Lightweight aggregate for concrete blocks

3R Reduce, reuse, and recycle. Almost everyone has heard those three words but the environment that we live are getting more polluted each day. In Malaysia, there is as annual production of over 4 million tonnes of waste Oil Palm Shell (OPS). Exploit this waste material not only maximises the use of oil palm, but also helps preserve natural resources and maintain ecological balance.

Certain workmanship factors can be appreciable effects on the strength of block work such as incorrect adjustment of suction rate in block, bond between the units of block and deviation from vertical plane or alignment. Therefore, interlocking design is one of the better solutions for concrete blocks to solve this kind of workmanship installation problem.

Interlocking lightweight concrete block can reduce building dead weight effectively and reduces transportation costs and foundation load requirements. Furthermore, interlocking lightweight concrete block is save time to installation for construction and allows many homeowners easy to do the work themselves. Interlocking lightweight concrete block provide better joint between units of block because they are self aligning and this is greatly increases the speed of construction. This is kill three birds is one stone for time, cost, and quality. So the selection of size, shape, body and surface appearance of Interlocking block is a great decision for prevent all those all common defect.

AIM

To apply waste material Oil Palm Shell (OPS) and Styrofoam as lightweight aggregate at Interlocking lightweight concrete blocks.

OBJECTIVE

- To study compressive strength and density of lightweight concrete
- To study Oil Palm Shell (OPS) and Styrofoam as lightweight aggregate.
- To study the factors affect the strength of block.
- To produce the prototype of Interlocking lightweight blocks.

SCOPE OF STUDY

The scope of study for this dissertation is concerned about design of interlocking lightweight blocks by using lightweight material. The material using is Oil Palm Shell (OPS) and Styrofoam as lightweight aggregate. This research will cover on the performance (strength and density), design, and production a prototype of interlocking lightweight concrete blocks.

BACKGROUND

Interlocking lightweight blocks is one of the building walls used as barrier to control mass, energy, and particulate flow both within and across the system.. The shape of the Interlocking blocks is tongues on the top surface of the block and grooves at the bottom surface of the block. The function of tongues and grooves is to restrain horizontal movement when laying the interlocking block at the top of another without the use of mortar joints to provide better bond between units of block and make the wall strong enough to carry loads. Besides, interlocking block is a great invention for construction industry to save time and easy labour installed the wall either stacked or running bond configuration. For the cost issue, interlocking block is economical than conventional block due to no need to high-wages skilled masons and less mortar to use. Therefore the building costs are lower than for standard masonry construction.

Lightweight concrete can be defined as a type of the concrete which is lighter than conventional concrete density in the range of 140 to 150ib/ft3 (2240to 2400 kg/mm3). Lightweight concrete can be categories into three types which is no-fine concrete, aerated/foamed concrete and lightweight aggregate concrete. The main specialties of lightweight concrete are it’s to lower density, basic strength (no load bearing wall) and thermal conduction. Its advantages of the lightweight concrete are reduced dead load of the building, speed up construction productivity and handling cost. This is research is based on the performance of the lightweight aggregate concrete. Therefore, the lightweight aggregate concerned to use is wastes and recycled material due to issue on environmental preservation and sustainability. Styrofoam and Oil Palm Shell (OPS) is the great selection in this researched. In Malaysia, there is an annual production of over 4 million tonnes of waste Oil Palm Shell (OPS). Oil Palm Shell (OPS) aggregate has a unit weight of 500-600 kg/m3and this is approximately 60% lighter compared to the conventional crushed stone aggregates Currently, there is also an increasing demand for low-cost houses in Malaysia and therefore Oil Palm Shell (OPS) can be used as an alternative to the conventional aggregates in fulfil this demand (D. C. L. TEO, 2006). The behaviour of Oil Palm Shell (OPS) concrete in a marine environment was also previously studied.

PROPOSED RESEARCH METHODOLOGY

HOW TO GET INFORMATION

The information is categories to two categories which is primary data and secondary data. The information provides the very useful knowledge,

experience and briefs our minds to achieve the aim and objective easily and success.

