PHYSICO-MECHANICAL AND THERMAL PERFORMANCE OF SOLID CEMENT BRICKS CONTAINING WASTE TIRE RUBBER

By

Amr Shaban Hassan Moustafa

A Thesis Submitted to the
Faculty of Engineering at Cairo University
in Partial Fulfillment of the
Requirements for the Degree of
MASTER OF SCIENCE
in
Structural Engineering

FACULTY OF ENGINEERING, CAIRO UNIVERSITY
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Title of Thesis:

Physico-mechanical and thermal performance of solid cement bricks containing waste tire rubber

Key Words:
Tire rubber; solid cement bricks; compressive strength; thermal performance; heat/cool cycles

Summary:

Major environmental problems are resulted worldwide from the disposal of worn out tires that are no longer suitable for use in vehicles. Hence, it is essential to reuse/recycle this waste for clean environment. This study aims at investigating the effect of using high percentages of waste tire rubber (up to 40%) as a partial replacement of natural aggregates in the production of solid cement bricks. The characteristics of solid cement bricks including their physical and mechanical properties were determined and results were compared with the relevant standards to investigate the possibility of using this waste in the Egyptian market. In addition, the behavior of bricks after exposure to elevated temperatures and heat/cool cycles was also investigated. There is a great potential for the utilization of scrap tires in the production of solid cement bricks suitable for use as load bearing and non-load bearing units. This innovative application will open a new field for the recycling of considerable amounts of waste tire rubber for cleaner environment.

Disclaimer

I hereby declare that this thesis is my own original work and that no part of it has been submitted for a degree qualification at any other university or institute.

I further declare that I have appropriately acknowledged all sources used and have cited them in the references section.

Name: Amr Shaban Hassan Moustafa Date: November 2018

Signature: 

Dedication

I wish to dedicate this thesis to my wife for her continuous support and encouragement.

Acknowledgments

First and foremost, praise and thanks to Almighty ALLAH, the most Gracious, the most merciful, and peace is on His Prophet, Mohamed.

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Abstract

Major environmental problems are resulted worldwide from the disposal of worn out tires that are no longer suitable for use in vehicles. Hence, it is essential to reuse/recycle this waste for clean environment. This study aims at investigating the effect of using high percentages of waste tire rubber (up to 40%) as a partial replacement of natural aggregates in the production of solid cement bricks. Two sizes of rubber were used to replace natural coarse and fine aggregates in the production of the bricks. The characteristics of solid cement bricks including their physical and mechanical properties were determined and results were compared with the relevant standards to investigate the possibility of using this waste in the Egyptian market. In addition, the behavior of bricks after exposure to elevated temperatures and heat/cool cycles was also investigated. There is a great potential for the utilization of scrap tires in the production of solid cement bricks suitable for use as load bearing and non-load bearing units. This innovative application will open a new field for the recycling of considerable amounts of waste tire rubber for cleaner environment

Chapter 1 : Introduction

1.1. General

Disposal of waste tire rubber has become a major environmental issue in all parts of the world. Every year millions of tires are discarded, thrown away or buried all over the world, representing a very serious threat to the ecology. It was estimated that almost 1000 million tires end their service life every year and out of that, more than 50% are discarded to landfills or garbage without any treatment. By the year 2030, there would be 5000 million tires to be discarded on a regular basis. Tire burning, which is the easiest and cheapest method of disposal, causes serious fire hazards. Temperature in that area rises and the poisonous smoke with uncontrolled emissions of potentially harmful compounds is very dangerous to humans, animals and plants. The residue powder left after burning pollutes the soil. Another easier solution is to leave discarded tires piling up in landfills which indirectly causing significant environmental and human health problems such as being breeding grounds for mosquitoes and rodent that are responsible for the spread of many diseases, in addition to increasing the risk of accidental fires at their storage locations. Hence, it is essential to reuse/recycle this waste for clean environment.

1.2. Thesis scope and Objectives

This study aims at investigating the effect of using high percentages of waste tire rubber (up to 40%) as a partial replacement of natural aggregates in the production of solid cement bricks. The characteristics of solid cement bricks including their physical and mechanical properties and their behavior after exposure to elevated temperatures and heat/cool cycles were determined and results were compared with the relevant standards to investigate the possibility of using this waste in the Egyptian market. The main objectives of this thesis can be outlined as follows:

1- The conversion of waste tire rubber from being a waste material to a value added product.

2- The Protection of the environment from pollution generated from the disposal of waste tire rubber.

3- Saving dump-sites used for disposing of waste tire rubber.

4- The conservation of natural aggregate by recycling of waste tire rubber as a partial replacement of natural aggregate.

1.3. Thesis outline

The thesis consists of 5 chapters summarized as follows:

Chapter (1): This chapter includes a general introduction, scope, objectives and outline of the thesis.

Chapter (2): This chapter contains a literature review, which provides an overview on the rubber and its production. In addition, waste tire rubber, its impact on the