EFFECTS OF GRINDING CYCLES AND TEMPERATURE ON THE PHYSICAL AND ENGINEERING PROPERTIES OF MIRHA IN CONCRETE

By

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Dissertation submitted in partial fulfillment of

The requirements for the

Bachelor of Engineering (Hons)

(Civil Engineering)

SEPTEMBER 2013

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CERTIFICATION OF APPROVAL

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A Project Dissertation Submitted To The
Civil Engineering Program

Universiti Teknologi PETRONAS

In Partial Fulfillment of the Requirement For The

BACHELOR OF ENGINEERING (Hons)
(CIVIL ENGINEERING)

Approved by,

____

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UNIVERSITI TEKNOLOGI PETRONAS

TRONOH, PERAK

September 2013

CERTIFICATION OF ORIGINALITY

This is to certify that I am responsible for the work submitted in this project, that the original work is my own except as specified in the references and acknowledgements, and that the original work contained herein have not been undertaken or done by unspecified sources or persons.

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FAISAL MOHAMMED AHMED

ABSTRACT

Rice is one of the primary sources of foods especially for human needs and it covers about 1% of the earth's surface. Nowadays, about 600 million tons of rice paddies are produced in a year. The annual production of the main sources is approximately about 120 million of tones whereby it remains about 20% of husks.

The rice husk ash is the most appropriate waste materials which essential to replace approximate of 20% for concrete. As we concern, the rice husk ash (RHA) contain of 50% of cellulose, 25% -30% of lignin and 14-20% of silica. The current problem nowadays happened when burning of paddy husk may affect the depletion of the ozone layer and it may damage the environmental surrounding areas when the RHA is being dumped. Whenever the rice husk is burned, about 80% of them contain of pure silica and it is an active structure which might be performed like cement. Although it is reactive but the rice husk still need to go through appropriate burning procedure to produce better cement replacement.

This study investigate on the strength measurement, durability and permeability of concrete materials based on rice husk ash (RHA) for purpose of substitute of cements. It has an additional materials which known as pozzolanic material which help to maintain the strength and durability of the concrete. Many sample tests were done through different experimental methods to get the optimal result of durability of concrete.

Lastly, it was found that burning MIRHA at 600°C and grind it at 3000 cycle , produce concrete with higher strength compared to other burning temperature and grinding cycles, regardless of MIRHA percentage inclusion. Temperatures of 600°C and 3000 grinding cycles revealed that addition of just 5% of MIRHA is the optimum percentage of cement replacement to produce concrete with good performance at early age and gained higher strength.

ACKNOWLEDGEMENT

First of all, I thank to Allah (God) the Almighty for giving me the ability and the strength to carry out and complete this project successfully.

I would like to express great appreciation to my supervisor Dr. Nasir Shafiq for his supervision and constant support. His constructive comments, encouragement and suggestions throughout the study have contributed to the success of this project. I would also like to thank laboratory technicians from Civil Engineering for their endless support and cooperation.

Special thanks go to my beloved parents, who are my constant source of inspiration and motivation, thank you for your constant love and care. Again, special thanks to my wife and my parents in law who stood beside me, advised and motivated me throughout my study with nonstop support.

Sincere thanks to my senior Osama Ali and my friends Nadhir Abdulwahab and Ahmat Makine for their direct and indirect help.

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CHAPTER 1

INTRODUCTION

1.1 Background

Basically, concrete is composite material composed of cement (commonly Portland cement), aggregate and water. This category of concrete is appropriate for construction industries as long as there is no disclosure on inconsiderate condition. All the elements harden subsequent to mixing with water due to a chemical process, known as hydration. The water possibly will react with the cement which attached with other components before it become a stone-like material. Due to knowledge and high technological advancement, many researchers found that waste materials such rice husk ash (RHA) contains of pozzolanic or latent hydraulic properties which might improve the properties of concrete. The grain materials such rice husk ash (RHA) could be added into concrete mix as mineral admixtures or as part of replacement for Portland cement (blended cements).

Cement replacement material is one of the new founded alternatives materials for some of the Portland cement in concrete industries which extensively used in many constructions as nowadays. Even though the cement replacement materials are unfamiliar use, but it brings economic benefits for construction industries. Nevertheless, the primary reason of using substitute cement replacement is for an enhancement or modifications to the concrete properties. Instead of that, it would reduce the human’s carbon footprint which could be an initial step to save planet from air pollution.

The carbon footprint is a set of greenhouse gas (GHG) releases may caused by an industries, event or products and it is most rapidly-growing component. Imagine in a day, the construction industry releases about 1 ton of cement whereby it is equivalent to 1 ton of carbon dioxide in the atmosphere. Today, more than 2.5 billion ton of cement is produced over countries in a year. Most of construction companies concern more on the reinforced concrete structures method which requires on estimation on high strength and performance concrete. It would increase the consumption of cements that might release high greenhouse gases.

The utilization of the agricultural waste such as rice husk ash show high tendency in concrete technology in this century. As far as the sustainability is concerned, it would help to solve problem of disposing waste materials. Therefore it would directly save environmental surrounding and natural energies to maintain quality of life among citizen and future generations.

The basic terminology of rice husk ash could be the same as grain of white rice surrounded with amount of silica which brings good potential and high values for construction industries and technologies development for cement replacement. The consumption of rice husk ash (RHA) has extensively used in many countries especially such South East Asia which mainly formed about 90% or 500 million tons per year as reported by Cook (1996).

It was described that Malaysia is one of countries which manufactured more than 2 million tones whereby about 20% of them are from husk while 90% of it contains of silica.

Researchers have found out that the rice husk ash (RHA) as waste materials which benefited for industries nowadays as it could be produced as an additional cementitious material.

On top of that, many studies has been prepared to investigate on utilization the rice husk ash(RHA) as substitute of concrete materials as well as the importance of the pozzolanic materials on rice husk ash(RHA) such countries like China, Japan, India, Guyana, Senegal, Taiwan and UK.

The benefits on the rice husk ash (RHA) could facilitate high strength and high performance of concrete while improving durability characteristic and subject property of concrete. These efforts would help to reduce the uncontrolled burning of rice husk ash from environmental pollution as well as to control pollozanic activities in the future.

1.2 Problem Statement

Rice plantations cover 1% of the earth's surface and it is the primary food for billions of people. The world's annual production of rice is about 500 million tons and more than 90% is produced in South East Asia, Malaysia produces about 2 million tons and 20% of which is husk, recent researches proved that the rice husk ash can be effectively used as a cement replacement material which will be an economical solution for the high energy and resources consumption and CO_2 emission associated with the cement production. Therefore, from economical, ecological and technical point of view to looks for an alternative material for the cement.

The rice husk ash produced under uncontrolled conditions may contain some crystalline compounds which will negatively affect its pozzolanic reactivity. Therefore, it is also necessary to produce the rice husk ash under controlled burning conditions at economical levels.

