iJRASET
International Journal For Research in Applied Science and Engineering Technology



INTERNATIONAL JOURNAL FOR RESEARCH

IN APPLIED SCIENCE & ENGINEERING TECHNOLOGY

Volume: 11 **Issue:** III **Month of publication:** March 2023

DOI: https://doi.org/10.22214/ijraset.2023.49867

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International Journal for Research in Applied Science & Engineering Technology (IJRASET)
ISSN: 2321-9653; IC Value: 45.98; SJ Impact Factor: 7.538
Volume 11 Issue III Mar 2023- Available at www.ijraset.com

Review on Analysis of Structure and Design of Steel Bridge Using Staad Pro Software

Aashish Nema[1], Dr. Rajeev Chandak[2]
[1, 2]*Department Structural Engineering (Civil), Jabalpur Engineering College JEC, Gokalpur, Jabalpur 482011. M.P*

Abstract: ***In this study the T-beam bridge is to be analysis on the staad pro sofware. A T-beam bridge is composite concrete structure which is composed of slab panel, longitudinal girder and cross girder. This project looks on the work of analysis and design of bridge deck and beam on software the specific bridge model is taken of a particular span and carriageway width the bridge is subjected to different IRC loadings like IRC Class AA, IRC Class 70R tracked loading etc. in order to obtain maximum bending moment and shear force. From the analysis it is observed and understand the behavior of bridge deck under different loading condition and comparing the result. The different codes of design will be use in this project are IRC 5-2015,IRC 6-2016, IRC 112-2011, IRC 21-2000.***
Keywords: T-beam bridge, Staad pro software, IRC Codes, Loadings.

I. INTRODUCTION

A developing country, Myanmar is rich in water resources and land areas. So, it needs a lot of roads. These roads cross many obstacles, such as rivers, valleys and streams. To overcome this condition, bridges are important roles. A bridge is a structure that across over a river, bay, or other obstruction, permitting the smooth and safe passage of vehicles, trains, and pedestrians. A bridge structure is divided into an upper part or the superstructure, which consists of the slab, the floor system and the main truss or girders and a lower part or the substructure, which are columns, piers, towers, footings, piles and abutments. The recent development in design technology, material, quality, and efficient construction technique in bridges engineering will enable construction of not only longer but also lighter and slender bridges.

Based on material, they can be classified as Stone Bridge, Brick Bridge, Timber Bridge, Steel Bridge, Composite Bridge, etc. Based on form of superstructure, they can be classified as Arch Bridge, Slab Bridge, Beam and Plate Girder Bridge, Trusses Bridge, Suspension Bridges, and Cabled Stayed Bridge.

II. RESEARCH MOTIVATION

Footbridges are scaffolding structures used for the transportation of pedestrians, cyclists, and riders of low velocity and assistive devices such as wheelchairs. Footbridges are not designed for any sort of vehicular activity, and they have numerous applications all around the world. In developed countries, they are used to connect two zones separated by either roads, canals or a body of water between them. In underdeveloped countries, where traffic and over congestion are major problems, they may be used to give access to public buildings such as shops and universities.

They are also used to connect to high-rise buildings from top floors, and in this case, they are specifically called “skyway” [1]. Footbridges are usually manufactured using the following types of materials: concrete, steel and timber, however steel footbridges are preferred in situations where the bridges have long spans and there is the quick availability of structural steel members. A great amount of technical literature is available on these members.

The American Institute of Steel Construction (AISC) manuals are available in which standard shapes of these structural steel members are available along with important design specifications, i.e., weight/length, the moment of inertia and section modulus, etc. [2].

Further, local area suppliers/manufacturers of steel members also provide their standard shapes and their technical specifications. This helps the designer to choose standard shapes easily and design the steel bridge with the members available in the local market, and thus results in inexpensive manufacturing. In this paper, we have chosen steel as a material for a footbridge. Another important point in selecting steel is that its strength to mass ratio is better than that of timber or concrete. Moreover, painted steel looks aesthetically attractive.

