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REVIEW PAPER ON RESPONSE OF CONCRETE BRIDGE DUE TO CONSTRUCTION DEFECTS

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ABSTRACT

Bridges with enormous, highly-strengthened (concrete and steel) constructions are utilised to cross geophysical obstacles. The bridge structures must function securely under all operating situations since they are an essential part of the transportation system. However, the bridges are currently operating at their critical limit because of high load vehicular movement and other damages. The present study examines various kinds of damage done to bridge decks and piers as a result of different environmental elements and loading circumstances, such as vehicle movement. For the purpose of identifying damage, current research relies on both numerical and experimental methods.

Key Words: Bridge, structural analysis, damage

I. INTRODUCTION

A bridge is a constructed infrastructure designed to provide passage over physical obstructions while maintaining the continuity of the path beneath it, including but not limited to water bodies, valleys, and roads. The design is intended to guarantee traversal across an obstruction. It is hypothesised that the initial bridges constructed by humans consisted of cut wooden logs or planks, and later on, stones. These bridges were built using a basic support and cross beam configuration. Arched bridges and aqueducts were constructed by the Romans.

Figure 1: Bridge structure

Cement was utilised by the Romans to mitigate the variability in the potency of indigenous stone. The design of bridges is contingent upon multiple factors, including the bridge's intended purpose, the topography of the surrounding area, the composition of the bridge's construction materials, and the financial resources allocated for its creation.

II. OBJECTIVE

The aim of investigating the reaction of concrete bridges to construction defects is to discern and assess the impacts of diverse construction defects on the conduct and functionality of concrete bridges. The comprehension of how construction defects can impact the structural stability and safety of concrete bridges, as well as the identification of the most probable types of defects that may arise during the construction phase, are both crucial.

The objective of the research is to examine the methodologies and approaches that can be employed for the identification and assessment of construction anomalies, encompassing non-invasive examination and surveillance mechanisms. The objective is to investigate various corrective actions that can be implemented to rectify construction deficiencies, encompassing methods for repair and rehabilitation.The study endeavours to offer suggestions for enhancing the quality of concrete bridge construction and reducing the incidence and consequences of construction defects by comprehending the reaction of concrete bridges to such defects. The aforementioned data can be utilised by professionals involved in the design, construction, and ownership of concrete bridges to augment their structural integrity and longevity, thereby promoting safety and sustained functionality. The primary goal of the investigation is to make a valuable contribution towards the enhancement of construction methodologies and benchmarks for concrete bridges.

III. LITERATURE REVIEW

Jeong-Tae Kim et. Alabama. [1] A scheme for monitoring damage based on vibrations has been investigated to provide notification of the presence, location, and extent of damage in situations where temperature is uncertain. The precision of the damage location and magnitude outcomes was significantly high when the frequencies acquired prior to and post damage were extracted under identical temperature conditions. Conversely, the precision exhibited a reduction as the temperature differential increased.

Brownjohn et al [2] Experimental and numerical investigations have been carried out on a bridge structure situated in Great Britain, Portugal, and Hong Kong. The natural frequencies and mode shapes were obtained from the analysis. Data sets spanning 23 years are being analysed to identify parameters that can be directly compared. The estimated parameters exhibit notable heterogeneity across diverse techniques and intra-method disparities, alongside temporal fluctuations and inherent variability. The phenomenon of bridge vibration is widely acknowledged and has been extensively researched, resulting in the verification of numerous parameters. The implementation of novel technologies has enabled the monitoring of the structural integrity of bridges.

Matthew J. Whelan et. Alabama. [3] I have performed vibrational analysis technique to conduct structural health monitoring and functional analysis of an integrated buttress highway bridge. Quantitative sensor-based assessment of structural health is considered the future of long-term bridge management programmes, with remote structural health monitoring systems being the preferred approach. The research discovered that the utilisation of SSI random subspace determination techniques for approximating standard parameters from experimental output data was more effective than the FDD method for frequency domain analysis, despite the substantial computational effort and subjectivity involved. Please determine the locations of the poles in the given system.

