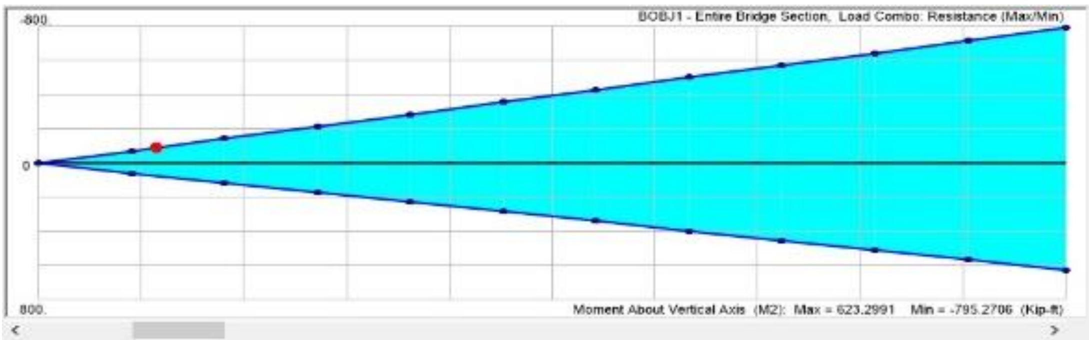

Fig. 4.13 M2 max min

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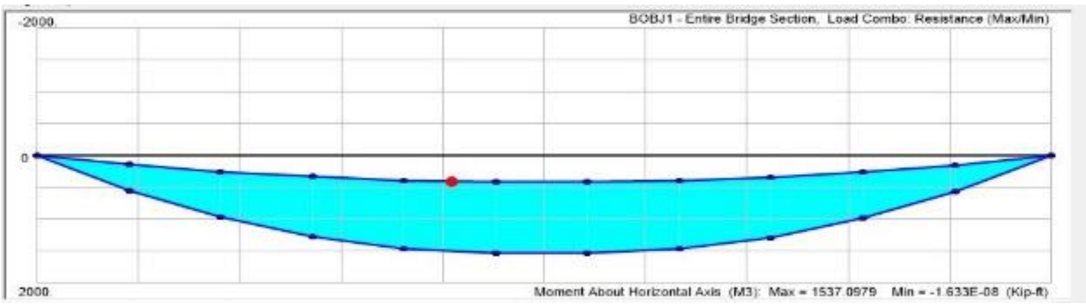

