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EDITORIAL

Tall Buildings: Structural Analysis, Preliminary Design, and Assessment of New and Unconventional Systems

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Tall buildings represent one of the fingerprints of the intensive urban development that is taking place in modern cities. In a world where population is growing more and more and in which people are increasingly moving from the countryside into overcrowded megalopolises, tall buildings can be a possible solution to avoid excessive horizontal land consumption by conquering vertical space.

The first tall buildings were realized in the United States during the late 19th century and allowed to reach just a few tens of stories. Nowadays, much taller structures are built all over the world, especially in Asia and Middle East countries, reaching extraordinary heights. The tallest building in the world is currently the Burj Khalifa in Dubai, with its sensational 828 meters. This record is probably going to be broken by the Jeddah Tower, that is currently under construction and is trying to beat the 1000 meter-height milestone [1].

The design and construction of a tall building raise a series of additional problems than those posed by a low-height structure. High-rise buildings need to withstand massive vertical stresses coming from the huge gravitational dead and live loads, and their stability under lateral actions requires careful attention. Lateral loads, such as those arising from wind pressure and earthquake motions, deeply affect the structural design of a tall building. As firstly pointed out by Fazlur Khan in the 1960s [2], as the building becomes taller, there is a *premium for height* due to the lateral loads, which makes the total structural material required to meet safety and serviceability requirements to increase drastically. To overcome these issues and push the design and technological development of taller buildings, new structural systems are developing [3]. The efficient combination of different building materials, as well as the coupling between unconventional internal and external systems, made the realization of efficient structural solutions for tall buildings possible, which brought us to the present era of the supertall Burj Khalifa and Jeddah Tower.

This Thematic Issue for *The Open Construction & Building Technology Journal* is dedicated to the recent studies in the area of tall building design, analysis and assessment. It collects four works from four different groups, which focus on different aspects of tall building behavior, ranging from the assessment of irregular high-rise buildings under intense earthquake motions [4], to the development of a novel grid layout for external structural systems [5], to the evaluation of the seismic response of megastructures *via* mega-subcontrol systems [6], up to the assessment of the structural and technological performance of timber high-rise buildings [7]. Together, these different research works shed light on several features of tall building design and behavior.

The first paper of this Thematic Issue comes from Çelebi and Swensen [4], who report the results of comprehensive seismic monitoring of an irregular and asymmetric 24-story tall building in San Diego, California, under the shaking motion of an M7.1 earthquake event. An extensive analysis is carried out based on the accelerometric data recorded by sensors placed at the different levels of the building. The recorded responses are shown to provide significant information on the main frequencies of vibration of the building, which are associated with the fundamental horizontal and torsional mode shapes. Important insights on the detected coupling between lateral and torsional modes, as well as on the critical damping percentages, are also provided and discussed throughout the paper.

Completely different is the second work of this Issue, contributed by Sheiki and Rezagholi Zadeh Omran [5]. Here, the authors propose a new structural system for tall buildings based on the tessellation of the external building surface into a pattern of isometric cubes (ICs) and is then called the IC-grid. The IC-grid system is someway in between the diagrid and the hexagrid, the former being associated with a pattern of triangles and the latter a pattern of hexagons throughout the

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building surface. The mathematical formulations for the IC-grid visual density, as well as for the axial and shear stiffness, are derived and compared to the ones corresponding to the diagrid and the hexagrid. A comparison between the performance of the IC-grid and one of the diagrids and the hexagrids is carried out, highlighting the optimal range of angles for the diagonal members.

Grid structural systems are also the focus of the third paper written by Faiella *et al*. [6]. Here, a diagrid-based megastructure (MS) configuration is used to investigate the seismic response of a 39-story tall building. Then, in order to enhance the mass-damping mechanism of the building and therefore to limit the earthquake-induced displacements, the external MS is detached from the internal sub-structures, generating a mega-sub-structure control system (MSCS). Modal and time-history analyses of these MS and MSCS configurations under three different earthquake conditions reveal the suitability of such systems in reducing the amplitude of motion of the building, as well as the total shear force induced by the building deformation. Relevant considerations for the technological adoption of these MSCSs and their feasibility in real tall buildings are also provided.

The last paper of this Thematic Issue is contributed by Angelucci *et al*. [7] which discusses the important subject of achieving higher sustainability in the construction of tall buildings by using timber elements. The work aims at comparing the structural performance of three hybrid timber-concrete systems. In the first one, a reinforced-concrete (RC) core is coupled with a moment resisting frame made of glued laminated timber (GLT) members. In the second one, the internal RC core is connected with cross-laminated timber (CLT) shear walls. Whereas in the third one, the RC core is coupled with a diagrid system made of GLT elements. The results being shown from modal analyses and the application of wind and seismic loads provide useful information about the structural efficiency of the three hybrid models. The different material usage and stiffness contribution between the timber systems and the RC cores are also thoroughly investigated.

As can be appreciated, the works included in this Thematic Issue offer a diversified overview of the present developments in the current research about tall buildings. The future will probably ask for new efforts towards more structurally efficient, environmentally sustainable, and economically feasible tall building constructions. We hope that the contents included in this Issue will further stimulate the interest and thinking process of the numerous researchers and designers working on these exciting topics.

CONFLICT OF INTEREST

The authors declare no conflict of interests, financial or otherwise.

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