CERIS : Civil Engineering Research and Innovation for Sustainability

Development of seismic-resistant connections for slender non-reinforced precast concrete façade panels

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Summary

The sustainability of the architecture, engineering, and construction (AEC) sector is fostering the development of innovative solutions for reducing its footprint using different approaches, such as adopting lighter/slender elements, reducing the cement dosage, or replacing natural aggregates with recycled ones. In this work, developed and conducted in cooperation with the prefabrication company Vigobloco, the first strategy has been adopted. The following goals have been identified: (i) to develop lighter/slender façade panels, by significantly reducing their thickness (to just 6 cm) and, thus, their deadload; (ii) to increase their structural performance; (iii) to avoid, or significantly reduce, the use of steel reinforcement; and, to make all these possible, (iv) to design a high-performance self-compacting fiber-reinforced concrete (HPSCFRC), using the constituents currently available on site.

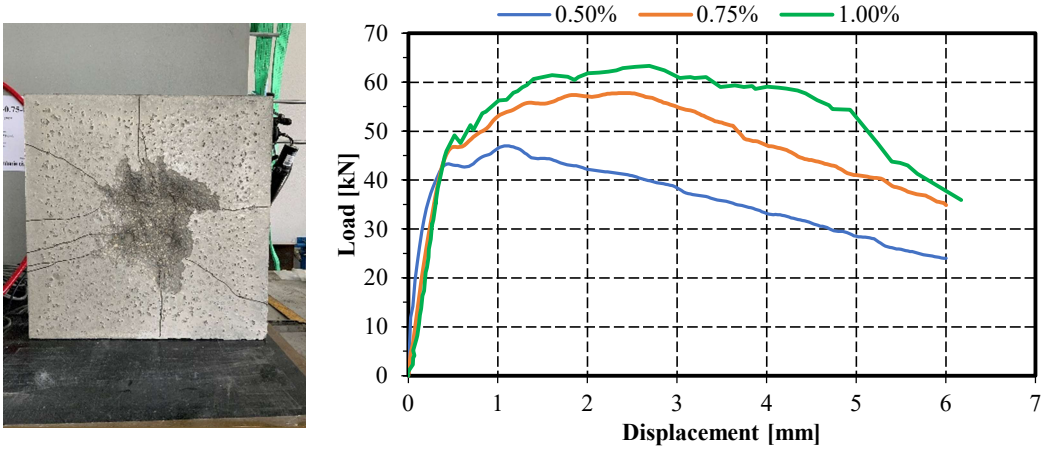
It must be highlighted that, despite the mass reduction reached, the use of these new low-thickness façade panels in seismic-prone areas and the lack of knowledge about fastening in HPSCFRC elements leads to the need to test the safety of fastening in such conditions.

Focusing on this aspect, a comprehensive experimental program was planned and conducted to characterize the behavior of headed anchors in precast low-thickness HPFRC façade panels, tested under static and cyclic loading, varying the dosage of fibers in the mixtures and the embedment lengths. The study was complemented by the development of a numerical model representing the behavior of the connectors in these conditions. Finally, the existing analytical expressions in the current standards were analyzed aiming at a proposal of a modified formula to account for the very low embedment and the fiber reinforcement.

Until now the results show an influence of both the fiber content in the HPFRC and the depth of embedment, in the performance of the connectors, increasing the max load supported and the ductility, as they were able to maintain the peak load even under large displacements. The comparison with the EN1992-4 provisions highlighted the differences in the behavior of these anchors, more evident with the increase in the amount of fibers. Present works are being conducted to propose a modified formula that better represents the response of these connections under the conditions studied.

Keywords

Pre-cast façade panels, high-performance fiber reinforced concrete, cast-in anchors, anchor pullout, anchor shear.



Anchor strength: tested specimen (left) and load-displacement curves with different fiber reinforcement levels (right)