Numerical study of pier-wall connections in typical Dutch URM buildings XII International Conference on Structural Analysis of Historical Constructions– SAHC2020

Daniela Fusco*, Francesco Messali†, Jan G. Rots†, Daniela Addessi+ and Stefano Pampanin+

* Sapienza Università di Roma
Via Eudossiana 18, 00184 Roma, Italy
email: d.fusco1994@gmail.com

† Delft University of Technology
Department 3MD
Building 23, Stevinweg 1, 2628 CN Delft, The Netherlands
email: F.Messali@tudelft.nl, email: J.G.Rots@tudelft.nl

+ Sapienza Università di Roma
Dipartimento di Ingegneria Strutturale e Geotecnica
Via Eudossiana 18, 00184 Roma, Italy
email: daniela.addessi@uniroma1.it, email: stefano.pampanin@uniroma1.it

ABSTRACT

In recent years, the seismic risk in the north of the Netherlands has increased due to gas extraction. Since 2014, the Delft University of Technology started a research program to assess the seismic response of unreinforced masonry (URM) buildings. The Dutch URM buildings are characterized by slender piers and transverse walls. In the common practice, the connections between piers and transverse walls are often modelled as rigid, but in real structures these connections may exhibit different behaviour. Especially, since the 1980s, calcium silicate element masonry has been commonly used in Dutch buildings, and vertical continuous joints are present between transverse walls. For this reason, it is essential to assess whether the connection is strong enough since its failure can reduce the seismic performance of the entire structure.

This work investigates and compares different numerical approaches to describe the behaviour of vertical glued connections at wall-pier corners in Dutch URM buildings. The modelling of the connection is analyzed first at element level, i.e considering only a wall-pier system tested by Raijmakers and Van der Pluijm [1], and then at structural level on a full-scale two-storey building tested at Delft University of Technology [2]. Masonry structural elements are modelled by means of 2D and 3D finite elements, while the glued connections are modelled through interface elements.

The study highlights the influence of the adopted constitutive law on the global structural response. The Coulomb friction failure criterion provides the most accurate simulation of the real behaviour of the connection, but it requires high computational efforts, and numerical instability of the solution during the brittle shear failure of the connection can occur. A simplified modelling approach for the connection is proposed in this work, adopting a nonlinear elastic constitutive law which decouples the response in the normal and tangential direction. Although this improves the robustness of the model and, thus, the stability of the analysis, it can only simulate the average behaviour of the connection. Therefore, a sensitivity study of the frictional parameters, i.e. friction angle and cohesion, is performed to analyze the influence of the strength of the glued connection on the global response of the URM structure.

REFERENCES

[1] Raijmakers, T. M. J., & Van der Pluijm, R. “Stability of the calcium silicate piers”. TNO-Bouw Report BI-91-0219, (1992).

[2] Esposito, R., Jafari, S., Ravenshorst, G. J. P., Schipper, H. R., & Rots, J. G. “Influence of the behavior of calcium silicate brick and element masonry on the lateral capacity of structures”. 10th Australasian Masonry Conference, (2018).