# A Review of Structural Health Monitoring and Auditing of Steel Bridge

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**Abstract -** *Outstanding to the considerable role of bridge in transport networks and in accordance with the limited funding for bridge management, remediation strategy have to be prioritized. A traditional bridge assessment will result in unnecessary actions, such as costly bridge intensification or repairs. On top of the other give, any bridge preservation neglect and delayed actions may lead to grave prospect expenses or tainted possessions. The accuracy of decision urbanized by any boss or viaduct engineer relies on the accuracy of the bridge condition assessment which emanates from visual examination. Many bridge rating systems are base on an extremely slanted process and exist associated with doubt and personal bias. The developing condition rating method described herein is a significant step in adding more holism and impartiality to the current approaches. Structural importance and fabric vulnerability are the two main factors that should be considered in the evaluation of constituent structural index and the causal factor as the representative of age, surroundings, road class and assessment is implementing as a coefficient to the in universal structural directory.*

## 1. INTRODUCTION

Every year, India loses an average of 2658 peoples to different kind of structural collapses; that is around 7 deaths a day. In this structural collapses include houses, buildings, bridges and still dams, amongst others. As many as 13178 peoples lost their lives owing to fall down of a variety of structures between 2010 and 2014, according to data compiled by National Crime Records Bureau. In which 297 peoples deaths are caused by only bridge failures. According to reports published by road & railway authorities, many bridges in our country are measured to be either structurally deficient or obsolete. The situation of greatly used city bridges is still worse: One in three is classified as ageing or unable to accommodate current vehicle weights and traffic volume.

Structural Health Monitoring (SHM) of steel bridges can provide a quantitative information concerning the structural behaviour & structural defects in order to assess the real present situation of the bridge & allow the engineers to take knowledgeable conclusion for the avoidance of failure events and to make sure or to increase the security of the structures. Structural Health Monitoring (SHM) can be used to increase the safety of the bridges and very helpful in serving as an alarm system for prevent bridge failures. In later, Structural Health Monitoring (SHM) provides information for the preparation of inspection and maintenance behavior.

Civil infrastructures as well as bridges and buildings, begin to deteriorate one time they are build and used. Maintain safe and reliable civil infrastructures for everyday use is significant to the well being of all of us. Meaningful the honesty of the structure in conditions of its age and usage, and its level of security to survive infrequent but high forces such as overweight loads, earthquake, and fatigue is significant and necessary. The process of determining and track structural honesty and assessing the natural history of damage in a structure is often referred to as health monitoring. Structural health monitoring and damage recognition are assuming larger and larger importance in civil engineering. Structural Health Monitoring (SHM) is defined as the use of in-situ, non-destructive sensing and analysis of structural characteristics in order to identify if damage has occurred, identify its position and estimate its severity, assess its penalty on the residual life of the structure

## 2. LITERATURE REVIEW

**2.1.1.** Danish Zaman, Amir Ali, Ayush Singh et al **"Structural Health Monitoring of Civil Infrastructure"**

Health monitoring of structures is becoming more and more important: its ultimate target is the ability to monitor the structure throughout its working life in order to reduce maintenance requirements and subsequent downtime. Currently, visual inspection is the standard method used for health measurement of structures, along with non-destructive evaluation technique. However, most of these techniques require a lot of manual work and a significant downtime. Thus, currently an increasing interest in SHM is rising, because it can provide cost savings by reducing the number of manual inspections. Wireless sensing are becoming desirable features in SHM systems and there has been a large growth of new sensors during the last years. However, optimized and autonomous SHM systems are still not so spread.

The most recent and innovative applications concern of possible interaction among earthquake early on warning, structural health monitoring and structural control. However, unlike traditional seismic monitoring, an event driven monitoring system is not useful: continuous condition assessment and performance-based maintenance of civil infrastructures are necessary in order to assess the shortterm impact due to earthquake and the long-term deterioration process due to physical aging and routine process.

**2.1.2.** Maria Rashidi, Peter Gibson et al **"Proposal of A Methodology For Bridge Condition Assessment"**

Due to the considerable role of bridges in transportation networks and in accordance with the limited funding for bridge management, remediation strategies have to be prioritised. A conservative bridge assessment will result in needless actions, such as costly bridge strengthening or repairs. On the other hand, any bridge maintenance negligence and delayed performance may lead to heavy future costs or degraded assets. The accuracy of decisions developed by any manager or bridge engineer relies on the accuracy of the bridge condition assessment which emanates from visual inspection. Many bridge rating systems are based on a very subjective procedure and are associated with uncertainty and personal bias. The developing situation rating method described herein is an important step in addition more holism and objectivity to the current approaches. Structural importance and material vulnerability are the two main factors that should be considered in the evaluation of element structural index and the causal factor as the representative of age, environment, road class and inspection is implemented as a coefficient to the overall structural index. The Analytical Hierarchy Process (AHP) has been applied to evaluate the priority vector of the causal parameters.

**2.1.3.** María Victoria Biezma And Frank Schanack et al **"Collapse Of Steel Bridges"**

The collapse of bridges is always an unfortunate incident because of the loss of human life and also economic losses; however, it is an integral part of the history and the development of bridges. The comparatively high safety that we benefit from today could not have been established without these terrible accidents. On one hand many effects on the structural performance were unknown previous to and could therefore not be investigated. On the other hand, even though calculation methods are well developed and model and material tests exact, it is still to be proven that the finished structures behave according to the predictions.

