THE COMPRESSIVE STRENGTH AND WATER ABSORTION OF SAND BRICK CONTAINING LIME AND DIFFERENT PERCENTAGE OF RHA AS PARTIALLY SAND REPLACEMENT

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ABSTRACT

One of the major elements in construction is brick. In Malaysia, the brick is commonly useful as a masonry wall. The improvement in the brick technology is important in reducing the cost of construction. The Rice Husk Ash (RHA) and lime is one of the elements in improving the strength of the brick as well as reducing the cost of brick. The RHA and lime can be used as the replacement of the sand where the cost of sand is increasing in market. The size of the RHA is less than the sand but it suitable to replace the sand in the brick. The strength of the brick that are containing the RHA and the lime is hoping can achieve the strength of the normal sand brick and can be used at the uncritical masonry in the construction. This study is aiming to determine the compressive strength and the water absorption of the brick that are replacing slightly the sand with RHA and lime. In this research, the brick size used is 117mm width × 75mm thickness × 215mm length. The result of compressive strength test shows the increments of strength of the brick rather than the normal sand brick. Instead of the increments of strength in the brick, there are reductions in the cost of making brick itself. Also the result of the water absorption test, the result shows the reduction of the absorption from the water that make the brick have more strength and not easily fragile.

ABSTRAK

Salah satu unsur utama dalam bidang pembinaan ialah bata. Di Malaysia, batu bata secara umumnya berguna sebagai dinding bata. Peningkatan dalam teknologi bata adalah penting untuk mengurangkan kos pembinaan. Abu sekam padi (RHA) dan batu kapur merupakan salah satu elemen dalam menigkatkan kekuatan bata di masa yang sama mengurangkan kos bata. Abu sekam padi dan batu kapur boleh digunakan sebagai pengganti pasir di mana kos pasir semakin manigkat di pasaran. Saiz abu sekam padi adalah kurang daripada pasir tetapi ia sesuai untuk menggantikan pasir di dalam batu-bata. Kekuatan bata yang mengandungi sekam padi dan kapur diharapkan mencapai kekuatan batu bata pasir biasa dan boleh digunakan pada dinding tidak kritikal dalam pembinaan. Kajian ini bertujuan untuk menentukan kekuatan mampatan dan penyerapan air dalam bata yang terdiri daripada gantian sedikit pasir dengan RHA dan didalam kajian ini, saiz bata yang digunakan mempunyai ukuran lebar 117mm, ketebalan 75 mm dan panjang 215mm. Keputusan ujian kekuatan mampatan menunjukkan kenaikan kekuatan batu bata daripada bata pasir biasa. Selain dari kenaikan kekuatan batu bata, terdapatnya pengurangan kos bata itu sendiri. Demikian juga dengan, hasil ujian penyerapan air, keputusan menunjukkan pengurangan penyerapan dari air yang membuat bata mempunyai kekuatan lebih dan tidak mudah rapuh.

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LIST OF SYMBOLS

σ	=	Stress
A	=	Area
P	=	Force
W	=	Water Absorption

LIST OF ABBREVIATIONS

ASTM	=	America Society for Testing and Materials
BS	=	British Standard
(W/C) Ratio	=	Water Cement Ratio
OPC	=	Ordinary Portland Cement

CHAPTER 1

INTRODUCTION

1.1 Background of Study

Construction industry in Malaysia today increasingly moving forward and is in the process of rapidly developing. According to Intan Rohani (2009) reported that since seventies, the economic in Malaysia has undergone rapid growth. It found that construction industry constitutes an important element of Malaysian economy. According to with a per capita yearly income measured at about US$5,300 in 2007,

Malaysia is now an upper-middle-income country. It has gone through several of the structural changes that its income comparators have experienced nevertheless it remains highly dependent on favorable external terms of trade to support domestic economic growth. The share of agriculture has fallen from above 30 percent of Gross domestic product (GDP) to below 10 percent, and that of industry (manufacturing) rose from 27 (12) to about 50 (31) percent. The initial growth response to the purposeful and increased industrialization of the economy from the mid-1970s was favorable, with volatility declining and the overall rate of growth rising towards 10 percent per year in the late 1980s. Foreign Direct Investment (FDI) and manufactured exports (especially high technology products) played an important role, with the latter rising from 5 percent of total exports to above 75 percent today, even as the share of total exports rose from 40 percent (mainly commodities) to 80 percent of GDP (Zainal Abidin, 2010).

