MECHANICAL PROPERTIES OF COMPRESS STABILISED LATERITE INTERLOCKING BLOCK USING RECYCLED LATERITE BLOCK

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ABSTRACT

Interlocking blocks are known to be an alternative building material used as a structural member like column and wall that can replace the use of conventional building materials such as concrete block and fired clay brick. The usage of recycled waste interlocking block is a possible solution that overall will reduce the materials and construction cost (Raheem, 2012). The aim of this study is to investigate the engineering properties of the recycled waste usage to produce the interlocking block using different percentage of natural fine aggregate and recycled aggregate (33.33% and 66.67%). There are 3 types of different curing sets. The result from curing set 1A# (14 days wet in sun) show the highest compressive strength (2.94Mpa) of 28 days curing. This curing method will be used in recycled sets experiment. The result for interlocking block using orange recycled laterite block (5.55Mpa) show a higher compressive strength than curing set 1A# (2.95Mpa) for 28 days. Water absorption for 33.33% recycled interlocking block shows lower percentage than 66.67% recycled interlocking block although the difference just a small value. The block also durable from any working condition and harsh environment as it is proven from abrasion test, the good block is under 6.9% material abraded (Raheem, 2012). Recycled block only loss lesser than 2% of weight after being abraded.

ABSTRAK

Blok saling mengunci dikenali sebagai satu bahan binaan alternatif yang digunakan sebagai anggota struktur seperti tiang dan dinding yang boleh menggantikan penggunaan bahan binaan konvensional seperti blok konkrit dan bata tanah liat. Penggunaan kitar semula sisa blok saling mengunci adalah satu cara penyelesaian yang keseluruhan akan mengurangkan bahan-bahan dan kos pembinaan (Raheem, 2012). Ini Tujuan kajian adalah untuk menyiasat sifat kejuruteraan penggunaan sisa dikitar semula untuk menghasilkan blok saling mengunci menggunakan peratusan yang berbeza agregat halus dan agregat semula jadi dikitar semula (66.67: 33.33%, dan 33.33:66.67%). Terdapat 3 jenis pengawetan set. Hasil daripada mengubati set 1A # (14 hari basah di bawah matahari) memberi kekuatan mampatan yang paling tinggi (2.94Mpa) 28 hari menyembuhkan. Kaedah pengawetan akan digunakan dalam set dikitar semula eksperimen. Keputusan untuk saling blok menggunakan oren dikitar semula blok laterit (5.55Mpa) menunjukkan kekuatan mampatan yang lebih tinggi daripada menyembuhkan set 1A # (2.95Mpa) selama 28 hari. Penyerapan air untuk 33.33% dikitar semula blok saling menunjukkan peratusan lebih rendah berbanding saling blok 66.67% dikitar semula walaupun perbezaan hanya bernilai kecil. Blok ini juga tahan lama daripada mana-mana keadaan dan persekitaran bekerja keras kerana ia terbukti dari ujian lelasan, blok yang baik adalah dibawah 6.9% (Raheem, 2012). Blok yang dikitar semula hanya kehilangan kurang daripada 2% daripada berat badan selepas lelasan.

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CHAPTER 1

INTRODUCTION

1.1 BACKGROUND OF STUDY

The use of Industrialised Building System (IBS) offers valuable advantages such as the reduction of unskilled workers, less wastage, less volume of building materials, increased environmental and construction site cleanliness and better quality control, among others (CIDB, 2012). Current global economy has lead a sustainable construction material demand on consistent with a lot of buildings been built. So an alternative material is used to reduce the usage of natural resources.

Interlocking blocks are known to be an alternative building system used as a structural member like column and wall that can replace the use of the conventional building materials which is clay brick and brick mortar. Interlocking block itself can support the load from the top without column or beam. In particular, the prospects of replacing raw material into recycled construction waste in interlocking block production are well recognised all over the world to preserve environmental.

The practical use of interlocking block technique in construction will save cost and time as there will be no mortar involve in bricklaying work and also does not require skilled labour (Nasly & Yassin, 2009). This study will investigate the mechanical properties of the interlocking block using different percentage of fresh and recycled laterite soil as the main material and the mix proportion consist of cement: soil: sand.

