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Review on Stability Analysis of Bridge Structures

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Abstract - *Bridges of huge structures made of high strength materials (concrete and steel) which is used to overcome geo-physical barriers. The bridge structures ought to work safely under all working conditions which is vital transportation network. However, due to high load vehicular movement and other damages the bridges are operating at critical limit. The current research reviews various types of damages incurred on bridge deck, bridge piers due to various environmental factors and loading conditions like vehicular movement. The existing researches are based on use of both numerical and experimental techniques for damage detection.*

Key Words: Bridge, structural analysis, damage

1.INTRODUCTION

A bridge is a man-made structure built to avoid physical obstacles without closing the path beneath it, such as a body of water, a valley, or a road. It is designed to ensure passage over an obstacle. The first bridges made by humans were probably spans of cut wooden logs or planks and eventually stones, using a simple arrangement of support and cross beam. The Romans built arched bridges and aqueducts.

Figure 1: Bridge structure

The Romans also used cement to reduce the fluctuation in strength of natural stone. Bridge designs vary depending on the function of the bridge, the nature of the terrain where the bridge is built and anchored, the material used to make it, and the funds available for its construction.

2. LITERATURE REVIEW

Jeong-Tae Kim et. Alabama. [1] A vibration-based damage monitoring scheme has been studied to alert the occurrence, location and severity of damage under conditions of temperature uncertainty. Damage location and damage magnitude results were highly accurate when the frequencies before and after damage were obtained from the same temperature conditions. On the contrary, this accuracy decreased with increasing temperature difference.

The environmental vibration study of the Humber Bridge was conducted by Brownjohn et al [2] have conducted experimental and numerical investigation on bridge structure located at Great Britain, Portugal and Hong Kong. From the analysis they obtained natural frequencies and mode shapes. Parameters over 23 years where a direct comparison can be made. Approximate parameters show significant variability between different methods and differences within the same method, while also changing over time and have inherent variability. Vibration of bridges is well known and many studies have been carried out and many parameters have been verified. New technologies have been used to monitor the condition of bridges.

Matthew J. Whelan et. Alabama. [3] have conducted structural health monitoring and functional analysis of integrated buttress highway bridge using vibrational analysis technique. Remote structural health monitoring systems that use quantitative sensor-based assessment of structural health are seen as the future in long-term bridge management programs. The study found that using SSI random subspace determination techniques to approximate typical parameters from experimental output data was better than FDD method for frequency domain analysis despite the high computational effort and subjectivity required to do so. Identify the poles of the system.

The investigation and study of more than 500 bridge failures by Wardhana and Hadipriono [4] looking at events from 1989 to 2000 concluded that common failures are caused by a launch event. Short-term micro-hydraulic events, long-term wear, impact, and overloading accounted for 73% of documented failures, while structural component deterioration, design errors, and structure-related issues accounted for approximately 12% of failures. . The response of a sensor-based monitoring system would proactively signal such a deterioration so that a refurbishment or shutdown plan could be implemented before an unsafe operation.

A review of recent operations of wireless sensors for integrated bridge health monitoring (Pakzad et al. [5], Paik et al. [6] and Lynch et al. [7]) reveals that networks have generally relied on local data logging and transmission of sensor data after sampling or at a low sampling rate and/ or a limited number of sensors to handle the bandwidth limitations of the transceiver. These assignments severely limit the flexibility and capacity of the SHC in terms of sampling period, data collection rate, and spatial resolution, as well as the quality of the derived mode forms.

Banerjee [8] presented a simplified method for vibration-free analysis of integral bridges. An analytical method for vibration- and impact-free analysis of bridge surfaces can be obtained by explicitly deriving each term required for the full analysis. The method is free from conditioning problems generally associated with the processing of complex (numerical) matrices. The oscillation speed and frequency of three illustrative examples of integrated bridges are illustrated using the proposed method. It is clear that this field needs further research to discover the vibration of the integrated bridge and to study the factors affecting the vibration analysis of the integrated bridges and the effect of the vibration of the integrated bridge due to traffic on the bridge infrastructures. Integrated bridge, as well as the phenomenon of undercut.

Kim et al. [9] He conducted extensive experiments on the diversity of dynamic properties of bridges resulting from changing temperature conditions. They have attempted to correlate typical properties with temperature and also to extend system definition models that can separate temperature effects from true indicators of damage in dynamic model parameters.

