A STUDY ON CONCRETE USING WASTE PLASTIC AS AGGREGATES

ROHAYA BINTI ABD WAHAB

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______________________	______________________
(TANDATANGAN PENULIS)	(TANDATANGAN PENYELIA)
Alamat Tetap: 1195-1 Kg. Baru, 24200 Kemasek, Kemaman, Terengganu	DR. DELSYE TEO (Nama Penyelia)
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Author	:	Rohaya Binti Abd Wahab
Matric No.	:	15119

Has been read and certified by:

____________________________ ____________________________

Dr. Delsye Teo
Supervisor

Date

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ABSTRACT

In Malaysia, most of plastics waste is abandoned and not recycled. This situation causes serious problems such as wastage of natural resources and environmental pollution. Solid waste management is one of the major environmental concerns in the world. In fact wide variety of waste materials can be utilized as inert in cement matrix. In this research, bottle plastics are used as plastics waste as fine aggregates. The aim of this work is to study the workability and strength of plastics waste as the replacement of fine aggregate in concrete. This study involved 3 tests to determine the competence of reusing waste plastic in the production of concrete. Waste plastic was used as a partial replacement for sand by 0%, 10%, 15%, and 20% with concrete mixtures. These tests include performing slump, compressive strength, and splitting tensile strength. 24 cubes were molded for compressive strength and 24 cylinders were cast for splitting tensile strength. Curing ages of 7, 14, and 28 days for the concrete mixtures were applied in this work. This study insures that reusing waste plastic as a sand-substitution aggregate in concrete gives a good approach to reduce the cost of materials and solve some of the solid waste problems posed by plastics.

ABSTRAK

Di Malaysia, kebanyakkan bahan-bahan buangan plastik dibiarkan terbengkalai dan tidak dikitar semula. Keadaan ini menyebabkan pelbagai masalah serius berlaku seperti pembaziran umpama sumber asli dan pencemaran alam sekitar. Pengurusan bahan buangan adalah salah satu yang penting berkaitan dengan persekitaran di dunia ini. Sebenarnya, pelbagai jenis bahan buangan boleh menjadi seperti bahan lengai atau agregat dalam matriks simen. Dalam penyelidikan ini, bahan buangan plastik dari plastik botol digunakan sebagai plastik buangan sebagai agregat halus Matlamat penyelidikan ini adalah untuk mengkaji tahap kebolehkerjaan dan kekuatan bahan plastik buangan sebagai pengganti agregat halus dalam konkrit. Dalam pembelajaran ini mengandungi 3 ujian untuk menentukan kecekapan dalam penghasilan konkrit. Bahan plastik yang digunakan untuk digantikan sebagai pasir dalam campuran konkrit adalah sebanyak 0%, 10%, 15% and 20%. Ujian ini adalah termasuk melakukan slump, kekuatan dimampatkan dan kekuatan direngangkan. 24 acuan kiub untuk kekuatan dimampatkan dan 24 acuan silinder untuk kekuatan direngangkan. Dalam kerja ini, masa untuk dicuring adalah 7, 14 dan 28 hari untuk campuran konkrit. Pembelajaran ini adalah untuk memastikan penggunaan balik buangan plastik sebagai gantian pasir sebagai agregat dalam konkrit memberikan pendekatan yang bagus untuk mengurangkan kos bahan dan dalam menyelesaikan sedikit masalah bahan buangan terutamanya dari plastik.

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INTRODUCTION

1.1 General

Following a normal growth in population, the amount and type of waste materials have increased accordingly. Many of the non-decaying waste materials will remain in the environment for hundreds, perhaps thousands of years. The non-decaying waste materials cause a waste disposal crisis, thereby contributing to the environmental problems. The problem of waste accumulation exists worldwide, specifically in the densely populated areas. Most of these materials are left as stockpiles, landfill material or illegally dumped in selected areas.

The use of plastic materials and glass in a number of civil engineering applications has been investigated through a large number of research studies. These have been conducted to examine the possibility of using plastics in various civil engineering projects in the construction field (Chanbane et al., 1999; Rindl, 1998; Shayan et al., 1999).

The productive use of waste material represents a means of alleviating some of the problems of solid waste management (Davis and Cornwell, 1998). The reuse of wastes is important from different points of view. It helps to save and sustain natural resources that are not replenished, it decreases the pollution of the environment and it also helps to save and recycle energy production processes. Wastes and industrial by-products should be considered as potentially valuable resources merely awaiting appropriate treatment and application. Plastic wastes are among these wastes; their disposal has harmful effects on the environment due to their long biodegradation period, and therefore one of the logical methods for reduction of their negative effects is the application of these materials in other industries (Hassani et al., 2005).