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III. RESEARCH GAP

Roads are the lifelines of contemporary transport and bridges are the foremost vital elements of transportation systems. They are prone to failure if their structural deficiencies are remain unidentified. Due to aging of existing bridges and the increasing traffic loads, monitoring of bridge steel beam during service time has become more important than ever. The structural health monitoring of bridge refers to the process of implementing a damage detection and characterization strategy. There is a need for Structural health monitoring techniques to supplement visual inspections as more bridges are in need of in-depth assessments and ongoing monitoring to ensure they are still fit for purpose. Vibration monitoring is a useful evaluation tool in the development of a non-destructive damage identification technique, and relies on the fact that occurrence of damage in a structural system leads to changes in its dynamic properties. The dynamic response of bridges subjected to moving loads has long been an interesting topic in the field of civil engineering. The load-bearing capacity of a bridge and its structural behavior under traffic can be evaluated using well-established modelling. Among the tools available today for structural investigation, dynamic techniques play an important role from several points of view. Particularly, by measuring the structural response, they allow us to identify the main parameters governing the dynamic behavior of a bridge, namely natural frequencies, mode shapes and damping factors. Modal analysis, usually based on finite element method, is commonly used to determine the vibration characteristics, such as natural frequencies and associated mode shapes of a structure.

IV. LITERATURE REVIEW

1) *Chao Jiang, Fatigue assessment of fillet weld in steel bridge towers considering corrosion effects:* Field inspection shows that the fillet weld in steel bridge towers may be subjected to corrosion and fatigue loading simultaneously. To ensure the structural safety in the service life, corrosion effects on the fatigue life of the fillet weld in steel towers were investigated in this study. A prediction procedure of the fatigue life of the weld was firstly proposed based on the fracture mechanics method and verified by the test results. Three types of corrosion effects, pitting corrosion at the initial crack, pitting corrosion near the initial crack, and the corrosion fatigue crack growth were considered. Three corrosion levels were also defined under different corrosive environments. By taking the Third Nanjing Yangtze River Bridge as an example, a modified finite element (FE) model integrated with the local shell model was established to analyze the stress variation of the fillet weld in steel towers. Based on the stress influence lines, the maximum stress range was obtained under the vehicle load. Fatigue assessment of the fillet weld was finally performed considering the corrosion effects. The result shows that the remaining fatigue life of the fillet weld was greatly reduced by the corrosion pits at the initial crack or the interactions of corrosion and fatigue. However, since the tensile stress range was small in the steel bridge towers, the fatigue performance of the fillet weld considering the corrosion effects can still meet the requirements of the code specification.
2) *Chenxing Cui, Shear behavior of stud connectors in steel bridge deck and ballastless track structural systems of high-speed railways:* Steel bridges with ballastless tracks have been increasingly used in high-speed railways (HSRs). This kind of steel bridge deck and ballastless track structural system can be considered a steel and multilayer concrete composite structure (SMCCS). However, rare information is available about the shear behavior of stud connectors embedded in the SMCCS. To address this research gap, it was extensively investigated through push-out tests and finite element (FE) analyses in this research. Three groups of experiments including a total of nine push-out specimens with single-layer or double-layer concrete slabs were performed, and the failure mode, load-slip curve, shear capacity, and shear stiffness were presented and discussed. Refined three-dimensional nonlinear FE models were established and verified using the push-out tests. Based upon the FE models, the shear behavior of stud connectors in the SMCCS was further studied, and the effects of key variables on the shear behavior of studs were discussed. Moreover, the design shear capacities of stud connectors calculated using the current design codes were evaluated, and the design recommendations were presented. The results indicate that double-layer concrete slab and group effect will reduce the shear performance of studs. The stud diameter and yield strength have a significant effect on the shear behavior of studs. The shear performance of studs improves with the increasing stud diameter and yield strength. Lower shear strength of the concrete-concrete interface will cause the interface cracking of the push-out specimen, which occurs before the stud shear failure. The results can provide essential data for future analysis and design of steel bridges and ballastless tracks for HSRs.
3) *Oskar Skoglund, A numerical evaluation of new structural details for an improved fatigue strength of steel bridges:* Fatigue is often the decisive design factor when designing steel bridges and improving the fatigue strength of critical details can reduce the amount of steel material used. In this paper, the fatigue strength of four different structural detail solutions are investigated and compared through numerical simulations. Two of the evaluated structural details have not been used before in bridge

construction. The most promising structural detail managed to improve the fatigue strength by more than 25% compared to the conventional solutions used today. The numerical studies were performed as a preparation for future testing.

