UNIVERSITI MALAYSIA PAHANG

DECLARATION OF THESIS AND COPYRIGHT

Author's Full Name : MUHAMMAD AIZUDDIN BIN MOHAMMAD

Date of Birth : 7 JULY 1994

Title : PROPERTIES OF CEMENT BRICK CONTAINING COCONUT HUSK FIBER AS PARTIAL SAND REPLACEMENT

Academic Session : 2016/2017 SEM 2

I declare that this thesis is classified as:

☐	CONFIDENTIAL	(Contains confidential information under the Official Secret Act 1997)*
☐	RESTRICTED	(Contains restricted information as specified by the organization where research was done)*
☑	OPEN ACCESS	I agree that my thesis to be published as online open access (Full Text)

I acknowledge that Universiti Malaysia Pahang reserves the following rights:

1. The Thesis is the Property of Universiti Malaysia Pahang
2. The Library of Universiti Malaysia Pahang has the right to make copies of the thesis for the purpose of research only.
3. The Library has the right to make copies of the thesis for academic exchange.

Certified by:

(Student's Signature) (Supervisor's Signature)

940707-03-5013
New IC/Passport Number
Date: 9/6/2017

Name of Supervisor
Date:

NOTE : * If the thesis is CONFIDENTIAL or RESTRICTED, please attach a thesis declaration letter.

THESIS DECLARATION LETTER (OPTIONAL)

Librarian,
Perpustakaan Universiti Malaysia Pahang,
Universiti Malaysia Pahang,
Lebuhraya Tun Razak,
26300, Gambang, Kuantan.

Dear Sir,

CLASSIFICATION OF THESIS AS RESTRICTED

Please be informed that the following thesis is classified as RESTRICTED for a period of three (3) years from the date of this letter. The reasons for this classification are as listed below.

Author's Name	MUHAMMAD AIZUDDIN BIN MOHAMMAD
Thesis Title	PROPERTIES OF CEMENT BRICK CONTAINING COCONUT HUSK FIBER AS PARTIAL SAND REPLACEMENT

Reasons (i)

(ii)

(iii)

Thank you.

Yours faithfully,

_____
(Supervisor's Signature)

Date:

Stamp:

Note: This letter should be written by the supervisor, addressed to the Librarian, *Perpustakaan Universiti Malaysia Pahang* with its copy attached to the thesis.

Universiti Malaysia PAHANG
Engineering • Technology • Creativity

SUPERVISOR'S DECLARATION

I/We* hereby declare that I/We* have checked this thesis/project* and in my/our* opinion, this thesis/project* is adequate in terms of scope and quality for the award of the degree of *Doctor of Philosophy/ Master of Engineering/ Master of Science in Bachelor of Civil Engineering

(Supervisor's Signature)

Full Name : DR. GUL AHMED JOKHIO

Position : SENIOR LECTURER

Date : 19 JUNE 2017

(Co-supervisor's Signature)

Full Name :

Position :

Date :

Universiti Malaysia PAHANG
Engineering • Technology • Creativity

STUDENT'S DECLARATION

I hereby declare that the work in this thesis is based on my original work except for quotations and citations which have been duly acknowledged. I also declare that it has not been previously or concurrently submitted for any other degree at Universiti Malaysia Pahang or any other institutions.

(Student's Signature)

Full Name : MUHAMMAD AIZUDDIN BIN MOHAMMAD

ID Number : AA13082

Date : 19 JUNE 2016

PROPERTIES OF CEMENT BRICK CONTAINING COCONUT HUSK FIBER AS PARTIAL SAND REPLACEMENT TITLE

MUHAMMAD AIZUDDIN BIN MOHAMMAD

Thesis submitted in fulfillment of the requirements
for the award of the
Bachelor Degree in Civil Engineering

Faculty of Civil Engineering and Earth Resources

UNIVERSITI MALAYSIA PAHANG

JUNE 2017

ACKNOWLEDGEMENTS

First of all I would like to give thanks my supervisor, Dr. Gul Ahmed Jokhio for his help in my effort to complete the research. He has shown encouragement and share knowledge and guided me to do this research. He has provide a lot of assistance from the beginning to the end and this has make me very thankful for having such a good supervisor.

I also would like to thanks my parent for all their support and encouragement for me to pursue my dream. Without their help, I would never become who I am today. I will try my best to make them proud of me. That is the only way I can make their effort and sacrifice worth it.

I also would like to thanks friends and all those who had contributed for this research either directly or indirectly. This really means a lot for me. I really appreciate every help that I have received from the beginning until the end no matter big or small.

ABSTRAK

Serat sabut kelapa boleh digunakan sebagai bahan untuk meningkatkat kualiti bata simen jika digunakan dengan betul. Kajian ini bertujuan untuk menyiasat sifat bata yang dicampurkan dengan serat sabut kelapa. Kesan penambahan serat sabut kelapa ke atas kekuatan mampatan, kekuatan lenturan dan penyerapan air bata akan dikaji.Serat kelapa adalah antara serat semulajadi yang paling mulur. Serat kelapa mampu adalah 4-6 kali lebih kuat berbanding serat lain. Sampel bersaiz 210mm x 100mm x 65mm disediakan untuk 7, 14 dan 28 hari. Sampel tersebut akan mengandungi 0%, 2%, 4%, dan 6% serat sabut kelapa. Kekuatan mampatan dan kekuatan lenturan meningkat dengan tinggi apabila 4% serat kelapa dicampur ke dalam bata. Sebagai kesimpulan, serat sabut kelapa boleh digunakan untuk meningkatkan kualiti bata simen.

