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AN EXPERIMENTAL INVESTIGATION OF PALM SHELL WITH PARTIAL REPLACEMENT OF COARSE AGGREGATE ON HIGH STRENGTH LIGHT WEIGHT CONCRETE

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Abstract:

This paper presents the strength characteristics of the light weight concrete with micro silica and palm shell based concrete specimen of M30 grade with ordinary Portland cement of 43 grade. The main aim of this study is to investigate the effect of micro silica and palm shell in light weight concrete with various proportions. A test conducted by aim of this work is to provide more data on the strengths of light weight concrete strength characteristics of concrete by using crushed granular palm shell as substitute for conventional coarse aggregate by partial replacement and silica fume as substitute for cement in the following ratios 1%, 2%, & 3%.

Key Words: Micro Silica & Palm Shell

1. Introduction:

Lightweight concrete (LWC) has been successfully used since the ancient Roman times and it has gained its popularity due to its lower density and superior thermal insulation properties. Compared with normal weight concrete (NWC), LWC can significantly reduce the dead load of structural elements, which makes it especially attractive in multi-storey buildings. However, most studies on LWC concern "semi lightweight" concretes, i.e. concrete made with lightweight coarse aggregate and natural sand. Although commercially available lightweight fine aggregate has been used in investigations in place of natural sand to manufacture the "total-lightweight" Lightweight concrete (LWC) has been used for structural purposes for many years. The density of LWC typically ranges from 1400 to 2000kg/m3 compared with that of 2400 kg/m3 for normal weight concrete (NWC). Some of the techniques used for producing LWC include using natural lightweight aggregates such as pumice, diatomite, and volcanic cinders or artificial by-products such expanded shale, clay, slate, and sintered pulverized fuel ash (PFA). Malaysia is the second largest palm oil producing country in the world and it produces more than half of world's palm oil. The PKS are available in large quantities in palm oil producing countries in Asia and Africa. Malaysia alone produces nearly 4 million tons of PKS annually and this is likely to increase as more production is expected in the near future. The world's largest importer of palm oil, India is seeking to slake its thirst domestically. The ministry of Agriculture estimates that India has the potential to cultivated oil palm in 1.03 million hectares of land-nearly the size of the U.S of Connecticut-and produces four to five million metric tons of palm oil per year. Lightweight concrete has established itself as a suitable construction material whenever the conditions require strict savings in the dead-loads in structures and energy conservations and whenever there is an abundance of local lightweight aggregates. In recent years, research and development in the field of LWAC has been focused especially on the achievement of a final composite material with high strength, workability and durability together with low density. Silica fume in concrete is useful to increase the compressive strength and decrease the drying shrinkage and the permeability. Also the incorporation of silica fume in concrete is effective to increase the bond strength with the steel reinforcement and abrasion resistance. Consequently, the use of silica fume concrete in civil structures is wide spreading Nevertheless, the loss of workability due to the use of silica fume creates the difficulty to utilize silica fume concrete accurately The smaller sizes (10 mm and 5mm) and rounded shape aggregates should be used for high strength of concrete than other sizes and shape respectively Incorporation of silica fume in concrete has an adverse effect on workability and higher percentage of super plasticizer is needed for higher percentage of cement replacement by silica fume.

2. Literature Review:

D. C. L. Teo, M. A. Mannan, V. J. Kurian, C. Ganapathy Light weight concrete Made From Oil Palm Shell (OPS); Structural Bond And Durability property. The first part of this experimental program was to determine the structural bond properties of lightweight concrete incorporating solid waste oil palm shell (OPS) as coarse aggregate and also to compare its behavior with other types of lightweight aggregate concretes. Other properties of OPS concrete namely the split tensile strength, modulus of rupture and modulus of elasticity were also determined.

Mohammad Momeen Ul Islam, U. Johnson, Mohd Zamin Jumaat Mechanical and fresh properties of sustainable oil palm shell lightweight concrete incorporating palm oil fuel ash. In this investigation, agro-solid waste materials from the palm oil industry such as oil palm shell (OPS) and palm oil fuel ash (POFA) were utilized to replace conventional concrete-making materials to produce lightweight concrete. The OPS was used as replacement for conventional coarse aggregate while ground POFA was used at partial cement replacement levels of up to 25%. The inclusion of POFA up to 25% did not detrimentally affect the fresh concrete properties while the use of POFA at 10–15% replacement levels improved the compressive strength of OPS concrete (OPSC).Although there was little effect of POFA on the modulus of elasticity, increased POFA replacement levels led to reduction in both the splitting and flexural tensile strengths of OPSC. The evaluation of the cost and eco-efficiencies showed that inclusion of 10% POFA gave the most optimum performance in terms of the sustainability of the OPSC.

