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Lime-Gypsum Renders Reinforced with Mineralised Hemp Fibres for Sustainable Renovation

Biofibres have been used in construction for centuries, but their renewed use today is increasingly driven by sustainability principles and the demand for low-carbon building materials. Hemp fibres are particularly attractive because they can improve thermal and acoustic insulation as well as the mechanical properties of renders (Özodabaş, 2023). However, their natural ignitability and high water absorption remain a challenge. Therefore, this research focuses on the development of low-carbon lime-gypsum renders reinforced with mineralised hemp fibres using traditional technology, as the lime-gypsum binder is not only a low-temperature material but is also considered the highest-quality binder for stucco decoration (Válek et al., 2020).

The study investigates two main aspects: (i) the effect of hemp-fibre length on the mechanical performance of lime-gypsum renders and (ii) the role of mineralisation in improving fire resistance. In addition, waste gypsum is combined with quicklime to avoid the need for calcination to obtain an air binder (hemihydrate) (Golež, Pogačnik, & Mladenović, 2018). This approach reduces the need for natural gypsum and contributes to waste reduction. It aligns with the circular economy and the principles of the New European Bauhaus, which emphasise sustainability, aesthetics, and integration (Rojas et al., 2019).

Lime-gypsum binders were produced by mixing calcium quicklime (CL 90-Q) with various proportions (5–50 wt%) of waste gypsum. The phase composition of the samples was characterised using X-ray powder diffraction (XRD), thermogravimetric and differential thermal analysis (TG/DTA), and microstructural analysis by scanning electron microscopy coupled with energy-dispersive spectroscopy (SEM/EDS). Renders were reinforced with hemp fibres of different lengths (0.5, 2, and 10 mm), and compressive strength was determined after 28 days. Mineralisation treatments were carried out to improve fire resistance and reduce the water absorption of the fibres. Water-absorption tests were also performed.

This research demonstrates the potential of combining biofibres, carbonate-based flame retardants, and industrial by-products to produce sustainable, low-carbon building materials with improved mechanical performance, increased fire safety, and reduced environmental impact.

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