Microwave incinerated rice husk ash is an ongoing research in UTP, previous researchers have already established that the optimum burning temperature of MIRHA is 800 °C while the grinding time of MIRHA has not been addressed, therefore it will also be beneficial if the optimum grinding time of MIRHA is determined.

1.3 Objectives

The main objective of this study is to reduce the amount of cement in concrete, in order to achieve the main objective the following sub-objectives are set:

1. To investigate the effects of grinding cycles and incinerate temperature on the compressive strength and splitting tensile strength.
2. To determine the optimum percentage of replacement of cement with MIRHA based on the results of obective-1

1.4 Scope and Limitation of Study

The scope of the study encompasses:

- Preparation of Microwave Incinerated Rice Husk Ash (MIRHA) at two different temperatures.
- Grinding of MIRHA using Los Angeles abrasion machine for 3000 and 4000 cycles.
- Characterization of produced MIRHA by XRD, XRF and FESEM techniques.
- Studying the effects of MIRHA produced at different temperature and grinding time on compressive strength development and durability of concrete mixes with 0, 5, and 10% replacement level.
- Slump test for workability.
- Compressive strength tests on 100 mm –side cubes at 3, 7, 28 and 56 days.
- Splitting tensile strength on 100 mm diameter and 200 mm height cylinders at 28 days.
- Bond strength of steel bars embedded in concrete at 28 days.

1.5 Schematic Flow Chart of the Methodology

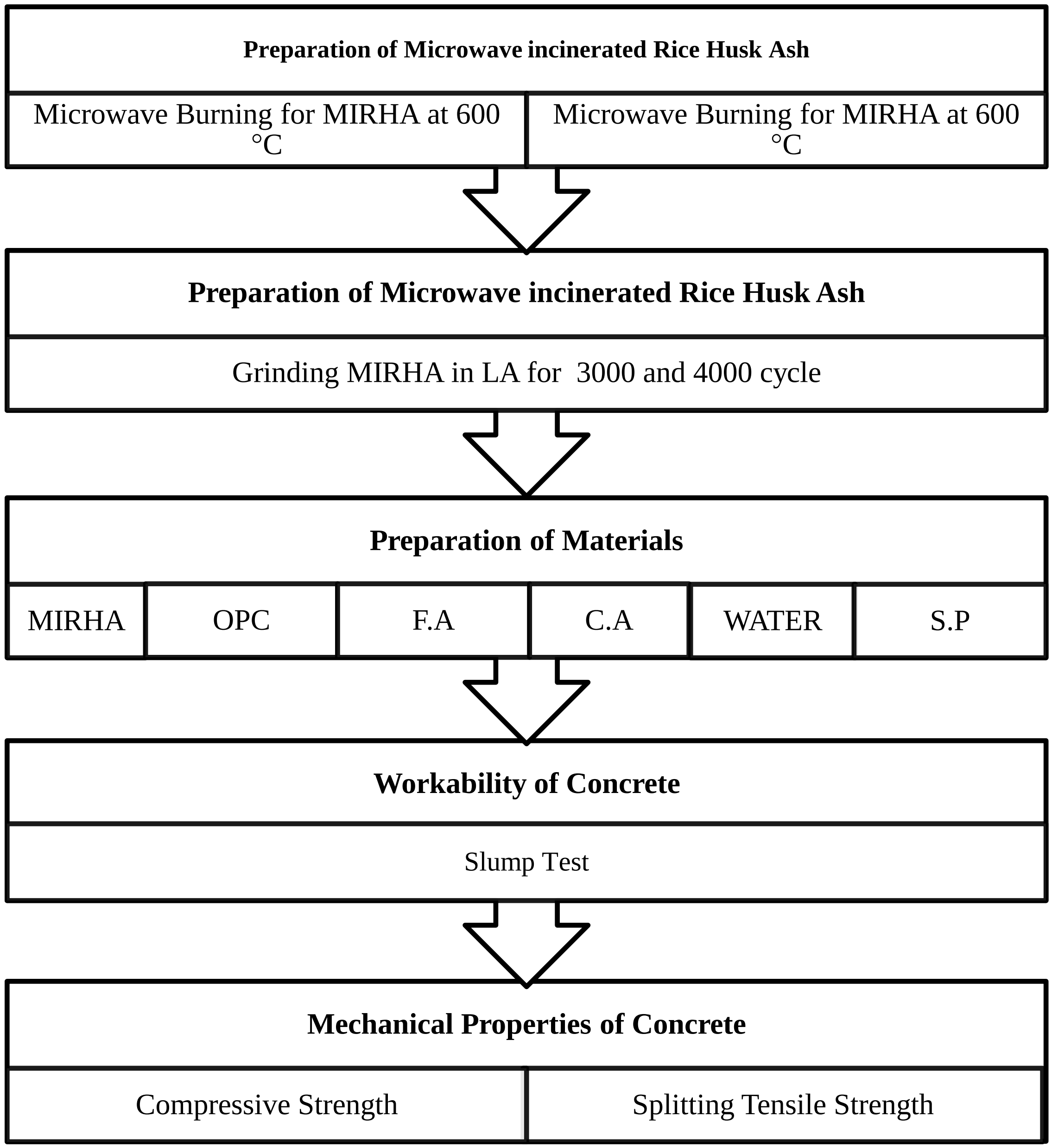

Figure 1: Schematic Flow Chart of the Methodology

CHAPTER 2

LITERATURE REVIEW

2.1 Introduction

In past, many researchers have examined the effectiveness on the usage of the rice husk ash to the concrete. Previously, majority of professional engineers were utilized the rice husk ash (RHA) as new founded materials which might be beneficial for construction industries. They found that the rice husk ash(RHA)would help to improve the microstructure or mix combination between cements and high performance concrete [4].

The materials have extensively used in many countries such rice husk ash (RHA), and palm oil whereby it could be one of the most effective materials which assist in construction industries as it mentioned by most of researchers [10]. The rice husk ash(RHA)has originally came from grain of paddy rice and it became one of the main products which highly demanded in market as nowadays due to daily necessities among citizen in Malaysia. Basically, the paddy rice contained about 20% of husk, at the same time it produced about 20% of ash after the burning process [17].

Besides, another description of the rice husk ash (RHA) covers surface grain of white rice with high concentration of silica. They founded that about 80-88% of rice husk ask (RHA) has contained the amount of silica which highly potential values to majority of engineers for construction development [5].

The research study was found in Uruguay where it clarifies on the primary usage of rice husk ash (RHA) purposely for the rice paddy milling process. The research in Uruguay purposely investigates on the importance of rice husk ash (RHA) in their country as well as in other countries such United States of America [8].

2.2 Benefits

Commonly, the agriculture waste materials such rice hush ask (RHA) show many advantages especially for construction industries to generate lower cost concrete [11]. Various benefits gained from to the studies done by researchers on the effectiveness of rice husk ash (RHA) in term of enhancement on strength and durability on cement and concrete. Apart of that, rice hush ash (RHA) found many benefits in term of saving energy cost of rice milling, power consumption and fuel of paddy drying [16].

