THE EFFECT OF SUGARCANE BAGASSE AS NATURAL ADMIXTURE TO PROLONG CONCRETE SETTING TIME

NORITA BINTI RIDZUAN

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NORITA BINTI RIDZUAN

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ABSTRACT

In construction activity, concrete need to be mixed with chemical retarder to prolong the setting time for the usage of transportation and limited pouring time especially in the area that far from concrete plant. Chemical retarder has been put to retard the hardened process. According to Building Specification 2015 by the Jabatan Kerja Raya Malaysia, concrete can set or hardened in 2 hours. There are three objectives in this research, which the first objective is to evaluate the usage of sugarcane bagasse in changing mechanical properties, second objective to determine the optimum content of sugarcane bagasse for the concrete setting time and third objective to determine the perception of industry the application of sugarcane bagasse in the ready mix concrete. A few samples were prepared from the sugarcane bagasse in 1%, 3% and 5% by weight of cement. By using Vicat apparatus for a penetration test, it can compare the time taken between normal mortar and mortar with sugarcane bagasse to set. 1% of sugarcane bagasse was used as an optimal percentage with the strength of concrete is higher than control sample for 28 days and 6 month. In addition, the setting time in penetration test for 1% of sugarcane bagasse also exceeded the control sample for 4 hours. This product will promote the sustainable waste material as non chemical admixture in concrete as a retarder.

ABSTRAK

Dalam aktiviti pembinaan, konkrit dicampurkan dengan perencat kimia bertujuan untuk memanjangkan masa tetapan penggunaan pengangkutan dan masa mencurah adalah terhad terutamanya di kawasan yang jauh dari kilang konkrit. Perencat kimia dimasukkan untuk melambatkan proses pengerasan. Menurut Spesifikasi Membina 2015 oleh Jabatan Kerja Raya Malaysia, konkrit boleh menetapkan masa atau mengeras dalam masa 2 jam. Terdapat tiga objektif dalam kajian ini, objektif pertama adalah untuk menilai penggunaan hampas tebu dalam mengubah sifat-sifat mekanik, objektif kedua untuk menentukan kandungan optimum hampas tebu untuk masa penetapan konkrit dan objektif ketiga untuk menentukan persepsi industri penggunaan hampas tebu dalam konkrit campuran siap. Beberapa sampel telah disediakan daripada hampas tebu iaitu 1%, 3% dan 5% mengikut berat simen. Dengan menggunakan peralatan Vicat untuk ujian penembusan, ia boleh membandingkan masa yang diambil antara mortar biasa dan mortar campuran hampas tebu untuk penetapan masa. 1% daripada hampas tebu digunakan sebagai peratusan optimum dengan kekuatan konkrit adalah lebih tinggi daripada sampel kawalan untuk 28 hari dan 6 bulan. Di samping itu, masa tetapan dalam ujian penembusan untuk 1% daripada hampas tebu juga melebihi sampel kawalan selama 4 jam. Produk ini akan menggalakkan bahan buangan sebagai bahan tambah bukan kimia di dalam konkrit sebagai perencat.

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This thesis was submitted to the Senate of Universiti Pertahanan Nasional Malaysia and has been accepted as fulfilment of the requirement for the degree of **Master of Science (Civil Engineering).** The Supervisor was as follows.

MUHAMAD AZANI BIN YAHYA

Department of Civil Engineering

Faculty of Engineering

Universiti Pertahanan Nasional Malaysia

UNIVERSITI PERTAHANAN NASIONAL MALAYSIA

DECLARATION OF THESIS

Author's full name : NORITA BINTI RIDZUAN

Date of birth : 10 JUNE 1989

Title : THE EFFECT OF SUGARCANE BAGASSE AS NATURAL ADMIXTURE TO PROLONG CONCRETE SETTING TIME

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TABLE OF CONTENTS

LIST OF ABBREVIATIONS

ASTM	American Society for Testing Materials
UPNM	Universiti Pertahanan Nasional Malaysia
JKR	Jabatan Kerja Raya Malaysia
BS	British Standard
DOE	Department of Environment
IS	Indian Standard
MS	Malaysian Standard
AFFD	Agriculture, Forestry and Fisheries Department
AD	Agricultural Department
AAS	Atomic Absorption Spectrophotometry
CS1	Construction Standard 1
C_3S	Tricalcium Silicate
C_2S	Dicalcium Silicate
C_3A	Tricalcium Aluminate
C_4AF	Tetracalcium Aluminate Ferrite
C	Calcium
S	Silicate
H	Hydrate
OPC	Ordinary Portland Cement

LIST OF FIGURES

LIST OF TABLES

CHAPTER 1

INTRODUCTION

1.1 Background study

For many years, lime, cement, fine aggregates (sand), coarse aggregate and brick have been used as materials in constructions. Among these construction materials, lime has been a binder which has been used in building construction for a long time. It is usually used in the mortar mix to bind the bricks, plastering and paintings. Next, an important material in the construction industry is cement which is a manufactured substance that is produced by burning a mixture of limestone and clay. This material has the properties of adhesion and cohesiveness, which allows the cement to act as a binder and this, is the process in binding bricks in the construction of the walls. Sand or stone fragments of a size less than 5mm is considered as a fine aggregate, this includes sand from the mine and the river. Fine aggregate is needed to be graded by using sieve filtration. The impurities in the fine aggregate and sand will affect the strength of concrete. Coarse aggregate sand consists of fragments of stone

size greater than 5mm and not more than 50mm. It is obtained from mines or stone quarries and crushed by machinery and then graded according to specific purposes. Coarse aggregates are hard, dense and durable which will produce a high-quality concrete. Another important material in the construction industries is brick, which is a popular material in the construction of walls, stairs, columns and many others. Brick is mainly made from clay, sand, lime and cement.