4) *Itunumi Savage, Seismic analysis and base isolation retrofit design of a steel truss vertical lift bridge:* Bridges with steel superstructures are frequently ideal candidates for seismic retrofit utilizing base isolation. The seismic assessment and retrofit design of the Three Mile Slough Bridge included both the evaluation of a conventional retrofit scenario and a base isolation retrofit scenario. The structure is a five span riveted steel truss bridge with a vertical center lift span attached to the top of each 100 ft lifting tower by steel cables. The comprehensive analysis model had the following properties: 1. Non-linear springs captured soil–foundation structure interaction (SFSI); 2. Moment-curvature elements modeled reinforced concrete pier columns and capbeams; 3. In-elastic truss elements modeled isolation bearings; 4. Cable elements modeled the cable supporting the counterweight. This paper discusses a non-linear time history analysis using ADINA. Also, the modeling and evaluation of the performance in the isolation bearings is discussed.
5) *Xin Shi, Cyclic load tests and finite element modeling of self-centering hollow-core FRP-concrete-steel bridge columns:* This paper presents experimental and numerical investigations of the seismic performance of a novel self-centering (SC) hollow-core (HC) fiber-reinforced polymer (FRP)-concrete-steel (SC-HC-FCS) bridge column. This new structure is fabricated by mounting external energy dissipators (ED) and applying unbonded post-tensioned (PT) basalt FRP (BFRP) tendon to the conventional HC-FCS column that consists of an outer FRP tube and an inner steel tube, with the space between filled with concrete. The SC-HC-FCS column combines the advantages of accelerated bridge construction and self-centering. The effects of the initial prestress force values and the configuration of the energy-dissipated aluminum bar on the column performance are studied. Based on the experimental and numerical results, it is found that the proposed SC-HC-FCS column shows adequate self-centering and energy dissipation capacities. However, it is required to properly select the configuration and material properties of the aluminum bar as energy dissipators to further refine the seismic resistance of the SC-HC-FCS column.
6) *D. Martínez-Muñoz, Discrete swarm intelligence optimization algorithms applied to steel–concrete composite bridges:* Composite bridge optimization might be challenging because of the significant number of variables involved in the problem. The optimization of a box-girder steel–concrete composite bridge was done in this study with cost and CO2 emissions as objective functions. Given this challenge, this study proposes a hybrid algorithm that integrates the unsupervised learning technique of k-means with continuous swarm intelligence metaheuristics to strengthen the latter's performance. In particular, the metaheuristics sine-cosine and cuckoo search are discretized. The contribution of the k-means operator regarding the quality of the solutions obtained is studied. First, random operators are designed to use transfer functions later to evaluate and compare the performances. Additionally, to have another point of comparison, a version of simulated annealing was adapted, which has solved related optimization problems efficiently. The results show that our hybrid proposal outperforms the different algorithms designed.
7) *Yangfan Shen, Experimental investigation on the vortex-induced vibration of an arch steel bridge tower:* This paper reports the wind tunnel study of the vortex-induced vibration (VIV) of a free-standing steel arch bridge tower with pentagon cross-section. The tests were carried out at different yaw angles β (0°–90°) of wind flow by employing a 1:50 scaled aeroelastic model. A series of aerodynamic measures were studied to mitigate the VIV of the tower at the most unfavorable yaw angle. Effects of turbulence intensity and structural damping on the VIV performance of the tower were evaluated. A sleeve-type eddy current damper (ECD) for increasing the structural damping of aeroelastic model was designed for reserved emergency measures. Experimental results indicate that the VIV occurs for a few yaw angles at wind velocity of 15–18 m/s and the maximum VIV amplitude happens for β = 35°. The aerodynamic measures are effective for some yaw angles but become invalid for other yaw angles. Compared to those in smooth flow, the VIV amplitude drops by 65% for a turbulence intensity of 8.5%. The VIV of the tower can be effectively suppressed by the eddy current damper which provides additional damping to the aeroelastic model. The sleeve-type eddy current damper is shown to be a convenient device to adjust the damping for aeroelastic models.
8) *Tomasz Maleska, Effect of the soil cover depth on the seismic response in a large-span thin-walled corrugated steel plate bridge:* The common use of corrugated steel plate (CSP) bridges and culverts has been increasing in recent years. Despite the growing popularity of these objects, there is very scarce research concerned with the response of such structures to seismic excitation. Therefore, the aim of the study is to determine the effect of seismic excitation on a CSP bridge with span exceeding 17 m and a variable depth of the soil cover above the steel shell (from 1.0 to 5.0 m). The obtained results demonstrate that the depth of the soil cover has a significant impact on the response of the bridge.

