Assessment of the condition and performance of long span bridges using automated monitoring systems – optimising inspection and maintenance efforts

Thomas SPULER
Civil Engineer
Mageba SA
Bulach, Switzerland
tspuler@mageba.ch

Thomas Spuler, born 1956, is CEO and Chairman of mageba Group. He is a member of the European expert team for Road Bridge Expansion Joints (EOTA), and Vice-Chair of IABSE's Working Group 5 on bridge bearings and expansion joints.

Gianni MOOR
Civil Engineer
Mageba USA
New York, USA
gmoor@magebausa.com

Gianni Moor, born 1968, received his civil engineering degree from the Swiss Federal Institute of Technology (ETHZ) and his MBA from the IESE Business School. He is COO of mageba Group and CEO of the American subsidiary mageba USA.

Santanu MAJUMDAR
Civil Engineer
Mageba Bridge Products
Kolkata, India
smajumdar@mageba.in

Santanu Majumdar, born in 1968, received his civil engineering degree from Jadavpur University, Kolkata, India, and has served on various Indian Roads Congress (IRC) committees. Today, he is CEO of mageba Bridge Products Pvt. Ltd.

Summary

Inspection and maintenance of long span bridges is critically important in ensuring long-term safety and performance and in minimising life-cycle costs. But if done manually, it can be a time-consuming and costly exercise, and thus often does not get the attention it deserves. Furthermore, since manual inspections are carried out only periodically, a delay in recognising the need to address any deterioration can have a serious impact on the bridge and its users, perhaps even compromising user safety. Automated structural health monitoring (SHM) systems offer solutions to such problems in many cases. They are fast, efficient and highly accurate, and the immediate notification they can provide of unexpected events can enable appropriate action to be quickly taken. This paper describes the role that can be played by modern SHM systems in the inspection and maintenance of bridges, and illustrates these with reference to a number of current projects.

Keywords: Monitoring, automated, bridges, structures, inspection, maintenance, measurement

1. Introduction

Automated SHM systems offer many benefits over manual observation and measurement methods. They can provide continuous records of almost any variable in a bridge's condition, such as the position or length of any part, or the forces arising within the structure (Figure 1), and can analyse the data gathered, presenting the results in any desired format. In doing this, they are typically much more efficient than manual methods, having far lower running costs. They are also capable of an extraordinary level of detail and accuracy, and they can be set up to operate 24 hours a day, 7 days a week, and can thus be relied on to immediately report unexpected events, no matter when they might occur. Thanks to these benefits, such systems can be used to serve many purposes. In the case of inspection and maintenance of bridges, all of the above benefits come into play, making this a particularly suitable application for this most versatile engineering tool.

Fig. 1: The ongoing condition of the Pont Nanin structure in the Swiss Alps has been monitored by an SHM system (with force monitoring at bearings as shown) since its static design was changed a decade ago (fixing one end of deck) [1]

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2. The contribution of SHM to the planning of bridge inspection and maintenance works

Routine inspection and maintenance of bridges, and of their mechanical components such as bearings and expansion joints, is critically important in ensuring long-term safety and performance and in minimising life-cycle costs. But if done manually, it can be a time-consuming and costly exercise, and thus often does not get the attention it deserves. Furthermore, manual inspections are carried out only periodically, with perhaps many months, or even years, elapsing between inspections. Such a delay in recognising the need to address any deterioration can have a serious impact on the bridge and its users, with far higher costs for repair or replacement, and disruption to traffic while such works are carried out. Yet more significantly in many cases, delayed awareness of deterioration or damage may compromise user safety. The immediate notification offered by automated monitoring systems can enable the responsible authorities to quickly take appropriate action following deterioration of the structure for any reason [1].

In some cases, a non-routine inspection and assessment of a structure is required – for instance in the aftermath of an unexpected event or where significant deterioration is noted in the course of planned maintenance inspections. Where specific concerns arise in such circumstances, it may not be a straightforward matter to properly assess the situation and conclude that the structure is not in need of any remedial action. In such cases, an automated monitoring system (for example, a portable version for short-term use) can be used to obtain the information required to make a sound engineering judgement. Such use of modern technology may allow costly and disruptive strengthening or other remedial works to be postponed, or even to be deemed unnecessary [2].

3. Case studies from current monitoring projects on long span bridges

Examples of the use of automated monitoring for inspection and maintenance purposes on newly constructed cable supported bridges are presented:

- the Signature Bridge in Wazirabad, Delhi;
- the Incheon Grand Bridge, South Korea;
- the Taizhou Yangtze River Bridge, China; and
- the River Suir Bridge, Waterford, Ireland.

The circumstances, objectives and benefits relating to these cases are varied, demonstrating the wide range of applications and the usefulness of such SHM systems in minimising the costs associated with such structures – not only during their life, but also by extending their life to minimise replacement costs and other impacts on bridge users and the environment.

4. Conclusions

Automated structural health monitoring systems can contribute much to the important tasks of inspection and maintenance of bridges. They can detect and accurately measure changes in variables which could not be detected by alternative manual methods, and far more efficiently when measurements are required over a protracted period of time. They can also be relied upon to provide immediate notification of any defined critical event, at any time of day or night – and could be considered far more reliable in doing this than any manual monitoring regime. Effectiveness and efficiency thus dictate that the use of automated monitoring systems to support inspection and maintenance activities should be considered for all important cable supported bridges.

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