# Destructive and Non-Destructive Evaluation of Carbon Fiber Reinforced Cement Mortar (CFRC)

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## Abstract

The mechanical properties of cement mortar systems with and without fibers were investigated using both destructive (static) and non destructive (dynamic) tests. Impact resonance test and Pulse (ultrasonic) velocity test were used to determine the non-destructive properties. Carbon fiber loading varied from 0-6%. In General, increasing the fiber content decreased the Young's modulus of elasticity but increased the failure strain. Also, fiber contents more than 1% decreased compressive strength of the mortar.

## Introduction:

Cement based materials are the most widely materials used in construction. For a long period of time, developing and enhancing mechanical properties of cement concrete systems took the greatest interest and have seen numerous improvements. One of the new methods to enhance cement concrete systems is adding of short carbon fibers to the concrete mixtures, (Chung et al. 1993), and limited studies have focused on developing and optimizing the mechanical properties of carbon fiber reinforced cement composites (CFRC) systems. Useful improvements in the mechanical behavior of tension-weak concrete or mortar matrices can be achieved by incorporating discrete fibers (glass, steel and carbon) in concrete. These composites with their superior mechanical properties may provide, on one hand, a long lasting material under sever loading and environmental conditions.

## Objectives

To investigate the effects of carbon fiber content on the mechanical properties of the CFRC systems.

## Materials

In preparing the cement mortar specimens, fine aggregates (well graded sand with coefficient of uniformity 5.8) were mixed with the carbon fibers and the cement and then water was added to the mixture. Specimens were cured at room temperature and 60% R.H. for 28 days. At least two specimens form each mix were tested under uniaxial compression.

## Test Program

The properties of the CFRC were determined using destructive and non-destructive tests. Non-destructive tests were performed on both cylindrical and prism specimens to study the shape effect on the measured material properties.

***Impact Resonance Test:*** Performed as per ASTM C 215. The test specimens were made to vibrate as a whole in one of their natural frequency modes: transverse, longitudinal or torsional modes.

***Pulse Velocity Test:*** Performed as per ASTM C 597.

**Results and Discussions**

Increasing of carbon fibers - in general - increased the failure strain for all mortar systems. Also, as the compaction of specimens becomes more difficult with high fiber content, increasing the fiber content for more than 1% (w/w) decreased the compressive strength; this was also accompanied by a significant decrease in the specific weight of the specimens, Fig.1.

Non-destructive tests also showed a decrease in the initial Young's modulus of elasticity for mortars with increasing the fiber content, Fig.2.

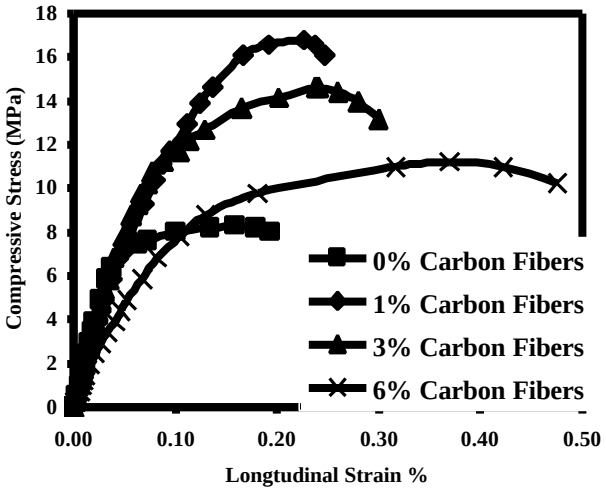


**Fig.1.**The stress-strain relationship for mortar

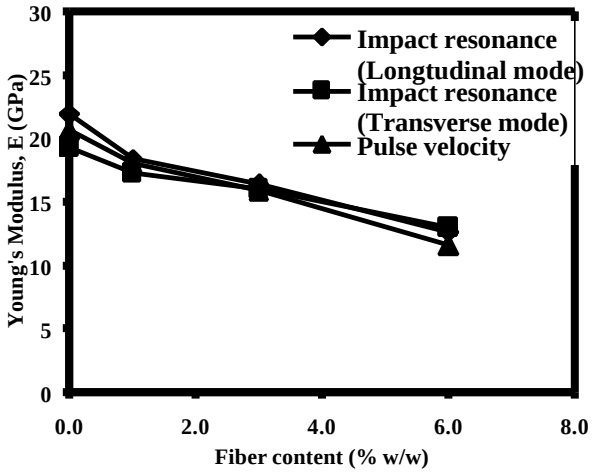


**Fig.2.** The effect of carbon content on the Young' s modulus

**Conclusions**

1. Increasing the carbon fiber content increased the failure strain for all mortar systems.
2. Increasing fiber content for more than 1% (w/w) decreased the compressive strength.
3. Increasing the fiber content decreased the initial Young's modulus of elasticity of the mortars.

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**References**

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