UNIVERSITI TEKNIKAL MALAYSIA MELAKA

THE INVESTIGATION OF LIGHTWEIGHT BRICK MADE FROM RICE HUSK

This report is submitted in accordance with requirement of the Universiti Teknikal Malaysia Melaka (UTeM) for the Bachelor Degree of Engineering Technology (Automotive Technology) with Honours.

by

MUHAMMAD HAZIQ ILHAM BIN ROSLAN
B071410491
950802-10-6165

FACULTY OF ENGINEERING TECHNOLOGY
2017

UNIVERSITI TEKNIKAL MALAYSIA MELAKA

BORANG PENGESAHAN STATUS LAPORAN PROJEK SARJANA MUDA

Tajuk: The Investigation of Lightweight Brick Made From Rice Husk

SESI PENGAJIAN: **2017/18 Semester 1**

Saya **MUHAMMAD HAZIQ ILHAM BIN ROSLAN**

mengaku membenarkan Laporan PSM ini disimpan di Perpustakaan Universiti Teknikal Malaysia Melaka (UTeM) dengan syarat-syarat kegunaan seperti berikut:

1. Laporan PSM adalah hak milik Universiti Teknikal Malaysia Melaka dan penulis.
2. Perpustakaan Universiti Teknikal Malaysia Melaka dibenarkan membuat salinan untuk tujuan pengajian sahaja dengan izin penulis.
3. Perpustakaan dibenarkan membuat salinan laporan PSM ini sebagai bahan pertukaran antara institusi pengajian tinggi.
4. **Sila tandakan (✓)

☐	SULIT	(Mengandungi maklumat yang berdarjah keselamatan atau kepentingan Malaysia sebagaimana yang termaktub dalam AKTA RAHSIA RASMI 1972)
☐	TERHAD	(Mengandungi maklumat TERHAD yang telah ditentukan oleh organisasi/badan di mana penyelidikan dijalankan)
☐	TIDAK TERHAD	

Disahkan oleh:

____

Alamat Tetap:

No. 71, Lorong Bunga Raya 4/C

Kg Sg Raya Batu 9 Cheras

43200, Kajang, Selangor

Cop Rasmi:

Tarikh: 06/1/2017

** Jika Laporan PSM ini SULIT atau TERHAD, sila lampirkan surat daripada pihak berkuasa/organisasi berkenaan dengan menyatakan sekali sebab dan tempoh laporan PSM ini perlu dikelaskan sebagai SULIT atau TERHAD.

DECLARATION

I hereby, declared this report entitled "The Investigation of Lightweight Brick Made from Rice Husk" is the results of my own research except as cited in references.

Signature	:	………………………………………….
Author's Name	:	MUHAMMAD HAZIQ ILHAM BIN ROSLAN
Date	:	06th JANUARY 2018

APPROVAL

This report is submitted to the Faculty of Engineering Technology of UTeM as a partial fulfillment of the requirements for the degree of Bachelor of Electrical Engineering Technology (Automotive Technology) with Honours. The member of the supervisory is as follow:

………………………………………..

Mr. Amir Abdullah Bin Muhamad Damanhuri

ABSTRAK

Malaysia kaya dengan pelbagai sumber semula jadi dan mineral dan salah satunya adalah tanah liat. Tanah liat tidak disangkal adalah bahan penting dalam pengeluaran bata tetapi eksploitasi sumber-sumber ini telah terbukti dalam pengurangan sumber. Penggunaan bahan buangan dalam pembuatan bata terkenal untuk pemuliharaan sumber yang semakin berkurang, mencegah kerosakan alam sekitar dan ekologi yang disebabkan oleh pengkelasan dan pengurangan bahan mentah. Bata yang terdapat di sesetengah kawasan mempunyai kualiti yang tidak baik, kekuatan mampatan yang rendah, penyerapan air yang lebih tinggi dan permukaan yang tidak rata. Oleh itu dalam kajian ini, abu sekam padi telah digunakan untuk penyediaan bata dalam penggantian tanah liat. Spesimen telah diganti dengan pelbagai penggantian tanah liat yang berbeza-beza sebanyak 0%, 5%, 10%, 15%, dan 20% dengan abu sekam padi. Spesimen telah diuji untuk penyerapan air dan kekuatan mampatan sesuai dengan Standard Malaysia EN 1008: 2010 selama 2 jam. Eksperimen menunjukkan bahawa penambahan abu sekam padi yang berlebihan mempunyai penyerapan air yang lebih tinggi dan kekuatan mampatan yang rendah adalah kerana peratusan abu sekam padi meningkatkan ciri abu sekam padi yang menguasai, ikatan antara zarah tanah liat dan zarah abu sekam padi adalah lemah. Dengan menambah 10% abu sekam padi mengikut beratnya adalah sifat batu bata yang paling baik iaitu 6.80 MPa kekuatan mampatan dan 16.30% penyerapan air. Spesimen dibandingkan dengan bata tanah liat yang sedia ada berdasarkan korelasi hasil dengan penambahan abu sekam padi.

