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Influence of Activator-to-Binder Ratio on the Mechanical Properties of One-Part Geopolymer Concrete

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Abstract

One-part geopolymer concrete (OPGC) is gaining attention as a sustainable substitute for Portland cement, primarily due to its lower carbon footprint and the utilization of industrial by-products. This study examines the effect of varying activator-to-solid (a/s) ratios on the fresh and hardened properties of OPGC. Mixtures were produced using 30% magnesium slag (MS) and 70% ground granulated blast-furnace slag (GGBS) with a constant water-to-binder ratio of 0.47. Activator dosages ranged between 0.12 and 0.20. Fresh properties were assessed through slump and density tests, while hardened performance was evaluated using compressive strength and ultrasonic pulse velocity (UPV) at different curing ages. Results indicated that increasing activator content reduced slump, indicating lower workability due to higher viscosity. In terms of mechanical performance, compressive strength improved significantly with higher activator ratios, reaching up to 59.3 MPa at 90 days. However, excessively high dosages adversely affected workability. The optimum dosage was identified at a/s = 0.16, which provided a balance of good strength (46.07 MPa at 90 days) and acceptable fresh properties. These findings underline the importance of optimizing activator dosage to achieve durable and workable OPGC for sustainable construction.

Keywords: One-part geopolymer concrete, activator-to-binder ratio, magnesium slag, ground granulated blast furnace slag, mechanical properties, sustainable construction