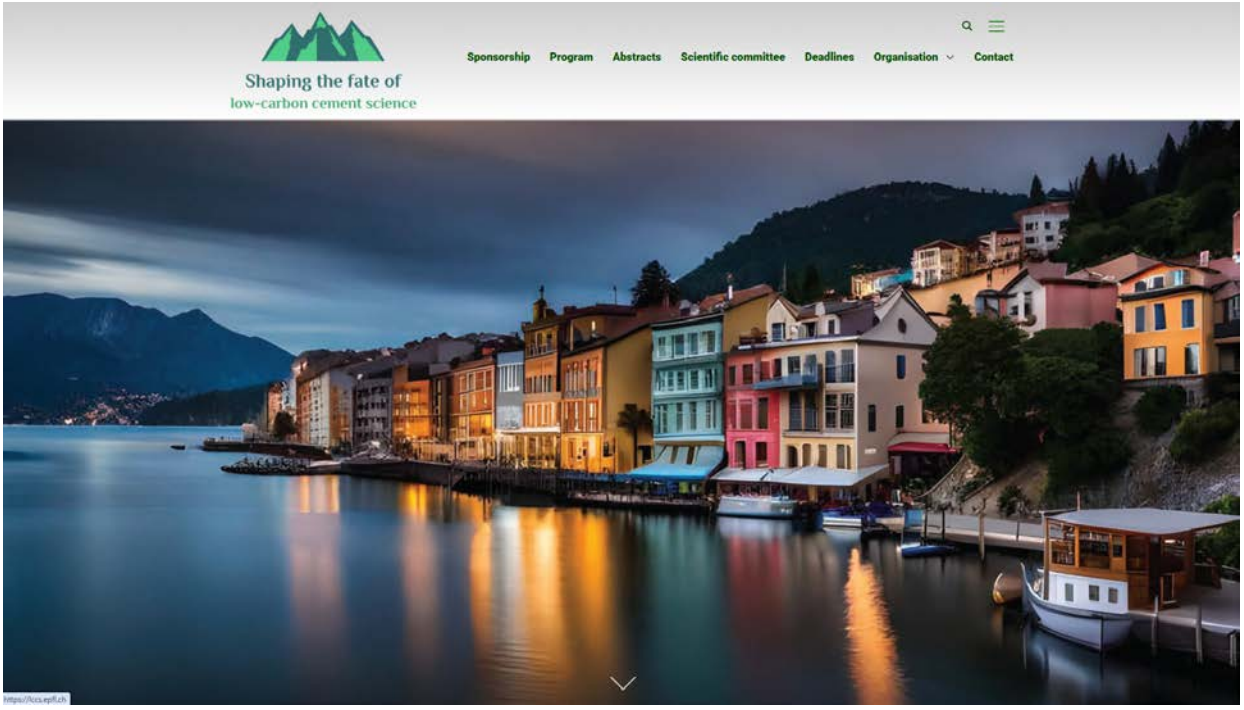

Vaterite Calcined Clay Cement (VC^3): A Promising Low-Carbon Binder

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The decarbonization of cement is of great interest due to its significant environmental impact. One effective approach to reducing the carbon footprint of concrete is the development of low-carbon binders. Vaterite is a metastable form of calcium carbonate which by recent technological advancements is economically viable in large scale production and offers considerable CO_2 reduction potentials in cement production.

This study investigates the potential of Vaterite Calcined Clay Cement (VC^3) as a low-carbon alternative to traditional cement, focusing on the influence of vaterite content on both the fresh and hardened properties of the material. Additionally, the research includes a comparative analysis with Limestone Calcined Clay Cement (LC^3) which is considered to be a sustainable alternative binding system and Ordinary Portland Cement (OPC) as the reference binder. The analysis was carried out to evaluate the relative performance and benefits of these innovative cementitious systems. The findings reveal that higher vaterite content improves long-term compressive strength, although it slows the early strength development, particularly in mixtures with higher vaterite proportions. After 28 days of curing, compressive strength in the LC^3 and VC^3 ranged from 60% to 80% of the strength of OPC mortars. Additionally, by 91 days of curing, these alternative mortars achieved 75% to 99% of the OPC mortar strength, respectively. Additionally, flow-table tests demonstrated that by increasing the vaterite, flowability is enhanced, while early hydration rate reduces due to vaterite's particle size.

This research employs an efficient lab-scale synthesis method for vaterite and utilizes various analytical techniques, such as SEM imaging and thermogravimetric analyses, to both raw materials and hardened mortars. The findings indicate that VC^3 not only offers superior long-term compressive strength compared to LC^3 but also exhibits improved workability, overcoming a significant limitation of LC^3. These properties make VC^3 a promising low-carbon binder for construction applications.

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