Primary sources -Experiment

For getting more information, the experiments play the very importance and indispensable roles. Experiment can provide the accurate information and helpful for experiment to get the confirmation of the data. In order to get the correct data for experiment bring to successful, the standard of experiment method must be follow during the experiments. British standard is one of the useful standards to provide wide range information and also for international levels. The experiment of the concrete testing will prepare and doing at the Laboratory in Tunku Abdul Rahman College.

Secondary sources -Literature review

Literature review is a secondary data source in the stage which is the information that has been gathered by researchers and recorded in books, articles, and other publications. Basically, this stage is concern to review all the getting information related to the lightweight concrete and interlocking sandwich block. For the relevant information, the source can get from conducted the reference book, newspaper, journal and website. Analysis and summarized the information after collect all the related data from research. Therefore, the data provide clear direction for achieve the objective and knowledgeable in this study.

WHERE TO GET INFORMATION

Besides get the information from the website, article books, journals, and newspaper the experiment result also is one of the rely sources. The experiment can provide the experiment results, hypothesis of the objective and conclude answer for the study during the laboratory experiments testing. Lastly, get the actual life experience from supervisor by conducted the interview and go though the site visit.

WHAT TO GET INFORMATION

The information can get is primary data when doing the experiment, and secondary data from website, article books, journals, and newspaper and etc. All the data will use for summarized and analysis for the purpose of achieve the objective of study.

LITERATURE REVIEW

INTRODUCTION OF LITERLOCKING BLOCKS

WHAT IS AN INTERLOCKING CONCRETE BLOCK?

According to the (Sukri 2009) defined that " interlocking hollow core concrete block that widely called interlocking block have tongues on the top surface of the block and grooves at the bottom surface of the block. The function of that tongue and groove is to restrain horizontal movement when laying the interlocking block on top of one another without the use of mortar joints to make the wall strong enough to carry loads from the upper floor or slab similar to the conventional load bearing walls." The design of interlocking concrete block is the tongues on the top surface of the block and grooves at the bottom surface of the block, is that they offer keys, which interlock with another blocks. Therefore, interlocking block provides better

jointing and enough strength to support the load bearing walls. The interlocking design techniques are very effective to solve the workmanship problem to ensure the installation of block works is under better quality. Besides, interlocking blocks are different from the conventional blocks since they no need use mortar to jointing. Because of these characteristics, this is save time and no need hire high-skill workers when doing the block work.

OIL PALM SHELL CONCRETE (OPSC)

What is oil palm shell concrete? These mean the concrete using oil palm shell as lightweight aggregate. (Abdullah 1984) was the first one to use Oil Palm Shell (OPS) as lightweight aggregate (LWA) in Malaysia and proved that complete replacement of normal weight aggregate (NWA) with Oil Palm Shell (OPS) is a possibility. Its state the oil palm shell as lightweight aggregate to substitute normal weight aggregate is possible and success techniques to make the lightweight concrete by mixing of the cement, sand, oil palm shell, and water. According to (U. Johnson Alengaram 2010) noted ” for conducted further study on the using oil palm shell and found out that similar to normal weight concrete (NWC), water to cement (w/c) ratio affects the mechanical properties of palm kernel shell-aggregate concrete. The 28-day compressive strength of Oil Palm Shell (OPS) concrete varied between 5 and 25 MPa based on mix design.” Based on the researched, the water cement ratio is one of the importances key point to mix the oil palm shell concrete because of the water ratio will direct affect the strength of the concrete with mechanical properties. Commonly, the water to be use is 0. 40 to 0. 60 water/cement ratio but only 0. 23 of the water is required for hydration and the extra water is for full hydration and compaction of the concrete.

