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"Optimization of Steel Structure Bridge Subjected to Pedestrian Loading"

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ABSTRACT: The optimization of steel structure bridges subjected to pedestrian loading is crucial for ensuring structural efficiency, safety, longevity, and cost-effectiveness. This project focuses on optimizing steel structure bridges subjected to pedestrian loading utilizing STAAD Pro, a powerful structural analysis and design software. Bridge modeling involves defining the geometry, material properties, support conditions, and load modeling using STAAD Pro. By considering various factors such as material properties, bridge geometry, and loading conditions, the proposed methodology aims to enhance the structural performance of steel bridges while meeting safety standards and economic constraints. This project focuses on optimizing the design of steel structure bridges to withstand pedestrian loading effectively.

KEYWORDS: steel structure bridge, pedestrian loading, optimization, STAAD pro, structural analysis

1. INTRODUCTION

Bridges are vital components of transportation infrastructure, connecting communities and facilitating the movement of goods and people. In the context of vehicular transportation, the optimization of steel structure bridges holds paramount importance. This optimization seeks to strike a delicate balance between engineering efficiency, safety, cost-effectiveness, environmental sustainability, and functionality. This introduction for a comprehensive exploration of the multifaceted challenges and opportunities associated with optimizing steel structure bridges for vehicular loading.

A bridge may be defined as the structure to transfer and obstacle namely a river, a valley, a roadway, or a railway the general term bridge is very often left for the first case that is a structure over a river leaving the most specific terms of viaduct for bridges over valleys or over other obstacles. Bridges play a crucial role within the highway and transportation systems in the United States. There are over 590,000 highway bridges in the United States, most being owned by state or local government institutions.

According to the Federal Highway Administration, there are over 200 million trips taken in metropolitan areas over structurally deficient bridges. This poses a serious risk to the safety and lives of millions of motorists every year. Maintenance of bridges is essential in order to reduce the risk of structural failure and to ensure the safety of travelers. Regular inspections and repairs, as well as the use of modern materials, are essential for the long-term sustainability of bridges.

2. LITERATURE REVIEW

[1] Title: The Detailed Appraisal and Design of Foot Over Bridge
M. Limje et al., (2019)

In the study by M. Limje et al. (2019), the aim was to analyze and design a foot over bridge connecting Surat railway station and Surat bus station, catering to high hourly volume traffic. The focus was on utilizing STAAD Pro for the analysis of the foot over bridge, specifically designed for pedestrians and cyclists. The foot over bridge had a total length of 171m, a height of 12m, and a width of 4m. The design process adhered to the guidelines of IS 800:2007, aiming for an economical and efficient structure. Future changes and loading considerations were also integrated into the design. Various components such as the Main Truss, Columns, and Footings were thoroughly analyzed using STAAD Pro software to determine the most economic and safe sections. The use of steel as the construction material was chosen for its cost-effectiveness over Reinforced Concrete Structure. Safety and adaptability to future changes were key factors in the design process.

Conclusion: In conclusion, the detailed appraisal and design of the foot over bridge provided an efficient and safe solution for the high traffic volume between Surat railway station and Surat bus station. The incorporation of STAAD Pro analysis and steel construction materials ensured both economic viability and structural integrity for future changes.

[2] Title: Materials for Foot Over Bridges
Aishwarya Kulkarni, et al., (April 2016)

In April 2016, Aishwarya Kulkarni and colleagues delved into the utilization of materials in foot over bridges to enhance strength and durability. Over the past three decades, a variety of materials have been introduced and continue to emerge in the market for new applications. These materials range from metals to natural, glass, and organic materials. By employing STAAD-Pro software, the design considerations align with IS codes to ensure safety under all conditions. Utilizing STAAD-Pro software, the study evaluated the design of slabs, beams, columns, and rectangular footings. These components were analyzed for deflection control and overall safety. The comparison between drawings, designs, and geometric models using STAAD-Pro showcased the efficacy of the design in meeting safety standards. Through case studies, researchers were able to construct more durable foot over bridges at a reduced cost.

Conclusion: The comparison between two types of foot over bridges utilizing STAAD-Pro software led to the conclusion that cable foot over bridges is both more durable and economically feasible. The aim of the study was to explore the use of innovative materials and design techniques in enhancing the durability of foot over bridges. With the right materials and design considerations, foot over bridges can be constructed to withstand various conditions while remaining cost-effective.

