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Rice Husk Ash as Admixture in Concrete

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ABSTRACT

The paper assesses the use of rice husk ash (RHA) as an admixture in concrete in normal environment by determining the effect of addition of RHA of 0%, 5%, 10% and 15% respectively to concrete grades 20 and 30 concrete respectively. RHA used was obtained by burning rice husk obtained from a local mill in Kano. The husk obtained was sun dried, screened and burned at a temperature of 400°C in an incinerator. The ash obtained was cooled and sieved through a 425µm sieve and added as an admixture during mixing. A concrete mix design in accordance with Department of Environment (DOE), U.K (1975) method as reported by Teychem et al (1975) was adopted to proportion the constituents of both grades of RHA Concrete. Concrete mixes of both grades of concrete were prepared and the properties of fresh and hardened concrete assessed. The compressive strength of cubes of samples of RHA concrete cured in water were determined at 7, 28 and 56 days respectively in accordance with BS 1881 part 116 (1983). The results showed that the slump of RHA concrete increases with increase in percentage addition of RHA for both concrete grades. The compressive strength of samples of both concrete grades cured in water increases with addition of 5% and 10% RHA respectively but 5% addition of RHA had a better improvement in strength. Further increase in addition of RHA (15%) decreased the strength of RHA concrete. The study has shown that RHA which is a product from rice husk (waste) could be used as substitute to more expensive imported admixtures to improve the workability and strength of concrete in normalenvironment.

***K*eywords *:* Concrete properties, Admixture, Rice husk ash.**

1. INTRODUCTION

Concrete for many years is one of the major materials used in the construction of buildings and civil engineering structures. Concrete is a composite material resulting from the mixtures of cement, fine aggregates coarse aggregates and water. Admixtures, where necessary, may be added to modify certain properties in the fresh and / or hardened states of the concrete. The material when properly batched and thoroughly mixed sets the process of hydration and hardens into a concrete mass capable of resisting compressive stresses. Fresh concrete due to its flexibility can be formed into varied shapes and sizes.

In developing countries like Nigeria, and most African countries, the demand for construction is never ending. Consequently the demand for building materials like Ordinary Portland Cement (OPC) and admixtures is high. The production of these products requires capital intensive plants and expertise. The cost of OPC and conventional admixtures is often too high for the common man. As a means of addressing these problems, researches have been carried out and some still ongoing to explore the possibilities of using locally available pozzolanic materials in blending OPC as a partial replacement of OPC, or as a replacement of the more expensive conventional admixtures in mortar and Concrete.

2. LITERATURE REVIEW

Pozzolanas are often used to blend with OPC or to partially replace OPC. Pozzolanas are natural or artificial materials which contain Silicon dioxide and/or alumina. They are not cementitious themselves but when finely ground and mixed with lime, the mixture will set and harden at ordinary temperature in the presence of water, like cement (ASTM 618-94a cited in Neville 2003). An example of the well known pozzolana is Rice Husk Ash (RHA). Rice husk is an agro-waste material that is produced all over the world. According to Zheng (1996), Tashima, etal 2009, about 100 million tons of rice husk is produced annually all over the world. Approximately, 20kg of rice husk are obtained from 100kg of rice. Rice husks contain organic substance and of inorganic materials. RHA is obtained by the combustion of rice husk. RHA is 20% by weight of rice husk and serve no economic purpose for either agriculture or industrial usage (Mehta, 1977; Dahiru and Zubairu, 2008). Prasad et al (2000) reported that RHA contains 87 % to 97 % of silica with small amount of alkalis and other trace elements. Tashima et al (2005) also indicated that RHA contains about 92.99 5 silica. RHA is a highly reactive pozzolanic material suitable for use in lime-pozzolana mixes and for OPC replacement. Based on the temperature range and the duration of burning of the husk, crystalline and amorphous forms of silica are obtained. The crystalline and amorphous forms of silica have different properties and it is important to produce ash with correct specifications for specific end use (Muthadhi et al, 2006). Generally, the amorphous forms of silica is composed of silica tetrahedral arranged in a random three-dimensional network without regular lattice structure. Due to disordered arrangement, the structure is open with holes in the network where electrical neutrality is not satisfied and the specific surface area is also large. This helps to increase the reactivity, due to large area available for reaction to take place (Shomglin et al, 2001).

