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Wet-Carbonation of RCA for Improved Carbonation Efficiency and Mechanical Properties of RCA and Recycled Concrete

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Abstract

Recycled concrete aggregates (RCA) are derived from the crushing process of demolished concrete. However, RCA typically exhibits weak interfacial transition zones (ITZ), high porosity, and microcracks due to residual mortar layers, which limit their performance in structural applications. To address these limitations, this study developed a novel wet carbonation process using glycine acid as an inducer to coat vaterite and calcite on the surface of RCA, thereby improving its physical properties. Carbonation results demonstrated that vaterite and calcite formation reduced alkalinity, lowered pH, and increased density. Microstructural analysis confirmed the presence of vaterite on glycine-acid carbonated RCA, contributing to a more cohesive and densified ITZ, which improved RCA's resistance to abrasion, reduced surface wear under mechanical stress, and enhanced California Bearing Ratio (CBR) values, reflecting better load-bearing performance in pavement applications. Alkali leachate tests showed that glycine-acid carbonated RCA exhibited lower pH and total dissolved solids (TDS) per pore volume compared to untreated RCA, mitigating environmental impacts. Recycled concrete incorporating carbonated RCA showed mechanical improvements: compressive strength increased by 13%, splitting tensile strength by 15%, and flexural strength by 12%. Improvements in surface resistivity, chloride resistance, and freeze-thaw durability indicated a densified ITZ, reduced ion permeability, and greater resistance to damage under cyclic freezing. This makes glycine-acid carbonated RCA a promising option for enhancing the properties of RCA and recycled concrete.

Keywords: recycled concrete aggregates; RCA carbonation; vaterite; calcite; interfacial transition zones