Smart expansion joints of long-span bridges: self-evaluating by advanced monitoring system

Kleidi Islami, Niculin Meng

mageba SA, Bülach, Switzerland

Contact: kislami@mageba.ch

Abstract

This paper presents the installed structural health monitoring (SHM) systems of three long suspension bridges, which measure high-frequency movements, inclinations, temperature and vibrations and thus enable a proper understanding of the bridges' behaviour to be developed. These case studies, based on both static and dynamic approaches, demonstrate the usefulness and ease of use of such systems, and the enormous gains in efficiency they offer over alternative manual monitoring methods. The availability of such systems has now led to the development of smart expansion joints: expansion joints that feature an integrated advanced monitoring system, already when fabricated.

Keywords: Expansion joints, damage detection, smart monitoring.

1 Introduction

Multi-span and long-span bridges are essential links in transportation networks, and must be inspected and maintained accordingly. They are more likely to experience large deck movements than other bridge types, and these movements must be accommodated by deck expansion joints and bridge bearings. The performance and life expectancy of such components are strongly dependent on the movements to which they are subjected, so the movement and vibration data that can be provided by modern automated SHM systems can play a pivotal role in improving their performance and extending their service lives. This is demonstrated below with reference to the SHM systems of three major suspension bridges.

To maximize in particular the ability to monitor the condition and performance of a bridge's expansion joints – perhaps the parts of the bridge that are subjected to the highest dynamic impacts – an upgrade to the standard monitoring system of a leading supplier has been realized in one of the bridges. A brand new application incorporates sensors at the expansion joints, providing clear information about the condition of the joints and sup-porting the planning of maintenance activities. The functioning of the new feature is based on the measurement of structure-borne vibrations. Damage can be clearly identified based on general testing and teaching of the system, facilitating very sensitive, highly robust damage identification. As a result, unexpected damage can be immediately recognized and automatically notified, enabling the timing of replacement of components to be optimized.

The implications of the development of techniques of monitoring, of statistical modelling of the

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