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PERFORMANCE AUGMENTATION OF SELF-COMPACTING GEPOLYMER CONCRETE VIA BACTERIAL ACTIVITY

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Abstract

Self-compacting geopolymer concrete (SCGC) represents a sustainable and eco-efficient alternative to conventional cement-based materials, offering superior performance and reduced environmental impact. The long-term durability and serviceability of concrete structures requires the selection of materials that can resist degradation and minimize maintenance needs. To address this, the present study investigates the integration of *Bacillus subtilis* bacteria into SCGC formulated with both unitary and binary blended precursors. The research aims to evaluate the synergistic influence of bacterial self-healing and geopolymer technology to improve the mechanical and durability performance. *Bacillus subtilis* was incorporated at three concentration levels (10^3 , 10^5 , and 10^7 cells/mL) into ground granulated blast furnace slag (GGBFS)-based and GGBFS–silica fume (SF)-based SCGC, cured under ambient conditions. Fresh concrete properties, including filling ability, passing ability, and segregation resistance, were evaluated alongside hardened concrete characteristics such as compressive strength, split tensile strength, water absorption, and rapid chloride penetration resistance. Statistical analysis was conducted to validate the significance of the observed variations across bacterial concentrations and mix types. The results demonstrated that the incorporation of *Bacillus subtilis* at an optimal concentration of 10^5 cells/mL enhanced both mechanical and durability performance, with binary GGBFS–SF-based SCGC exhibiting superior matrix densification. Microstructural analyses further confirmed bacterial survivability and self-healing activity through the formation of calcite and additional geopolymeric gel phases within the matrix. This study establishes *Bacillus subtilis*-based SCGC as a sustainable and high-performance construction material capable of improving concrete longevity while reducing environmental impact.

Key words: Bacillus subtilis, Durability, Mechanical Properties, SCGC

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