RICE HUSK ASH - A SUSTAINABLE MATERIAL FOR PARTIAL REPLACEMENT WITH CEMENT IN CONCRETE

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ABSTRACT

Rapid increase in construction activities has led to a shortage of conventional construction materials with increase in demand of non-conventional sources of construction materials which will prove sustainability. At present, cost of construction material has become a major issue and thus it affects the housing delivery in world. The effective housing techniques deal with reduction in cost of construction as well as providing strength to buildings. use of agricultural by-product i.e. rice husk as a partial replacement with the conventional fine aggregates is expected to serve the purpose of encouraging housing developers in building construction. Rice husk is produced in about 100 million tons per annum in India. Twenty kg of rice husk are obtained from 100 kg of rice. It contains organic substances and 20% inorganic material. Ash from rice is obtained as a result of combustion of rice husk at suitable temperature. this paper focuses on the addition of Furnace Incinerated Rice Husk Ash (RHA) into blended cement OPC was replaced with RHA by weight at 0%, 5%, 10%, 15%, 20% and 25%. 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 - rice husk, concrete, agricultural by-product, compacting factor, compressive strength.

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1. INTRODUCTION

The need to reduce the high cost of Ordinary Portland Cement in order to provide accommodation for the populace has intensified research into the use of some locally available materials that could be used as partial replacement for Ordinary Portland Cement (OPC) in Civil Engineering and Building Works. Historically agricultural and industrial wastes have created waste management and pollution problems. Different alternative waste materials and industrial by-products such as fly ash, bottom ash, recycled aggregates, crumb rubber, saw dust, brick bats etc. were replaced with natural aggregates. Although these materials are traditionally considered as “primitive” and therefore inferior to more highly processes in terms of safety, durability, performance, occupant’s health and comfort with respect to environmental issue, consumption of environmental products and energy within the construction industry has created a significant demand for raw materials and for production thereby contributing to the many environmental problems associated with diverse ecosystem. Rice Husk Ash (RHA) which is an agricultural by-product has been reported to be a good pozzolan by numerous researchers. Mehta and Pirth (2000) investigated the use of RHA to reduce temperature in high strength mass concrete and got result showing that RHA is very effective in reducing the temperature of mass concrete compared to OPC concrete. Malhotra and Mehta (2004) later reported that ground RHA with finer particle size than OPC improves concrete properties, including that higher substitution amounts results in lower water absorption values and the addition of RHA causes an increment in the compressive strength.in the carried-out tests by Cordeiro, Filho and Fairbarn (2009) grinding increases the puzzolanitity of RHA. Habeeb and Fayyadh (2009) investigated the influence of RHA average particle size on the properties of concrete and found out that at early ages the strength was comparable, while at the age of 28 days, finer RHA exhibited higher strength than the sample with coarser RHA. Rukzon, Chindaprasirt and Mahachai (2009) further studied the effect of grinding on the chemical and physical properties of rice husk ash and the effect of RHA fineness on properties of mortar and found that pozzolans with finer particles had greater pozzolanic reaction.

This paper examines the use of Rice Husk Ash as partial replacement for Ordinary Portland Cement in concrete. It involved the determination of workability and compressive strength of the concrete at different level of replacement.

2. MATERIALS AND EXPERIMENTS

A. MATERIALS

i.) Rice Husk Ash

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.

ii) Cement

The cement used was Ordinary Portland Cement. It was sourced from Iree, Osun State, Nigeria and it conformed to the requirements of BS EN 197-1: 2000. The physical and chemical properties of the cement obtained on conducting appropriate tests as per IS: 269/4831 and the requirements as per IS 1489-1991

iii) aggregates

a. Coarse Aggregate

Aggregate occupy 70 to 80% of the volume of the concrete. Coarse aggregate is the important constituent in concrete. The granite used for this research work was 12mm size. The sieve analysis of combined aggregates confirms to the specifications of IS 383: 1970 for graded aggregates.

Specific gravity =2.64

Fineness Modulus = 6.816

b. Fine Aggregate

The sand was purchased and the impurities were removed and it conformed to the requirements of BS 882 (1992). the fine aggregates used in this work should satisfy the properties of fine aggregates used in this experimental work and the sand conforms to zone III as per the specifications of IS 383: 1970.