Fig. 4.14 M3 max min

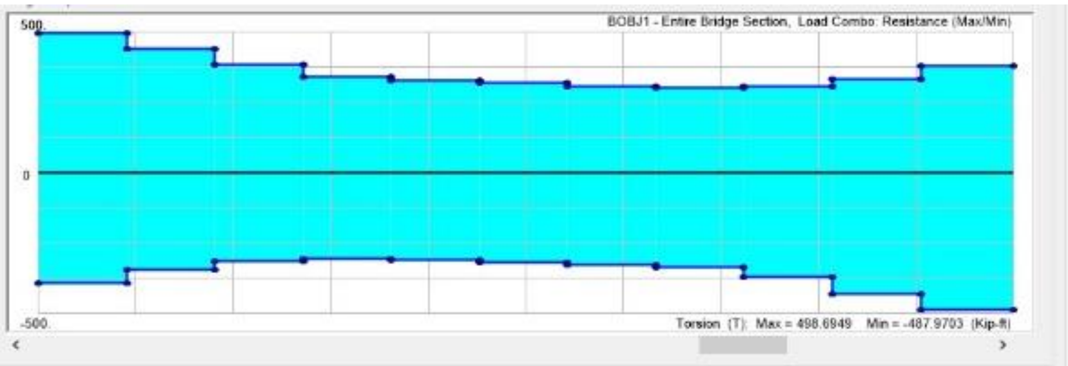

Fig.4.15 Torsion max min

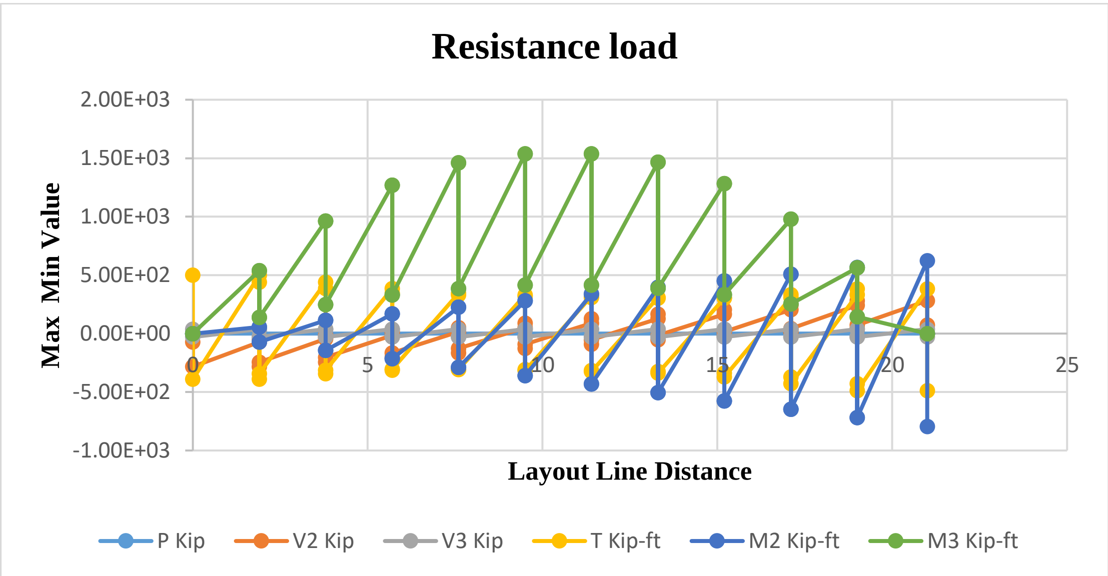

Fig. 4.16 Resistance load

4.4.3 Response display to Service load (AASHTO)

Axial Force (P), Shear force vertical (V2), Shear force Horizontal (V3), Moment About Vertical Axis (M2) , Moment About Horizontal Axis (M3) Torsion (T) obtained during analysis (respectively for AASHTO)
Generated by software CSI-Bridge

Table 4.3 Service load

Layout Line Distance	Item Type	P	V2	V3	T	M2	M3
.ft.		Kip	Kip	Kip	Kip-ft.	Kip-ft.	Kip-ft.
0	Max	-2.60E-10	-50.988	21.636	284.9283	7.20E-08	4.13E-07
0	Min	-2.60E-10	-171.512	-16.965	-223.0491	1.84E-08	1.38E-07
1.9	Max	-2.60E-10	-50.988	21.636	284.9283	32.2333	325.8722
1.9	Min	-2.60E-10	-171.512	-16.965	-223.0491	-41.1077	96.8766
1.9	Max	-2.61E-10	-32.922	21.636	251.8099	32.2333	325.8722
1.9	Min	-2.61E-10	-147.122	-16.965	-196.2215	-41.1077	96.8766
3.8	Max	-2.61E-10	-32.922	21.636	251.8099	64.4666	582.123
3.8	Min	-2.61E-10	-147.122	-16.965	-196.2215	-82.2154	174.4793
3.8	Max	-2.61E-10	-14.637	21.636	219.8536	64.4666	582.123
3.8	Min	-2.61E-10	-122.953	-16.965	-178.5163	-82.2154	174.4793
5.7	Max	-2.60E-10	-14.637	21.636	219.8536	96.7	768.7525
5.7	Min	-2.60E-10	-122.953	-16.965	-178.5163	-123.3231	232.8081
5.7	Max	-2.59E-10	4.198	21.636	196.2172	96.7	768.7525
5.7	Min	-2.59E-10	-99.003	-16.965	-174.0791	-123.3231	232.8081
7.6	Max	-2.59E-10	4.198	21.636	196.2172	128.9333	885.7607
7.6	Min	-2.59E-10	-99.003	-16.965	-174.0791	-164.4308	271.8631
7.6	Max	-2.58E-10	27.256	21.636	187.9065	128.9333	885.7607
7.6	Min	-2.58E-10	-75.274	-16.965	-176.1559	-164.4308	271.8631
9.5	Max	-2.58E-10	27.256	21.636	187.9065	161.1666	933.1475
9.5	Min	-2.58E-10	-75.274	-16.965	-176.1559	-205.5385	291.6441
9.5	Max	-2.57E-10	50.534	21.636	182.3735	161.1666	933.1475
9.5	Min	-2.57E-10	-51.765	-16.965	-180.9955	-205.5385	291.6441
11.4	Max	-2.57E-10	50.534	21.636	182.3735	193.3999	933.713
11.4	Min	-2.57E-10	-51.765	-16.965	-180.9955	-246.6462	292.1514
11.4	Max	-2.59E-10	74.031	21.636	176.55	193.3999	933.713
11.4	Min	-2.59E-10	-28.476	-16.965	-185.6092	-246.6462	292.1514
13.3	Max	-2.59E-10	74.031	21.636	176.55	225.6332	889.9904
13.3	Min	-2.59E-10	-28.476	-16.965	-185.6092	-287.7539	273.3847

