STRENGTH PERFORMANCE OF BANANA FIBER ASH AS CEMENTITIOUS MATERIAL WITH DIFFERENT TEMPERATURE

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ABSTRACT

Concrete is one of the materials that is widely used in construction all around the world. This material is widely used because it has several benefits such as, more durable, energy-efficient, low maintenance, affordability, fire-resistance, excellent thermal mass and also versatility. This research was conducted to determine the optimum temperature and strength of concrete to produce good cementitious material by using banana fiber ash. Agriculture waste material can help to increase the strength of concrete. The source of natural fibre are found in plant and they are readily environmental friendly and cheap. In addition, natural fiber ash has an excellent potential to improve the performance of concrete. In this study, compressive strength test was conducted to know the strength of concrete with three different temperatures. Banana trunk is cut layer by layer and burn in furnace with three different temperatures that is 400°C, 500°C, and 600°C. A total of 27 cubes with 100mm×100mm×100mm were used to determine the strength of concrete using banana fiber ash. All this specimens is cure for 7 days, 14 days and 28 days using water curing method. 2% of banana fiber ash was replaced with cement by weight. The materials use in this study was banana fibre ash, sand, cement, coarse aggregate, and water. The result analysis shows, The higest temperature obtain in this research was by burned banana ash with 500°C. while the lowest temperature was 600°C when the concrete was curing for 28 days. The lowest the temperature the higher the strength of concrete can be obtained.

ABSTRAK

Konkrit merupakan salah satu bahan yg digunakan di seluruh dunia disebabkan oleh beberapa factor. Diantara faktor yang terdapat pada konkrit adalah ia mempunyai daya ketahanan yang tinggi, kos yang rendah, daya tahan api dan juga mempunyai daya ketahanan yang tinggi. Kajian ini dijalankan untuk menentukan suhu optimum dan kekuatan konkrit menggunakan abu serat pisang bagi menghasilkan konkrit yang lebih berkualiti dari segi kekuatan. Bahan buangan yang berasaskan daripada industri pertanian boleh membantu meningkatkan kualiti konkrit. Serat semula jadi yang terdapat di dalam tumbuhan-tumbuhan ini merupakan bahan yang boleh diklasifikasikan sebagai bahan mesra alam sekitar dan juga mudah untuk didapati. Di samping itu, serat semula jadi juga mempunyai potensi yang sangat baik untuk meningkatkan tahap kekuatan konkrit. Melalui kajian ini, ujian kekuatan mampatan dijalankan untuk mengetahui kekuatan konkrit dengan menggunakan suhu yang berbeza. Batang pisang dipotong lapisan demi lapisan dan dibakar di dalam mesin "furnace" dengan menggunakan tiga suhu yang berbeza iaitu 400°C, 500°C, dan juga 600°C. Sebanyak 27 kiub bersaiz 100mm × 100mm × 100mm telah digunakan. Kesemua kiub ini direndam di dalam air selama 7 hari, 14 hari dan 28 hari dengan menggunakan kaedah pengawetan air. 2% daripada abu pisang telah digantikan dengan simen. Bahan-bahan yang digunakan untuk menghasikan kajian ini adalah dengan menggunakan abu serat pisang, pasir, simen, batu, dan juga air. Melalui kajian ini didapati bahawa dengan membakar abu serat pisang menggunakan suha 500°C akan menghasilkan kekuatan konkrit yang lebih tinggi manakala 600°C akan menghasilkan kekuatan konkrit yang lebih rendah. Semakin rendah suhu pembakaran konkrit, semakin tinggi kekuatan konkrit yang dapat dihasilkan.

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LIST OF ABBREVIATION

Al_2O_3	Aluminium Oxide
ASTM	American Society for Testing and Materials
CaO	Calcium Oxide
°C	Degree Celsius
Fe_2O_3	Iron Oxide
LOI	Loss of Ignition
MgO	Magnesium Oxide
OPC	Ordinary Portland Cement
%	Percent
P_2O_5	Phosphorus Oxide
SiO_2	Silicon Dioxide
Na_2O	Sodium Oxide
SO_3	Sulphur Trioxide

CHAPTER 1

INTRODUCTION

1.1 INTRODUCTION

Concrete is one of the materials that are widely used in construction all around the world. It is used to build schools, buildings, tunnels, apartments, bridges, and more. This material is widely used because it has several benefits such as, more durable, energy-efficient, low maintenance, affordability, fire-resistance, excellent thermal mass and also versatility.

