NEED FOR CONDITION MONITORING OF BRIDGES

The road network is, perhaps, most important system in the transportation infrastructure of a nation. It helps to sustain commerce in almost every sector of the national economy and is used for both pleasure and necessity by almost every citizen. Maintaining this system at a high performance level is vital for public safety, societal well-being and economic productivity and growth. Bridges comprise significant and critical discrete links in the road transportation system. Clearly, the job of managing and maintaining the bridges represents a significant challenge, especially considering the difficulties in generating the level of additional funds necessary to finance these activities.

Significant improvements in inspection, rating and management operations of bridges have taken place globally. However, according to FHWA, a fundamental weakness in the bridge management systems has been the reliance on visual inspection and subjective condition assessment. These inspections cannot evaluate damage in the absence of visible symptoms such as deck concrete deterioration under asphalt overlay, corrosion of reinforcement, scour etc. Moreover, data analysis is based on characterizations that typically do not incorporate the mechanisms significantly influencing actual bridge behavior. Current practices in evaluating serviceability, fatigue and ultimate limit capacity of a bridge are accomplished only with great uncertainty; thus, their effectiveness in decision making is greatly reduced. Without more accurate information on bridge superstructure and substructure, implementing agencies are not able to decide where, when, and how to spend limited resources efficiently.

Increase in traffic in recent years has put more strain on the road infrastructure than it was initially intended for though it is also a fact that bridges and other structures built in the past are performing more satisfactorily than more recently constructed concrete structures in the same environment. However, professionals, to-day, put the blame of lack of durability of structures primarily, on the more corrosive nature of environment and secondary on poor workmanship in finishing the structures. Whatever may be the causes, many of the reinforced and prestressed concrete bridges constructed during recent decades, have suffered from early corrosion in the steel elements and the consequent structural decay and distress.

Bridge engineers need a reliable way to assess structural integrity of bridges to maintain the continuous operation of the road network while ensuring the safety of the public. The preventive maintenance of bridges and structures has long centered on traditional methods of Non-Destructive Evaluation (NDE) for the early detection of potentially catastrophic faults such as stress cracks and corrosion-induced fractures. Such methods include visual inspections and dye-penetrant tests which require a degree of experience to obtain results that are still subjective in interpretation. Further, such tests are invariably time consuming and tedious to perform. They are qualitative in nature and can only assess outward appearance. Any internal damage may go unnoticed for a long period of time. With the relentless aging of the road infrastructure, an effective bridge health monitoring system has become imperative.

Bridge monitoring is the application of Structural Health Monitoring (SHM) and inspection techniques to bridge structures. Bridge Health Monitoring can be subdivided into multiple types of categories. Both the time frame of monitoring and the scale of monitoring are necessary considerations that need to be addressed before choosing a type of monitoring system. Online Condition Monitoring has emerged as an attractive alternative to the traditional approach of preventive maintenance. This is especially so in the civil and structural industry where it is finding widespread application in the health monitoring of bridges and other vital infrastructures which have been converted into 'intelligent' systems through the incorporation of computer-linked sensors. The potential of smart structure technology to yield operational benefits, such as near-instantaneous damage detection and quantification of residual load capacity in military bridges exposed to enemy fire, is enormous and constitutes a true combat-multiplier.

Just a few years ago, the capabilities described above would have been possible only in the realm of sci-fi. Today, achieving the above is strictly a matter of time, money and some research efforts. Advances in sensor technology, especially fiber optics and piezo-ceramics, coupled with the increasing use of composites as a material for mobile structures, could expedite the development process and, perhaps, could even introduce hitherto un-thought-of capabilities.

Literature survey has revealed that determination of bridge foundation conditions is very essential element of bridge condition survey. The results of this survey would have to be predicted accurately for quantifying losses in foundation stiffness caused by earthquakes, scour and impact events. Identification of bridge foundation type could be employed to estimate bridge stability and vulnerability under dead and live load ratings, particularly for unknown bridge foundations. The dynamic evaluation and monitoring results eventually may be integrated into current and proposed Bridge Management System (BMS) databases to provide baseline data for comparison of bridge substructures after catastrophic events. Bridge superstructure condition evaluation surveys generally focus on two primary areas i.e. ultimate load tests and dynamic tests. These studies provide some insight on the ultimate load capacity and mechanisms of failure that could be used, in future. However, laboratory and field studies need to be correlated to evaluate dynamic properties and relate them to condition assessments of bridges.

In addition to these initiatives, the development of Bridge Management System (BMS) has been necessitated by the large imbalances between the need for extensive repairs and replacement of structures in the road network and the limited budget available to agencies for implementing the required repairs. Safety and serviceability of bridges can only be ensured by establishing a proper system of management of bridges through BMS.

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