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Water Sealing Effect of Rice Husk Ash in Concrete

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Abstract- Concrete is a naturally porous material, containing pores and interconnected capillaries. These capillaries admit deleterious liquids and gases into the hardened concrete and reduce the durability of the concrete. In this study the possibility of using rice-husk-ash (RHA) to tackle this problem was investigated by studying the water sealing effect of rice-husk-ash in hardened concrete through a water absorption experiment. A concrete mix proportion of 1:2:4 was used. Rice-husk-ash was added to six separate batches of the concrete mix in varying percentages of 0%, 2%, 4%, 7%, 10% and 12%, respectively, by weight of the cement content. Water-to-binder ratio of 0.53 was use throughout. The workability of the various fresh concretes were measured via slump test, and two concrete cubes cast from each of the fresh concretes. A total of twelve concrete cubes were prepared. The cubes were tested for water absorption by immersion after the normal 28 days water curing. The results obtained showed that the slump values reduced form 80mm (for 0% rice-husk-ash content) to 20mm (for 12% rice-husk-ash content). The water absorbed by the concrete cubes reduced from $750cm^3$ for 0% RHA (normal concrete) to $100cm^3$ for concrete containing 12% RHA. It was then concluded that RHA can be used to seal off deleterious liquids and gases from concrete. Specifications were also recommended for use of rice-husk –ash in different concrete work based on the workability requirements.

Keywords: concrete, deleterious substances, porous material, rice-husk-ash, water absorption, water sealing, workability

1 Introduction

Concrete is a naturally porous material, filled with pores and capillaries. These pores and capillaries permit the absorption of deleterious liquids and gases into the concrete which reduce the durability of the concrete. These deleterious substances may be in the form of acidic effluents from factory, weak acid from rain water, sulphates in lakes, sea water and organic soil; and also chloride salts in contact with structures near the sea.

The key factor that determines the extent of deteriorative action of these harmful liquids and gases in concrete is the absorptive power of the concrete [1],[2]. This problem of concrete has always been tackled through the use of admixtures, which are defined as materials added in small quantity to the concrete, during mixing, to improve one property of the concrete or the other[3]. Admixtures are of various types, and minerals like pozzolanas are some of them. Pozzolanas are defined as substances which in themselves do not possess cementitious property, but in finely divided state and in the presence of lime (calcium hydroxide) and water, acquire cementitious property[4] . The pore filling effect of pozzolanas in concrete arises from the fact the calcium hydroxide produced during the hydration of cement stirs up pozzolanic reaction in concrete containing pozzolanas and more cementitious products are formed making the concrete denser and less porous. It should be remembered that this calcium hydroxide, if left in the concrete is easily leached off by water and renders other components of the concrete more prone to disintegration by harmful chemicals [5].

Rice-husk-ash has long been known as a very reactive pozzolana. It has high percentage of silicon dioxide and iron oxide, characteristic of most pozzolanas (see Table 1).

Table 1

Oxide composition of Rice husk ash burnt at 600-700°C

Oxides	Percentage composition
SiO_2	88.32
Al_20_3	0.46
CaO	0.47
Fe_20_3	0.47
MgO	0.44
Na_2O	0.12
K_2O	2.91
SO_3	-
LOI	5.81

Source: Ghassan and Mohmud [6]

The aim of this research is to study the water sealing effect of rice-husk-ash in concrete. The main objective is to obtain the percentages of rice-husk-ash to be added to concrete by weight of the cement content in order to achieve appreciable reduction in water absorption of the hardened concrete, at acceptable workability, for different site conditions.

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2 Methodology

i. Materials

The materials used were river-sand, crushed granite gravels, Portland cement and rice-husk-ash. The river-sand was naturally clean sand washed by flowing river. It was well graded with maximum size of 2mm. The granite gravel was also clean of dust and had a maximum size of 16mm. Rice-husk-ash was processed from husk obtained from a local rice mill. It was burnt in a murphy furnace at a controlled temperature of 600 ^{0}C. The resulting ash, grey in color, was ground by rolling it on a very smooth surface to make it fine enough for use. It was then preserved in an air-tight container to prevent crystallization. The cement was a grade 42.5N/mm^2, by Nigerian standard [7].

The equipment used include 150 by 150 by 150-mm cube mold, weighing balance, mold oil, trowel, curing tank, a tamping rod and slump test equipment.

ii Experimental procedures

The quantities of sand, gravel, cement, rice-husk-ash and water were carefully calculated and weighed out using mix proportion of 1:2:4 to enable two concrete cubes to be cast at a time (see Table 2). Cement, rice-husk-ash and sand were thoroughly mixed using shovel on a nonabsorbent surface, before the gravel was added and mixed again, after which water was added and final mixing done until a uniform paste was obtained. The paste was fed in three layers into the slump cone placed on the glass plate. Each layer uniformly tamped 25 times. The cone was raised and the slump measured. Using the same paste two concrete cubes were cast to B.S 1889 standard [9]. This process was applied to 0%, 2%, 4%, 7% 10% and 12% rice-husk-ash additions[1] to the concrete by weight of cement content. The twelve concrete cubes were water-cured for 28 days in a curing tank. They were brought out of water at the expiration of 28 days and allowed to dry for three days, after which their various weights were measured and re-immersed in water for another 7 days with their new weights measured after each day of immersion. The cumulative weight of water absorbed at each day of measurement were obtained by subtracting the weight of the concrete cube before immersion from the new weight measured on that day and the averages were tabulated.