Throughout on several experimental tests, the researchers believed that the utilization of rice husk ash (RHA) would reduce costs. The surface of grain on white rice could protect the environmental surrounding and pollution of carbon dioxide without disposing these waste materials. Thus, it could give better improvement of life among generations in the future [16].

2.3 Disadvantages

Nevertheless, many countries believed that too much husk from the paddy rice were either burned or dumped after processing of paddy rice would affect the environment. Higher quantity of ash may cause of pollution and air contamination. These have been proven by themselves that the rice husk ash (RHA) may cause to the danger for environmental surrounding areas if the situation could not be controlled in future [16].

The husk from the paddy rice might not useful and infertile after processing for people. Besides, the negative environment such pollution and air contamination may easily occurred within short period [16].

Even though, the controlled burning is the most effective way of throwing away the rice hush ash(RHA) and maintain the porosity of concrete, but it tend to bring negative environmental effects such as air contamination[9].

2.4 Materials

Many years researchers have extensively practiced materials such fly ash and silica fume as pozzolanic materials in high strength of concrete. But recently, only few researchers have started to apply new founded materials such rice hush ash (RHA) or palm oil fuel ash for the concrete study. Research studied by Jaubertie et.al (2000, 2003) shows that pozzolanic materials contained lot of silica which mixed with calcium hydroxide and cementitious materials in experimental purposes [10].

The silica of rice hush ash (RHA) include of 50% of cellulose, 25%-30% of lignin and 15-20% of silica. Therefore, majority of them believed that rice husk ash (RHA) as replacement of cements for the concrete [12].

Many assessments determine the quantity amount of silica in rice husk ash (RHA) for their research study. They have concluded that the strong concentration of silica in rice husk ash (RHA) also known as crystalline or crystobalite [16]. About 95% amount of non- crystal line or amorphous of silica in rice husk ash (RHA) whereby it controls the heat temperature in order to produce maximum amorphous [16].

The proper burning method must be chosen appropriately to obtain the best quality of high reactivity of silica in concrete material. Researcher suggested that by controlled the burning temperature of rice husk ash (RHA), it would maintain the quantity amount of silica almost 85 -90% [9].

The best way to protect environmental problem from uncontrolled burning of rice husk ash (RHA) is through microwave incinerator which help to generate amorphous MIRHA with high prozzolanic activity [16].These help to improve better quality of concrete such as reduce heat evolution, reduce permeability as well as to increase the strength of the concrete for the long period [16].

The other studies many countries concern on improvement of durability of the concrete. They have evaluated the rice husk ash (RHA) into the concrete mixture to measure in term of compressive strength, water absorption and durability of the concrete. Therefore, the rice husk ash (RHA) has tendency to replace and improve durability of concrete [17].

This was stated in one of research on Off White Rice Husk Ash (OWRHA) where it has mixed with white Portland cement to measure on the strength, porosity, corrosion and thermal conductivity [11]. Likewise, another study concern on cost reduction, performance, durability and environmental effects which become primary characteristic that influence the rice husk ash (RHA) on Portland cement.

2.5 Strength of the Concrete

The ground rice husk ash (RHA) has high compressive strength for concrete against the other materials. The research study has found that high compressive strength of concrete may cause capacity of pozzolanic materials in rice husk ash (RHA), calcium hydroxide as well as reaction on the hydration of cements [17].

Pozzolanic materials in rice husk ash (RHA) potentially increase greater strength on the concrete [16]. Few experiments have been tested to confirm that the rice husk ash (RHA) has about 90% amount of strength against to the other materials [1].

In the earlier stages, pozzolanic materials contain mix of concrete which produce lesser strength than normal OPC concrete. This would achieve high compressive strength after long days [16]. Indeed, the pozzolanic effect could be seen through hydration process which facilitates the strength of the concrete [16]. Thus, the pozzolanic effects increase the compressive strength of the concrete as a whole. The other reason that show that the rice husk ash (RHA)maintain higher strength in concrete mixture is it has burned in lower temperature between 400-700 Celsius within a day.

Unlike, the uncontrolled burning of the rice husk ash (RHA) may reflect to poor pozzolanic activity and at the same time it might reduce the strength of the concrete [16].The lower strength of the concrete might be affected against water deficient. These show that sufficient water is required to stimulate the strength of concrete within short period [16].

Nevertheless, researcher has conclude that rice husk ash (RHA) tend to decrease the compressive strength if achieve only for 10% grade of concrete. The different percentage of MIRHA represents on different development of concrete strength. Based on the experimental result, the higher percentage of MIRHA will slow down the compressive strength of the concrete [16]

2.6 Durability

High Strength Concrete is considered as point that maintains durability of the concrete as well as to show less defects in structural elements of the buildings. The researchers has found many alternative ways in testing rice husk ash (RHA) to prove on the durability of conventional concrete according to different stages in Thailand [9]. The experiment tests are required to fulfill the criteria to maintain high quality of buildings. Study was done by Nuruddin et al show that the rice husk ash(RHA) is cost saving materials where it help to improve the durability of concrete [9].

From our point of view, the end results have taken into consideration based on different experimental tests done to show variances or any discrepancies on durability properties with cements and other types of silica. Due from the research done, they perceived that black rice hush ash(BRHA) bring negative impact on the durability of the concrete as it may difficult to dry the shrinkage of the concrete comparing to white rice husk ash(WRHA) [9].

CHAPTER 3
METHODOLOGY

3.1 Introduction

In construction, the concrete quality is the main factor which meet standard requirement. The characteristic of interfacial zone is one of primary factor in order to maintain a good quality and strength of concrete

This research will focus more on the effective of ultra-microwave incinerated rice husk ash on the strength and durability. In order to meet the objectives of this research, the sub objectives mentioned on the earlier chapter need to be performed. This chapter will present a laboratory works as part of materials preparation, sampling and test arrangement.

3.1.1 Project equipments.

For this project, the following chart has been designed to shows the work progress of the experiment that will be conducted throughout this project.

