39th IABSE Symposium – *Engineering the Future*
September 21-23 2017, Vancouver, Canada

Ambient Vibration Testing of the Hawkshaw Bridge

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Abstract

This paper presents the ambient vibration tests that were conducted on the Hawkshaw Bridge, a three-span cable-stayed bridge located in New Brunswick, Canada. Tri-axial wireless sensors were installed on the bridge girders to capture the bridge acceleration due to the normal traffic condition. Challenges that were faced during the tests and the post-processing of the data are discussed in this paper. The natural vibration frequencies were extracted using Operational Modal Analysis. The vibration frequencies were compared with the finite element analysis results of the original designed bridge and the discrepancies were discussed.

Keywords: ambient vibration testing; cable-stayed bridge; operational modal analysis; finite element method; full-scale bridge testing

1 Introduction

Assessment and detection of structural deficiencies or damage is crucial for maintenance and operational planning of large infrastructure such as bridges. Detailed assessments allow for prediction of current service life and bridge condition, and therefore the planning for future operation and maintenance. Traditionally, this has been done by visually inspecting the bridge structural elements [1]. This imposes some problems as the visual inspection methods are semi-qualitative and therefore subjected to the inspector's judgement. Structural Health Monitoring (SHM) can be a modern and reliable addition to visual inspection when assessing existing structures. SHM can also be integrated into the reliability-based management of bridges which accurately quantifies the structural performance [2-3].

Nowadays, in the case of long-span bridges in countries like South Korea and Japan, sensor-based monitoring systems are mandatory. China has also included a monitoring routine for their newly-constructed bridges [4]. SHM instrumentation can be used for short-term to long-term monitoring, which allows for different types of measurements. The collected data which can be stored in a cloud-based database may include temperature, wind speed, static deformation, dynamic responses and internal forces [5].

In the case of SHM of bridges, vibration tests and modal analysis have shown promising success. The modal analysis can describe a structure in terms of its dynamic properties such as natural frequencies, their corresponding mode shapes and modal damping factor using the dynamic test results [6]. Comparing the modal properties extracted from the test results with the dynamic properties of the

https://doi.org/10.2749/vancouver.2017.1973
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