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VIABILITY OF OIL PALM SHELL IN DEVELOPING STRUCTURAL LIGHT WEIGHT CONCRETE

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Abstract: The project study with the special concrete such as light weight concrete by using oil palm shell as a replacer to the coarse aggregate light weight concrete having low density, reduction of dead load. The reduction in density produced by using oil palm shell as a partial replacement of coarse aggregate in concrete. In this investigation M20 grade has used and coarse aggregate was replaced by various percentage of OPS i.e. 0%,10%,20%,30%,40%,50%. Then determine the compression, tensile, flexural strength of concrete to check the favourable replacement of OPS concrete. Finally, the results are compared with the nominal concrete. Light weight concrete is used for pavement filling and wall panels etc.

Keywords: oil palm shell, light weight concrete, palm kernel shell.

I. INTRODUCTION:

"There were many experimental works conducted to improve the property of the concrete by putting new materials, whether it is natural material or recycled materials or synthetic materials in the concrete mix. A large number of agricultural wastes were disposed in most of the tropical countries, especially in Asia for countries like Thailand, Philippines and Malaysia. If the waste cannot be disposed properly it will lead to social and environmental problems. The high cost of conventional building material is a major factor affecting housing delivery in Malaysia. This has necessitated research into alternative materials of construction"[2]. The present investigation deals with the various characteristics of the basic ingredients of concrete e.g. cement, oil palm shell (OPS), fine aggregate and coarse aggregate.

"In this study, oil palm shell is used as light weight aggregate Production of lightweight concrete is a technology aimed at reducing dead load on structures and to reduce the overall cost of the structure. Nearly all LWACs are fire resistant. In addition, depending up-on the densities and strength. The use of agricultural waste as aggregates can provide an alternative to conventional methods for production of lightweight aggregates"[1,4]. "structural lightweight concrete has an in-place density (unit weight) on the order of 1440 to 1840 kg/m3 compared to normal weight concrete with a density in the range of 2240 to 2400 kg/m3, for structural applications the concrete strength should be greater than 17 Mpa."[3].

"Lightweight concrete is defined as a concrete that has a density, after oven drying, that isn't larger than 2000 kg/m3, total or partially produced with porous structure aggregate"[4]. "Nowadays, the use of lightweight concrete is increasing, not only for structural applications, but also for other purposes, such as rehabilitation or pavement filling. The application of lightweight concrete on pavements is increasing, mainly due to the lower self-weight compared to the ordinary concrete, making possible the decrease of loading in the structure"[5].

A). Objectives:

- To develop the "lightweight concrete".
- To find out "whether the oil palm shell concrete" can be used as a structural concrete.
- To study "the properties of the oil palm shell concrete" and compare it with the properties of the normal weight concrete of similar grade (M20)
- To find out the optimum content of "OPS as a substitute for coarse aggregate in concrete".
- To study the effect of various types of replacements (0%, 10%, 20%, 30%,40%,50%) of natural aggregate by light weight aggregate (OPS) and conventional concrete on 7, 28 days compressive strength.

II. MATERIALS.

A). Cement.

"Ordinary Portland cement" (OPC 53) was used in this investigation. The cement physical properties are tested in the laboratory as per IS: 12269-1999 code

cement properties.

- Normal consistency test - 31%

- Fineness of cement - 6.32%
- Sp. Gravity of cement - 3.14
- Initial Setting time - 44 min
- Final Setting time - 600 min
- Soundness of cement - 6 mm

B). Fine Aggregate.

"Local river sand is used as a fine aggregate" in concrete preparation. "Aggregate is the granular material used to produce concrete or mortar and when the particles of the granular material are so fine that they pass through a 4.75mm sieve, it is called fine aggregate. It is widely used in the construction industry to increase the volume of concrete" [6]. 2.64 is the "Specific gravity of fine aggregate".

C). Coarse Aggregate.

Coarse aggregate of nominal size 12 mm, obtained from the local quarry confirming to IS: 383:1970 was used. 2.66 is the specific gravity of coarse aggregate. "Basically, aggregates are used as an economical option to lower down the cost of concrete usage. In simpler words, we can say that these are the fillers used in the concrete mix. The majority of construction applications use different coarse aggregate size, but it is essential to keep the characteristics in mind to get uniform and strong output" [6].

