buildings

Editorial

Masonry Buildings: Research and Practice

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Masonry is a construction material that has been used throughout the years as a structural or non-structural component in buildings. Masonry can be described as a composite material made up of different units, diverse types of arrangements with or without mortar, and used in many ancient public buildings as well as with the latest new technologies being applied in construction. Research in the multiple relevant fields, as well as crossing structural with non-structural needs, is crucial for understanding the qualities of existent buildings and to develop new products and construction technologies.

This special issue on "Masonry Buildings: Research and Practice" is intended to address and promote the discussion related to the different topics to do with the use of masonry in the construction sciences and in practice, including theory and research, numerical approaches and technical applications in new works, and repair actions and interventions in the built environment, connecting theory and application across topics from academia to industry.

The outcome was ten high-quality contributions authored by international experts from nine different countries, such as Bosnia and Herzegovina, Croatia, Egypt, Greece, Indonesia, Italy, Nepal, Portugal and Slovenia, which are presented and discussed, with several approaches giving an additional contribution to the state of the field.

Three submitted papers are related to non-structural masonry elements, and in particular the effect of infill masonry walls in the seismic behavior of RC (recinforced concrete) structures. Though the effect of these non-structural elements in buildings' behavior is well known, they are usually not considered during design, however, the studies presented provide some additional contributions. Kalman, Šipoš, and Strukar present a methodology to estimate the contribution of infill in masonry-infilled frame response based on a bi-linear approach, and the methodology was developed using neural networks supported by an experimental database [1]. Furtado et al. present a particular case of a post-earthquake study in Nepal of a 15-story infilled and reinforced concrete structure, in which the model was calibrated with experimental data collected on site and the strategies that need to be considered with regards to the influence of infill masonry in linear analyses, with and without damages, have been analyzed, discussing the effects of the masonry particularly in the torsional response of the building [2]. Previous studies have shown the influence of the masonry infill walls in structural response, associated in several cases with non-structural damage, and De Risi et al. provides an important contribution based on the available data collected after the L'Aquila earthquake in Italy that was used to estimate the repair costs for infills in a damage scenario [3]. The development of proper models and their use in real structures for assessing structural and non-structural damage is important for the estimation of direct and indirect losses due to earthquake events, which is a key aspect to help mitigate seismic risks.

The other papers are related to the use of masonry as a structural element. Indeed, Bayuaji and Biyanto present a work using an artificial neural network to predict the deflection deformation caused by dynamic loads [4]. The modeling of the structural behavior, as well as the mechanical characteristics of masonry structures and the materials comprising it, is still an open issue to this day, even considering the non-homogeneous and anisotropic nature of masonry [5], as well as that of the materials comprising it. It is also worth considering all the uncertainties that are common, especially in traditional materials, that are leading the research in the use of advanced technologies, like the use of artificial neural networks, which have emerged over the last decade. Take, for example, the already discussed infill masonry as an attractive meta-modelling technique that is applicable to a vast number of scientific fields, including material sciences [6].

Three papers have focused on the characterization and evaluation of the structural behavior of existent masonry buildings in very different locations, as well as their typologies and materials used. Two of the papers have focused on seismic assessment and strengthening. Domingues et al. present a complete case of the typological and mechanical characterization of granite stone masonry walls frequently found in old Portuguese urban centers, describing the different in situ and laboratory experimental campaigns, the results of which provide an understanding of the local buildings, and also show how the results can be used for further analysis [7]. Ademović et al. present a seismic assessment of the vulnerability of a typical multi-story residential unreinforced load-bearing masonry building in Sarajevo, Bosnia and Herzegovina, built without seismic concerns. This represents an important part of the masonry building stock built between the 1920s and 1960s in this city and in the Balkan region in general [8]. Like the work presented previously, also in this study, the use of site and laboratory tests is presented and discussed to support the structural assessment. At the end, a brief discussion is presented about strengthening solutions to reduce the seismic vulnerability. On the same topic, Fathalla and Salem perform a numerical parametric study also motivated by seismic assessment and retrofitting, focused on a typical four-story, load-bearing building in Giza, Egypt [9] for different earthquake zones, studying different retrofitting strategies based on carbon fiber reinforced polymer. These papers have highlighted the importance of in-situ investigations and laboratory tests, allowing for a better definition of necessary materials and reducing some uncertainties, while also presenting different numerical approaches to perform the seismic assessments and to study different retrofitting solutions that are needed for buildings built without regard to seismic concerns around the globe.

Unreinforced stone masonry is one of the most common materials used in monuments all around the world. The last group of papers published in this special issue presents three different case studies on this topic. It is well known that, regarding monuments, each case should be studied as a singular incident, however, researchers and engineers can learn from the different cases reported in the literature. The first case study is related to research into the causes of the damage in the cylindrical masonry shell structure in St. Jacob's church in Dolenja Trebuša, Slovenia [10]. Based on a numerical analysis, it was possible to understand the influence of the different possible causes, namely dead loads, settlements, differential temperatures and extreme events like earthquakes. Based on the results obtained, a monitoring plan and the study of a strengthening strategy are discussed. The other two cases are mainly focused on the seismic assessment and retrofitting of existent monuments. The first of these is focused on the seismic strengthening of the Bagh Durbar Heritage Building, located in Kathmandu, Nepal [11], which was damaged after the earthquake of 2015. ased on the numerical analysis, it was possible to preserve and improve the seismic safety of the ancient building. The second case is related to the assessment of an unreinforced stone masonry Basilica-style church, located in Greece, and focused on the long-term, permanent, and uneven foundation settlement, combined with seismic forces generated from relatively strong earthquake ground motions in the area [12].

From all the cases presented, it is possible to conclude that the behavior of new RC masonry-infilled structures or old masonry structures is complex, and with some limitations and simplifications, can be simulated with numerical models in order to assess the effects of external loads and evaluate performance under extreme events, like earthquakes. The use of these numerical models, which can be more simply performed only with elastic properties, or in more advanced ways by exploring the non-linear behavior of the materials, should be based on data from the site, from experimental data, and with the information provided by other researchers in the same field. The knowledge thus acquired can increase confidence in structural analyses, and in even more complex problems when the intention is to study retrofitting solutions. It should also be highlighted that all types of masonry that are faced with immense variability in terms of materials and construction techniques even now have a relative lack of relevant in situ and laboratory tests. Consequently, it is essential to keep improving numerical models with reliable experimental data, which allows the use of either more simplified or more complex models that provide reliable results.

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