ABSTRACT

Malaysia are gifted with a variety of natural and mineral resources and one of it is clay. Clay unarguable the most important materials in brick production but the exploitation of this sources has proven in resource depletion. The usage of waste materials in brick manufacturing is well known for conservation of dwindling resources, preventing environmental and ecological damages caused by quarrying and depletion of raw materials. Bricks that available in some regions have poor quality, low compressive strength, higher water absorption and uneven surfaces Therefore in this study, rice husk ash has been utilized for the preparation of bricks in partial replacement of clay. The specimens were cast with different replacement levels of clay varying as 0%, 5%, 10%, 15%, and 20% with rice husk ash. The specimens were tested for water absorption and compressive strength accordingly to Malaysian Standard EN 1008:2010 for 2 hours. Experimental shows that excessive addition of rice husk ash has higher water absorption and low compressive strength it is because rice husk ash percentage increases rice husk ash characteristics predominate, the bonding between the clay particle and the rice husk ash particles is weak. By adding 10% of rice husk ash by weight is the best brick properties which 6.80 MPa of compressive strength and 16.30% of water absorption. The specimens were compared with the existing clay brick based on the result correlation with the addition of rice husk ash.

DEDICATION

To my beloved parents

ROSLAN BIN IBERAHIM and **SITI INAH BINTI SAHADAN**.

Thank you for your softness in taking care of me, supporting, advisory and loving that gives my life happiness all the time.

My lovely sisters',

IZZATI, **FATIN** and **BELLA.**

Your support has always motivated me when I need it the most.

To all my friends,

Thanks for all the supports.

Wish all the happiness and cheerfulness will always colouring our life.

ACKNOWLEDGEMENT

First and foremost, gratitude and praises goes to ALLAH S.W.T, in whom I have put my faith and trust in. During the entire course of this study, my faith has been tested countless times and with the help of the Almighty, I have been able to pass the obstacles that stood in my way.

I also would like to take this opportunity to express profound gratitude to my supervisor En Amir Abdullah for the noble guidance and valuable advice throughout the period of study. His patience, time, and understanding are highly appreciated. A word of thanks also goes to the staffs of Jabatan Teknologi Kejuruteraan Mekanikal of Faculty of Engineering Technology who were directly or indirectly involved in the process of producing this research report, for their generous assistance, useful views and tips.

My sincere appreciation also extends to all my friends especially Syazwan, Malindo, Abi Dzar, Ong, Munawir, Muhammad, Faiz Nazari and others who have provided assistance at various. Their views and tips are useful indeed. Unfortunately, it is not possible to list all of them in this limited space.

Last but not least I would like to thank my family members whom I owe a debt of attitude for their prayers, encouragement and moral support throughout the whole duration of this studies.

TABLE OF CONTENT

LIST OF TABLES

LIST OF FIGURE

LIST OF SYMBOLS AND ABBREVIATIONS

Al_2O_3	-	Aluminium Oxide
BC	-	Before Century
BS	-	British Standard
C	-	Carbon
CO_2	-	Carbon Dioxide
CaO	-	Calcium Oxide
EN	-	European Standard
EPDM	-	Ethyl-ene-Propylene-dieneterpolymer
FaL – G	-	Fly Ash, Lime and Gypsum
Fe_2O_3	-	Iron Oxide
HSC	-	High Strength Concrete
MgO	-	Magnesium Oxide
O	-	Oxygen
OPC	-	Ordinary Portland Cement
PC	-	Portland Cement
RH	-	Rice Husk
RHA	-	Rice Husk Ash
Si	-	Silicon
SiC	-	Silicon Carbide
SiO2	-	Silicon Dioxide
w/c	-	Weight/Cement Ratio

CHAPTER 1
INTRODUCTION

1.1 Project Background

Malaysia is located in a tropical zone with relatively high temperature and it is known with its variability of natural resources and minerals which to a large extent constitutes the mass of a nation's richest. Such natural resources can be regenerative resources like land or non-renewable resources such as oil, natural gas, minerals (Ding, 2006). The rate of these resources have been long and it has been the defining semiotic code in reference to nations in where there are found. For such nations, these natural resources has become valuable national assets and an indication of their riches (Highly et al 2004, Akhtar 2005). This is because, when these natural resources and minerals are properly exploited and utilized, it will create wealth through industrialization and contribute to the socio-economic structure and development of any country (Akhtar, 2005).

