SUGARCANE BAGASSE ASH AS REPLACEMENT OF CEMENT IN MORTAR

SYAZWANA BT MOHD SUKRI

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ABSTRACT

Mortar was consisted of Ordinary Portland Cement (OPC), fine aggregates and water. Blended cement contain pozzolanic reaction cement due to the present of pozzolanic materials like sugarcane bagasse ash (SCBA), fly ash ,palm oil fuel ash(POFA) and others. In this research the blended cement used was made up of SCBA. Bagasse is the fibrous residue of sugarcane after crushing and extraction of juice. In sugarcane bagasse it made up of water (about 50 percent), fiber (above 48 percent) and also some small amount of soluble solids. Mostly, bagasse produced is burnt for energy needed for sugar processing .The use of sugarcane bagasse ash (SCBA) as cement replacement material to improves quality and reduce the cost of construction material such as mortar and concrete pavers. In this research, laboratory testing includes tests to determine the compressive strength of mortar containing sugarcane bagasse ash replace the Portland cement with different rates 0%, 5%,10% and 15%. Portland cement will be used for all samples and mixtures. The project expected to get the result compressive strength by using sugarcane bagasse ash (SCBA) as replacement of cements in mortar. This testing is needed to know whether the strength can be acceptable or not when follow ASTM mix design standard. Secondly, this research was to know the porosity of mortar when replaced with different proportion of sugarcane bagasse ash with cement. The porosity test will help to know the porous of the samples when placed in differences condition.

ABSTRAK

Mortar berasal daripada simen Portland biasa (OPC), agregat halus dan air. Simen dicampur mengandungi simen reaksi pozzolanic ,antara bahan pozzolanic seperti hampas tebu tebu abu (SCBA), terbang abu, minyak kelapa sawit abu (POFA) dan lain-lain. Dalam kajian ini simen dicampur dengan menggunakan SCBA. Hampas tebu adalah baki berserabut tebu selepas menghancurkan dan pengeluaran jus. Dalam hampas tebu tebu ia terdiri daripada air (kira-kira 50 peratus), serat (melebihi 48 peratus) dan juga sedikit jumlah pepejal larut. Kebanyakannya, hampas tebu yang dihasilkan adalah dibakar untuk tenaga yang diperlukan untuk pemprosesan gula. Penggunaan hampas tebu tebu abu (SCBA) sebagai simen penggantian bahan untuk meningkatkan kualiti dan mengurangkan kos bahan binaan seperti mortar dan pavers konkrit. Dalam kajian ini, ujian makmal termasuk ujian untuk menentukan kekuatan mampatan mortar yang mengandungi hampas tebu tebu abu menggantikan simen Portland dengan kadar yang berbeza 0%, 5%, 10% dan 15%. Portland simen akan digunakan untuk semua sampel dan campuran. Projek ini dijangka untuk mendapatkan kekuatan mampatan hasil dengan menggunakan hampas tebu tebu abu (SCBA) sebagai pengganti simen dalam mortar. Ujian ini diperlukan untuk mengetahui sama ada kekuatan yang boleh diterima atau tidak apabila mengikuti ASTM campuran standard reka bentuk. Kedua, kajian ini adalah untuk mengetahui keliangan mortar apabila digantikan dengan bahagian yang berbeza daripada tebu hampas tebu abu dengan simen. Ujian keliangan akan membantu untuk mengetahui berliang sampel apabila diletakkan dalam keadaan perbezaan.

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LIST OF ABBREVIATIONS

ASTM	American Society for Testing and Materials
SCBA	Sugarcane Bagasse Ash
OPC	Ordinary Portland Cement

CHAPTER 1

INTRODUCTION

1.1 INTRODUCTION

Civil engineering practice and construction works around the world depend to a very large extent on concrete. Mortar is one of the construction material that made by mixing of cement, fine aggregates and water in the proper proportions.

