Comparing fragility functions derived from simplified analytical models to those developed with empirical data from past earthquakes

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ABSTRACT

Assessing the seismic risk of regional portfolios of reinforced concrete (RC) buildings is essential in earthquake engineering, given their high vulnerability and prevalence in seismically active areas. A key aspect of regional seismic risk analysis is the quantification of various damage states, typically achieved through fragility functions. This study investigates both high-fidelity and reduced-order analytical fragility functions tailored for large-scale seismic risk assessments of non-ductile RC buildings with masonry infills, common to the Italian peninsula and Southern Europe. These functions were derived from an extensive database of archetype buildings representing the evolution of construction practices in Italy, built on a thorough literature review and consultations with engineers and architects. Fragility functions for several infilled RC building classes were developed for multiple damage states using advanced analysis on detailed numerical models. The functions were then compared to empirical data from past Italian earthquakes, specifically L'Aquila 2009 and Umbria-Marche 1997. Empirical fragility functions were generated using a novel method for deriving average spectral acceleration-based ground-motion fields that accounts for spatial and cross-period correlations—an important contribution of this work. This paper illustrates how recent advancements in analytical fragility function development, combined with empirical data, can improve the accuracy and representativeness of damage estimates for regional seismic assessments.