MECHANICAL PROPERTIES OF CONCRETE CONTAINING 15% AND 20% OF TEXTILE WASTEWATER.

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A thesis submitted in partial fulfillment of the
requirement for the award of the degree of
Bachelor of Civil Engineering

Faculty of Civil Engineering and Earth Resources
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DECEMBER 2010

ABSTRACT

Textile industry is one of the most important and rapidly developing industrial sectors in Malaysia. It has a high effect in terms of its environmental impact in producing highly polluted discharge water in large amounts. Textile mills in Malaysia are required to control their discharge and therefore have started installing treatment plants in the name of environmental protection. Besides that, concrete are the most widely used man-made construction material and playing important part in all building. It can be defined as a composite material composed of a coarse granular material embedded in a hard matrix of material (cement or binder) that fills the space between the particles and bond together. Many researchers have been done to produce concrete which is economic as possible. The environmental regulation have initiated in increasing interest in using wastewater as a construction materials partially replacing the tap water in concrete structures. In this study, the idea is replacing tap water with textile wastewater (WWC) as concrete material. The objective of this study concentrates on mechanical properties that are compressive and flexural strength of concrete with WWC. There are two different percentages of WWC which is 15% and 20% were used to replaced the tap water and were tested at 7 and 28 days. The strength of normal concrete as a control mix has been compared with the concrete with WWC. The result revealed that the normal concrete presented the highest compressive and flexural strength and the followed by concrete with 15% and 20% WWC but have the potential to increase from 15% to 20% WWC. As a conclusion, WWC will increases the compressive and flexural strength of concrete but still need suitable percentage to be targeted for concrete used in construction.

ABSTRAK

Industri tekstil merupakan salah satu sektor industri yang paling penting dan berkembang pesat di Malaysia. Ia mempunyai pengaruh yang cukup besar dari segi kesan persekitaran dalam menghasilkan keluaran air tercemar dalam jumlah yang sangat besar. Kilang tekstil di Malaysia hendaklah mengawal pengeluaran mereka. Justeru itu mula memasang loji rawatan untuk perlindungan alam sekitar. Selain itu, konkrit adalah buatan manusia yang paling banyak digunakan sebagai bahan bangunan dan memainkan bahagian penting dalam pembangunan. Hal ini dapat ditakrifkan sebagai bahan komposit terdiri dari bahan granular kasar dan keras yang tertanam dalam matriks bahan (simen atau pengikat) yang mengisi ruang antara zarah dan mengikat bersama-sama. Banyak penyelidikan telah dilakukan untuk menghasilkan konkrit yang sangat ekonomi. Keadaan persekitaran telah memulakan dalam meningkatkan minat dalam menggunakan air sisa sebagai bahan pembinaan seterusnya mengantikan air paip didalam struktur konkrit. Dalam kajian ini, idea adalah menggantikan air paip dengan air sisa tekstil (WWC) sebagai bahan konkrit. Tujuan kajian ini tertumpu kepada sifat mekanik iaitu kekuatan mampatan dan lenturan konkrit yang mengandungi WWC. Terdapat dua peratusan WWC yang berbeza iaitu 15% dan 20% digunakan untuk menggantikan air paip dan diuji pada 7 dan 28 hari umur konkrit. Kekuatan konkrit biasa dijadikan sebagai bancuhan kawalan untuk dibandingkan dengan kekuatan konkrit dengan WWC. Keputusan kajian menunjukkan bahawa konkrit biasa menghasilkan kekuatan mampatan yang tertinggi dan diikuti dengan konkrit dengan 15% dan 20% WWC namun mempunyai potensi meningkat dari 15% kepada 20% WWC. Sebagai kesimpulan, WWC akan meningkatkan kekuatan mampatan dan lenturan konkrit tetapi masih memerlukan peratusan yang sesuai untuk digunakan dalam pembinaan konkrit.