According to Worrall (1986), the usage of clay itself could contribute immensely to socio-economic development. Clay has been defined as, "an earth that forms a coherent, sticky mass when mixed with water. When wet, this mass is easily mouldable, but if dried it becomes hard and brittle and retains its shape" which is great materials in brick manufacturing.

The mostly used bricks are prepared from clay and shale, they are used widely in the construction of walls by bleeding and jointing of bricks into setting up bonding arrangement. Clay is an abundant raw material with a variety of usages and properties .It is a compound of group of material that consist of minerals commodities, each having somewhat different mineralogy, geological occurrence, technology and applications .They are natural earthy fine grained minerals of secondary origin that are composed of an aluminates silicate structure with an additional iron, alkalis and alkaline earth element. Common clays are sufficiently plastic to allow ready molding and when firing, they vitrify beneath 1000°C (Oliveira & Holand, 2004).

The usage of earth-based resources such as soil, shale and sand in brick production can lead to resource depletion, environmental degradation, and energy consumption. Virgin material are extracted from riverbeds and hillsides to service brick industry leaving mines areas un-reclaimed. Environmental degradation go together with such mining activities with air pollution and remains after the mines cease operations, leaves scars on the landscape (Shakir & Mohammed, 2013).

Since the RHA as shown in Figure 1.1 were environmentally friendly, energy saving recycle it has been a replacement for clay as it contains silicate which in turn reacts with calcium hydroxide and produce bonding substances (Chiang et al. 2009; Cook et al.1977; Rahman). Materials that contained reactive silica are known as pozzolans and are commonly used in cement production and the manufacturer of concrete (Hossain et al., 2011). Pozzolans enhance the workability, strength and permeability of concrete mixes.

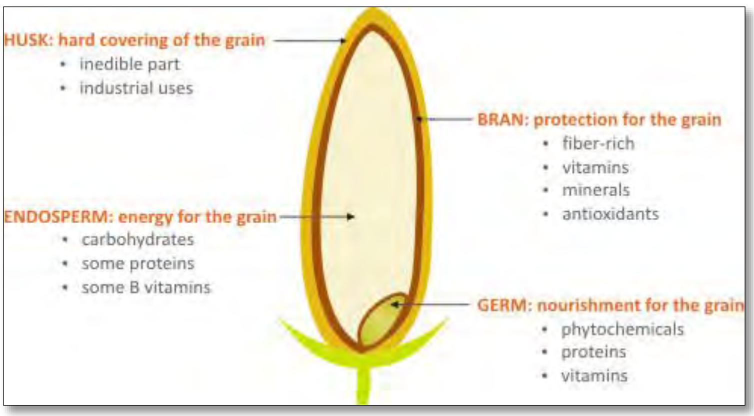

Figure 1. 1: Paddy Anatomy (Retrieved from www.kohinoorrice.com)

1.2 Problem Statement

Clay bricks are considered one of the most important materials in making a building. Meanwhile, fired clay bricks are the best known type of brick and also one of the oldest construction materials but the usage of this material resulted in resource depletion, environmental degradation, and energy consumption. Organic materials seemly can be a candidate to the alternative clay since its characteristics are biodegradable and renewable sources. Rice husk available locally, relatively cheaper and also more environmental friendly than the existing industrial insulators. RHA has 90-95% amorphous silica where it enhance the workability, strength and permeability of the concrete mixes (Metha, 1992). Bricks that available in some regions have poor quality, low compressive strength, higher water absorption and uneven surfaces (H. . R. Prasad & Prasad, 2014). Previous study shows the addition of rice husk ash will lowers initial surface absorption, permeability, absorption characteristics, and increase the resistance of concrete. Hence, this study will test RHA under various type of water condition to test the physical changes of the materials as a replacement of clay.

