PROPERTIES OF PEPPER WASTE BRICKS

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Student Name : Holson Yu Shen

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has been read and approved by:

_____ _____

Ms Siti Nor Ain Musa Date

(Supervisor)

Dedicated to my family and friends.

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ABSTRAK

Sisa lada boleh diproses semula dengan tanah liat untuk menghasilkan bahan yang berguna untuk tujuan aspalan. Objektif kajian ini adalah bagi menyiasat ciri-ciri mekanikal bata pernembusan air yang dibuat daripada sisa lada. Disebabkan sifat semulajadi bahan tersebut, keupayaan sisa lada untuk membentuk liang telah disiasat. Dengan tujuan membandingkan keputusan kajian, nisbah yang berbeza bagi sisa lada (0%, 2%, 5%, dan 10% oleh jisim) telah diadunkan dengan tanah liat dan 'abu terbang'. Kemudian, semua sampel bata yang berbeza komposisi telah dibentuk, dikeringkan dan dibakar pada suhu 900 ºC. Penyerapan air, ketertembusan dan kekuatan mampatan batu-bata yang telah siap diuji dan dibandingkan dengan spesifikasi berkaitan. Sampel batu-bata didapati mempunyai penyerapan air antara 18.41% – 29.05%, ketertembusan pada kadar 5.278×10^{-10} m^3s^{-1} dan kekuatan mampatan antara 6.17 MPa – 30.81 MPa. Kekuatan kemampatan untuk sampel batu bata adalah melebihi keperluan minimum standard Malaysia untuk batu bata yang berkualiti biasa, iaitu tidak kurang dari 5.2 MPa. Keputusan kajian menunjukkan tambahan sisa lada akan menghasilkan batu bata yang berliang dengan ciri-ciri mekanikal yang memuaskan.

ABSTRACT

Pepper waste can be reprocessed with clay to produce useful materials for pavement purpose. The objective of this study is to investigate the mechanical properties of water penetrable bricks made from pepper waste. Due to the nature of the material, pore-forming ability of pepper waste was investigated. In order to compare the results, different ratios of the pepper waste (0%, 2%, 5%, and 10% by mass) were mixed with clay and fly ash. Then, all the brick samples of different compositions were moulded, dried and lastly, fired at 900 ºC. The water absorption, penetrability and compressive strength of the fired bricks were tested and compared with standard specifications. The brick samples have water absorption between 18.41% – 29.05%, penetrability rate as fast as 5.278×10^{-10} m^3s^{-1} and compressive strength between 6.17 MPa – 30.81 MPa. The compressive strength for all samples passed the minimum requirement by Malaysian Standard for the ordinary quality clay brick, which is not less than 5.2 MPa. The results showed that pepper waste addition would produce porous bricks with satisfactory mechanical properties.

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CHAPTER 1

INTRODUCTION

1.1 Background of Bricks

A brick is a block of ceramic material used in building material construction. It is an important building block for buildings around the world. The use of bricks has been found dated back to 7,500 B.C.[14] This shows that bricks have been existed in our civilization long time ago. Bricks can be made from clay, shale (finely sedimentary rock), soft slate (fine-grained metamorphic rock), calcium silicate (lime mixed with quartz), and concrete or shaped from quarried stone. Clay is the most common material used as it is easy to find and cheap. In the late-20th century, brick was confined to low and medium-rise structures, as a slim decorative cladding over concrete-steel buildings and for internal walls.

The bricks are continually use at large scale even though brick has been restricted to low and medium size buildings as there are many constructions still requiring it. As such, many researches had been done over the years to increase its potential in terms of strength, thermal resistance, high melting point and porosity. Many improvements have been done on the earlier sun-dried mud brick and the result is the varieties of bricks with different composition these days. With the

advancement of bricks manufacturing methods and using different kind of materials, the production of bricks is expected to meet the strong demand from the consumers globally.

In year 2007, a new type of brick based on fly ash was invented by Dr. Henry Liu, a retired civil engineer. [15] Fly ash is a residue of coal from power plants. Since the manufacturing method uses a waste by-product rather than clay, and solidification takes place under pressure rather than heat, it has important environmental benefits. Meanwhile in United Kingdom, a technology company Geofusion is producing bricks made of recycled glass and glass waste, which is expensive to recycle. [16] The technology can also be used to make porous paving stones and tiles. Water engineers stated that floods and water shortages caused by urban developments would disrupt the flow of rainwater back to the land. Geofusion's porous bricks will allow them to capture the rainwater falling on car parks along with buildings walls and reuse it.