TABLE OF CONTENT

LIST OF TABLES

LIST OF FIGURES

LIST OF ABBREVIATIONS

ASTM	**-**	American Standard of Testing and Materials
APHA	**-**	American Public Health Association
BOD	-	Biochemical Oxygen Demand
BS	-	British Standard
CMD	**-**	Concrete Mix Design
COD	-	Chemical Oxygen Demand
C25	-	Concrete Grade 25
C30	-	Concrete Grade 30
OPC	-	Ordinary Portland cement
DOE	-	Department of Environment
MOR	-	Modulus of Rupture
Mpa	-	Mega Pascal
N/mm^2	-	Newton per Millimeter square
Psi	**-**	Pound per Square Inch.
MS	-	Malaysia Standard
TSS	-	Total Suspended Solids
UMP	-	Universiti Malaysia Pahang
W/C	-	Water Cement Ratio
WWC	-	Wastewater Concrete
WWC15	-	Wastewater Concrete at 15%
WWC20	**-**	Wastewater Concrete at 20%

LIST OF APPENDICES

CHAPTER 1

INTRODUCTION

1.1 Background of Study

The availability of water supply adequate in terms of both quality and quantity is essential to human existence. Early people recognized the importance of water from a quantity viewpoint. Civilization developed around water bodies that could support agriculture and transportation as well as provide drinking water. Recognition of the importance of water quality developed more slowly. Early humans could judge water quality only through the physical senses of sight, taste, and smell (Florio, 2003).

Generally, the most widely used construction material is concrete, commonly made by mixing Portland cement with sand, crushed rock, and water. Today, the rate at which concrete is used is much higher than 40 years ago. Concrete are the most widely used man-made construction material and playing part in all building structures. Concrete can be defined as a mixture of cement, water, aggregate (fine and coarse), and admixture. Too many researchers have been done to produce concrete which is economic as possible (Gambhir, 2004).

The strength, durability, and other characteristic of concrete depend upon the properties of its ingredients, the proportions of mix, the method of transporting, placing, compacting, and curing. Concrete grade is defined as that number, which indicates the characteristic compressive strength of concrete in N/mm^2, determined by cube tests made at 28 days. Thus, a grade 30 concrete has a characteristic strength of 30 N/mm^2. According to BS-5337, 93 the grade 25(C25) is the lowest grade that may be used as reinforced concrete, but in practice, a C30 mix invariably necessary because of durability considerations and almost all concrete production that using the grade 30 concrete (Gambhir, 2004).

Normally, the composition in concrete consists of cement, water, and aggregate are 7-15%, 14-21%, and 60-80% respectively. The water/cement ratio (w/c) of the mixture has the most control over the final properties of the concrete. The water/cement ratio is the relative weight of the water to the cement in the mixture. The water/cement ratio can control over two opposing, yet desirable properties which are strength and workability (Neville, 2005).

In general the waste water contains dissolved solids which include sulfates and hydroxides from cement, chlorides from the use of calcium chloride as an admixture, oil and grease from the equipment, and small quantities of other chemicals associated with hydration of Portland cement and derivatives from chemical admixtures (Sivakumar, 2008).

The composition of wastewater varies widely such as pathogens, bacteria, organic and inorganic materials, microorganism, gases, emulsion and toxins. The quality of wastewater can be determined by using the wastewater quality indicator such as the Biochemical Oxygen Demand (BOD) and the Chemical Oxygen Demand (COD) to obtain the relative oxygen-depletion effect of a waste contaminant. Both have been widely adopted as a measure of pollution effect. The BOD test measures the oxygen demand of biodegradable pollutants whereas the COD test measures the oxygen demand of biogradable pollutants plus the oxygen demand of non-biodegradable oxidizable pollutant. The suitable wastewater which is fulfill the requirement needed can replace the potable water function as the concrete mixing water. In this situation the clean water source can be reserved for the other important usage (Hassan, 2005).

