Monitoring of Environmental Effects on Modal Estimates of Large Structures

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Summary

This paper aims at describing some applications recently developed by the Laboratory of Vibrations and Structural Monitoring (www.fe.up.pt/vibest) of FEUP in which an accurate monitoring of the effects of environmental factors on modal frequency estimates was continuously performed, and appropriate statistical techniques were employed to remove or mitigate such effects, enabling a correct vibration based damage detection approach. The monitored structures are the Infante D. Henrique Bridge, the Pedro e Inês and the FEUP stress-ribbon footbridges, and the suspension cable roof of Braga stadium. The paper focuses on the effects of temperature on modal parameters.

Keywords: Continuous Dynamic Monitoring; Environmental factors; Temperature; Intensity of traffic, Modal frequency estimates; Damage detection.

1. Introduction

The concern with different complementary aspects of the structural behaviour of bridges and special structures, such as the understanding and accurate modelling of the aerodynamic behaviour, the checking of vibration serviceability limits, as well as the verification of the efficiency of vibration control devices, or the ageing and structural degradation of large structures, has motivated an increasing interest of designers, constructers and owners by vibration-based structural health monitoring (SHM) programs.

This recent trend has been enabled not only by important technological progresses of instrumentation systems for dynamic testing and continuous dynamic monitoring of large structures, but mainly by the development and software implementation of efficient strategies to efficiently and automatically extract useful information from the huge amount of data regularly collected by dynamic monitoring systems.

A key aspect in this perspective is the influence that environmental and operational factors, like temperature, traffic intensity or wind speed can have on the variability of modal estimates, as these changes can be of the same order of magnitude of the modal variability induced by structural damage.

In this context, this paper aims at describing some applications recently developed by the Laboratory of Vibrations and Structural Monitoring (ViBest, www.fe.up.pt/vibest) of FEUP, in which an accurate monitoring of the effects of those environmental factors on modal frequency estimates was continuously performed, and appropriate statistical techniques were employed to remove or mitigate such effects, enabling a correct vibration based damage detection approach. The monitored structures are the Infante D. Henrique roadway bridge, the Pedro e Inês and the FEUP stress-ribbon lively footbridges, and the suspension cable-roof of Braga stadium. The paper focuses specifically on the effects of temperature on modal parameters of those structures and the purpose is to evaluate the minimum level of damage that can be detected by means of continuous dynamic monitoring.

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