Concrete is consists of four different type of ingredients, that is course aggregate, fine aggregate, Portland cement, and also water. But concrete has its own disadvantages due to considerable brittleness, which results in poor fracture toughness, poor resistance to crack propagation, and low impact strength.

New developments continue in the application of concrete materials. There are many researchers used natural fiber as cementitious material to increase the concrete strength. The investigation has been carried out using several natural fibers as cementitious materials such as, bamboo, jute, banana, hemp and also rice husk. Nowadays, many studies had been done to utilize natural waste as cementitious material replacing Ordinary Portland Cement (OPC). For example, rice husk which have reactive pozzolanic properties (Elizabeth, 2013).

In this research, banana fiber ash was used as cementitious material to produced high strength concrete. Banana fiber ash has its own properties that can be

found in stem itself. It has low density, appropriate stiffness, high disposability, and renewable. (Mukhopadhyay, 2008).

1.2 PROBLEM STATEMENT

Agriculture waste is a raw material for industry nowadays. It does not only economical but also can lead to air pollution such as global warming (R.Srinivasan K. , 2010). Agriculture waste material usually disposed into landfill or dispose by open burning that may lead to air pollution.

This waste material can be used to increase the strength of concrete. The source of natural fiber as cementitious material are found in plant and they are readily environmental friendly as well as cheap. In addition, natural fibers such as banana have an excellent potential to improve the properties of materials, and could be used effectively to improve the performance of concrete.

1.3 OBJECTIVE

The general objective of this study is to investigate the compressive strength of concrete banana fiber as cementitious to produce high strength concrete with different temperature. The specific objectives of this study were:

1) To determine the compressive strength of concrete using banana fiber ash as waste agriculture with various temperature.
2) To determine the chemical properties of banana fiber ash burning with different temperatures as cement replacement.

1.4 SCOPE OF WORK

This study was conducted to investigate the optimum temperature and determine the strength of concrete using banana fiber ash. In addition, natural fiber

ash has an excellent potential to improve the performance of concrete. The scope of work mainly focuses on:

i. In this research, compressive strength test was conducted to determine the strength of concrete with three different temperatures.
ii. Banana trunk was cut layer by layer and burnt in furnace with three different temperatures that is 400°C, 500°C, and 600°C.
iii. A total number of 27 cubes with 100mm×100mm×100mm were used to determine the compressive test as shows in Table 1.1 below.
iv. All this mixture is cured for 7 days, 14 days and 28 days which will be performed at the concrete laboratory of Civil Engineering (FKASA lab) using water curing method.
v. 2% of banana fiber ash was use to replaced the cement by weight.
vi. The materials use in this study were banana fiber ash, sand, cement, coarse aggregate, and water,

Table 1.1: Number of Samples and Test

Temperature		**400°C**			**500°C**			**600°C**		
Test	**Curing (days)**	**7**	**14**	**28**	**7**	**14**	**28**	**7**	**14**	**28**
Compressive Strength Test	Water	3	3	3	3	3	3	3	3	3
Total sample		27 samples								

1.5 SIGNIFICANCE STUDY

This research was conducted to determine the optimum temperature using banana fiber ash as cementitious material. Compressive strength of concrete using banana fiber ash with various temperatures can be increase. Banana fiber ash acts as additive material for concrete mixture using different burning temperature to produce better quality of concrete. In addition, natural fiber ash has an excellent potential to improve the strength and could be used effectively to improve the performance of concrete.

1.6 SUMMARY

This research was conducted through experimentally where all the experimental work was involved in order to investigate the compressive strength of 400°C, 500°C, and 600°C banana fiber ash. There were a lot of advantages using banana fiber ash as cementitious material which has low density, appropriate stiffness, high disposability and renewable (Mukhopadhyay, 2008). Finally, by using agriculture waste product also can save the waste produce from industry as well as save the environment from global warming.

CHAPTER 2

LITERATURE REVIEW

2.1 INTRODUCTIONS

The purpose of this chapter is to study and analyze the previous study that has been done earlier through journals, articles, research papers and also thesis. This chapter will review more detail regarding banana fiber ash, its advantages and analyze more valuable information.