ABSTRACT

Coconut Husk Fiber can be use as material to increase the quality of concrete brick if used properly. This research is to investigate the properties of brick when coconut husk are mixed as material. The effect of the coconut husk fiber amount on the compressive strength, flexural strength and water absorption will be investigated in this research. Coconut fibre amongst all natural fibres is the most ductile. Coconut fibres have the capacity of taking strain 4-6 times more than that of other natural fibres. Sample with size 210mm x 100mm x 65 mm were cast and tested at 7, 14 and 28 days. The sample consist of 0%(control), 2%, 4% and 6% coconut husk fiber content. There is an increase in compressive and flexural strenght for 4% and below percentage of coconut husk fiber. In conclusion, coconut husk fiber can be use as material to increase the quality of concrete brick.

TABLE OF CONTENT

CHAPTER 3 METHODOLOGY

CHAPTER 4 RESULTS AND DISCUSSION

CHAPTER 5 CONCLUSION

LIST OF TABLES

LIST OF FIGURES

CHAPTER 1

INTRODUCTION

1.1 Background

Even though there are many advanced technologies in construction industry such as reinforced concrete, steel structure and Industrial Building System, brick are still use as important material in some construction. Brick is a building material used in constructing wall, pavement and sometimes column.

There are many type of brick used in construction. The types are common burnt clay brick, sand lime brick, engineering brick, concrete brick and fly ash clay brick. Common burnt clay brick are made by pressing clay in moulds. Then it is dried and burn in a kiln. This brick are reddish in colour. Sand lime brick are made from sand, fly ash and lime mixed together. After it is mixed, the mix is moulded under pressure to make the brick. The brick are gray in colour. Engineering brick are manufactured at very high temperature causing it to become dense and strong. Concrete bricks are made from concrete. Fly ash clay brick are manufactured from clay and fly ash at 1000 degrees celcius.

Bricks are chosen as construction material for many reasons. The first one is aesthetic. Brick has variety of colour and textures. It also has excellent compressive strength. Brick is also good for insulation. It is used to help maintain interior temperature and save energy. A brick structure can have 6 hour maximum fire protection rating if prepared

Malaysia produced a lot of natural waste material from industry and agriculture. The waste can be reduced by recycling them into materials for building construction. In this research, coconut husk fibers are used as additive material to reinforced brick.

1.2 Problem Statement

The demand of concrete brick increase as the construction industry grows. A lot of concrete brick are use in many constructions. High usage of bricks increases the cost of construction. New type of environmental friendly and cheaper brick is required to reduce construction cost and take care of the environment.

Waste from agricultural industry can be use to increase the strength of concrete brick. The material can be found easily, environmental friendly and cheap. The natural fiber in the coconut husk has potential to improve the properties of the concrete brick to create better quality brick at less cost.

To find a solution to the situation, a study to investigate the effect of using coconut husk as additive material in concrete brick. Use of coconut husk fiber will lower the cost of construction, reduce environmental problem and optimize the use of waste material.

1.3 Objective

i. To study the effect of increasing percentage of coconut husk fiber as material on compressive strength of bricks
ii. To determine the effect of increasing coconut husk fiber on the flexural strength of bricks
iii. To investigate the effect of coconut husk fiber as additive material on the water absortion of brick

1.4 Scope Of Study

The coconut fibers are used as material for the purpose of strengthening the brick mechanical properties. It will be use as partial sand replacement in the bricks sample of 1:5 cement to sand ration brick. The brick will undergo water curing for 7, 14 and 28 days.

The bricks sample will be tested for compressive strength, flexural strength and water absorption test. The sample contain 2%, 4% and 6% of coconut husk fibers. Compressive strength and flexural strength are tested on day 7^{th} , day 14^{th} and day 28^{th} of curing and water absorption of the sample are tested on day 28^{th}.

1.5 Significance of study

This study will help us to reduce the waste product from agriculture industry by recycling it for better use. If we can recycle the waste, we can reduce the pollution of the environment and help keep the earth clean. We also may be able to reduce the cost of construction material by using recycled waste product to replace part of it.

CHAPTER 2

LITERATURE REVIEW

2.1 INTRODUCTION

Brick are the most common used element in construction. It is the basic building component. A brick is building material used to make walls, pavements and other elements in masonry construction. Traditionally, the term brick referred to a unit composed of clay, but it is now used to denote any rectangular units laid in mortar.

2.2 Type of Brick

2.2.1 Common Burnt Clay Brick

These type of bricks are made from clay. Regular clay are pressed in the mold to give turn them to rectangular shape. The clay used is soft and after being mold it will be left to dry before burnt in a kiln. They are used in regular work and require plastering or rendering when used in a wall.

2.2.2 Sand Lime Brick

Sand lime brick is made using lime instead of cement. It is usually white brick made of lime, sand and water. The production of this type of brick is limited. They are available in severe weathering and moderate weathering.

2.2.3 Engineering Brick

This type of brick is used when high compressive strength and low water porosity are needed. Engineering brick are rated by class A or class B. Class A is the

stronger one with compressive strength greater than 125N/mm^2. Class B have compressive strength greater than 75N/mm^2.

2.2.4 Concrete Brick

This type of brick is very common for homebuilder. They are made from a dry, small aggregate concrete which is formed in steel moulds by vibration and compaction in either an "egglayer" or static machine. The finished blocks are cured, rather than fired, using low-pressure steam.