There are many materials used in the construction of buildings such as concrete, steel and timber. Although building technology has advanced with new techniques introduced in the construction industries, but the use of concrete is still the option for developers in Malaysia, to build the main structures of buildings and bridges. There are many types of concrete available, followed by the proportion of the main ingredients such as aggregate, sand, cement and water. Cement can suddenly become harden when left exposed to the environment. It will bind other materials together. The important use of cement is to form a strong building material when combined with aggregate. The condition of temperature in Malaysia could make cement change to stiffness and hardens gradually when mixed with water. The term, stiffness is also known as a setting time. According to Neville (1996), this is the term used to describe the stiffening of the cement paste, although the definition of the stiffness of the paste which is considered to set arbitrarily.

Basically, concrete mix is designed in accordance with the usage and design criteria. Two methods are adopted to test concrete in either wet or dry condition. According to Bazid and Bulent (2002), when the temperature of cement mortar with a water cement (w/c) ratio of 0.6 is increased from 27.8˚C to 45.5˚C, both the initial and final setting times are nearly halved. In doing so, some processes need to be

avoided, such as delay in supply and placing the concrete. Some problems were detected in the concrete mix such as the formation of cold joints, plastic shrinkage cracks, decrease of durability and decrease in ultimate strength of concrete.

Chemical admixtures were added into the concrete at the mixing stage to modify some properties of the concrete mix, accordingly to the needs of the user. The common reason for using the admixture in the concrete mix is to increase workability without adding or changing the water content, to adjust the setting time of concrete and to increase the strength of concrete. Each admixture has its own function that focuses on a specific need and has been developed independently.

According to JKR of Malaysia (2015) clause 4.7.1.1, around two (2) hours after adding the cement to water and the dry aggregates in concrete mixer, each batch shall be placed and compacted. Proper time for concreting process is very important, especially to provide the optimum concrete strength. According to ASTM (1982), an admixture is a material other than water, aggregates, hydraulic cement and fibre reinforcement, used as an ingredient of concrete or mortar and added to a batch before or during mixing. A retarder is an admixture that retards the setting of cement concrete, mortar or grout.

The composition in retarding admixture can be divided into groups based on their chemical content. According to IS 9103 (1999), the main ingredients of retarders are four groups. Which the first group is lingo-sulphonic acids, second group is hydro-carboxylic acids, third group is carbohydrates and fourth group is inorganic salts based on fluoride, phosphates, oxides, borax and magnesium salts. The sugarcane bagasse belongs to a third group because the major content in sugarcane is carbohydrate from the photosynthesis process.

Sucrose is the main ingredient found in sugarcane, it is used as a sweetener in the food industry. In Brazil, the sugarcane industry produced ethanol on a large scale as a result of the cane marinade. According to Batta and Singh (1996), sucrose, glucose, and fructose are the only free sugars detected in leaf (source) and stem (sink) tissues of sugarcane. The sugar found in sugarcane can act as a natural retarder because of the main content of the chemical retarder is sucrose. According to Lea (1988), sugar belongs to the type of retarders that can hold upsetting and hardening indefinitely and called it 'cement destroyers' because sugar reacts with the cement and slows down the hydration process of concrete. But use of sugar content in the concrete must be in accordance with the correct proportion. If less amount of sugar is used in the concrete, it can cause the sugar to act as a retarder but, if more sugar is used in concrete, it can cause the sugar to act as an accelerator.

1.2 Problem statement

Common materials for concrete mixture are water, cement, sand and aggregate. The concrete mixture follows a fixed ratio to produce the required grade of concrete to be used. According to BS 8110, it is the specification for the structural use of concrete in buildings and structures. Many researchers have been found to reduce costs in the construction and to preserve the quality of concrete during the mixing process. By transporting, placing and curing in different weather condition can produce a more flexible concrete with external factors. These external factors may influence the hardening of concrete and need to identify the precise material that can be added into the concrete to get an optimum strength of concrete. Normally, the concrete will begin to harden after two hours. Hence, within two hours, the process

of pouring the cement and compacting the concrete need to be completed to avoid the hardening process. Any delay in the process can affect the quality of the concrete. Besides, it also can affect the ethical concrete mixer truck drivers, who need to exceed the speed limit because they have to arrive early at the construction site, if not the concrete order will be cancelled. These are the problems that will occur when concrete start to harden after two hours. To solve these problems the retarder is needed to prolong the setting time.

