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Entitled

BEHAVIOR OF STEEL FIBER-REINFORCED GEOPOLYMER CONCRETE MADE WITH RECYCLED CONCRETE AGGREGATES

by

Abdalla Ahmed Moallim Hussein

Faculty Advisor

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

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Abstract

Industrial by-products and recycled concrete aggregates (RCA) have the potential to fully replace cement and natural aggregates, respectively, in the production of concrete rather than being discarded wastefully into landfills or stockpiles. Yet, their combined use in the development of a novel RCA geopolymer concrete has been limited to non-structural purposes, owing to the inferior mechanical and durability properties of said concrete. To improve the properties of geopolymer concrete made with RCA, steel fibers may be added to the mix. This research aims to study the feasibility of reutilizing locally available industrial solid wastes and RCA in geopolymer concrete for structural applications. A combination of ground granulated blast furnace slag and fly ash were used to form a blended precursor binding material. The mechanical properties of steel fiber-reinforced geopolymer concrete made with RCA were studied through testing for compressive strength, splitting tensile strength, flexural properties, and modulus of elasticity. In turn, the durability performance was assessed using water absorption, sorptivity, bulk resistivity, and abrasion resistance. Experimental test results highlight the ability to fully replace natural aggregates with RCA in blended geopolymer concrete incorporating 2% steel fibers, by volume. Compared to the control mix made with no RCA and steel fibers, such concrete provided superior mechanical and comparable durability performance. Additionally, new tensile softening relationships were established from the experimental test data and using inverse finite element analysis. Three-dimensional finite element (FE) models were developed to simulate and predict the shear behavior of steel fiber-reinforced RCA geopolymer concrete beams. Based on regression analysis of FE results, a simplified empirical equation that accounts for the compressive strength of concrete and steel fiber volume fraction was established to predict the nominal shear resistance of steel fiber-reinforced geopolymer concrete beams.

Keywords: Geopolymer, recycled concrete aggregate, steel fibers, performance evaluation