In construction project, mostly in Malaysia brick is one of the important raw materials. This situation happen because the location of Malaysia that in the equator liner. So the use of the steel in making the building is not the option while the brick is cheaper than the steel. Normally brick can be classified into two types which are clay brick and cement brick. Cement brick is cheaper than the clay brick. Because of that, the cement brick is mostly uses in the building construction in Malaysia.

Sand is one of important raw in manufactured of brick, cement, and many things in construction project. Nowadays, price of sand more expensive in the raw materials market. The other alternative that can be used to replace the sand is Rice Husk Ash (RHA). Rice milling industry generates a lot of rice husk during milling of paddy which comes from the fields. This rice husk is mostly used as a fuel in the boilers for processing of paddy. Rice husk is also used as a fuel for power generation. Rice husk is a waste product that generated from the accumulation of the outer covering of rice grains during the milling process. It constitutes about 20% of 300 million matric tonnes of rice produced annually in the world (Cook *et. al*, 1976).

About the replacement of the sand, RHA is can be one of replacer in terms of the cost, environmental content and availability of RHA properties. However, the use of RHA in the brick manufacturing might effect to the strength of the normal brick. Because of that, the study about the RHA in brick manufacture is become crucial to exploit its benefit.

In this study, lime also been used to replace a sand, but the RHA that been used are constant. A non-hydraulic lime (slaked lime) can be made to set much more rapidly by the addition of a hydraulic or 'pozzolanic' additive. This practice is known as 'gauging'. Typical additives are finely crushed brick powder or cement. These contain highly reactive silica and/or alumina, which give a rapid chemical set by reaction with water. Of these, cement is by far the most widely used in the UK, and the cheapest.

1.2 Problem Statement

In the manufacturing of the brick, sand is the important raw material. High cost of the sand in construction industry makes the manufacturer of the brick want to have the other solution to replace the sand.

As an alternative this study is conducted in order to investigate the availability of the RHA and lime as the replacement of the sand in brick and to reduce the cost of manufacturing brick using sand. Furthermore, this study also wants to reveal the strength of using RHA and lime as the sand replacement. This alternative study also want to investigate this experiment brick have more strength than the normal brick. The problem might occur to the brick when use RHA and lime as a replacement material such as improper quality of material, incorrect specifications, faulty design, error in construction process, and exposure of structure to the extreme environment conditions.

1.3 Objectives of Study

The objectives of this study are:

i. To investigate the compressive strength and water absorption of brick by replacing 10% of sand with RHA (by weight).

ii. To investigate the compressive strength and water absorption of brick 0%, 10%, 20% and 30% of lime as sand replacement

1.4 Scope of Study

The Rice Husk Ash (RHA) that been used in this study was taken from Kilang Beras BERNAS at Rompin, Pahang. This raw material that replacing normal sand also with the lime to will be experimented as composite in making concrete brick sample with the ratio of cement water and sand is 1:10 according to industry. The water curing methods have to be done to 7 days and 28 days.

The testing of brick consists of the compressive strength and the water absorption of the brick. In this study, the percentage that been used are 10% for RHA and 0%, 10%, 20%, and 30% of lime.

The testing for compressive strength and water absorption of the brick is according to BS1881 1983. In sieve analysis the Rice Husk Ash (RHA) that been used will be sieve to take the size that same as sand. In this study size of brick use is 215mm x 117mm x 75mm as accordance BS3921 1985.

1.5 Significant of Study

The waste such as Rice Husk Ash (RHA) can be used in a variety of applications like green concrete, high performance concrete, roofing shingles, and ceramic glaze. In this study, RHA and lime is new material in the cement brick that author discover. This material may give effect to the cement brick.

In addition, by producing this cement brick containing RHA and lime might effect to availability and strength of this cement brick. It also might influence to long life structure.

Therefore, if this study can be done in flying color, this material can be the alternative way to replacing the sand that might be expensive in the future. Furthermore, this replacer may not be wasted and can be utilized in developing construction industry.

CHAPTER 2

LITERATURE REVIEW

2.1 Introduction

Sand brick is a construction material composed of cement, water, and chemical admixtures. Sand brick is commonly used in construction industry in Malaysia. In Malaysia, brick are usually used as masonry. Masonry is a building of structure from individual units laid in and bound together by bonding mixture known as mortar. One of the raw materials in sand brick is sand. Sand is the important material in producing a sand brick. Sand brick solidifiers and hardens after mixing with water and placement due to a chemical process known as hydration. The water reacts with the cement, which bonds the other component together, eventually creating a stone-like material. Sand brick grows stronger with increasing of age.

Quality brick is related to the quality of materials that used to mix it. If materials have high quality, the brick also will have a quality. It is can be increase the strength of the brick. Nowadays, this raw material increasingly difficult to get and more expensive. The alternative materials in this experience used are Rice Husk Ash (RHA) and lime.