Payam Shafigh, Hilmi Bin Mahmud, Mohd Zamin Bin Jumaat, Rasel Ahmmad Structural lightweight aggregate concrete using two types of waste from the palm oil industry as aggregate. Huge quantities of raw materials are used in making concrete. Due to the limitations of natural materials the use of waste and by-product materials in concrete can eliminate the negative impact of concrete on the environment. To produce a cleaner and greener concrete two waste materials from the palm oil industry were used as coarse and fine aggregates. For this purpose normal sand was replaced with oil-palm-boiler clinker (OPBC) sand from 0 to 50% in oil palm shell (OPS) lightweight aggregate concrete. Properties, including workability, different types of density, compressive strength in different curing regimes, splitting tensile and flexural strengths, stress–strain curve, modulus of elasticity, water absorption and drying shrinkage strain of green lightweight concretes, were measured and discussed. The results showed that it is possible to produce environmentally-friendly structural lightweight concrete by incorporating high volume waste lightweight aggregates from the palm oil industry

K. Y. Foo, B.H. Hameed Value-added utilization of oil palm ash: A superior recycling of the industrial agricultural waste. Concern about environmental protection has increased over the years from a global viewpoint. To date, the infiltration of oil palm ash into the groundwater tables and aquifer systems which poses a potential risk and significant hazards towards the public health and ecosystems, remain an intricate challenge for the 21st century. With the revolution of biomass reutilization strategy, there has been a steadily growing interest in this research field. Confirming the assertion, this paper presents a state of art review of oil palm ash industry, its fundamental characteristics and environmental implications. Moreover, the key advance of its implementations, major challenges together with the future expectation are summarized and discussed. Conclusively, the expanding of oil palm ash in numerous field of application represents a plausible and powerful circumstance, for accruing the worldwide environmental benefit and shaping the national economy.

D. C. L. Teo, M. A. Mannan, V. J. Kurian Structural Concrete Using Oil Palm Shell (OPS) as Lightweight Aggregate. This paper presents part of the experimental results of an on-going research project to produce structural light weight concrete using solid waste, oil palm shell (OPS), as a coarse aggregate. Reported in the paper are the compressive strength, bond strength, modulus of elasticity, and flexural behavior of OPS concrete. It was found that although OPS concrete has a low modulus of elasticity, full-scale beam tests revealed that deflection under the design service loads is acceptable as the span-deflection ratios ranged between 252 and263, which are within the allowable limit provided by BS 8110. Laboratory investigations show encouraging results and it can be summarized that OPS has good potential as a coarse aggregate for the production of structural lightweight concrete, especially for low-cost housing construction .

3. Material Type:

Palm Shell: The palm oil industry produces wastes such as palm kernel shells, palm oil fibers which are usually dumped in the open thereby impacting the environment negatively without any economic benefits. Palm kernel shells (PKS) are hard, carbonaceous, and organic by- products of the processing of the palm oil fruit. PKS consists of small size particles, medium size particles and large size particles in the range 0-5mm, 5-10mm and 10-15mm. The shells have no commercial value, but create disposal and waste management problems. They are light and naturally sized; they are ideal for substituting aggregates in LWC construction. Being hard and of organic origin, they will not contaminate or leach to produce toxic substances once they are bound in concrete matrix. Normally, the shells are flaky and of irregular shape that depend on the breaking pattern of the nut.

Figure 1: Palm Shell

Cement: Concrete involves huge amount of consumption of cement depending on the grade of concrete. Cement is an important construction ingredient produced in virtually all countries. Carbon dioxide (CO_2) is a byproduct of a chemical conversion process used in the production of clinker, a component of cement, in which limestone ($CaCO_3$) is converted to lime (CaO).

$$CaCO_3+heat = CaO+CO_2$$

CO_2 is also emitted during cement production by fossil fuel combustion. The usage of mass quantity of cement leads to consumption of huge natural resources (i.e., lime) and also involves emission of CO_2 increase .It is reported that production of one M.T. of cement releases one M.T.ofCO_2 which leads to global warming .nearly 5-8%of the world's manmade greenhouse gas emissions from the cement industry.