1.2 Problem Statement

Water scarcity and water pollution are some of the crucial issues in the world. One of the ways to reduce the impact of water scarcity and pollution is to expand water and wastewater reuse. It is a common practice to discharge untreated sewage directly into bodies of water or put onto agricultural land, causing significant health and economic risks. Nowadays, batik industries will be grown following the market request. Because of that, the waste water from that batik industry will increase then can give a bad effect to environment impact such as water pollution. As an alternative to solve this problem sewage water (water waste textiles) is use as water replacement in concrete and behavior of concrete will be investigated

Therefore, Malaysia as a developing country should be aware about this issue from now on and start to consider the alternative of wastewater reuse to avoid any possible effect to human health and the environment in the future besides to preserve the clean water supply. So industries should be encouraged to invest in better water efficiency, more recycling and management for clean water conservation. Industrial water reuse has the following specific benefits, in addition to reduction in water consumption and pollution load to the environment (Florio, 2003). The reasons for establishing a waste water reuse program is to identify new water sources for increasing water demand and economical ways to meet increasingly more stringent discharge standards. Textile wastewater includes a large variety of dyes and chemicals additions that make the environmental challenge for textile industry not only as liquid waste but also in its chemical composition

Major pollutants in textile wastewaters are high suspended solids, chemical oxygen demand, heat, colour, acidity, and other soluble substances (Dae-Hee et al., 1999). The removal of colour from textile industry and dyestuff manufacturing industry wastewaters represents a major environmental concern. In addition, only 47% of 87 of dyestuff are biodegradable. It has been documented that residual colour is usually due to insoluble dyes which have low biodegradability as reactive blue 21, direct blue 80 and vat violet with COD/BOD ratio of 59.0, 17.7, and 10.8, respectively (Hassan, 2005).

Nowadays, the clean water supplies are still available, however in the future the scarcity of the clean water supplies will become the world's crisis if the possible alternatives are not taken into consideration. This is the main reason why the potential of textile wastewater reuse should be explored and be applied wisely in every aspect that possible.

1.3 The Objective of Study

The study is carried out to achieve the following objectives:

I. To determine the quality of wastewater sample.
II. To determine the value of compressive strength and flexural strength of concrete with different percentage of waste water replacement.
III. To investigate the effect of waste water to the strength and durability of concrete.

1.4 The Scope of Study

The concrete samples which will be mixed with the domestic wastewater (textile waste) will be prepared at the Concrete Laboratory. The test to the concrete samples will also be carried out at the laboratory to determine the quality of the concrete with the domestic wastewater as the concrete mixing water. Before that, the wastewater samples will be tested to determine the composition and the quality whether they are fulfill the requirement of concrete mixing water or not.

The concrete samples of grades C30 with partially water replacement the textile of waste water will be prepared. The percentage of textile waste water 0%,15% and 20%. The sizes of specimen are 150mm × 150mm × 150mm cube for compressive strength test and 100mm × 100mm × 500mm prism for flexural strength test. The testing will be carried out at the age of 7 and 28 day for all batches. The scope is related to the material and equipments that involved in this study and fulfill the requirement according to standard BS 1881: Part 116:1983: Concrete Compression Test and ASTM C 78 - 08: Concrete Flexural Test and BS 3148:1980: Water for making concrete (including notes on the suitability of the water).

1.5 Significant of Study

Although the industrial batik in this country is grown following the market required but textile wastewater reuse is not be used for to commercial. The application in construction area especially in Malaysia is still cannot be determined. Therefore, by conducting this study the potential of the wastewater reuse can be further investigated and contribute to expand the application of the wastewater reuse. Besides, the study can help to promote the new alternatives to use the wastewater in the industrial sector thus; will probably lead to water pollution diminution. Therefore wastewater reuse has a big potential to bring about environmental, economic and financial benefits. Finally, the data obtained during the research can be applied or used as a reference in future research to improve the outcome obtained.

CHAPTER 2

LITERATURE REVIEW

2.1 Introduction

This chapter will discuss more about the textile wastewater, the textile wastewater reuse, the strength and weakness of concrete and also the concrete mixing water requirements.

2.2 Concrete

Concrete is the most widely used man-made construction material in the world, and is second only to water as the most utilized substance on the planet. It is obtained by mixing cementitious materials, water and aggregates (and sometimes admixtures) in required proportions. The mixture when placed in forms and allowed to cure hardens into rock-like mass known as concrete (Gambhir, 2004).

