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Utilizing Oil Palm Shell to Produce Light Weight Concrete

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Abstract: In unusual concrete sets, lightweight concrete is considered as one of the most important substances in these sets. It has utilized for many years in architecture and insulation field of work. This research illustrates a new procedure used to generate structural lightweight concrete by utilizing oil palm shell (OPS) as a kind of an agriculture solid waste. More specifically, the researcher concentrated on using OPS aggregate for reinforced concrete beam as an example of structural members. The purpose of this research is to provide engineers with a better design idea and suitable application of using waste light weight aggregate specially oil palm shell for producing light weight concrete .in this research, the main properties of OPS concrete specifically the density of concrete, modulus of elasticity, compression strength and the flexural strength have been discussed in addition to cost analysis of using such materials.

Keywords: Lightweight concrete, Oil palm shell, modulus of elasticity, compression strength, flexural strength.

1. Introduction

There are usually incredible highly demand of using concrete as an essential material for constructing structural materials and this relates to concrete durability and workability characteristics. But on the other hand, when use concrete, additional steel reinforced will apply and this will result in increasing dead loads which imposed to the structure of the building. Thus aid in emerging the idea of utilizing lightweight aggregate as a kind of light weight concrete and as a solution of reducing the total dead load which are imposed on a building, particularly for building which are considered relatively high.

In the region of Southeast Asia, Many states depend on the industry of agriculture for their economic prosperity, and that's relate to the fact that most of these regions own an equatorial humid weather , and they have an exuberant rainfall during the year which considered as an ideal situation for growing products. In addition to the existence of highly productive soils which considered as an enhancement for most crops production processes. The palm oil manufacture considered as one of the most well-known agriculture manufactures in this area. Many states in the area own a wide plantation of oil palm such as Malaysia, Thailand and Indonesia. In 2009, these states added 90% of the whole world's palm oil manufacture. Rapidly increasing instance for palm oil was observed all over the world because the ability of using palms oil in multiple sectors. As a result, this increment also guides to a huge waste materials quantity

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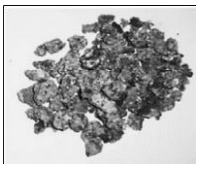
produced like oil palm shell (OPS) and palm oil clinker (POC). The Oil Palm Shell, Palm Oil Clinker and Coconut Shell were the most utilized wastes to produce light weight concrete and these materials is illustrated in figure (1).


1. a oil palm shell 1.b Palm oil clinker 1.c coconut shell

Figure (1): The most utilized waste types to produce light weight concrete.

Oil Palm Shell is directly created by the process of breaking the palm nucleus cortex that happens due to the extraction of palm oil and is often lying in the surrounding of the factories that affected the nature of ground and contaminate it [1]. The main function of palm shell wastes is to produce Lightweight concrete as many researchers presented. One advantage of utilizing such materials in manufacture process that they cannot generate poisonous materials when they creating bonds in the matrix of concrete and that's related to the stiff surfaces that generated from organic resource. Another benefit of these materials that they considered lighter with comparing them to traditional coarse aggregate so the concrete resulted from this type of aggregate is considered lightweight concrete[2].

The basic goal is to support the idea of utilizing OPS waste aggregate as special construction materials in low-cost building and in situations where it's considered uneconomical to use crushed stones for producing light weight concrete and to offer a range of technical, ecological and economical improvements in the construction procedures. This research will also illustrate the outcomes of a detailed examination of strength characteristics and cost study on the type of concrete which utilized varies proportions of oil palm shells .a comparison between OPS concrete with ordinary concrete are also done.

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2. Methodology

An experimental procedure was held in this research in order to examine the strength properties and cost effectiveness study of concrete that generated by using specific gradation of OPS .The justification behind utilizing this methodology which is to examine the comparative cost analysis and the strength characteristics of concrete has been recognized by many researchers [3].The experimental approach is a highly appropriate method for investigating the dynamic changes occurs when utilizing such materials in construction processes.

