OPERATIONAL MODAL ANALYSIS AND VIBRATION SERVICEABILITY ASSESSMENT OF A FOOTBRIGDE

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Summary

Due to the increasing strength of materials and the trend towards greater slenderness, modern pedestrian bridges are very often lively structures prone to human induced vibrations. Predicting the dynamic performance of these civil engineering structures due to crowd induced loading is an increasingly critical aspect of the vibration serviceability design process, for which reliable dynamical characteristics are of crucial importance.

This paper presents the extensive analysis of the vibration serviceability of a footbridge in Eeklo (Belgium). The operational modal analysis is performed to obtain the operational modal characteristics of the footbridge. These results are applied for the updating procedure of the numerical model (FE model) of the footbridge using the support stiffnesses as updating parameters. An optimal correspondence is found between measured and calculated modal characteristics, improving the accuracy of the numerical predictions of the dynamic response of the bridge to pedestrian loading.

The vibration serviceability check according to the current codes of practice is performed for both the initial versus the updated model of the footbridge. In some cases this results into a different evaluation (comfort class), indicating the difficulty of making a reliable assessment of the dynamic performance of a the footbridge in the design phase.

Keywords: footbridge; crowd-induced loading; vibration serviceability; operational modal analysis; model updating.

1. Introduction

Vibration serviceability has become an important issue in the design of modern slender footbridges with large spans. The natural frequencies of these bridges are often in the range of the loading frequencies of the dynamic walking excitation of (groups of) pedestrians. This causes vibrations which may reduce the comfort of the users of the footbridge. Current codes of practice [1-4] provide methodologies to assess the dynamic behaviour in the design phase. However, additional experimental analysis is needed to validate the predictive load models [5,6].

This paper presents the vibration serviceability check of a footbridge in Eeklo (Figure 1). Based on the operational modal analysis and the calibration of the numerical model (FE model), the difficulty of making a reliable dynamic assessment at in the design phase, is demonstrated. The footbridge, situated in a rural region, provides pedestrians and cyclists with a safe passage across the highway N49. The bridge has three spans, a main middle span of 42 meters (across the N49) and two side spans of 27 meters. The bridge is simply supported with neoprene bearings at the land abutments and at the top of the pillars at the midspan. The outline of the paper is as follows. First, the operational modal analysis of the footbridge is presented, together with the updating procedure of the finite element (FE) model. Second, the vibration serviceability check of the footbridge is performed according to the Setra and HiVoSS guideline [1,3], for both the initial and the updated FE model and in the last section these results are discussed.