Evaluation of the effect of operational modal analysis algorithms on identified modal parameters of railway bridges

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Abstract

The accuracy of modal parameters identified by Operational Modal Analysis (OMA) algorithms is of vital importance in vibration-based health monitoring. This paper reports the effects of using different OMA algorithms on identified modal parameters of railway bridges. For this purpose, comparison and application of three different OMA methods including FDD, ARX, SSI-COV are discussed. The vibration measurements are conducted on two railway bridges in Northern Norway for using five triaxial accelerometers. The first bridge is a single-span bridge with the length of 50 m, while the second is a two-span bridge with a total length of 85m. OMA has been conducted on the free vibration responses after passage of different types of trains including light-weight railway vehicles and heavily loaded iron ore trains to evaluate the variation of the identified modal parameters with the chosen algorithm and the vibration source on the OMA results.

Keywords: modal identification; free vibration; railway bridge, modal parameters, OMA.

1 Introduction

Over the past decades, evaluation of dynamic response of structures from recorded vibrations has become increasingly popular in various engineering applications. Evaluation of the modal parameters from vibrations recorded while the structure is in use are often utilized in different Structural Health Monitoring (SHM) applications such as computational model updating and damage detection. Since the modal parameters are inherent characteristics of the structures, they can be used as the parameters to monitor the structural condition of the structure [1]. In large-scale civil structures such as bridges, providing input excitation with strong and precise content has always been a challenging task. In order to alleviate input-based uncertainty, variety of modal identification techniques such as Operational Modal Analysis (OMA) and Operational Deflection Shapes (ODS) have been developed. OMA techniques are mainly based on the idea of Fourier transform and the state space dynamic model [2], whereas ODS techniques utilize only vibration amplitude and simply extracts the system response under the applied loads.

Over the past decade, numerous studies have been conducted on modal parameter identification of bridges. Lorenzoni et al. [3] applied different out-put only system identification techniques to extract the modal parameters of five different types of road and railway bridges. He et al. [4] studied the newly built suspension bridges and identified the modal parameters. Brownjohn et al. [5] evaluated the Humer suspension bridge and employed three different identification techniques and the results were compared with a 1985 modal test of the bridge to show the changes in modal parameters over 23 years. Chen et al. [6] investigated modal parameters of an eleven-span concrete bridge subjected to weak ambient excitation to investigate the reliability and feasibility of the

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