What seismic risk do we design for when we design buildings?

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Abstract This paper[*] discusses two issues related to the seismic performance of code-conforming structures from the probabilistic standpoint: (i) the risk structures are implicitly exposed to when designed via state-of-the-art codes; (ii) which earthquake scenarios are expected to erode the portion of safety margins determined by elastic seismic actions for these structures. Both issues are addressed using recent research results referring to Italy.

Regarding (i), during the last few years, the Italian earthquake engineering community is putting effort to assess the seismic risk of structures designed according to the code currently enforced in the country, which has extended similarities with Eurocode 8. For the scope of the project, five structural typologies were designed according to standard practice at five sites, spanning a wide range of seismic hazard levels. The seismic risk assessment follows the principles of performance-based earthquake engineering, integrating probabilistic hazard and vulnerability, to get the annual failure rates. Results, although not fully consolidated yet, show risk increasing with hazard and uneven seismic reliability across typologies.

With regard to (ii) it is discussed that, in the case of elastic design actions based on probabilistic hazard analysis (i.e., uniform hazard spectra), exceedance of spectral ordinates can be likely-to-very-likely to happen in the epicentral area of earthquakes, which occur relatively frequently over a country such as Italy. Although this can be intuitive, it means that design spectra, by definition, do not necessarily determine (elastic) design actions that are conservative for earthquakes occurring close to the construction site. In other words, for these scenarios protection is essentially warranted by the rarity with which it is expected they occur close to the structure and further safety margins implicit to earthquake-resistant design (i.e., those discussed in the first part).

[*] This manuscript is largely based on the papers by Iervolino et al. (2017) and Iervolino and Giorgio (2017).