[3] Title: Design of a Steel Foot Over Bridge in A Railway Station
S. Rajesh (2017)

work carried out by S. Rajesh (2017) focused on the design of a steel foot over bridge at the Chennai railway station. The aim was to create a lightweight and economical structure while ensuring maximum safety. The location chosen for the foot over bridge was at the Chennai railway station, spanning a total length of 28m over 3 tracks. The gangway width was set at 3m in accordance with Indian railway code standards. The various components of the foot over bridge, such as the main truss, column, and footings, were meticulously analyzed using STAAD Pro structural software. The design process involved the use of steel material, compared to a reinforced concrete structure, to achieve overall construction economy. The column, bracing, top cord, and bottom cord members were designed according to IS800:2007 standards, while the footings were designed as per IS456:2000 regulations.

Conclusion: The authors concluded that the foot over bridge components were designed for maximum safety and incorporated economical sections. Through the use of steel as the primary construction material, the structure not only achieved cost-effectiveness but also ensured adaptability to future changes. The design process involved both software analysis and manual design to arrive at the most economic and safe sections for the foot over bridge.

[4] Title: Review on Analysis of Structure and Design of Steel Bridge Using STAAD pro. Software
Aashish Nema, Dr. Rajeev Chandak, et al., (March 2023)

Aashish Nema, Dr. Rajeev Chandak, et al., conducted a research study in March 2023 on the "Review on Analysis of Structure and Design of Steel Bridge Using STAAD Pro Software." The main focus of this study was on analyzing and designing a T-beam bridge using STAAD Pro software. The selected bridge model had specific span and carriageway width, and it consisted of a composite concrete structure with a slab panel, longitudinal girder, and cross girder. The primary aim of this research was to investigate the behavior of the bridge deck under various loading conditions, such as IRC Class AA, IRC Class 70R tracked loading, and others. The analysis performed aimed to determine the maximum bending moments and shear forces experienced by the bridge. By utilizing STAAD Pro software, the study provided valuable insights into the structural performance of the T-beam bridge and its compliance with design codes and standards.

Conclusion: In conclusion, the research paper presented a detailed analysis and design of a T- beam bridge using STAAD Pro software. The study shed light on the bridge's behavior under different loading conditions, offering essential information on its structural performance. The findings of this research contribute significantly to the understanding of bridge design and analysis processes.

[5] Title: Design and Analysis of Steel Girder Bridge using STAAD Pro. V8i

Garav Saha, Aditya Chavan, et al., (July 3, 2021)

In a recent study conducted by Garav Saha, Aditya Chavan, et al. (July 3, 2021), the design and analysis of a steel plate girder bridge were explored using the powerful STAAD Pro software. This particular bridge consists of three spans, with a total length of 110 meters. The side spans measure 30 meters each, while the main span spans 50 meters. The roadway width is 12 meters, and there are sidewalks measuring 1.5 meters on each side. The design of the bridge adheres to AASHTO specifications, taking into account truckloads as per IRC standards. Various loads, such as temperature, impact, wind, and seismic loads, are considered based on IS (Indian Standards) codes: IS875 (Part 3)-1987, IS1893:1962, and IS800. The main aim of this study is to demonstrate the comprehensive design and analysis process of a steel girder bridge using STAAD Pro software. By following established standards and protocols, the study aims to showcase the efficiency and accuracy of the software in designing and analyzing complex bridge structures. The design process of the steel girder bridge involved analyzing various factors such as span lengths, roadway width, and sidewalk dimensions. The AASHTO specifications were meticulously followed, ensuring that the bridge can withstand diverse loads such as temperature changes, impacts, wind forces, and seismic activities. By incorporating the IS codes, the design process prioritized structural integrity and safety of the bridge. The use of STAAD Pro software facilitated a detailed analysis of the steel girder bridge, considering the complex structural components and loads acting on the structure. The software enabled engineers to simulate different scenarios and optimize the design for maximum efficiency and safety. By utilizing advanced features of STAAD Pro, the analysis phase of the bridge design ensured that all load conditions were adequately addressed.

Conclusion: In conclusion, the design and analysis of a steel girder bridge using STAAD Pro software exemplify the integration of advanced technology in bridge engineering. The study successfully demonstrated the effectiveness of the software in designing robust and resilient bridge structures. By adhering to industry standards and regulations, the bridge design process showcased a comprehensive approach towards ensuring structural stability and safety. The incorporation of IS codes and AASHTO specifications further reinforced the credibility and reliability of the design. Overall, this study highlights the importance of utilizing cutting-edge software tools for optimizing bridge design and analysis processes.

