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THE SUITABILITY OF RICEHUSK ASH IN THE PRODUCTION OF MEDIUM GRADE CONCRETE

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Abstract: **Rice husk ash (RHA) is one of the promising pozzolanic materials that can be blended with Portland cement for the production of durable concrete and the reduction of the environmental impact of the cement industry. Rice husk ash was used in this study for partial replacement of cement in concrete production, which was classified through its oxides composition and thus indicates a high content of SiO_2 proving it to be a good pozzolana material. The rice husk is burnt into ash to produce rice husk ash (RHA), the mechanical properties of RHA was determined and cement was partially replaced at the ratio of 5%, 10%, 15% and 20 % respectively. Concrete grade M20 was used and compressive strength of 7 days, 14 days and 28 days are determined according to BS 8110. The study found that the optimum replacement of rice husk ash (RHA) in cement was 15% which is having very significant variation with the strength of concrete without rice husk ash (RHA) and thus conforms to findings of other researchers.**

Keywords: **Rice husk ash (RHA), cement, medium grade concrete, compressive strength.**

1. INTRODUCTION

Rice husk is a byproduct of the rice milling process, accounting for about 20–23% of the paddy weight [1-2]. However, about 83% of this amount is simply discarded as waste [3], polluting water and soil. The ash is often disposed of in rivers or landfill and can contaminate the environment [4]. The use of rice husk as a fuel causes another environmental issue related to the treatment of waste RHA; if the ash is not treated properly, use of the rice husks cannot be considered completely "eco-friendly" [5]. RHA is a highly reactive pozzolanic material, and it has been successfully used to replace some of the cement [6-7] in concrete, without noticeable degradation in strength and durability. The need of reducing the carbon footprint associated to cement production drove much research towards the study of by-products to be used as supplementary cementitious materials. Cement being a binder substance which sets and hardens independently, and can bind other materials together, its production is responsible for 5% of global warming. During cement production, CO_2 is emitted which is one of the greenhouse gases. In order to minimize this effect, the use of pozzolans is adopted for partial replacement of cement in concrete. The highest compressive strength of concrete with RHA was obtained at 15%. The compressive strength thus reduces for both 7 and 28 days respectively [8]. The addition of 10% RHA for 7, 14 and 28 days concrete attained to 12, 14, and 22 N/mm^2 respectively while the addition of 20% RHA reduces concrete strength to 11, 13 and 20 N/mm^2 respectively [9]. Findings from Harshit Varshney (2016) shows concrete increases in strength with addition of 10% RHA until it reaches 15%. Further addition of RHA to 20% reduces concrete compressive strength [10]. Concrete compressive strength increases with the addition of 10% RHA and subsequently decreases with further addition of 15%, 20% and 25% RHA [11].

2. MATERIALS AND METHODS

2.1 Materials

2.1.1 Cement

The cement used for this research was Ordinary Portland Cement of grade 45.5 obtained in open market along Bama road in Maiduguri, Borno State. However, the cement was stored away from air and moisture in the laboratory to ensure the material was in good condition during the period of the experiment.

2.1.2Aggregates

2.1.2.1 Fine Aggregates

The fine aggregate used for the research was river sand obtained from Alau River located at 11^0 42' North and 13^0 01' East, in Maiduguri, Borno state. River sand was selected because it is easier to obtain and it was free from clay, organic material and chemicals.

2.1.2.2 Coarse Aggregates

The aggregate used was 20 mm in size, washed and dried under the ambient temperature before concrete mixing. This is because the material has been kept for long and has particles less than 20mm which will reduce efficiency of result.

2.1.3 Water

Tap water was used for the concrete mixing and curing process sourced from a tap in civil engineering department, university of Maiduguri. The quality of the tap water satisfied the requirements of concrete mixing.

2.1.4 Rice Husk (RH)

The rice husk was collected from local rice mill of Bulumkutu Dala Street adjacent IZALAH Mosque, Maiduguri, Borno state.

2.2 Methods

2.2.1 Preparation of Rice Husk Ash (RHA)

The rice husk collected from the local mill was burnt in an incinerator using a blower to supply air to support combustion for more than an hour. Two (2) thermocouples were fixed at top and bottom in the incinerator used to measure the temperatures of the environment. The average temperature of burning was obtained as 450 ^{0}C and percentage weight of RHA was recorded.

2.2.2 Concrete Mix Design

In this study, the mix used was designed according to BS 8110 of 1997 mix design procedure. The composition of concrete for this work comprise of cement, RHA, fine and coarse aggregates with a mix ratio of 1:2.3:4.3 and mixes of five from C, R1, R2, R3, and R4 representing mixes of control, RHA at 5%, 10%, 15% and 20% respectively.

2.2.3 Mixing Proportions of Medium Grade Concrete

Concrete grading from the mix design process provide a target strength of M20. The mix was carried out for M20 grade of concrete having designations as shown in table 1.

