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Review article

FE modelling of light weight wooden assemblies – Parameter study and comparison between analyses and experiments

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ABSTRACT

A finite element (FE) analysis of a model representing a mock-up structure previously investigated experimentally is investigated in this study. The aim is to make a correlation and calibration between test and analysis of the full scale wooden structure; both eigenmodes and acceleration levels are compared. Large scatter is found in material properties used for light weight wooden structures in literature. In this study, a parameter evaluation is therefore made to show how different properties influence the dynamic behaviour of the structure. It is shown that the wood beam material properties influence the behaviour of the light weight wooden structure FE model most.

Two types of junctions are modelled and evaluated; a tied connection is used to simulate screwed junctions and spring/dashpot elements are used to represent elastomer junctions between the floor and the walls. The springs and dashpots used to model the elastomer in the junction work well in the bearing direction but need to be improved to obtain correct rotational stiffness, shear motion and friction. There are still many unknown parameters in a complex wooden structure that remain to be investigated. However, the results presented in this paper add data to be used for FE modelling of a complex wooden structure.

Contents

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1. Introduction

Multi-apartment buildings with wooden structures have become more and more common and it would be of great benefit if reliable finite element (FE) models could be used to evaluate the interior sound distribution prior to building such houses. Before this is the case, however, more data are needed on for example material properties and boundary conditions. Although the end objective is to enhance modelling of sound distribution, the present paper is focused on material properties and correlation between FE models and experimental data for better structural dynamics results. These results may be used to make better acoustic models.

1.1. Background

Analysis of an FE model of a room in an eight-storey building showed that the dynamic behaviour of a single room is hard to capture [1]. An unknown factor was believed to be the interaction with other building parts which have to be included in the FE model. In another study, measurements of a floor structure supported along two sides were evaluated against results stemming from an FE model of the same structure [2]. The importance of accurate modelling of joints and the influence from material properties in order to get good agreement between measurements and FE models was also discussed. In [3], the issues of material properties and their statistical distributions were addressed for a small wooden junction. The authors built ten specimens intended to be identical. Experimental modal analysis showed large deviations in the eigenfrequencies of the specimens. The authors also made an FE model, using the FE code Abaqus [4], representing the same specimens and calibrated the material properties of the chipboard until good agreement between frequencies of the model and test were obtained.

Due to difficulties to find reliable damping properties in previous field studies [1], experimental modal analysis (EMA) of a free-free structure having dimensions approximately half the size

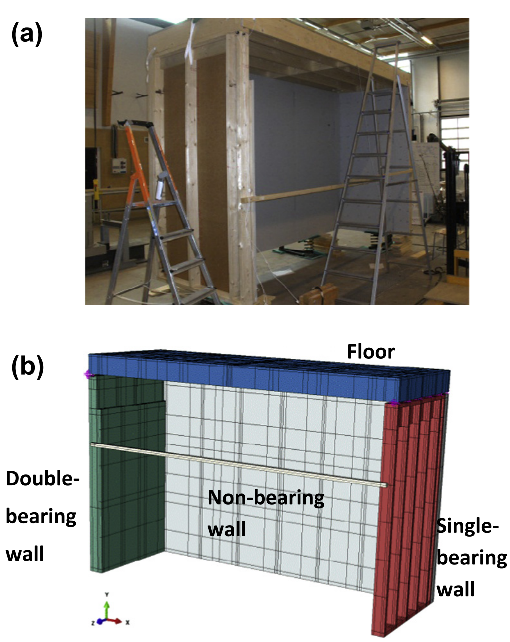

Fig. 1. (a) The mock-up during the test and (b) the FE model and the building element nomenclature.

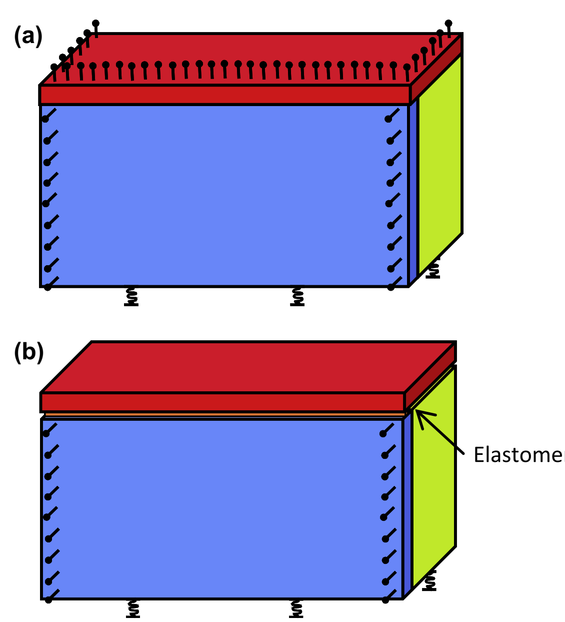

Fig. 2. (a) The first mock-up with the walls and the floor screwed together and (b) the second mock-up where the roof was placed on top of elastomer material.