TOWARDS EFFECTIVE INSPECTION AND MAINTENANCE OF HIGHWAY BRIDGES

Bridges, including the tunnels, are integral elements of the highway system. Despite their importance, however, they are not given the priority they deserve. As per Reports, over 40 percent of the bridges across the country are, perhaps, over 40 years old and a significant percentage of them are structurally or functionally deficient, which means they require costly rehabilitation or replacement. The consequences of a bridge failure can vary from a minor disruption of traffic to catastrophic collapse with large scale injuries and loss of lives. Demands on most of these bridges have been increasing annually due to increasing traffic volumes, higher loads and harsh environment. These conditions, coupled with the inadequate funding allocated for maintenance, are leading to accelerated ageing and extensive deterioration of these crucial structures.

Demands on limited resources alongwith giving priorities to the road for increasing capacity and improving riding surfaces, often result in deferred maintenance of bridges. The consequences are obvious - bridges are deteriorating faster than they are being rehabilitated. It is of pressing concern to accurately assess bridge structural stability and identify concerns to assure continued serviceability of the highway system in a timely and prudent manner.

A large number of the bridge structures on the roads have been constructed during the past few decades. Considering the enormous increase in intensity and volume of traffic, these old structures have now been evaluated as unserviceable, by present standards. However, these structures cannot be discarded overnight as this will entail colossal investment. Coming to the more recent structures, the modern bridges are designed with optimum sections and are constructed with the latest sophisticated techniques. The development of new materials, technologies, equipment and processes has been fully exploited in constructing these new structures. But, refinements in construction can only be possible if these are well maintained and their behaviour exhaustively monitored over the years to come. There is simply no place for unsafe bridges in our highway system, no matter how old or modern they are.

Safety and functionality of the structures and the users should be the primary consideration during inspection and maintenance. Attempts should be made to classify the existing structures according to the load carrying capacity and limiting the loads plying on them; questionable bridges should be closed immediately rather than risking collapse and immediate steps should be taken to strengthen/replace them, as per the inspection evidences. Equal emphasis needs to be laid on proper maintenance of highway bridges, both in respect of the older ones, showing visible signs of distress and the newer bridges, which are being designed critically with optimum sections. The problem in respect of modern-day bridges is more of keeping a close watch to ascertain that they behave in the same manner as contemplated in the design. Structures located in the coastal areas and steel bridges prone to constant atmospheric attacks should be inspected more frequently and suitable remedial measures taken to keep them in sound condition.

To date, the primary method of bridge structure preventive maintenance has centered upon visual inspections by trained teams of inspectors. But, this is not without flaws. In a study conducted by the Federal Highway Administration (FHWA)

on the reliability of visual inspections, it was found that the success rate is only 3.9 percent for up-close, arm's length inspections of bridge structures. Accordingly, the FHWA is of the view that on-site visual inspections could be supplemented with technological advancements to improve the accuracy and reduce the costs associated with such inspections.

Literature Survey has revealed that non-destructive evaluation and testing technologies have been implemented in the field in USA to investigate structural characteristics which lie outside the capability of visual inspection techniques. While many non-destructive techniques have been developed, the cost limitations and effectiveness within a real world environment have prohibited the use of such technologies outside the laboratory. For these reasons, the primary non-destructive technologies have been limited to strain gauges, accelerometers, fibre optics, ground penetrating radar and acoustic sensors. Some key areas where instrumentation could be used for providing quantitative data supporting the determination of structural integrity are; bridge deck and road surface, steel superstructure, concrete supports, joints, abutments and foundations.

To reconcile the drawbacks of the non-destructive evaluation methods, macro structural analysis could provide an assessment of the bridge through the characterization of dynamic structural characteristics. The vibration response of a bridge structure could give an insight into the integrity of the design under normal operating conditions and overall bridge performance such as structural damping and the effects of environmental variability. This dynamic analysis could be used to obtain information supporting future improvements in the methods of bridge designing as well as preventive maintenance.

Implementation of intelligent technologies could also assist in the development of an instrumentation solution capable of systematic bridge condition evaluation. In tandem with the development of instrumentation technologies, there is a need to develop communication solutions which provide simple means to install and maintain a viable sensory network on a bridge structure. Research into wireless networking communication solutions and remote power sources could serve to develop discrete, low cost sensor modules that could easily be applied to provide increased analysis resolution of key elements of bridges.

Considering the scope of the possible sources of failure within the highway system as a whole, there is a distinct need to quickly identify, assess and prioritize bridge structural health in a cost effective manner. It is, however, realized that the application of structural health monitoring technology to bridge structures for the purpose of developing an accurate qualitative and quantitative assessment of bridge integrity is presently an immature field. While several instrumentation options exist for the purposes of the analysis of structures, there has been difficulty in the applications where data collected provides valuable insight at a reasonable cost. A strong focus on the development of advanced instrumentation technologies coupled with state-of-the-art data analysis methods will lead to a better understanding of the performance of bridges throughout their lifetime. Throughout this evolution of structural monitoring solutions, the application of assessment technology to support preventive maintenance will save money and save lives.

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