

POZZOLANICITY AND SOME ENGINEERING PROPERTIES OF RICE HUSK ASH

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ABSTRACT

Rice Husk Ash (RHA) is an agro-waste material. It is found locally in abundance in Nigeria and many other parts of the world. Rice Husks pose environmental nuisance in developing countries. Efforts have been made to convert the material to economic usage. RHA is a form of pozzolan, a potential cementitious material. The material was mixed with 45 per cent slaked lime. The resultant product 'cement' has a specific gravity of 2.1. The initial and final setting times were found to be 4 ½ and 76 hours respectively. The pozzolanic Activity Index of the ash was determined. It was found to be highly pozzolanic. The average compressive strength was found to be 3.2 N/mm² (32.6 kg/cm²). The relationship between the compressive strength of its concrete and water-cement ratio was also studied. The optimum water-cement ratio was found to be 0.86.

KEYWORDS: Rice Husk Ash, Pozzolan, Compressive strength, Setting times.

INTRODUCTION

Pozzolanas are materials containing reactive silica and /or alumina, which on their own, have little or no binding property but, when mixed with lime in the presence of water, will set and harden like cement (ASTM 618-94(a)). They are important ingredients in the production of an alternative cementing material to ordinary Portland cement (ITDG, 2003).

Rice Husks are natural organic wastes ((Mazlum, 1993). They are in abundance in Nigeria and many other parts of the world. Rice Husks pose serious environmental nuisance. Its burnt waste known as Rice Husk ASH is a form of pozzolan (Mehta, 1992). Rice Husks wastes pose serious environmental nuisance, especially in developing countries that produce them. There is interest in using this material in concrete (Neville, 1996). Rice Husks have been found to

contain very high silica content, slow firing at a room temperature of 500 to 700 degrees Celsius (Roy, 1987).

The resulting ash is amorphous with a porous structure (Massazza, 1979). The ash has a specific surface as high as 50,000m²/kg and a specific gravity of 1.9 to 2.4 (Neville, 1996). The IS 4098(1967) stipulates specific characteristics of different grades of lime-pozzolan mixture. The strength and other properties are affected by lime-pozzolan ratio.

Setting and hardening of cement paste are the main physical characteristics associated with hydration of cement. Hydration results in the formation of a gel around each of the cement particles. The gel continues to grow until cement paste loses its fluidity (Saad, 1982). The beginning of noticeable stiffening in cement paste is known as initial set. Further stiffening occurs as the volume of gel increases until hardening of

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the paste commences, which is responsible for its strength and this is known as final set (Jackson, 1984).

An assessment of pozzolanic activity with cement can be carried out. One of the ways to measure strength activity index (I) is given by (ASTM 311-94(a)), $I = (A/B) \times 100$ where A is the average compressive strength of mortar with a specified replacement of cement (OPC) by the pozzolana and B is the average compressive strength of mortar containing cement only. Pozzolanic activity consists of fixing of calcium hydroxide by the pozzolan (Collepari, 1978); Hence, the lower the resulting quantity of calcium hydroxide, the higher the pozzolanicity.

Strength of concrete depends on the effective water-cement ratio, that is, mix water less the water absorbed by the aggregates (Neville and Brook, 1994). RHA has a porous structure and therefore, requires high water content in concrete (Cook, 1976).

MATERIALS AND METHOD

The main material for this research is Rice Husk Ash (RHA). The RHA-slaked lime mix was used as supplied by Udeala (Udeala, 2003). The specific gravity of the material was determined according to BS 4550 part 3: 1978. Other materials used are sand and crushed stone chippings. The sand was collected from River Benue, Makurdi, Nigeria. It was prepared to BS 882: 1992. The sand belongs to zone C (Neville, 1997) as shown in figure 1. The crushed stone chippings were collected from Kwande, Benue State, Nigeria. The grading is shown in figure 2. The initial and final setting times of the RHA 'cement' were determined with vicat apparatus to BS 4550: part 3, 1978 (EN 196-3:1987).

Pozzolanicity Test

The Pozzolanicity test of the RHA was carried out according to ENVI 96-5:1989.

Cube strengths versus water-cement ratio

Selected (Obam, 2002) cement, sand and crushed granite chippings ratio 1:2:4 were used to cast cubes of size 150 x 150 x 150 mm. This ratio was maintained constant but at varying water-cement ratio. The batching was done by weight; the concrete cubes were cast according to BS 1881-108:1983. Spraying of water to the cubes in the moulds started after 24 hours. The cubes were demoulded after 3 days (72 hours) and immediately transferred to the curing tank at room temperature for 56 days (IS 4098: 1967).

The cubes were tested for compressive strength, on removal from the curing tank, using compression machine to the requirements of BS 1881-115: 1986. The compressive strength is obtained from the ratio: $\sigma = \text{maximum load/cross-sectional area (N/mm}^2\text{)}$.

Three cubes were tested for each point and the average of the two values taken as the compressive strength for the point in question.

RESULTS AND ANALYSIS

Specific gravity

The specific gravity of the RHA was found to be 2.1. The result is similar to the ones found in literature (Mazlum and Uyan, 1993).

Setting Times of the RHA

The initial and final setting times of the Rice Husk Ash with 45 per cent slaked lime were found to be 4½ and 76 hours respectively. The results are, expectedly, high when compared with Ordinary Portland Cement that has these properties about 45 minutes and 2 hours respectively (Neville, 1997). However, these high results are typical of cements derived from organic materials (Mehta, 1992).

Pozzolanicity of the RHA

The pozzolanic Activity Index (P_i) of the Rice Husk Ash Pozzolan is shown in table 1. The results show that the RHA is highly pozzolanic.