1.2 PROBLEM STATEMENT

With all sort of construction, it is likely to increase the market demand of concrete. Production of concrete will lead to the demand of raw material especially aggregate (Lung, 2011). Construction waste has been a major concern among the government, political leaders and town planners over the past few years. As a development country, Malaysia government has face in disposal waste growth (Council, 2010). Hence, using recycled waste as alternative course aggregate will give huge effect to the world especially to construction field. Furthermore, the advantages of replacing natural aggregate block to recycled construction waste block can reduce cost and disposal area problem as the materials used to produce is from recycled construction waste. From research had been done before by Hasbullah Ali in 2013, best curing method still did not obtained, so several curing method will be done.

1.3 OBJECTIVE OF STUDY

The objectives of this research are:

i. To determine the characteristic of interlocking block using recycled waste, which is recycled laterite block and natural aggregate in term of water absorption, durability and compressive strength.

ii. To compare the mechanical properties of interlocking block using recycled laterite block with interlocking block using newly natural aggregate.

iii. To determine the best curing method in term of compressive strength.

1.4 SCOPE OF STUDY

This scope of study is focus on:

i. Crushed the construction waste such as laterite block

ii. Testing the characteristic aggregate to use in interlocking block using sieve analysis, bulk density, moisture content and compaction test.

iii. Produce the interlocking block from recycled laterite block by using different ratio. Cement: soil: sand (1:2:6 with 33.33% and 66.67% of recycled laterite block replacing sand).

iv. Testing the interlocking block using recycled laterite block such as compression test, abrasion test and water absorption test.

1.5 SIGNIFICANCE OF STUDY

In Malaysia, the supply of houses by both public and private sectors is still far from meeting the demand, especially in the low cost housing sector. For the purpose of developing and promoting a new system, that is fast in construction and more economical, the use of interlocking hollow block systems is adopted. This research is aimed at assessing the feasibility of using the new design of interlocking hollow block in the construction of residential or official buildings. The interconnection between the blocks has to be designed to withstand the different stresses developed in the wall due to the applied load. Practically the shapes of the block must be as simple as possible for easy production and construction. Moreover, interlocking block from recycled construction waste will give much benefit either in economy or environmental. Economy get the benefit from recycling waste since it will reduce most the cost of construction as low-cost of production for each block is lower compared to rather than use natural aggregate which will be more costly. As for environment, recycling construction waste in making interlocking block would save a lot of natural resources, and solve disposal problems. It is important to recycle waste since this is the least that we can do to preserve our natural resources for future generations.

CHAPTER 2

LITERATURE REVIEW

2.1 INTRODUCTION

Interlocking block is now being widely used around the world. The use of the mortar less interlocking block building system has not yet become popular in India even though this system has been used in other countries. (SHARATH, 2013). . In Malaysia, interlocking block is used to construct the small building for the benefits of time save consumption and cost effective term. With this factor, this system was used to develop low-cost houses which proven to be better than conventional method in term of time and cost.

With the increase in material costs in the construction industry, there is a need to find more cost saving alternatives so as to maintain the cost of constructing houses at prices affordable to clients. So recycled construction waste are used since according to (Ithim, 2009) the cost of producing the block can be reduced by using the materials that are easily found locally and is more sustainable in terms of environmental issues. The soil that makes up the bulk of soil-cement is either in place or obtained nearby, and water is usually hauled only in a short distance. This perhaps can reduce some of the costing in construction site in the future.

2.2 LATERITE SOIL

Laterite is a red tropical soil that is rich in iron oxide and is usually derived from rock weathering under strongly oxidising and leaching conditions (Raheem et al. (2013). It forms in tropical and sub-tropical regions where the climate is humid (Mahalinga-Iyer and Williams, 1997). Laterite is very abundant in Ceylon, India, Burma, Central Africa, West Africa and Central America (Encyclopedia Britannica, 2001). It has been found to be less permeable when stabilised with palm oil, ordinary Portland cement (OPC) or clay from termite heaps (Encyclopedia Encarta, 2004). Because of the large deposits of laterite in Nigeria and most neighbouring African countries, the material is easily acquired and inexpensive. The potential of laterite is not presently being maximised in the area of brick production for building purposes.

2.3 AGGREGATE

The possible use of recycled fine aggregate made from waste rubble wall to substitute partially for the natural sand used in the production of cement and sand bricks. The bricks specimens were prepared by using 100% natural sand; they were then replaced by recycled fine aggregate at 25, 50, 75, and 100% by weight of natural sand (S. Ismail, 2010).

Replacement 40% crushed clay brick as fine aggragete after 28 days of curing period will get optimum compressive strength and flexural strength (Ummi Kalsum, 2008).