D). Oil Palm Shell Aggregate.

"An oil Palm shell (OPS) is available in various shapes, such as curved, flaky, elongated, roughly parabolic, and other irregular shapes. Normally, the Oil Palm shell is obtained from breaking the palm nut. Shells are lightweight in nature, but hard and come in different shapes and sizes. Further, the shells are often dumped as waste products of the oil palm industry. In South East Asia, Oil Palm Shell (OPS) is one of the most quantitative waste materials produced every year" [3]. "Hence, using Oil Palm Shell would impose lower construction costs compared to other waste materials like rubber crump, plastic waste etc. Every year, palm oil industries produce the large volume of Oil Palm shell as waste material after the production of palm oil. This will increase the production of both palm oil and its wastes such as Oil Palm shells. Oil Palm shells are not fully utilized and it has contributed to environmental pollution. This kind of waste material can be utilized to substitute the conventional coarse aggregate to produce concrete" [4].

***OPS properties*.**

- Specific gravity of oil palm shell aggregate - 1.6
- Water absorption of oil palm shell - 28%
- Bulk unit weight of oil palm shell - 672.56 kg/m^3
- Fineness modulus of oil palm shell - 6.08
- Los Angeles abrasion value (oil palm shell) - 4.90%
- Aggregate impact value (oil palm shell) - 7.51%
- Aggregate crushing value (oil palm shell) - 8.00%

E). Water

Water plays a vital role in preparation of concrete and potable water is used in this investigation.

III. METHODOLOGY.

A). Mix Design

In the present experimental investigation oil palm shell (OPS) aggregate has been using a partial replacer of coarse aggregate in concrete mix. The specimens are casted in the ratio of 0%, 10%, 20%, 30%, 40%, 50%, the replacement of oil palm shell aggregate respectively with each ratio comprising of 6 cubes and 6 cylinders and 6 prisms. "A total of 36 cubes and 36 cylinders and 36 prisms were casted". After the casting process, the cubes, prisms and cylinders were demoulded then they were cured for 7 and 28 days. "The mix proportion obtained for normal M20 grade concrete is 1: 1.72: 2.83 with a water-cement ratio of 0.50"[7,8].

Table - 1: Mix proportion of different % of oil palm shell aggregate.

"Mix Designation"	OPS %	Cement in "kg/m^3"	Fine Aggregate in "kg/m^3"	Coarse Aggregate "kg/m^3"	OPS in "kg/m^3"	Proportion [C: FA: CA: PA]
M_0	0%	394.32	680.16	1118.15	0	1 : 1.72 : 2.83 : 0
M_1	10%	394.32	680.16	1006.33	67.25	1 : 1.72 : 2.55 : 0.17

M_2	20%	394.32	680.16	894.52	134.51	1 : 1.72 : 2.26 : 0.34
M_3	30%	394.32	680.16	782.70	201.76	1 : 1.72 : 1.98 : 0.51
M_4	40%	394.32	680.16	670.89	269.02	1 : 1.72 : 1.70 : 0.68
M_5	50%	394.32	680.16	559.07	336.28	1 : 1.72 : 1.41 : 0.85

III. TEST RESULTS

A). Compression strength results

The cubes of standard size 150x150x150 mm are used to calculate the concrete compression strength. The failure load is noted down and compressive strength was calculated. The compression strengths of the casted specimens were determined and are tabulated as follows.

S.NO	Percentage of Replacement (oil palm shell)	"Average compression strength in N/mm^2"	
		7days	28days
1	0%	18.18	26.14
2	10%	17.59	26.84
3	20%	19.81	27.14
4	30%	18.29	29.12
5	40%	16.90	25.92
6	50%	16.09	25.07

