ASSESSMENT OF RUNNING PEDESTRIAN INDUCED VIBRATIONS ON A STRESS-RIBBON FOOTBRIDGE

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Summary

The paper presents a numerical and experimental assessment of the dynamic effects induced by pedestrians on a stress-ribbon footbridge built in the Portuguese city of Benavente. As a characteristic of this typology, the bridge displays a lively behaviour and is particularly vulnerable to the excitation induced by running and jogging pedestrians. The present investigation aims at verifying the conservativeness of existing load models on the basis of an experiment in which both the pedestrian action and the footbridge response are characterised.

Keywords: stress-ribbon footbridge; dynamic testing; design guidelines; running pedestrian.

1. Introduction

The enormous impact of the Millennium Bridge lock-in vibrations [1] implied an immense effort all over the world to better understand the dynamic effects induced by pedestrians when crossing a footbridge and to define load models to be applied with the purpose of guaranteeing a safe and comfortable design. This effort resulted in particular in the SETRA [2] and the HIVOSS [3] guidelines, which specify measures to avoid lateral lock-in, propose load models associated with the action of walking, and indicate ranges of comfort expected as a function of the response to these load models. It is nevertheless surprising that no consensus has been reached by the scientific community with respect to the modelling of the effects of running pedestrians and consequently none of these guidelines proposes load models or vibration limits for this particular action. Yet, the governing dynamic effects induced by pedestrians in many footbridges are in fact those associated with running and jogging. An adequate characterisation of the loads induced by single and groups of running pedestrians is therefore of high interest and constitutes the main purpose of the present study. Using innovative sensors developed within the Electronic Engineering Department of FEUP, which are interposed between the foot and the shoe of a group of pedestrians, the characteristics of the running action are established, namely the velocity of propagation, the time of contact with the bridge, the applied pressure, the running frequency, and the relative phase. It is aimed to use these parameters in the calibration of a load model to apply to the footbridge, comparing the calculated and measured responses based on this footbridge. The present paper describes the first results obtained from the ongoing study.

2. Dynamic Characteristics of the Footbridge

2.1 General Description

Located in the Linear Park of Benavente, in Portugal, the footbridge was designed by Câncio Martins [4] and constructed in 2004 along the banks of the river Sorraia, a tributary of the river Tagus close to Lisbon. It is a 100 m long footbridge of the stress-ribbon type, formed by a central span of 50 m and two side spans of 25 m (Fig. 1). The catenary shape results from hanging four steel strips, arranged in pairs, between the abutments and passing over two intermediate hinged columns, and applying the deck weight to these “stressed ribbons”. The deck is formed by precast concrete slabs bolted to the steel strips with interposition of neoprene layers (Fig. 2).