Specific gravity = 2.7

Fineness modulus = 2.71

iv) Water

The water used for the study was obtained from a free-flowing stream. Since it helps to form the strength giving cement gel, the quantity and quality of water is required to be looked in to very carefully the water was clean and free from any visible impurities. It conformed to BS EN 1008:2002 requirements.

B. BATCHING AND MIXING OF CONCRETE

Batching of materials was done by weight. The percentage replacements of Ordinary Portland cement (OPC) by Rice Husk Ash (RHA) were 0%, 5%, 10%, 15%, 20% and 25%. The 0% replacement was to serve as control for other samples.

C. Preparation of Materials

All materials shall be brought to room temperature, preferably 270+ 30 C before commencing the results. The cement samples, on arrival at the laboratory, shall be thoroughly mixed dry either by hand or in a suitable mixer in such a manner as to ensure the greatest possible blending and uniformity in the material, care is being taken to avoid the intrusion of foreign matter. The cement shall then be stored in a dry place, preferably in air-tight metal containers. Samples of aggregates for each batch of concrete shall be of the desired grading and shall be in an air-dried condition. In general, the aggregate shall be separated into fine and coarse fraction and recombined for each concrete batch in such a manner as to produce the desired grading. IS sieve 480 shall be normally used for separating the fine and coarse fractions, but where special gradings are being investigated, both fine and coarse fractions shall be further separated into different sizes.

D. **Proportioning**

The proportions of the materials, including water, in concrete mixes used for determining the suitability of the materials available, shall be similar in all respects to those to be employed in the work.Where the proportions of the ingredients of the concrete as used on the site are to be specified by volume, they shall be calculated from the proportions by weight used in the test cubes and the unit weights of the materials.

E. **Weighing**

The quantities of cement, each size of aggregate, and water for each batch shall be determined by weight, to an accuracy of 0.1 percent of the total weight of the batch.

F. **Concrete Mix Design**

The concrete used in this research work was made using Binder, Sand and Gravel. The concrete mix proportion was 1:2:4 by weight.

G. **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, 5, 10, 15, 20 and 25 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)

H. **Testing of samples**

The compressive strength tests on the concrete cubes were carried out with the COMTEST Crushing Machine . 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

A. Results from the compacting factor test:

Table 1: Compacting factor values of RHA concrete

Percentage replacement of RHA (%)	**Compacting Factor values**
0	0.91
5	0.91
10	0.9
15	0.9
20	0.89
25	0.88

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The test indicates that the value of compacting factor decreases with increase in the percentage of RHA. 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.

B. Bulk densities of concrete cube

The bulk densities of concrete cubes are stated as they were cured at certain specified days.

Table 2. Bulk Densities of Concrete Cubes with various percentages of RHA

Rice Husk Ash Replacement	Bulk Density (g/cm^3)		
(%)	7 days	14 days	28 days
0	2.32	2.37	2.43
5	2.30	2.31	2.33
10	2.26	2.28	2.30
15	2.25	2.25	2.30

20	2.07	2.25	2.29
25	2.04	2.13	2.28

The results of the bulk densities show that the bulk density reduces as the percentage RHA increases. This could be attributed to the increase in voids in the concrete cubes as the percentage RHA increases. However, the bulk densities increase as the number of days of curing increase as the concrete cubes become denser.

C. Result of compressive strength test

Cubes of concrete were tested for their compressive strength at various intervals of 7,14 and 28 days.the results obtained were:

Table 3: Compressive Strength of Concrete Cubeswith various percentages of RHA

Rice Husk Ash Replacement	Compressive Strength (N/mm^2)		
(%)	7 days	14 days	28 days
0	17.51	21.60	29.15
5	16.88	17.44	27.68
10	12.01	12.83	20.88
15	11.24	12.55	18.70
20	10.86	11.51	18.59
25	7.95	8.98	13.29

The results of the compressive strength of concrete cubes show that the compressive strengths reduced as the percentage RHA increased. However, the compressive strengths increased as the number of days of curing increased for each percentage RHA replacement.

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 0-20%.

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.

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