DYNAMIC BEHAVIOR OF A WALKWAY IN THEORY AND FIELD TEST

Daia ZWICKY
Professor, PhD / MSc ETH
University of Applied Sciences
Fribourg, Switzerland
daia.zwicky@hefr.ch

Julien BIELMANN
Project engineer, BSc Civil Eng.
CSD Ingénieurs SA
Bulle, Switzerland
j.bielmann@csd.ch

Summary

The walkways between two wings of the College of Engineering and Architecture of Fribourg exhibit clearly perceptible vibrations, especially in the longitudinal direction, experienced by people on the walkway when other pedestrians cross. The dynamic behavior of these walkways was investigated in a Bachelor thesis, by step-wise refinement of theoretical modeling, verification in a field test and adapting the theoretical model with regard to the test results.

The paper reports on the different models developed for the determination of natural frequencies, i.e. simple beam-and-lumped-mass models, 2D and 3D frame models. It also presents results from a more sophisticated time-history analysis, allowing for derivation of theoretical dynamic responses. The test procedure and results of the field test performed on the walkway is also reported on. Selected results from measured responses are presented, in particular with regard to longitudinal vibrations already assessed to be governing in the theoretical analysis. Fourier amplitude spectra derived from field test results as well as experimentally resulting damping ratios and accelerations are shown as well.

Finally, the paper comments on modifications in the theoretical modeling of the vibration behavior with regard to the obtained field test results. It is completed by general and specific conclusions drawn from the theoretical analysis and the field test of this slender steel structure, being so typical for our days.

Keywords: walkway; steel structure; longitudinal vibration; natural frequencies; structural modeling; time-history analysis; field test; damping; bachelor thesis.

1. Introduction

The two main wings of the buildings of the College of Engineering and Architecture Fribourg (EIA-FR) of the University of Applied Sciences Western Switzerland (HES-SO) are connected by covered walkways (Fig. 1). The walkways exhibit clearly perceptible vibrations in the longitudinal direction, primarily experienced by people standing on the walkway when other pedestrians cross. These vibrations were the starting point of the Bachelor thesis [1] this paper is based on, carried out by the second author and supervised by the first. Here, selected results from the theoretical and experimental analysis performed in the Bachelor thesis are presented.

Fig. 1 Connecting walkway at EIA-FR

It should be noted that the dynamic behavior of structures is not explicitly lectured in the course of Bachelor studies at EIA-FR due to the restricted time-frame, the high volume of material to be studied and the limited number of lecture hours. Hence, the Bachelor student had to gain a remarkable amount of knowledge in a short time; he was rewarded for his efforts by presenting the best Bachelor thesis of his year, receiving the highest grade possible and being awarded a distinction by the local Fribourg group of the Swiss Society of Engineers and Architects (SIA).