9) *Kai Liu, Thermal transfer analysis method for judging the best time of removing the steel bridge deck asphalt pavement by induction heating:* The application of induction heating technology to remove the steel bridge deck asphalt pavement (SBDP) is a green, efficient and non-destructive bridge deck pavement removal method. The temperature between the steel bridge deck and the asphalt pavement is the key to the removal efficiency and effect. In order to analyze the distribution law of the temperature field, a heat transfer analysis method considering various factors is proposed, in which the thermal contact resistance (TCR) is an important factor. At the same time, this paper analyzes the influence of interlayer delamination disease on thermal resistance. Besides, by simplifying the SBDP, this study built an induction heating experimental platform to verify the effectiveness of the above method. Through this method, the distribution of the interlayer temperature field in the process of induction heating the SBDP can be accurately analyzed, so as to determine the best removal occasion of SBDP.
10) *K. Chu, Fatigue behaviour of joint-free bridges with steel and GFRP-reinforced ECC link slabs:* Engineered Cementitious Composite (ECC) link slabs provide a feasible alternative to leaking expansion joints for improving long-term durability of slab-on-girder bridges. The use of Glass Fiber Reinforced Polymer (GFRP) rebars have become increasingly common for inducing superior chemical resistance in bridge decks in salt-prone locations. Existing literature lacks experimental research on effects of fatigue load on joint-free bridges with ECC link slabs reinforced with GFRP bars. This paper presents results of experimental testing of joint-free bridges with GFRP or steel-reinforced ECC link slabs subjected to static and fatigue (up to 1 million cycles at 4 Hz) loadings. Comparative performance between GFRP and steel-reinforced ECC link slab bridges is described based on load–deflection or moment-rotation behaviour, strain characteristics and crack development in pre-fatigue, fatigue and post-fatigue stages. After 1 million fatigue cycles, the GFRP-reinforced ECC link slab exhibited smaller crack widths and higher deformation capacity while its incorporation provided superior ductility and deformation capability of the full bridge. A finite element (FE) model was also developed using experimental results to simulate load–deflection behaviour of composite deck-steel girder joint-free bridge with ECC link slab subjected to fatigue loading. Parametric FE study showed that increasing mean stress level caused increased composite deck-steel girder deflection while link slab deflection was limited by bridge span deformation.
11) *Bin Qiang, Mechanical properties of bridge-steel weldments at elevated temperatures:* The fire-resistance design of welded steel bridges depends on the temperature-dependent mechanical properties at elevated temperatures. This study investigates experimentally the temperature-induced degradation of the mechanical properties of a bridge-steel weldment. A butt-welded joint, containing the base metal (BM) Q345qD steel and weld metal (WM), was welded via submerged arc welding. Monotonic tension tests of BM and WM cylindrical specimens were carried out under various temperatures in the range of 20–700 °C, and their stress-strain relationships, failure modes, yield strength, elastic modulus, and ultimate strength at elevated temperatures were obtained and analyzed. The reduction factors of yield strength, elastic modulus and ultimate strength are compared with those recommended in current design codes. It is shown that elevated temperatures can decrease significantly the material performance of the Q345qD weldment, and the degradation of the mechanical properties of the BM and WM differs with increasing temperature. The test data indicate that the reductions in yield strength, elastic modulus, and ultimate strength at 700 °C from those at 20 °C are 78%, 55%, and 84%, respectively, for the BM and 75%, 53%, and 79%, respectively, for WM. The predictive equations for characterizing the material properties and stress-strain relationships of the BM and WM at elevated temperatures are proposed, thereby providing essential data for evaluating the fire response of steel bridges.
12) *Hua Zhao, The design and experimental study of the steel-concrete composite box girder of a harp-shaped single span cable-stayed bridge:* The chapter presents the issues of design and experiment results of a harp-shaped single span cable-stayed bridge, Hongshan Bridge, located in Changsha, China. The inclined pylon is a prestressed concrete structure, and the main girder is an orthotropic steel-concrete composite box girder. The chapter presents a scaled full model test to verify the design and analyze the results of the bridge. The chapter investigates the experimental study of the local stability of the steel box girder and the dynamic characteristics of the model with different auxiliary equipments. The chapter provides recommendations that the pylon should be in a status of axial compression when the girder is loaded by all dead loads and half live loads, and the weight of the pylon and the girder deck should be in a balanced condition. For this type of bridge, the main girder prefer to an orthotropic steel-concrete composite box girder, and the concrete deck is installed near the neutral axis of the girder. To prevent the cracking of the concrete deck, the prebending prestressing method is presented in the chapter. The chapter also indicates that setting temporary piers in the construction of the bridge is a practical and economic approach to improve wind-resistance characteristics.

