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Continuous dynamic monitoring of lively footbridges

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Abstract

This paper presents three different case studies of continuous dynamic monitoring of lively footbridges, aiming at the verification of vibration serviceability limits defined by recent footbridge guidelines for vertical and lateral human induced vibrations, as well as the demonstration of the feasibility of vibration based damage detection, taking into account the experience gained at the Laboratory of Vibrations and Structural Monitoring (ViBest, www.fe.up.pt/vibest) of FEUP with the development of different research and consultancy works.

Keywords: footbridge; vibration serviceability; damage detection; structural health monitoring.

1 Introduction

Modern footbridges are often light structures characterized by very high slenderness and low damping, which makes them easily susceptible to vertical vibrations for spans longer than 50 m or to horizontal vibrations and lock-in for spans usually in the range 80 – 120 m.

Therefore their design normally requires a reliable numerical prediction of the levels of vibration and degree of human comfort associated to normal walking (of groups or flows of pedestrians) or jogging, which can be in general obtained on the basis of simplified load models and analysis procedures established in recent guidelines and recommendations [1, 2].

In case of occurrence of excessive lateral and/or vertical human induced vibrations, the design and implementation of vibration control devices (normally tuned-mass or viscous dampers) may be required, and though the efficiency of such devices can be preliminary assessed on the basis of forced vibration tests [3], the most reliable verification of their efficiency is based on temporary or long-term dynamic monitoring.

Moreover, continuous dynamic monitoring duly conjugated with the application of robust software tools to develop an online output-only modal identification of the collected data and the statistical removal of the influence of environmental and operational factors on the modal variability can be also used to detect early damage by construction of suitable control charts [4, 5].

In this context, this paper presents three different case studies of continuous dynamic monitoring of Portuguese lively footbridges, aiming at the verification of vibration serviceability limits defined by recent footbridge guidelines, as well as the demonstration of the feasibility of vibration based damage detection, taking into account the experience gained at the Laboratory of Vibrations and Structural Monitoring (ViBest, www.fe.up.pt/vibest) of FEUP with the development of different research and consultancy works.

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