1.3 Objectives

Based on the problem statement stated above, the objectives of this study are stated below:

1. To develop the lightweight brick using RHA mixture as replacement of clay.

2. To investigate the compressive strength and physical changes of the rice husk ash brick

3. To compare the lightweight brick using RHA with conventional clay brick

1.4 Scopes

In order to reach the objectives, a few scopes have been drawn

1. The mixtures of brick are only using rice husk ash (RHA) as clay replacement material

2. The investigation of water absorption and compressive rice husk ash brick to be compared with clay brick.

3. The comparison of lightweight brick using RHA with conventional clay brick

CHAPTER 2

LITERATURE REVIEW

2.1 Introduction

This chapter will cover and explain the theory that being used for the research and how the each of characteristics affect the material by revising the past literatures related to the topic. In addition, correlated writings of this study will be as reference and guide to fit the purpose and objective of the study in order to provide better understanding and general overview regarding the mechanical and thermal properties of lightweight brick made from rice husk. From this chapter the introduction of brick and concrete components also being highlights about what are pozzolanic materials, why these materials are mainly used in the production of brick and how their effects on the properties of hardened cement paste and concrete. There are various types of pozzolanic materials but only rice husk ash is reviewed in more detail.

2.2 Agricultural Residues

Agricultural residues are consist of organic constitutes such as cellulose, lignin, fibre and a small amount of crude protein and fat. In addition, they contain a range of minerals, which include silica, alumina and iron oxide. During the development of plants, some plants absorb various minerals and silicates from the soil and accumulate it into their structures. Silicates are found in higher proportions of inorganic materials in annually grown plants than long lived trees. Such plants with a high concentration of silica are therefore rice plant, wheat plant, sunflower, tobacco and sugar cane. The agricultural residue itself cannot be used as a replacement and it is the ash obtained from controlled processing the residue which is of interest. Two factors require for the consideration in the controlled processing are the ash content and the chemical constituents of the ash. The ash content is important as it indicates the amount of residues which needs to be burnt. Silica is generally the major chemical constituent of the ash, which is important for cement replacement. These ashes will also contain as much as 10% alkalis, traces of iron, aluminum, calcium and magnesium oxides plus oxides of trace elements is introduced into the soil through fertilization practices. Table 2.1 shows the ashes and silica content of some plants as well as those of rice husk, rice straw and bagasse (Cook 1986). According to Werther et al., (2000) these agricultural residue has been used in biomass field and fuel. The use of biomass to provide partial substitution of fossil fuels, has an additional importance as concerns global warming since biomass combustion has the potential to be CO_2 neutral.

Table 2. 1: Ash and Silica Content of Plants (Cook, 1986, Werther et al., 2000)

Plant	Part of plant	Ash (%)	Silica (%)
Sorghum	Leaf sheath epidermis	12.55	88.70
Wheat	Leaf sheath	10.48	90.56
Corn	Leaf blade	12.15	64.20
Bamboo	Nodes (inner portions)	1.49	57.40
Bagasse	-	14.71	73.00
Lantana	Leaf and stem	11.24	23.28
Sunflower	Leaf and stem	11.53	25.32
Rice Husk	-	22.15	93.00
Rice Straw	-	14.65	82.00
Breadfruit tree	Stem	8.64	81.80

From Table 2.1, it can be observed that rice husk has the greatest yield (ash content 22.15%) and silica content (93%). Rice husk is a residue waste product, generated from the accumulation of the outer covering of rice grains during the milling process, produced in significant quantities on a global basis. There are about 20% of 500 million tons of rice produced in the world.

2.3 Rice Husk

Rice is the main chain food of Asia and part of the Pacific. Over 90% of the world's rice is produced and consumed in the Asia-Pacific Region (Papademetriou et al., 2000). Due to the population and growth in demands the large amount of paddy production and the development of agro-based in many countries of the world has produced large quantities of paddy residue (Tonnayopas, Tekasakul, & Jaritgnam, 2008). Paddy residue consists of paddy straw and rice husk. Both of these deposits are still not fully utilized in Malaysia. Malaysia is distinctive of the prominent producers of paddy. It has gained 0.48 Million tonne of rice husk (UNDP, 2002) with 3, 176, 593.2 tonnes production of rice straw in a year (Malaysia Economics Statistics, 2011). This residue occupies large areas, where it can self-burn, spreading the ashes and causing tremendous harms to the nature (Gonçalves & Bergmann, 2007).

