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EDITORIAL

Nonlinear Behaviour, Design and Analysis of Steel Structures: Recent Findings and New Trends for the Next Generation of European Design Standards

Keywords: Behaviour of steel members, Connections, Steel composite structures, Robustness, Seismic design.

In Europe, Eurocodes are the set of standards for structural design, integrating all specific National experiences and research outputs. However, about ten years have elapsed since the official issue of these codes. Within this last decade, European codes for structural design have been extensively used by designers and practitioners, thus showing the lacks and fallacies in the application of some requirements and confirming the need to update the codes. On the other hand, prolific research activities have been carried out in different fields of structural design introducing a number of novel results on different topics. In line with that, the CEN Technical Committee, called CEN/TC 250 'Structural Eurocodes', and specific sub-committee working groups (SC/WG) made up of renown experts have been organized to work on each and/or new additional Eurocode within a six year program of work to develop the next generation of European standards for structural design, which should be ended within 2020 with the aim to embrace new technologies and future market needs.

It is clear that this stirring ferment will require the conjunct engagement and effort of a large number of researchers and practitioners in each field covered by Eurocodes.

Within this background, the field of steel structures is one of the most prolific in terms of novelties and recent findings covering the main topics that traditionally characterize the sector. Hence, a better understanding of the behaviour of steel structures in the light of new research findings will enable to design more economical and innovative structures and to ensure the safety without increasing the constructional costs.

It is clear that sharing knowledge is crucial to put under the table of discussion of the relevant panels and working groups the main issues requiring improvements and/or clarifications. In this regard, the present thematic Issue on "*recent findings and new trends about nonlinear behaviour, design and analysis of steel structures*" aims at promoting the discussion by sharing recent research outcomes among the technical and scientific communities as contribution, although humble, to finalize the revision of the European standards dealing with steel structures.

A total number of 41 researchers working in the field of design, testing, analysis and assessment of steel structures joined this Special Issue, which is composed by eighteen contributions. Table **1** summarizes the distribution and the origin of all Authors. As expected considering the theme related to European codes, most researchers are from European countries and they represent the main areas of the continent, from East to West and from South to North of Europe. However, also researchers from extra EU countries, like Iran, Turkey and Brazil have participated.

The accepted contributions cover most important topics for steel structures, as behaviour of members, connections, steel composite structures, robustness, seismic design, and sustainability.

Five of the accepted papers focus on the behavior of steel members (each discussed in the order of appearance in the issue). The first paper by Crisan and Dogariu [1] describes and discusses the results of an experimental campaign, carried out at CEMSIG Research Centre of "Politehnica" University of Timisoara, to study the influence of residual stresses due to result cold rolling process on buckling capacity of two pallet rack upright sections. The second paper authored by Di Lorenzo and Formisano [2] investigates the main geometrical and mechanical parameters influencing the structural efficiency of I and H European profiles, allowing for a quick numerical evaluation of the effects produced by the rolling process on the semi-finished casting products and providing design criteria to select the optimal profile. Dogariu *et al*. [3] present the results of experimental tests performed on tapered beam-columns elements, subjected to both bending moment and compressive axial force. The results of this study highlight some limits of the verification formulas recommended by EN1993:1-1 [4]. Jandera *et al*. [5] investigated interaction of axial force and bending moment formula for stainless steel profiles. By means of comprehensive parametric finite element analyses, those authors compared the efficiency of EN 1993-1-4 [6] with the recent state of the art, highlighting the limits of the code.

Table 1. Distribution and origin of authors.

Continent	Nation/Country	No. of Authors/Country	No. of Papers/Country
Europe	Italy	17	4
	Romania	5	2
	Belgium	4	1
	Portugal	3	2
	Hungary	3	1
	Czech Republic	3	1
Middle East/Asia	Turkey	2	1
	Iran	2	1
Latin America	Brazil	2	1
	Total No. of Nationalities	Total No. of Authors	
	9	41	

Regarding the steel connections, the paper by Tartaglia and D'Aniello [7] presents a numerical study on the behaviour of extended stiffened end plate bolted beam-to-column joints subjected to sudden column removal. This study highlights that in case of catenary action, the bolt row in the middle of the connections, which is generally ineffective in case of design for pure bending response, has a beneficial influence to improve the rotation capacity of the joint as also recently highlighted by [8].