Silica Fume: Silica fume, also known as micro silica, is an amorphous (non-crystalline) polymorph of silicon dioxide, silica. It is an ultrafine powder collected as a by-product of the silicon and ferrosilicon alloy production and consists of spherical particles with an average particle diameter of 150mm.The main field of application is as pozzolanic material for high performance concrete. Silica fume is added to Portland cement concrete to improve its properties, in particular its compressive strength, bond strength, and abrasion resistance. These improvements resulting from addition of a very fine powder to the cement paste mix as well as from the pozzolanic reactions between the silica fume and free calcium hydroxide in the paste. Addition of silica fume also

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reduces the permeability of concrete to chloride ions, Which protects the reinforcing steel of concrete from corrosion, especially in chloride-rich environments such as coastal regions and those of humid continental roadways and runways (because of the use of deicing salts)and saltwater bridges

Figure 2: Silica Fume

Composition (%)	Silica fume
SiO_2	98.87%
Al_2O_3	0.01%
Fe_2O_3	0.01%
CaO	0.23%
MgO	0.01%
K_2O	0.08%
Na_2O	0.06%

Table 1: Chemical compositions of Silica Fume

Fine Aggregate: Natural sand of 4.75mm maximum size was used as fine aggregate. The grading of original fine aggregate is shown in Table-2. Results indicate that fine aggregate grading is within the requirements of the B.S. 882/1992 specification.

Coarse Aggregate: Normal aggregate that is of maximum size 20 mm was used**.** The aggregate is very important as it affects the packing and voids content. The water absorption, fineness modulus, specific gravity, bulk density of all aggregates should be closely and continuously monitored as per IS: 2386-1963(part I & ii)/IS: 383-1970 and must be taken into account in order to produce internal curing concrete of constant quality. The results are given in table 3.6 & 3.7 presents the sieve analysis of coarse aggregate.

DESCRIPTION	CEMENT CONTENT	FINE AGGREGATE	COARSE AGGREGATE	WATER
WEIGHT	437.78kg/m^3	666.12kg/m^3	1086.83kg/m^3	197.58kg/m^3
RATIO	1	1.52	2.48	0.45

Table 2: Mix proportion

4. Results:

Compressive Strength Test: The results of compressive strength were presented in table 5.1.the test was carried out by conforming IS516-1965&IS 4031Part 6-1988 to obtain compressive strength of concrete at the age of 28 days. The cubes were tested using compression testing machine (CTM) 2000KN.

Figure 3: Compression testing of cube

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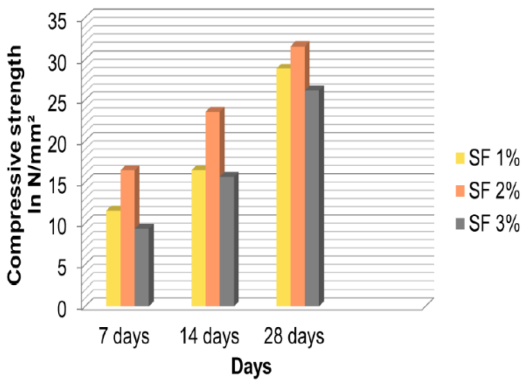

Figure 4: Comparison of Compressive Strength of replacement of Silica Fume

Split Tensile Strength: The result of split tensile strength was presented in table 5.2.The test was carried out conforming to IS516-1959 to obtain split tensile strength of concrete at the age of 28 days. The cylinders were tested using compression testing machine (CTM) of capacity2000KN

Figure 5: Split tensile testing of cylinder

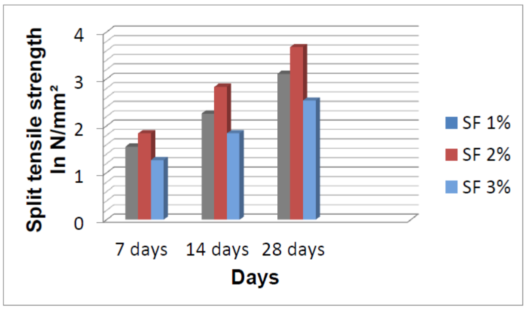

Figure 6: Comparison of Tensile Strength of replacement of Silica Fume

Flexural Strength: The results of flexural strength of conventional concrete were presented in table 5.3. The test was carried out conforming to IS 516-1959 to obtain flexural strength of concrete at the age of 28 days. The prisms were tested using flexural testing machine.

