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Development of a multifunctional composite sandwich panel for the rehabilitation of building façades

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Period
2014 -2021

Funding
FCT scholarship EcoCoRe PhD program (PD/BD/52657/2014)

Summary

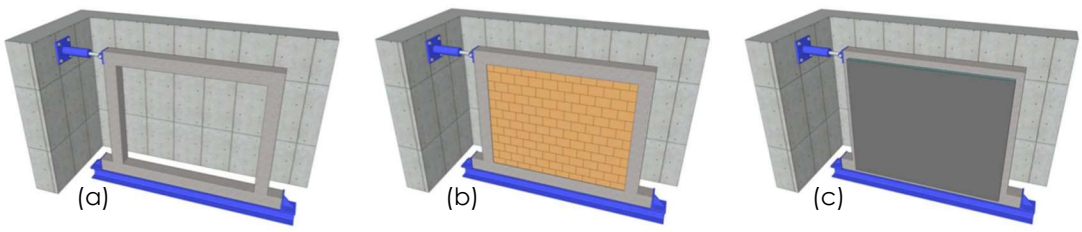
This work dealt with the development of a sustainable and multifunctional composite sandwich panel for the rehabilitation of reinforced concrete (RC) buildings from the 1960s to mid-1980s. The sandwich panel comprised four main components: (i) thin outer layers of recycled steel fibre reinforced micro concrete (RSFRC); (ii) a polystyrene lightweight core; (iii) internally distributed glass fibre reinforced polymer (GFRP) connectors; and (iv) steel anchors for fixing the panel to the existing structure. The first part of this work's experimental program encompassed pushout and pullout tests, carried out on reduced-scale specimens' representative of the sandwich panel solution; these tests aimed at assessing the overall composite behaviour of the sandwich panel and analysing the influence of the type of core polystyrene insulation layer, and of the anchoring conditions and diameter of the GFRP connectors. The tests showed that the adopted structural GFRP connectors are able to adequately ensure shear load transfer between RSFRC layers.

The second part of the experimental program involved testing different variations of quasi real-scale RC frame specimens under in-plane cyclic loading conditions: (i) a bare RC frame; (ii) an RC frame with traditional masonry infill wall; and (iii) an RC frame with incorporation of a sandwich panel prototype developed in the scope of this research work. Obtained results showed that, in comparison with traditional masonry infill wall solution, the proposed rehabilitation solution enabled a significant improvement of the RC frame's cyclic performance, providing higher load carrying capacity and energy dissipation. The numerical part of this study included numerical simulations conducted to assist the sandwich panel design process and, more specifically, the modelling of the failure mechanisms observed at the interface between the RSFRC layers and the polystyrene core; good agreement was obtained between experimental and numerical results, with important conclusions being drawn regarding the cohesion and friction angle between these components of the sandwich panel.

Keywords

Rehabilitation, RC frame buildings, building façades, sandwich panel, precast concrete, recycled steel fibres, GFRP connectors, polystyrene, pullout tests, pushout tests, cyclic tests, finite element method.

Illustration of proposed retrofit approach.



Cyclic tests: (a) RC frame; (b) RC frame with infill wall; (c) RC frame with sandwich panel.