Different materials were employed in the experimental procedure such as :(cement and water, aggregates and oil palm shell).Three mix ratios were used to fulfill a 28-day design strength of concrete cube which are :[1:1.65:2.45 , 1:2.5:3.3 , 1:3.3:4.2] through the weight of normal Portland cement ,crushed rocks, river sand OPS as a replacement for coarse aggregates were utilized to shape the specimens .The ratio of water/cement was 0,45 , 0,6 and 0,75 and for each mixture the ratio of water/cement was stayed stable for the whole proportion of crushed rocks with OPS aggregates.

First, the preparation of the test samples was accomplished through preparing concrete cubes with sizes of 150× 150× 150 mm and cylinders with 300 mm height and 150 mm diameter, in addition to beams that carry variable of 100×100×500 mm in order to determine variable characteristics of OPS concrete. The mixing procedure was done in a flat plate depending on manual technique. For each mix ratios, the gravel was substituted by oil palm shell in the scale of 0-50%.So the whole number of samples were 96 which were casted in the laboratory in order to accomplish variable testing procedures. For the purposes of preparing the samples, firstly, the mix between sand and cement were done through a shovel .After that, the addition of oil palm shells and crushed rocks were accomplished to the mix. All the components materials were mixed through a trowel and the addition of water were done during periods after the end stage of mixing aggregates and cements.

The workability of fresh concrete was examined directly after the end of concrete mixing procedures through utilizing slump test. We depend on a steel rod with dimensions of 16 mm diameter in order to compact the three mould layers. The compacting procedure was done by hitting each layer with 25 blows from the mentioned rod before pouring the following layer.

Each layer was imposing to one hundred and fifty blows concentrated throughout the overall prisms length. At normal weight concrete ,were 0% replacement stage existed, the value of slump were equal to 62 mm for the first mix proportion (mixture ration of [1:1.65:2.45]), while slump value achieved 48 mm for mix ratio of [1:2.5:3.3] and at the final mix proportion [1:3.3:4.2] , the value equal to 42 mm, which illustrate medium and large level of workability. While increasing the proportion of OPS replacement in the mixture; the magnitudes of slump will decrease in gradual way. Then we left all samples in molds for a complete day (24 hour) in order to cool these samples as the surrounding temperature. After that the mold were removed and transported to a specific treating tank which is filled with pure water. Depending on the terms and requirements of BS and ASTM codes, the preparation of samples and Cement blends were accomplished [4], [5], [6], [7]. Samples after that were exposed to multiple experiments as follow; the examination of above mentioned prepared cylinders and cubes were held through utilizing an Electronic Compression instrument with 2000 KN capacity and depending on loading averages with a magnitudes of 6 KN/sec plus 4.42 KN/sec within a duration ranges between 7 and 28 days. In order to calibrate the compressive strength, the calculation of the average load rate at which the set average of three examined cubes for each

combination failed was done. Another test were accomplished which is the bending test for a specific beam with an effective span length equal to 300 mm and through using a rate of loading of 4.42 KN/sec and the beam is considered simply supported beam. For the purposes of the flexural strength determination according to the proportion of oil palm shell in the mixture, we utilize the highest mean rate of the load which caused the failure of the tested beams. In a specified laboratory conditions, a special gauge was used in order to determine the modulus of elasticity of concrete that contains Oil Palm Shell and the ordinary normal weight concrete which is a Compress meter-extensometer. The tests held in order to determine the splitting tensile strength, modulus of elasticity and flexural strength needed 28 days to complete perfectly.

3. Results

3.1. Concrete Density: the generated density of concrete decreased by increasing of the OPS portion through the conventional crushed granite (as course aggregate).