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13.3	Max	-2.61E-10	97.749	21.636	172.4365	225.6332	889.9904
13.3	Min	-2.61E-10	-5.406	-16.965	-192.3843	-287.7539	273.3847
15.2	Max	-2.60E-10	97.749	21.636	172.4365	257.8666	776.6465
15.2	Min	-2.60E-10	-5.406	-16.965	-192.3843	-328.8616	235.3441
15.2	Max	-2.60E-10	121.687	21.636	176.3422	257.8666	776.6465
15.2	Min	-2.60E-10	13.668	-16.965	-212.0489	-328.8616	235.3441
17.1	Max	-2.61E-10	121.687	21.636	176.3422	290.0999	593.6813
17.1	Min	-2.61E-10	13.668	-16.965	-212.0489	-369.9693	178.0297
17.1	Max	-2.60E-10	145.845	21.636	190.4832	290.0999	593.6813
17.1	Min	-2.60E-10	31.965	-16.965	-244.5575	-369.9693	178.0297
19	Max	-2.61E-10	145.845	21.636	190.4832	322.3332	341.0948
19	Min	-2.61E-10	31.965	-16.965	-244.5575	-411.077	101.4414
19	Max	-2.61E-10	170.547	21.636	218.2068	322.3332	341.0948
19	Min	-2.61E-10	50.721	-16.965	-278.8016	-411.077	101.4414
21	Max	-2.62E-10	170.547	21.636	218.2068	356.263	2.83E-07
21	Min	-2.62E-10	50.721	-16.965	-278.8016	-454.3482	2.70E-09

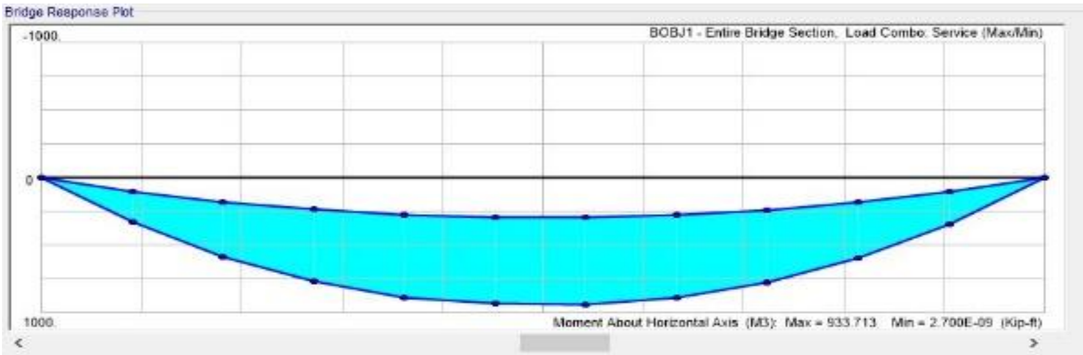

Fig. 4.17 M3 Max min

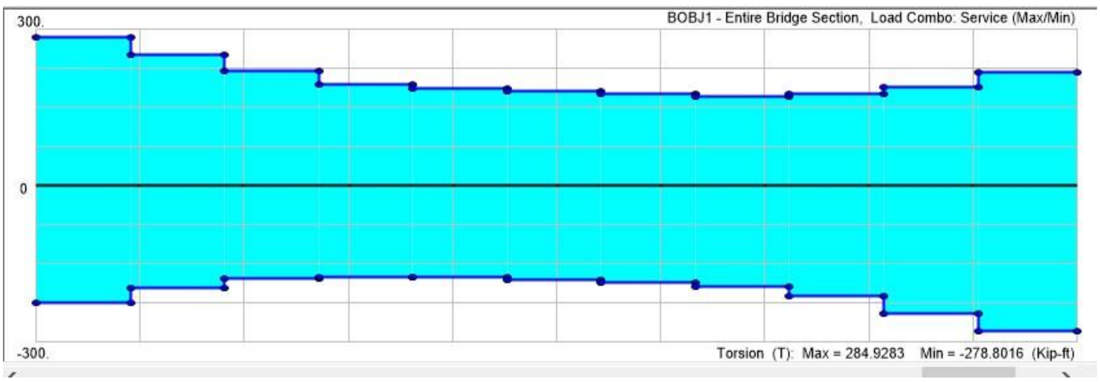

Fig. 4.18 Torsion max min

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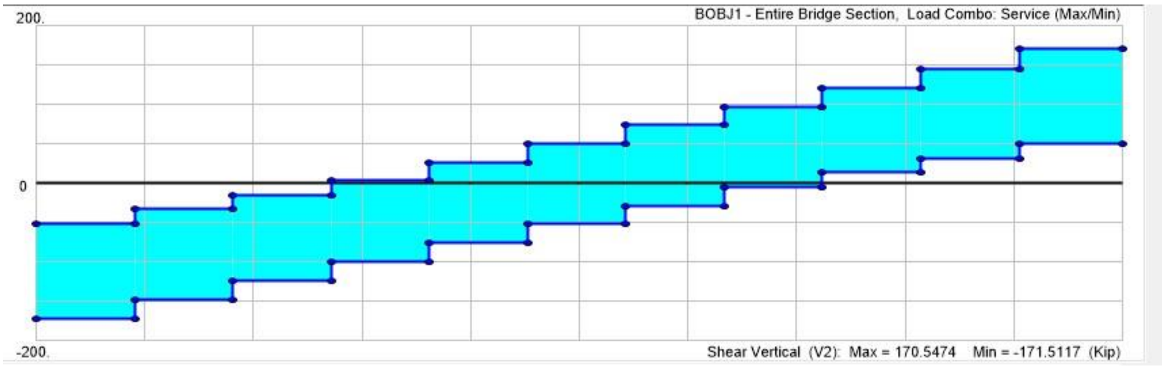