On the other hand, the structure of crystalline silica is built by repetition of a basic unit, the silicon tetrahedron in an oriented three-dimensional framework. The factors influencing the ash properties are the incinerating conditions (temperature and duration), rate of heating, geographic location, fineness and crop variety. Among these, the incinerating conditions make great impact on the quality of the final product (Muthadhi et al, 2006). In general, lower temperature and prolonged duration will result in amorphous ash. The reactivity of the RHA depends on the non-crystalline (amorphous) silica content and its specific surface. The amorphous silica is obtained by burning the ash at temperatures of 650oC to 700oC (UNIDO, 1984). Muthadhi et al (2006) reported that amorphous silica is obtained at temperature in the range of 500oC to 700oC and the duration of firing varies from a few hours to a day producing ash that is white in colour. Uncontrolled combustion of rice husk, for example, when used as a fuel or heap burning, may occur at temperature above 800oC producing ash that is lilac pink in colour and predominantly containing crystalline silica, which is less reactive.

Research on producing rice husk ash (RHA) did not start recently. Metha (1977) reported on the use of RHA in blended cement. Since then a lot of studies have been reported, these include Cook et al (1977), Okpala (1987), Yogenda and Jagadish (1988), Okpala (1993) Metha and Pitt (1996). Other recent researches on RHA in concrete and mortar have been reported by Cisse and Laguerbe (2000), Sampalo et al (2002), Oyekan and Kamiyo (2008), Dahiru and Zubairu (2008). All the researches reported on RHA as a partial replacement of OPC in concrete and mortar have been positive and shown to be economical and also addressing the problem of environmental pollution. RHA could also be considered for use in concrete in small quantities as an admixture to improve on the properties of fresh and hardened concrete, and if suitable would replace the use of more expensive imported admixtures. It is against these backgrounds that this research is set to investigate the use of RHA as an admixture in concrete.

3. METHODOLOGY

3.1 Materials

3.1.1 Rice Husk Ash The husk was collected from a local rice mill at Karfi in Kura Local Government Area of Kano State of Nigeria. The husk was sun-dried and screened. The screened husk was place and burnt in an incinerator at a temperature of 400oC. The ash obtained after the rice husk had been burnt completely was placed in a free air circulation environment to cool and later sieved through 425 μm sieve. The portion of the ash passing this sieve was used in this research.

3.1.2 Cement The cement used in this research is the ordinary Portland cement manufactured by Ashaka Cement Company Plc, Ashaka, Gombe State. The cement was obtained from the local cement dealers in Kano.

3.1.3 Fine Aggregates The fine aggregate was naturally occurring sand obtained from suppliers in Kano. Sieve analysis was conducted and the results indicate that the fine aggregate is of zone 2

3.1.4 Coarse Aggragate The coarse aggregate used in this project was made of crushed granite obtained from the suppliers in Kano, Kano State. 3.1.5 Water The water used in the concrete making was portable tap water . 3.2 Methods 3.2.1 Determination of particle size distribution of sand and coarse aggregate This was done in accordance to BS 812 part 1: 1975: The results of the sieve analysis is presented in figure 1 and indicate that the sand is in zone 2. The nominal size of coarse aggregate is 20mm. 3.2.2 Determination of moisture content of RHA and cement This is done in accordance to BS 812 part 109: 1990: The results show that the optimum moisture content for RHA and cement are 92% and 20% respectively. 3.2.3 Concrete Mix design, production and curing.
Department of Environment U.K design of Normal concrete mixes (Teychem, et al, 1975) popularly known as DOE mix design method was adopted for both grades of concrete i.e. 20 and 30. Grade 20 and 30 RHA concrete with the following

percentage addition of RHA were made: - 0%, 5%, 10%, and 15% and slump test conducted on the various fresh samples. 150mm x 150mm x 150mm size concrete cubes of the samples were cast and demoulded after 24 hours and then cured in water. Compressive strength tests were conducted on the concrete cube samples at 7, 28 and 56 days respectively aimed at determining the effect of RHA on the strength development of concrete.

3.2.4 Workability test

This was done in accordance to BS 1881: part 102: 1983 for RHA concrete of both grades. The results are presented in Table 1

3.2.5 Determination of compressive strength of concrete

This was done in accordance to BS 1881: part 116: 1983. Cubes of various percentage addition of RHA cured in water were tested for compressive strength. The results are presented in Table 2 and 3.

4. RESULTS AND DISCUSSION

Tables 1, 2, and 3 presents Slump test results and compressive strength test results of grades 20 and 30 RHA Concrete cured in water. The results of the slump recorded in table 1 shows that the actual slump for concrete grade 20 and 30 having 0%, 5%, 10% and 15% RHA addition were within the assumed slump indicating no serious effect. It could also be seen from the results that slump increases with increase in percentage addition of RHA in both Grades of concrete though more increase was noticed on Grade 20 concrete. This flow could be attributed to the fine and spherical particles of RHA in contact with cement (Chaiyesena, 1992).

