Structural behavior of eco-efficient and high durability pre-walls

Summary

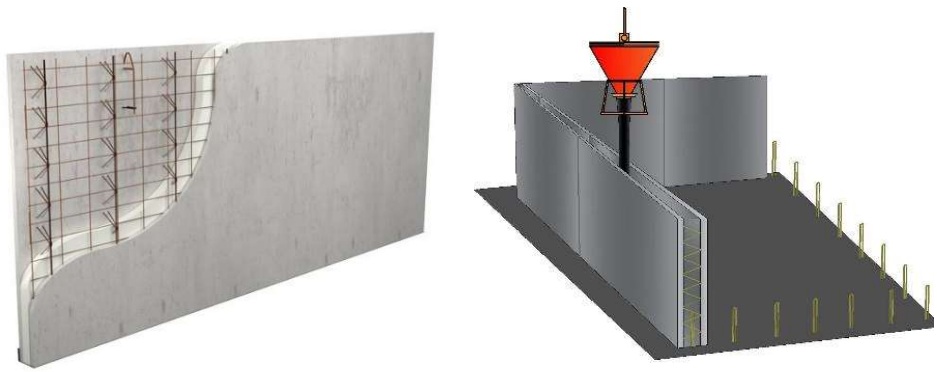
The prefabrication sector has been evolved over the last years, bringing many advantages of industrialization to civil construction. The use of precast members allows to shift work from construction sites to factories with controlled environments, qualified workers, and automated equipment, promoting rational and efficient manufacturing processes. The prefabricated structures can be built faster than conventional reinforced concrete structures cast in situ and at a more affordable cost. These characteristics can be particularly relevant to produce emergency constructions, such as field hospitals and shelters, in calamity situations (natural disasters, wars).

This PhD thesis is focused on the study of precast hollow concrete modules, constituted by two panels, spaced and connected by metallic trusses, designated as 'pre-walls'. The main goal is to improve this constructive solution to be used in low-rise buildings as structural members, avoiding the need of columns and beams. The structural wall system can be a very versatile solution to build constructions with different configurations. These 'pre-walls' will be optimized to reduce the environmental impact associated to its production and will be designed to support vertical and horizontal forces (due to wind and earthquakes). The connections between the 'pre-walls' are also a key issue in this system to guarantee an effective transfer of forces, restrict movements and assure adequate stability to the entire structure, and will be also studied.

The work is divided into three stages: (i) formulation, production, and characterization (mechanical properties and durability) of the 'pre-wall' concrete. This concrete will be optimized, reducing the cement dosage and replacing it with other additions, in order to improve its eco-efficiency, without compromising durability and performance; (ii) characterization of the structural behaviour of the walls, subjected to vertical and horizontal loads. The walls will be also studied without concrete in the core, to allow the placement of installations inside the 'pre-walls' and to reduce the amount of concrete used, which is advantageous for sustainability, transportation and handling; (iii) evaluation of the connections between the precast walls and between the walls and slabs. Different types of connection will be explored, from wet-connection, with cast concrete in the core, to dry-connection (*e.g.* bolts), to allow a faster assembly and, if necessary, disassembly of the structure.

Keywords

Prefabrication, structural walls, faster and affordable construction, connections, sustainability.



Pre-walls system: constitution of a pre-wall (left), assembly between pre-walls and casting the concrete core (right).

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