A contribution on steel composite structures is authored by Zona *et al.* [9], which investigated the behaviour of continuous steel-concrete composite beams with different shear connection distributions obtained from two design methods, *i.e.* Eurocode 4 [10] and a proposed alternative approach. On the basis of finite element analyses, the obtained results focused on the ductility requirements of the shear connectors when the connection design approach and distribution vary.

Three contributions on robustness were accepted, covering different aspects which characterize the performance of steel structures under abnormal loading conditions. The paper by Bedon and Amadio [11] deals with a very interesting and quite novel issue, namely the performance of glazing curtain walls under the effect of air blast pressures of variable intensity by means of finite element simulations. In particular, they examined the structural efficiency, criticalities and feasibility of two different typologies of dissipative devices introduced at the point of supports of each curtain wall modular unit.

The paper by Cassiano *et al*. [12] addresses more conventional topics. In particular, they examined the influence of seismic design rules given by EN1998-1 on the robustness of multistorey steel frames. The main results highlight that capacity design principles at global level do not guarantee a satisfactory performance against progressive collapse, while are beneficial at local level to guarantee the ductility of the connections. The paper by Demonceau *et al*. [13] closes the discussion about robustness. In their interesting and stimulating work, on the basis of experimental, numerical and analytical approaches, those authors propose an effective and simplified procedure useful for practitioners, allowing ensuring an appropriate level of robustness to structures for the considered scenario.

Regarding the seismic design of steel structures, all accepted contributions focus on braced frames. The first of this set of articles is authored by Costanzo and Landolfo [14], which addresses a review of seismic design provisions for concentrically braced frames (CBFs) in both European [15] and North-American [16, 17] codes. In line with [18], this work critically discusses about (i) the ductility classes and the correlated force-reduction factors; (ii) the structural analysis methods permitted by different codes; (iii) the detailing rules for both dissipative (bracing members) and non-dissipative elements. The second paper describes the results of a numerical study carried out by Faggiano *et al*. [19] aimed at investigating the seismic performance of inverted V concentrically braced frames designed according to [15, 20]. The results show that the examined structures experience poor seismic performance without tensile yielding of bracing members. The authors highlighted that the flexural stiffness of the braced-intercepted beams in chevron bracing is mainly responsible for the poor performance of inverted V CBF, which is in line with the recent findings by [21]. The paper by Güneyisi and Gültekin [22] deals with the seismic performance of gate braced frames. This structural typology recently is under the renewed interest of practitioners in southern Europe. The paper examines the role of bracing eccentricity on the seismic performance of a mid-rise steel building. The influence of out-of-plane offset irregularities on the seismic performance of steel concentrically braced frames was investigated by Mohebkhah and Akefi [23]. This study shows that the overstrength factor prescribed by seismic provisions to amplify columns axial seismic forces in OCBFs is not conservative. Moreover, low- and mid-rise regular and irregular concentrically braced frames may experience inter-story drift demands greater than those predicted by the amplified elastic analysis recommended by the codes. The paper by Tenchini *et al*. [24] investigates the potential advantages of using high strength steel in the seismic design of chevron braced frames. In line with former studies carried out by those authors [25, 26], the actual benefit of using high strength steel is quite limited for medium rise buildings. A very interesting paper on buckling restrained braces (BRBs) was presented by Zsarnóczay *et al*. [27], which completes this thematic issue. Nowadays, BRBs are not yet codified in Europe. With this regard, those Authors present a robust design procedure for buckling restrained braced frames in the framework of Eurocode 8 [15]. Moreover, this study shows that there is an actual need for additional regulations in the Eurocodes that introduce reasonable structural reliability index limits for seismic design.

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