The large quantities of husk are available as waste from rice milling industries where it can be used as an industrial materials, for example, as an insulating material (Chowdhury et al., 1947), fillers in plastics (Clark & Williamson, 1946), building material (Daniel,1946), for making panel boards (Ojha et al., 1974) and activated carbon (Chowdhury et al., 1947). Apart from that, rice husk wastes were usually used for animal feed, fertilizer and fuel for energy production but little work has been carried out to develop utilization of rice husk ash (RHA) in the production of fired clay brick (Dondi et al., 1997, Tonnayopas & Phattalung, 1997).

In certain rural areas, it is sometimes used as a fuel for parboiling paddy in the rice mills and to power steam engines. The partially burnt rice husk in turn contributes to environmental pollution. It would be beneficial to the environment to recycle the waste to produce eco-material having a high end value (Pijarn, N et al, 2010). End use of any material, including wastes depends on its structure, properties and mainly on chemical composition. Chemical compositions of rice husk vary from sample to sample. This variance is due to differences in climatic and geographical conditions and type of paddy (Rao et al, 1980).

The chemical analysis of rice husk is shown in Table 2.2. SiO_2 is found to be 22.12%, the organic material and water content is 74% and (Al_2O_3+Fe_2O_3+CaO+ MgO) constitute about 4%. The percentage of SiO_2 varies from 15 to 22%.

Table 2. 2: chemical composition of RHA (Hossain, Sarker, & Basak, 2011)

Constituent	% Composition
Fe_2O_3	1.28 – 1.38
SiO_2	22.12 – 90.20
Al_2O_3	0.85 – 1.23
CaO	1.21 – 1.24
MgO	0.21 – 1.21
Loss on ignition	3.95

Sharma et al. (1984) have analysed the organic constituents in rice husk after excluding silica and reported as in Table 2.3.

Table 2. 3: Organic constituents in rice husk (Prasad & Pandey, 2012)

Constituents	Amount present in rice husk (wt %)
α-cellulose	43.30
Lignin	22.00
D-xylose	17.52
I-arabinose	6.53
Methylglucuronic acid	3.27
D-galactose	2.37
Total	94.99

Pozzolanic activity of rice husk ash (RHA) firstly depends on the silica content, secondly on the silica crystallization phase, and lastly on the size and surface area of ash particles. In addition, ash must contain only a small amount of carbon. RHA that has amorphous silica content and large surface area can be produced by combustion of rice husk at controlled temperature. Suitable incinerator/furnace as well as grinding method is required for burning and grinding rice husk in order to obtain good quality ash. Although the studies on pozzolanic activity of RHA, its use as a supplementary cementitious material, and its environmental and economical benefits are available in many literatures, very few of them deal with rice husk combustion and grinding methods. The optimized RHA, by controlled burn and/or grinding, has been used as a pozzolanic material in cement and concrete (Kulkarni et al., 2014).

Apart from that, rice husk also one of the best insulating materials. RHA acts as a very good insulator, which is why it's been utilized as fully/partial replacement of cement. General properties of brick easily allow heat transfer and keep the heat inside for a long time, which means high heat capacity, where the brick is appropriate for construction material (J. Sutas, 2011). The increasing of rice husk in product decline the compressive strength because the combusted rice husk replace with the space in product which effect the density and compressive strength. Next, the higher RHA addition to the product required a higher water content to ensure the right dry density.

2.3.1 Properties of Rice Husk Ash (RHA)

Rice husk is a potential material, which is amenable for value addition. When burnt, it produces a large quantity of ash - about one tone for every five tons of husks. The ash typically contains approximately 80% silica and is therefore an excellent pozzolana. Completely burnt rice-husk is grey to white in colour, while partially burnt rice husk ash is blackish.

The exterior of rice husk are composed of dentate rectangular elements, which themselves are composed mostly of silica coated with a thick cuticle and surface hairs. The mid region and inner epidermis contain little silica (Bronzeoak, 2003). Jauberthie et al., (2000) confirmed that the presence of amorphous silica is concentrated at the surfaces of the rice husk and not within the husk itself. This portion of the silica is un-dissolved in alkali and can withstand very high temperatures (Patel, M & Karera, A., 1991). It has been cleared that once the organic part of RH is extracted, the inorganic residue may be relatively pure, forming a better source for silica. There is no other plant except paddy husk is able to retain such a huge proportion of silica in it.