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Investigating the Effects of Polypropylene Fibers on the Mechanical Strength, Permeability, and Erosion Resistance of Freshwater and Seawater Mixed Concretes

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Abstract

Seawater mixed (SW) concrete lessens the freshwater (FW) demand and eases the stress on the already depleting FW resources. The use of SW concrete is a sustainable solution that mitigates the environmental impact of concrete production, especially in coastal regions and islands vulnerable to FW scarcity. This study investigated the influence of polypropylene (PP) fiber incorporation on high-performance-SW concrete's long-term mechanical and durability performance. The findings indicate that the incorporation of seawater in the production of concrete containing ground granulated blast furnace slag (GGBFS) has a beneficial effect on its early strength. This is due to the fact that SW accelerates the hardening process. SW concrete mixes showed an improvement in strength with aging. The difference between the strength of SW and FW concretes reduced with aging. The PP fiber showed phenomenal improvements in the tensile properties of SW and FW concretes. At the addition of 0.3% PP fiber, SW yielded 56% and 48% higher splitting tensile and flexural strength than plain FW concrete at 28 days, respectively. The use of 0.15% of PP fiber caused notable reductions of around 20% in the water absorption (WA) capacity and a 12–20% reduction in chloride ion permeability (CIP) of SW concrete. The incorporation of PP fiber increases the number of drying–wetting cycles to initiate the erosion of SW and FW concretes in a simulated environment. The use of 0.15% PP fiber is beneficial, as