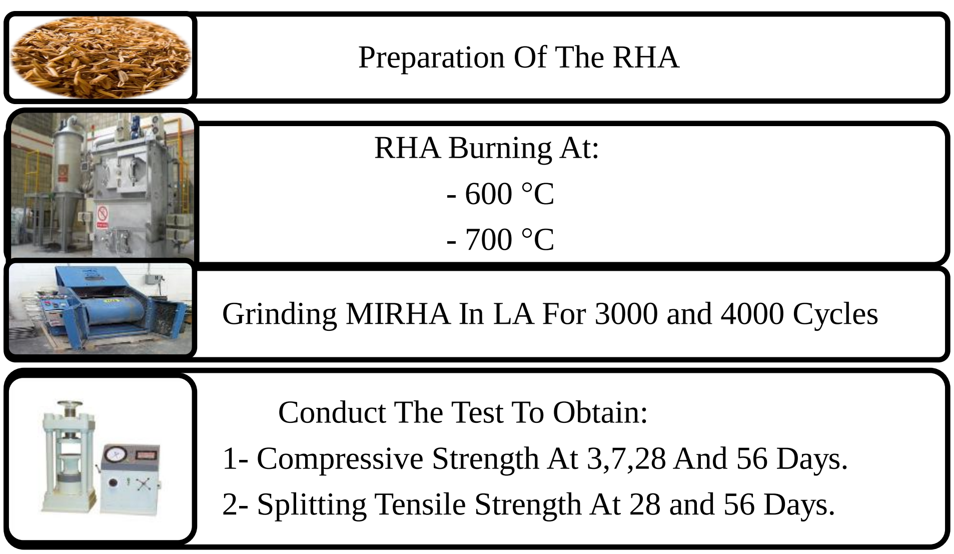

Figure 2: Project equipments chart

3.2 Materials

Concrete is a heavy, rough building material made from a mixture of broken stone or gravel, sand, cement, and water, that can be spread or poured into molds and that forms a stone like mass on hardening. The key ingredients of concrete are cement, coarse, fine aggregates and water. The rice husk ash (RHA) as a cement replacement in concrete also elaborated. Super plasticizer is added to the concrete to include MIRHA in order to enhance workability of concrete. The complete mixture properties are shown in the following table.

Mixture properties of concert						
(%) Replacement	CEMENT (kg/m^3)	MIRHA (kg/m^3)	SAND (kg/m^3)	AGGREGATE (kg/m^3)	WATER (kg/m^3)	SP (kg/m^3)
0	500	0	650	1100	150	7.5
5	475	25	650	1100	150	7.5
10	450	50	650	1100	150	7.5

Table 1: Mixture properties of concrete

Concrete is known for its compressive strength which is an important property in the design and the construction of the concrete structures. Although, concrete is very strong in compression, but, due to the development of various types of admixtures, it is necessary to investigate the effect of mineral admixtures on the compressive strength of cement and concrete.

3.2.1 Microwave Incinerator Rice Husk Ash (MIRHA)

The UTP Microwave Incinerator (UTPMI) will be used in the research adopt (or combine) the Air Cooled Magnetron system with an overall dimension of 2.3(H)x4.0(W)x4.0(L) with a chamber capacity of 1 m^3. Ceramic filter is used in the emission and ash control system with PLC mode of operation. Flue Gas Filter is equipped to the microwave incinerator in order to provide significant positive effect to the environment.

Rice husks were dried under direct sunlight to reduce their moisture content so that when they were burnt, they would not produce large amount of smoke.

Figure 3: UTP Microwave Incinerator

The microwave incinerator as shown in figure 3 has set the temperatures in range of 700°C and 600°C in order to establish the optimum burning temperature.

Grinding of MIRHA is conducted using a Los Angeles abrasion machine as shown in figure 4, at 3000 and 4000 cycles.

Figure 4: Los Angles Machine

3.2.2 Aggregate

Aggregate is one of the important components in concrete. It is the rock that is being bound by the hardened cement. Aggregate increases the strength of concrete and is a fundamental economical factor because it takes up a large volume of the concrete and is much less expensive than an equivalent volume of cement.

In this project, the fine aggregate will be used is natural sand with the fineness modulus 2.7 as shown if figure 5, and it has classified in Zone 3 while coarse aggregate is crushed aggregate with the maximum size of 20 mm.

Figure 5: Course Aggregate

3.2.3 Water

The water–cement ratio is the ratio of the weight of water to the weight of cement used in a concrete mix and has an important influence on the quality of concrete produced. A lower water-cement ratio leads to higher strength and durability, but may make the mix more difficult to place. Placement difficulties can be resolved by using plasticizers or super-plasticizers. More typical, water-cement ratios of 0.4 to 0.6 are used. For higher-strength concrete, lower water: cement ratios are used, along with a plasticizer to increase flow ability.

Too much water will result in segregation of the sand and aggregate components from the cement paste. Also, water that is not consumed by the hydration reaction may leave the concrete as it hardens, resulting in microscopic pores (bleeding) that will reduce the final strength of the concrete. A mix with too much water will experience more shrinkage as the excess water leaves, resulting in internal cracks and visible fractures (particularly around inside corners) which again will reduce the final strength.

Water is an extremely important part of concrete, and drinking quality water is commonly required, or water from an approved source free from impurities. The water that will be used in the mix should be free from harmful chemicals, oil, cholride, silt, or any harmful ingredients that could impact the performance of the concrete.

3.2.4 Cement

Ordinary Portland Cement is the most common type of cement in general use around the world, used as a basic ingredient of concrete. It usually originates from limestone. Ordinary Portland Cement is a fine powder produced by grinding Portland cement clinker (more than 90%), a limited amount of calcium sulfate (which controls the set time) and up to 5% minor constituents as allowed by various standards.

Ordinary Portland Cement (OPC) Type 1 will be used in this research. OPC Type 1 is preferred because the observation on concrete properties could be done in normal hydration process hence the advantages of MIRHA usage in concrete can be optimized.

3.2.5 Superplasticizer

Superplasticizer is a type of water reducers; however, the difference between superplasticizer and water reducer is that superplasticizer will significantly reduce the water required for concrete mixing. Effects of superplasticizer are obvious, i.e. to produce concrete with a very high workability or concrete with a very high strength. Mechanism of superplasticizer is through giving the cement particles highly negative charge so that they repel each other due to the same electrostatic charge [18].

The utilization of superplasticizer has positive effects on properties of concrete, both in the fresh and hardened states. In the fresh state, utilization of superplasticizer will normally reduce tendency to bleeding due to the reduction in water/ cement ratio or water content of concrete.

Superplasticizer (SP) that will be used is high range water-reducing concrete admixtures. Superplasticizer Sikament-163 will be used to maintain a constant workability; expressed as constant slump without any additional amount of mixing water and without any direct effect on the compressive strength of the concrete. It is combined of sodium salt (sulfonated) naphthalene formaldehyde condensate.

3.3 Mixing and Sampling

This is important to add up concrete ingredients properly according to BS 1881-125.1986 so that it produces fresh concrete in which the surface of all aggregate particles is coated with cement paste and which is homogenous on the macro-scale and therefore possessing uniform properties. Slump test in this research was conducted according to BS EN 12350-2:2000. It has used steel cone mould 305 mm high with small opening at the top. The target slump of all concrete mixed with different percentages of MIRHA was in the ranged between 230 mm and 260 mm, using suitable doses of superplastizer (SP).

3.3.1 Compressive Strength

Concrete mixtures can be designed to provide a wide range of mechanical and durability properties to meet the design requirements of a structure. The compressive strength of concrete is the most common performance measure used by the engineers in designing building and other structures.

The compressive strength is measured by breaking cubes concrete specimens in a compression- testing machine. The compressive strength is calculated from the failure load divided by the cross- sectional area resisting the load and reported in units of megapascals (MPa) in SI units.