Table 1 Slump Test Results

CONCRETE GRADE	ADDITION OF RHA (%)	SLUMP(mm)
20	0	17
	5	20
	10	24
	15	28
30	0	12
	5	15
	10	17
	15	19

Table 2 Summary of Average Compressive Strength (N/mm^2) For Grade 20 and 30 RHA Concretes

Grade	Age of Concrete (Days)	0% RHA	5% RHA	10% RHA	15% RHA
20	7	18.70	20.21	19.20	13.77
	28	22.90	26.01	24.89	18.34
	56	26.63	29.60	27.12	20.13
30	7	28.30	30.71	29.64	22.80
	28	33.60	39.20	34.50	25.50
	56	36.60	45.04	37.01	32.21

Table 3 Increase in compressive strength (N/mm^2) for grades 20 and 30 Concrete with addition of RHA

Grade	Age of Concrete (Days)	0% RHA	5% RHA	10% RHA	15% RHA
20	7	-	1.51 (8.1%)	0.50 (2.7%)	-4.93 (-26.4%)
	28	-	3.11 (13.6%)	1.99 (8.7%)	-4.56 (-19.9%)
	56	-	2.97 (11.2%)	0.49 (1.8%)	-6.5 (-24.4%)
30	7	-	2.41 (8.56%)	1.34 (4.7%)	-5.5 (-19.4%)
	28	-	5.6 (16.7%)	0.9 (2.7%)	-8.1 (-24%)
	56	-	8.44 (23.0%)	0.41 (1.1%)	-4.39 (-12.0%)

The compressive strength test results in table 2 and 3 and also in Figures 2 and 3 show that 5% and 10% RHA addition in concrete grades 20 and 30 increases the compressive strength when cured in water, though 5% RHA addition increases the compressive strength more than that of 10%. The increase in compressive strength with age when cured in water is attributed to the pozzolanic effect of RHA in the concrete. 5% addition of RHA could be the amount of RHA which when added to concrete result to optimum silicate formation for the achievement of maximum strength in RHA concrete. Increase beyond 5% leads to reduction in compressive strength of RHA concrete. 10% and 15% addition of RHA over saturates the concrete mix with silicates from increased RHA content causing disruption and weakening of the bond structure resulting to lesser strength. This is consistent with Chaiyasena (1992) that the more RHA is used in concrete the less the compressive strength obtained due to imbalance of silica and free calcium hydroxide in the mixture.

