Numerical finite element development of a strengthened wall-to-floor seismic connection: calibration and application on building prototype.

Fabio Solarino*†♣, Daniel V. Oliveira† and Linda Giresini♣

*† ISISE, Institute of Science and Innovation for Bio-Sustainability (IB-S)
Department of Civil Engineering, University of Minho
Campus de Azurém, 4800-058, Guimarães, Portugal
e-mail: solarino.fabio@gmail.com, web page: http://www.hms.civil.uminho.pt/

♣ Department of Energy, Systems, Territory and Constructions Engineering (DESTEC)
University of Pisa
Largo Lucio Lazzarino, 1, 56126, Pisa (PI) Italy
e-mail: linda.giresini@unipi.it - Web page: http:// http://www.dic.unipi.it/linda.giresini/index.html

ABSTRACT

Effective wall-to-floor connections are crucial components of historical buildings to avoid dangerous mechanisms under seismic actions. Despite current regulations suggest detailing and techniques to ensure the so-called "box behavior" in newer buildings, only few information are given about assessment and reinforcement of existing buildings, often presenting poor friction-based links between timber floor and masonry wall.

Nonlinear static analysis is one of the most valid and common tools for the seismic assessment of unreinforced masonry building considering advanced nonlinear materials and allowing for different approaches. Nevertheless, it is not sensitive to any cyclic damage occurring in the materials and in the connections actually present under dynamic actions, and it is often hard to select an appropriate control node defining the capacity curve. Moreover, connections are modelled as simply fixed or absent at all. Dynamic nonlinear analysis seems preferable even suffering the higher computational effort.

On the bases of previous experimental campaign developed at the University of Minho, the pull-out behavior of a strengthened and unstrengthened masonry-to-timber solution was simulated numerically using Pinching4 material model available in OpenSees database. The connection model allows for strength degradation and pinching, in agreement with experimental behavior, and is validated from the energetic point of view, ready to be included in a global finite element model to study the influence of the hysteretic energy dissipated within the connections on the overall seismic response.

This paper shows the calibration process and the application of the connection model into a unreinforced masonry prototype using dynamic nonlinear analysis under real seismic input. Both strengthened and unstrengthened configuration are implemented and results compared. The model is part of the blind prediction competition organised within the SERA-AIMS project involving the shaking table test of a half-scaled aggregate of two buildings, planned for January 2020.

The main outcomes show the importance of accounting for hysteretic connections in the global model. While premature mechanisms are captured by the damage pattern when unreinforced configuration is applied, even under low seismic action, the strengthened configuration allows for a better distribution of the inertial forces to the walls increasing the overall seismic capacity. High stress concentration is also depicted within the aggregate interface, index of possible pounding effect given by dynamic interaction among the two units.

REFERENCES

[1] F. Solarino, D. V. Oliveira, L. Giresini, "Wall-to-horizontal diaphragm connections in historical buildings: A state-of-the-art review", *Engineering Structures* 1999 (2019).

[2] S. Moreira, "Seismic retrofit of masonry-to-timber connections in historical constructions [Ph.d. thesis]. University of Minho (2015).

[3] S. Mazzoni, F. McKenna, M. H. Scott, G. L. Fenves, et al. "Open System for Earthquake Engineering Simulation (OpenSees)", The Regents of the University of California (2000).