Vulnerability assessment of Italian unreinforced masonry churches using multi-linear regression models

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ABSTRACT

The extensive damage occurred to the Italian historical and architectural heritage after the 2016-2017 earthquake sequence, and particularly to unreinforced masonry churches, emphasises the need to better understand the vulnerability of religious buildings. It is widely known that churches frequently exhibit a vulnerability higher than ordinary buildings (D'Ayala 2000), because of their architectural and structural characteristics such as open plan, large wall height-to-thickness and length-to-thickness ratios, and the use of thrusting horizontal structural elements for vaults and roofs. A sample of 158 buildings belonging to the four stricken regions is studied and their performance analysed statistically. Structural behaviour of these churches is described in terms of mechanisms affecting the so-called macroelements, being portions of the building behaving more or less independently (Lagomarsino and Podestà 2004). In order to define fragility curves correlating the damage related to each collapse mechanism against ground motion intensity and churches' specific characteristics, the observed behaviour of the sample is herein analysed by means of statistical procedures accounting for 28 possible local collapse mechanisms, according to DPCM (2011). Several regressions strategies are considered, accounting for vulnerability modifiers increasing/reducing the vulnerability of each macroelement, since the severity of shaking alone is not capable to fully explain the damage, strongly influenced by structural details that can worsen the seismic performance or improve it through earthquake-resistant elements (Marotta et al. 2017, 2018). Results show the relevance of the proposed multi-linear regression models for the national heritage of churches and the advisability of extending mechanism-based regressions to other countries besides Italy. The proposed regression models can be used as predictive tools to support seismic vulnerability mitigation at a territorial scale.

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