The hardening is caused by chemical reaction between water and cement and it continues for a long time, and consequently the concrete grows stronger with age. The hardened concrete may also be considered as an artificial stone in which the voids of larger particles (coarse aggregate) are filled by the smaller particles (fine aggregate) and the voids of fine aggregate s are filled with cement. In a concrete mix the cementitious material and water form a paste called cement-water paste which in addition to filling the voids of fine aggregate, coats the surface of fine and coarse aggregates and bind them together as it cures, thereby cementing the particles of the aggregates together in a compact mass (Gambhir, 2004).

The major factors responsible for wide usage of cement-concrete are mouldability, early hardening, and high early compressive strength, development of desired properties with admixture to be used in adverse situations, pumpability and durability. These are simple reasons for its extensive use in the construction within a wide range by using appropriate ingredients and by special mechanical, physical and chemical processing techniques.

2.2.1 Properties of Concrete

During hydration and hardening, concrete needs to develop certain physical and chemical properties. Among other qualities, mechanical strength, low moisture permeability, and chemical and volumetric stability are necessary.

2.2.1.1 Workability

Workability is the ability of a fresh (plastic) concrete mix to fill the form/mold properly with the desired work (vibration) and without reducing the concrete's quality. Workability depends on water content, aggregate (shape and size distribution), cementations content and age (level of hydration), and can be modified by adding chemical admixtures. Raising the water content or adding chemical admixtures will increase concrete workability. Excessive water will lead to increased bleeding (surface water) and/or segregation of aggregates (when the cement and aggregates start to separate), with the resulting concrete having reduced quality. The use of an aggregate with an undesirable gradation can result in a very harsh mix design with a very low slump, which cannot be readily made more workable by addition of reasonable amounts of water.

Workability can be measured by the slump test, a simplistic measure of the plasticity of a fresh batch of concrete following the ASTM C 143 or EN 12350-2 test standards. Slump is normally measured by filling an "Abrams cone" with a sample from a fresh batch of concrete. The cone is placed with the wide end down onto a level, non-absorptive surface. It is then filled in three layers of equal volume, with each layer being tamped with a steel rod in order to consolidate the layer. When the cone is carefully lifted off, the enclosed material will slump a certain amount due to gravity. A relatively dry sample will slump very little, having a slump value of one or two inches (25 or 50 mm). A relatively wet concrete sample may slump as much as six or seven inches (150 to 175 mm).

2.2.1.2 Strength

Concrete has relatively high compressive strength, but significantly lower tensile strength. It is fair to assume that a concrete sample's tensile strength is about 15%- 20% of its compressive strength. As a result, without compensating, concrete would almost always fail from tensile stresses even when loaded in compression. The practical implication of this is that concrete elements subjected to tensile stresses must be reinforced with materials that are strong in tension (Neville, 2005).

The ultimate strength of concrete is influenced by the water-cement ratio (w/c) the design constituents, and the mixing, placement and curing methods employed. All things being equal, concrete with a lower water-cement (cementations) ratio makes a stronger concrete than that with a higher ratio. The total quantity of cementations materials can affect strength, water demand, shrinkage, abrasion resistance and density.

All concrete will crack independent of whether or not it has sufficient compressive strength (Neville, 2005).

In fact, high Portland cement content mixtures actually crack earlier due to increased hydration rate. As concrete transforms from its plastic state, hydrating to a solid, the material undergoes shrinkage. Plastic shrinkage cracks can occur soon after placement; but if the evaporation rate is high, they often can actually occur during finishing operations for example in hot weather or a breezy day. In very high strength concrete mixtures greater than 10,000 psi, the crushing strength of the aggregate can be a limiting factor to the ultimate compressive strength. In lean concretes with a high water-cement ratio the crushing strength of the aggregates is not so significant.

Experimentation with various mix designs begins by specifying desired workability as defined by a given slump, durability requirements taking into consideration the weather exposure conditions (freeze-thaw) to which the concrete will be exposed in service, and finally the required 28 day compressive strength, as determined by properly molded standard-cured cylinder samples. The characteristics of the cementations content, coarse and fine aggregates, and chemical admixtures determine the water demand of the mix in order to achieve the desired workability. The 28 day compressive strength is obtained by determination of the correct amount of cementations (and often chemical admixtures) to achieve the target water-cementations ratio. Compressive strength is widely used for specification requirement and quality control of concrete (Neville, 2005).