The modified concrete based on recycled brick has approximately the same value of compressive and bending strength, better waterproofness and frost resistance, smaller shrinkage strains, worse modulus of elasticity and slighter greater creep strains than natural aggregate concrete (Jankovic, 2010)

2.4 BENEFITS USING LATERITE INTERLOCKING BLOCK

The use of interlocking block using laterite block will give environmental benefit. Interlocking block can reduce the usage of cement thus decrease the amount of CO2 emitted and energy used for construction (Radhi, 2009). The amount of world's cement-carbon-dioxide was evaluated at 1 and 1.8 billion tons in 1988 and 2000. By considering the trend observed in the cement market and industry production, these CO2 emissions are expected will reach 3.5 billion tons by the year 2015 (Davidovits, 2008).

The reduction of CO2 is of every importance as this harmful gas contributes to global warming through greenhouse effect. The thermal insulation and thermal mass properties of building materials have been proven to significantly affect the amount of energy required for heating or cooling and affect the total amount of electricity used in residential houses (Radhi, 2009).

2.5 PRODUCTION OF INTERLOCKING BLOCK

There is several ways to produce interlocking block which is manually by hand or using machinery, that depend on the block type, material used and resource availabilities. The mixing process also needs to be done on an impermeable surface made free from harmful material that could change the properties of the mix. Moreover, the laterite block required proper compaction since manually press by hand can affect the quality and strength of the block produced.

2.6 COMPRESSIVE STRENGTH

Compressive strength test performed to determine the load-bearing capacities of the blocks. The wet and dry compressive strengths need to be determined. As for the dry compressive strength tests, the blocks aged 3, 7, 21 and 28 days tested will be recorded (Raheem, Falola & Adeyeye, 2012)

The minimum requirement from the Ministry of Work for non-load bearing blocks is 2.8 MN/m^2 and for load bearing blocks is 5.2 MN/m^2 (Nasly M.A, 2009).

2.7 DISCUSSION

From the analysis of the previous studies related to this topic of study, the optimum mix proportion to produce the interlocking block will be the 1:2:6 mix proportion. This mix proportion will used to carry out the curing sets experimental and the recycled sets experimental. The compressive strength of recycled fine aggregate at level 50% is higher than 66.67% as research conducted by previous researcher (Hasbullah Ali, 2013)

CHAPTER 3

MATERIALS AND METHODOLOGY

3.1 GENERAL

This chapter will discuss in detail works and procedures to achieve the objective of this study. It will discuss on how to produce samples of interlocking block using recycled fine aggregate and variety of tests procedure to be carried out on the interlocking blocks. There will be sand and recycled fine aggregate to be used as the main material to produce the interlocking block. To determine the silt content in laterite soil and river sand, sieve analysis will be carried out. Testing such as wet compression test, compression test, and abrasion test will be carried out after the blocks have been produced and cured for several weeks. The mix proportion 1:2:6 of cement-soil-sand with different percentage of sand and recycled fine aggregate to be used will influence the testing results.

3.2 MATERIALS PREPARATION AND TESTING

This section will mainly focus on the preparation of raw materials needed to produce the interlocking block. These raw materials include Ordinary Portland Cement (OPC), Fresh Laterite Soil, Recycled Fine Aggregate and River Sand.

3.2.1 Ordinary Portland cement

Ordinary Portland cement is chosen to be used in producing interlocking block although variety of cement type available in the market. This is because this type of cement is widely used in most construction project.

3.2.2 Laterite Soil

The laterite soils were obtained from a project near Kolej Matrikulasi Pahang, Gambang, Kuantan.

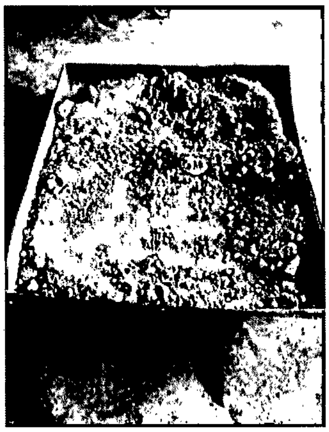

Figure 3.1: Laterite soils

3.2.2 Recycled Fine Aggregate

Generally, the recycled fine aggregate will probably obtained from demolition waste or old laterite interlocking block that already be used before, in this study the recycled fine aggregate will be obtained by crushing the samples interlocking block produced in curing sets experimental earlier from other student to determine the suitable curing method as the composition of the samples block are known (1:2:6 of cement-laterite-sand)

Figure 3.2: Crushed interlocking block

3.2.3 Sand

River sand has been chosen to be used in this study for the natural fine aggregate.