2.2 INTRODUCTION TO CONCRETE

Concrete is widely used in construction industry such as high rise building, bridge, houses, and others due to its durability. The concrete behavior is strong and durable and also produces environmental friendly structure. To obtain environmental friendly concrete, recycling by product such as fly ash is more economical (Naik, 2008) .This concrete is done by mixing the organic material such as cement with water together with natural stones, fine aggregate and also course aggregate. Concrete is done by mixing, batching, transporting, placing, compaction and also curing process.

2.3 CONCRETE MATERIALS

Concrete is the composite material that is compose by mixing several raw materials such as water, cement, course aggregate, fine aggregate and sometimes admixture. This raw material can be found naturally on earth and have several advantages.

According to R.Srinivasan, (2010), the major material used in construction through the world is ordinary Portland cement (OPC). 80 to 90 percent of the total production comes from OPC. OPC was made up from five different raw materials. These are alumina, silica, lime, iron, and also gypsum. This raw material went through three different processes mainly, milling process, manufacturing process, and also burning process.

The most important function of aggregate is to assist in producing workability and uniformity of concrete and to provide binder to the concrete. This material usually found near river bed and the size of course aggregate commonly use is 20mm nominal maximum size. (R.srinivarsan, 2010). By using natural fiber ash as cementitious material, it can produce better mixes with less aggregate quantities (Ellie Award, 2010). This aggregate is used to create a good concrete strength that accepts the shrinkage tension and to give the concrete with less shrinkage. Aggregate is one of material that make up majority ingredient in concrete mixture. For example, sand, gravel, crushed aggregate and also course aggregate.

Water is the most important material use in concrete making. Usually water is used to bind all the materials together until concrete is hardened. Too much water will reduce the strength of concrete while too little water can lead to high workability of concrete. Therefore, water cement ratio is important in concrete mixing because it can influence the grade of concrete.

2.4 NATURAL AGRICULTURE WASTE

There are two processes to dispose agriculture waste materials. Usually this material was disposed into landfill or by open burning. These processes were harmful for our environment because it can lead to air pollution and global warming (Girisha, C. et al., 2012). From previous study, it is proved that agriculture waste can help to enhance the strength of concrete in form of fiber or ash (Elizabeth, O., 2013).

Large quantities of waste materials can lead to social and environmental problems. Concrete technology need to be conducted based on this issue. Several researchers have been conducted to study on cementitious agriculture wastes. For example, coconuts, sugar canes, vegetables, corn cobs and others. The used of waste materials also can reduce the cost of concrete production, by reducing the quantity of cement used (Elizabeth O., 2013).

According to Samrat Mukhopadhyay (2008), a lot of researches have been conducted to study the use of natural fiber ash to produce high quality of concrete. Banana fiber ash is one of the potential materials to use because it has cementitious and also mechanical properties. A lingo-cellulose fiber is obtained from banana stem and it is the best fiber which it has relatively good in mechanical properties. In this industry, there were many researchers conducted in investigating the natural fiber such as wood, sisal, bamboo, coconut, and other organic fiber to produce high strength concrete (Ellie Award, 2010).

2.5 ADVANTAGES OF NATURAL FIBRE

Natural fiber ash has its own advantages and disadvantages. The importance of this natural fiber ash is that it has low density, appropriate stiffness, high disposability, and renewable. Furthermore, this natural fiber is easy to recycle and biodegradable (Samrat Mukhopadhyay, 2008).

According to Marthog. C (2012), natural fiber ash is sustainable and effective material in order to minimize the used of cement and reduce the construction cost. By using waste product, it also can lead to environmental friendly because it helps in reducing the production of carbon dioxide gases which will contribute to air pollution. Agriculture waste material usually disposed into landfill or dispose by open burning (Girisha, C., 2012).

Compressive strength can be increase by using natural fiber compared to some fiber such as glass, steel, polymer, and other. According to Ellie Award, (2010), the compressive strength improved in increasing the modulus of elasticity and stress-strain diagram.

According to Rodrigo C.K etl.al, (2014), the use of banana fiber ash can reduce the consumption of cement nearly 8 to 10 percent. This research has been done by previous researcher by using mineral admixture. Banana fiber ash has proved to be technically feasible to improve concrete performance, save cost and decrease the environment impact.