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13) *Biao Wei, Investigation of equal strength mild steel tenons as displacement restraining devices for long-span railway arch bridges:* In this paper, Equal Strength Mild Steel Tenons (ESMSTs) have been developed as a candidate for displacement restraining device of long-span railway arch bridges. They are made of a cheap and easily fabricated material, low carbon mild steel. The geometry is designed according to the principle of equal strength beam to make full use of the ductile deformation of mild steel, increase the energy dissipation capacity and alleviate damage concentration. To begin, the design concept of ESMST is given followed by the derivation of the theoretical formula of the mechanical properties with the vertical free mechanism which is of no vertical load to guide the design. A pseudo-static experiment program is then presented for two full-scale 2.5 m tall ESMSTs. Besides, a rigorous 3D numerical model was developed in ABAQUS to reproduce the behavior of ESMSTs to guide the design of ESMST in future application. Finally, a case study is presented for the application of ESMST in one of typical long-span railway arch bridges to evaluate its efficiency and effectiveness. The test results indicate that the tested ESMSTs can meet the demands of the long-span railway arch bridges for high initial stiffness, energy dissipation and deformability under strong earthquake action. It was also found that the ESMST had good fatigue performance. In addition, the developed numerical model in ABAQUS can accurately reproduce hysteretic behavior of the ESMST and hence can be used with confidence in the future to guide the design of ESMSTs. Results from the case study show the ESMSTs can work effectively and efficiently in reducing the response of long-span railway arch bridges without imposing much additional demand on the substructure. Findings of this study can provide guidance on the design of ESMSTs as well as support for the application of the ESMSTs in long-span railway arch bridges.
14) *Miroslav Škaloud, 7.5 - A User-friendly Design of the Webs of Steel Bridges Subjected to Many Times Repeated Loading:* In the first part of the paper, two ways of steel bridge construction are discussed, viz. (i) thin-walled construction and (ii) economic-fabrication one. Then it is reported about new stages of the Prague research, both theoretical and experimental, on the fatigue limit state of steel plate girders whose webs breathe under repeated loading. Based on analysis of the new results and conclusions, simple formulae are established such as to give (i) the maximum web slenderness or (ii) the maximum load for which the impact of the complex problem of web breathing can entirely be disregarded in design. This approach can substantially simplify the analysis of steel girders subjected to repeated loading.
15) *Yazan M. Alshawabkeh, Lateral buckling capacity of steel H-piles supporting integral abutment bridges (IABs):* Integral abutment bridges (IABs) have been gaining wide popularity in the United States and neighboring countries due to the rapid increase in maintenance costs associated with conventional bridges. The elimination of expansion joints in IABs allows the thermally induced lateral demand in the superstructure to be transferred to the supporting piles. This paper aims to study the behavior of steel H-piles supporting IABs through a detailed nonlinear finite element analysis that was calibrated and validated against available experimental data. A total of 30 models were established to examine the effect of various parameters (pile size, pile orientation, pile material yield strength, pile equivalent cantilever length, and axial compressive load) on piles supporting jointless bridges subjected to a combined axial load and lateral cyclic displacement amplitude. Local buckling was the dominant failure mode for all the specimens. Furthermore, this paper reiterates the various parameters and assesses their influence through a statistical regression analysis to develop an empirical formula for calculating the lateral buckling capacity. The rationality of the developed formula was examined and tested with existing experimental data, which testified the reliability to be used for future design considerations.

