The College of Graduate Studies and the College of Engineering Cordially Invite You to a

Master Thesis Defense

Entitled

PERFORMANCE OF CEMENT-FREE GEOPOLYMER CONCRETE MADE WITH CERAMIC WASTE POWDER USING TAGUCHI METHOD

by

Ponalagappan Chokkalingam

Faculty Advisor

Dr. Hilal El-Hassan, Department of Civil and Environmental Engineering
College of Engineering

Date & Venue

11:00 AM
Monday, 19 April 2021
Microsoft Teams
https://bit.ly/3danAXz

Abstract

The ceramic industry produces a substantial amount of waste during its production processes. Recycling and reutilizing such ceramic waste is a challenge due to its extended biodegradation period. Consequently, the ceramic industry is dedicated on attaining a sustainable solution to dispose of this waste rather than discarding it wastefully into landfills or stockpiles. In turn, the demand for ordinary Portland cement has been on a steady increase, leading to concerns about the sustainability of the construction industry. As a sustainable alternative to cement, alkali-activated binders have been proposed owing to their ability to reduce carbon emissions, preserve nonrenewable natural resources, and recycle industrial solid wastes. This research aims to evaluate the feasibility of recycling ceramic waste powder (CWP) in cement-free geopolymer concrete. Ground granulated blast furnace slag (GGBFS) was integrated at different mass replacement percentages to enhance the performance of said concrete and promote the use of CWP as a main component. The study encompassed three experimental phases. The first phase characterized the as-received materials, while the second phase involved the use of the Taguchi method to proportion different geopolymer concrete mixes. Various factors and levels were utilized to generate an orthogonal array of the parameters. Mixture proportions were optimized to attain superior mechanical and short-term durability performance. Further augmentation was performed in the third phase through multi-response optimization using the Best Worst Method (BWM) and Technique for Order Preference by Similarity to Ideal Solution (TOPSIS) based Taguchi method. The optimized CWP-GGBFS blended geopolymer concrete mix made with a binder content of 450 kg/m^3, GGBFS replacement percentage of 60%, alkaline-activator solution-to-binder ratio of 0.50, sodium silicate-to-sodium hydroxide ratio of 1.5, and molarity of SH solution of 10 M exhibited a compressive strength of 80.3 MPa, a flexural strength of 5.72 MPa, and a splitting tensile strength of 3.81 MPa, among other properties. Nevertheless, it was possible to produce a concrete made with 80% CWP with acceptable performance for structural applications. Accordingly, this work highlights the feasibility of producing geopolymer concrete made with CWP to promote the recycling of industrial solid waste, reduce carbon emissions, and preserve natural resources. Recommendations for future investigations were also included.

Keywords: Ceramic waste powder, ground granulated blast furnace slag, geopolymer concrete, Taguchi method, BWM, TOPSIS, mechanical performance, durability performance.