

Thermal Characterization of Pozzolanic Activity of Hydrated Cement System Modified by Silica Based Industrial Waste

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Abstract

This study investigates the potential of using silica based industrial waste specifically waste calcined clay (WCC) from ceramic industry as partial cement replacement. Pozzolanic activity characterization was done by using thermal and mechanical characterization techniques namely Thermal Gravimetric Analysis (TGA) and Compressive Strength Test (CS), respectively. Finely grounded waste vase of varying particles sizes range from less than 75 μ m, 75 μ m and 150 μ m were used as 10%, 20%, and 30% cement replacements with 0.45 water to cement ratio (w/c). First, progression of CS from day 1 to 28 of WCC modified mortar and unmodified cement mortar (UCM) was monitored as an indirect indication of pozzolanic activity. It was found that 75WCC10% performed higher 28 day compressive strength compared to unmodified cement mortar (UCM). To further confirm the result, TGA characterization of Calcium Silicate Hydrate (C-S-H) and Calcium Hydroxide (CH) as pozzolanic activity indicator was done on WCC modified cement pastes in comparison to unmodified cement paste (UCP). TGA analysis has shown the pozzolanic activity indicated by the decrease of CH and the increase of C-S-H in WCC modified cement paste. Based on this study, WCC possesses pozzolanic characteristic which is the main criteria to be qualified as an effective material as partial cement replacement.

Keywords: Waste calcined clay, cement replacement, Thermal gravimetric analysis (TGA), compressive strength test (CS)

1. Introduction

Production of unsustainable cement that emits CO₂ has lead researchers to find several sustainable alternatives to partially replace it if not all [1, 2]. This is why the terms such as supplementary, partial cement replacements, mineral admixtures and geo polymer emerges in the recent development on cement and concrete research. One of the ways to reduce cement dependency is by using industrial by-product or waste as partial cement replacement in concrete production. This serves as two edged sword whereby it can reduce the negative environmental impact caused by the waste and cement production [3]. One of the industrial wastes that has not been fully utilized, is waste from ceramic industry called calcined clay.

Historically, structures such as water tank, walls and bridges have been constructed using thermally activated clay and lime mortars before the invention of Portland cement. The Romans used crushed tiles as cementitious material other than volcanic ash since they discover that the combination of lime and calcined earths could form strong cementing materials [4–6]. Several studies have been

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