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EXPERIMENTAL INVESTIGATION OF PARTIAL REPLACEMENT OF CEMENT BY RHA IN CONCRETE

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ABSTRACT

This paper summarizes the research work on the properties of Rice Husk Ash (RHA) when used as partial replacement for Ordinary Portland Cement (OPC) in concrete. OPC was replaced with RHA by weight at 0%, 10%, 20% and 30%. 0% replacement served as the control. Compacting factor test was carried out on fresh concrete while Compressive Strength test was carried out on hardened 150mm concrete cubes after 7, 14 and 28 days curing in water. The results revealed that the Compacting factor decreased as the percentage replacement of OPC with RHA increased. The compressive strength of the hardened concrete also decreased with increasing OPC replacement with RHA. It is recommended that further studies be carried out to gather more facts about the suitability of partial replacement of OPC with RHA in concrete.

Keywords: Concrete, Rice Husk Ash, Compacting factor, Compressive strength

1.0 INTRODUCTION

The manufacture of concrete, primarily its ingredients; cement and aggregates; presents various sustainability issues that need to be dealt. The production of concrete has always lead to massive exploitation of natural resources. Manufacturing 1 tonne of Portland cement requires quarrying 1.5 tonne of limestone and clay (Civil and Marine, 2007). Moreover, continuous extraction of natural aggregate; sand and gravel; from river beds, lake and other water bodies over the years have led to erosion which eventually leads to flooding and landslides. Further, there is less filtration of rainwater due to reduced amount of natural sand, causing contamination of water needed for human consumption. 1.4 tonne of Ordinary Portland cement being produced yearly around the globe contributes to 5 percent of greenhouse gas, carbon dioxide, emissions worldwide (Civil and Marine, 2007). Not only burning fuel to heat the kiln emits carbon dioxide, but also decomposition of limestone emits even more gas. These identified problems clearly, contribute significantly to climate change. The ideal target to partly solve the above phenomenon is to develop a sustainable system loop which can turn resources which are landfilled as waste materials into useful products in the construction industry, thus preserving the natural resources.

Concrete is a tension-weak building material, which is often crack ridden connected to plastic and hardened states, drying shrinkage, and the like. The cracks generally develop with time and stress to penetrate the concrete, thereby impairing the water proofing properties and exposing the interior of the concrete to the destructive substances containing moisture, bromine, acid sulphate, etc. The exposure acts to deteriorate the concrete, with the reinforcing steel corrosion. To counteract the cracks, a fighting strategy has come into use, which mixes the concrete with the addition of discrete fibres and pozzolanic materials. Experimental studies have shown that fibres and pozzolanic materials improve the mechanical properties of concrete such as flexural strength, compressive strength, tensile strength, creep behaviour, impact resistance and toughness. Moreover, the addition of fibres and pozzolanic

materials makes the concrete more homogeneous and isotropic.

This research work examined the use of Rice Husk Ash as partial replacement for Ordinary Portland Cement in concrete. It invoved the determination of workability and compressive strength of the concrete at different level of replacement.

2. MATERIALS AND METHODS

2.1. Materials

2.1.1. Rice Husk Ash (RHA)

The Rice Husk used was obtained from Ile Ife, Nigeria. After collection, the Rice Husk was burnt under guided or enclosed place to limit the amount of ash that will be blown off.. The ash was ground to the required level of fineness and sieved through 600 μm sieve in order to remove any impurity and larger size particles.

2.1.2. Coarse Aggregate

The granite used for this research work was 20mm size. It was sourced from a quarry in Madurai.

2.1.3. Fine Aggregate

The sand used for this research work was sourced from Madurai. The impurities were removed and it conformed to the requirements of BS 882 (1992).

2.1.4. Cement

The cement used was Ordinary Portland Cement. It was sourced from Rajapalaim and it conformed to the requirements of BS EN 197-1: 2000.

2.1.5. Water

The water used for the study was obtained from a free flowing stream. The water was clean and free from any visible impurities. It conformed to BS EN 1008:2002 requirements.

2.2. Batching and mixing of materials

Batching of materials was done by weight. The percentage replacements of Ordinary Portland cement (OPC) by Rice Husk Ash (RHA) were 0%, 10%, 20% and 30%. The 0% replacement was to serve as control for other samples.

2.3. Concrete Mix Design

The concrete used in this research work was made using M_{30} grade . The concrete mix proportion was 1:1.42 : 3.37.

2.4. Casting of samples

Cubic specimens of concrete with size 150 x 150 x 150 mm were cast for determination of all measurements. Six mixes were prepared using different percentages of 0, 10, 20 and 30 RHA. The concrete was mixed, placed and compacted in three layers. The samples were demoulded after 24 hours and kept in a curing tank for 7, 14 and 28 days as required. The Compacting Factor apparatus was also used to determine the compacting factor values of the fresh concrete in accordance with BS 1881: Part 103 (1983).

2.5. Testing of samples

The compressive strength tests on the concrete cubes were carried out with the Compressive testing machine in our college. This was done in accordance with BS 1881: Part 116 (1983). The sample was weighed before being put in the compressive test machine. The machine automatically stops when failure occurs and then displays the failure load.