In this research, the concrete were prepared in the laboratory using a 1.0 m³ capacity of mixer. Cubes of 100 mm x100 mm x100 mm dimension as shown on the following figure were prepared for the compressive strength test and compacted using a poker vibrator. After casting, the moulded specimens were covered with plastic sheet and left in the casting room for 24 hours. They were then demoulded and moved into the curing tank with the temperature range between 19°C and 22°C until end testing.

Figure 6: Concrete Cube Mould

3.3.2 Splitting tensile strength

The tensile strength is one of the basic and important properties of the concrete. The concrete is not usually expected to resist the direct tension because of its low tensile strength and brittle nature. However, the determination of tensile strength of concrete is necessary to determine the load at which the concrete members may crack. The cracking is a form of tension failure.

Tensile strength test is a measure of the ability of a material to withstand a longitudinal stress, expressed as the greatest stress that the material can stand without breaking. This test method consists of applying a diametral compressive force along the length of a cylindrical concrete specimen at a rate that is within a prescribed rang until failure occurs. This loading induces tensile stresses on the plane containing the applied load and relatively high compressive stresses in the area immediately around the applied load rather than compressive failure because the areas of load application are in a state of triaxial compression. Tensile failure occurs.

In this research, Cylinders of 100 x 200 mm as shown in figure 7 were prepared for spitting tensile strength test and compacted using a poker vibrator. After casting, the moulded specimens left in casting room for 24 hours. The samples were removed from the moulded specimens and it moved into the curing tank until testing.

Figure 7: Splitting Tensile Strength Mould

3.3.3 Slump test

The concrete slump test is considered as an empirical test that measures the workability of fresh concrete. The slump cone is a right circular cone that is 300 mm high. The base of the cone is 200mm in diameter and the top of the cone is 100mm in diameter. The cone is filled with fresh concrete in three layers of equal volume. Each layer is stroked with a rod that is 19mm in diameter. The end of the rod is bullet shaped. After the cone is filled with concrete and the concrete has been cut off level with the top of the cone, the cone is raised vertically allowing the concrete to fall or slump. The distance that the concrete falls or slumps from the original height is the slump of the concrete. Steps of conducting slump test are shown in figure 8.

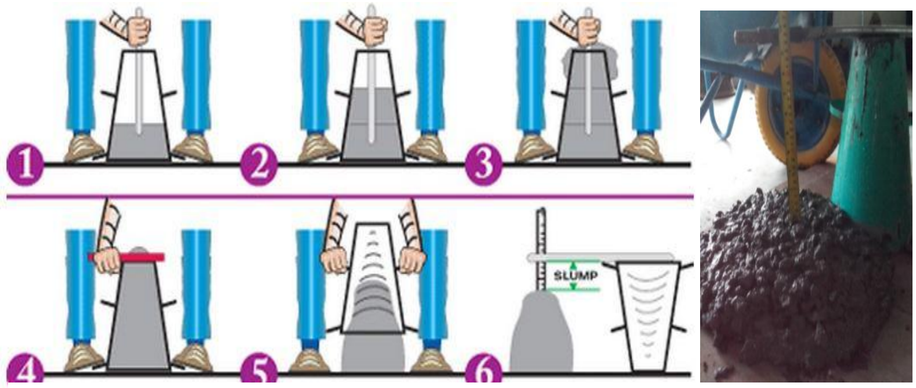

Figure 8: Steps of Conducting the Slump Test

Slump test has a direct effect on compressive strength of the hardened concrete as slump test shows the water/cementing material ratio. In other words, when slump is big then water/cement ratio is big and the compressive strength of concrete is low. Figure 9 is shows the workability of fresh concrete by slump Test

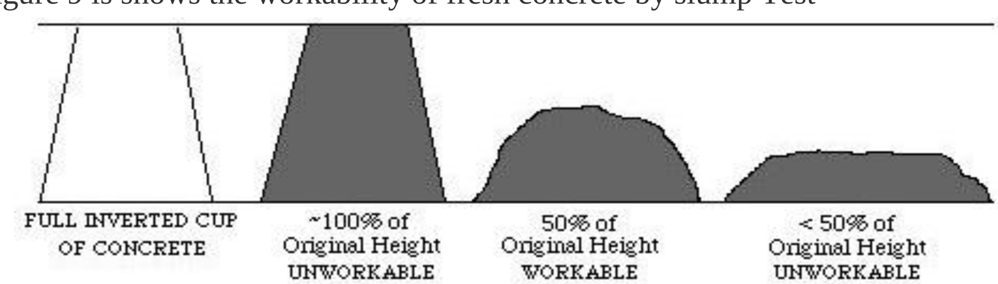

Figure 9: workability of fresh concrete by Slump Test

3.4 TESTING ARRANGEMENT

3.4.1 Compressive Strength Test

Compressive strength developments of the concrete samples were measured according to BS EN 12390-3:2002 using Digital Compressive Testing Machine as it referred in Figure10. Since destructive testing method has taken into consideration, compressive strength test was done after non- destructive tests were completed. The measurement was taken for three concrete cubes per mix between ages 3, 7, 28, and 56 days. During the test, concrete cube was loaded with constant loads without any sudden shock loads. Compressive strength value was taken from ultimate load that can be sustained by the concrete cube divided by surface area of the cube.

Figure 10: Digital Compressive Testing Machine

3.4.2 Splitting Tensile Strength

This experimental test method measures the splitting tensile strength of concrete by the application of a diametral compressive force on a cylindrical concrete specimen placed with its axis horizontal between the platens of a testing machine. Using the same machine, the compressive strength test with different setting mode of splitting tensile strength been obtained.

In this project, the measurement was taken for different three concrete cylinders per mix at ages 28 and 56 days. During these test, concrete cylinder was loaded with constant loads applying to the steel rod which attached to the sample and its mould. Splitting tensile strength value was then taken from an auto digital screen attached to the machine as shown in figure 11.

Figure 11: An auto digital screen and splitting tensile testing machine

CHAPTER 4
RESULTS AND DISCUSSIONS

4.1 Introduction

In the previous chapter, methods and materials required were discussed to prepare and produce good quality concrete model. The proposed grinding cycles, burning temperatures and various replacements percentage of MIRHA were used to understand the behaviour of concrete. This chapter presents and discusses the end results of laboratory work.

4.2 Mix quantities

Basically, the projects contain of 8 different mixes which have the same quantity for all materials except for cement replacement since there were two types of mixes with different replacement percentage of MIRHA. The quantities of the materials which were used in this project, shown in the following table.

