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Editorial

Special Issue on "Buildings and Structures under Extreme Loads II"

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1. Introduction

Exceptional loads on buildings and structures are known to take origin and manifest from different causes, like natural hazards and possible high-strain dynamic effects, human-made attacks and impact issues for load-bearing components, possible accidents, and even unfavorable/extreme operational conditions. All these aspects can be critical for specific structural typologies and/or materials that are particularly sensitive to external conditions. In this regard, dedicated analysis methods and performance indicators are required for the design and maintenance under the expected lifetime. Typical issues and challenges can find huge efforts and clarification in research studies, which are able to address with experiments and/or numerical analyses the expected performance and capacity of a given structural system, with respect to demands. Accordingly, especially for existing structures or strategic buildings, the need for retrofit or mitigation of adverse effects suggests the definition of optimal and safe use of innovative materials, techniques, and procedures. This Special Issue follows the first successful edition [1] and confirms the need of continuous research efforts in support of building design under extreme loads, with 13 original research papers focused on various key aspects of structural performance assessment for buildings and systems under exceptional design actions and operational conditions.

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2. Contents

Generally speaking, it is known that joints and connections represent a first critical component in buildings and systems. Depending on their actual mechanical features and capacities, as well as sensitivity to external conditions, the structural performance assessment of the building as a whole can be strongly affected. In this regard, a first set of research papers is dedicated to the experimental, numerical or hybrid analysis of special joints for constructional systems, under a variety of mechanical properties and loading conditions [2–6]. For timber structures, for example, it is known that both material and geometrical parameters for connections arrangement can have severe effects on mechanical performances, in the same way of moisture, loading protocol, etc. Experimental studies are thus reported in [2] for Bonded-in-Rod (BIR) connections under various operational conditions for bonding adhesives, while the study in [3] presents a critical analysis of performance indicators for timber-to-timber screwed connections with various configurations. As far as connections parameters are taken into account for steel structures are considered, several calculation approaches can be notoriously taken into account in support of design [4]. The study presented in [5] and validated to literature experiments for bolted connections proves that artificial intelligence can offer useful feedback and support for component design optimization. The structural performance of slab-to-column connections in concrete frames can be especially critical when subjected to blast loads. The investigation summarized in [6], in this regard, gives recommendations with the support of efficient and realistic finite element numerical models. A prediction equation for the blast-resistant performance of slab-column joints under blast is also presented in [6], as obtained based on additional numerical analyses.

Blast loads, impact events and earthquakes certainly need a special attention for design and verification of critical infrastructures. Besides, critical situations for buildings and components may derive from a multitude of scenarios. First, in any case, it is required to properly describe the structural dynamic problem with reliable mathematical models [7]. Successively, the use of more complex and advanced numerical tools can provide additional important indications about the actual performance and capacity.

The study in [8] focuses on cable-stayed bridges under blast accidents resulting from explosions produced by vehicle collisions or terrorist attacks. An efficient procedure to assess structural blast-resistance performance of key structural components in cable-stayed bridges is suggested, based on a numerical analysis approach. Impact test methods are presented in [9] to assess the structural capacity of bridge piers, given that the stability of bridge substructures is closely related to safety problems. Often, however, safety inspections are mostly focused on materials and structural issues problems, and there are no recommendations for quantitative analysis of substructures. When existing bridge structures are subjected to earthquakes, finally, special retrofit interventions should be needed for piers and connection details. An experimental study is presented in [10], based on six small scale specimens reconstructed to describe existing bridge piers under seismic (laboratory) conditions.

For bridges, but also for structures in general and building components, there is a strong correlation of mechanical capacities and natural characteristics, such as wind phenomena, soil effects, and ambient. The study in [11] proves that uncertainty due to the randomness of wind tunnel wind flows is a critical aspect for the design of high-rise buildings under wind. This uncertainty should be taken into account during experiments and output processing by examining the cumulative probability trends and assuming a reliable level of confidence for the estimated crucial magnitudes, such as the modal shapes, frequencies and damping ratio parameters.

The investigation reported in [12] presents a field analysis for damage issues incurred in a historical cathedral subjected to foundation strengthening works. Considering the historic data related to the cathedral, the on-site registered damages, the results of geodetic measurements and the experiences gained from rehabilitation works, the authors conclude that soil-structure interactions for historical buildings represent a very complex, multidisciplinary problem. Damage propagation and patterns in the cathedral facade are monitored in support of intervention design and optimization.

The study in [13] starts from the analysis of the failure mechanism for a roof, with steel truss construction, of a factory building in the northwestern part of Turkey. The failure occurred under hefty weather conditions including lightning strikes, heavy rain, and fierce winds. In order to interpret the reason for the failure, the effects of different combinations of factors on the design and dimensioning of the roof are studied by authors, with the support of finite element analysis and on-site investigations.

Finally, the investigation reported in [14] proves that creep properties of Balau wood timber cross-arms reinforced with additional braced arms can be significantly reduced, compared to existing design wooden cross-arms. Accordingly, the implementation of bracing system in cross-arm structures displays a more stable stress independent material exponent in members. This results in improved dimensional structural stability in service life.

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