Yeunga and Smithb [10] developed a study to perceive the onset of bridge damage, using dynamic response spectrum assessed from non-stop monitoring tools, combined with pattern recognition neural networks. Finally, a reliable damage determination rate of about 70% can be achieved even with the addition of a small amount of noise to the dynamic response signals.

The environmental vibration study of the Humber Bridge was conducted by Brownjohn et al [11] in July 2008 by a team from Great Britain, Portugal and Hong Kong. Obtained using three techniques, namely natural excitation technique/eigensystem realization algorithm, random subspace determination, and multi-slit square frequency field method, compared with each other and with those obtained from the 1985 bridge test. Parameters over 23 years where a direct comparison can be made. Approximate parameters show significant variability between different methods and differences within the same method, while also changing over time and have inherent variability. Vibration of bridges is well known and many studies have been carried out and many parameters have been verified. New technologies have been used to monitor the condition of bridges.

Seddik et al [12] performed an evaluation and measurement of vibration-based damage detection for an integrated abutment bridge. It was found that localized damage to the upper concrete surface of the bridge deck could be reliably detected and localized if the sensors were placed close to the damage and if the uncertainty in the shapes of the patterns was mitigated with a reasonable number of drills. .

Wireless real-time vibration monitoring for a functional modular analysis of an integrated buttress highway bridge Matthew J. Whelan et. Alabama. [13]. Remote structural health monitoring systems that use quantitative sensor-based assessment of structural health are seen as the future in long-term bridge management programs. The study found that using SSI random subspace determination techniques to approximate typical parameters from experimental output data was better than FDD method for frequency domain analysis despite the high computational effort and subjectivity required to do so. Identify the poles of the system.

Investigation and study of more than 500 bridge failures by Wardhana and Hadipriono [14] considering events from 1989 to 2000 concluded that common failures are caused by a launch event. Short-term micro-hydraulic events, long-term wear, impact, and overloading accounted for 73% of documented failures, while structural component deterioration, design errors, and structure-related issues accounted for approximately 12% of failures. . The response of the sensor-based monitoring system would proactively indicate such deterioration so that a refurbishment or shutdown plan could be implemented before unsafe operation.

A review of recent operations of wireless sensors for integrated bridge health monitoring (Pakzad et al. [15], Paik et al. [16] and Lynch et al. [17]) shows that networks have generally relied on local data logging and transmission of sensor data after sampling or at a low sampling rate and/ or a limited number of sensors to handle the bandwidth limitations of the transceiver. These assignments severely limit the flexibility and capacity of the SHC in terms of sampling period, data acquisition rate, and spatial resolution, as well as the quality of the derived mode forms.

Banerjee [18] presented a simplified method for vibration-free and flutter-free analysis of integrated bridges. An analytical method for vibration- and impact-free analysis of bridge surfaces can be obtained by explicitly deriving each term required for the full analysis. The method is free from conditioning problems generally associated with the processing of complex (numerical) matrices. speed and frequency

Dr. Mohankar.R.H and Dr. Ronghe.G.N [19] gave a discussion on "Analysis and Design of RCC Underpass" and stated that the underpass RCC bridge is rarely used in "bridge construction, but recently the underpass RCC bridge has been used for traffic movement. In this article, an analysis of the RCC tunnel bridge is performed. This lower RCC bridge analysis is performed keeping in mind the final static state. Finite element method (FEM) analysis is performed and the results are presented. A comparison of the different forces between 2D and 3D models of the stationary end state is provided" [19].

Mahesh Tandon (2005) [20] has studied that with every major earthquake in the past, "there has been an almost global trend to increase the amplitude requirements of the structure to handle such events. Only in the last decade have new strategies been successfully developed to economically manage this problem. Current international practice has moved towards performance-based engineering design" [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.

A rough analysis of concrete box girder bridges was made by Kenneth W. Schockewicz [22]. The actual 3D behavior of "box bridges, as predicted by curved panel, finite lattice or finite element analysis, can be approximated using some simple diaphragm equations combined with planar frame analysis. This is a useful method because almost all structural engineers have access to a computer program with a flat architecture, while many do not have the access or desire to use more complex software. In particular, this method allows transverse bending and prestressing abutment design, as well as the design of longitudinal shear and torsion abutments in single-cell precast concrete chamber bridges. The author takes into account the following points for clarification: (1) Grids can be diagonal or vertical. (ii) The self-weight, uniform load and rib load may be considered with respect to transverse bend. (iii) Both symmetric (bending) and asymmetric (torsion) loading can be considered with respect to longitudinal shear and torsion. This article is particularly useful in the design of single-span precast concrete bridges without considering the effect of shear shoulder and torsion stress. The author gives three examples of girder bridges with different loading conditions and concludes that the results of curved plate analysis, which are considered accurate, can be approximated very precisely by a simple diaphragm equation in combination with planar frame analysis" [22].