Fig. 4.19 V2 max min

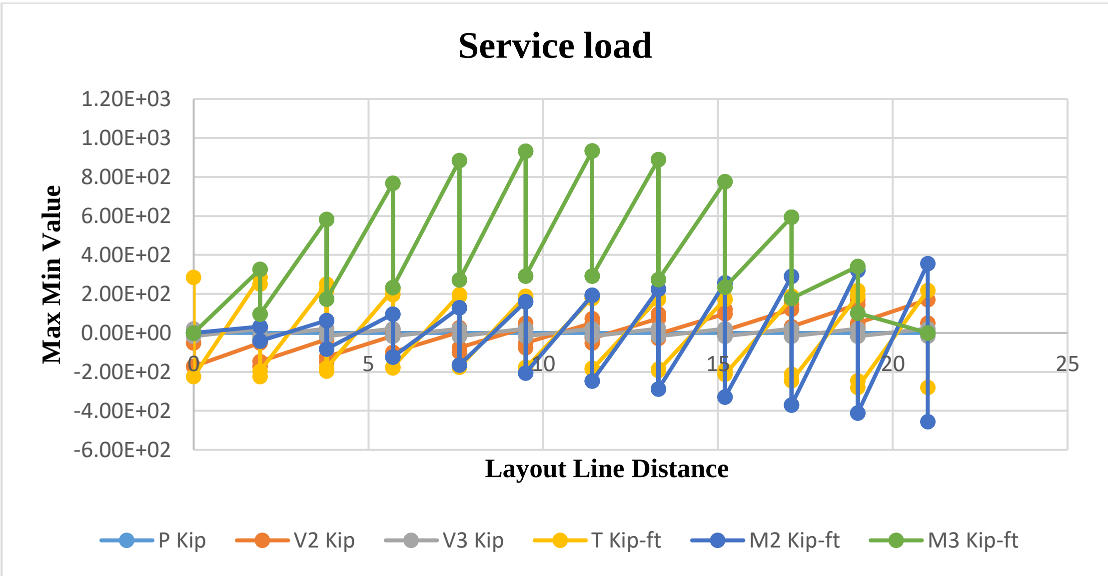

Fig. 4.20 Service load

4.4.4 Response display to Truck load (AASHTO)

Axial Force (P), Shear force vertical (V2), Shear force Horizontal (V3), Moment About Vertical Axis (M2) , Moment About Horizontal Axis (M3) Torsion (T) obtained during analysis (respectively for AASHTO)
Generated by software CSI-Bridge

Table 4.4 Truck load

Layout Line Distance	Item Type	P	V2	V3	T	M2	M3
ft.		Kip	Kip	Kip	Kip-ft.	Kip-ft.	Kip-ft.
0	Max	1.66E-10	3.43E-11	2.733	39.5474	2.18E-08	1.28E-07
0	Min	-5.23E-10	-62.984	-1.494	-85.8669	-3.02E-10	8.99E-10
1.9	Max	1.66E-10	3.44E-11	2.733	39.5474	2.8385	119.6698
1.9	Min	-5.23E-10	-62.984	-1.494	-85.8669	-5.1936	8.34E-10
1.9	Max	1.66E-10	0.635	2.733	38.0328	2.8385	119.6698
1.9	Min	-5.24E-10	-53.46	-1.494	-79.3793	-5.1936	8.34E-10
3.8	Max	1.66E-10	0.635	2.733	38.0328	5.6771	204.3111
3.8	Min	-5.24E-10	-53.46	-1.494	-79.3793	-10.3871	7.69E-10
3.8	Max	1.65E-10	7.683	2.733	31.668	5.6771	204.3111
3.8	Min	-5.23E-10	-45.756	-1.494	-75.6351	-10.3871	7.69E-10
5.7	Max	1.66E-10	7.683	2.733	31.668	8.5156	262.9429
5.7	Min	-5.23E-10	-45.756	-1.494	-75.6351	-15.5807	7.04E-10
5.7	Max	1.67E-10	14.825	2.733	35.348	8.5156	262.9429
5.7	Min	-5.23E-10	-38.73	-1.494	-80.0939	-15.5807	7.04E-10
7.6	Max	1.67E-10	14.825	2.733	35.348	11.3542	294.5016
7.6	Min	-5.23E-10	-38.73	-1.494	-80.0939	-20.7742	6.40E-10
7.6	Max	1.67E-10	20.591	2.733	39.5474	11.3542	294.5016
7.6	Min	-5.24E-10	-31.873	-1.494	-80.0939	-20.7742	6.40E-10
9.5	Max	1.67E-10	20.591	2.733	39.5474	14.1927	308.8889
9.5	Min	-5.24E-10	-31.873	-1.494	-80.0939	-25.9678	5.76E-10
9.5	Max	1.67E-10	26.413	2.733	39.5474	14.1927	308.8889
9.5	Min	-5.23E-10	-25.036	-1.494	-93.7386	-25.9678	5.76E-10
11.4	Max	1.68E-10	26.413	2.733	39.5474	17.0313	307.8857
11.4	Min	-5.23E-10	-25.036	-1.494	-93.7386	-31.1614	5.12E-10
11.4	Max	1.65E-10	31.846	2.733	39.5474	17.0313	307.8857
11.4	Min	-5.25E-10	-16.254	-1.494	101.3854	-31.1614	5.12E-10
13.3	Max	1.65E-10	31.846	2.733	39.5474	19.8698	284.9778
13.3	Min	-5.24E-10	-16.254	-1.494	101.3854	-36.3549	4.48E-10
13.3	Max	1.64E-10	36.698	2.733	39.5474	19.8698	284.9778
13.3	Min	-5.26E-10	-3.556	-1.494	-89.4801	-36.3549	4.48E-10
15.2	Max	1.65E-10	36.698	2.733	39.5474	22.7084	256.3048
15.2	Min	-5.25E-10	-3.556	-1.494	-89.4801	-41.5485	3.84E-10
15.2	Max	1.64E-10	44.19	2.733	39.5474	22.7084	256.3048
15.2	Min	-5.25E-10	3.39E|11	-1.494	-81.3314	-41.5485	3.84E-10
17.1	Max	1.63E-10	44.19	2.733	39.5474	25.5469	204.1905
17.1	Min	-5.26E-10	3.40E-11	-1.494	-81.3314	-46.7421	3.19E-10
17.1	Max	1.64E-10	51.302	2.733	33.5055	25.5469	204.1905
17.1	Min	-5.25E-10	3.40E-11	-1.494	-76.652	-46.7421	3.19E-10