2.6 PROPERTIES OF BANANA FIBER ASH

According to Rodrigo C.K et al., (2014), banana fiber ash can be use to produce concrete and mortar which can be classified to have cementitious properties. His used banana leaf as part of component material instead of using banana trunk. Almost 95 million tons of banana waste was produce since 2012.

Banana fiber ash can be classified as pozzolanic material in civil engineering construction with several benefits such as lower cost and give equivalent reduction to environmental impact. The banana leaf ash has been proved to increase the strength of concrete and demonstrate pozzolanic activity by replacing 10% of banana leaf ash into the concrete (Rodrigo C.K et al., 2014).

The process to produce banana fiber ash is by burning the banana leaves with 900°C for 24 hour in air. Then, the material was ground in Marconi ball mill with capacity of 351 rpm for 30 minutes and was sent to laboratory to determine the physical and chemical properties of banana fiber ash. Table 2.1 below show the chemical compositions found in banana leaves ash.

Table 2.1: Chemical Compositions in Banana Leaves Ash

Parameter	**Composition Banana Leaves Ash (%)**
Silicon Dioxide (SiO_2)	48.7
Iron Oxide (Fe_2O_3)	1.4
Aluminium Oxide (Al_2O_3)	2.6
Sodium Oxide (Na_2O)	0.21
Loss of Ignition (LOI)	5.06

Source: Kanning, R.C. et al., (2014)

From Table 2.1 above, the chemical composition that can be found inside banana fiber ash are Silicon Dioxide (SiO_2), Iron Oxide (Fe_2O_3), Aluminium Oxide (Al_2O_3), Sodium Oxide (Na_2O), and also Loss of Ignition (LOI). The highest chemical composition that can be found in banana fiber ash is SiO_2 which has 48.7% composition. The Silicon Dioxide (SiO_2) is very important chemical composition that must have in every pozzolanic material because it will react with calcium hydroxide at an ordinary temperature to form compound that has cementitious properties. This reaction will produce calcium silicate hydrate gel and it is used to fill the void inside the concrete as well as increase the strength of concrete. The lowest composition that can be found in banana fiber ash is Sodium Oxide (Na2O) which is 0.21%.

CHAPTER 3

RESEARCH METHODOLOGY

3.1 INTRODUCTION

The experimental procedures, material use, preparation of materials, and apparatus, regarding this research will be discussed further in this chapter. This research was focused on compressive strength using banana fiber ash burnt with different temperatures.

