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MECHANICAL AND DURABILITY PERFORMANCE OF CUPOLA FURNACE SLAG GEOPOLYMER CONCRETE BASED ON FLY ASH AND RICE HUSK ASH

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Abstract

The increasing demand, declining reserve, and heightened pressure on natural resources have necessitated waste recycling and re-use. Research on the substitution of cement and aggregates with recycled materials can yield valuable results in terms of natural resource conservation, waste handling, cost-saving, and reduction of embodied energy in concrete. Hence, this study explores the use of coal fly ash (CFA) and rice husk ash (RHA) as geopolymer binders to partially substitute cement (0%, 5%, 5%, 10%, 20%, 15%, 10%, and 20% for CFA; and %, 5%, 10%, 10%, 5%, 20%, 25%, and 20% for RHA, by wt. of cement), and cupola furnace slag (CFS) as partial replacement of crushed granite from 0% to 35%, in steps of 5% in the production of geopolymer concrete (GPC). A mixture of 8 M sodium hydroxide (NaOH) and sodium silicate (Na_2SiO_3) as alkaline activator were used to synthesize the RHA and CFA geopolymers. Fresh and hardened properties of GPC such as workability, compressive strength, and rapid chloride penetration tests were evaluated under different water-binder ratios (w/b) of 0.50 and 0.65. The investigation was done on the traditional concrete as control and geopolymer concrete (GPC) containing CFS. The outcomes showed that incorporating 15%CFA, 20%RHA and 30%CFS with w/b of 0.50 and 0.60, improved the workability by as much as 180% and 105.7%, respectively, but compressive strength is significantly reduced. The results showed that incorporating 20%CFS, 5%RHA, and 20CFA gives optimum compressive strength of 19.68 N/mm^2 and 21.49 N/mm^2, respectively, at 28-d and 56-d with w/b of 0.50 as compared with the minimum strength requirement of 20 N/mm^2. Permeability of chloride ion was determined for various concrete mixes using the Rapid Migration Test (RMT). The result shows that the GPC has better penetration resistance to chloride ion than other concrete mixes and are, therefore, more durable.

Keywords: Chloride ion, compressive strength, cupola furnace slag, geopolymer concrete, pozzolans

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