The cube strengths versus water-cement ratio

The results of cube compressive strengths of the pozzolan concrete versus water-cement ratio are shown in figure 3. The results indicate that there is an optimum water-cement ratio for maximum strength of concrete. This is about 0.86.

CONCLUSION

The Rice Husk Ash (RHA) used for this research is patented product of Udeala (Udeala, 2003). Laboratory tests showed that it has an average specific gravity of 2.1. Its initial and final setting times are 4 ½ and 76 hours respectively. The RHA has high pozzolanicity as shown by the pozzolanic activity index (Table 1), though low, it meets the minimum standard requirements for pozzolanic materials (IS 4098-1967). Results (Figure 3) show that RHA-concrete requires high water content. This is due to its amorphous structure (Nassaza and Costa, 1979). The average compressive strength was found to be

3.2 N/mm² (32.6 kg/cm²). This meets the minimum standard requirements (IS 4098-1967). The optimum water-cement ratio is about 0.86.

Most of the coarse aggregate sizes used are between 10-20 mm. The River sand used belongs to grading curve C.

Table 1: The pozzolanic Activity Index (PI) of the RHA

Percentage replacement Of OPC with RHA	Compressive strength N/mm ²	P _i
0	17.1	-
10	15.4	90
20	13.5	79
30	12.3	72
40	8.2	48

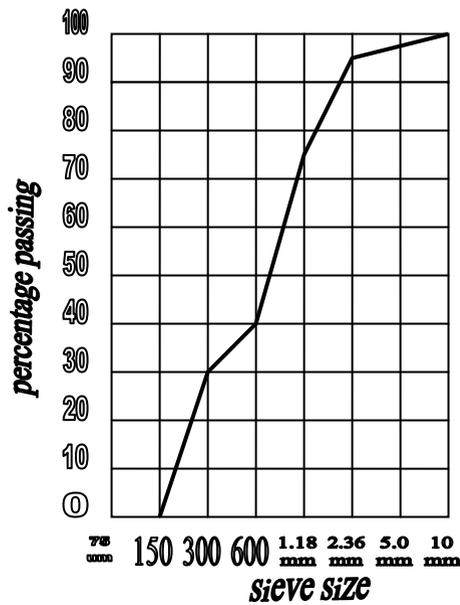


Figure 1. Grading curve for the river sand

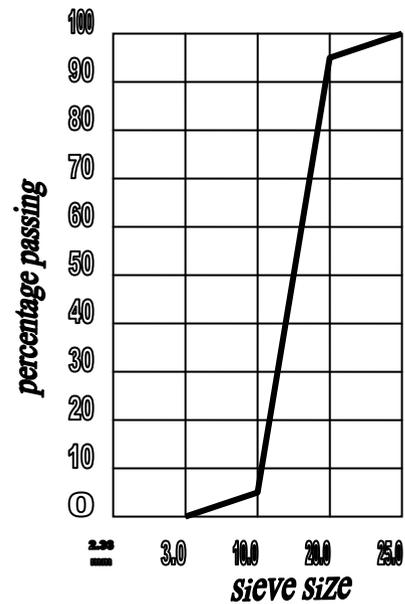


Figure 2. Grading curve for the crushed granite

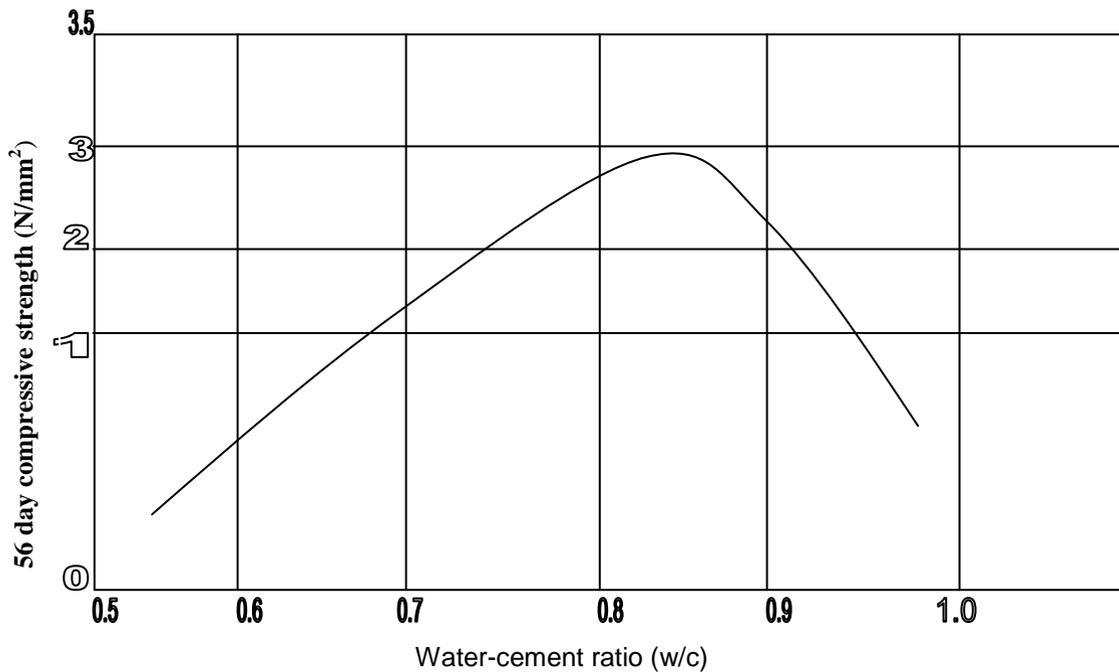


Figure 3. Strength versus w/c

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