Seismic vulnerability assessment of representative building typologies from Barcelona's Eixample District

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ABSTRACT

Unreinforced masonry buildings are prevailing in many old historical centres and urban areas worldwide. These structures have shown quite poor and vulnerable seismic performance based on the fact that they were typically designed without considering any seismic design requirements. Hence, they are highly susceptible to damage from earthquakes, even of low intensity. Vulnerability assessment of existing buildings is of great importance for the seismic risk analysis, where the engineering research can intervene.

This work investigates the seismic vulnerability of typical unreinforced masonry buildings situated in the Eixample district of Barcelona, Spain. Most of the buildings are designed only for vertical static loads with load-bearing masonry walls, flexible floors of quite large span and openings of considerable size. They often present lack of connections between the structural elements. The identification of the main parameters affecting the structural behaviour under lateral loading is necessary to evaluate their seismic vulnerability. All structural elements and their mechanical properties are studied and evaluated extensively.

The building taxonomy for the Eixample district is done with the purpose of classifying the different structural typologies, characterized by a similar structural response. This typology classification helps to empirically evaluate the buildings' vulnerability and also to provide the basis for creating a structural model of a representative building for analysing its dynamic performance.

The main objective of this paper is to assess the global seismic behaviour of a typical unreinforced masonry structure through the nonlinear static analysis. The Finite Element Method was used for the modelling of a three-dimensional macro-model for evaluating the seismic performance of the representative buildings. Non-linear static (pushover) analyses are performed for both main directions (parallel and perpendicular to the façades) to simulate the typical failure mechanisms and the seismic capacity of these building typologies.

Several parametric analyses regarding the influence of different input material properties have been performed. The seismic vulnerability assessment of this type of constructions includes the generation of fragility curves that combine the in-plane and out-of-plane response following different criteria and methods of analyses. Finally, a complete discussion of the results obtained from the analysis is included. These data will represent the basis for a future analysis devoted to large scale seismic vulnerability assessment.

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