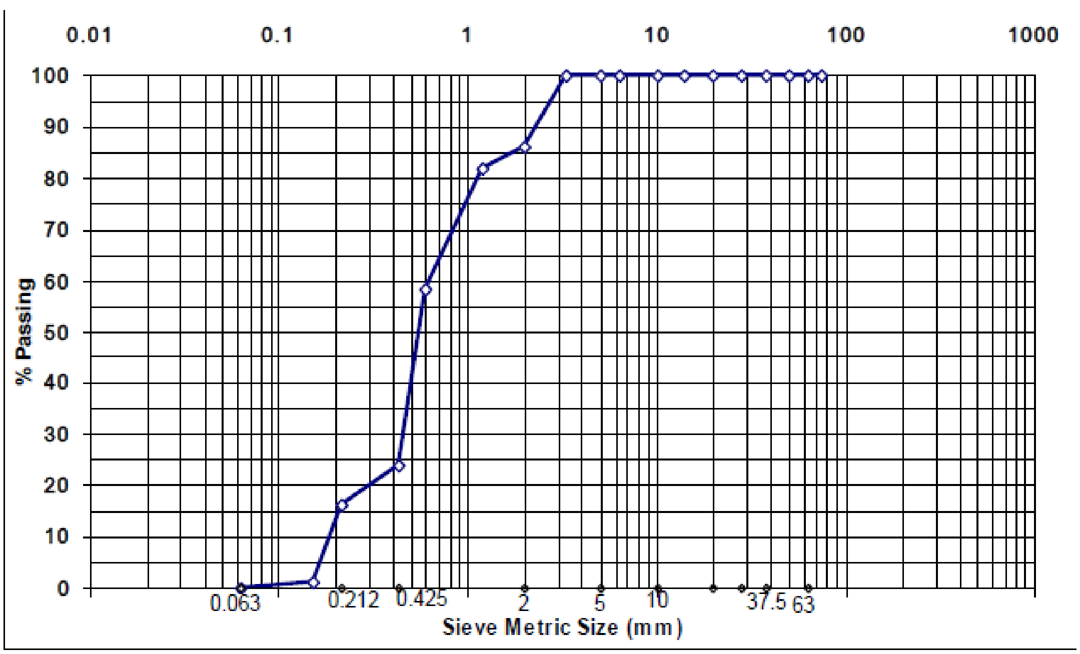

Figure 1 Particle size distribution of fine aggregates

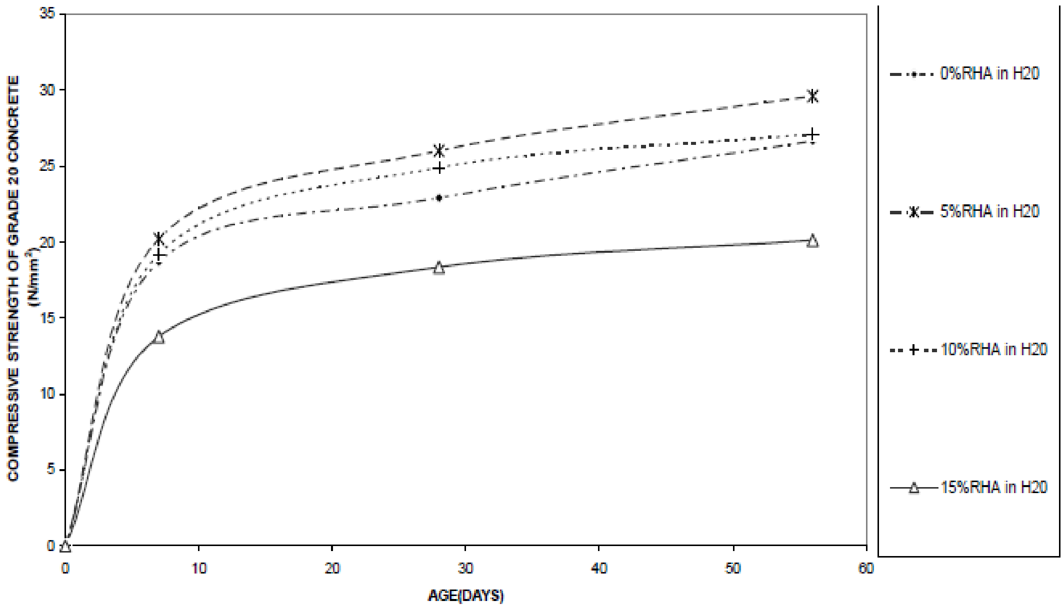

FIG 2 COMPRESSIVE STRENGTH OF GRADE 20 CONCRETE WITH VARYING PERCENTAGE ADDITION OF RHA CURED IN WATER

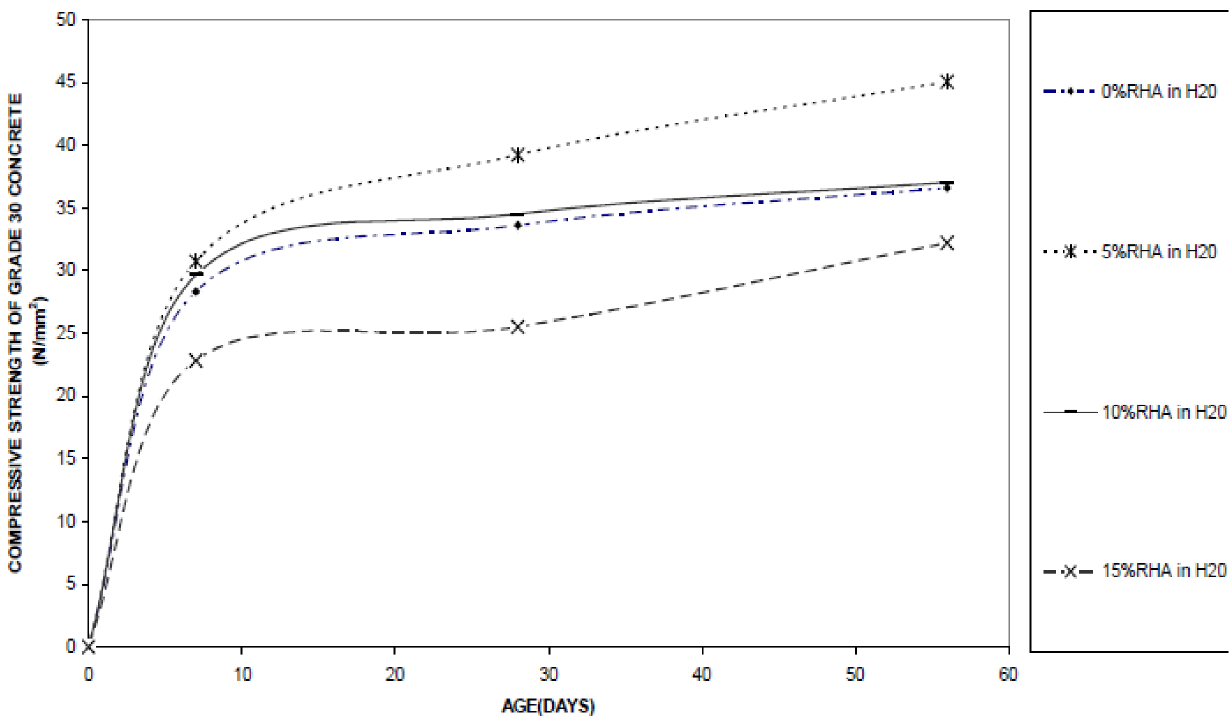

FIG 3 COMPRESSIVE STRENGTH OF GRADE 30 CONCRETE AT VARYING PERCENTAGE ADDITION OF RHA CURED IN WATER

5. CONCLUSION AND RECOMMENDATION

Based on the research conducted, the following conclusion could be drawn:-

(i) The workability of concrete increases with increase in addition of RHA, and was within the design limit.
(ii) The compressive strength of grade 20 and 30 concrete cured in water, increased with addition of 5% and 10% RHA. It however, increases with 5% addition more than with 10% addition, but reduces with further increase in percentage addition of RHA.

REFERENCES

[1]. ASTM 618-1994a: Specification for Coal fly ash and raw or calcined natural pozzolanas for use as mineral admixtures in OPC concrete. Annual book of ASTM standards, Vol.4, West Conshocken, USA.

[2]. BS 812, part 1 (1975); Methods of determination of particle size and shape. Her majesty stationery office, London

[3]. BS 812, part 109 (1990); Methods of determination of moisture content of aggregates. British Standard Institution, London. BS 1881, part 102 (1983); Methods of determination of Slump. Her majesty stationery office, London.

[4]. BS 1881, part 116 (1983); Methods of determination of Compressive strength of concrete cubes. Her majesty stationery office, London

[5]. BS 1881, part 122 (1983); Methods of determination of water absorption. Her majesty stationery office, London