2.2.1.3 Curing

As the cement requires time to fully hydrate before it acquires strength and hardness, concrete must be cured once it has been placed and achieved initial setting. Curing is the process of keeping concrete under a specific environmental condition until hydration is relatively complete. Good curing is typically considered to provide a moist environment and control temperature.

A moist environment promotes hydration, since increased hydration lowers permeability and increases strength resulting in a higher quality material. Allowing the concrete surface to dry out excessively can result in tensile stresses, which the still-hydrating interior cannot withstand, causing the concrete to crack. Also, the amount of heat generated by the exothermic chemical process of hydration can be problematic for very large placements. Allowing the concrete to freeze in cold climates before the curing is complete will interrupt the hydration process, reducing the concrete strength and leading to scaling and other damage or failure.

The effects of curing are primarily a function of geometry (the relation between exposed surface area and volume), the permeability of the concrete, curing time, and curing history. Improper curing can lead to several serviceability problems including cracking, increased scaling, and reduced abrasion resistance. (Pierce, 2000).

2.3 Concrete Mixture

Thorough mixing is essential for the production of uniform, high quality concrete. Therefore, equipment and methods should be capable of effectively mixing concrete materials containing the largest specified aggregate to produce uniform mixtures of the lowest slump practical for the work (Gambhir, 2004).

2.3.1 Cement

Portland cement is the most common type of cement in general usage. It is a basic ingredient of concrete, mortar and plaster. English engineer Joseph Aspin patented Portland cement in 1824; it was named because of its similarity in color to Portland limestone, quarried from the English Isle of Portland and used extensively in London architecture. It consists of a mixture of oxides of calcium, silicon and aluminums. Portland cement and similar materials are made by heating limestone (a source of calcium) with clay, and grinding this product (called clinker) with a source of sulfate (most commonly gypsum). When mixed with water, the resulting powder will become a hydrated solid over time (Blackledge, 1999).

High temperature applications, such as masonry ovens and the like, generally require the use of refractory cement; concretes based on Portland cement can be damaged or destroyed by elevated temperatures, but refractory concretes are better able to withstand such conditions (Blackledge, 1999).

2.3.2 Aggregates

The water and cement paste hardens and develops strength over time. Both fine and coarse aggregates are used to make up the bulk of a concrete mixture. Sand, natural gravel and crushed stone are mainly used for this purpose. However, it is increasingly common for recycled aggregates (from construction, demolition and excavation waste) to be used as partial replacements of natural aggregates, while a number of manufactured aggregates, including air-cooled blast furnace slag and bottom ash are also permitted. Decorative stones such as quartzite, small river stones or crushed glass are sometimes added to the surface of concrete for a decorative "exposed aggregate" finish, popular among landscape designers (Gambhir, 2004).

2.3.3 Water

Potable water can be used for manufacturing concrete. The water/cement ratio is the key factor that determines the strength of concrete. A lower w/c ratio will yield a concrete which is stronger and more durable, while a higher w/c ratio yields a concrete with a larger slump, so it may be placed more easily. Cement paste is the material formed by combination of water and cementations materials; that part of the concrete which is not aggregate or reinforcing. The workability or consistency is affected by the water content, the amount of cement paste in the overall mix and the physical characteristics such as maximum size, shape, and grading of the aggregates (Seeley, 1995).

2.4 Textile Wastewater

Generally, the textile industry is very water intensive. Treatment of wastewater is one of the biggest problems faced by textile manufacturers. Textile industry is one of the most important and rapidly developing industrial sectors in Malaysia. It has a high importance in terms of its environmental impact, since it consumes considerably high amounts of processed water and produces highly polluted discharge water in large amounts. The textile wastewater from batik manufacturing is so much and can give more effect to human health and for our environment (Florio, 2003)

2.4.1 Definition of Textile Wastewater

Water is used for cleaning the raw material and for many flushing steps during the whole production. Produced waste water has to be cleaned from, wax, oil, colour and other chemicals, which are used during the several production steps. That also can