Doctoral Programme in Civil, Environmental and Mechanical Engineering

Research subjects proposed for the 41st cycle – second call

Additional position with scholarship

Curriculum C - Modelling and Simulation

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C6 - scholarship on reserved topics

Funded by: Department of Civil, Environmental and Mechanical Engineering.

Title: Tools and strategies to study the performance and design of LSF systems under static and seismic loading conditions

Light steel framing (LSF) systems have recently grown in popularity within low/medium-rise construction industry, emerging as a competitive and efficient alternative to traditional materials such as wood and concrete [1]. Advantages include fast construction times, sustainability, environmental benefits, design flexibility and structural advantages such as a high strength-to-weight ratio and lightness, making them suitable for use in earthquake-prone areas [2]. Despite their various structural, technological and economic advantages, however, LSF systems are not widespread in Europe nor Italy, unlike in other countries where specific design documents have been developed to guide practitioners.

The system consists of a steel frame made of cold-formed steel profiles that are sheathed in materials such as wood, gypsum, cement-based panels or steel sheets. The steel skeleton and sheathings are screwed together and connected at the base to a concrete slab.

In recent decades, numerous studies have addressed various issues with LSF buildings. Studies of elementary components (e.g. steel profiles, sheathings and connections) [3,4], sub-assemblies (e.g. wall and floor structures) [5,6,7,8] and whole building [9] clearly demonstrate the complex behaviour of these systems, influenced not only by the behaviour of their individual components, but also by components' interaction phenomena. This complexity is reflected in the availability of design criteria limited to the 'common' typologies of components and sub-assemblies that have been investigated in-depth, both experimentally and numerically. Outside this limited range of cases, a design-by-testing approach must be followed. In recent years, the numerical approach to the design of structures has become very popular thanks to increased computational capacity associated with more sophisticated software tools. However, in the case of LSF systems, its use is prevented by the high complexity of the models that must be set up to take into account all the phenomena affecting the structural response [10,11]. Besides, sub-assemblage and full-scale LSF tests are fairly costly.

The research project aims to develop design-oriented criteria for LSF buildings under static and seismic loading conditions, focusing on the main structural sub-assemblies (i.e. wall and floor diaphragms) and of the structure as a whole. An in-depth investigation of the response of the building and its components is performed through numerical analysis, supplemented by experimental results from literature and/or tools based on innovative analysis technique. The study considers the main parameters affecting the structural response of both sub-assemblages and the whole structure in order to: i) create reliable analysis models able to reproduce the structural response; ii) investigate the influence of the parameters considered in the study; iii) identify the essential parameters to be considered in the design process; iv) define simplified analysis models; and finally v) derive design criteria. In the study, particular attention is paid to the mechanisms of force transmission between individual components and to the boundary restraint conditions. The work will also check the potential use of machine learning for extending the application range of the results. The study outcomes are expected to create the background

for the exploration of the potential and limitations of LSF systems and to suggest possible innovative solutions aimed at improving the structural behaviour. Results of the research will contribute to draw out design guidelines to support practitioners' design activities. The research outcomes will be disseminated via presentations at national and international conferences, as well as publications in high-ranking international journals.

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