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DSF Elements in High-Rise Timber Buildings

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Abstract : The utilization of prefabricated timber-wall elements with double glazing, called as double-skin façade element (DSF), represents an innovative structural approach in the context of new high-rise timber construction, simultaneously combining sustainable solutions with improved energy efficiency and living quality. In addition to the minimum energy needs of buildings, the design of modern buildings is also increasingly focused on the optimal indoor comfort, in particular on sufficient natural light indoors. An optimally energy-designed building with an optimal layout of glazed areas around the building envelope represents a great potential in modern timber construction. Usually, all these transparent façade elements, because of energy benefits, are primary asymmetrical oriented and if they are considered as non-resisting against a horizontal load impact, a strong torsion effects in the building can appear. The problem of structural stability against a strong horizontal load impact of such modern timber buildings especially increase in a case of high-rise structures where additional bracing elements have to be used. In such a case, special diagonal bracing systems or other bracing solutions with common timber wall elements have to be incorporated into the structure of the building to satisfy all prescribed resisting requirements given by the standards. However, all such structural solutions are usually not environmentally friendly and also not contribute to an improved living comfort, or they are not accepted by the architects at all. Consequently, it is a special need to develop innovative load-bearing timber-glass wall elements which are in the same time environmentally friendly, can increase internal comfort in the building, but are also load-bearing. The new developed load-bearing DSF elements can be a good answer on all these requirements. Timber-glass façade elements DSF wall elements consist of two transparent layers, thermal-insulated three-layered glass pane on the internal side and an additional single-layered glass pane on the external side of the wall. The both panes are separated by an air channel which can be of any dimensions and can have a significant influence on the thermal insulation or acoustic response of such a wall element. Most already published studies on DSF elements primarily deal only with energy and LCA solutions and do not address any structural problems. In previous studies according to experimental analysis and mathematical modeling it was already presented a possible benefit of such load-bearing DSF elements, especially comparing with previously developed load-bearing single-skin timber wall elements, but they were not applicate yet in any high-rise timber structure. Therefore, in the presented study specially selected 10-storey prefabricated timber building constructed in a cross-laminated timber (CLT) structural wall system is analyzed using the developed DSF elements in a sense to increase a structural lateral stability of the whole building. The results evidently highlight the importance the load-bearing DSF elements, as their incorporation can have a significant impact on the overall behavior of the structure through their influence on the stiffness properties. Taking these considerations into account is crucial to ensure compliance with seismic design codes and to improve the structural resilience of high-rise timber buildings.

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