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Innovative One-part Mixing Geopolymer Concrete with Magnesium Slag: Assessing Mechanical Properties, Durability and Environmental Benefits

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Abstract

In recent years, significant interest has emerged in utilizing industrial waste by-products, such as blast furnace slag or fly ash, for the production of geopolymer concretes (GPC). However, the exploration, characterization, and optimization of geopolymer concretes incorporating magnesium slag (MS) remain under-researched. In this research, magnesium slag was used to create an environmentally friendly, one-part mixing geopolymer concrete that cures at ambient temperature. The alumino-silicate precursors employed were magnesium slag and fly ash, while hybridization of anhydrous sodium metasilicate (Na2SiO3) and sodium carbonate (Na2CO3) was used as alkaline activators. The initial properties were evaluated using workability tests; specifically setting time and flowability. To assess the hardened properties of the newly developed geopolymer concrete specimens- cube, cylinder and prism- were conducted for compressive strength, split tensile strength, flexural strength, water absorption, and drying shrinkage. To evaluate the microstructure of the geopolymer concrete mix; X-ray diffraction (XRD) and Scanning Electron Microscopy (SEM) examinations were conducted. After initial, hardened and microstructure analyses; the cost and environmental impact was assessed by measuring the carbon dioxide equivalent (CO2e) of the geopolymer concrete constituents. The experimental study demonstrated that incorporating fly ash into magnesium slag based one- part mixing geopolymers enhanced their reactivity, enabling hardening at ambient temperature.

Keywords: geopolymer, one-part mixing, magnesium slag, fresh properties, mechanical properties, environmental effects