For the paving industry, it has been pioneered by Unilock Company, which originally introduced the paving stone to North America back in 1972. Backed by a commitment to quality and innovation, Unilock has grown to become the leading manufacturer of paving stones and retaining walls in United States.[17] The company produced different kind of pavers from classic paver like Hollandstone to permeable pavers like Turfstone, Ecoloc and Uni Eco-Stone. However, these permeable pavers do not function like water penetrable bricks. This is because the design of it is to create small openings between the pavers providing drainage into the earth. Hence, permeable refers to water moving through openings between pavers and aggregate.

While, porous refers to the material allowing water to move through it, as is the case with porous bricks that has voids in the material.

1.2 Overview of Water Penetrable Bricks

Water penetrable brick is another type of bricks that is under the investigation by many institutions. This type of brick is used for pavement purpose. Through its porous property, water can flow into ground easily and sunshine is not necessary needed to dry it up. This feature is considered supportive as it can minimize pooling problem especially on pavement, parking lots, roads and ground of bazaar or wet market. Pooling is a major setback in urban construction because for non-permeable construction materials, such as bitumen and cement are indirectly destroying the ability for the earth to retain water. Whenever it rains, the consequences will be flooded rivers and during a drought, the riverbeds will be dried up.

Besides diffusing water into the earth, which providing flood assistance, these construction materials are capable of contributing to temperature control. For normal bricks, it can store the heat energy slowly from the sun during the day and continuing to release heat for several hours after sunset. However, water penetrable brick have cooling effect because of the evaporation process in the bricks. Evaporation takes heat from the environment and thus, cools the surrounding temperature. With this added benefit, the water penetrable bricks prove to be suitable for the hot and rainy climate in Malaysia.

Currently, such bricks are significantly used in the construction of venue's paving, roads and squares in many Olympic stadiums in China for the 2008 Beijing Olympic Games. For example, water permeable blocks make up much of the paving at the Fengtai Softball venue. These allow rainwater to leak through to the underground water collection systems. While, in the Olympic Media Village, at least 3,000 cubic metres of rainwater can be captured using water permeable bricks, pipes and wells installed on roofs, roads and green areas.[18]

Water penetrable brick serves as a medium between the external surface and the ground. From the voids of the bricks itself, it allows water from the external surface to flow through the bricks and into the ground. Figure 1.1 illustrated the overall concept of water penetrability using this type of brick. Besides reducing overflow problem and heat insulation problem, water penetrable brick can prevent raw sewage discharged into the rivers.

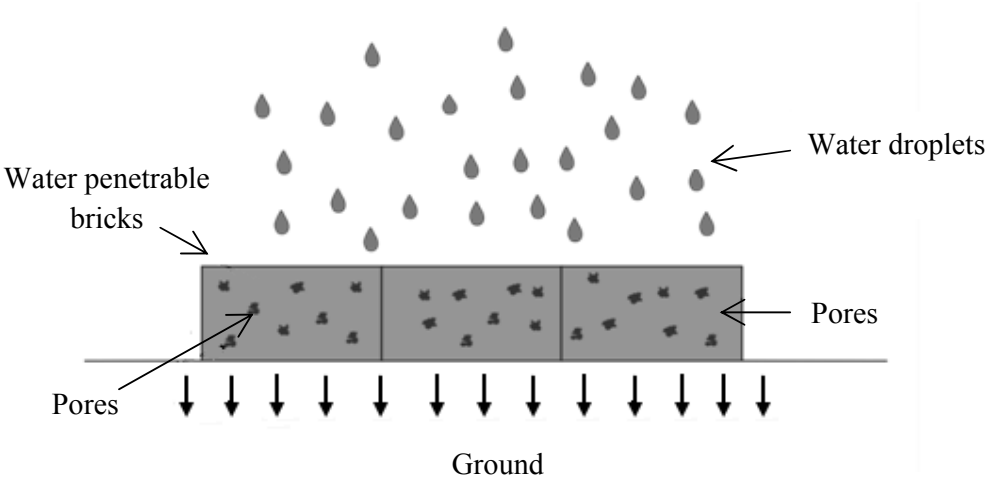

Figure 1.1 Mechanism of water penetrable bricks

The range of using water penetrable brick is within the part of urban, suburban and metropolitan areas. In big cities where everything is congested, such brick play a critical role in town irrigation structure. For the heat effect inside cities, using this brick will reduce the environment warming and balancing the temperature between the external surface and the ground.

1.3 Application of Pepper Waste to Produce Water Penetrable Bricks

In order to produce water penetrable bricks, organic material is required to mix with clay brick to create pores. This is because organic material will decompose if it is exposed to the high temperature or considerable heat, thus leaving pores. The idea of using pepper waste totally fit the criteria and it is easy to be found locally as pepper is mainly produced in Sarawak. Therefore, pepper waste can be manipulated to facilitate the production of water penetrable bricks instead of being dumped or burnt up.

