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CHLORIDE ION RESISTANCE AND ULTRASONIC PULSE VELOCITY PERFORMANCE OF STEEL FIBER-REINFORCED MORTAR CONTAINING SILICA FUME AND RECYCLED CONCRETE AGGREGATE

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Abstract

This study presents a comprehensive investigation into the individual and combined effects of steel fiber (S) and silica fume (SF) on the performance characteristics of mortar mixtures incorporating 100% recycled fine aggregate (RFA) as a complete replacement for natural limestone aggregate. The experimental program evaluated two critical material properties: ultrasonic pulse velocity (UPV) as a nondestructive measure of structural integrity, and chloride-ion penetration resistance as an indicator of long-term durability. Eight distinct mortar formulations were systematically prepared, including a control mixture and combinations incorporating 1% S by volume, 10% SF by cement weight, and complete (100%) RFA substitution by limestone weight. Experimental results demonstrated that both SF and S additions significantly reduced the total charge passed during rapid chloride permeability testing, indicating improved resistance to chloride-ion penetration. However, all RFA-containing mixtures exhibited greater charge passage compared to conventional mixtures, reflecting the inherent challenges of recycled aggregate utilization. Quantitative analysis revealed that steel fiber reinforcement enhanced chloride-ion resistance by 12% in RFA mixtures, while silica fume proved more effective, achieving 66% and 41% resistance improvements in conventional and RFA mixtures, respectively. The synergistic combination of SF and S yielded a 44% enhancement in chloride resistance for RFA mixtures. Regarding structural performance, UPV measurements showed a consistent 6% reduction in pulse velocity across all mixtures when limestone was replaced with RFA, suggesting a modest but measurable impact on internal material density and homogeneity. These findings provide valuable insights into the complex interactions between supplementary cementitious materials, fiber reinforcement, and recycled aggregates in mortar systems. The results highlight both the potential benefits and limitations of RFA utilization in cementitious composites, while demonstrating the effectiveness of SF and S in mitigating certain durability concerns associated with recycled materials.

Key words: chloride-ion resistance, recycled fine aggregate, silica fume, steel fiber, ultrasonic pulse velocity

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