INTI INTERNATIONAL UNIVERSITY

Faculty of Engineering and Quantity Surveying

DETERMINATION OF MECHANICAL PROPERTIES OF CONCRETE WITH PARTIAL REPLACEMENT OF TIRE RUBBER CRUMB

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SUPERVISOR'S DECLARATION

This project report entitled Determination of Mechanical Properties of Concrete with Partial Replacement of Tire Rubber Crumb prepared by Sim Jian Qin (I13004343) as partial fulfillment of the requirement for Bachelor of Engineering (HONS) in Civil Engineering, INTI International University.

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Date: 4th MAY 2018

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STUDENT'S DECLARATION

I hereby declare that the final year project is based on my original work except for quotations and citations, which have been duly acknowledged. I also declare that it has not been previously or concurrently submitted for any other degree at INTI INTERNATIONAL UNIVERISTY or other institutions.

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ABSTRACT

The use of waste tire rubber crumb as fine aggregate can be useful for improvement of the concrete mechanism. At the same time reduce the usage of natural resources and environmental impact that caused of concrete construction. In this research waste tire rubber were used to study the effectiveness of concrete with replacement of tire rubber crumb and conventional concrete due to compressive strength and ductility. The rubber crumb were prepared by replacing by 11%, 13%, 15% and 17% of fine aggregate by the volume of the aggregate needed in the concrete mix. The concrete cubes were constructed in size of 150 x 150 x 150(mm) and test under compressive strength test. The ductility of the concrete are studied by getting the deformation of the cube through dial gauge and plotted the stress strain curve. The workability, compressive strength and the ductility ratio are discussed in this research. RC11 showed the most increase in the slump value, further increase in the percentage of rubber crumb may lead to further drop in the slump value and eventually fall below the required range for slump. The compressive strength of RCC achieved a lower compressive strength compared with the control sample. At 28 days, the control sample achieved an average of 24.32MPa while the RCC get an average of 20.97MPa, 19.15MPa, 18.87MPa and 16.87MPa for RC11, RC13, RC15, and RC17 respectively. When the percentage of rubber crumb replacement increase, the compressive strength of the concrete cube will decrease. This proved that the replacement of fine aggregates with rubber crumb will decrease the compressive strength of the concrete cube. The concrete cube with higher percentage of rubber crumb replacement had higher strain compared to the concrete cube with lower percentage of rubber crumb replacement. All of the concrete cube with rubber crumb replacement obtained a higher strain than the control sample.

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CHAPTER 1

INTRODUCTION

1.1 General

Concrete is very commonly used as construction material all over the world. Concrete is playing a very important model in this modern era due to the rapid rate of developing nowadays. Concrete is a mixture of sand, rock, water and cement after hardened. All the concrete ingredients are bound together by cement. Cement provided strong bond between the aggregates after mixed with water to form concrete. After the consistent mass production of cement became readily available back in late 1800s, the world has been changed by all sort of concrete structure through various design and construction by using concrete. The usage and demand of concrete has been increasing from time to time due to the rapid development of construction industry. Concrete as a structural material, has expanded its function and uses with innovations from the science and technology experts but the main concern is that concrete is not sustainable after it was hardened for numerous reason.

This research was implemented to develop and to determine the properties of rubberized concrete with partially replacing the fine aggregates with rubber crumb. Concrete cube with partially rubber crumb replacement was tested by using various tests such as, Compressive Strength Test and Slump Test. The result of the tests were tabulated and discussed in this research. The applications of the rubberized concrete was also recommended in this research.

1.2 Problem Statement

Sand as one of the concrete ingredients is the most widely consumed resources for construction purpose (Syed Farrukh Anwar et al, 2016). The growing of construction industry in Asia especially the Middle East since the past two centuries has make the sand become a vital commodity for the growth of economies in every country. After the concrete had hardened, the sand and other mixing materials were bound forever and it is no longer available as a resource to be reused.

At the same time, large quantities of tire are being generated every year after it was worn out and disposed in any legal or illegal way (Syed Farrukh Anwar et al, 2016). Recycling of tire by replacing the materials needed for concrete construction is an innovative idea to prevent the environmental problem especially when disposal of tires has become one of the most concern issues in environmentalist and at the same time reduce the usage of natural resources for concrete production.

1.3 Research Objectives

The research objectives of this research are:

- To study the compressive strength of concrete with partial replacement of tire rubber crumb
- To study the optimum percentage of tire rubber crumb in concrete which can improve the mechanical properties of concrete.
- To determine the ductility of the concrete with partial replacement of rubber crumb

1.4 Scope of Study

Previously, researches have been carried out by replacing the coarse aggregate with waste tire rubber to utilize the industrial wastes and increase the strength of the concrete. In this research,

rubber crumb was used to replace the fine aggregates to increase the workability and enhance the ductility of the rubberized concrete. The addition of rubber crumb in concrete production was expected to slightly decrease the compressive strength but increase the ductility of the concrete. This research conducted the slump test for the workability of concrete mix and the compressive strength test for rubberized concrete cube. The ductility of the concrete was testing by measuring the deformation of the cube during the compressive strength test. Every batch of concrete mix were tested immediately after mixing process to get the value for slump. A total of 45 concrete cube with 150mm of side length was casted which included 9 cubes without rubber crumb replacement and 36 cubes with rubber crumb replacement up to 11%, 13%, 15% and 17%. All the cube were cured in the curing tank before the compressive strength test carried out on 7, 14, 28 days after casting.