Plastics have become an inseparable and integral part of our lives. The amount of plastics consumed annually has been growing steadily. Its low density, strength, user friendly designs, fabrication capabilities, long life, light weight, and low cost are the factors behind such phenomenal growth. Plastics have been used in packaging, automotive and industrial applications, medical delivery systems, artificial implants, other healthcare applications, water desalination, land/soil conservation, food prevention, preservation and distribution of food, housing, communication materials, security systems, and other uses. With such large and varying applications, plastics contribute to an ever increasing volume in the solid waste stream.

In addition to reducing the amount of plastics waste requiring disposal, recycling plastic can have several other advantages. Plastic wastes are very visible as they contribute to a large volume of the total solid wastes. Precisely because of their large visibility, plastic wastes (and particularly non-sustainable plastic products) have been viewed as a serious solid waste problem.

There is significant interest the development of concrete with plastics waste. Recycling plastics waste is effective for environmental conservation and economical advantages. Therefore, the most common bottle plastics were collected from the landfill and environment to be included in concrete as an aggregate.

A basic experimental study on the characterization of plastics waste is suitable to replace as fine aggregate and the effects in the physical and mechanical properties of concrete containing plastics waste was carried out. The principal target of the experimental program was to determine the contribution of the waste aggregate types to the improvement of the strength behavior of the confined concrete.

1.2 Objectives

The main objectives of this study are:

1. To obtain a suitable mix for natural concrete and concrete with waste plastics with the required strength and workability.

2. To determine the workability, compressive strength and splitting tensile strength characteristics of concrete with waste plastics.

3. To compare the workability and strength for concrete with and without waste plastic.

1.3 Significance of Study

Solid wastes in Malaysia do not through any formal processing activities. However in 1993, recycling programme has been launched in 23 Local Authorities and the recycling activities are being carried out of these areas to varying extents. The major recyclable items include paper, cardboard, bottles, metal and plastics. There is a great potential for resource recovery as is evident from the presence of scavenging activities on some landfill sites and at collection points. Apart from recycling, no other formal processing activity is being carried out. As recycling helps in reducing waste and it is inline with the concept of sustainable development, it has the potential of becoming one of the national tools in combating problems related to managing of solid waste [Ministry of Housing and Local Government Malaysia, 2000].

Besides that, the environmental and economic benefits from the reuse of recycled waste glasses in cement and concrete production can also be very significant depending on the end uses and production scale. The reuse of waste plastic in concrete production has many benefits:

- Cuts waste disposal costs, which are likely to rise due to landfill tax.
- Conserves the environment by saving large amount of primary raw materials each year.
- Extends the life of our landfill sites, helping to conserve the countryside.

- Saves a significant amount of energy and reduces the amount of CO_2, NOx, and other air pollutants emitted from the manufacturer cement clinker when ground glass powder used as a cement replacement.
- Increases public awareness of the problem of waste and benefits of recycling.
- Offers many alternative uses for recycled glass based products, without compromising on either cost or quality.

1.4 Scope of Study

This study is determined the workability and compressive strength characteristics of concrete with waste plastics. For this study, the wastes plastics used are plastic bottles. In this research, plastics waste can be collected from the bottle plastics only. The plastics waste to be used replace as fine aggregate in concrete.

For concrete mixtures, each mixture consisted of sand, cement, aggregates and water. These mixtures were of 0% waste plastics. For waste plastic concrete mixtures, these mixtures are presented corresponding to the 10%, 15% and 20% addition of waste plastic as sand replacement, respectively.

This study involved 3 tests to determine the competence of reusing waste plastic in the production of concrete. These tests include performing slump, compressive strength, and splitting tensile strength. 24 cubes were molded for compressive strength and 24 cylinders were cast for splitting tensile strength. Curing ages of 7, 14, and 28 days for the concrete mixtures were applied in this work.

CHAPTER 2

LITERATURE REVIEW

2.1 Introduction

Concrete plays an important role in the beneficial use of these materials in construction. Although some of these materials can be beneficially incorporated in concrete, both as part of the cementations binder phase or as aggregates, it is important to realize that not all waste materials are suitable for such use (Anon., 2003).

In construction, concrete is a composite building material made from the combination of aggregate and cement binder. The most common form of concrete is Portland cement concrete, which consists of mineral aggregate (generally gravel and sand), Portland cement and water. Contrary to common belief, concrete does not solidify from drying after mixing and placement. Instead, the cement hydrates, gluing the other components together and eventually creating a stone-like material.