MIX	CEMENT	MIRHA 600 -3K	MIRRH 600-4K	MIRRH 700-3K	MIRRH 700-4K	C.A	FA	WATER	S.P
				Kg/m^3					
CONTROL (0%)	500	0	0	0	0	1100	650	150	7.5
M600-3k (5%)	475	25	0	0	0	1100	650	150	7.5
M600-3k (10%)	450	50	0	0	0	1100	650	150	7.5
M600-4k (5%)	475	0	25	0	0	1100	650	150	7.5
M600-4k (10%)	450	0	50	0	0	1100	650	150	7.5
M700-3k (5%)	475	0	0	25	0	1100	650	150	7.5
M700-3k (10%)	450	0	0	50	0	1100	650	150	7.5
M700-4k (5%)	475	0	0	0	25	1100	650	150	7.5

Table 2: Materials Quantity of the Project

4.3 Compressive Strength

Compressive strength test was conducted to analyse the impact of MIRHA addition into the concrete mix proportion. The strength development of the concrete samples was measured at 3, 7, 28, and 56 days of age. The data analysis was made for each concrete samples to compare between control concrete (without MIRHA) and concrete samples containing various percentages of MIRHA. The following table shows the compressive strength development of all concrete samples.

Types of MIRHA	MIRHA (%)	Compressive Strength (MPa)			
		3 days	7 days	28 days	56 days
Normal concrete	0%	60.80	63.6	76.0	79.81
MIRHA 600-3K	5%	68.40	67.85	91.50	83.25
MIRHA 700-3K	5%	57.25	64.4	73.53	89.77
MIRHA 600-4K	5%	53.40	65.20	76.96	76.40
MIRHA 700-4K	5%	62.50	60.45	88.10	71.79
MIRHA 600-3K	10%	59.70	74.45	84.25	87.49
MIRHA 600-3K	10%	53.55	67.50	77.65	80.49
MIRHA 700-4K	10%	46.44	70.35	83.44	65.82

Table 3: Compressive Strength

The additional samples of MIRHA into concrete mixture significantly enhanced concrete strength performance. Compressive strength data of MIRHA at 600ºC and 3000 grinding cycles' concrete were higher than those of the normal concrete, irrespective of age.

4.3.1 Compressive Strength of Concrete Samples of MIRHA 600°C and 3000 Cycles.

Compressive strength data of MIRHA at 600ºC and 3000 cycle's concrete were higher than those of the normal concrete, irrespective of different age as shown in Figure 12.

Higher compressive strength of MIRHA concrete samples compare to control concrete from early curing days also show that pozzolanic reaction started to occur even at early ages.

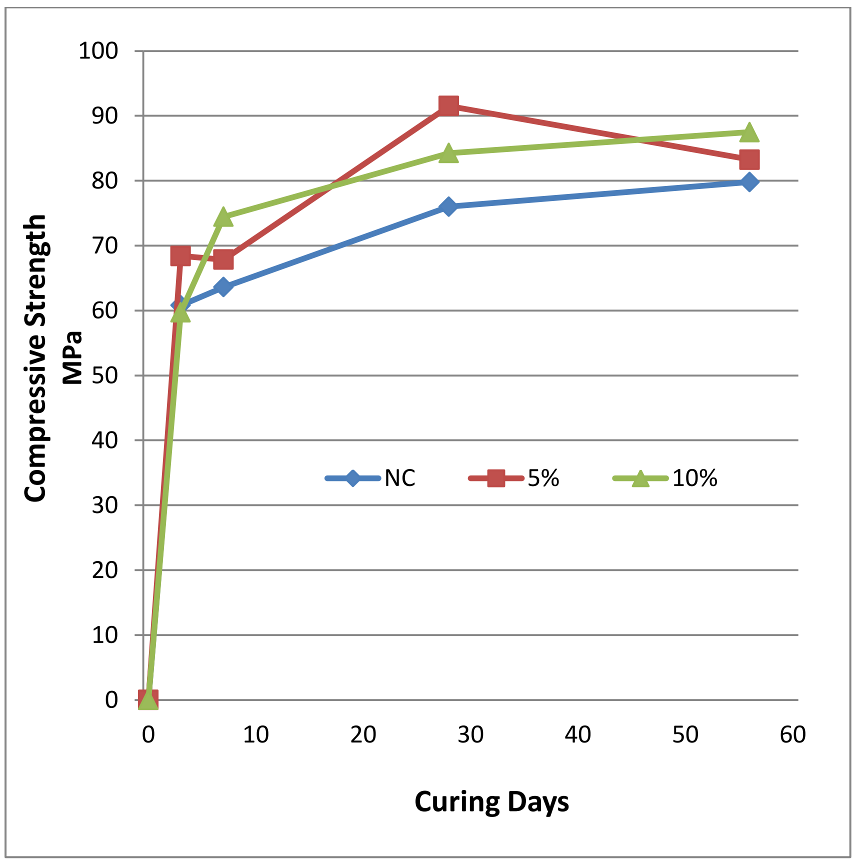

Figure 12: Compressive Strength Development of Concreate sample with MIRHA at 600°C and 3000 griding cycle

The development concrete strength of different percentage inclusion of MIRHA is shown in the Figure 12 and it is observed that the increase percentage of MIRHA directly slow down the compressive strength development of concrete.

After 3 days, 10% MIRHA concrete achieved compressive strength performance, 17.05% higher than Normal concrete, and 9.72% higher than 5% MIRHA concrete while at 56 days 10% MIRHA concrete achieved compressive strength performance, 9.62% higher than Normal concrete, and 5.09% higher than 5% MIRHA concrete. From early curing days, MIRHA concrete samples have gained strength faster than controlled samples while 5% additional amount of MIRHA show the highest level of compressive strength among MIRHA at 600°C and 3000 cycles concrete samples.

However, within the short period of 3 and 7 days, the effect of absorptive characteristic of MIRHA that caused lack of water in 10% MIRHA concrete slow down the development of strength. It is believed that the adequate amount of water and high pozzolanic reactivity were the reasons why 5% MIRHA concrete has faster strength acceleration until achieved 28 days.

4.3.2 Compressive Strength of Concrete Samples of MIRHA 600 °C and 4000 cycles.

Burning the MIRHA at 600°C and grinding it for 4000 cycles increase the performance of MIRHA replacement concrete especially for long term of curing days. Figure 13 shows that the higher percentage of MIRHA at 600°C and 4000 grinding cycles added into the concrete directly, slower down the development of compressive strength at early age if compare to the MIRHA concrete at 600 °C and 3000 grinding cycles.