At the beginning, with adding 0% percentage of OPS to the mix, the density of the concrete were observed to be equal to 2360 Kg/m², 2255 kg/m² and 2232 kg/m² for the mix proportions of [1 : 1.65 : 2.45], [1 : 2.5 : 3.3], and [1 : 3.3 : 4.2]. The density has reduced to be equal to 2180 Kg/m², 2092 Kg/m² and 1785 kg/m² for the first mix proportion (1.65:2.45) at 10%, 15% and 40% stages of OPS replacement. On the other hand, for the next mix ratio(1:2.5:3.3) and at the same percentage of OPS substitution the density decreased to be equal to 2160 Kg/m²,2078 kg/m² and 1760 kg/m² , and at the final mix portion(1:3.3:4.2) the density decreased to be (2116 kg/m², 2012 kg/m² and 1708 kg/m²). So the density of light weight concrete ranges between 300 – 1850 kg/m² (Neville, 1995).

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3.2 Modulus of Elasticity: Experiment results indicated that the modulus of elasticity of 15% OPS substituted concrete is decreased to be approximately equal to the half value of regular concrete modulus of elasticity for the three mix ratios respectively([1 : 1.65 : 2.45], [1 : 2.5 : 3.3], and [p1 : 3.3 : 4.2]).

This is related directly to the minimum value of the stiffness of aggregate of OPS compared to gravel. The enlargement of the values of concrete modulus of elasticity can be affected by the coarse aggregate sort, cement category, the ratio of w/c in the mixture, size of aggregate in addition to curing age [8].In general, the value of modulus of elasticity in concrete mainly depends on the coarse aggregate stiffness, the interfacial area amid of paste and mix aggregates and the elastic characteristics of involving substances.

3.3 3.3 Compressive strength: results explained that concrete compressive strength reduced by increasing the percentage of OPS. Generally, the concrete that owns a portion of 0% OPS carry the highest value of compressive strength when comparing it to other mix ratios. The strength of concrete basically relays on stiffness, density and the strength of coarse aggregates. Many facts could be noticed from this experiment results, firstly; when the density is low then the strength is low, and in general lower values of density lead to low strength values .When the percentage of OPS increases then the concrete density will decrease, thus, lead to lower compressive strength of concrete. Figure (2) and (3) illustrate a comparison of compressive strength of OPS at 28 and 7 days of curing.

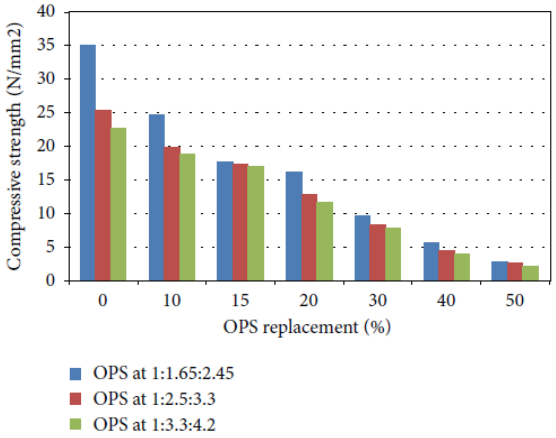

Figure (2): A comparison of compressive strength of OPS at 28 days of curing

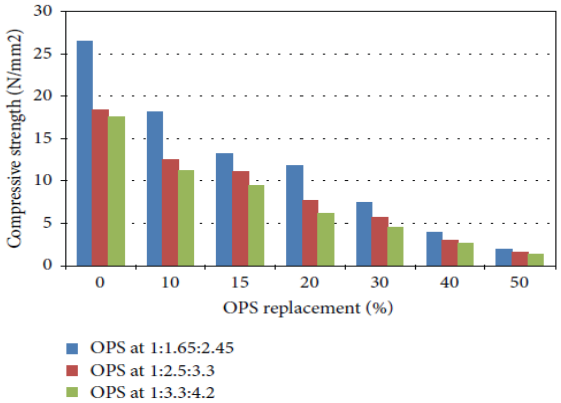

Figure (3): A comparison of compressive strength of OPS at 7 days of curing

3.4 Flexural Strength: The results illustrate that when increasing the proportion of OPS in the mix design, then the concrete flexural strength will decrease. The strength achieved at 7 and 28 days were 2.92 N/mm² and 4.3 N/mm² for the mix proportion of 1: 1.65: 2.45.The values correspond for 50% replacement of OPS are 0.9 N/mm² and 1.1 N/mm².The two other proportions

illustrate the same behavior of decreasing the strength while increasing the percentage of OPS in concrete. Generally, the suitable strength for the concrete flexural strength can be achieved when utilizing a percentage of 15% replacement of OPS. Figure (4) and (5) indicated a comparison of flexural strength of OPS at 28 and 7 days of curing