3. OBJECTIVES

Optimize a steel bridge that handles pedestrian traffic -

1. To study the various types of foot over bridge on highway
2. To decide geometry of foot over bridge
3. To decide pedestrian loading as per codal provision
4. To analyze and design the plate girder using Staad Pro.

4. METHODOLOGY

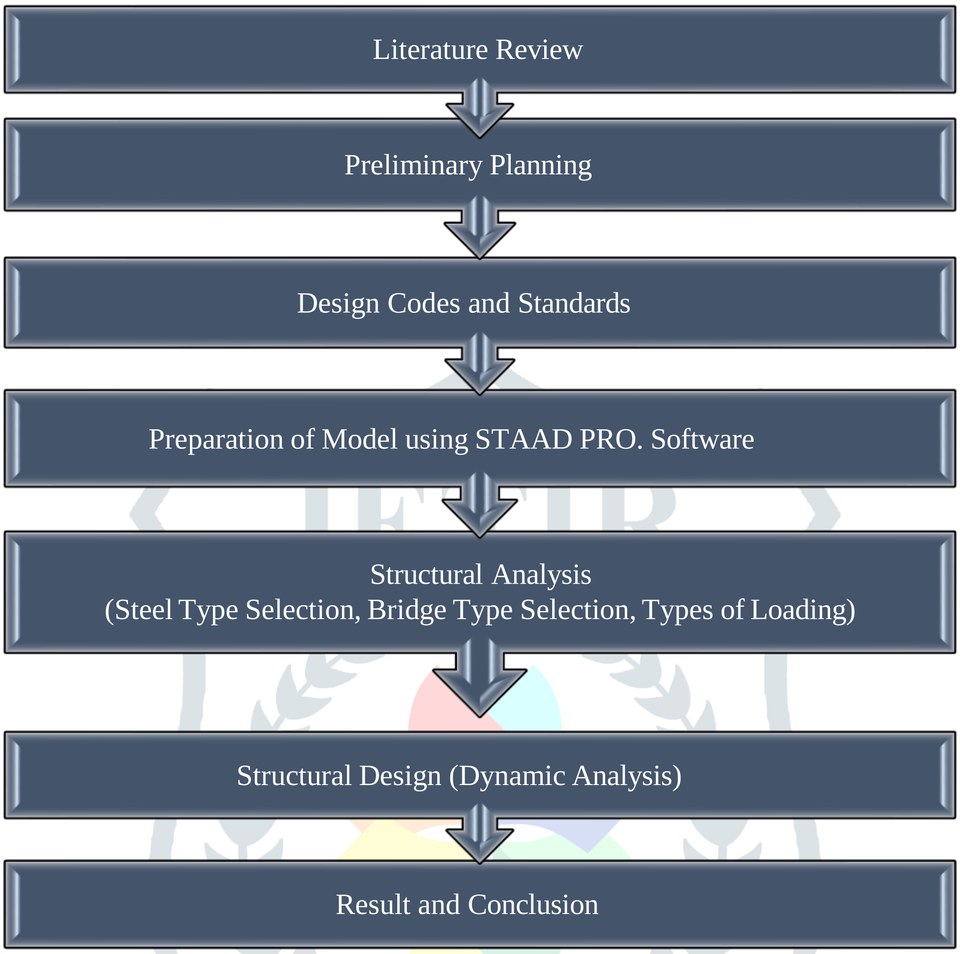

Fig: Flow Chart Procedure for Optimization and Analysis of steel structure bridge

