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Intermediate hazard levels in the seismic analysis of frame structures

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ABSTRACT

Four hazard levels (HLs) are assumed by most Technical Seismic Standards and Regulations worldwide for the design of new structures and the performance assessment analysis of existing ones. The HLs, also denoted in terms of earthquake severity, i.e. Frequent Design Earthquake—FDE, Serviceability Design Earthquake—SDE, Basic Design Earthquake—BDE, and Maximum Considered Earthquake—MCE, are characterized by different probabilities, P_{VR}, of being exceeded over the reference structural lifespan, V_R. The P_{VR} values adopted by the Italian Standards are equal to 81%/V_R (FDE), 63%/V_R (SDE), 10%/V_R (BDE) and 5%/V_R (MCE), which are similar to the values selected by several other national and international Regulations. The remarkable P_{VR} gap between SDE and BDE, and thus between the corresponding normative peak ground accelerations, does not allow exploring the wide spectrum of damage levels related to "moderate" earthquake levels, also recently occurred in seismically active regions.

In order to critically discuss this limitation, an extension of the analysis to intermediate hazard levels is examined in this paper, where four additional levels are considered, identified by 50%/V_R, 40%/V_R, 30%/V_R and 20%/V_R probabilities of exceedance. The effects of this extended input ground motion range are explored by referring to an actual case study building, i.e. a school with reinforced concrete structure situated in Florence, built in the mid-1960s. With the aim of evaluating both structural and non-structural damage for the eight seismic input levels, the masonry infills and partitions of the building are included in the structural model, by adopting a non-linear strut equivalent elements to simulate their response, as implemented in Sorace et al. (2023).

The results of the study highlight that irreparable damage of most non-structural members is reached starting from the action scaled at a probability of 30%/V_R, stressing the opportunity of considering intermediate seismic hazard levels especially in the assessment analysis of existing buildings.

REFERENCES

Sorace, S., Costoli, I. and Terenzi G. (2023). "Seismic assessment and dissipative bracing retrofit-based protection of infills and partitions in RC structures", *Engineering Structures*, **281**, article number 115781.