2.3 Coconut Husk Fiber

The coconut tree (Cocos nucifera) is a member of the family Arecaceae (palm family) and the only species of the genus Cocos. The coconut husk fiber is waste product from the agriculture industry. The husk of the coconut also known as Coir contains fiber that can be used to improve the compressive strength of concrete.

It can also be used for fuel. In ancient time, the coconut husk fiber were used to make rope and cordage. The sailor would use the fiber for their ship rope. Mature brown fiber contain more lignin and less cellulose.

Total coconut husk production is 250, 000 tonnes. Sri Lanka produce 36% of brown coconut husk fiber output.

2.4 Type of strength

There are 2 type of strength that will be tested in this research.

2.4.1 Compressive strength

Compressive strength is the capacity of a structure to withstand load tending to reduce size. Some material may fracture at their compressive strength limit. Compressive strength is often measured on a universal testing machine

2.4.2 Flexural Strength

Flexural strength, also known as modulus of rupture, or bend strength, or transverse rupture strength is a material property, defined as the stress in a material just before it yields in a flexure test. (Michael Ashby, 2011)

Flexural strength identifies the amount of stress and force an unreinforced concrete slab, beam or other structure can withstand such that it resists any bending failures

2.5 Water Absorption Test

Water absorption is a major factor for the durability of bricks. The higher absorption of water would contribute to a rapid deterioration of the material. Water absorption of quarry fly ash clay brick was lower compared to clay brick during all the days of testing and this may result in a reduction of damping (Sivagnanaprakash et al., 2016).

The coir fiber is relatively water proof and is one of the natural fiber that are resistant to damage by salt water.

CHAPTER 3

METHODOLOGY

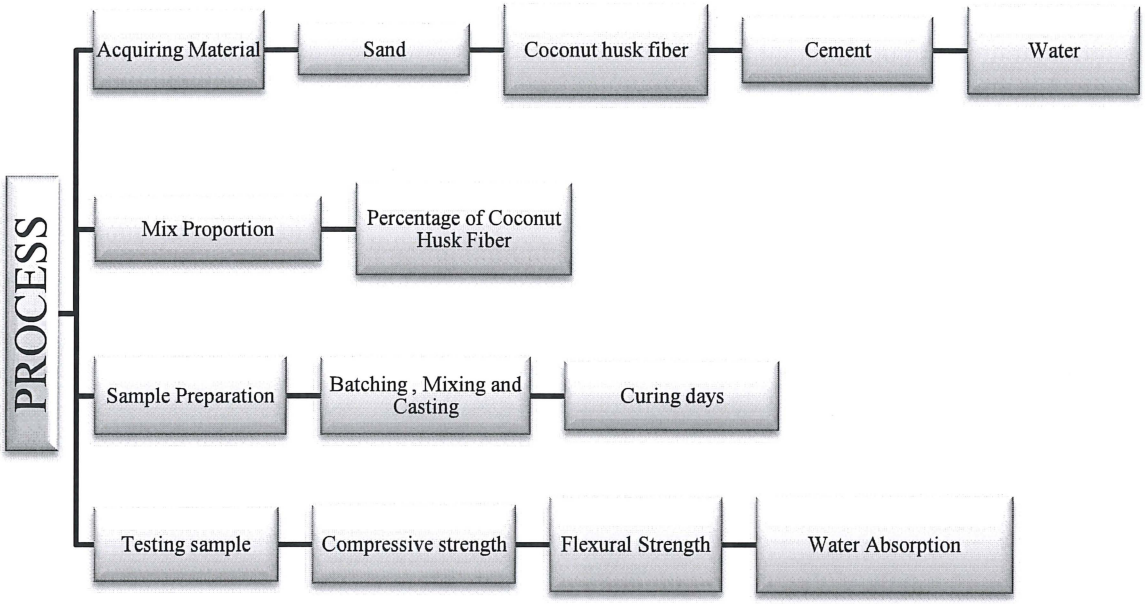
3.1 Introduction

This chapter will discuss about the physical and mechanical properties of the test specimen and the procedure of specimen preparation. The objective of this research to determine the effect of different percentage of coconut husk fiber on the compressive strength, flexural strength and water absorption of concrete brick.

In order to obtain the data for the properties, three test will need to be conducted. The test that are conducted are compressive strength test, flexural strength test, and water absorption test. The data obtain from this laboratory experiment will be use in the analysis and will be visualize in the from of table, graph and chart.

There are 4 different percentage of coconut husk fiber used for the testing that are 0%, 2%, 4% and 6% of sand replacement. The test for compressive strength and flexural strength are conducted at day 7^{th}, 14^{th} and 28^{th}, while the water absorption test is conducted day 28^{th}.

3.2 Flow of works



3.3 Preparation of Material

3.3.1 Ordinary Portland Cement

Portland cement is the most commonly used type of cement. It is used as basic ingredient in concrete, mortar and grout. It is made up of fine powder that is produced by heating limestone and clay mineral in kiln. It form clinker and the clinker are grinded. The function of the cement in the mix is as a binding material that holds the other materials together. Cement binds the material by becoming harder. Cement hardens by chemical process called hydration.

Figure 3.1: Portland Cement

3.3.2 Sand

Sand is a naturally occurring granular material composed of finely divided rock and mineral particles. It is defined by size, being finer than gravel and coarser than silt. The sands used in the making of the sample are sieved through 4.75 mm before added into the mix. This makes sure the size of the sand is uniform. Sand reduce the shrinkage in setting and drying, therefore minimizing cracking.