Bagasse is the fibrous residue of sugarcane after crushing and extraction of juice. In sugarcane bagasse it made up of water (about 50 percent), fiber (above 48 percent) and also some small amount of soluble solids. Mostly, bagasse produced is burnt for energy needed for sugar processing .The use of sugarcane bagasse ash (SCBA) as cement replacement material to improves quality and reduce the cost of construction material such as mortar and concrete pavers.

Beside, by using this replacement in Portland cement also to avoid environmental pollution and to economize the use of cement. Each of these concrete contribute the strength to it possess. Seven percent of world carbon dioxide coming up from Portland cements industry. Portland cement manufacture can cause environmental impacts at all stages of the process. These include release of airborne pollution in the form of dust, gases, noise and vibration when operating machinery and during blasting in quarries, consumption of large quantities of fuel during manufacture. The CO2 release from the raw materials during manufacture, and will damage the countryside from quarrying.

Since the prices of cement are increases, there is the need to search for local materials as alternatives for the construction of functional but low cost buildings in both the rural and urban areas. The important of this research is to help reduce the cost of cement and reduce the volume of solid waste generated from bagasse ash in concrete. So this will economize the using of Portland cement in construction.

Portland cement is one of the important gradients in mortar. From my reading of journal, the current cement production rate of the world is approximately 1.2 billion tons/year. In this bagasse ash have the pozzolanic properties, so they will impact technical advantages to the resulting concrete and also enable large quantities of cement replacement to be achieved.

The popularity of the concrete is due to the common ingredients, it is possible to tailor the properties of concrete to meet the demands of any particular situation. Among the various properties of concrete, its compressive strength is considered to be the most important and is taken as a measure of its overall quality.

The strength of mortar is defined as resistance to its failure against a system of loading. The strength of mortar is measured in various ways depending on loading pattern such as compressive strength, flexure test, bond strength and resistance to abrasion. In this test only include compressive and porosity test.

Compressive strengths are the resistance of the mortar to crushing. The compressive strength of cement mortar mainly depends on the type, quality and quantity of cement, the type, size, shape , strength and grading of aggregates, the water cement ratio, the degree of workability and compaction, the type ,quality and age of curing.

In this chapter will discuss about the problem statement of the research, objective of the study, the scope of study, significance of study and lastly is conclusion. All of this will make more detail to know about the research.

1.2 PROBLEM STATEMENT

Nowadays, the increasing of using Portland cement in making mortar will affect the environment when the pollution occurs. So with the replacement of sugarcane bagasse ash will help to reduce the problem. If many of construction use this type of materials, the request for use Portland cement will decrease.

As we know the amount of cement use more in construction that will make release of carbon dioxide that will affect the environmental pollution & the wastage of sugarcane bagasse will increase from year to year. Although Malaysian still do not practice this way of replacement sugarcane bagasse ash with cement, but it is not impossible that one day Malaysia will adopt this method because the current situation show the waste of sugarcane bagasse increase around the world.

1.3 OBJECTIVE OF STUDY

Firstly, to study the strength of mortar by did testing of compressive strength by using sugarcane bagasse ash (SCBA) as replacement of cements in mortar. This testing is needed to know whether the strength can be acceptable or not when follow mix design standard.

Secondly, this research was to know the porosity of mortar when replaced with different proportion of sugarcane bagasse ash with cement. The porosity test will help to know the porous of the samples when placed in differences condition.

1.4 SCOPE OF STUDY

In this research, laboratory testing includes tests to determine the compressive strength of mortar containing sugarcane bagasse ash replace the Portland cement with different rates 0%, 5%,10% and 15%. Portland cement will be used for all samples and mixtures.

Compressive test specimen size of mortar in cube size is (50mm*50mm*50mm). After that the sample had been tested after 7, 28 and 60 days of air curing. The porosity test was also observed to know the porous of each sample.