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19	Max	1.63E-10	51.302	2.733	33.5055	28.3855	125.4603
19	Min	-5.25E-10	3.41E-11	-1.494	-76.652	-51.9356	2.55E-10
19	Max	1.64E-10	62.73	2.733	34.3826	28.3855	125.4603
19	Min	-5.27E-10	3.40E-11	-1.494	-78.4945	-51.9356	2.55E-10
21	Max	1.64E-10	62.73	2.733	34.3826	31.3734	6.82E-08
21	Min	-5.27E-10	3.39E-11	-1.494	-78.4945	-57.4025	1.87E-10

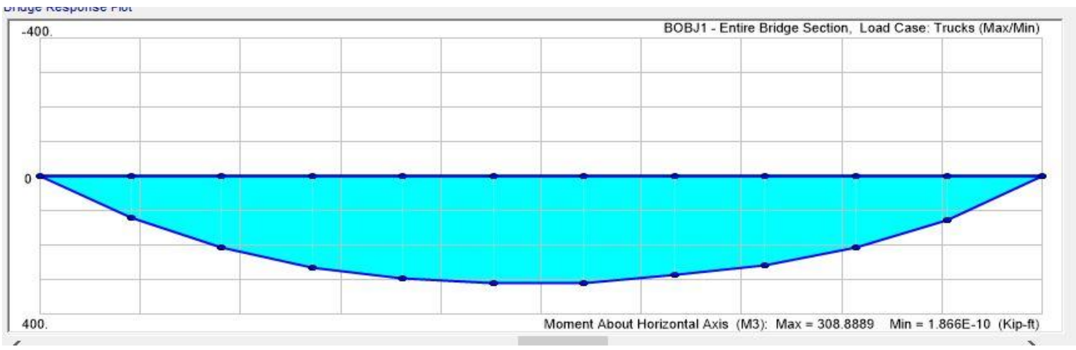