Figure 3.2: Sand

3.3.3 Water

Water is the chemical reaction agent in cement to bind all fine aggregates in the mixture. Tap water is used in this experiment to avoid chemical or organic materials. Chemical or organic material may influence the strength of the concrete if it reacts with the mix. Water combines with cement to form cement paste. The combination reacts and hardens through hydration process binding the material together. The volume of water will affect the workability, compressive strength, permeability and water tightness, durability and weathering, drying shrinkage and potential for cracking.

3.3.4 Coconut Husk Fiber

Coconut husk fibers are waste product that is produced from agriculture industry. It is also known as coir. Natural fibers had been used before to reinforced inorganic material.

Figure 3.3: Coconut Husk Fiber

3.4 Mix Proportion

The percentages of coconut husk fibers used to partially replace sand are 0%, 2%, 4% and 6%. The cement to sand ratio is 1:5 and the water to cement ratio is 0:6

Percentage %	Cement Kg/m^3	Sand Kg/m^3	Coconut Fiber Kg/m^3
0	10.50	52.5	-
2	10.50	51.45	1.05
4	10.50	50.04	2.1
6	10.50	49.35	3.15

Table 3.1: Mix proportion

3.5 Brick Design

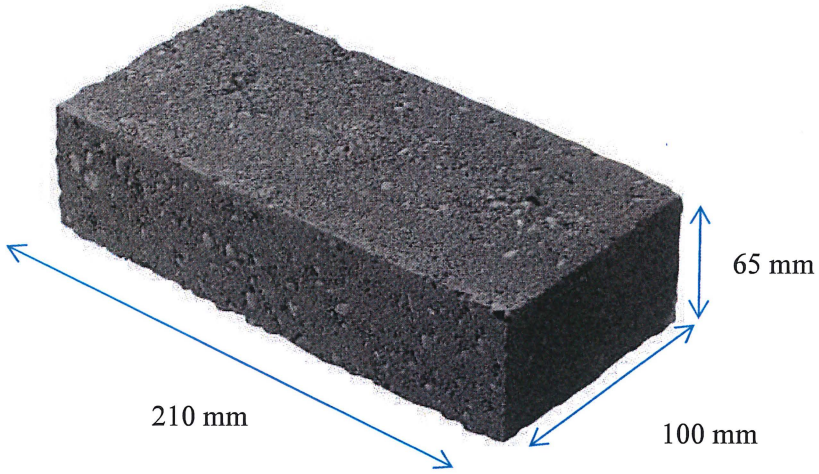


Figure 3.4: Brick Size

The mix design is based on mix proportion. The size of the brick is 100 mm x 210 mm x 65 mm (WxHxL)

3.6 Mould Design

Timbers are used to make the mould for casting the brick because it is the easiest to use and build. The timber mould consists of ten space for casting and each space is the size of the brick. It can be recycle for casting another concrete brick.

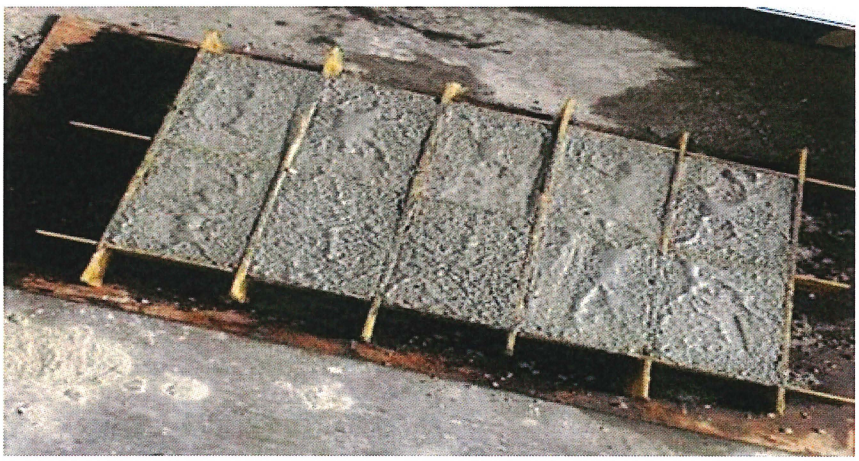


Figure 3.5: Mould

3.7 Mixing Procedure

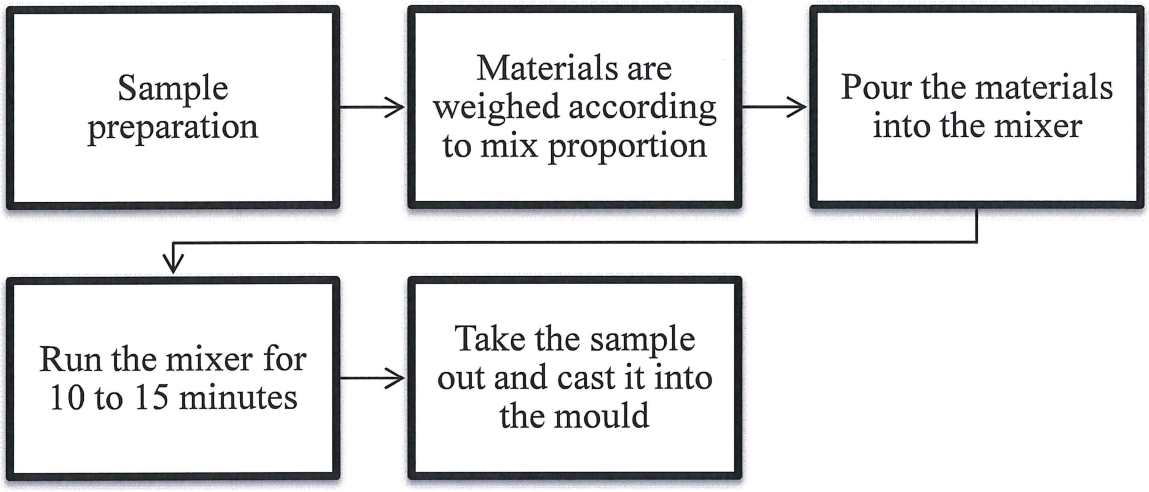


Figure 3.6: Work flow for mixing

Figure 3.7: Mixing Process

3.8 Curing

Water curing is used for this experiment. Water curing is the most effective way to prevent water evaporation from the mix. The brick is immersed in water for several days for proper time for water curing. The moisture will retain in the brick and it will

