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EDITORIAL

Thematic Issue on Advances in Modeling, Analysis and Design of Steel Connections

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Modeling, analysis and design of steel connections between structural members are of primary importance in structural steel design, because the connections' behavior significantly affects the response of steel structures under monotonic loading conditions, both in elastic and in plastic range, and exceptional impact loading conditions. In addition, also the seismic response of steel structures is strongly affected by the ultimate behavior of structural connections under cyclic loading conditions [1 - 3]. In particular, seismic design of steel structures is commonly carried out to assure the dissipation of the seismic input energy in the so-called "Dissipative Zones" which has to be properly detailed in order to assure wide and stable hysteresis loops. Once the yielding of non-dissipative structural members is avoided, connections play a role of paramount importance. In fact, they can be designed either as Full Strength (FS) or Partial Strength (PS). In the first case, the seismic input energy is dissipated by means of plastic cyclic excursions in structural members. In the second case, dissipation requires the plastic engagement of ductile connection components.

As it is well known, before the introduction of the concept of semi-rigidity [2, 4, 5], steel frame design was accomplished by properly considering a limit assumption regarding the joint behavior. Depending on the beam-to-column joint typology, it was either assumed that all the ends of the members converging in the joint are subjected to the same rotation and the same displacements or assumed that the joints are able to permit free rotations. The first case leads to continuous frames, while the second one to pinned frames. The application of the semi-rigidity concept requires the development of a general methodology working out in detail the provision of the rotational stiffness and the flexural resistance of joints. This resulted in a strong effort, in Europe more than in United States, which has led to complete definition and codification of the component method [2, 5]. This allows the analysis of actual semi-continuous structural systems, starting from the knowledge of geometrical and mechanical properties of beam-to-column joints.

The component method is essentially based on mechanical models constituted by the assembling of spring elements modeling the joint components. The non-linearity of the joint moment-rotation response is obtained starting from the inelastic constitutive laws adopted for the components. The method is suitable for modeling of any kind of joint, provided that the components are properly identified and their constitutive law is rightfully modeled.

This thematic issue is constituted by ten papers focused on topics that provide a significant contribution to the revision of code provisions. Currently, the revision of Structural Eurocodes is in progress and most of the authors of the papers selected for the thematic issue are involved in the Working Groups organized by CEN, the European Committee for Normalization, to support the Project Teams charged of the revision of Eurocodes. Most of the papers herein presented are, therefore, the result of a deep cooperation between researchers coming from different countries.

In particular, some papers are devoted to the influence of technological issues on the behavior of structural steel connections. Critical issues concerning the use of laser cutting technologies are investigated [6]. The application of the component method for the modeling of steel rack connections is analyzed [7]. The influence of the connections' behavior on robustness and impact loading resistance is studied [8, 9]. Some critical issues regarding the role of structural steel connections in the seismic design of moment-resisting frames are analyzed [10 - 12]. In particular, the use of beam-to-column connections equipped with friction dampers is suggested [12] where the results obtained by means of different design strategies is presented. Reference is made to both MRFs designed according to Eurocode 8 and to MRFs designed according to the Theory of Plastic Mechanism Control [13 - 15]. The efficiency, during the service life of structures, of the innovative connections [16] analyzed [12] is strictly related to behavior of the material adopted for the friction pads [17] and to the long term behavior concerning the applied bolt preload [18].

With reference to connections equipped with friction dampers, experimental analysis and FE simulations devoted to assess the friction coefficients of several interfaces evaluating also their ability to withstand cyclic loading histories in terms of energy and strength degradation are presented [19]. The experimental work is with regard to eight different materials tested at low frequency applied on mild steel plates by means of thermal spray or by chemical bonding with the electroless nickel procedure. The experimental results have been used to validate finite element models able to simulate the behaviour of lap shear friction connections, showing the influence of different modelling approaches over the simulated data.

The accuracy in the prediction of the seismic response of steel structures is strongly affected by the modeling of the cyclic behavior joints. The critical issues regarding the calibration of the cyclic model parameter have been recently investigated [20], showing that the optimization of the calibration procedure requires the combined use of experimental results coming from both monotonic experimental tests and cyclic experimental tests. This critical issue has been emphasized by means of a comparison with the experimental results obtained by means of the pseudo-dynamic testing method.

In case of bolted connections, the most important joint components are modeled by means of an equivalent T-stub. For this reason, within elementary connections, bolted T-stubs are perhaps the most studied. FE analyses of bolted T-Stubs in the large deformation range are presented in this thematic issue [21].

Bolted extended end-plate connections are commonly used also for tubular members with rectangular and square hollow sections. The tension resistance of this type of splice can be analytically calculated by means of the component method. However, Eurocode 3 does not give effective rules to compute the effective length in the case of corner bolts. This critical issue is investigated [22] where the influence of corner bolts on the tensile resistance of the splice is analyzed by means of a a parametric study based on finite element simulations.

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