Table 1: Mix designation of material composition for 1m^3 of M20 concrete

Mix designation	C	R1	R2	R3	R4
RHA (%)	0	5	10	15	20
w/c ratio	0.64	0.64	0.64	0.64	0.64
Cement (kg/m^3)	297	282.15	267.30	252.45	237.60
Fine aggregate (kg/m^3)	680	680	680	680	680
Coarse aggregate (kg/m^3)	1263	1263	1263	1263	1263
Water (kg/m^3)	190	190	190	190	190

2.2.4 Mixing and Casting Process

Mixing of concrete was carried out in the Civil Engineering Laboratory, University of Maiduguri. Hand mixing of concrete was used in this study. All the materials were batched accurately before mixing (batching is by weight). The surface was swept, cleaned and wetted before putting the materials to enhance efficiency. Sharp sand, aggregates (coarse), RHA and cement were put on the surface accordingly and mixed well with shovel. After the fresh concrete was formed, slump test was performed to check its workability. The fresh concrete was then poured into the steel mould in three layers, tamped using the tamping rod in 27 blows and surface scraped in which the height difference was taken to obtain the slump. A layer of lubricant oil was coated on the inner surface of the mould for the ease of removal of the cubes. The concrete was demoulded after 42 hours and cured in a tank of water. The concrete samples were cured in accordance with BS8110 of 1997 7, 14 and 28 days.

2.2.5 Compressive Strength Test

Concrete compressive strength was obtained using the compressive strength test machine in the Civil Engineering Laboratory of Ramat Polytechnic Maiduguri, Nigeria. Cubes were tested to British Standard of mould dimension of 150×150×150 mm. Sample was loaded to failure and the maximum load was recorded as well as the compressive strength of the concrete. The weight of concrete sample was recorded before conducting the test.

3. RESULT AND DISCUSSION

The compressive strength of the cubes for M20 mix results at the ages of 7, 14 and 28 days and at replacement ratios of 0%, 5%, 10%, 15% and 20% of rice husk ash respectively are presented in table 2and figure 1.

Table 2: Result of the Compressive Strength Test

Sample Label	RHA Content %	7 Days		14 Days		28 Days	
		Load (KN)	Strength (N/mm^2)	Load (KN)	Strength (N/mm^2)	Load (KN)	Strength (N/mm^2)
C (Control)	0	372.5	16.6	483.8	21.5	580.0	25.7
R1	5	331.3	14.7	480.0	21.3	497.5	22.1
R2	10	325.0	14.4	427.5	19.0	477.5	21.2
R3	15	350.0	15.6	497.5	22.1	503.8	22.4
R4	20	290.5	12.9	399.5	17.8	427.5	19.0

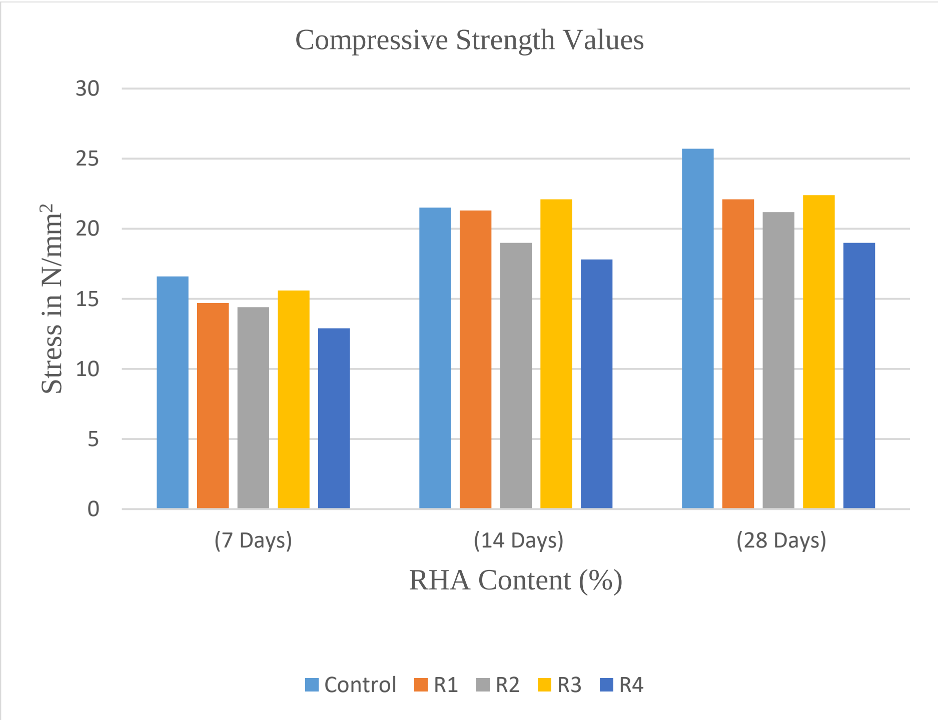

Figure 1: Variation of Compressive Strength

It is shown clearly from table 3, the strength of compressive test result is higher for control concrete (i.e 0% replacement). With the inclusion of RHA, the strength decreases, considering the 15% replacement, the strength thus slightly increases compared to that of control concrete for each curing age and hence indicates that replacement of cement with RHA can be made from 0 – 15% replacement with no effect to concrete strength since variations are that significant. The result however is in concomitant with findings of Chopra et. al (2015) and Harshit Varshey (2016) as concrete compressive strength with RHA replacement was achieved at a peak of 15%, while subsequent increase of RHA decreases concrete compressive strength.

4. CONCLUSION

The hardened concrete after curing for 7, 14 and 28 days was tested for compressive strength and the results were evaluated. From the experimental investigation it was found that the compressive strength of concrete increased with the increase percentage of RHA and an optimum replacement percentage of 15% was attained for RHA in terms of workability and strength. With all the percentage of cement replaced the target strength was achieved at 28 days. The usage of Rice husk ash in concrete as a replacement for cement can decrease the emission of green-house gases to a larger extent which automatically increases the possibility for gaining more number of carbon credits.

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