According to ASTM C 494-92, the main purpose of type B (retarding) is to slow down the hardening process that occurs in the fresh concrete. This is because there are several factors that speed up the process, such as hot weather. The other factors of contingency such as traffic jams and distance from the concrete plant to the construction site can affect the travelling time. These can cause the concrete to harden before reaching the destination. For example, if the supply chain and pouring process are more than two hours, the use of retarder as an admixture in concrete is needed to prolong the process of hardening of the concrete. There are many chemical retarders already commercialized in the markets. The materials needed for the production of chemical retarder are difficult to get. Therefore, the best option would be to use the natural retarder as an alternative in selecting the concrete retarder. Sugarcane bagasse, the natural waste material can be utilized as the natural retarder. Normally, sugarcane bagasse is thrown away after the juice has been extracted from it. Many people unnoticed that sugarcane bagasse still contains sucrose, which allows it to be used as a green retarder. Besides, it is easily available in Malaysia.

1.3 Objectives of research

The objectives of the research are,

i. To evaluate the usage of sugarcane bagasse in changing mechanical properties of fresh and harden concrete;

ii. To determine the optimum content of sugarcane bagasse for the concrete setting time;

iii. To determine the perception of industry the application of sugarcane bagasse in the ready mix concrete.

1.4 Significance of research

The main significance in this study is to use sugarcane bagasse in the concrete mix as concrete retarder. It is also to obtain the effect of sucrose level in the sugarcane bagasse for concrete setting time. Sugarcane bagasse is used to act as a natural retarder and to replace the chemical retarder in concrete mix. Many of the natural waste materials that can be used as an admixture in the concrete such as rice husk, palm kernel shell, pineapple husk and sugarcane bagasse. In general, natural waste materials can only be used for the strength of the concrete and cement replacement, but sugarcane bagasse was chosen to be used as a concrete retarder because of the sugar content which is capable of slowing down the hardening process of the concrete. The content is similar to the chemical retarder. With the existence of the sugar which reacts with the cement has an effect on the concrete hardening process. Besides, the use of sugarcane bagasse as a natural retarder, it can also save the cost of using chemical retarder. Sugarcane bagasse can easily be found in the stalls selling sugarcane juice without any cost. Apart from that, it is suitable for small projects because a small quantity of natural retarder used can easily get compared to chemical retarder. It also can be used on a smaller portion at a particular rate. Besides, it can improve the supply chain management. On the other hand, by using sugarcane bagasse in the construction industry will save the environment from the air pollution. Sugarcane bagasse that has been exposed for too long will eventually produce leach and cause water pollution. Under rainy condition, the situation will get worse if sugarcane bagasse was not cleaned.

1.5 Scope of research

The scope of this work begins with the sample preparation. The sample sugarcane bagasse is available in stalls that sell sugarcane juice in Sg Besi, Kuala Lumpur. The type of sugarcane in the Sg Besi is the yellow sugarcane. The sample of sugarcane bagasse will be grind by chopper machine and sieve by the mechanical sieve shaker to control the size of sugarcane bagasse powder through the 2mm size of sieve. Sample will be divided 1%, 3% and 5% of sugarcane bagasse by cement weight. Concrete grade 30Mpa will be used to provide a control sample, samples with sugarcane bagasse and sample with chemical retarder. The tests were conducted on all samples after 28 days and 6 months.

The tests to be performed are compressive strength test, split tensile test and flexural strength test to achieve the first objective. The compressive strength test can be done for a minimum curing concrete of 28 days. This concrete must be achieved at least 70% of compressive strength of 30N/mm^2. The compressive strength test according to BS 1881: Part 108: 1983 Standard is conducted to measure the strength of concrete. The tensile splitting test follows the BS 1881: Part 1771: 1983 Standard to determine the forces needed to split the concrete and according to BS 1881: Part 118: 1983 Standard, the flexural strength test is conducted. This test measures the maximum load that can be bent by the concrete in terms of the bending.

To achieve the second objective, the penetration test was conducted by referring to ASTM C403/C403M-8 standard test for time of setting by using Vicat apparatus. The level of needle penetration will show the setting time for the concrete mix.

To achieve the third objective that is to determine the perception of industry the application of sugarcane bagasse in the ready mix concrete, the penetration test was conduct by using concrete mix design from the industry and distribute survey questionnaire forms to the industry.

This research will promote the sustainable waste material as non-chemical adding material for concrete in prolonging the concrete setting time. It also promotes the usage of sustainable material in building construction practice.

1.6 Organisation of research

This thesis is divided into five chapters. Chapter 1 gives an introduction on this research and all the objectives which have been derived from the problem statement. This chapter include the methodology used in research, the significant of the research and scope of the research.

Chapter 2 consists of the overview of the natural material that will be used in this research which is sugarcane bagasse. The research is about the usage of sugarcane bagasse as a natural retarder in the concrete mix to prolong the setting time based on the previous research. The literature review for the mechanical properties test of the sugarcane bagasse also based on previous research conducted.

Chapter 3 shows the methodology and materials that are used in this research. A specific approach in conducting the experimental works, preparation of materials and design mix is planned accordingly.