Wardhana and Hadipriono [4] Upon analysing events spanning from 1989 to 2000, it has been determined that launch events are a common cause of failures. 73% of recorded failures were attributed to short-term micro-hydraulic events, long-term wear, impact, and overloading, while approximately 12% of failures were caused by structural component deterioration, design errors, and structure-related issues. A sensor-based monitoring system would provide an early warning of any deterioration, enabling the implementation of a refurbishment or shutdown plan prior to any unsafe operation.

(Pakzad et al. [5], Paik et al. [6] and Lynch et al. [7]) It has been observed that networks typically utilise local data logging and transmission of sensor data either post-sampling or at a restricted sampling rate and/or with a restricted number of sensors to manage the bandwidth constraints of the transceiver. The limitations imposed by these assignments significantly constrain the SHC's flexibility and capacity with respect to sampling period, data collection rate, spatial resolution, and mode form quality.

Banerjee [8] A method for conducting vibration-free analysis of integral bridges was presented in a simplified manner. A technique for conducting vibration- and impact-free analysis of bridge surfaces can be achieved through explicit derivation of each term necessary for complete analysis. The technique exhibits a lack of conditioning issues that are commonly linked to the manipulation of intricate (numeric) matrices. The proposed method is utilised to demonstrate the oscillation speed and frequency of three integrated bridges. It is evident that additional research is required in this domain to ascertain the vibration characteristics of integrated bridges, investigate the variables that impact the vibration analysis of integrated bridges, and evaluate the impact of traffic-induced vibration on bridge infrastructure. The concept of an integrated bridge and the occurrence of undercut.

Kim et al. [9] The individual carried out comprehensive tests on the variability of dynamic characteristics exhibited by bridges due to alterations in temperature conditions. The endeavour involves establishing a correlation between conventional properties and temperature, as well as expanding system definition models that can differentiate temperature impacts from authentic damage indicators in dynamic model parameters.

Yeunga and Smithb [10] A study was conducted to detect the initiation of bridge damage by utilising dynamic response spectrum obtained from continuous monitoring devices, in conjunction with pattern recognition neural networks. A dependable rate of damage determination of approximately 70% can be attained with the inclusion of minimal noise in the dynamic response signals.

Brownjohn et al [11] The collaborative effort of a team from Great Britain, Portugal, and Hong Kong resulted in the establishment of a project in July 2008. The data was acquired through three distinct methodologies, namely the natural excitation technique/eigensystem realisation algorithm, random subspace determination, and multi-slit square frequency field method. A comparative analysis was conducted between the aforementioned techniques and the data obtained from the 1985 bridge test. Data sets spanning 23 years are being analysed for direct comparison of parameters. The estimated parameters exhibit notable heterogeneity across various techniques and intra-method disparities, in addition to being subject to temporal fluctuations and inherent variability. The phenomenon of bridge vibration is widely recognised and has been extensively researched, resulting in the verification of numerous parameters. Novel technologies have been employed for the purpose of monitoring the structural integrity of bridges.

Seddik et al [12] Conducted an assessment and quantification of vibration-induced impairment identification for an integrated abutment bridge. The study revealed that precise detection and localization of upper concrete surface damage on the bridge deck can be achieved through the placement of sensors in close proximity to the damage site. Additionally, the uncertainty in pattern shapes can be minimised by employing a reasonable number of drills.

Matthew J. Whelan et. Alabama. [13]. Quantitative sensor-based assessment of structural health is considered the future of long-term bridge management programmes, with remote structural health monitoring systems being the preferred approach. The research discovered that the utilisation of SSI random subspace determination techniques for approximating standard parameters from experimental output data was superior to the FDD method for frequency domain analysis, notwithstanding the considerable computational effort and subjectivity involved in the process. Please determine the locations of the poles of the given system.

Wardhana and Hadipriono [14] Based on an analysis of events spanning from 1989 to 2000, it has been determined that launch events are a common cause of failures. 73% of recorded failures were attributed to short-term micro-hydraulic events, long-term wear, impact, and overloading, whereas approximately 12% of failures were caused by structural component deterioration, design errors, and structure-related issues. The sensor-based monitoring system would provide an early indication of any deterioration, enabling the implementation of a refurbishment or shutdown plan to prevent unsafe operation.