STYROFOAM CONCRETE

For the Styrofoam concrete, (M. H. Ahmad 2008) noted that " From the point been mentioned above we have to look for a possible lightweight concrete which is less water adsorption and hence less cement content and therefore enhance its matrix characteristic. The potential lightweight aggregates to be used as concrete component is Styrofoam. Styrofoam has hydrophobic characteristics, non-absorbent, good insulation properties and closed cellular aggregates may have the potential to be developed as good commercial lightweight aggregates and Styrofoam concrete produced density in the range of 1297-1387 kg/m3". Commonly, the lightweight concrete requirements are including lightweight, strength, sound insulation, heat insulation, and water resistance. Based on that, Styrofoam is one of the better materials for lightweight concrete because of lightweight, and strength strong enough. Furthermore, due to Styrofoam is a hydrophobic characteristic, the water cement ratio is the main factor need to take more consideration when doing the concrete. Lastly, the Styrofoam concrete is light weight about 45% savings in total dead load of a structural member compared to conventional concrete. Therefore, this is save the cost of foundation required more special or strong technique to support the load of the building.

PROPERTIES OF THE INTERLOCKING CONCRETE BLOCK

REQUIREMENT OF THE INTERLOCKING CONCRETE BLOCK

The interlocking concrete blocks have to provide the following functions (John Straube 2006):

Support

The blocks as the external or internal walls need to enough strong to support the static load (dead load) or dynamic load (live load) of the load bearing or non-load bearing walls. These loads have to be properly supported, resisted, and transferred to the building foundation.

Control

Interlocking blocks must be able to control mass, energy, and particulate flows both within and across the system. These include water, wind, air, smoke, odour, heat, light, noise, fire, blast, thief, birds, and insects.

Finish (aesthetics)

The finish function at the both of interior and exterior is the aesthetics of the finish surface, the visual, textural, and other aspect the designer wishes to convey with the visible element of the system.

Distribution of service

This function is related to the distribution of service through a building, both within a single element, and also multiple elements. Services like pipes, cables may run through envelope element as to provide services to the area close by.

TYPES OF CONCRETE BLOCK

Nowadays, concrete block have create varies designs and difference strength since they are varies types, so according (Michael Gage and Tom Krikbride 1980) notes that, “ with continues improvement in quality and

design of concrete blocks and their wider range of applications, BS 2028: 1953 and BS 1364: 1947 have been repeatedly revised and amended. Now, the two standards have been incorporated in one edition BS 2028, 1364: 1968 Precast Concrete Blocks.” This is publication gives new defined for the block and specifies new strength categories and test procedures. The distinction between type A, B and C concrete block, is based on the block density which is calculate by weight of the block by the overall volume (include holes and cavities). See table 1.

CONCRETE BLOCK – TYPE A

For the type A concrete block, generally is used in the building including use below ground level damp-proof course. The concrete block must be of dense concrete or one of the denser lightweight aggregates.

CONCRETE BLOCK – TYPE B

For the type B concrete block, generally is used in the building including use below ground level damp-proof course in internal walls, and the inner leaf of external cavity walls. The concrete block must be of dense concrete or one of the denser lightweight aggregates. Normally, should be solid hollow or cellular block made with dense aggregate and average compressive strength not less than 7. 0 N/mm2.

CONCRETE BLOCK – TYPE C

For the type c concrete block, generally is used in the building which is non load bearing walls such as the partitions and panels in framed construction. The purpose just for building insulation, finish (aesthetics) and service (privacy) but no for supporting the building load.

FACTORS AFFECT THE STRENGTH OF BLOCK

The common defects arising from the production process which will affect the strength of the concrete block such as the defects of size, defects of shape, defects of body, and defects of appearance.

DEFECT OF SIZE

For the defects of the size, generally defects are oversized and undersized of concrete block caused by pool material preparation, and faulty mould. The wall will uneven due to the blocks size is not uniform to do the structure bond. This will affect structure load cannot transfer properly of the wall.

DEFECT OF SHAPE

Defect of shape, is the shape which is difference with the actual accurate shape to propose. Normally causes the misshapen of block are the poor preparation of the mould, faults of stacking, rough handling and uneven drying.

DEFECT OF BODY

Common defect of the body is faults in the raw material body can make the defect happen such as cracking, bloating and laminations. This kind of defect will make the block breaking easily with the gap on the surface.

