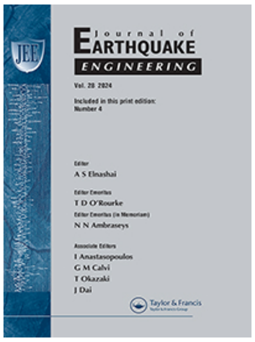


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# Foreword to the Special Issue for the 2019-2021 RINTC (The Implicit Seismic Risk of Existing Structures) Project


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# Foreword to the Special Issue for the 2019-2021 RINTC (The Implicit Seismic Risk of Existing Structures) Project

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This special issue of *Journal of Earthquake Engineering* (JEE) follows a previous one from 2018, which dealt with the results of a research project performed between 2015 and 2017, whose acronym was RINTC, and aimed at evaluating the seismic reliability of code-conforming structures in Italy (Iervolino and Dolce 2018). The need for research on this topic, and its international value, come from the well-known fact that in most building codes, applying multi-limit-state-based design (sometimes also referred to as a simplified version of the *performance-based design*), the structural reliability is not explicitly controlled, and ultimately it is unknown. This happens even if the ground motion intensity is determined based on the *limit state* considered in the design and the corresponding exceedance return period from the probabilistic seismic hazard analysis (PSHA) for the construction site.

The JEE special issue for the 2015–2017 (first) RINTC project documents the design, modelling, and analysis of tens of code-conforming buildings, belonging to five structural typologies, located at three sites spanning a wide range of seismic hazard levels in Italy. It was found that the seismic structural reliability and safety of code-conforming structures, measured in terms of annual failure and fatality rates, tend to decrease as the hazard increases.

In countries such as Italy, most of the building stock was designed with obsolete seismic codes, that is *low-code* buildings, or without any seismic provisions at all, that is *pre-code* buildings. For these constructions, the link between the design and the seismic reliability is even weaker as the design is not directly based on the PSHA and the design goals are not performance-based. Therefore, a second RINTC project for existing buildings (also known as RINTC-e) was funded by the *Dipartimento della Protezione Civile* (i.e. the Italian civil defence) and carried out between 2019 and 2021 by the same large group of researchers involved in the 2015–2017 RINTC, with the goal of assessing the structural reliability of pre- or low-code buildings in Italy.

One of the premises of the 2019–2021 RINTC was to be consistent as much as possible with the 2015–2017 project in terms of structural typologies and sites, modelling and analysis approach, performance levels against to which evaluate failure, and the assessment of seismic reliability. Therefore, in RINTC for existing buildings, the same five structural residential and industrial typologies were retained, that is: (i) *reinforced concrete* (De Risi et al. 2022; Di Domenico et al. 2022), which includes some cases where soil-structure interaction is considered (Iovino et al. 2022) (ii) *pre-cast reinforced concrete* (Bosio et al. 2022), (iii) *base-isolated reinforced concrete* (Cardone et al. 2022), and *unreinforced masonry* (Lagomarsino et al. 2022; Penna et al. 2022), and (v) *steel* (Cantisani and Della Corte 2022). For each typology, the design was carried out considering all the major changes in provisions and practice in the last century or longer, a period during which seismic design in Italy has undergone profound revisions following international research. The considered structures are assumed to be located at five

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Italian sites, which not only are representative of different seismic hazard levels according to today's standards, but also featured different design actions at the supposed time of design. As a result, more than one-hundred-forty buildings were designed. Three-dimensional state-of-the-art nonlinear numerical models were developed for each of them, and these models were analysed via multi-stripe nonlinear dynamic analysis, featuring hazard-consistent record selection. It is also noted that modelling was benchmarked against the performance of real buildings in recent earthquakes (Angiolilli et al. 2022). The analyses of the models ultimately led to a probabilistic representation of the structural seismic vulnerability; that is, the seismic fragility, evaluated with respect to two performance levels named *global collapse* and *usability-preventing damage*. The resulting reliability assessment, intentionally, does not include uncertainty in the structural modelling, the possible effect of ageing, or other issues about the existing buildings, to isolate the effects of design. The results of the project (Iervolino, Baraschino, and Spillatura 2022) include parametric fragility curves and failure rates that describe the variation of seismic safety with the evolution of codes and compare those with that implied by current design.

The objective of this special issue is to illustrate and discuss the main results of the 2019–2021 RINTC project, which is of interest to the international scientific community in the field of earthquake engineering. In fact, apart from the insights on modelling and analysis of existing buildings, the reliability assessment shows that:

(1) the seismic structural reliability of pre-code or low-code buildings is systematically lower than that of current-code-conforming structures; this result, although somewhat expected, has now been quantified in a consistent manner as much as possible;
(2) the evolution of seismic codes over the last century generally corresponds to an improvement in the structural seismic reliability, with the largest improvement corresponding to the current code, which features capacity-design principles, performance objectives, and design structural actions defined on a probabilistic basis;
(3) similar to current-code-conforming structures, the reliability of existing buildings tends to decrease as the seismic hazard, evaluated according to PSHA, increases.

These conclusions notwithstanding, it is important to underline that that the modelling and design choices taken in the project are inevitably conventional, at least to some extent. This is also because of capabilities of numerical modelling in capturing structural behaviour, especially with respect to capturing the failure conditions of interest to the reliability assessment. Moreover, the inherent differences between the code-conforming and pre- and/or low-code buildings made the consistency between the two studies far from perfect. Finally, the views of the researchers involved in the RINTC project may have influenced the quantitative conclusions listed above. Therefore, the results of this work should be always considered with due caution and having in mind the scientific matters, assumptions, and choices discussed in the papers of this special issue of JEE.

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