[1]litrature shows that properties of concrete vary sharply from 2 to 4 percent RHA content and increase at a very slow rate from 5 percent upward, so 6%and 8% RHA content were omitted in the fxperiment as they would give the same result as 7% [8]

Table 2

Materials mixed for preparation of two concrete cubes for the various RHA content at a mix proportion of 1:2:4 and water-to-binder ratio of 0.53.

S/N	RHA content (%)	Cement (kg)	Sand (kg)	Gravel (kg)	Rice Husk Ash (g)	Water (kg)
1(control)	0	3.98	7.97	15.93	0	2.109
2	2	3.98	7.97	15.93	79.6	2.194
3	4	3.98	7.97	15.93	159.2	2.194
4	7	3.98	7.97	15.93	278.6	2.257
5	10	3.98	7.97	15.93	398.0	2.230
6	12	3.98	7.97	15.93	477.6	2.363

3 Results and Discussion

The results of the slump test for the various percentage additions of rice-husk-ash are shown in Table 3, while the results of the water absorption test of the concrete cubes are given in Table 4.

Table 3:

Slump values of the fresh concrete for the various additions of RHA.

RHA	Slump value (mm)
0	80
2	65
4	55
7	49
10	30
12	20

Table4

Cumulative weights of water absorbed by the concrete cubes for each day of measurement for 7 days of water immersion

RHA content (%)	Cumulative weight of water absorbed after each day of water immersions(kg)						
	1 day	2 days	3 days	4 days	5 days	6 days	7days
0 control	0.30	0.30	0.45	0.50	0.65	0.65	0.75
2	0	0.05	0.05	0.10	0.19	0.19	0.19
4	0	0.05	0.05	0.10	0.20	0.20	0.20
7	0.05	0.05	0.05	0.15	0.20	0.20	0.20
10	0	0	0	0.05	0.05	0.10	0.10
12	0	0	0.05	0.05	0.05	0.05	0.10

From Table 3, it can be observed that the workability of the concrete is medium from 0% to 7% rice-husk-ash content; and becomes low workability from 10% to 12% RHA content. In Table 4, the cumulative weight of water absorbed remained almost constant from 4 to 7 days water immersion for each specimen except the control. This suggests that the pores may be considered as filled up after seven days for all the concrete cubes containing RHA. Bearing this mind, it can also be observed that the control (0% RHA specimen) absorbed 0.75kg of water (750cm^3) after 7 days ,while concrete cube specimens containing 2%, 4%, 7%, 10% and 12% rice- husk- ash absorbed 190cm^3, 200cm^3, 200cm^3, 100 cm^3, and 100cm^3 of water, respectively, after the same 7days. The corresponding percentage reductions in water absorbed by the concrete cube specimens after 7 days, when compared with the control, were as follows: 2% RHA addition, 74%; 4% RHA addition, 73%; 7% RHA addition, 73%; 10% RHA addition, 87% and 12% RHA addition, 87 %. This result is in agreement with Allen [10]. It is also known that hydration of concrete at 28 days water curing is only about 75% of the total [11]. It therefore suggests that for concrete of initial high to medium workability, 2 to 4% RHA may be added to the concrete without appreciable change in the initial consistency. This will be good for plastering of walls of hydraulic structures like septic tanks and swimming pools. For low workability, and for the same range of initial workability, 5 to 12% RHA may be used, depending on the type of work. These may include over site concrete, bridge foundations, piers and concrete dams.

4 Conclusion

In conclusion therefore, RHA can be used as a water sealing admixture in concrete, when added to the fresh concrete at various dosages of 2 to 12 percent, by weight of the cement content, and with regards to the walkability requirement of the particular concreting work.

5 Recommendations

The recommendable dosages of the RHA admixture for water sealing purpose based on this study are summarized in Table 5

Table 5

Suggested dosages of rice-husk-ash in concrete, as a percentage of the cement content, for sealing off water in concretes of initial high to medium workability

RHA addition (%)	Range of final workability	Type of work
2 to 4	High to medium	Plastering of swimming pools and septic tanks.
5 to 10	Medium to low workability	Over site concrete or dump proof course, piers, abutments, foundations in contact with water and dams
11 and above	Low workability	Concrete dams and road pavements.

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