gain strength. Water curing also delay shrinkage of brick until it is strong enough to resist cracking due to shrinkage. The duration for curing in this experiment is 7, 14 and 28 days.

Figure 3.8: Water Curing

3.9 Testing Method

The sample are tested for compressive strength, flexural strength and water absorption. It will be explained in the section below.

3.9.1 Compressive Strength

To determine the average strength, three cement bricks are tested for the compressive strength value. The tests are carried on the 7, 14 and 28 days. The brick are placed on a flat surface and applied force by movable steel bearing. The loads are applied at constant rate. When the brick fails, record the reading of the maximum load

that was applied to it. Divide the load by the value of the surface area that was applied the load and you will get the compressive strength of the brick.

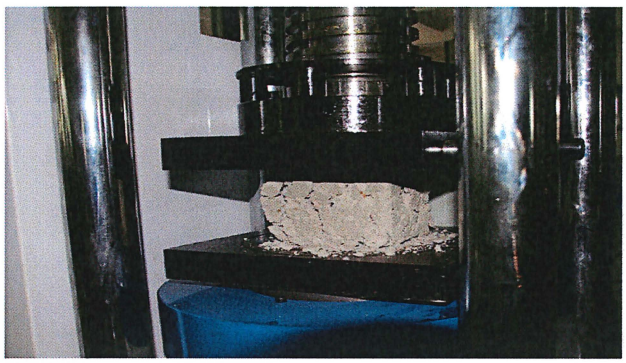


Figure 3.9: Compressive Strength Test

3.9.2 Flexural Strength

To determine the average strength, three cement bricks are tested for the flexural strength value. The tests are carried on the 7, 14 and 28 days. The brick are placed on a two bearing surface supporting each end of the brick and applied force by block in the middle of it. The loads are applied at constant rate. When the brick fails, record the reading of the maximum load that was applied to it.

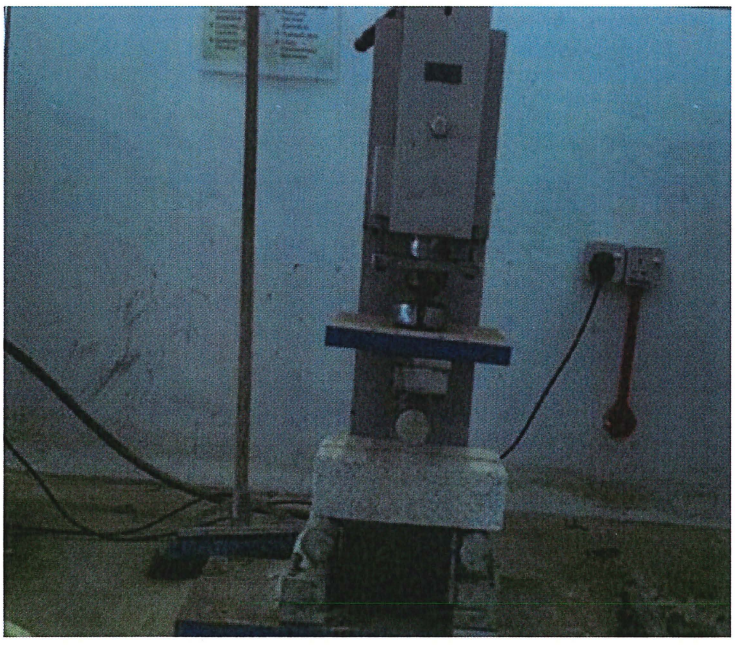


Figure 3.10: Flexural Strength Test

3.9.3 Water Absorption

Water absorption test is carried out to investigate the percentage of water absorption of the bricks. To obtain the average water absorption, three bricks are used for the experiment. The test is carried out on the 28 days. First the sample is dried in the oven at 105^{O} for 24 hours. After that, cool the sample at room temperature. Then weight each of the samples to obtain the value of M1. Immerse the samples in clean water at temperature $27+2^{O}$ for 24 hours. Take the sample out and wipe the traces of water on the surface away with a damp cloth. Weight the sample to obtain M2. The formula to calculate the water absorption is as follow:

$$W = \frac{M1+M2}{M1} \qquad (3.1)$$

Figure 3.11 Water Absorption Test

CHAPTER 4

RESULTS AND DISCUSSION

4.1 Introduction

This chapter will be about the result about the mechanical properties of the brick when different percentage of coconut husk that was use as partial sand replacement that was used in the experiment. The results are obtained from three test that are compressive strength test, flexural strength test and water absorption test. The data and result will be presented in the form of graph, table and bar chart to better illustrate the effect of the different percentage of coconut husk fiber. It will be divided into 3 section. Section 4.2 will show the result of compressive strength test. Section 4.3 will show the result of flexural strength test. Section 4.4 will show the result from the water absorption test.