[6]. Chaiyasena T. (1992): A study of properties of high strength concrete made from Portland coment containing rice hush ash and super plasticizers http://Library.kku.ac.th/abtarct/thesis/meng/sde 2535/se35000lehtml

[7]. Cisse, I.K and Laguerbe, M (2000): Mechanical characterization of filler sancretes with rice husk ash additions, Study applied Senegal. Journal of cement and concrete research. Vol. 30,No. 1, pp.13-18

[8]. Cook, D.J, Pama, K.P, Paul B.K (1977); Rice husk ash-Lime cement mixes for use in masonry units. Journal of Building and Environ, Vol 12, pp. 281-288

[9]. Dahiru, D and Zubairu,I.K (2008): An assessment of properties of concrete made with rice husk ash as partial replacement of cement. Journal of Engineering and Technology (JET), Faculty of Technology Bayero University, Kano. Vol. 3 No.1, pp.32-40

[10]. Mehta, P.K (1977): Properties of blended cements made from rice husk ash. ACI Journal, Sept. 1977, pp.440-442

[11]. Mehta, P.K and Pitt, N (1996): Energy and Industrial materials from crop residnes. In resources recorvery and construction, 2, Elservier Scientific publishing company, pp.23-38

[12]. Muthadhi, A; Anitha, R and Kothandaraman, S. (2006): Rice Husk Ash- Properties and its Uses: A Review. IE(I) Journal-CV.

[13]. Neville, A.M (2003): Properties of concrete, fourth edition, Peerson Education, Singapore pp.83-87

[14]. Okpala, D.C (1987): Rice husk ash (RHA) as partial replacement of cement in concrete.

[15]. Proceedings of 1987 annual conference of Nigerian Society of Engineers, Port Harcourt, pp.83 -90

[16]. Okpala, D.C (1993): Some Engineering Properties of sandcrete blocks containing rice husk ash. Journal of Building and Environ, Vol. 28, No. 3, pp.235-241