A NEW CONSTRUCTION SYSTEM FOR CLT STRUCTURES

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ABSTRACT: The technique proposed herein, aims to solve the construction site issues related to both the handling and the assembly of cross laminated timber walls (CLT), through an innovative preassembled connection system. This system, which thanks to its being prefabricated permits to save time during the installation process, provides also a high strength and a high stiffness to the panel joints. As a result, an improvement of the building safety is attained for both static and seismic conditions. The main purpose of the original solution is the enhancement of the production, the handling and the onsite assembly processes of CLT panels, by means of an higher degree of prefabrication which implies higher safety, precision and speed of assembly as well as an advantage in terms of costs and time schedule planning.

KEYWORDS: CLT construction system, prefabrication, innovative connection system, seismic behaviour

1 INTRODUCTION

In the last decade, Cross Laminated Timber (CLT) buildings have undoubtedly thrived. This positive trend has not stopped owing to the remarkable versatility of such product. CLT panels provide the timber structures with quite good strength levels, no matter the load direction they are subjected to (wall/diaphragm configuration) and, if loaded edgewise, they offer an extremely high stiffness as well. Another aspect that should not be neglected is the “environmental friendliness” of CLT, which is a renewable and recyclable material with excellent insulating qualities. The CLT technology is characterized by a high level of prefabrication: the panels are manufactured in modern factories equipped with computer numerical control (CNC) systems. By contrast, the speed of the construction process and the possibility of controlling the quality of the onsite installation are hindered by the difficulty of assembly due to the need of positioning the panels (secured with hundreds of nails and timber screws) without any reference point. From the in-depth analysis of the details of the CLT construction method, it can be deduced that the critical point of the whole system is represented by the mechanical connections. In the traditional CLT assembling system, single panels are connected to the foundation and to the panels of the upper floor through hold-down elements and angle brackets which are nailed to the panels (Figures 4 and 5). These connectors which have been designed for other technologies (like platform frame) have been adopted for CLT structures with little or no modifications. As a result, the building capacity is limited by the strength of the connectors, which also show ultimate deformations not compatible with the CLT panel stiffness. This is accompanied by poor dissipating capabilities in case of an earthquake.

Figure 1: The new connection X-RAD fixed at a corner of a CLT panel, (left) and schematic representation of an entire node between four walls (right)
2 X-RAD INNOVATIVE CONSTRUCTION SYSTEM

The proposed connection system leads to a new idea of CLT construction. Due to the possibility of assembling the X-RAD connectors directly within the factory, the CLT panels can be lifted during the production phases, transported to the construction site and assembled by the use of a unique element represented by the steel elements placed at the edge of the different panels. The X-RAD components are meant to be pre-assembled in the factory using all-threaded self-tapping screws, so that the system could act as a lifting point for the positioning operations. Finally the installation of the panels, thanks to this innovative connection, requires just the tightening of few bolts in order to secure a timber wall to the next or to the foundation.

3 MECHANICAL BEHAVIOR OF THE SYSTEM

In the traditional CLT assembling system the CLT walls are connected to the foundation and to the floors by the use of hold down and angular brackets. Considering that the X-RAD connecting system is located at the corners of the panels it is possible to create slots where to insert the panels constituting the floor diaphragms (Figure 3 and 4). By doing this, the vertical loads can be transferred to the foundations by direct contact between the vertical walls, thus preventing any failure of the floor panels due to compression orthogonal to the grain.

The floor panels can be connected to the vertical panels directly by the use of the X-RAD system, applied both on vertical and horizontal panels, and proper steel plates at the corner nodes or screwing the floor directly to the aforementioned slots created into the CLT wall.

4 CONCLUSION

A new connection system and a new assembling structural system for CLT was developed. In particular, the proposed joint is a point-to-point mechanical connection system, designed to be fixed to the corners of the CLT panels and intended to substitute both the hold downs and the shear angular brackets, usually adopted by the traditional CLT construction system. The innovative system will be factory-preassembled and meant to be used as a lifting hook for a rapid and safe positioning. This will help improve the safety of the building process, its quality level and also its profitability. The materials and the technology processes which the prototype had to be realized with, were carefully analyzed. A detailed experimental campaign aimed to characterize the prototype mechanical properties is currently being carried out. X-RAD will boost the construction of big industrial and residential complexes (social housing). It will also help the process urban requalification by facilitating the construction of an extra storey on top of existing masonry/concrete buildings.