2.2 Brick

According to BS 5628-3 1985, brick are a mixture of cement, fine aggregate, water and admixture. Cement has a different type. Those are portland cement (ordinary and rapid hardening), portland blast furnace cement, Sulphate-resisting portland cement and masonry cement. While aggregate have natural aggregates and lightweight aggregates. Admixtures may affect the strength and adhesion of mortars and care should be exercised in their use. The types of admixture are plasticizers and colouring agents. Lastly, water should be mains water or other potable supply. If mains water is not available, the water should be clean and should not contain any material, either in solution or in suspension, in quantity sufficient to have a harmful effect on the mortar or on metals or to impair the durability of the construction.

2.2.1 Type of Sand brick

BS6073 1981 define brick have many type that been used in construction work. There are solid brick, perforated brick, hollow brick and cellular brick. Solid brick is a brick in which small holes passing through, or nearly through, the brick do not exceed 25 % of its volume, or in which frogs (depressions in the bed faces of a brick) do not exceed 20 % of its volume. For the purposes of this brick, small holes are defined as being less than 20 mm wide or less than 500 mm^2 in area. Up to three larger holes, not exceeding 3 250 mm^2 each, may be incorporated as aids to handling, within the total of 25 %. While, perforated brick is a brick in which small holes passing through the brick exceed 25 % of its volume. Up to three larger holes, not exceeding 3 250 mm^2 each, may be incorporated as aids to handling. Definition of the hollow brick is a brick in which holes passing through the brick exceed 25 % of its volume and the holes are not small, as defined in the solid brick definition. Lastly, the cellular brick is a brick in which holes closed at one end exceed 20 % of the volume of the brick.

2.2.2 Physical Properties of Brick

In the brick manufacturing, the industry should consider the physical properties of the brick.

2.2.2.1 Compressive Strength

In accordance with MS 76 1972 or to comply with building regulations, the classification given in Table 2.1 shall apply:

Table 2.1: Strength and Water Absorption (MS 76 1972)

Designation	**Class**	**Average compressive strength MN/m~ not less than~**	**Average absorption boiling or vacuum percent weight not greater than**
Engineering brick	A B	69.0 (10,000 lbf/in2) 48.5 (7,000 lbf/in2)	4.5 7.0
Loadbearing brick	15 10 7 5 4 3 2 1	103.0 (15,000 lbf/in2) 69.0 (10,000 lbf/in2) 48.5 (7,000 lbf/in2) 34.5 (5,000 lbf/in2) 27.5 (4,000 lbf/in2) 20.5 (3,000 lbf/in2) 14.0 (2,000 lbf/in2) 7.0 (1,000 lbf/in2)	No specific requirements
Bricks for dampproof courses	D P C	as required	4.5

Interpolation of classes of load bearing bricks not given in the above table 3.1 may be used for bricks having average crushing strengths intermediate between those given in the table. Thus for instance 'Class 4.5' may be used to describe bricks with an average strength of 31.0 MN/m^2 and Class 11 to describe bricks with an average strength of 76 MN/m^2. Bricks to 5.2 MN/m^2 and blocks to 2.8 MN/m^2 in Clauses 12, 17 and 22 can also be load bearing e g as used in one- and two-storey dwelling houses, the 5.2 MN/m^2 brick is not limited to non-load bearing uses. Compliance with the requirements of the Clause shall be checked by the methods set out in Clauses 39 and 40. If the manufacturer works a quality control system that includes strength testing, the results of the quality control tests may be made the basis of acceptance. Where load bearing brickwork is not calculated, the only strength requirements of this standard are those of Clauses 12, 16 and 20.

Unless a higher strength is agreed in accordance with Clause 10 the compressive strength of bricks of ordinary quality when tested in accordance with Clause 39, shall be not less than 5.2 MN/m^2 and of blocks of ordinary quality shall be not less than 2.8 MN/m^2. These minimum strengths are acceptable provided the bricks and blocks are satisfactory in other respects (MS 76, 1972).

2.2.2.2 Water Absorption

Water absorption in the bricks contain pores will allow passage of water. Due to capillary action at the pores of the bricks, the pores will absorb the water content from mortar that lay on the bricks. The absorption of water will affect the properties of the mortars and thus affect the bonding of mortar between bricks. The initial rate of absorption (IRA) by the clay bricks should fall between the range of 0.25 and 2.05 kg/min/m2 in order to form strong bond between mortar and bricks. If the IRA of the clay bricks is less than 0.25 kg/min/m2, the bricks do not absorb much water from the mortar and the water may tend to float on the mortar. If the IRA value is too high, too much moisture is drawn from the mortar (Robert *et. al*, 1994). If too much moisture is drawn from the mortar, the mortar may dried and harden faster than the bonds made with the bricks. The bonds between mortar and bricks may be not strong enough although the mortar has hardened.