DEFECT OF APPEARANCE

The defect of the appearance is the surfaces of the block have a bubble or the honey comb shape. Honey comb is a void on the exterior of a concrete face. When the concrete is not vibrated properly during installation, honeycomb will form. This is a serious flaw, since reducing the strength of block.

ADVANTAGES AND DISADVANTAGES OF INTERLOCKING LIGHTWEIGHT CONCRETE BLOCK

ADVANTAGES OF INTERLOCKING LIGHTWEIGHT CONCRETE BLOCK

According to researched (Msesut Asik 2006) noted that, " lightweight concrete lower dead load: Saving in the structural can be achieved due to the reduced dead load, particularly for longer span bridges." Lightweight concrete is light in weight than convention concrete weight; therefore reduced the dead load of the concrete for the building for supporting and transfer the load.

(Msesut Asik 2006) noted that, these savings can also be reflected in the cost of foundations (particularly where pilings are required), and in formwork and false-work requirements. The lighter weight also results in savings in the handling and transportation of materials, and pre-cast elements, etc. The lighter weight can permit the use of longer spans with a consequent reduction in the number of supports required." Lightweight concrete usually will be using the recycle material as lightweight aggregate to replace the normal weight aggregate since which to save the cost of the material and environment. Besides, the concrete blocks are lightweight and precast, therefore they is results in savings in the handling and transportation of materials, and pre-cast elements.

According to the interlocking lightweight concrete block advantages (Bankole-Ojo 2008) noted that, " hollow interlocking lightweight concrete block, compared to hollow concrete blocks, is that they offer keys, which interlock in the other blocks. Thus these walls offer more resistance to shear

and buildings would be even stronger.” The interlocking block provides the shapes of tongues on the top surface of the block and grooves at the bottom surface of the block. The advantage of this technique is provides the better jointing with another block with accurate horizontal alignment when doing block work.

Without the need for high-waged skilled masons (except for the base course), by saving cement (less mortar) and with the speed of construction, the building costs are lower than for standard masonry construction. The interlocking concrete blocks are no need skill worker to installation because the interlocking design technique provides general worker easy and convenience to install the block works with better alignment and jointing. Additional costs are saved by building load bearing walls, instead of infill walls between structural frameworks.

DISADVANTAGES OF LIGHTWEIGHT CONCRETE BLOCK

According to researched (Msesut Asik 2006) noted that, the disadvantages is “ Reduce resistance to locally concentrated loads as they occur at pre-stressing anchorages or bearings, hence increased confining reinforcement is required, lightweight concrete is more brittle because of high strength cement paste.” The lightweight concrete need to provide more reinforcement to solve the concrete strength problem because the concrete weaker when load is concentrated. The lightweight concrete is using the high strength cement paste. Therefore this is brittle easily.

The interlocking concrete blocks are no need skill worker to installation because the interlocking design technique provides general worker easy and

convenience to install the block works. But still need to provide certain amount of training is required to ensure that the walls are properly aligned and no gaps are left. Because the technique is still considered new to worker compare to conventional block works. Besides, interlocking block is better in jointing and alignment but the joints are not entirely resistant to wind and rain penetration, therefore, plastering the interior wall surfaces is usually necessary.

RESEARCH METHODOLOGY

INTRODUCTION

The research methodology that will conduct for my project dissertation is laboratory experiment material testing and application. The project dissertation is carried out at the Tunku Abdul Rahman College laboratory.

OIL PALM SHELL CONCRTE

Oil palm shell concrete is mixing of cement, sand, aggregates and water. But the aggregate to be use is oil palm shell to substitute normal weight aggregate. Based on (Abdullah 1984) was the first one to use Oil Palm Shell (OPS) as lightweight aggregate (LWA) in Malaysia and proved that complete replacement of normal weight aggregate (NWA) with Oil Palm Shell (OPS) is a possibility. The oil palm shell as lightweight concrete is possible and successfully to proven that can use for the building envelop. In Malaysia, there is an annual production of over 4 million tonnes of waste Oil Palm Shell (OPS). Therefore oil palm shell is very common material that can be easy get from everywhere, huge amount and cheaper. For this project dissertation, that will to do the comparison of strength and density between oil palm shell lightweight concrete (OPSLC) and normal weight concrete (NWC).