(Pakzad et al. [15], Paik et al. [16] and Lynch et al. [17]) The study indicates that networks typically utilise local data logging and transmit sensor data either after sampling or at a low sampling rate. This is done to manage the bandwidth limitations of the transceiver and may involve a restricted number of sensors. The limitations imposed by the assignments have a significant impact on the flexibility and capacity of the SHC with respect to the sampling period, data acquisition rate, and spatial resolution. Additionally, the quality of the derived mode forms is also affected.

Banerjee [18] A method for analysing integrated bridges was presented, which ensures the absence of vibration and flutter. The method was simplified for ease of implementation. A technique for conducting a vibration- and impact-free assessment of bridge surfaces can be achieved through the explicit derivation of each term necessary for a comprehensive analysis. The technique exhibits immunity to conditioning issues that are typically linked to the manipulation of intricate (numeric) matrices, in terms of velocity and frequency.

Dr. Mohankar.R.H and Dr. Ronghe.G.N [19] The speaker delivered a discourse on the "Analysis and Design of RCC Underpass," highlighting that the RCC underpass bridge is not commonly employed in bridge construction. However, it has been increasingly utilised for facilitating traffic movement. This article presents a technical analysis of the RCC tunnel bridge. The analysis of the lower RCC bridge is conducted with the final static state in consideration. A Finite Element Method (FEM) analysis has been conducted and the outcomes have been exhibited. An analysis of the distinct forces present in the stationary end state is presented for both 2D and 3D models. [19].

Mahesh Tandon (2005) [20] It has been observed that following each significant seismic activity in the past, there has been a nearly universal inclination to augment the amplitude prerequisites of the edifice to withstand such occurrences. In the recent decade, novel approaches have been efficaciously formulated for the economic management of this issue. The present global norm has shifted towards the engineering design based on performance, as stated in reference [20].

Conducted by Khaled M. Sana and John B. Kennedy [21] (1) elastic analysis and (2) experimental studies of the elastic response of cellular bridges. In elastic analysis, "they represent bone plate theory method, lattice analogy method, curved plate method, finite element method, thin curved beam theory, etc. The curvilinear nature of box bridges, along with their complex deformation patterns and stress fields. , led designers to adopt approximate and conservative methods for their analysis and proposal. Recent literature on straight and curvilinear box bridges has addressed analytical formulas to better understand the behavior of these complex structural systems" [21]. A few authors conducted experimental studies to verify the accuracy of the current method.

Kenneth W. Schockewicz [22]. The 3D behaviour of box bridges can be approximated by utilising diaphragm equations in conjunction with planar frame analysis, based on predictions made by curved panel, finite lattice, or finite element analysis. This methodology is advantageous as a majority of structural engineers possess a computer programme featuring a flat architecture, whereas several individuals lack the inclination or accessibility to employ intricate software. This methodology facilitates the design of abutments for single-cell precast concrete chamber bridges, encompassing longitudinal shear and torsion abutments, as well as transverse bending and prestressing abutment design. The author considers the subsequent aspects for elucidation: (1) Grids can have either diagonal or vertical orientation. The transverse bend can be analysed in relation to the self-weight, uniform load, and rib load. (iii) Longitudinal shear and torsion can be analysed in relation to both symmetric (bending) and asymmetric (torsion) loading. This article provides technical guidance for the design of single-span precast concrete bridges, specifically excluding the consideration of shear shoulder and torsion stress effects. The author presents three instances of girder bridges subjected to varying loading conditions and deduces that the outcomes of the analysis of curved plates, which are deemed precise, can be closely estimated by a basic diaphragm equation in conjunction with planar frame analysis. [22].

YK Cheung et al. [23] The topic of discussion pertained to curved box-girder bridges utilising the curvilinear coordinate system, and the finite bar spline method was applied to conduct elasticity analysis. Due to the presence of the bending effect, it is imperative to consider the bridge grilles as thin plates and the flanges as flat curved plates. The displacement field, comprising radial, transverse, and vertical components, is represented by figure functions that are obtained by multiplying the functions of the B-3 slice in the longitudinal direction with its polynomial parts in the other directions. The construction of stress-strain matrices can be accomplished in a manner similar to that of the conventional finite element technique. In contrast to the finite element method, this technique yields substantial reductions in computational effort and time, as the analysis necessitates only a limited number of unknowns. This article showcases three distinct examples of box bridges with varying geometries, highlighting the nuanced and adaptable nature of the approach.