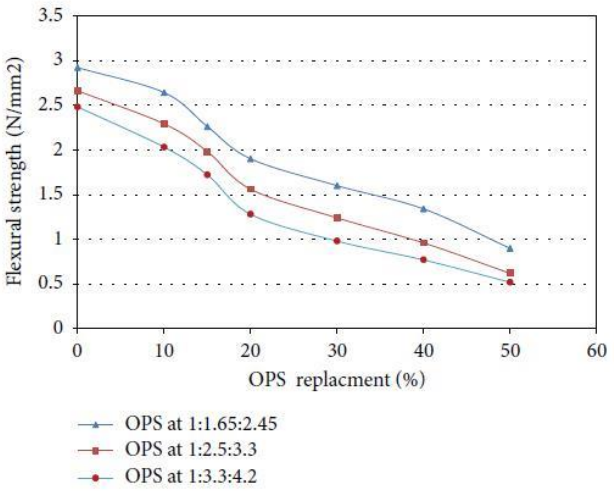

Figure (4): Comparison of flexural strength of OPS at 7 days of curing

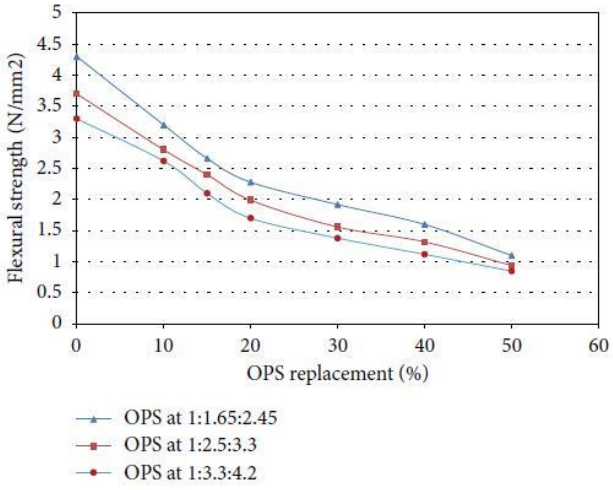

Figure (5): Comparison of flexural strength of OPS at 28 Days of curing

3.5 Splitting Tensile Strength: The splitting tensile strength for the usual concrete is approximately equal to 10% , while the splitting tensile strength of 15% OPS replacement concrete is nearly 12% from the compressive strength that reached at 28 days. So, for higher OPS replacement or higher mix percentages of concrete, the splitting tensile strength of OPS replacement concrete will decrease.

3.6 Cost Investigation : we can see from results that the reduction of cost for about 15%,12% and 10% could be obtained through the 15% replacement for coarse aggregate in the proportions of mix of (1:1.65 :2.45) , (1 :2.5 :3.3), and (1 :3.3 :4.2).So, for the purposes of construct low price housing, we can utilize concrete which is rather substitute aggregate with OPS partially .

4. Conclusions:

Oil palm shells are considered as an agrarian solid waste in the industry of palm oil in addition they could be considered as an optional substance for fabrication of light weight aggregate concrete and for producing sustainable buildings.
From this research, it was found that there are many advantages derived from utilizing waste light weight aggregate specifically Oil Palm Shell to produce light weight concrete in concrete beams. The main benefits of using light weight aggregate for concrete member is the improved ductility compared with usual reinforced concrete member. In addition to many benefits that can be understood from above mentioned experimental results of using oil palm shell for the process of production of Light Weight Concrete such as; the decreased concrete compressive strength when increasing OPS percentage in the mix. However, many studies are necessary in order to further explain the feasibility of these reinforced light weight concrete members from structural point to achieve the ultimate objective of utilizing such light weight concrete members for real thematic implementations for future times.

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