During hydration and hardening, concrete needs to develop certain physical and chemical properties, among others, mechanical strength, low permeability to ingress of moisture, and chemical and volume stability.

Concrete contains numerous flaws and micro cracks. The rapid propagation of micro cracks under an applied load is considered responsible for the low tensile strength of concrete. It is reasonable to assume that the tensile strength as well as the flexural strength of concrete can be substantially increased by introducing closely spaced fibers. These fibers would arrest the propagation of micro cracks, thus delaying the onset of tensile cracks and increasing the tensile strength of the material (Yin and Hsu., 1995).

For structural lightweight concrete, it made with rotary kiln produced structural lightweight aggregate solves weight and durability problems in buildings and exposed structures. Structural lightweight concrete has strengths comparable to normal weight concrete, yet is typically 25% to 35% lighter. Structural lightweight concrete offers design flexibility and substantial cost savings by providing less dead load, improved seismic structural response, longer spans, better fire ratings, thinner sections, decreased story height, smaller size structural members, less reinforcing steel, and lower foundations costs. The excellent durability performance of structural lightweight concrete made with expanded shale, clay or slate structural lightweight aggregate is result of the ceramic nature of the aggregate, and its exceptional bond to and elastic compatibility with the cementations matrix.

Lightweight concretes can either be Lightweight Aggregate concrete, Foamed concrete or Autoclaved Aerated concrete (AAC). Such lightweight concrete are often used in house construction. The required properties of the lightweight concrete will have a bearing on the best type of lightweight aggregate to use. If little structural requirement, but high thermal insulation properties are needed, then a light, weak aggregate can be used. This will result in relatively low strength concrete.

Lightweight aggregate concretes can however be used for structural applications, with strengths equivalent to normal weight concrete. The benefits of using lightweight aggregate concrete include reduction in dead loads making savings in foundations and reinforcement, improved thermal properties, improved fire resistance, savings in transporting and handling pre-cast units on site and reduction in formwork and propping.

2.2 Plastics

Plastic wastes are among these wastes, their disposal has harmful effects on the environment due to their long biodegradation period, and therefore one of the logical methods for reduction of their negative effects is the application of these materials in other industries (Hassani et al., 2005).

Plastics have become an inseparable and integral part of our lives. The amount of plastics consumed annually has been growing steadily. Its low density, strength, user-friendly designs, fabrication capabilities, long life, light weight, and low cost are the factors behind such phenomenal growth. Plastics have been used in packaging, automotive and industrial applications, medical delivery systems, artificial implants, other healthcare applications, water desalination, land/soil conservation, flood prevention, preservation and distribution of food, housing, communication materials, security systems, and other uses. With such large and varying applications, plastics contribute to an ever increasing volume in the solid waste stream.

2.2.1 Types of plastics

Plastics can be separated into two types. The first type is thermoplastic, which can be melted for recycling in the plastic industry. These plastics are polyethylene, polypropylene, polyoxymethylene, polytetrafluorethylene, polyamide and polyethyleneterephthalate. The second type is thermosetting plastic. This plastic cannot be melted by heating because the molecular chains are bonded firmly with meshed cross links. These plastic types are known as phenolic, melamine, unsaturated polyester, epoxy resin, silicone, and polyurethane. At present, these plastic wastes are disposed by either burning or burying. However, these processes are costly. If the thermosetting plastic waste can be reused, the pollution that is caused by the burning process as well as the cost of these waste management processes can be reduced.

There are about 50 different groups of plastics, with hundreds of different varieties. All types of plastic are recyclable. To make sorting and thus recycling easier, the American Society of Plastics Industry developed a standard marking code to help consumers identify and sort the main types of plastic. These types and their most common uses are:

1	PET	**Polyethylene terephthalate** - Fizzy drink bottles and oven-ready meal trays.
2	HDPE	**High-density polyethylene** - Bottles for milk and washing-up liquids.
3	PVC	**Polyvinyl chloride** - Food trays, cling film, bottles for squash, mineral water and shampoo.
4	LDPE	**Low density polyethylene -** Carrier bags and bin liners.
5	PP	**Polypropylene** - Margarine tubs, microwaveable meal trays.
6	PS	**Polystyrene** - Yoghurt pots, foam meat or fish trays, hamburger boxes and egg cartons, vending cups, plastic cutlery, protective packaging for electronic goods and toys.