4.2 Compressive Strength Result

The compressive strength of the brick was tested after water curing of 7, 14 and 28 days. The test was done by applying uniform load to the brick until it start to crack.

The result for compressive strength for day 7 are shown in table 4.1 and illustrated in figure 4.1.

Percentage of Coconut Husk Fiber (%)	Stress (MPa)
0	5.32
2	5.87
4	6.07
6	5.27

Table 4.1: Compressive Strength For 7 days Curing Period

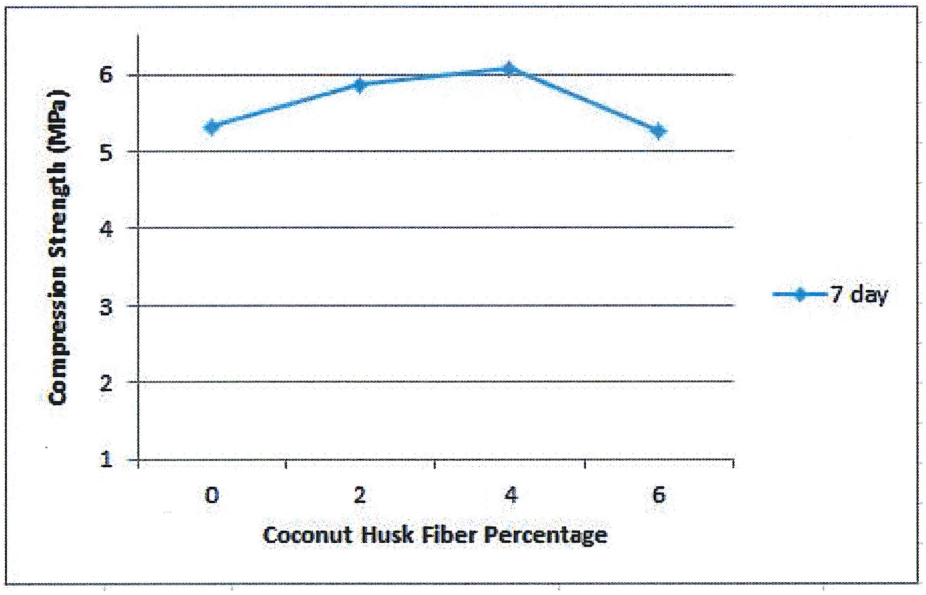


Figure 4.1: Compressive Strength For 7 days Curing Period

The result for compressive strength for day 14 are shown in table 4.2 and illustrated in figure 4.2.

Percentage of Coconut Husk Fiber (%)	Stress (MPa)
0	6.04
2	6.15
4	6.91
6	5.76

Table 4.2: Compressive Strength For 14 days Curing Period

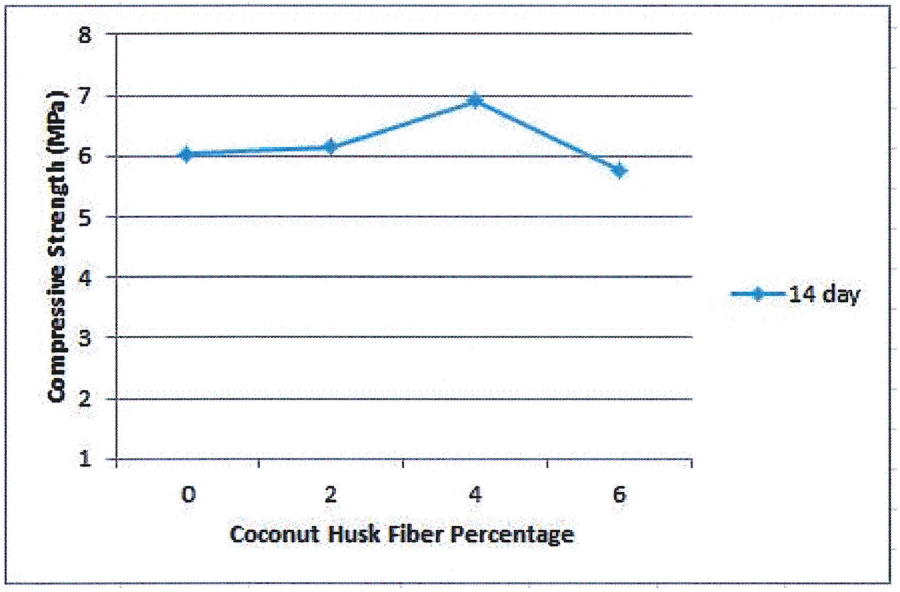


Figure 4.2: Compressive Strength For 14 days Curing Period

The result for compressive strength for day 28 are shown in table 4.3 and illustrated in figure 4.3.