1.5 SIGNIFICANCE OF STUDY

The main interest of this research is to study the suitability of the use sugarcane bagasse ash in mortar. Next the result of compression by using sugarcane bagasse ash can be obtain .Lastly, this study can be used as a guide for others researchers that conducting similar studies

1.6 CONCLUSION

As conclusion the experimental is to know about the strength of mortar by doing compressive strength by replacement of SCBA with cement. Besides, the porosity test is also observed to know the porous samples of mortar. The next chapter is about the previous study and standard that relate to this study.

CHAPTER 2

LITERATURE REVIEW

2.1 INTRODUCTION

This chapter discuss about the literature review that had been search and identify related with the title of the project about sugarcane bagasse ash (SCBA). This part of topic is important because to give the information and comparison of subtopic that have large scope related others research. So this will give more clearly flow to continue this research.

In this chapter the sub-topic will be discussed are about mortar and concrete, historical development, advantages, materials, properties of mortar, reactions and application of process that have related and used in mortar .Though discussion about this sub-topic will help to know more details off all things related to this research.

What had been found from previous chapter that had in chapter 1, the aim or objective of the research was to know the compressive strength and also porosity test of all samples. From the last chapter also share about the significance of the research and also the scope of study that give information what is the scope of words influence in the process from starting until the end of process.

2.2 CONCRETE

Based on P.Kumar Mehta and Paulo J.M. Monteiro, concrete is one of the important and widely used in construction. It had been used to make a variety of structure for examples to make pavements, foundations, building structures, parking structures, poles,

footings for gates and so on. Approximately about six billion cubic meters of concrete were produced every year, one cubic meter person on earth. The concrete was analysis to determine soluble silica and calcium oxide contents, and the cement content is calculated from the two determinations. If the two results are within 1 per cent of each other, the mean value is reported. If not, reasons for the discrepancy are investigated. If a reason is found then the preferred value is reported. For example, if the aggregate contains a large proportion of calcareous material, the result based on calcium oxide content may be unreliable, so the result based on soluble silica content is preferred. If no reason is found then the lower value is preferred.

2.2.1 Historical Development of Concrete

Based from R.C.Valore 1954, the first comprehensive about cellular concrete was presented by Valore in 1954 that was summarizing about the composition, properties and function of cellular concrete. The Romans used a primal mix for their concrete. In there have small gravel and coarse sand that have been mixed with hot lime and water, and sometime also consist of animal blood. To trim down shrinkage, they used horsehair. The historical also have been proven from the states of Assyrians and Babylonians that used clay as the bonding material.

2.2.2 Advantages of concrete

Many of the advantage and benefit can be obtained from concrete compare to other materials like steel and timber. Concrete have the characteristic that are high compressive strength and low tensile strength. Besides that, concrete was naturally fire resistance. It was typically qualify for reduced fire resistance rates to 60 percent less on fire. The present of concrete wall and partitions effectively divide the building into compartment will help limiting amount of property damage if fire does occur. Lastly, concrete have a mixture that was feasible and its surface were resistant to freezing and wear. So, it has the chance to live a longer life expectancy.

2.3 MATERIALS OF THE MORTAR

In making concrete design the materials that includes are cement, water, fine aggregates and sugarcane bagasse ash (SBA)

2.3.1 Fine aggregates

According to B.K Baguant and G.T.G. Mohamadbhai, Sugarcane Bagasse Ash can be used as replacement in fine aggregates, even it was for a small quantity, but this will help reduce the crushing of basal rock quarrying and reserve natural coral sand. These replacements for fine aggregates produce a good result for Mauritus when the concrete produce a range of compressive strength up to 70 N/mm 2.

Besides, the authors R.Srinivasan and Sathiya also mention in their journal that the fine aggregates used must give minimum void ratio, higher voids content that suitable for mixing with water as requirement. The size of fine aggregates use were 4.75 mm, bulk density is 1393.16 kg/m3. Lastly, nominal size for fine aggregates is less than 5 mm sand.