Ayman Mohamed Aqil and Sherif Al-Taweel [24] A comprehensive analysis was performed on the stress factors related to deformation in 18 composite concrete bridges and steel boxes. The bridge designs have undergone adaptation from pre-existing plans in Florida, encompassing a diverse range of parameters such as cross-sectional features, horizontal curvature, and span count. The bridges utilised as analytical prototypes have been developed by diverse organisations and constructed at varying intervals, serving as exemplars of contemporary design methodologies. The evaluation of forces is conducted via analyses that consider the construction sequence and deformation effects. The load was evaluated in accordance with AASHTO-LRFD 1998 specifications. The disparity between stresses derived from deformation-inclusive analysis and stresses calculated without accounting for deformation is utilised to assess the impact of deformation. As per the findings of the analysis, it has been observed that the deformation has minimal impact on the shear and normal stress in all the bridges, as stated in reference [24].

D.Vamshee Krishna (2015) [25] I conducted a parametric soil structure interaction study to analyse and model an RCC bridge. This article presents a technical analysis of the RCC tunnel bridge. The analysis of the lower RCC bridge is conducted based on the final static state, and the interactions between the soil structure are presented in distinct sections. The model presents various sections that offer a contrast of the distinct forces and results for the fixed equilibrium state. The 2D model is deemed suitable for analysis in this study, specifically for the loading conditions stipulated in IRC. 6

Derek J. Hodson et al. [26] Research has been carried out on box-girder bridges utilising sophisticated health monitoring methodologies. The bridge's structural integrity is evaluated under dynamic loading conditions in accordance with IRC 8 standards, specifically for driving vehicles and a six-lane bridge deck. Displacement transducers and strain gauges are utilised to assess the impact of mobile loads. Based on the experimental and finite element analysis (FEA) outcomes, a deduction is made concerning the areas of utmost importance.

Molish K. Pathak (2014) [27] A research investigation was carried out to analyse the performance of box-type concrete-filled steel tube composite structural components in curved bridge structures. The research offers multiplication coefficients for various parameters concerning different levels of bending, ranging from 10° to 90° with respect to. A linear structure with zero degree inclination, commonly referred to as a straight bridge, available in a range of sizes spanning from 15 metres to 30 metres. The implementation of a multiplication factor in the analysis of a straight bridge can prove advantageous in comparison to a curvilinear bridge. This can prove to be highly advantageous in formulating the primary partition.

Radek Wooziness et al [28] I have performed an investigation on the free vibration analysis of steel girder bridges. The analysis is performed utilising the ABAQUS simulation software. The vibrational characteristics of a bridge are analysed by examining the natural frequency and mode shape output parameters in relation to the curvature ratio and span length. The empirical evidence indicates that the vibrational characteristics of a bridge are significantly impacted by the quantity and width of its beams.

Md Tautened Riyaz and Syed Nikhat Fathima [29] Conduct a comparative analysis between AASHTO and IRC standards with regards to the design of bridge superstructures and application of extreme loads. Evaluate two types of examples, namely single-cell and four-cell beam, and draw comparisons between them. When a box-type superstructure-style load is installed, an IRC AA class load is implemented. The AASHTO code shall be utilised. The AASHTO token is utilised for its secure Internet Relay Chat (IRC) capabilities. As the depth of the beam reduces, there is a corresponding reduction in prestressing strength and cable count. The AASHTO standard is comparatively more cost-effective than the IRC cod**e.**

Virajan Verma et al. [30] have performed an investigation on a thin-walled box-girder bridge subjected to both static and dynamic loading scenarios. The analysis is performed utilising the MATLAB FEA simulation package through a 1D model due to its straightforwardness. Various output parameters are assessed to determine the impact of distinct variables such as radius, span length, loading position, and cross-section alteration on strength and deformation.

IV. CONCLUSION

The extant review delineated various methodologies for evaluating bridge deterioration. The aforementioned methodologies employ computational systems, non-invasive inspection procedures, and numerical algorithms. The design of a structural health monitoring system can be characterised by its data acquisition rate, spatial resolution, and sampling frequency. The occurrence of bridge collapse can be ascribed to factors such as fatigue cracks, structural deficiencies, and defects.

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