

A STUDY ON THE EFFECT OF TYRE RUBBER WASTE POWDER AS PARTIAL SAND REPLACEMENT IN CEMENT MORTAR PROPERTIES

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I hereby declare that the work in this thesis 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 University Malaysia Pahang or any other institutions.

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Thesis submitted in fulfillment of the requirements
for the award of the
Bachelor Degree in Civil Engineering

Faculty of Civil Engineering and Earth Resources

UNIVERSITY MALAYSIA PAHANG

JANUARY 2019

ACKNOWLEDGEMENTS

First and foremost, I would like to express my sincere gratitude to God for everything that necessary in completing this thesis. I would like to express my very great appreciation to my dearest supervisor, Dr Doh Shu Ing for his valuable and constructive advice, suggestions, enthusiastic motivation and immense knowledge ever since the beginning of the thesis. His willingness to give his time to help me in completing this thesis has been very much appreciated. I wouldn't have completed this thesis without his guidance for sure.

Besides that, I would like to extend my gratitude to the laboratory technicians of concrete laboratory for all guidance and assistance provided throughout my research. Next, I would like to express my very special appreciation to my friends, batch mates, seniors and juniors, especially Eric Jason and Nagatarshini whom helped, motivated and supported me in all aspects in completing this research.

Most importantly, none of this would have happen without this without the overwhelming love, continuous support and patience of my family. I would love to express my heartfelt appreciation and love to my parents, Mr Yathagan and Mrs Tamil Selvi who have been my pillar of strength of all time.

ABSTRAK

Simen mortar merupakan salah satu bahan yang penting yang digunakan secara luas dalam industri pembinaan. Pembuatan simen mortar mempunyai kesan negative yang besar untuk alam dan ekosistem. Banyak masalah berkaitan dengan alam semakin berleluasa terutamanya perlombongan pasir kerana pasir merupakan salah satu bahan utama dalam simen mortar. Tayar buangan juga merupakan salah satu pembuangan yang semakin hari semakin meningkat kerana industri otomobil semakin maju. Pelupusan pembuangan yang tidak betul mengundang masalah pencemaran dan kesihatan.. Oleh itu, penyelidikan ini telah dijalankan untuk membantu industri untuk mengurangkan bilangan pembuangan di tanah lupus dan juga mengurangkan pergantungan terhadap pasir semata-matanya bertujuan mengurangkan perlombongan pasir yang memberi kesan terhadap alam dan ekosistem. Penyelidikan ini adalah untuk mengkaji kesan sisa buangan tayar getah sebagai separa gantian untuk pasir dalam simen mortar dari segi kekuatan, kebolehkerjaan, dan kesan suhu terhadap kadar pengawetan. Peratusan sisa buangan tayar getah yang dikaji ialah 0% (kawalan), 5%, 10% dan 15%. Sebanyak lima ujian telah dijalankan; ujian kekuatan kemampatan, ujian kekuatan kelenturan, aliran ujian meja, ujian UPV dan ujian suhu. Prisma dengan saiz (40 x 40 x 160) mm digunakan untuk ujian kekuatan kelenturan manakala kiub dengan saiz (50 x 50 x 50) mm digunakan untuk ujian selebihnya. Ujian kekuatan kemampatan menunjukkan penurunan sekiranya peratusan sisa buangan tayar getah sebagai separa gantian menaik. Kekuatan kelenturan pula menunjukkan bahawa 10% sisa buangan tayar getah dalam simen mortar memiliki kekuatan awal paling tinggi pada hari ke-3 tetapi 5% memiliki kekuatan kelenturan tertinggi pada hari ke-28 jika dibandingkan dengan 10% dan 15%. Aliran ujian meja pula menunjukkan bahawa kebolehkerjaan simen mortar semakin naik sekiranya peratusan kandungan sisa buangan tayar getah dalam simen mortar meningkat. Ujian UPV menunjukkan bahawa semakin kurang peratusan kandungan sisa buangan tayar getah dalam simen mortar semakin kurang kandungan lubang dan retak dalam simen mortar. Ujian suhu menunjukkan bahawa penambahan sisa buangan tayar getah dalam simen mortar, semakin tinggi suhu simen mortar yang segar. Peratusan optimum kandungan sisa buangan tayar getah dalam penyelidikan ini ialah 5%.

ABSTRACT

Cement mortar is one of the most important materials widely used in construction industry. The production of cement mortar has a huge negative impact on nature and ecosystem. Many of nature based problems arises especially sand mining as sand is one of the main ingredient for cement mortar. Scrap tyres are also one of waste that drastically increasing day by day as the automobile industry progressing well. Improper disposal of waste tyre leads to pollutions and health issues. Hence, this research is carried out to help the industry to reduce the amount of waste at dump fill and also to reduce the dependency on sand solely in order to reduce sand mining which affects the nature and ecosystem. This research is basically to determine the effect of rubber waste powder content as partial sand replacement in cement mortar in terms of strength, workability and effect on temperature on rate of curing. The percentage of tyre rubber waste powder used to be tested were 0% (controlled), 5%, 10% and 15% .Total of five tests were conducted; compressive strength test, flexural test, flow table test, UPV test and temperature test. Prisms with size of (40 x 40 x 160) mm are used for flexural test and cube with the size of (50 x 50 x 50) mm used for the rest of the experiments. The compressive strength shows declination as the percentage of tyre rubber waste powder as sand replacement increases. The flexural test shows that 10% tyre rubber waste in cement mortar content has higher early strength on 3rd day but 5% has the highest flexural strength on 28th day has the highest compared to 10% and 15%. Flow table test indicates that the workability of the cement mortar increases as the percentage of tyre rubber waste increases in the cement mortar mix. UPV test shows that lesser the tyre rubber waste in cement mortar mix the lesser void and cracks exists. Temperature test shows that addition of tyre rubber waste powder increases the temperature of the fresh cement mortar. The optimum percentage of tyre rubber waste powder as sand replacement for the cement mortar in this research is 5%.

