Ain Shams University
Faculty of Engineering
Structural Engineering Department

The Use of Wollastonite to Enhance the Mechanical Properties of Cementitious Composites

By

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A Thesis

Submitted in Partial Fulfillment for the Requirements of the Degree
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(Structural Engineering)

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Thesis **:** Master of Science in Civil Engineering (Structural)

Researcher Name **:** Amira Abdallah Mohamed

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STATEMENT

This thesis is submitted to the Faculty of Engineering, Ain shams University, as a partial fulfillment for the degree of Master of Science in Civil Engineering (Structural Engineering).

The work included in this thesis was carried out by the author, and no part of it has been submitted for a degree or a qualification at any other scientific entity.

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AIN SHAMS UNIVERSITY
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Abstract of the M.Sc. Thesis Submitted by
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ABSTRACT

Cement composites are designed for two main goals; strength and durability. Reinforcing concrete with steel or carbon microfibers nowadays became the first solution to enhance their resistance and durability. On the other hand these microfibers are considered to be expensive comparing to natural occurring mineral microfibers as Wollastonite.

Wollastonite is commonly known worldwide and it has a major industrial importance. It is used primarily in ceramics, friction products, paint filler, and plastics. In the past years studies have been made to use Wollastonite in cementitious composites to enhance its strength and durability.

In this study, the potential of using Wollastonite powder as a partial substitute of cement or sand to enhance the properties of Portland cement mortars was investigated. The experimental program included the following tests: time of setting test, compression test, flexure test, drying shrinkage test and scanning electron microscopy.

Two groups of Portland cement mortar mixes were used in this research. The first group incorporated Wollastonite powder as partial substitute of cement with replacement levels of 10%, 20%, and 30% by weight. The second group incorporated Wollastonite powder as partial substitute of natural sand with replacement levels of 10%, 20%, and 30% by weight.

The reference mortar mixes were prepared according to standard specifications for strength determination and drying shrinkage tests. Flow table test was carried out to ensure constant flow for different mortar mixes before testing.

The experimental results revealed that the use of Wollastonite powder in Portland cement mortars increases the initial setting time up to 60% for mortar mixes with 30% sand replacement while a marginal increase in setting time up to 5% was observed for mortar mixes with 30% cement replacement.

The replacement of sand or cement with Wollastonite powder in Portland cement mortar mixes had an advantageous effect on the early-age compressive strength of all mixes with an increase ranged from 24% to 120%. While the incorporation of Wollastonite powder in Portland cement mortars up to 20% as a partial substitute of sand enhances the compressive and flexural strengths at 28 days up to 145% and 128% respectively. Beyond this replacement level Wollastonite powder starts to weaken the bond in the matrix. On the other hand the incorporation of Wollastonite powder as a partial substitute of cement up to 30% decreases the compressive and flexural strengths at 28 days up to 65% and 83% respectively. These results indicate that Wollastonite is an inert mineral and does not contribute to strength development.

Improvement in drying shrinkage resistance was obtained by incorporating Wollastonite powder with its acicular features in Portland cement mortars. Results showed a reduction in length change for both mortar mixes with 30% cement replacement and 30% sand replacement up to 47% and 44% respectively. The microstructure observation of mortar mixes incorporating Wollastonite as sand replacement revealed the pores refinement in mortar mixes which resulted in their enhanced strength.

Keywords: *Wollastonite powder, Portland cement mortar, initial setting time, compressive strength, flexural strength, drying shrinkage*

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