1.5 Significance of Study

The findings of this research can benefit the industry of structural construction by reducing the usage of natural resources. The greater demands of natural resources such as sand can be reduced by replacing sand with rubber crumb. At the same time, the industrial wastes, scrap tire can be utilized as a replacement of concrete ingredients hence reduce the need of tire disposal. The improvement in the mechanical properties of the rubberized concrete is applicable for areas with severe dynamic action such as earthquake area due to its ability to absorb plastic energy. For researchers, this study can help them to determine the optimum percentage of rubber crumb replacement to achieve the desired concrete mechanism.

CHAPTER 2

LITERATURE REVIEW

2.1 Introduction

Since the disposal of used tires has been banned from landfills, the recycling of automobile tires has become an important concern. The consequences of this ban was millions of used tires stockpiled which caused even bigger concern. The short of alternative technology to dispose these wastes is one of the main reasons. The potential fire and health hazards caused by the growing stockpiles of wastes tires have yet to become another concern. In order to reduce the amount of waste tires disposed into the landfills and conserves the valuable natural resources, recycling waste tire rubber is a very promising alternative. Partial replacing the tire rubber particles in concrete is consider as a main recycling method to utilize the wastes.

Rubberized concrete possess lower density, higher ductility, greater toughness and better absorption of energy but lower compressive and tensile strengths which indicates in the result. (Siddique et al., 2008). "The mortars incorporating rubber shreds achieved better workability compare to a control mortar without rubber particles" Raghavan et al. (1998) reported that. The increase in the rubber content decrease the unit weight of the mixture because of the low specific gravity of rubber particles. By incorporating rubber shreds into mortar, plastic shrinkage cracking was reduced when compared to the control mortar.

According to the research by Eldin and Senouci (1993), the rubberized concrete exhibited lower mechanical strength but demonstrated a ductile and plastic failure which can become an advantages in construction. The elastic behavior of the modified concrete is improved despite a

loss in both unit weight and compressive strength. The mechanical properties of the rubberized concretes is improved by adding silica fume into the matrix hence diminished the rate of strength loss (Güneyisi et al., 2004).

2.2 Rubber Crumb

Crumb rubber is a product from automotive and truck tires. During the recycling process, the steel and tire cord are removed from the tire. In order to achieve the required size, tires have to pass through several process to get to the desired size. Then, the particles are classified and sized based on various criteria. (Davide Lo Presti, 2013)

2.2.1 The Process of Rubber Crumb

The rubber crumb used to replace the fine aggregates should be passing through the seize size 4.75mm which is the same requirement for the fine aggregate. The size of the rubber crumb used in this research is 30 mesh which is 0.425mm. The three-stage processing of manufacturing of rubber crumb from waste tires was primarily shredding, granulation and fine grinding. (Rajesh Kumar Jain, 2013)

2.2.1.1 Shredding

Shredding is the first step in recycling tires. After shredding, waste tire were broke into pieces and the wire and mesh from the tire were separated. Tire is torn to pieces after the machine with moving parts separated out the wires from the tires. Any kinds of input materials can be shred by using this machine because it was designed to suit for different industries. The motor with different diameter ranges are driven by gearboxes to carry out the shredding process. In order to save space and protect the machine from damage, a well-integrated hydraulic power was pack into

the machine house. Even so, the machine is still easy to remove and access for maintenance to be carried out.

2.2.1.2 Granulation

The next step of this recycling process is grind the waste tires by using granulators. During this process, large quantity of granules were produced. The granulators were developed as a slow running grinders for the applications of blow molding sector and injection. In order to suit the wide range of application, the materials is fed by a sound-absorbing feed hopper.

2.2.1.3 Pulverizer

At the end of the production, tires granules were break in smaller particles in order to produce the rubber crumb. A high speed and precision grinder were used to produce the rubber crumb which is the pulverizer. A high speed rotating disc was mounted concentrically with a vertically fixed grinding disc to produce the fine powder of tire. The centrifugal force acts on the material inside the pulverizer carried the material through the grinding area and grind in into powder. Then, the powder of the tire was collected by using a blower.

2.3 Effect of Compressive Strength

According to Khaldoon and Ahmed, (2015), considerable loss of strength was observed when the rubber crumb content in the mix was increased. Losses up to 90% of the compressive strength was measured, depending on the percentage of crumb rubber in the mix. The reduce of the compressive strength of the concrete with increases rubber content in the concrete make it not suitable to use as a high strength concrete which is not applicable for high rise building and also load bearing structure.