2.3.2 Water

According to R.Srinivasan and K.Sathiya , the available for college campus perform for the requirements for water is 456-2000 kg for concreting and curing.

2.3.3 Cement

Based on R.Srinivasan and K.Sathiya , ordinary Portland cement (OPC) has been use in this test as the common cement used in construction building. The Portland cement used is about 80 until 90 percent. But the test use that related to this cement before been use that related to this cement before been used are consistency test , setting test ,soundness test and others.

Refered to R.Srinivasan and K.Sathiya, ordinary Portland cement has been used in this test as common cement used is about 80- 90 percent. But the test use that related to this cement before been used were consistency test, setting test, soundness test and others.

Through M.S. Morsy ,A.M.Rashad and Shebl the cement was used in the research Ordinary Portland Cement by follow ASTM C-50 requirements.

Reported by Asma Abd Elhameed Hussein, Nasir Shafiq and Muhd Fadhil Nuruddin, the way to use the replacement of cement by other material because the cement production consumes high energy and increase release of carbon dioxide to the air.

Lastly, the characteristics from cement a sticky and wet adhesion, then it is solidify, harden and bind the solid into a solid project. Cement also can be divided into two types that are hydraulic and non-hydraulic cement. Function of hydraulic cement is it can solidify and harden when reacting with water such as Portland cement, having silicates and aluminates.

2.3.4 Sugarcane Bagasse Ash (SCBA)

Based on Asma Abd Elhameed Hussein, Nasir Shafiq and Muhd Fadhil Nuruddin ,SCB is the waste come from juice extraction in sugar industry and the factories have produce higher amount of ash.

According to B.K.Baguant and G.T.G. Mohamadbhai Bagasse ash gives energy in sugar factories because this product use for combustion. This bagasse was residue of sugarcane that contains juice through extraction process. In this juice contain water (about 50 percent), fibres(above 48 percent) and some small amount of soluble solids.

Refered to R.Srinivasan and K.Sathiya, the author describe that the sugarcain contain about 50 percent of cellulose, 25 percent of hemicelluloses and 25 percent of lignin. Every ton of sugarcane provides 26 percent of bagasse and 0.62 percent of residual ash. After the combusting the presents of chemical composition that contain silicon dioxide (sio2).

2.4 PROPERTIES OF MORTAR

2.4.1 Durability

Durability always synonymous with a long service life .According to ACI Committee 201, durability Portland cement workers an ability to resist weathering action, chemical attack , abrasion ,or any other process of deterioration(ACI Committee 201, 2002). Based on Gambler presented in 2006, the most durability problems in concrete can be refer from the change of volume in the concrete even though concrete was durable material that require the normal environment (ML Gambler, 2006).

These materials have the tendency as permeable result for capillary voids in cement paste matrix. Garboczi research some theories that relate to microstructural parameters of cement product with either diffusivity (Garboczi et.al. 1990). Normally, the water cement ratio is high with degree of hydration is low.

Based on Asma Abd Elhameed Hussein, Nasir Shafiq and Muhd Fadhil Nuruddin, when the durability is increases by using Sugarcane Bagasse Ash (SCBA) as the replacement in material this will reduce permeability, chloride ion penetration, sulphate attack and heat evolution.

According to B.K.Baguant and G.T.G. Mohamadbhai. 1990, when compare with basalt sand concrete , the initial surface absorption characteristics of bagasse ash not give any character to low durability.

Based on Franco Massazza, the main properties of Portland cement is higher rate of hardening, the main property of pozzolanic cements is the higher resistance to chemical attacks. The most outstanding of which are carbonatiom, leaching, chlorides, sulphates and so on.

2.4.2 Workability

Workability is the physical property of concrete alone without seen to the circumstances of a particular type of construction. Based on Mehta, the consideration for the workability of concrete mixture are the water requirement for a given consistency together between sand and coarse aggregates ratio. To increase the cohesiveness and finish ability of concrete, the proportion fine and coarse aggregates must be increase too (Metha et.al.2006).

