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Editorial

Reducing the Seismic Vulnerability of Existing Buildings: Assessment and Retrofit

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Devastating seismic events occurring all over the world keep raising the awareness of the scientific, technical and political communities to the need of identifying assets at risk and developing more effective and cost-efficient seismic risk mitigation strategies. Significant advances in earthquake engineering research have been achieved with the rise of new technologies and techniques with potential use in risk assessment, management and mitigation. Nevertheless, there is still much to be done, particularly with regard to existing buildings, most of them built without anti-seismic provisions. The wide variety of construction and structural systems, associated with the complex behaviour of their materials (raw earth, timber, masonry, steel and reinforced concrete), greatly limit the application of current codes and building standards to the existing building stock. To tackle this global issue, there is a fundamental need for developing multidisciplinary research that can lead to the development of more sophisticated and reliable methods of analysis, as well as to improved seismic retrofitting techniques compliant with buildings conservation principles.

The present Special Issue of Buildings intends to contribute to the aforementioned goal by stimulating the exchange of ideas and knowledge on the assessment and reduction of the seismic vulnerability of existing buildings. As outcome, 10 high quality contributions authored by international experts from Italy, Portugal, Morocco, Nepal, Czech Republic and Spain were published. All contributions pursue the protection of existing buildings by considering the most updated methods and advanced solutions emerging from different fields of expertise.

Ferreira et al. [1] starts by presenting a comprehensive review of the most relevant vulnerability assessment methods applicable at different scales, as well as the most significant traditional and innovative seismic retrofitting solutions for existing masonry buildings. The authors highlight the need for a proper balance between simplicity and accuracy when selecting the most appropriate seismic vulnerability method or technique, and stress the importance of adopting vulnerability indicators that can be easily understood and interpreted, not only by the technical and scientific community, but also by citizens and governmental and civil protection authorities.

Mascort-Albea et al. [2] proposes the development of a set of documents for the evaluation and diagnosis of the state of existing buildings and infrastructure regarding seismic activity in Andalusia. The authors establish two specific protocols. The first, a short-term guideline, which enables the classification of damage and risk levels, and the determination of what immediate interventions should be carried out through the generation of a preliminary on-site report. The second one, a long-term protocol, which provides calculation procedures and constructive solutions for the improvement of the seismic behaviour of affected buildings. The validity of the protocols is demonstrated by specially designed tests, which further illustrate the need for information and communication technologies (ICT) tools in the evaluation of architectonic technical aspects.

The main purpose of the study presented in Cherif et al. [3] was to assess seismic risk and present earthquake loss scenarios for the city of Imzouren, in northern Morocco. The authors resort to an empirical approach to assess the seismic vulnerability of the existing buildings, using the Vulnerability Index Method (RISK-UE), and considering both deterministic and probabilistic earthquake scenarios.

In the same line, Chieffo and Formisano [4] analysed a sub-urban sector of the historic centre of Qualiano, Naples (Italy). The seismic vulnerability of both masonry and reinforced concrete buildings is assessed resorting to a simplified typological-based approach and damage scenarios are created taking into account site and topographical local conditions. The site effects were shown to play an important role in the vulnerability and risk assessment of urban areas.

Estêvão [5] discusses the feasibility of using neural networks to obtain simplified capacity curves for seismic assessment. In the proposed approach, an artificial neural network (ANN) is used by the author to obtain a simplified capacity curve of a building typology, in order to use the N2 method to assess the structural seismic behaviour. The case study presented allowed the conclusion that the ANN precision is very dependent on the amount of data used to train the ANN and demonstrated that it is possible to use ANN to obtain simplified capacity curves for seismic assessment purposes with high precision.

Moving the focus to timber buildings, Drdácký and Urushadze [6] discuss possibilities for seismic improvement of traditional timber carpentry joints. The authors analyse two approaches, each using different retrofitting technologies that avoid completely dismantling the joint, allowing for the conservation of frame integrity. According to experimental observation, fully fastening the brake plates to the wood using screws, proved to be the most effective technique. Reinforcing timber carpentry joints with nails also produced interesting results, as did the use of a combination of nails and inserted plates.

d'Aragona et al. [7], investigate the effect of infills on the lateral seismic capacity of reinforced concrete (RC) framed buildings by explicitly considering possible brittle failures in either unconfined beam-column joints or columns. From a series of non-linear static analyses, the authors observe that the considered existing gravity load designed buildings attain the life safety limit state in a very premature stage of the analysis. They further show evidence that such a poor structural behaviour can be improved through the application of local retrofit interventions whose efficacy, in some cases, varies depending on the consistency of the infills.

Malla et al. [8] discuss the seismic performance of a high-rise RC apartment building with brick infill masonry walls, which was assessed through a nonlinear time history analysis. This work arose in response to the need for more research on the seismic response of this typology, which was identified in a rapid visual assessment campaign performed after the 2015 Gorkha Earthquake. The numerical simulations confirmed that the building sustained reduced damaged for the PGA value of the 2015 Gorkha Earthquake (0.16 g), though for earthquakes with PGA values equal to or higher than 0.36 g, the building would present severe damage, failing to fulfil safety demands.

A discrete element analysis of a shaking table test performed on a traditional stone masonry house is presented by Lemos [9], as a demonstration of the capabilities of this analysis method. Practical application issues are examined, namely the computational requirements for dynamic analysis. Among other remarks, the author stresses that model simplification strategies, whether in terms of geometry or in the constitutive assumptions, are a key to provide meaningful results with the existing data in practical situations.

Finally, Ramírez, Mendes and Lourenço [10] addresses the state of conservation of the Benedictine Monastery of São Miguel de Refojos, located in Cabeceiras de Basto (Portugal), as well as the evaluation of its structural behaviour and seismic performance resorting to nonlinear static analyses. Based on the diagnosis and analyses made, the authors draw a series of conclusions about the need for putting in place a monitoring plan and a set of preventive measures in order to guarantee a more efficient structural behaviour of the building.

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