Most defects or collapses of bridges occur independently from the construction material: Force majeure (65%), accidental overload and impact (12%), and scour (9%). Concerning the other three collapse causes, which are structural and design deficiencies (9%), construction and supervision mistakes (3.5%), and lack of maintenance (1.5%), steel bridges show particular risks for failures like, e.g., column and plate buckling, fatigue, brittle fracture at low temperature, and corrosion. Only when these problems are respected is it possible to make use of the great advantages, like high strength and weld-ability, and build outstanding, durable bridges.

**2.1.4.** Amanda Bao, Michael Gulasey, Caleb Guillaume, Nadezhda Levitova, Alana Moraes, Christopher Satter et al **"Structural Capacity Analysis of Corroded Steel Girder Bridges"**

More than 9% of the bridges in the United States were labelled structurally deficient according to the 2017 American Society of Civil Engineers' infrastructure report card. The main causes of bridge deterioration are repeated vehicular loads and adverse environmental exposure. The most dominant deterioration form for steel bridges is corrosion, which is characterized by the loss of metal area resulting in reduction of structural capacity. Corrosion in steel multi-girder bridges is ordinary in cold regions because of the frequent use of dicing chemicals during the winter season as well as leakage caused by bridge joint damage. At times, the rust is serious enough to disconnect the web from the flanges of the girder. This poses important concerns for load capacity especially at girder ends. The consequences of bridge failure can be disastrous. This research investigates the structural capacity of these corroded steel girders. The mechanical behaviours of deteriorated girders are studied by 3-D finite element models built in ABAQUS and by lab testing. Our analysis is focused on web area loss and web thinning due to corrosion, and their consequences for load capacity reduction. The effects of location, size, and shape of area loss on shear and web buckling resistance will be studied. Lab tests on steel girder models will be conducted to verify the results from finite element modelling. Based on our analysis and findings, a simple and dependable rating method to assess deteriorated steel girder bridges will be developed.

**2.1.5.** Y. Matsumoto & H. Yamaguchi T. Yoshioka et al **"A Field Investigation Of Vibration-Based Structural Health Monitoring In A Steel Truss Bridge"**

This paper presents an investigation to seek the applicability of vibration-based technique to structural health monitoring of steel truss bridges. A Warren truss bridge for road traffic in-service for more than 40 years was used in this examination. There were a partial fracture, cracks and pitting corrosions in diagonal members of the truss bridge detected during recent visual inspections and some of those damages were repaired during the investigation. Vibration measurements were conducted for the identification of global vibration mode of a single span and local vibration modes dominated by vibration of diagonal members. Road traffic was the source of vibration during the measurements. Impact testing was also conducted for the measurement of local vibration. The possibilities of modal properties of global and local vibration modes in the identification of structural changes in truss bridges were discussed based on the results of measurement and finite element analysis.

**2.1.6.** M. de Bouw & I. Wouters **"Investigation of The Restoration of The Iron Suspension Bridge At The Castle of Wissekerke"**

The two world wars have seriously limited the number of historical bridges in Belgium. Many strategic bridges have been blown up or bombed. Therefore, the history of bridge building can only be examined by (small) ornamental bridges, for example in castle parks and gardens. The oldest existing wrought iron suspension bridge in Belgium and one of the oldest on the European Continent is spanned over the pond at the castle of Wissekerke in the district of Bazel-Kruibeke. The Brussels engineer Jean-Baptiste Vifquain designed it in 1824. In spite of the modest span of 23 meters, the bridge is of great industrial archaeological value, because of its historical and structural uniqueness. Since 1981, the bridge at Bazel has been a protected historic monument. Because of the lack of maintenance and the specific building type, different parts of the ironwork are broken or bent, and strongly corroded. So, at present, this historical heritage is in very poor condition and some urgent maintenance and restoration work should be conducted. Fortunately, the council of Bazel intends to buy the park and the bridge. As from August 2004, they invited us to start with the restoration of this historical suspension bridge.

**2.1.7.** Sudhakar R. Kulkarni **"Bridge Deterioration And Its Imp Act On Bridge Rating- A Parametric Study"**

Determining the vehicular load carrying capacity of the existing highway bridges provides a challenge to the engineer. As the accessible bridges age, deterioration, corrosion, fatigue, completion of foundations, and potential scour problems pose number of challenges in computing the strength of bridge machinery. At the same time, the truck traffic is mounting and also the weights carried by various commercial trucks. The engineer should take into account conditions of the superstructure including the bearings in some cases, conditions of substructures units such as abutments and piers. Foundations should be evaluated, as needed, if settlements or scour problems are observed. One needs to take a look at the entire bridge and evaluate load transfer from the superstructure to foundations. This may not be needed in each case, but few situations may require evaluation of bridge superstructure and substructure at what time computing the load carrying capacity.

## 3. CONCLUSIONS

The progress of attack on manufacturing metals and alloys is usually observed to be linear when the total smash up is plotted against exposure time on logarithmic coordinates. Guiding values of corrosion attack can be used to predict the extent of corrosion show aggression in long-term exposures based on measurements of corrosion attack in the first-year exposure to the outdoor atmosphere in question. Crevices and sheltered areas not exposed to rain impingement have been observed to knowledge significantly higher deterioration damage than open surfaces. The following conclusion can be done:

- Health monitoring of structures is becoming more and more essential: its ultimate target is the ability to check the structure throughout its working life in order to reduce maintenance requirements and subsequent downtime.
- Currently, visual examination is the standard method used for health assessment of structures, along with non-destructive evaluation techniques. However, most of these techniques necessitate a lot of manual work and a significant downtime. Thus, currently an rising interest in SHM is rising, because it can provide cost savings by reducing the number of manual inspections.

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