

Numerical assessment of the influence of various light timber retrofit layouts on the dynamic response of typical Dutch URM terraced houses

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ABSTRACT

The majority of the residential building stock in Groningen (The Netherlands), which has been lately exposed to low intensity ground motions due to gas extraction, consists of unreinforced masonry (URM) structures not originally designed to withstand earthquakes. Amongst others, the terraced house building typology proved to be particularly vulnerable towards horizontal actions. This notwithstanding, the preliminary results from a recently-performed shake-table test on a full-scale terraced house prototype performed at the laboratory of Eucentre (Pavia, Italy), characterised by the presence of a timber retrofit system which consisted in a nailed assembly of vertical (strong-backs) and longitudinal noggings elements covered by oriented strand board (OSB) panels, seem to indicate that their dynamic response might be consistently improved through the employment of such as a cost-effective light retrofitting solution. In this work, an advanced discontinuum-based model, implemented in the framework of the Applied Element Method (AEM), was developed with a view to investigate numerically the potential influence on the specimen's behaviour of various aspects related to design of the retrofit scheme, which have not been assessed experimentally yet, including different geometrical configurations (e.g. spacing between vertical and longitudinal elements), as well as mechanical properties of both timber members and connections. To this end, several different scenarios were investigated and the obtained strength and displacement capacities, damage patterns and failure modes accurately monitored and compared to each other. Aimed at representing the possible interaction among URM walls and retrofit system, each timber component was explicitly represented in the AEM models. On the other hand, with a view to reduce computational expense, its nonlinear response, mainly associated to the presence of both screwed and nailed connections, was lumped into discrete joints among timber members, which were idealised as elastic beam elements. First, the AEM model was validated against experimental tests on both standard and retrofitted URM panels subjected to shear-compression cyclic loading protocol. Then, calibrated mechanical parameters were directly implemented in the global house model. Given the good agreement between numerical and experimental results in terms of both damage evolution and hysteretic response, a comprehensive parametric study was undertaken. Since a relatively high dispersion of numerical outcomes was observed, this modelling exercise seem to suggest that different retrofit layouts may have a significant influence on the dynamic behaviour of the considered URM building type. Finally, based on numerical evidence, practical design considerations are discussed and potential enhancements proposed.

REFERENCES

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