

# SUSTAINABLE TERNARY BINDERS: EVALUATING THE PERFORMANCE OF LOW-GRADE KAOLINITIC CLAY IN LIMESTONE CALCINED CLAY CEMENT (LC3)

MWV-036

<https://dx.doi.org/10.4314/just.v44i2.20s>

**Kwesi Appiah Boakye, Kofi Sokoto, Lord Addo Hanson**

CSIR-Building and Road Research Institute, P. O. Box 40, KNUST, Kumasi, Ghana

## Abstract

The carbon intensity of Ordinary Portland Cement (OPC) has necessitated the development of eco-efficient alternatives like Limestone Calcined Clay Cement (LC3). While LC3 typically relies on high-grade kaolinitic clays (>40% kaolinite), industrial competition for high-purity resources limits scalability. This study investigates the technical viability of utilizing a low-grade kaolinitic clay (~17% kaolinite), calcined at 900 °C, as a sustainable substitute in ternary blended systems.

Four LC3 formulations were developed with calcined clay substitution levels ranging from 20% to 50% by weight of cement, while maintaining constant limestone (15%) and gypsum (5%) content. Characterization via XRD, TGA, and Isothermal Calorimetry monitored hydration kinetics and mineralogical phase development. Mechanical and durability assessments included compressive strength, water absorption, and drying shrinkage up to 91 days.

Results indicate that while LC3 blends exhibit higher water demand and lower early-age strength compared to an OPC control, pozzolanic activity significantly bridges the strength gap by 28 and 91 days. The LC20% mix achieved approximately 95% of the control's strength at 91 days. Crucially, LC3 blends demonstrated superior durability, characterized by reduced water absorption and permeable porosity due to microstructural refinement from carboaluminate formation. This study concludes that low-grade clays are technically feasible for LC3 production, offering a pathway to reduce clinker factors by up to 50% without compromising long-term performance.

**Keywords:** Geopolymer and sustainable material.

*This book of abstracts published © 2026 by the Journal of Science and Technology is licensed under CC BY 4.0*