3.2.4 Water

The water is also needed in the mixing process. Specified water content used in the mix proportion is 10% from the weight of sand.

3.2.5 Sieve Analysis

The objective of this analysis is to produce a "Grading Curve" for fine aggregate according to BS 1377: Part 2:1990:9.2/9.3/9.4/9.6/9.7. It is to determine how many percentages of silt and clay in the soil. Only gravel and sand particle from soil will be used to produce the interlocking block as the silt and clay give a low compressive strength.

Test Procedure:

- Crush the soil using Jaw Crusher machine and sieved through 1.18mm sieve for laterite soil and recycled fine aggregate
- For river sand, sieved through 1.18mm sieve

3.3 CURING SETS

In this set of experimental will focus on the curing process of the blocks. There will be 3 types of curing process. The results of this curing experimental set will affect the curing process use in the recycled set. All set will be test for compressive strength after 28 days. A mix proportion of 1:2:6 (cement-laterite-sand) will be used.

3.3.1 Curing Process

The completed produce interlocking block will be subjected to curing process. The blocks will be cover with translucent poly covering and will be sprinkle with water in the morning and evening for a total of 14 days. There will be 3 type of curing.

1. Set 1A# Left in Sun

7 nos sample will be subjected to this type of curing process, 3 nos for compressive strength test, 2 for abrasion test days and 2 for water absorption test.

The procedure:-

- The block sample will be wet in the sun for 14 days then left to dry until 28 days
- The block will be watered twice a day (morning and evening).

2. Set 1B# 7 days in Shade

7 nos sample will be subjected to this type of curing process, , 3 nos for compressive strength test, 2 for abrasion test days and 2 for water absorption test.

The procedure:-

- The block sample will be wet in the shade 7 days then left dry in the sun until 28 days
- The block samples will be watered twice a day (morning and evening).

3. Set 2# Left in shade

7 nos sample will be subjected to this type of curing process, , 3 nos for compressive strength test, 2 for abrasion test days and 2 for water absorption test.

The procedure:-

- The sample for the first day will be wet in the shade then left dry until 28 days
- The sample will be put in the rack and dry place

Table 3.1: Number of Samples Produces

Set 1	Curing Type	1#A	1#B	2#	
1 : 2 : 6	Compressive strength	3 nos	3 nos	3 nos	
	Abrasion	2 nos	2 nos	2 nos	
	Water Absorption	2 nos	2 nos	2 nos	
Total		7 nos	7 nos	7 nos	21 nos

3.4 RECYCLED SETS

This set of experimental will be focusing on the production of the interlocking block using recycled fine aggregate as a sand replacement. The mix proportion of 1: 2: 6 is depending on percentage of recycled laterite block used replacing the aggregate

3.4.1 Mix Proportion

Table 3.2: Mix Proportion with partial percentage of recycled fine aggregate

Mix Proportion	Ratio				Percentage of Partial Recycled Fine Aggregate
	Cement	Laterite soil	Sand	Recycled block	
A	1	2	4	2	33.33%
B	1	2	2	4	66.67%

3.5 MIXING PROCESS

The most important process to produce the interlocking block is the mixing process of the materials. This is because a proper mixing technique is needed to produce a good quality of block.

3.5.1 Mixing Procedure

i. The estimated weight of 1 block sample is 6 kg. The materials required are first being prepared and weighed accordingly.

ii. The sand will be left for 1 hour in the pan after water (10% weight of sand) are added and mix together. Then soil and cement will be poured in the mixing machine (Figure 3.3) until properly blended together followed by pouring the sand.

iii. After the materials are mix well together, water will be added gradually using a sprinkling action if the mix did not ready for casting yet.

iv. It is important to test the mixture is ready to be pressed. Take a handful of the mixture and squeeze to check whether the mix already ready for casting. If the mix break up into 2 or 3 pieces, the casting can be proceed

v. A 6kg of mixture will be weighed in the bucket and then filled thoroughly in the mould. After that, closed and lock properly the hydraulic compressing machine.

vi. The hydraulic compressing machine (Figure 3.4) is handled carefully. Press the "Auto" button located in the controller panel and the interlocking block will be produced.