V. CONCLUSION

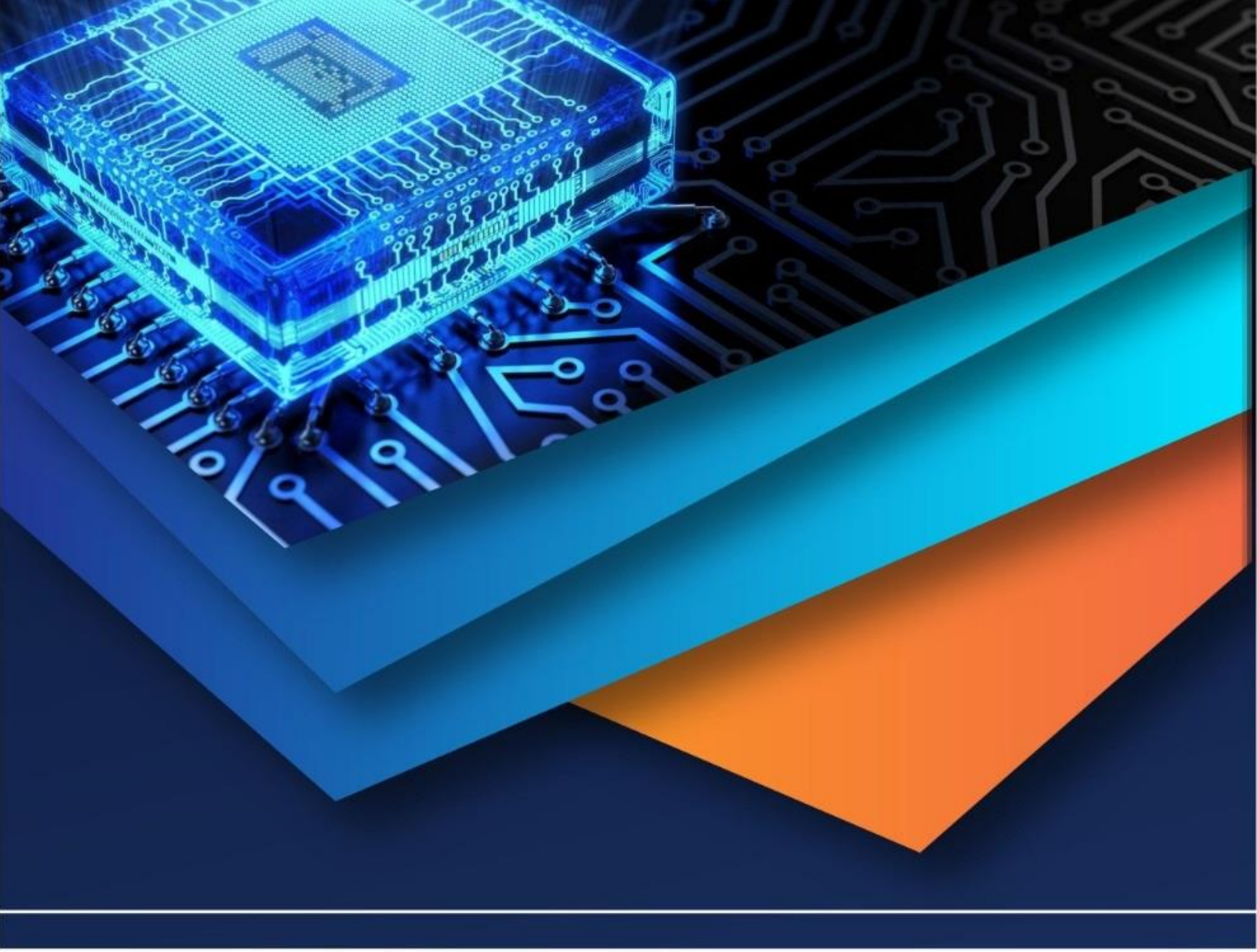
This paper reviewed the bridge vibration issues under linedinnovation and research in the future. The future direction proposed by the current review of the study, based on the gap or shortfall in existing studies linked with bridges conventional vibration test for detecting the effects of vibration scouring the work on the bridge. In addition, an investigation into the effect of vibration promotes integrated bridges also in the apparent since the behaviour of the bridge is an integral a static and different from the conventional part of the bridge. The effects of different types of sediment also are a possibility of establishing a new area of research to study the effect of vibration on the bridge.

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