Figure 7: Flexural testing of prism

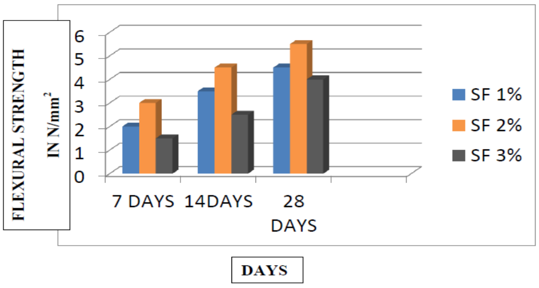

Figure 8: Comparison of Flexural Strength of replacement of Silica Fume

Light Weight Concrete: The density of LWC typically ranges from 1400 to 2000 kg/m3 compared with that of 2400 kg/m3 for normal weight concrete (NWC).

Cube weight = 6.039kg
Volume of Cube = 0.15x0.15x0.15 m3
Density of LWC = 6.039/ (0.15)3
= 1795.85 kg/m3
Hence Safe Above Condition

5. Conclusion:

- ✓ Analysis of the strength characteristics of light weight concrete containing renewable resources of palm shell and micro silica.
- ✓ The growing concern of resource depletion and global pollution has challenged engineers to seek and develop new materials relying on renewable resources. One of the promising agro waste materials is palm shell. India has the potential to cultivated oil palm in 1.03 million hectares of land.
- ✓ Lightweight concrete has established itself as a suitable. In general, palm shell has good potential as a coarse aggregate in structural concrete production and can even be used for low to moderate strength applications such as structural members for low cost houses. Based on this investigation the work can be done.
- ✓ The approach adopted is experimentally to determine the suitability of palm shell as partial replacement as a coarse aggregate in concrete works. Addition of silica fume in the mix considerably improves the strength index of control mix as well as palm shell.
- ✓ The strength development of adding silica fume of 2% based on the light weight concrete results of 28 days in compressive, split tensile and flexural strength has more strength when compared to the addition of silica fume in 1% and 3%.
- ✓ It has been finally concluded of partial replacement of palm shell as a coarse aggregate and the 2% of silica fume is replaced by cement in concrete without any long term detrimental effects and with acceptable strength development properties in light weight concrete

6. References:

1. F. O. Okafor, "Palm kernel shell as a lightweight aggregate for concrete," Cement and Concrete Research, vol. 18, no. 6, pp. 901–910, 1988.
2. P. Shafigh, M. Z. Jumaat, and H. Mahmud, "Mix design and mechanical properties of oil palm shell lightweight aggregate concrete: a review," International Journal of Physical Sciences, vol. 5, no. 14, pp. 2127–2134, 2010. 3. U. J.
3. Alengaram, H. Mahmud, and M. Z. Jumaat, "Enhancement and prediction of modulus of elasticity of palm kernel shell concrete," Materials and Design, vol. 32, no. 4, pp. 2143–2148, 2011.
4. D. C. L. Teo, M. A. Mannan, V. J. Kurian, and C. Ganapathy, "Lightweight concrete made from oil palm shell (OPS): structural bond and durability properties," Building and Environment, vol. 42, no. 7, pp. 2614–2621, 2007. 5. J.
5. Newman and P. Owens, "Properties of Lightweight Concrete," Advanced Concrete Technology Set, Butterworth-Heinemann, Oxford, UK, 2003. 6. M. A. Mannan and C. Ganapathy, "Engineering properties of concrete with oil palm shell as coarse aggregate," Construction and Building Materials, vol. 16, no. 1, pp. 29–34, 2002.
6. M. A. Mannan, J. Alexander, C. Ganapathy, and D. C. L. Teo, "Quality improvement of oil palm shell (OPS) as coarse aggregate in lightweight concrete," Building and Environment, vol. 41, no. 9, pp. 1239–1242, 2006.
7. M. K. Yew, H. Mahmud, B. C. Ang, and M. C. Yew, "Effects of heat treatment on oil palm shell coarse aggregates for high strength lightweight concrete," Materials & Design, vol. 54, pp. 702–707, 2014.
8. P. Shafigh, M. Z. Jumaat, H. B. Mahmud, and U. J. Alengaram, "A new method of producing high strength oil palm shell lightweight concrete," Materials and Design, vol. 32, no. 10, pp.4839–48, 2011.