Table -2: compression strength results for 7days & 28 days

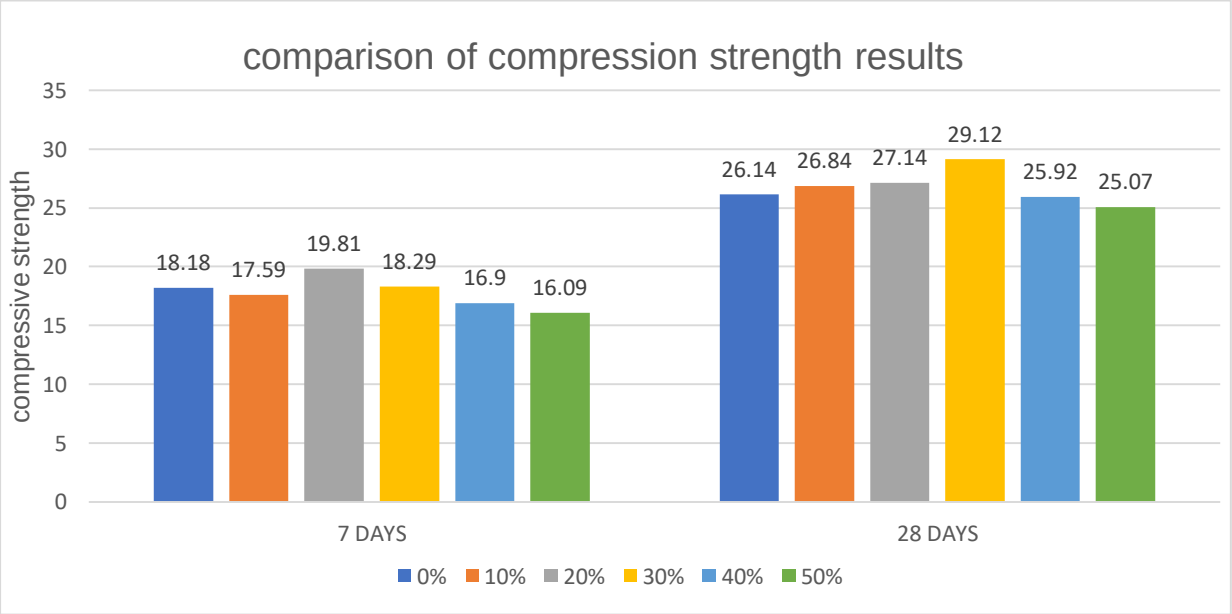

Figure-1: comparison of compressive strength results

B). Split - tensile strength results.

In this investigation the standard cylinder specimen ("150mm dia and 300mm length") was used to determine the split tensile strength. And the results are tabulated as follows.

S.NO	Percentage of Replacement (oil palm shell)	"Average tensile strength in N/mm^2"	
		7days	28days
1	0%	2.67	4.22
2	10%	2.98	4.41
3	20%	2.17	4.61
4	30%	2.71	4.94
5	40%	1.97	3.92
6	50%	2.31	3.02

Table -3: split-tensile strength results (7days & 28 days)

