Modal testing of an unreinforced masonry house

Claudio A. Oyarzo-Vera
University of Auckland, Department of Civil and Environmental Engineering, New Zealand
Universidad Católica de la Santísima. Concepción, Department of Civil Engineering, Chile

Abdul Razak Abdul Karim
University of Auckland, Department of Civil and Environmental Engineering, New Zealand
Universiti Malaysia Sarawak, Department of Civil Engineering, Malaysia

Dr. Nawawi Chouw
University of Auckland, Department of Civil and Environmental Engineering, New Zealand

ABSTRACT: There are a significant number of uncertainties in finite element models of unreinforced masonry structures related to the modelling assumptions and the properties of local materials. Therefore, it is necessary to implement calibration techniques for these models. Modal testing is a good option for assessing the dynamic properties of the structure. The experimental data is used to verify and improve the predicted response obtained by finite element model. The study presents the modal testing of a full-scale physical model of an unreinforced masonry house. The structure is tested under three different excitations: an impact by a calibrated hammer, a random excitation induced by a calibrated hammer, and a stepped-sine excitation induced by a shaker. In addition, an operational modal test has been performed using ambient and random excitations. Two different methods are used for system identification: peak picking and stochastic subspace identification. The results of this research will be used in future studies for updating the model.

1 INTRODUCTION

Masonry is basically a composite, anisotropic and non-homogeneous material. It is compounded of masonry units (bricks) and mortar joints. In general, masonry behaviour depends on the mechanical properties of its components, the interfaces between them, the arrangement of the bricks and the interaction with the others structural members and materials used in the building (concrete frames, steel or timber beams and columns and timber floors).

Numerical modelling of masonry structures is usually a very computationally demanding procedure. The high numerical cost is related to the intrinsic complexity of masonry (bricks connected by mortar joints) that requires a large number of degree of freedoms (Giordano et al., 2002) and excludes typical simplifications (e.g. rigid diaphragms and ideal connections) applied in modelling of other kind of structures. Another reason for this complexity is that the material constitutive models are not well defined, especially in the non-linear range.

So far, the numerical models have mainly been validated by studies based on structural component behaviour (e.g. a single wall or pier). However, a validation at system level (entire building or sections of a building) is not available. Adequate techniques to validate numerical models can be a significant contribution, because they provide a powerful tool to assess and predict the performance of URM structures. Two promising techniques for this purpose are modal testing and model updating. Modal testing is used for assessing the dynamic properties of the structure, such as, natural frequencies, mode shapes and damping factors. These properties are utilized to verify the degree of accuracy between the numerical model and the measured response of the structure. The measured response is employed as a target condition in the process of improving the numerical model (model updating). The updated model can then be used to predict the performance of the structure under different loading, for instance,