

Lightweight Mineral-Based Hybrid Panel as a Sustainable Alternative to Conventional Insulation Materials: Mechanical and Physical Characterization

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Abstract

The construction sector remains highly dependent on conventional insulation materials with significant environmental impacts. This study aims to develop and characterize a lightweight mineral-based panel as a more sustainable alternative using recycled and low-impact components.

The proposed panel is composed of gypsum, recycled glass wool, and sepiolite. An experimental program was conducted on 51 specimens and 8 panels, including controlled fabrication and testing of mechanical (flexural and compressive strength), physical (density), and absorption properties.

Results show that the incorporation of glass wool (3%) and sepiolite (2–5%) reduces the required gypsum content, decreasing the consumption of virgin materials and associated embodied energy. The developed composites exhibit a density reduction of 12–18%, contributing to lower transport emissions and reduced energy demand during production. In addition, the presence of sepiolite improves absorption capacity and enhances the overall performance of the material.

These findings demonstrate the feasibility of mineral-based hybrid panels as sustainable alternatives to conventional construction materials. The proposed solution contributes to resource efficiency and supports current strategies in green engineering and circular economy within the building sector.

Keywords

Sustainable construction materials, hybrid mineral composites, gypsum-based panels, recycled glass wool, sepiolite.