P.Kumarh also state that the requirement of high consistency at the time placement, the uses of water-reducing and set-retarding admixture must be consider for workability of concrete mixture. The failure to follow the way to accounted of water to be put into mix proportion will make failure of concrete in design specification (P.Kumar et.al.2006).

Workability is a general term to describe the properties of fresh concrete. It defined as the amount of mechanical work required for full compaction of the concrete without segregation. This characteristic is important the result of final strength was influenced by the degree of compaction. A small increase in void content due to insufficient compaction could lead to a large decease in strength.

2.4.3 Pozzolanic

Based on Asma Abd Elhameed Hussein, Nasir Shafiq and Muhd Fadhil Nuruddin , to enhance of concrete , the addition of other pozzolonic material will help to reduce cost of produced concrete , and disposal the sugar cane bagasse ash beside save the environment.

The ash of SCBA show that 145 completely chemical, which influence the way thath the material function as pozzolanic when mixed with the cement reported by Marcos Oliveira De Souza Rodrigues and Jairo Alexander Osorio Saraz(2008).

According to B.K.Baguant and G.T.G. Mohamadbhai. 1990 the use of bagasse ash in concrete have pozzolana, which as a partial replacement for cement.

Based on Franco Massazza, the term pozzolana have two mening that is firstly about pyroclastic rocks, essentially glassy and sometimes zeolitised. The second meaning was about inorganics materials either natural that have harden in water when mixed with lime or other material which can release calcium hydroxide. Pozzolana is an active phases which thermodynamically unstable in glasses as well as amorphous constituents.

According to H. S. Otuozel, Y. D. Amartey, B. H. Sada, H. A. Ahmed, M. I. Sanni and M. A.Suleiman ,a pozzolana is a material, occurring either normally or artificially, and which contains silica, steel and steel ions. According to ASTM C618 (1992), a pozzolana is defined as a siliceous or siliceous and aluminous material which in itself have little or no cementitious value, but one which in completely divided kind and in the lifestyle of moisture, will substance react with calcium nutrient mineral hydroxide at typical conditions to form ingredients having cementitious features.

2.4.4 Burning Temperature

Based on Asma Abd Elhameed Hussein, Nasir Shafiq and Muhd Fadhil Nuruddin, the authors write that commonly the sugarcane bagasse ash bruning under uncontrolled condition in boilers of the conegeration process, with the high temperature above 800 degree for prolonged time. The ash will contain black particles because the presence of carbon and crystalline silica. When the high rate of heating temperatures is increase, the quality of ash can improved. But to have high amorphous silica, the bagasse ash must be burnt under controlled conditions, so the pozzolanic properties will present.

According to Marcos Oliveira De Paula, LDa D e Fatima Ferreira Tinoco, Conrado De Souza Rodrigeues and Jairo Alexander Osorio Saraz . 2008, sugarcane bagasse was burned 6 hours at temperature, 600 degree after collected by using a store. As the result, a larger light colored ash observed on surface and ash of black color and also heterogenous composition.

Refered to R.Srinivasan and K.Sathiya when the waste of SCBA is controlled condition it will gives ash that made up of amorphous silica that contains pozzolanic properties. The controlled combustion of SCBA, that is –produced from Tamilnadu in India.

2.4.5 Curing Temperature

Based on M.S. Morsy, A.M.Rashad and S. S. Shebl the curing temperature on reaction rate constants was influenced the reaction of rate constants and on the behavior and stability of hydration phases.

Report from Franco Massazza, the mixes proportioned to creates the same 28 day strength, the 1-3 day strength of pozzolana containing concrete.

2.4.6 Pozzolanic reaction

According to Franco Massazza , in pozzolanic activity have parameters which is about the maximum amount of lime that a pozzolana combine with rate of combination occur. Both of the factors were depend on nature of pozzolanas and more precisely on the quality and quantity of the active phases. The overall amounts were depend on nature of the active phases, their content in the pozzolana, their SiO2 content and lastly the lime pozzolana ratio of the mix.