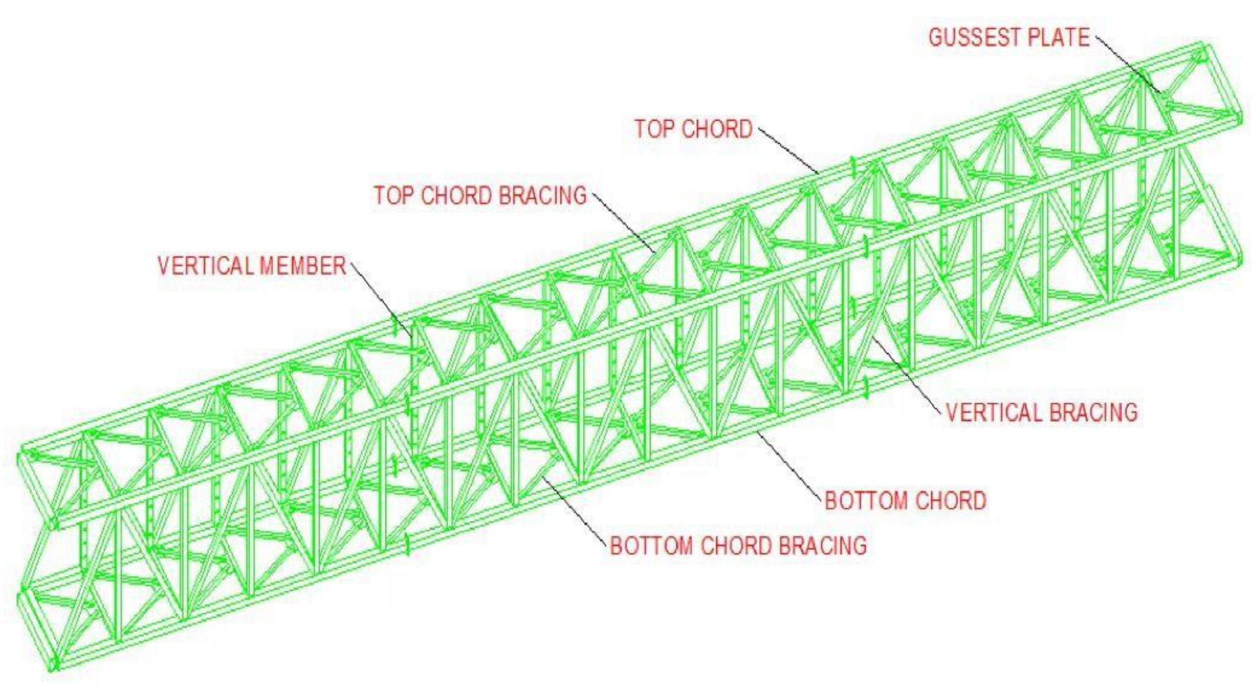

Fig. Parts of Bridge Span

5. SPECIFICATION

a) DESIGN DATA:

1. Name of structure: Steel truss foot over bridge
2. Height of bridge: 11.73 m
3. Span of bridge: 30 m
4. Width of span = 1.8 m
5. Type of staircase used: Single flight straight staircase
6. Staircase Riser Width: 0.15 m
7. Staircase Tread Width: 0.3 m
8. Type of truss used: Modified Queen post truss
9. Type of truss used from top chord to bottom chord: Warren (with vertical) steel truss

b) DESIGN OF COLUMN: -

1. Width of walkway: 1.8m
2. Spacing of columns: 1.8 m
3. Length of the column: 8.5 m

6. EXPECTED OUTCOMES

The project titled "Optimization of Steel Structure Bridge Subjected to Pedestrian Loading" culminates with the thorough analysis of a foot over bridge utilizing STAAD Pro.

Optimizing a steel structure bridge subjected to vehicular loading entails determining the most suitable design that fulfills various engineering criteria and constraints while minimizing specific objectives. The anticipated outcomes of such optimization endeavor to accomplish the following:

Structural Integrity: The paramount objective is to guarantee that the bridge possesses ample structural integrity to safely withstand the loads imposed by vehicular traffic without experiencing excessive deformation or failure. Outcomes within this realm include ensuring that stresses, strains, and deformations remain within acceptable limits as dictated by design codes and safety standards.

Material Efficiency: Optimization endeavors to minimize the utilization of steel in the bridge while still adhering to all safety and performance criteria. Diminishing material usage can contribute to cost reduction and lessen environmental impact.

Cost Reduction: Optimization frequently involves minimizing construction expenses while still attaining the requisite structural performance. This may encompass selecting cost-effective construction methodologies and materials to achieve an optimal balance between cost and performance.

Weight Reduction: Decreasing the weight of the bridge can result in cost savings and potentially enhance performance in terms of load distribution and foundation design. This aspect holds particular significance for long-span bridges where weight reduction can yield substantial benefits.

Durability: The bridge ought to be designed to withstand environmental elements such as corrosion, temperature fluctuations, and moisture, which could influence its long-term performance. Optimizing durability can prolong the bridge's lifespan and mitigate maintenance costs over time.

In conclusion, the optimization of a steel structure bridge subjected to vehicular loading aims to achieve a balance between structural integrity, material efficiency, cost reduction, weight reduction, and durability. Through meticulous analysis and application of engineering principles, the project endeavors to deliver a robust and cost-effective bridge design that ensures long-term reliability and safety.

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