3. RESULTS AND DISCUSSIONS

3.1. Results of compacting factor test on fresh concrete sample. The results obtained from the compacting factor test on fresh concrete samples are given in

Table 1: Compaction factor values

Percentage replacement of RHA (%)	Compacting factor values
0	0.91
10	0.90
20	0.89
30	0.87

The table indicates that the compacting factor values reduce as the RHA content increases. The compacting factor values reduced from 0.91 to 0.87 as the percentage RHA replacement increased from 0% to 30%. These results indicate that the concrete becomes less workable (stiff) as the RHA percentage increases meaning that more water is required to make the mixes more workable. The high demand for water as the RHA content increases is due to increased amount of silica in the mixture. This is typical of pozzolan cement concrete as the silica-lime reaction requires more water in addition to water required during hydration of cement.

3.2. Results of Compressive Strength Tests on Concrete Cubes

The results of the compressive strength tests on concrete cubes are shown in Table 2 and Figure 1

Table 2: Compressive Strength of Concrete Cubes

S. NO	NAME OF THE SPECIMEN	PERCENTAGE OF REPLACEMENT(RHA)	COMPRESSIVE STRENGTH(N/mm^2)		
			7 days	14 days	28 days
1	M1	0	17.75	21.80	30.12
2	M2	10	12.02	12.19	20.84
3	M3	20	10.62	11.49	18.40
4	M4	30	7.83	8.79	13.34

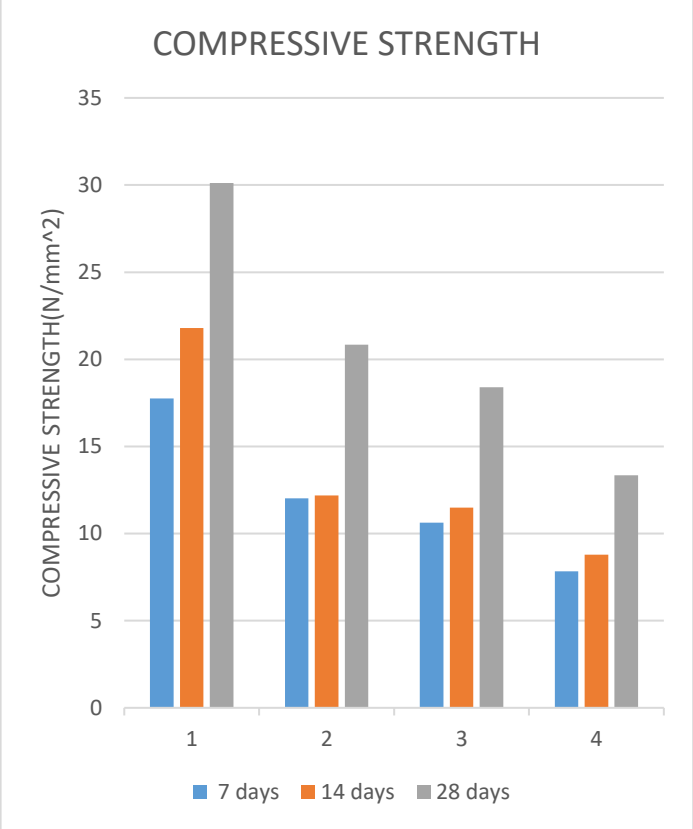

Figure 1

The results of the compressive strength tests on concrete cubes are shown in Table 3 and Figure 2

Table 3: Split tensile strength of concrete

S.NO	PERCENTAGE OF REPLACEMENT OF RHA (%)	SPLIT TENSILE STRENGTH(N/mm^2)			
		7days	Mean value	28days	Mean value
1	0	2.41	2.38	3.54	3.40
		2.36		3.39	
		2.38		3.28	
2	10	2.49	2.47	3.04	3.09
		2.50		3.09	
		2.42		3.15	
		1.52		2.62	

3	20	1.47	1.46	2.58	2.63
		1.40		2.61	
4	30	1.12	1.11	1.27	1.29
		1.02		1.23	
		1.20		1.36	

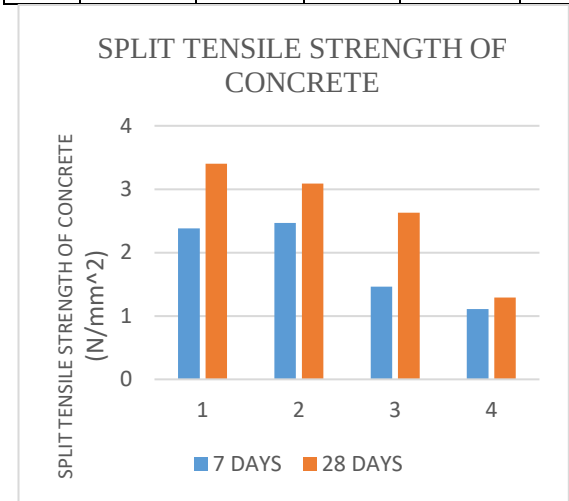

Figure 2

4. CONCLUSIONS

From the investigations carried out, the following conclusions can be made:

The optimum addition of RHA as partial replacement for cement is in the range 0-30%.

The compacting factor values of the concrete reduced as the percentage of RHA increased.

The Bulk Densities of concrete reduced as the percentage RHA replacement increased.

The Compressive Strengths of concrete reduced as the percentage RHA replacement increased.

5. RECOMMENDATIONS

The following are recommended from this study:

The use of local materials like RHA as pozzolans should be encouraged in concrete production.

Similar studies are recommended for concrete beams and slab sections to ascertain the flexural behaviour of lightweight concrete made with this material.

Durability studies of concrete cubes made with RHA as partial replacement for cement should be carried out.

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