Percentage of Coconut Husk Fiber (%)	Stress (MPa)
0	6.75
2	6.90
4	7.88
6	6.55

Table 4.3: Compressive Strength For 28 days Curing Period

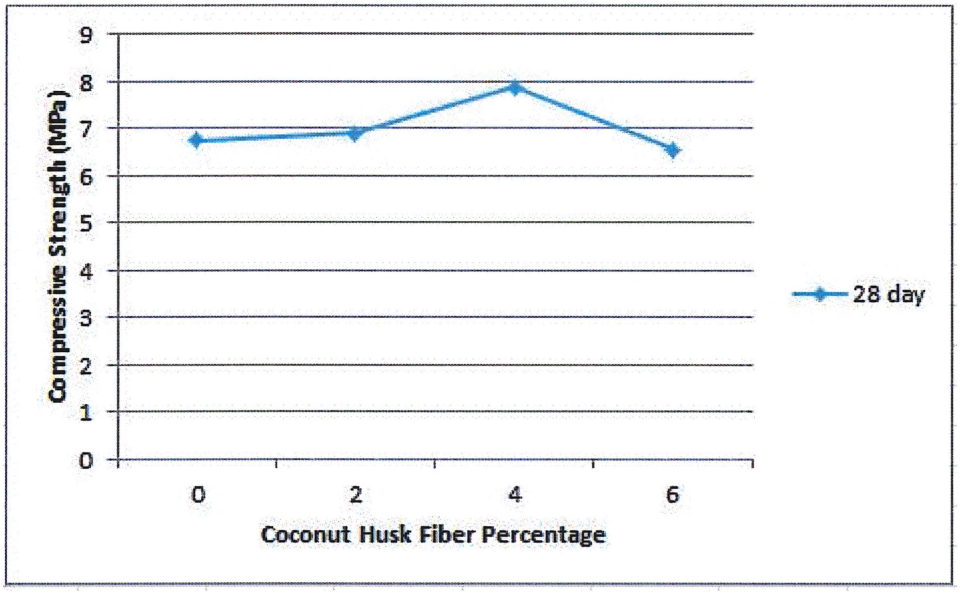


Figure 4.3: Compressive Strength For 28 days Curing Period

4.3 Flexural Strength Result

The flexural strength of the brick was tested after water curing of 7, 14 and 28 days. The test was done by applying load to the center of brick until it break.

The result for flexural strength for day 7 are shown in table 4.4 and illustrated in figure 4.4.

Percentage of Coconut Husk Fiber (%)	Stress (MPa)
0	0.183
2	0.192
4	0.268
6	0.161

Table 4.4: Flexural Strength For 7 days Curing Period

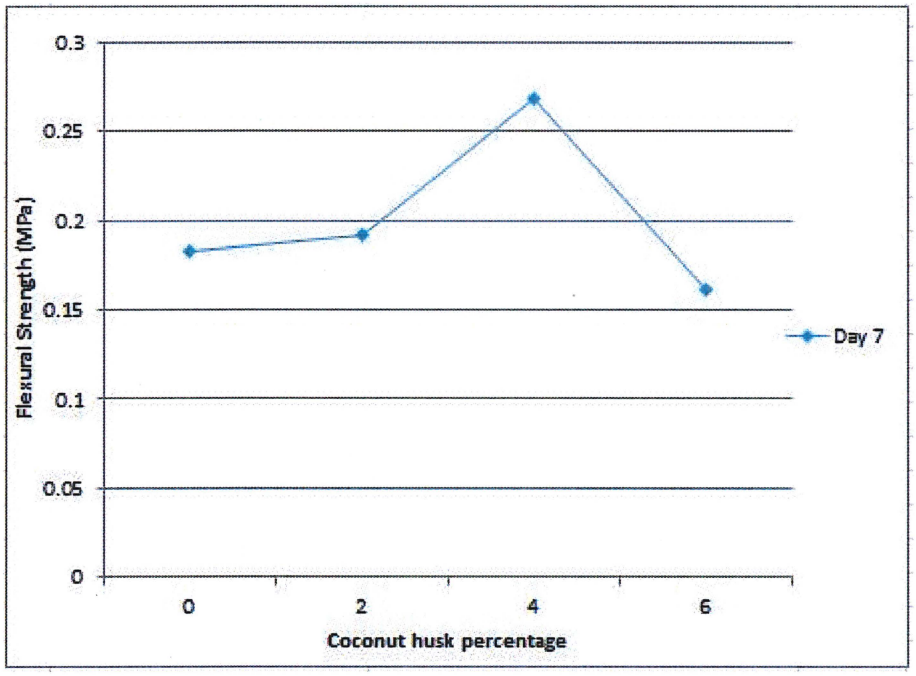


Figure 4.4: Flexural Strength For 7 days Curing Period

The result for flexural strength for day 14 are shown in table 4.5 and illustrated in figure 4.5.

Percentage of Coconut Husk Fiber (%)	Stress (MPa)
0	0.279
2	0.310
4	0.329
6	0.218