Pepper that is the world most widely used spice for food seasoning is the fruit of the tropical climbing vine, Piper nigrum L, which is illustrated in Figure 1.2. It is native to southwestern India and is extensively cultivated there and in other tropical regions. The commercial black peppercorn is the entire dried berry while the white peppercorn is the seed. Peppercorn pungency is due to the presence of the alkaloids piperine, chavicine and piperettine.

In Sarawak, pepper cultivation dates back to 1856 but more extensive planting started in the 1900s. Nearly 98% of Malaysian pepper is produced in Sarawak. The plantations in Sarawak are in small farms averaging 0.2 hectares, mostly planted by rural dwellers in upland areas. Peppers from Sarawak are concentrated in certain area of Kuching, Samarahan, Sri Aman, Betong and Sarikei Divisions. Malaysia now ranks No. 5 after Vietnam, India, Indonesia, and Brazil in terms of pepper production.[19]

About 70 % of Sarawak's pepper is exported as whole black pepper and the remaining as white pepper, green pepper in brine, value-added pepper and pepper products. The production in 2004 was about 20,000 tonnes.[19] This shows that the wastes and residues from such production are also likely to be in tonnes. The waste that was separated from the production is outer pericarp layer, damaged or broken fruits, the unfertilized buds, dust, pepper hulls or shells removed during the preparation of white pepper and lastly the stems or stalks of the plant.

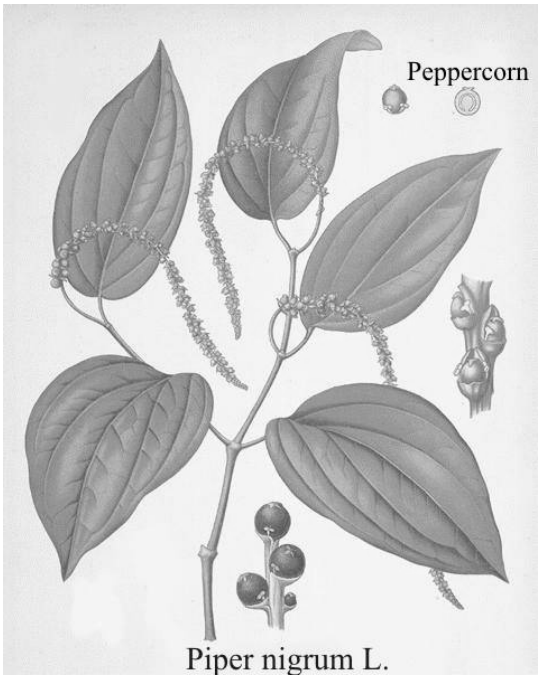

Figure 1.2 Pepper plants [20]

1.4 Objectives of the Project

The objectives of this project are to:

1. Produce samples of water penetrable bricks using pepper waste for research and testing.
2. Investigate the mechanical properties of water penetrable bricks produced.
3. Study the effect of pepper waste in the bricks produced.
4. Compare the properties of standard size bricks and sample size bricks.

1.5 Project Overview

This is a research and experimental based project, which aims to increase the strength of pepper waste bricks. Fly ash was chosen to improve its strength properties. This is because fly ash is pozzolanic in nature as it reacts with lime with lime and water to form a cementitious compound. It is anticipated that the bricks produced is more durable and have a better porosity. From this project, it validates the draw on of pepper waste in production of porous bricks. Samples were produced in different percentage of residue addition. Then, tests were done to determine the bricks mechanical properties. The information and data collected can be used to support the implementation of such bricks in the clay bricks industry. Lastly, a review and evaluation for the overall research was carried out.

1.6 Outline of Project Report

This Final Year Project Report is split into five chapters: Introduction, Literature Review, Methodology, Data and Analysis, and Discussion, Conclusion and Recommendations. The brief information of each chapter is described as below:

Chapter 1 (Introduction) will introduce the background and provide the overview and objectives of the project. Besides that, the sequence of the final year project report is provided in this chapter as well.

Chapter 2 (Literature Review) provides summary and overview of the studies or researches which are related to the project done. For example, processed waste tea, kraft pulp residues and other organic waste are used as an additive to clay bricks to generate porosity.

Chapter 3 (Methodology) provides the information of the methods used in the project. This chapter provides techniques apply to do the experimental works as well as how the specimen is produced for the research.

Chapter 4 (Results, Analysis and Discussions) will show the results analyzed from the experiment and testing approach. It includes the discussion of the results.

Chapter 5 (Conclusions and Recommendations) summarizes the overall performance of the project and recommendations for the future works.