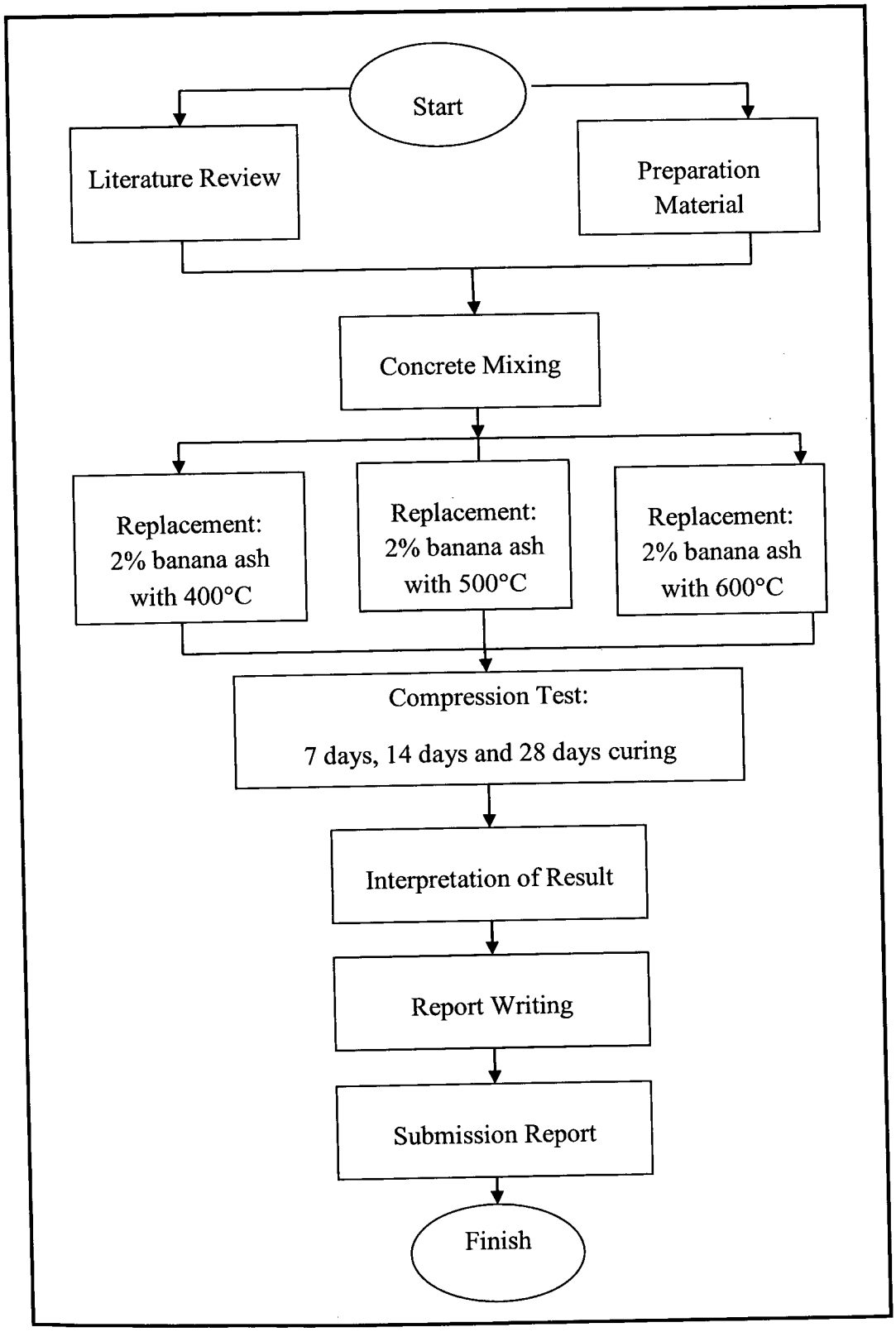

Figure 3.1: Research methodology flow chart

3.2 EXPERIMENTAL PROGRAM

This research was conducted to investigate the optimum temperature and determine the strength of concrete using banana fiber ash. All 27 specimens was prepared using three different types of mix which is mix A, mix B and also mix C. All the mixes were partially replaced by two percent of banana fiber ash with three different temperatures which is mix A for 400°C, mix B 500°C and mix C 600°C. The compression strength test was carried out to determine the strength of specimens. For each mix, cube with 100mm×100mm×100mm was prepared for testing at 7, 14 and 28 days. The total numbers of 27 specimens were prepared altogether as shown in Table 3.1 below.

Table 3.1: Number of Samples and Test

Temperature		**400°C**			**500°C**			**600°C**		
Test	**Curing (days)**	**7**	**14**	**28**	**7**	**14**	**28**	**7**	**14**	**28**
Compressive Strength Test	Water	3	3	3	3	3	3	3	3	3
Total sample		27 samples								

3.3 PREPARATION OF MATERIALS

In this research, Ordinary Portland Cement, water, fine aggregate, course aggregate and also banana fiber ash were used in this experimental work.

3.3.1 Ordinary Portland cement

Cement is widely use in our country and it is use to hold concrete together. Ordinary Portland Cement (OPC) was manufactured in four types of processes that is, quarrying process, raw material preparation, clinkering and also cement milling. In quarrying process, limestone and cement rock are use. These materials contain Lime ($CaCO_3$), Silica (SiO_2), Alumina (Al_2O_3) and Ferrous Oxide (Fe_2O_3). In clinkering process, the raw materials were heated in kiln at very high temperature to produce Tricalcium Silicate ($3CaOSiO_2$), Dicalcium Silicate ($2CaOSiO_2$), Tricalcium Aluminate ($3CaOAL_2O_3$), and also Tetracalcium Alumino-Ferrate ($4CaOAL_2O_3Fe_2O_2$). In cement milling process, the clinker will be crush to a fine powder to form cement. Table 3.2 shows the percentage of chemical composition for Portland cement.

Based on Table 3.2 below, the highest percentage of chemical composition for Portland cement is Calcium Oxide (CaO) which is 65.1% followed by Silica (SiO_3), 21.8% and Alumina (AL_2O_3), 4.2%. The lowest percentage of chemical composition for Portland cement was Sodium (Na_2O) which is 0.13%, followed by Potassium Oxide (K_2O), 0.72% and Sulphur Trioxide (SO_3), 2.4%.