By the previous research, the value of water absorption was determined. Fired clay brick was found to exhibit the highest initial rate of absorption and unit water absorption than calcium silicates brick and sand brick (Badorul *et. al*, 2007).

2.3 Brick Material

The brick material consists of cement, water, and sand.

2.3.1 Cement

ASTM C 150 defines portland cement as hydraulic cement that not only hardens by reacting with water but also forms a water-resistant product. Cement produced by pulverizing clinkers consisting essentially of hydraulic calcium silicates, usually containing one or more of the forms of calcium sulfate as an inter ground addition. Clinkers are nodules (diameters 5-25 mm) of a sintered material that is produced when a raw mixture of predetermined composition is heated to high temperature.

2.3.1.1 Type of Cement

Different types of portland cement are manufactured to meet different physical and chemical requirements for specific purposes, such as durability and high-early strength. The American Society for Testing and Materials (ASTM) Designation C 150 provides for eight types of portland cement:

a) Type one

Type one in portland cement is a general purpose portland cement suitable for all uses where the special properties of other types are not required. It is used where cement or concrete is not subject to specific exposures, such as sulfate attack from soil or water, or to an objectionable temperature rise due to heat generated by hydration. Its uses include pavements and sidewalks, reinforced concrete buildings, bridges, railway structures, tanks, reservoirs, culverts, sewers, water pipes and masonry units.

b) Type two

Type two portland cement is used where precaution against moderate sulfate attack is important, as in drainage structures where sulfate concentrations in ground waters are higher than normal but not unusually severe. Type two portland cement will usually generate less heat at a slower rate than type one. With this moderate heat of hydration, type two portland cement can be used in structures of considerable mass, such as large piers, heavy abutments, and heavy retaining walls. Its use will reduce temperature rise especially important when the concrete is placed in warm weather.

c) Type three

Type three is a high-early strength Portland cement that provides high strengths at an early period, usually a week or less. It is used when forms are to be removed as soon as possible, or when the structure must be put into service quickly. In cold weather, its use permits a reduction in the controlled curing period. Although richer mixtures of type one cement can be used to gain high early strength, type three, high early strength portland cement, may provide it more satisfactorily and more economically.

d) Type four

In type four, they call it type IA, IIA, IIIA. They correspond in composition to ASTM types one, two, and three, respectively, except that small quantities of air entraining materials are interground with the clinker during manufacture to produce minute, well distributed, and completely separated air bubbles. These cements produce concrete with improved resistance to freeze thaw action. While type four is a low heat of hydration portland cement for use where the rate and amount of heat generated must be minimized. It develops strength at a slower rate than type one portland cement. Type four portland cement is intended for use in massive concrete structures, such as large gravity dams, where the temperature rise resulting from heat generated during curing is a critical factor.

e) Type five

Type between this ASTM Portland cement is type five. Type five is a sulfate resisting cement used only in concrete exposed to severe sulfate action principally where soils or ground waters have high sulfate content.

2.3.2 Aggregates

Aggregate may be defined as the solid materials contained in concrete which play no part in the chemical reactions that cause the concrete to set. Aggregates can be classified as normal weight or lightweight. Normal weight aggregates generally consist of various combinations of naturally occurring sands, gravel and stones, and of different sizes of crushed rock. Lightweight aggregates are generally manufactured for example expanded clay or expanded shale but can also be natural rock.

2.3.2.1 Fine Aggregate

The fine aggregate comprises the portion of the aggregate, which has a small particle size. BS 882 defines the fine aggregate as containing a high proportion of particles passing a 5mm (0.197 in.) sieve. In the US and elsewhere a 4.75mm (0.187 in.) sieve is used as the limit. For concrete mix design the most significant properties of the fine aggregate are the type and grading.

The fine aggregate can be specified either crushed or uncrushed. Uncrushed aggregates are usually smoother than crushed aggregates and in comparison with concrete made with crushed fine aggregate, concrete containing uncrushed fine aggregate will generally have superior workability. In contrast to the coarse aggregate type, the fine aggregate type does not appear to influence the concrete strength significantly.

2.3.3 Water

In manufacturing brick, the clean and clear tap water should be used. Any organic material in water will prevent the cement from setting. Chemicals and impurities could also affect the strength of the end product (BS3148 1980).