

Salt Weathering Performance of Ternary Lime-Pozzolana-Cement Renders with Microencapsulated and Silica-Supported Phase Change Materials

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The incorporation of Phase Change Materials (PCMs) into lime-based renders offers a promising approach to enhancing the thermal performance of building envelopes while preserving the material compatibility required for both contemporary constructions and cultural heritage applications. In this study, lime renders composed primarily of hydrated lime (50 wt.%), with minor additions of natural pozzolan (35 wt.%) and white cement (15 wt.%), were modified with four distinct PCM systems, two microencapsulated paraffin-based PCMs (PCM10 and PCM25) and two silica-supported PCMs (PX5 and PX25), each characterized by different crystallization temperatures and integration mechanisms. Despite the growing interest in PCM-modified lime composites, their durability under saline exposure remains insufficiently understood. This work therefore investigates their salt weathering performance through controlled laboratory testing and microstructural evaluation.

Lime renders with constant PCM content were formulated, cured under controlled laboratory conditions, and subjected to accelerated salt crystallization tests using magnesium sulfate (MgSO_4). The physical, mechanical, and microstructural properties of the modified composites were evaluated prior to saline cycling, enabling a comparative assessment of deterioration patterns and protective mechanisms associated with each PCM type.

Results indicate that all PCM-modified renders exhibited a reduction in average pore size diameter, as well as a notable decrease in the capillary absorption coefficient compared to the reference mix. Among the tested systems, silica-supported PCMs demonstrated improved cohesion, higher mechanical strength, and the greatest resistance to salt crystallization, attributed to the structural characteristics of the silica support. The microencapsulated PCMs also enhanced the durability of the lime renders compared to the reference, though to a slightly lesser extent than the silica-supported ones. These findings contribute to a deeper understanding of the relationship between microstructure and durability in PCM-modified lime renders and support their potential application in energy-efficient, sustainable, and heritage-compatible building materials.

Keywords: lime-based renders, Phase Change Materials, salt weathering, microencapsulated PCMs, silica-supported PCMs, durability

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