CHAPTER 1

INTRODUCTION

1.1. BACKGROUND

According to Rubber Manufactures Association (RMA) [1], about 265.8 million scrap tires are produced in the United States each year and more than 80 million scrap tires are currently in stock piles. According to RMA, in 1990 about 17 % of the existing rubber waste was recycled. However, this value increased to 80.4% in 2011. This magnificence progress in waste tires recycling is due to the new regulations to eliminate the storage areas for used tired (landfills) and to encourage the rubber recycling industry. The recycling of scrap tires are mainly as tire-derived fuel representing 37.7% of the total tire disposition, while 13% are dumped in landfills. Scrap tires that are used in civil engineering applications represent only 7.8% while tire recycling as ground rubber represents 24.5%. Recycling of waste tires is becoming a big concern worldwide, as the total worldwide production of waste tires represents about 2% of total solid wastes.

Concrete is the most widely used material in the construction field because of its unique properties; low cost, ease of raw materials obtainment, ease of fabrication, high mechanical properties and great durability [2]. However, concrete doesn't fulfill high impact resistance, high toughness or high durability. As rubber is an elastic material, the rubberized concrete is expected to obtain better impact resistance, toughness and ductility comparing to that of conventional concrete [3]. Furthermore, rubber yields significant sound and thermal insulation properties, so the combination of rubber particles and cement, as a binder, for precast concrete products, is very promising. Thus, the implementation of rubber particles in concrete may be beneficial, not only to reduce the impact on the environment, but also to improve some properties of concrete.

The rubber particles used in the study were crumb rubber of 1 to 4 mm size, which were obtained from a local company "Hoppic", and rubber fibers obtained from local company "Italian Egyptian Company for Tires renewal" as a by-product from truck tires renewal process. The main concern in this research is to study the effect of using different types of rubber particles with various ways of surface treatment and additives at different cement contents on the mechanical properties of concrete. Also, the availability of using waste rubber particles in non-structural applications was evaluated.

1.2. PROBLEM STATEMENT

In Egypt there is no organized method to dispose waste tires by dumping in landfills or recycling. According to The Cabinet, Information and Decision Support Center (IDSC) [4], the number of registered licensed vehicles in Egypt was 4.1 million vehicles in 2007, which indicates that about 4.3 million scrap tires are generated each year. Many ways have been developed for recycling of tires including whole tires, tires chips, shredded tires, and ground rubber. Retreading also saves millions of scrap tires from being disposed as scrap tires each year.

The major obstacle in the implementation of rubber particles in concrete is the reduction in mechanical properties of concrete due to the weak bond between rubber particles and cement paste. Furthermore, rubber particles are quite soft comparing to natural aggregates. Thus, many ways were used in this investigation to enhance the surface texture of rubber particles by using two methods of surface treatment. Also, silica fume was used to eliminate the reduction in compressive strength.

1.3. RESEARCH SIGNIFICANCE

- The aim is to obtain the optimum rubberized concrete mix with best mechanical properties to be suitable for application where high impact resistance and ductility are required.

- To study the effect of change in concrete grade, rubber volume fraction, the addition of silica fume or polypropylene fibers, the shape of rubber particles and the method of rubber surface treatment.

- In addition, Fractional factorial method of experimentation was considered to organize the tested variables and to analysis the test results. Twenty seven mixes were conducted and five variable factors were considered (1/9 fractional factorial of 3^5 design based on the Principle Block)

- In the second section of this investigation the availability of using waste rubber particles in non-structural applications was evaluated.

- For rubberized concrete, crumb rubber was used to replace fine aggregate by volume from 20% to 100 %. The aim is to make the maximum use of waste rubber in concrete to improve sound and thermal insulation properties.

- New composites of rubber-cement and rubber-epoxy were casted through the investigation. These composites were investigated in terms of sound and thermal insulation properties, and also the stress-strain relation and related properties were determined.

1.4. RESEARCH CONTENTS

This research consists of six chapters as follow:

- CHAPTER ONE: includes the introduction of the research
- CHAPTER TWO: includes the literature review of the research.
- CHAPTER THREE: explains the materials and the program of the research.
- CHAPTER FOUR: includes test results of rubberized concrete at low volume fractions.
- CHAPTER FIVE: include the tests results of rubberized concrete at high volume fractions and rubber-binder composites.
- CHAPTER SIX: includes the conclusions of the research.