

Effects of fiber and glass on the mechanical properties of self-compacting concrete

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Abstract

A variety of materials are added to concrete so as to improve its mechanical behavior. Moreover, it can help reduce the environmental pollution by replacing certain waste materials as cement or aggregate. This study involved waste glass as a replacement for aggregate. The polypropylene fiber was added to the glass-containing concrete so as to improve its behavior at different percentages (0, 0.5, 1 and 1.5%). Replacement of glass as aggregate can curtail the compressive and tensile strengths of the concrete. Furthermore, fibers enhance the tensile strength and slightly reduce the compressive strength of the concrete. Glass and fibers in concrete reduce slump. Therefore, the slump required by the concrete can be supplied by adding a lubricant. There were eighty cubic specimens (15 cm) constructed to investigate the compressive strength as well as sixty concrete beams (10 * 10 * 40 cm) to evaluate the flexural behavior of the glass-containing concrete and polypropylene fibers. The results demonstrated that the addition of 0.5–1% of fibers to the glass-containing concrete can enhance the compressive strength of the glass-containing fiber-free concrete. The flexural strength of the concrete containing 50–70% of glass entails variations of less than 1%.

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.

Keywords: Glass aggregate; Ground glass fiber; Glass powder; Glass and polypropylene fibers; Compressive strength; Glasses to the concrete; Concrete Prism Test.

Introduction

According to a report by the Environment Protection Agency on the Municipal Solid Waste (MSW), published in 2014, around 11.5 million tons of waste glass are produced in the US (1). Although the amount of recycled glass has considerably increased from 0.16 million tons in 1970 to 2.99 million tons in 2014, almost 61% of the total waste glass is discarded in landfills (1). Some of the difficulties in increased recycling level of waste glass