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Efficiency of Ground Glass Fiber as a cementitious material, in mitigation of alkali-silica reaction of glass aggregates in mortars and concrete

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Abstract

Millions of tons of waste glass are produced annually around the world. In the absence of an effective recycling method, much of the waste glass is disposed in landfills. Utilization of this material as an aggregate source in concrete mixtures has been widely explored in the past in reducing the burden of the waste glass on landfills. However, the susceptibility of this material to Alkali-Silica Reaction (ASR) in concrete has been the main barrier against its widespread use. Alternatively, waste glass in a finely ground form can be used as a pozzolanic additive in concrete that can potentially counter the negative effects of crushed glass aggregate.

Waste glass fiber is one of the materials that can be used as a supplementary cementitious material (SCM), if it is milled in to a fine powder. Results from earlier studies have shown the promising performance of this material as an SCM in improving mechanical properties of concrete. In this study the effectiveness of ground glass fiber (GGF) in mitigation of ASR in mixtures containing crushed glass aggregates is investigated. In this study, the accelerated mortar bar tests (ASTM C1260-ASTM C1567) and the miniature concrete prism tests (AASHTO TP110) were conducted on mixtures containing crushed glass aggregate as a reactive aggregate in combination with GGF at different cement replacement levels. Simultaneously, a finely ground glass powder derived from soda-lime glass (GLP) and metakaolin were also investigated in this study. The findings from this investigation showed the superior performance of GGF in mitigating ASR compared to GLP and MK. The beneficial effects of GGF were attributed to its high aluminum content and high specific surface area. While MK was found to be similarly effective as GGF at lower dosage levels, difficulty associated with workability of mixtures containing MK at higher dosage levels was found to be a limiting factor. Mixtures containing GLP were found to be not as effective as either MK or GGF in mitigating ASR at equivalent dosage levels.

Keywords: Glass aggregate; Ground glass fiber; Glass powder; Alkali-silica reaction; Durability