Fig. 4.21 M3 max min

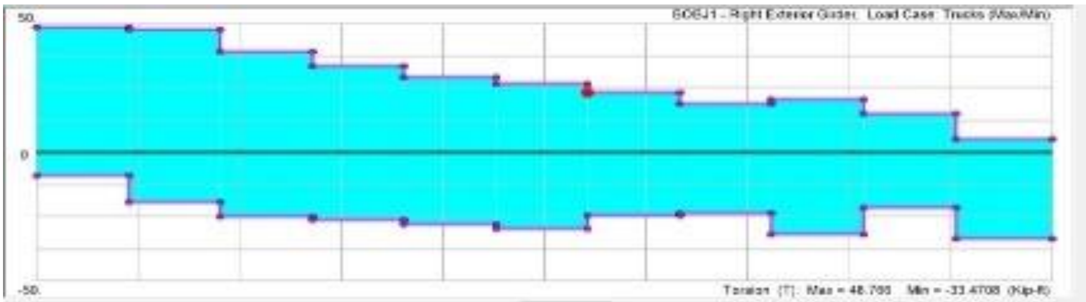

Fig. 4.22 Torsion max min

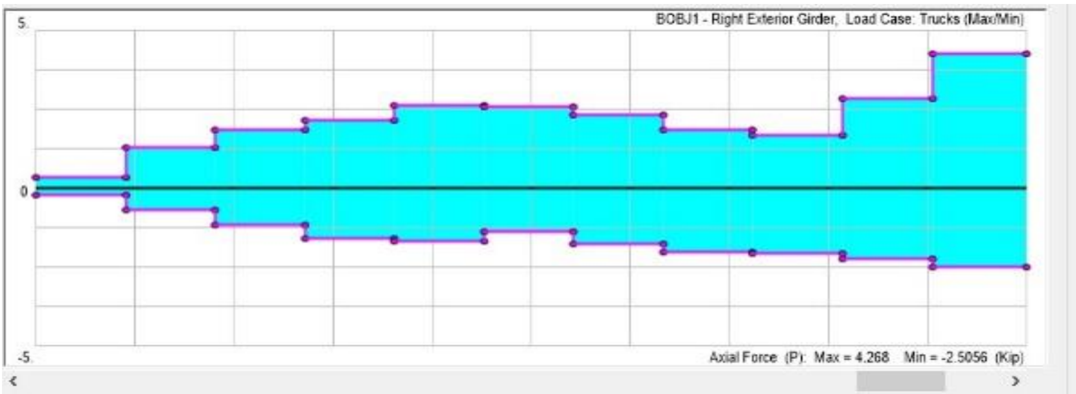

Fig. 4.23 Axial force max min

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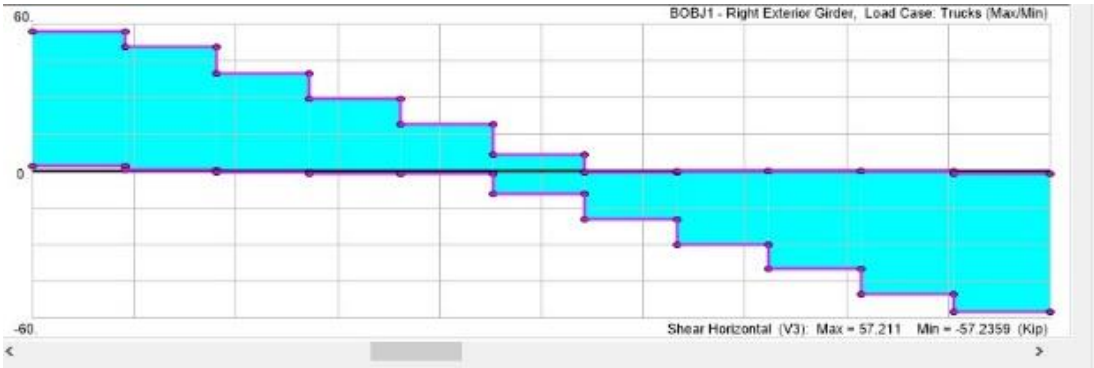

Fig. 4.24 V3 max min

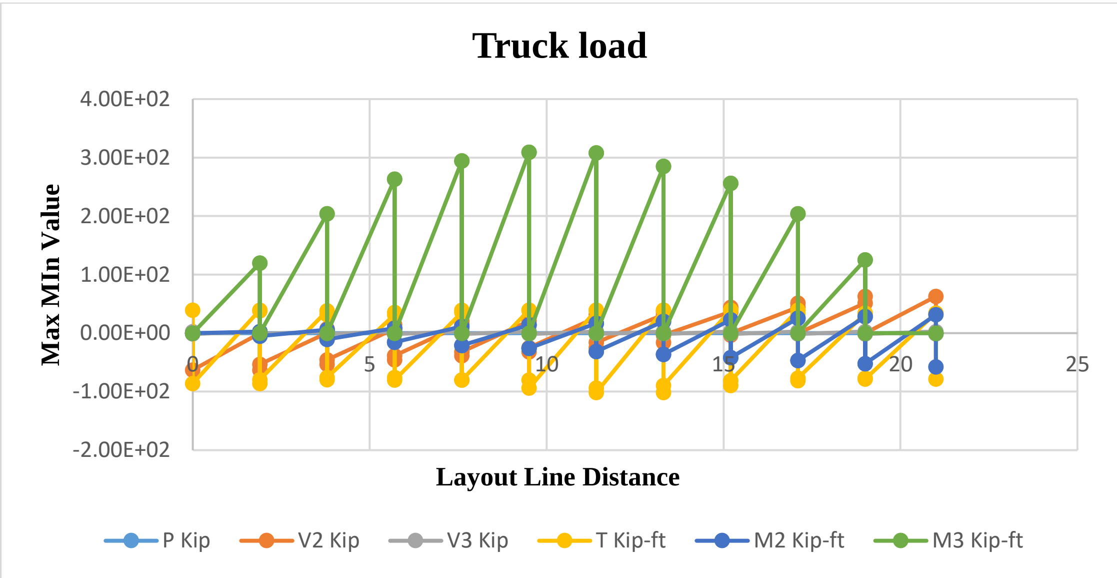

Fig. 4.25 Truck load

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4.4.5 Resultant of Truck Load

