Available online at www.CivileJournal.org

Civil Engineering Journal

Vol. 2, No. 10, October, 2016

# Effects of Hybridization of Carbon and Polypropylene Short Fibers as Reinforcement on Flexural Properties of Fine Aggregate Concretes

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Received 26 August 2016; Accepted 23 October 2016

**Abstract**

Nowadays, the advantages of short fibers as reinforcement in cement based materials are well known. In this paper, the effect of hybridization of short polypropylene (PP) and carbon fibers on flexural properties of a fine aggregate concrete has been investigated. Samples with dimensions of $230 \times 100 \times 9\ mm$ containing 2 vol% of the polypropylene and carbon fibers with 6 and 8mm length were made. The PP to carbon fiber proportion in the samples were selected as 100:0, 75:25, 50:50, 25:75 and 0:100. A four-point bending test was carried out on all the samples to investigate the flexural behaviour. It was found that the addition of carbon fibers significantly increases the flexural load (i.e. 260%). The application of PP fibers leads to a 2590% increase in the toughness compared to the control sample. It was also found that the sample with carbon to PP ratio of 75/25 shows the optimum results and it leads to 190% and 2070% increment in the flexural load and toughness, respectively, in comparison to the control sample.

*Keywords:* Fine Aggregate Concrete; Flexural Properties; Carbon Fibers; Polypropylene Fibers; Strain Hardening Behavior.

## 1. Introduction

Cement materials are brittle in nature and their flexural and tensile strengths are much lower than their compressive strength. Utilization of short staple fibers is one of the effective methods to overcome this weakness [1-3]. Usually, the addition of fibers into the matrix improves flexural strength, energy absorbent capacity, ductility and toughness of the composite [4, 5].

The effect of utilizing a variety of fibers such as steel fibers [1], glass fibers [6], carbon fibers [7], synthetic fibers [2, 8] and natural fibers have been investigated. Fibers with high strength/modulus lead to an increase in composite strength, while low modulus fibers increase the ductility of the composite. The use of hybrid fibers has also been considered in order to achieve both high strength and ductility [9].

Carbon fibers are high strength/modulus fibers which are alkali resistant [10]. Therefore, they have been used as reinforcement in cement based composites. The addition of carbon fibers leads to significant improvement in flexural strength of cement paste and concrete. Both the tensile and flexural strengths of the cementitious materials increase with an increase in the fibers length and content [11-13]. For example, the addition of 0.6 vol% of carbon fibers 30mm in length has increased the concrete flexural strength and ductility by 20% and 50%, respectively [14].

Generally, carbon fiber reinforced concretes show good tensile and flexural properties, low dry shrinkage, high specific heat, low thermal conductivity, high electrical conductivity and high abrasion resistance [15]. However, the usage of these fibers leads to an increase in the composite cost.

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