The Evolving Metropolis
2019 IABSE Congress
New York City

IABSE 90 YEARS

Beam tests for a wireless modal-based bridge monitoring system

Mareike KOHM

M.Sc.

KIT – Karlsruhe Institute of Technology, IMB

Karlsruhe, Germany
mareike.kohm@kit.edu

Mareike Kohm has been scientific staff at the IMB (KIT) since May 2016. She is working on the research field 'modal-based bridge monitoring '.

Lothar STEMPNIEWSKI

Prof. Dr.-Ing.

KIT – Karlsruhe Institute of Technology, IMB

Karlsruhe, Germany
lothar.stempniewski@kit.edu

Lothar Stempniewski has headed the IMB since 2000 and is active in expert committees of the DIBt (e.g. strengthening, earthquake engineering)

Contact: mareike.kohm@kit.edu

1 Abstract

Many bridge superstructures, with internal bonded pre-stressing systems, are in a critical state-of-health, due to enormously increased traffic loads. They can no longer comply with the requirements of today's and tomorrow's traffic. Therefore, intensive monitoring is required to ensure timely detection and localization of damages in the structure.

In this paper, we present our experiment results on a method to timely detect bridge damages. We analyzed the influence of beam damage and crack formation on the modal parameter's natural frequencies and mode shapes. In our lab experiment, we introduced vibrations into concrete beams, measuring them with MEMS acceleration sensors. The progressive crack formation was measured by the classical use of a crack lineal and with the optical measurement system ARAMIS by GOM GmbH [1]. We were able to successfully measure a frequency drop at a crack width significantly below the serviceability limit state (SLS), showing the partial applicability of the presented method. As we were unable to measure the expected change of the mode shapes with sufficient accuracy, we suspected an unprecise time synchronization of our sensors. By performing numerical simulations, we were able to show that synchronization has no impact on the natural frequencies. However, synchronization has a significant impact on the quality and accuracy of the mode shapes.

Keywords: operational modal analysis, time synchronization.

2 Introduction

An efficient infrastructure is one of the most important prerequisites for a competitive economy. In particular, bridge superstructures represent in case of restriction or loss of use critical points of the transport infrastructure and can lead to large-scale disturbances of passenger and cargo traffic due to often missing redundancies. The aims are the reduction of costs of maintenance and the assurance of the safety and serviceability to expand the durability of existing structures. Therefore, the interest in global, effective, practicable and economical SHM systems gained a lot of interest over the past few years. The modal parameters are global parameters and functions of the physical properties of a structure. Consequently, *structural damage* can be detected with the aid of the change of the modal parameters. In the context of this paper, *structural damage* is defined as a decrease of the structure's stiffness. Therefore, fine hairline cracks are already considered as a damage in order to be able to investigate the sensitivity of the modal

https://doi.org/10.2749/newyork.2019.0669
Distributed by Structurae