PROCEDURE TO CAST OIL PALM SHELL CONCRTE

The constituents of oil palm shell concrete to be use include Ordinary Portland Cement (OPC), oil palm shell, sand and water. Usually the oil palm shell surface is still coating with some oil, therefore pre-treatment to remove the surface oil is necessary. The methods to be use include natural weathering, boiling in water, washing with detergent. After removed the oil palm shell surface oil, the selected aggregate size will be done by sieve analysis. For the recommended from researched, the size of aggregate which passing through the 12. 5mm sieve and retained on the 4. 75mm sieve was used. For the experiment, oil palm shell concrete mixing ratio will be proposed such as 1: 1: 2, 1: 1: 3 and 1: 1: 4 (cement: sand: ops aggregate).

STYROFOAM CONCRETE

Styrofoam concrete is mixing of cement, sand, styrofoam s and water. The Styrofoam will be use to substitute normal weight aggregate. Based on, (M. H. Ahmad 2008) noted that, he said the styrofoam is hydrophobic characteristics, non-absorbent, good insulation properties and closed cellular aggregates may have the potential to be developed as good commercial lightweight aggregates. But the problem of mixing Styrofoam concrete is water/cement ratio because of styrofoam is hydrophobic characteristics, and non-absorbent. Therefore the water cement ratio to be use is less than conventional concrete mixing method. Due to these characteristic, Styrofoam is very difficult to mix with cement and sand. Therefore, from the researched find out the additional of the adhesive material can increase the plasticiser of the concrete and solve this kind of the problem.

PROCEDUCE TO CAST STYROFOAM CONCRETE

The constituents of Styrofoam concrete to be use include Ordinary Portland Cement (OPC), Styrofoam, sand and water. The size of the Styrofoam to use is approximate 3mm to 5mm which is Styrofoam beads. Due to Styrofoam is a hydrophobic characteristic since they are no absorber of water, therefore the water/cement ratio is less than conventional concrete required. Besides, the compaction of the Styrofoam concrete for experiment cube is by using vibration machines or hand compaction. The compaction of the Styrofoam concrete cannot by using tamping rod because of the Styrofoam will damage the Styrofoam components. From the researched, the recommend water cement ratio to be for Styrofoam concrete is 400 to 500ml.

DENSITY

Lightweight concrete is a concrete which is light by using the lightweight materials to replace the conventional materials. Therefore, the density of the lightweight concrete is depended on the material to be use. The different type of the lightweight materials will determine the different densities. Lastly, the density of the lightweight materials is importance to the concrete because the density of the concrete will affect the strength of the concrete. Referred to the Neville (1995), commonly the density lightweight aggregate material is range between 300 to 1850 kg/m3. The calculation the density is based on weight and size of the concrete. The method and formula to determine the density of the lightweight concrete will show in the appendix 1.

COMPRESSION STRENGTH

Compressive strength is one if the primary properties to ensure the strength of the concrete. They are many ways to test the compressive strength of the concrete which include destructive and non destructive tests. From the project dissertation, the method to be use for the lightweight aggregate concrete is destructive test which is cube test. The reason of choosing this method is accuracy, easy and convenient due to the size of cube is small. Furthermore, it is used as the standard method of measure compressive strength for the quality control purposes (Neville, 1994). The procedure of compressive strength test will show in the appendix 2.

MAKING OF PROTOTYPE-INTERLOCKING BLOCK

For this stage, the oil palm shell concrete and Styrofoam concrete as the lightweight aggregate concrete to produce interlocking blocks. The type of concrete block design is hollow concrete block which is has one or more large cavities which pass through the block. The purpose of hollow concrete block is to reduce the weight of the concrete block and provide a hole at the middle for allow reinforcement steel bar pass through it.