The pozzolanic reaction only can take place after the availability of CaOH that been produced through the occurrence of hydration process. However water is essential to ensure faster hydration process to create a large amount of lime for the occurrence of pozzolanic reaction as well. Formation of additional C-S-H gel would fill the existing voids in concrete thus creating denser concrete. Furthermore, reduction in amount of amount CaOH that is vulnerable to aggressive environment improves the durability of concrete. The finally , increases the strength and durability of this hardened material.

2.4.7 Porosity

Based on Franco Massazza , the total porosity was come from pozzolanic cement is higher than in portland cement pastes manufactured with the same w/c ratio. When porosity value was consider, the experimental results like pore volume measured on 105 degree oven dried specimens was higher than that found in the water specimens from which extracted by solvent replacement.

Based on P.Kumar Mehta and Paulo J.M. Monteiro , In solids, there exists a fundamental inverse relationship between porosity (volume fraction of voids) and strength. Consequently, in multiphase materials such as concrete, the porosity of each component of the microstructure can become strength-limiting. Natural aggregates are generally dense and strong, therefore, it is the porosity of the cement paste matrix as well as the interfacial transition zone between the matrix and coarse aggregate, which usually determines the strength characteristic of normal-weight concrete. Although the water-cement ratio is important in determining the porosity of both the matrix and the interfacial transition zone and hence the strength of concrete, factors such as compaction and curing conditions (degree of cement hydration), aggregate size and mineralogy, admixtures types, specimen geometry and moisture condition, type of stress, and rate of loading can also have an important effect on strength.

2.4.8 Hydration Process

Hydration was the chemical reaction that takes places when the Portland cement and water react together. The heat was generated when the water and cement chemically react is called as heat of hydration. The amount of heat generated dependent upon the chemical composition of cement. Rate of heat generated depends on fineness, chemical composition of cement and curing temperatures. During the hydration process, the first reaction of hydration produced C-S-L gel, and then the second reaction occur which secondary C-S-L gel ,that was production give more stronger the concrete strength.

2.4.9 Permeability

Permeability was considered the most important factor for durability. It can be noticed that higher permeability is usually caused by higher porosity. Therefore a proper curing, sufficient cement, proper compaction and suitable concrete cover could provide a low permeability concrete.

2.4.10 Strength Properties

Based on P.Kumar Mehta and Paulo J.M. Monteiro, the strength of concrete is the property most valued by designers and quality control engineers. In this chapter, the influence of various factors on concrete strength is examined in detail. Since the uniaxial strength in compression is commonly accepted as a general index of the concrete strength, the relationships between the uniaxial compressive strength and other strength types like tensile, flexural, shear, and biaxial strength are discussed.

2.4.11 Compressive Strength

Compressive strength of concrete was the most technical properties of concrete. Sandor reported that the compressive strength is the most suitable to measure a concrete because concrete was used to resist compressive stress (Sandor Popovic, 1998). So, technically compressive strength was a good index number to determine the strength of concrete.

2.5 CONCLUSION

As a conclusion for this chapter, fine aggregates, Ordinary Portland Cement (OPC), Sugarcane Bagasse Ash (SCBA) and water are the materials needed to be used in making samples of mortar. The reaction occurs in this process of age curing and fresh mortar are hydration process and chemical reactions that make the concrete production occurs and more stronger .The consideration towards pozzolanic reaction to occur influence by some factors like fineness of ash, burning temperature under controlled condition , workability of fresh mortar and also its water cement ratio.

The chapter 3 will be discussed more about the method to be used during making sample specimens of mortar from beginning until the end of process. In the next chapter also will make easy to know the flow of the process and how the design of the samples can be calculate. Lastly, in the next chapter also includes an apparatus and test equipment's .All of the apparatus and materials need must be booking with laboratory concrete before start casting.