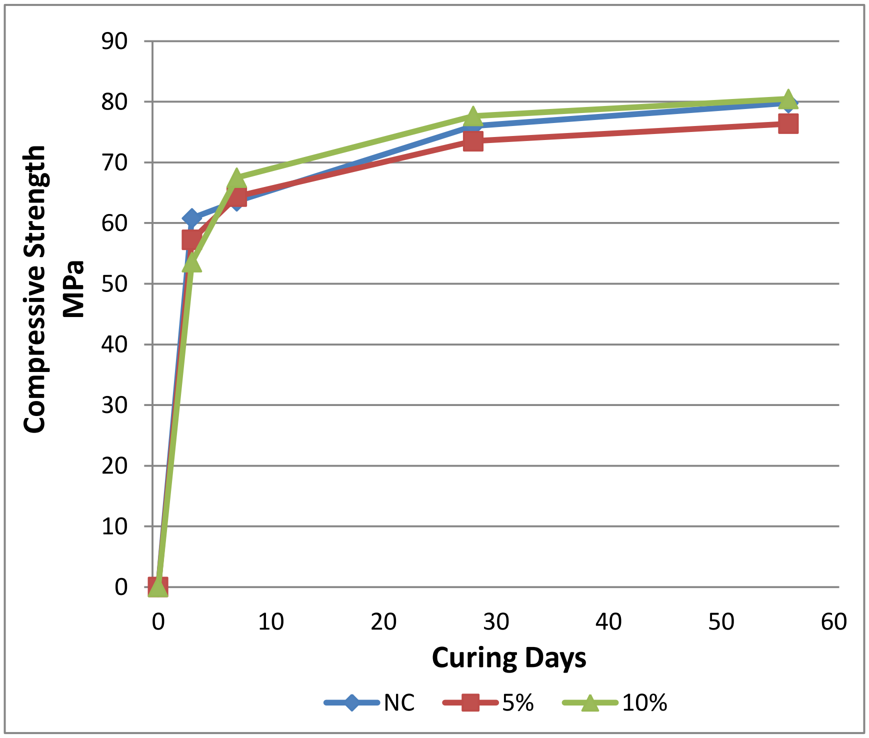

Figure 13: compressive strength development of concrete sample with MIRHA at 600C and 4000 grinding cycle

Burning MIRHA at 600 °C and grinding it for 4000 cycles obtained lower compressive strength performance than control concrete. There is a significant difference of compressive strength between 5% and 10% MIRHA concrete at all curing days.

The results obtained from this experiment show that Normal concrete is achieved higher compressive strength performance at the early age while the 10% replacement MIRHA concrete is achieved the highest compressive strength performance at 65 days.

Strikingly, results of up to 56 days show that 10% MIRHA achieved 5.305 % higher than 5% MIRHA at 28 days and 5.08% at the age of 56 days. There is no significant difference in terms of compressive strength between normal concrete and MIRHA concrete at the age of 7, 28 and 56 days.

4.3.3 Compressive Strength of Concrete Samples of MIRHA at 700°C and 3000 cycles.

Figure 14 shows the compressive strength development of concrete with MIRHA at 700°C. Result displays that compressive strength developments of MIRHA concrete are significantly higher compared to control concrete.

The development concrete strength of different percentage inclusion of MIRHA has shown in the Figure 14. From the observation that has been done, the increase percentage of MIRHA directly slow down the compressive strength development of concrete.

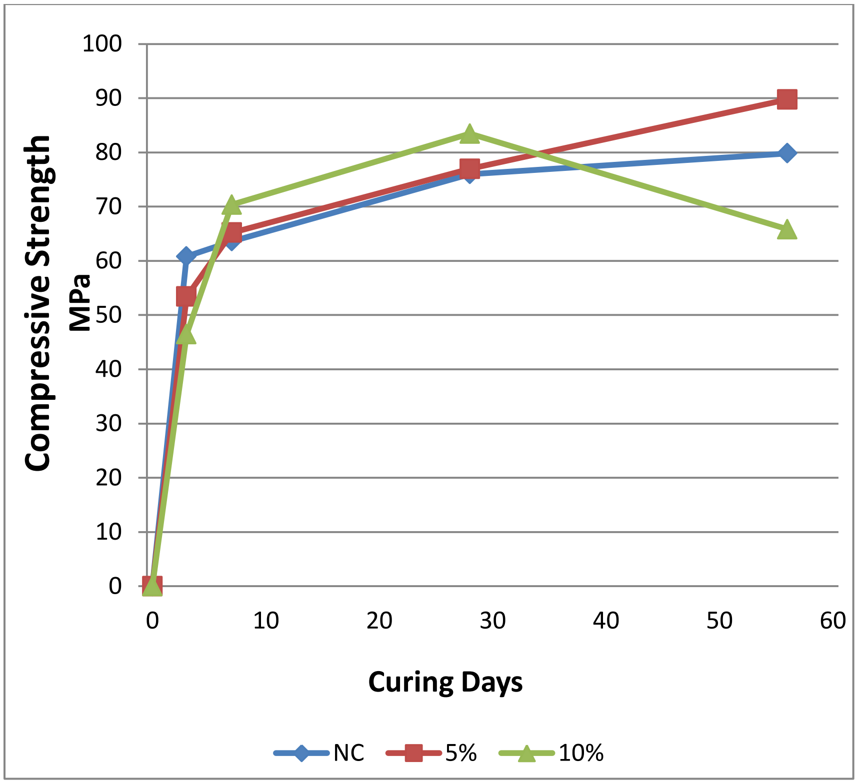

Figure 14: Compressive strength development of concrete sample with MIRHA at 700 °C and 3000 cycles

In the early curing days, control concrete samples have gained strength faster than MIRHA concrete samples while 5% additional of MIRHA at 56 days has the highest level of compressive strength among MIRHA at 700°C and 3000 cycles concrete samples.

After 28 days, the 10 % MIRHA achieved compressive strength performance 9.78% higher than control concrete, and 8.419% higher than 5% MIRHA concrete. However, at the age of 56 days, 5% MIRHA concrete achieved compressive strength performance 12.47% higher than control concrete, and 36.36% higher than 10% MIRHA concrete.

4.4 Splitting tensile strength

Splitting tensile strength data of MIRHA at both temperatures and grinding cycles, concrete were lower than those of the normal concrete at the age of 28 days, while MIRHA concrete achieved the highest splitting tensile strength at the age of 56 days.