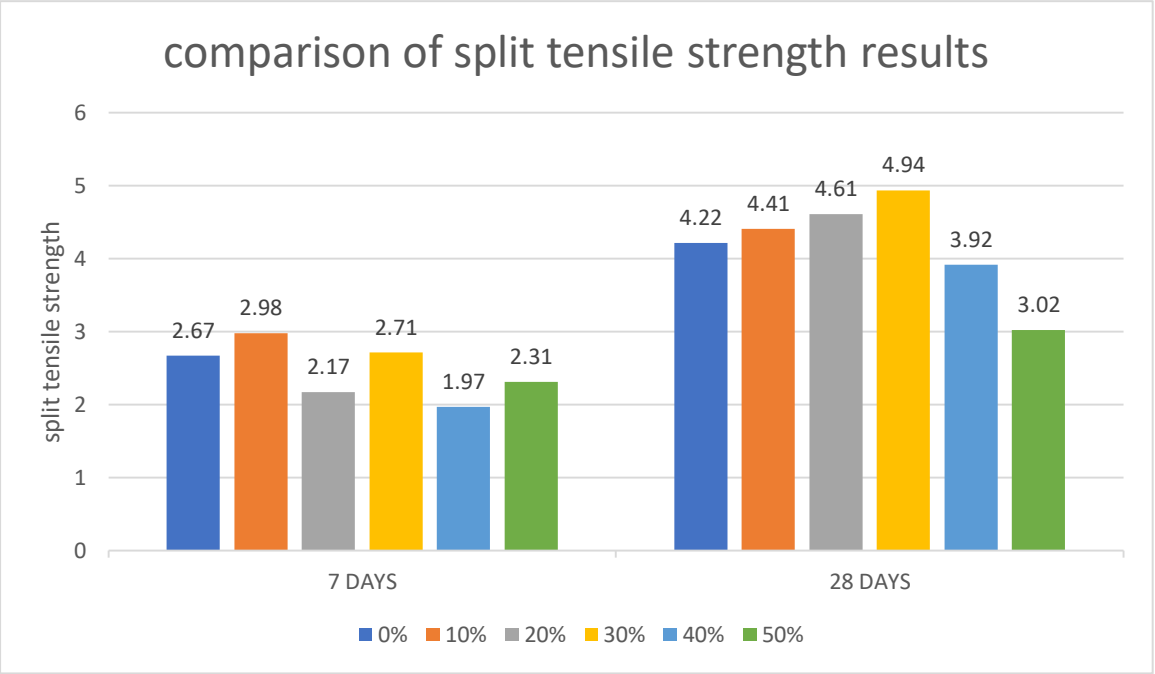

Figure-2: comparison of split tensile strength results

C) Flexural strength test:

In this investigation the standard Prism specimen of size 500*100*100mm was used to calculate the flexural strength of prism. And results are tabulated as follows.

S.NO	Percentage of Replacement (oil palm shell)	Average Flexural strength in N/mm^2	
		7days	28days
1	0%	2.12	3.62
2	10%	1.98	3.73
3	20%	2.24	3.96
4	30%	1.72	4.50
5	40%	2.29	4.23

Table -4: Flexural strength results (7days & 28 days)

6	50%	1.90	3.51

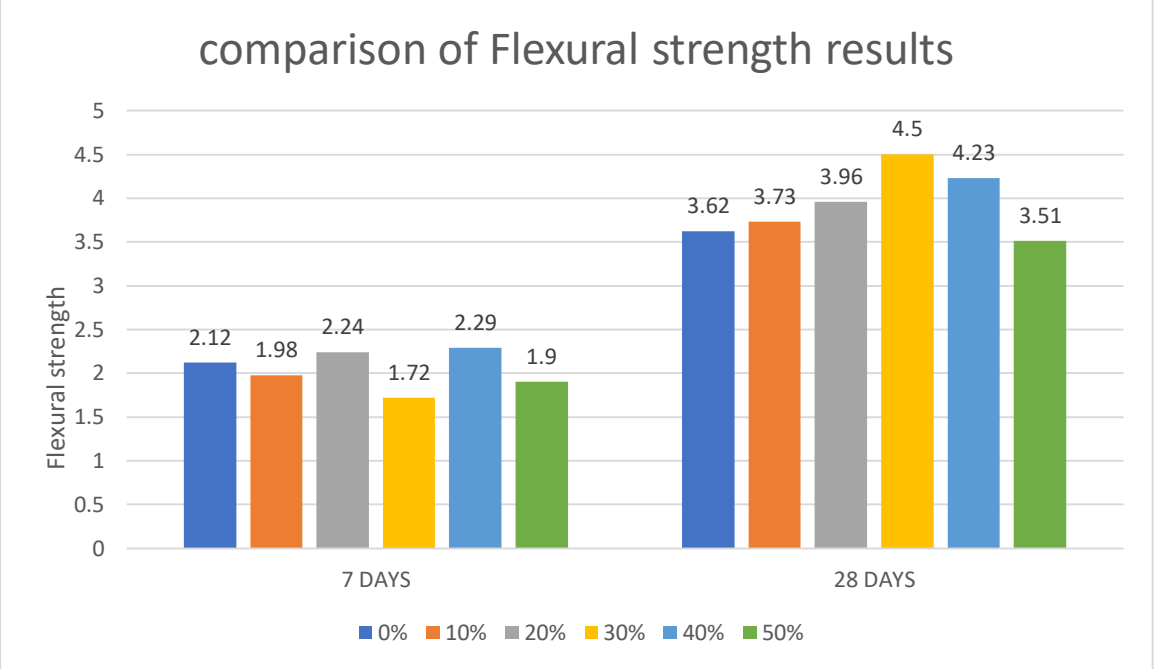

Figure-3: comparison of Flexural strength results

C). Concrete Density

Table – 5: density of concrete at various mix designations

S. No.	"Mix Designation"	Concrete Density ("Kg/m^3")
1	M_0 (0% REPLACEMENT)	2466.7
2	M_1 (10% REPLACEMENT)	2298.4
3	M_2 (20% REPLACEMENT)	1828.0
4	M_3 (30% REPLACEMENT)	1717.0
5	M_4 (40% REPLACEMENT)	1648.2
6	M_4 (50% REPLACEMENT)	1592.2

