CERIS Civil Engineering Research and Innovation for Sustainability

Eco-efficient and multifunctional thermal renders based on silica aerogel and fibres

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Summary

The development of new constructive solutions to use in buildings should improve their energy performance and the users' comfort, while also mitigating the energy poverty and contributing to this sector's progressive decarbonisation. One of the adopted solutions is related to the facades' coating with thermal renders. Therefore, this study develops and characterises thermal renders based on silica aerogel while also incorporating natural and human-made fibres. Additionally, to developing a new aerogel-based thermal render formulation, it is evaluated the impacts and improvements that the fibres' incorporation has on its performance (mechanical, physical, environmental and economic). Through various experimental campaigns which evaluated several mixtures and lightweight aggregates, it was possible to obtain an initial formulation, incorporating aerogel granules, with thermal conductivity of less than 0.030 Wm−1 K−1, but with reduced mechanical resistance and high capillary water absorption, not complying with the requirements of EN 998-1 for thermal renders. To improve these properties, different natural and human-made fibre percentages, by volume, of aramid, polypropylene, sisal, and biomass were incorporated in the render, with and without the application of a protective coating system. The most promising mixtures (aramid 0.50%, sisal and biomass 0.10% vol/vol) were then characterised in terms of mechanical, physical, microstructural, environmental, and economic properties.

The experimental results showed that the fibre's incorporation in the aerogel-based render improved the initial formulation's mechanical and water absorption properties due to their microstructural influence. Nonetheless, the initial low thermal conductivity and high water vapour permeability were not compromised. Hygrothermal simulations and a Life Cycle Assessment (LCA) study of the multilayer coating system (render + protective system), with a sensitivity analysis to the aerogel synthesis, it was possible to carry out an integrated environmental, economic and energy analysis. The results were obtained for different application scenarios and geographic locations and allowed to confirm these renders' eco-efficiency and multifunctionality, showing great potential for their future application in walls of new and retrofitted buildings.

Keywords

Multifunctional thermal renders, silica aerogel, natural fibers, eco-efficiency.

Thermal render prototype containing silica aerogel.