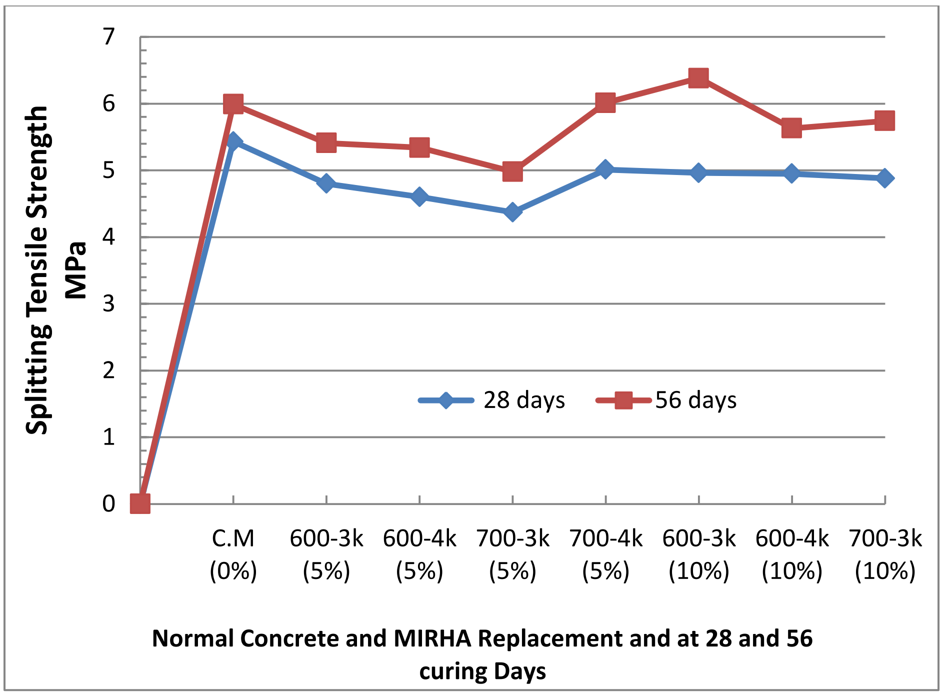

Figure 15: splitting tensile strength development of concrete

Figure 15 shows that the highest value obtained from splitting tensile strength among MIRHA concrete at 56 days, is in the range of 600 °C and 3000 cycles with 10 % replacement of MIRHA. Control concrete achieved splitting tensile strength performance at 28 days,11.6 % higher than 600-4k for 5% replacement, 15.2 % higher than 600-4k for 5% replacement, 19.5% higher than 700-3k for 5% replacement, 7.73% higher than 700-4k for 5%replacement, 8.66% higher than 600-3k for 10% replacement, 8.84 higher than 600-4k for 10% replacement, and 10.12% higher than 700-3k for 10%replacement.

After 28 days, additional of 10% MIRHA concrete with 600 °C and 3000 cycles achieved splitting tensile strength performance 6.51% higher than Normal concrete,17.93% higher than 600-3k for 5% replacement, 19.47% higher than 600-4k for 5% replacement, 28.11% higher than 700-3k for 5%replacement, 13.32% higher than 700-3k for 10% replacement, and 11.14% higher than 700-4k for 10% replacement.

4.5 Workability of concrete

From Figure 16 shows that the MIRHA concrete for 600°C and 3000 grinding cycles obtained higher workability compared to control concrete. The end results show that the less grinding and replacement of MIRHA, the high workability of MIRHA concrete is achieved.

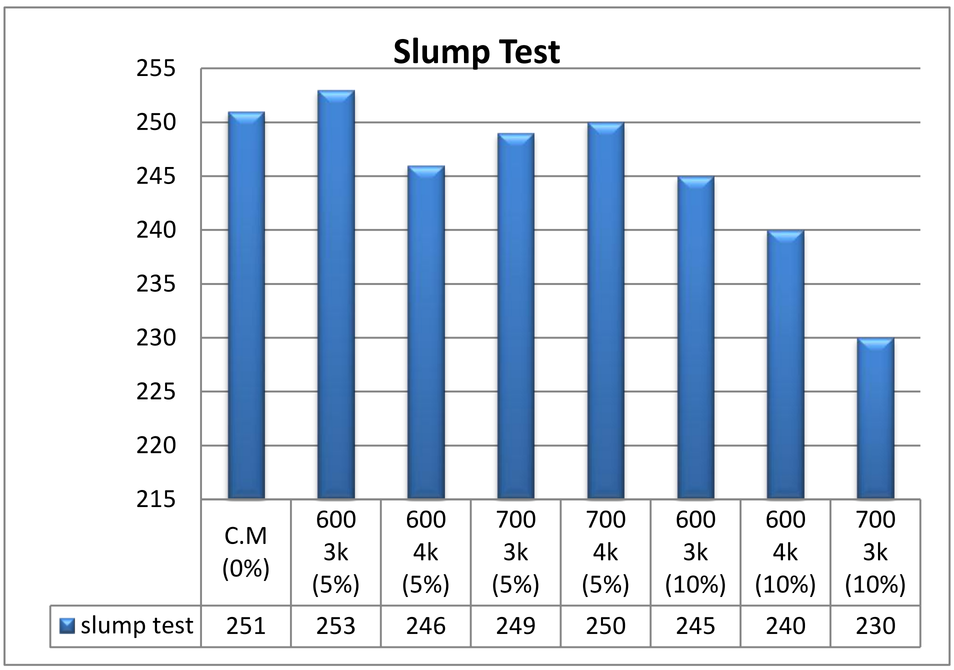

Figure 16: Slump Test Result

The 5 % MIRHA replacement concrete for both optimum temperatures show higher workability on concrete comparing to 10 % MIRHA replacement concrete.

CHAPTER 5

CONCLUSION

5.1 Conclusions

This research were carried out to identify the best burning procedure of rice husk, to obtain quality rice husk ash that can significantly improve the concrete properties. The utilization of Microwave Incinerated Rice Husk Ash (MIRHA) into the concrete mix proportions has brought into various effects to the concrete properties. The improvement of compressive strength and splitting tensile strength results of MIRHA concrete samples were influenced by the quality of MIRHA and mix proportion. The following conclusions can be drawn from the study:

1- MIRHA is a new material that can be used as cement replacement material (CRM) and it gives opportunity to the construction industries to reduce their cost while preserving the environment quality.

2- Burning RHA by using microwave incinerator was found to be the best way to produce optimal output of RHA in terms of Si2O quantity and quality [9].

3- Even at three days, MIRHA concretes show higher in terms of strength compared to NC (normal concrete). This research shows that burning MIRHA at 600°C and grind it at 3000 cycle , produce concrete with higher strength compared to other burning temperature and grinding cycles, regardless of MIRHA percentage inclusion. Temperatures of 600°C and 3000 grinding cycles revealed that an additional of 5% of MIRHA is the optimum percentage of cement replacement to produce concrete with good performance at early age and gained higher strength.

4- Splitting tensile strength of MIRHA at both temperatures and grinding cycles, concrete were lower than those of the control concrete at the age of 28 days, while 10% replacement of MIRHA concrete achieved the highest splitting tensile strength at the age of 56 days at 600°C and 3000 cycles.

5- MIRHA concrete for 600°C and 3000 grinding cycles obtained higher workability of concrete among all MIRHA mixes, and compared to control concrete. The end results show that the less grinding and replacement of MIRHA, the high workability of MIRHA concrete is achieved.

5.2 Recommendations for Future Research.

To explore the potential of MIRHA application in construction industries, the following works are recommended to analyze the concrete properties containing MIRHA more comprehensively:

1- This research observed the effect of MIRHA on dry and wet concrete with the slump value kept between 30 – 60 mm. As the amount of water can affect the performances of MIRHA, it is recommended that wider range of H2O content is taken into consideration.

2- For finest of MIRHA particle, this research observed the effect of MIRHA with two range of size. Grinding the MIRHA more finely may result in a more rapid increase in strength.

Hence, commercializations of MIRHA also need to be considered. There have a lot of findings and studies show MIRHA is a good material as a cement replacement material. Up to this extent, the utilization of MIRHA can be exploited.

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