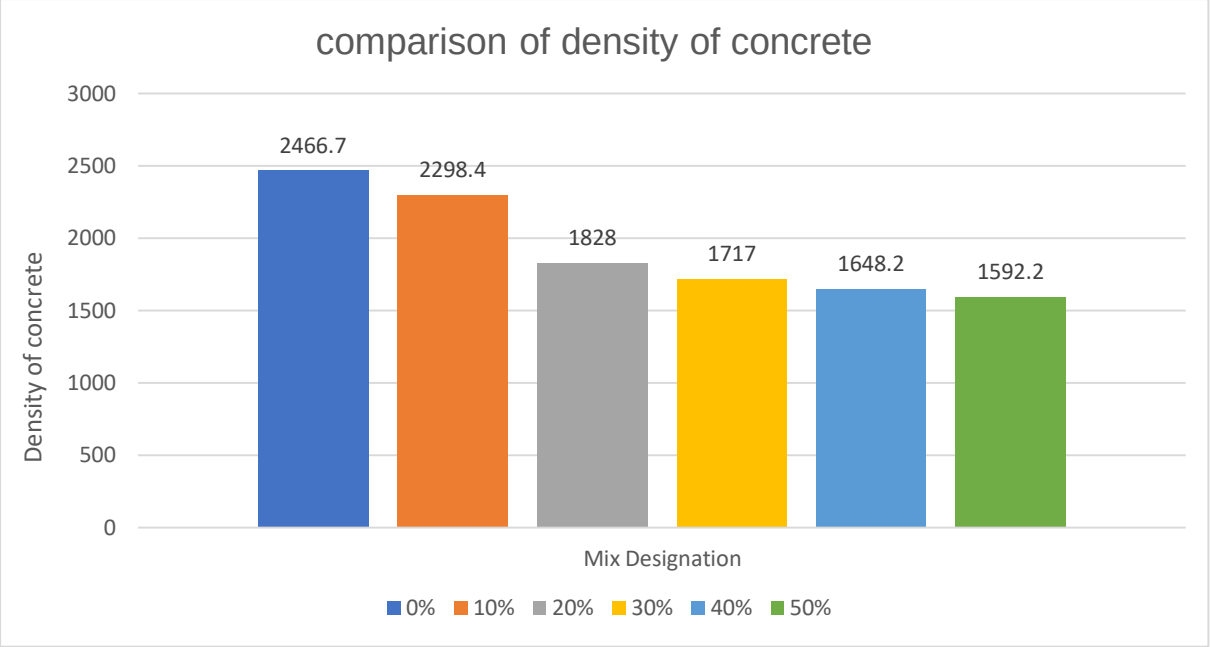

Figure- 4: comparison of density of concrete

IV. CONCLUSIONS.

The concluding remarks are obtained from the comparative study of strength using different percentage of replacements with OPS. "Based on the above results the following conclusions may be drawn".

1. Generally, "OPS aggregate was founded to be a good replacer of coarse aggregate in concrete production from strength and workability point of view and according to recycle of waste material".
2. The "strength of 10%, 20%, 30%, 40%, 50% OPS concrete samples produced lightweight concrete with compressive strength reaching up to maximum of 29.12 N/mm^2 and least of 25.07N/mm^2 for 28 days" which satisfies the requirement for structural light weight concrete.
3. Concrete with the 30% replacement gives highest at all tests such as compression test, tensile test and flexural test.
4. 40% & 50% replacement gives least compressive strength, tensile and flexural strength with more reduction in weight of concrete
5. However, "the strength of the concrete is depending on the two variables i.e. amount of OPS and curing period".
6. Finally, from the results we can conclude that 10% replacement sample is considered as partial lightweight concrete, because its density more than 2000kg/m^3.
7. 20% & 30% samples are the ideal percentages of OPS concrete, it gives density below 2000kg/m^3 and compressive strength results also promising. so, these two samples are considered as structural lightweight concrete.
8. 40%,50% samples also consider full light weight concrete but the results are not satisfying so they considered as non-structural light weight concrete.

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