Table 4.5: Flexural Strength For 14 days Curing Period

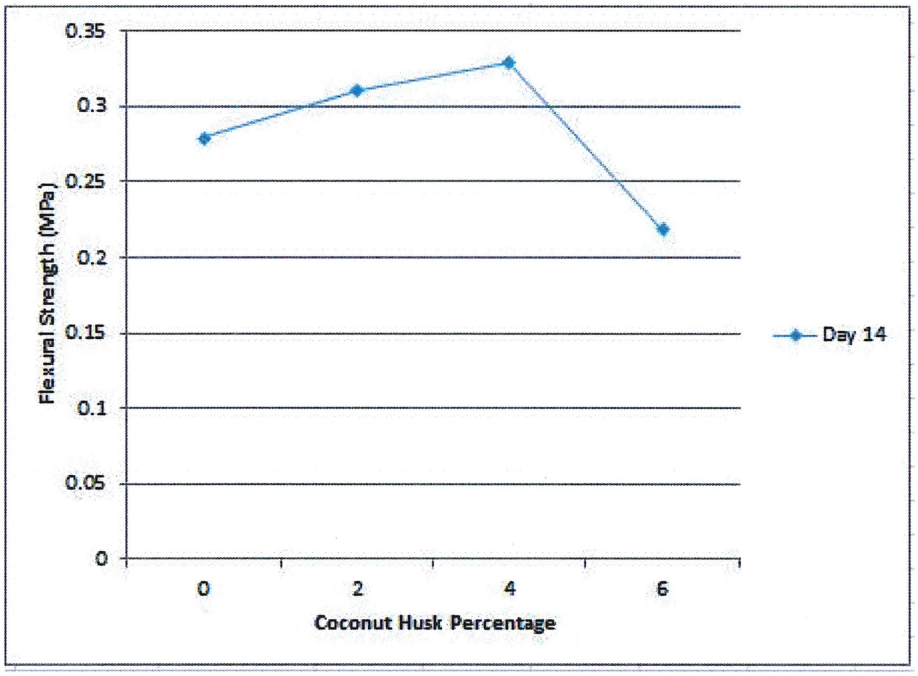


Figure 4.5: Flexural Strength For 14 days Curing Period

The result for flexural strength for day 28 are shown in table 4.6 and illustrated in figure 4.6.

Percentage of Coconut Husk Fiber (%)	Stress (MPa)
0	0.345
2	0.429
4	0.457
6	0.339

Table 4.6: Flexural Strength For 28 days Curing Period

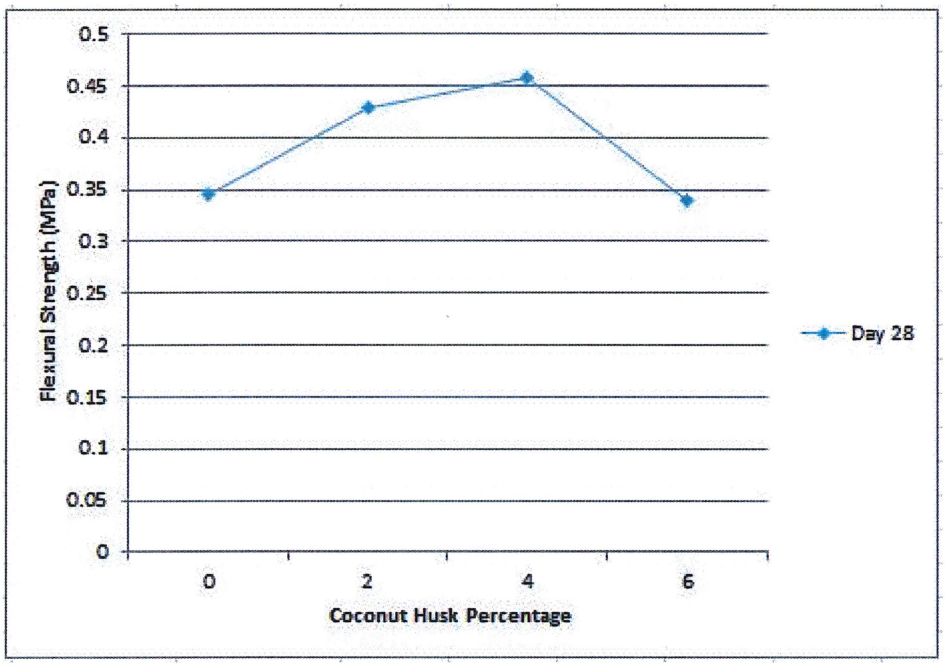


Figure 4.6: Compressive Strength For 28 days Curing Period

4.4 Water Absorption Result

The water absorption results for 28 days curing period are shown in Table 4.7 and Figure 4.9.

Percentage of Coconut Husk Fiber (%)	Stress (MPa)
0	9.82
2	10.15
4	10.32
6	10.81

Table 4.7: Water Absorption For 28 days Curing Period

CHAPTER 5

CONCLUSION

5.1 Introduction

The main objective of this research is to find the optimum ratio of coconut husk fiber in cement brick. The second objective was to determine the characterictic of cement brick in term of compressive strength, flexural strength and water absorption. The data was analysed to reach conclusion to the objective of the study.

5.2 Conclusion

The conclusions that can be made from this study are:

i) The compressive strength of the brick can be increased using coconut husk fiber percentage of 4% and below. At 6%, the effect become the opposite and causes the compressive strength to drop with more increase of coconut husk. The test have shown that coconut fiber at 4% concentration is optimal to increase the compressive strength of concrete

ii) The flexural strength also found out to increase with addition of the coconut fiber. This prove that coconut husk fiber can be use to increase the strength of concrete brick. The flexural strength is the highest for brick that contain 4% coconut husk fiber and decrease at 6% coconut husk fiber content.

iii) The water absorption is affected by the addition of coconut husk fiber into the brick. Brick with higher content of coconut husk fiber show increase in water absorption. This can be caused by the fiber ability to absorb water. Coconut husk fiber has high ability to absorb water.

iv) This study shows that coconut husk fiber could be a prospective potential as a partial sand replacement material

5.3 Recommendation

i. Use different percentage of fibre to study the effect of higher fibre content

ii. Adjustment of w/c to get workability of concrete

iii. Use the fibre as partial replacement for cement instead of sand

REFERENCES

Olanipekun et al., (2006); Nor et al., (2010)

Noor Md. Sadiqul Hasan, al, (2012). The Use of Coconut Fibre in the Production of Structural Lightweight Concrete.

Mulinari, D.R., C.A.R. Baptista, J.V.C. Souza and H.J.C. Voorwald, 2011. Mech properties of coconut fibers reinforced polyester composites. Procedia Eng., 10: 2074-2079

Gunasekaran, K. and P.S. Kumar, 2008. lightweight concrete using coconut shells as aggregate. Proceedings of International Conference on Advances in Concrete and Construction, February 7-9, 2008, Hyderabad, India, pp: 450-459 4