YK Cheung et al. [23] We discussed curved box-girder bridges based on the curvilinear coordinate system, and the finite bar spline method extends to elasticity analysis. Since the bending effect cannot be ignored, the bridge grilles should be treated as thin plates and the flanges as flat curved plates. Figure functions are given to describe the displacement field (radial, transverse and vertical) as a product of the functions of the B-3 slice in the longitudinal direction and its polynomial parts in the other directions. Stress-strain matrices can be constructed as in the standard finite element method. Compared with the finite element method, this method provides significant savings in computational time and effort, as the analysis requires only a few unknowns. This article presents three examples of box bridges of different geometries that demonstrate the subtlety and versatility of the method.

Ayman Mohamed Aqil and Sherif Al-Taweel [24] conducted a detailed investigation of the stresses associated with deformation in 18 composite concrete bridges and steel box. Bridge designs have been adapted from existing bridge plans in Florida and include a wide range of parameters, such as horizontal curvature, cross-section characteristics, and number of spans. The "bridges on which analytic prototypes are designed have been designed by different companies and built at different times and are representative of current design practices. The forces are evaluated through analyzes that take into account the construction sequence and the effect of deformation. The load was considered according to AASHTO-LRFD 1998. The differences between stresses obtained considering deformation and stresses computed ignoring deformation are used to evaluate the effect of deformation. The results of the analysis show that the deformation has little effect on both shear and normal stress in all bridges" [24].

D.Vamshee Krishna (2015) [25] studied RCC bridge modeling and analysis using a parametric soil structure interaction study. In this article, an analysis of the RCC tunnel bridge is performed. This lower RCC bridge analysis is performed considering the final static state and soil structure interactions are presented in different sections. A comparison of the different forces and outcomes are provided in different parts of the model for the stationary end state. In this study, the 2D model can be effectively used for analysis purposes for the loading conditions given in IRC: 6

Derek J. Hodson et al. [26] have conducted research on box-cast bridges using advanced health monitoring techniques. The bridge structure is tested using moving load conditions as per IRC 8 i.e. for drive vehicles and for 6 lane bridge deck. The effect of moving loads are evaluated using displacement transducers and strain gauges. Using the experimental and FEA results, the conclusion is drawn regarding critical regions.

Molish K. Pathak (2014) [27] conducted a study on the behavior of box-type CSCs in curved bridges. The study provides multiplication factors for all parameters for different degrees of bending (ie from 10° to 90°) WRT. A straight bridge (0°) and of various dimensions (between 15 m and 30 m). They can be useful to simplify the analysis when considering a straight bridge rather than a curvilinear bridge where the multiplication factor is used by the procedure corresponding to a straight bridge. This can be very useful in designing the initial partition.

Radek Wooziness et al [28] have conducted research on free vibration analysis of steel girder bridges. The analysis is conducted using ABAQUS simulation package. The effect of curvature ratio and span length on vibrational characteristics of bridge is investigated on the basis of output parameters i.e. natural frequency, mode shape. The research findings have shown that number of beams and thickness of beams have significant effect on vibrational characteristics of bridge.

Md Tautened Riyaz and Syed Nikhat Fathima [29] In a comparative study and analysis of two standards, AASHTO and IRC, follow the design of the bridge superstructure and application of extreme load for two types of examples, namely single-cell and four-cell beam and compare them. An IRC AA class load is followed when a box-type superstructure-style load is installed. AASHTO code will be used. The AASHTO token is used due to its IRC security. As the beam depth decreases, the prestressing strength decreases and the number of cables decreases. AASHTO code is obviously cheaper than IRC.

Virajan Verma et al. [30] have conducted research on thin-walled box-girder bridge under static and dynamic loading conditions. The analysis is conducted using MATLAB FEA simulation package using 1D model owing to its simplicity. Different output parameters are evaluated and the effect of different variables like radius, span length, loading position, cross-section change are evaluated on strength and deformation.

3. CONCLUSION

The existing review presented different techniques for bridge damage assessment. These techniques use computer systems, non-destructive testing methods and numerical techniques. A robust structural health monitoring system can be designed in terms of data collection speed, spatial resolution, and sampling period. Bridge collapse can also be attributed to fatigue cracks, structural and structural defects.

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