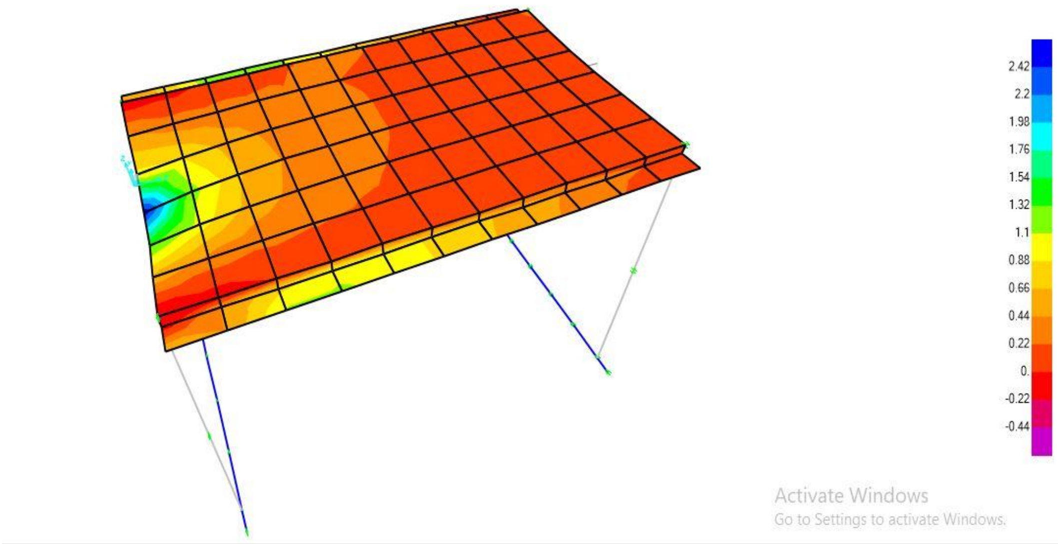


Fig. 4.26 Truck resultant M max diagram

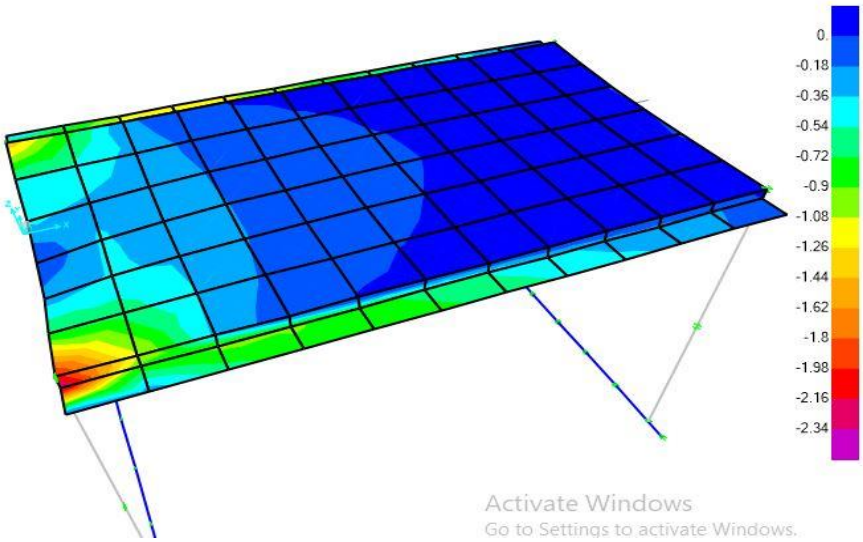
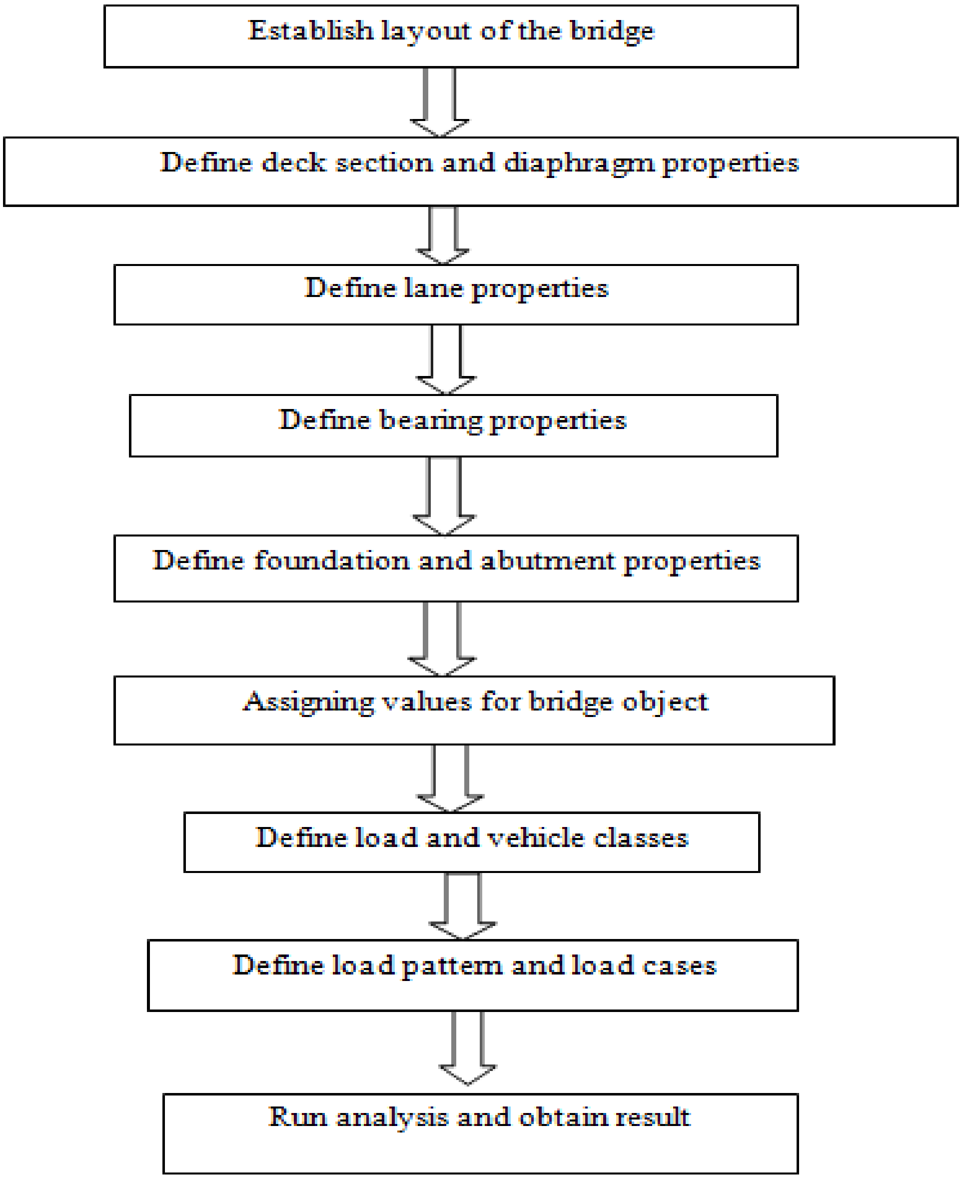