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LIST OF SYMBOLS

°C	Degree Celsius
mm	millimetre
MPa	Mega Pascal
Km/s	Kilometre per second

LIST OF ABBREVIATIONS

POFA	Palm Oil Fly Ash
UPV	Ultrasonic Pulse Velocity
OPC	Ordinary Portland Cement
kN	kilo Newton

CHAPTER 1

INTRODUCTION

1.1 Introduction

In this modern era of construction, cement mortar is a very essential and crucial material and widely used as construction material. Cement mortar is to be said as one of the oldest manufactured construction material used in construction of various structures around the world. Concrete is a mixture of aggregates like sand and stones combined with cement and water. The mixture is then allowed to dry and harden. Basically, cement mortar is the stone-like structure formed after this cement and other materials mixtures are hardened (cured). The cement is just a part of the cement mortar. Cement has been used as a binder of material. Early forms of cement used things like lime and pozzolana, a type of volcanic ash. The Romans were able to produce massive structures like the Pantheon and the Roman aqueducts based on this discovery. The growth rate of demands of cement mortar in construction industry increases drastically day by day. Cement mortar has a very high compressive strength but also high in terms of weight as the composition of the cement mortar is pure. In contrast, the production of cement mortar has a huge negative impact on nature and the ecosystem as well. Since fine aggregates are one of the main ingredients in production of cement mortar, sand mining in river became a very normal issue. This issue become serious when the demand for fine aggregate increases day by day.

Scrap tyres are one of the solid wastes that are produced drastically in this era. As the industry of automobile is progressing well, the production of tyre are increasing as well. The rate of the waste tyre also increases as the rate of car producing and usage of car on the road increases. These tyres usually dumped due to worn out condition or burst case and not safe to use anymore. These scrap tyres are often dumped in dump fill.

These kind of wastes are usually hard to disposed but will be reused by recycling it. Scrap tyres are referred as one of the solid waste classified under special solid wastage category. Thus, by using it in construction industry will bring.

1.2 Problem Statement

In this era of developing country and technology, many industries often forget to manage the sustainability of nature. The end products especially all these waste materials are often dumped uncontrollably in landfills. This dumping industrial waste problem is being a very serious issue where dump fill areas are getting out of control. Waste tyres are often used for landfills but this action has many negative effects to mankind and also nature. Improper disposal will cause water accumulation which will lead to breeding of mosquitoes, bacteria and etc. Besides that, if there is any fire accident, these tyres releases toxic gases which will cause serious health issues and severe pollutions (Dhir et al, 2001). In order to reduce all these negative impact on environment, few precaution steps need to be taken. The waste tyres can be reduced on land in a beneficial way which is through construction field (Po YW, 2004). Landfill disposal is normally used in construction in order to dump these tyre wastes but since European Union has set up new restrictions to reduce the usage of this method to introduce alternatives oriented towards material and recovery (Yung et al, 2013).

On the other side of this, researchers have revealed that concrete paving blocks containing tyre rubber crumb has improvised in terms of toughness and increase in ductility. Another research reported that addition of crumbs will increase the flexural impact on strength and toughness of hybrid concrete beams comprised of a rubberized concrete top layer increased. Therefore, this research is to investigate the effect of tyre rubber waste powder on cement mortar properties. The strength to withstand maximum load will be analysed.

The modulus of rupture is identified based on optimum amount of tyre powder to replace the fine aggregate. The effect of tyre rubber powder on temperature of cement mortar also tested to identify how it will affect the rate of curing. The Ultrasonic Pulse Velocity test will also be conducted to check whether the presence of tyre rubber will reduce the cracking and increase the flexibility of the cement mortar. In the end of

this study, the proper percentage of tyre rubber replacing the sand will be identified to introduce this alternative in construction field for a better and developed future.

1.3 Objectives

The objectives of this research are:

- i. To determine effect of rubber waste powder content as partial sand replacement on compressive and flexural strength of concrete.
- ii. To investigate the effect of rubber waste powder as partial sand replacement on workability.
- iii. To investigate the effect of tyre rubber waste powder as partial sand replacement on concrete temperature and rate of curing

1.4 Scope of Research

This research is all about investigating the effect of tyre rubber waste as partial cement replacement in cement mortar. The cement mortar properties will be identified through flexure test, compression test, flow table test, effect of temperature and. In this research, the content of the cement mortar are water, sand, Ordinary Portland Cement, and tyre rubber waste. The cement mortar is first mixed without tyre rubber waste powder to be kept as control mix which is used to compare with the tyre rubber mixed cement mortar to figure out the changes in properties of cement mortar. The sand is replaced by tyre rubber waste with 5%, 10%, and 15% of the sand mass.

Cement mortar cubes were casted in cube moulds of (50 x 50 x 50) mm³ with 0%, 5%, 10% and 15% of tyre rubber waste of cement mass, 2 cubes for each percentage respectively. After removal of the cubes from the moulds are done, the temperature of a controlled cube and a tyre rubber waste mixed cube where taken precisely every 5 minutes from setting time until the first 2 hours and then every 1 hour until 17 hours of setting time. The cubes are let to be air cured. The following day, the cubes are immersed in water for water curing. The compression test, flow table and flexural test were conducted on 3rd, 7th, and 28th days and the data were analysed. The test and experiments were conducted according to the existing standards.

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