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AIN SHAMS UNIVERSITY
FACULTY OF ENGINEERING
Design and Production Engineering

Factors Affecting the Physico-Mechanical Properties of Cement paste Grafted with Rubber Waste

A Thesis submitted in partial fulfillment of the requirements of the degree of

Doctor of Philosophy in Mechanical Engineering

(Design and Production Engineering)

Submitted by

Mohamed Atef Sayed Ahmed

Master of Science in Mechanical Engineering
(Design and Production Engineering)
Faculty of Engineering, Ain Shams University, 2017

Supervised By

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Prof. Dr./ Ghada Bassioni

Cairo (March 2022)

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Statement

This thesis is submitted as a partial fulfillment of Doctor of Philosophy in Mechanical Engineering, Faculty of Engineering, Ain Shams University.

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

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Thesis Summary

Egypt plays an important role in the consuming markets for tires all over the world. There is an urgent need to get rid of them in an economic and environmental way since it is considered as a harmful waste if burnt. The World trend is directed towards the improvement of new techniques to insert the rubber into useful products to maximize the benefit of recycling. The consumed rubber tires are one of the most important solid wastes which harm the world environmentally and economically.

Composite materials are considered as the most commonly used in all applications due to lightness, durability and reliability with proper strength, toughness and rigidity. However, in recent times their use has increased significantly because of their widespread in structural applications.

This research deals with the expansion of novel techniques for rubber powder recycling as a composite for various purposes in a robust construction. Waste fine Rubber Particles (WRP) are generated from grinding waste tire rubber as a partial replacement for ordinary Portland cement (OPC). OPC/WRP were blended with the ratios of 100/0, 95/5, 85/15, and 75/25 weight%, then mixed with water. Waste fine rubber particles (WRP) are mixed with ordinary Portland cement (OPC) using two water to binder ratio (W/B) of 0.3 and 0.4.

Fourier transform – infrared (FT-IR) spectrum is measured for WRP. The compressive strength was investigated for the rubberized cement pastes at 1,3,7,14 and 28 days. The Physicomechanical properties: compressive strength, apparent porosity, and bulk density of the hardened composites were measured after 28-days of hydration. The sound absorption coefficient (SAC) and noise reduction coefficient (NRC) were assessed using the two mics method. The specific sound transmission loss (SSTL) was calculated to show the correlation between the STL and the density of the prepared specimens. The WRP dispersion in the matrix of the composite was analyzed using a digital microscope and ImageJ program to investigate the homogeneity of dispersion. The morphology and microstructure of the formed hydration products were examined by environmental scanning electron microscope (ESEM). The major goal of this study is to develop a low-cost composite that may be used in practical engineering applications using waste fine rubber particles (WRP).

Keywords OPC, Rubber particles; Waste management; Cement paste; Mechanical Properties; Cement composites, rubberized composites, Physicomechanical properties, Sound Absorption, Acoustic Assessment, and Noise Reduction.

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