Fig. 4.27 Truck resultant M min diagram

4.5 Steps to model the bridge in CSI-Bridge v24.2.0



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CHAPTER V
CONCLUSIONS AND RECOMMENDATIONS

5.1 Introduction

Slab bridge analysis uses a variable bridge-to-depth quantitative relation, where deflection and stresses are always within acceptable bounds at certain intervals. The force and steel both diminish as the beam's depth drops. In addition to controlling usefulness well, more concrete strength is used. The deflection achieved as a result of different loading and service circumstances is determined to be well within AASHTO-permitted intervals.

It is discovered that the greatest vertical deflection happens in proximity to the beam's mid-span point. In order to optimize the section, many types of checks that are used in this article should be carried out. Although the bending moment and stress results for self-weight and superimposed weight are the same, they are completely different for the moving load because of AASHTO codes, even if the load combination has a considerable loading.

2.2 Conclusion

This thesis examines various modeling techniques used in structural analysis for concrete slab bridge design. The findings demonstrate that for the most part. There aren't many differences between the structural analysis models and procedures. It was discovered that if specific precautions were not taken when modeling by certain principles unintentional restraint might be added to the model. This could significantly change the Response while remaining hard to notice. Inadvertent restraint introduction was primarily a problem when modeling with rigid Shell elements in frame corners. It was found that errors and unwanted results could easily result from a lack of verification and difficulties in interpreting the results. It was also observed that different results are obtained from different load models. It was evident that various approaches to simulating the interaction between the soil and frame walls produced varying moment distributions over the frame walls despite the fact that this was not thoroughly investigated.

A structural engineer could be relatively free in building structural analysis models because the influence of decisions made during model construction is minimal, provided that mistakes are avoided. Since the variations between models are minimal, there is more. Emphasizing that a model is 100% accurate if it does not introduce errors

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is important. To put it succinctly, the importance of error prevention over accurate modeling cannot be overstated.

5.3 Recommendations

We designed with the measurements of the built bridge. Measurements have been taken through many hurdles. For this reason we have assumed the value of a few things. Due to the presence of water in the lake we could not measure the level below the bridge properly. Due to this, the result may vary slightly.

When the bridge was built there were no lakes on either side of the bridge. Now due to lacing many technical defects of the bridge may occur. The bridge should be rebuilt properly. The size of the bridge is much smaller than the size of the lake. This may cause the bridge to collapse due to water flow

We designed using AASHTO hsn-44 vehicle code with capacity more than 20 tons. But such heavy vehicles usually do not plying through this bridge. Low and low volume vehicles plying. Due to this the bridge will not be damaged now.

5.3 Suggestions for further work within the subject

Development of guidelines for modelling in 3D, together with easy to use. Methods for model verification. Adapt current design codes to 3D modelling, for AASHTO. Additional research on how structural analysis affects design, for instance. Study the influence of design based on structural analysis on Verification of response in.

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