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Seismic behaviour of wood-concrete frame shear-wall system and comparison with code provisions

ABSTRACT

Constructive systems adopting mixed shear walls made of a wood frame and fibrous or cementitious sheets nowadays are largely spread, particularly for prefabricated buildings. The use of gypsum boards as bracing panels is already widely proposed, but also fiber cement or reinforced concrete slabs can be used. The choice of such different materials allows to reach excellent thermal and acoustic insulation performance and for economic reason.
Perhaps the demonstration of their sound structural behavior, especially towards the earthquake resistance is still to be given, and their ductility and dissipative capacities still need to be fully assessed even if some experimental tests have already been conducted. Moreover these particular constructive systems are yet not accounted in the building codes (Eurocode 5 and Eurocode 8) and no guidelines are given for their seismic design in order to assure an adequate overstrength of the bracing panels and the adequacy of the fixing system of the panels to the wooden frames.
This work reports the investigation of the structural behavior of a newly developed wood-reinforced concrete constructive system. The investigated modular prefabricated system combines a typical platform frame system with an external thin reinforced concrete slab acting as a diaphragm against the horizontal actions and having also thermal ad acoustic functions.
The structural design procedure of such innovative system imitates the calculations normally adopted for the platform frame system; the bracing stiffness and strength assured by a OSB panel nailed to the wooden structure are cumulated with those given by the concrete slabs which are screwed to the frame by means of large diameter connectors which assure a considerable stiffness and, in the meantime, a great capacity of energy dissipation in case of seismic events.
In order to verify the real performance of this construction system under seismic actions several cyclic tests on single panel modules and on an assembled wall were carried out in accordance with the testing protocol specified in EN 12512. The results of the experimental tests are reported. It has been demonstrated that the seismic performance of the structural system fulfills the requirements given by EC8 for the structures that belong to the higher ductility class.
The analytical expressions that best fit the experimental load-displacement curves are reported and the comparison of the obtained results with that calculated according to the analytical formulas given by EC5 for the used connection type are discussed.
Finally a FEM nonlinear element able to reproduce the load-displacement hysteretic response of the connectors has been developed and implemented into a finite-element model to understand the mechanical behavior of the studied walls subjected by cyclic load. By the use of the this numerical model it was possible to estimate the seismic performance of the proposed wood-concrete system in terms of ductility and dissipative capacity. Several non-linear numerical analyses were performed and a sound behavior q-factor (i.e. reduction factor) for the wood-reinforced concrete walls was proposed.

REFERENCES

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