

# Marl and Calcined Clay as Sustainable Alternatives for Cement Replacement

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**Abstract.** In response to the need to reduce carbon emissions and the ecological impact of cement production, sustainable materials like ternary cement blends, such as Limestone Calcined Clay Cements (LC3), have been proposed for their lower clinker content.

This study investigates the influence of a type of clay from the western region of Chania, Crete, Greece, which was identified in previous studies as one of the most reactive when combined with cement to form mortar. The clay was calcined at 700 °C and reacted with saturated lime to assess its pozzolanic activity as a potential cement substitute. Additionally, a local marl was calcined at 800 °C and hydrated to evaluate its binding capacity for designing mortars with hydraulic binders. The silica and alumina minerals in the calcined clays and marl, upon reacting with lime and undergoing hydration, formed calcium silicate hydrate (CSH) and calcium aluminate hydrate (CAH), respectively, which contribute to the hardening of plasters and mortars.

The study includes workability tests on fresh mortars, and compression tests on mortar samples aged up to 56 days. Results indicate that mortars containing clay and lime had lower workability compared to cement-based mortars with a similar water-to-mortar ratio.

Compressive strength testing revealed that the portlandite generated from marl and lime hydration was insufficient to fully react with calcined clay and cement to form adequate CSH. Additional research will be conducted to determine the optimal lime content required to effectively promote the hydrolysis reaction in line with LC3 principles.

**Keywords:** calcined marl; calcined clay; pozzolanic activity; hydration; cement substitution