INVESTIGATION OF THE TENSILE AND FLEXURAL STRENGTHS OF CONCRETE CONTAINING RICE HUSK AND SAW DUST ASHES

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ABSTRACT

This work investigated the tensile and flexural strengths of concrete containing Rice Husk and Saw Dust Ashes. 36 concrete beams of 150mm x 150mm x 600mm were produced with OPC-RHA-SDA, 36 concrete cylinders of ø150 mm x 300 mm were produce with OPC-RHA-SDA. Rice Husk Ash and Saw dust Ash were combined at equal proportion of 50% RHA and 50% SDA at 0% (control), 5%, 10% and 15%. Three concrete beams and three concrete cylinders were casted for each percentage replacements using 1:2:4 cement-sand-aggregate mix ratio and 0.6 water to cement ratio. The concrete beams and concrete cylinders were cured by immersion and the concrete beam were tested for flexural strengths for 28 days, 90 days and150 days, while the concrete cylinders were tested for tensile strengths for 28days, 90days and150 days. The results obtained indicated that the flexural and tensile strengths of the OPC-RHA-SDA composites increased as the curing age increased but reduced with higher amount of RHA-SDA. The maximum flexural strengths at 150 days for 0 %(Control concrete), 5%, 10% and 15% were 6.41 Nmm^{-2}, 5.35 Nmm^{-2}, 4.32 Nmm^{-2} and 3.78 Nmm^{-2} respectively. The results for maximum tensile strength at 150 days at 0% (Control concrete), 5%, 10% and 15% were 2.26 Nmm^{-2}, 1.50 Nmm^{-2}, 1.10 Nmm^{-2} and 0.80 Nmm^{-2} respectively. OPC-RHA-SDA concrete with 5% replacement is suitable for concrete work.

Keyword: Flexural strength, Tensile strength, Concrete, Rice Husk Ash, Saw Dust Ash, Pozzolan

1. INTRODUCTION

The need for supplementary cementitious materials which would reduce the high cost of ordinary Portland cement (OPC) and produce high strength durable concrete which will provide accommodation for the populace southern Nigeria, has challenged many researchers and engineers to seek and develop alternative cementitious materials that are locally available and cheap that can partially replace cement in Civil Engineering works and building works. Supplementary cementitious materials have been proven to be effective in meeting most of the requirement of durable concrete and blended cements.

Studies have been previously conducted on cement concrete containing RHA and SDA, Givi, et al,(2010) studied the contribution of rice husk ash to the properties of Mortar and concrete Deshmukh, et al. (2012) studied ‘’The effect of the use of RHA on the strength of concrete. Mahmoodb (2002), Elinwa and Ejeh (2004) used SDA to partially replace cement in mortar and concrete works, Smith et al,(1986) and Zhang et al(1996) in their studies observed that due to its high pozzolanic reactivity, RHA is suitable for use as partial cement replacement in concrete and mortar. Ettu et al (2013) has confirmed the suitability of Nigerian SDA as a pozzolanic material, he studied the variation of strength of OPC- Saw Dust ash cement composites with water cement ratio. Cheah and Ramli (2011) in their investigation used wood ash to partially

replace cement in concrete and mortar. Elinwa et al(2008)
used saw dust ash in their investigation of concrete properties of fresh self compacting concrete. Elinwa and Mahmoodb (2002) accessed the suitability or timber ash as partial replacement for cement. (Habeeb concrete made with RHA which had finner particles, showed better strength development than the concrete made with RHA which had coarse particles. Fuho and Fairbairn (2009) conducted detailed investigations on rice husk ash and concluded that Rice Husk Ash is suitable for use in the making of blocks with adequate bearing strength. Their studies concluded that combining RHA and Rice Straw Ash with lime resulted in a week cementatious material which nevertheless is useful in stabilizing laterite in order to increase its bearing strength. Mehta and Pith(2000) in their investivation concluded that RHA is suitable for use in lowering the temperature of high strength mass concrete when compared to concrete made with ordinary Portland cement. Ismail and Waliuddin (1996) investigated how rice Husk Ash affect the behavior of high strength (HSC) by investigating the effect of passing through sieve sizes of 200 and 325 micron and using it to replace 10%- 30% of cement. Molhotra (1993) investigated that RHA gains early strength more other blended cement concrete.

This research work examined the investigation of the tensile and flexural strengths of concrete containing Rice Husk and Saw Dust Ashes. It involves the determination of the tensile and flexural strength of concrete at different percentage replacement of cement with RHA and SDA.

2. MATERIALS AND METHODS

2.1 Materials

2.1.1 Rice Husk Ash (RHA) and Saw dust Ash (SDA).

The Rice Husk used was obtained from a rice mill in Afikpo, Ebonyi State while the Saw dust used was collected from a timber market in owerri, Imo state, both in South Eastern Nigeria. The rice husk and saw dust were properly sun dried to remove moisture from them so as to make the burning easier. The RHA and SDA was burnt in an enclose place to limit the amount of ash that will be blown off. Burning was by open-air and Fayyadh (2009) in their study on the ‘’Influence of RHA average particle size on the properties of concrete’’ investigated that RHA. Concrete developed early strength which was comparable to that of OPC, while at the age of 28 days, the

calcinations method at a very high temperature. The pozzolanic ashes (RHA and SDA) obtained were then sieved with a 300 micron sieve after cooling to obtain very fine particles.

2.1.2 Ordinary Portland Cement

The Dangote brand of ordinary Portland cement (OPC) was used in this study. It was source from owerri, imo state, Nigeria.

2.1.3 Coarse Aggregate

The coarse aggregate (granite) used for this work was sourced from a quarry okigwe in imo state Nigeria.

2.1.4 Fine Aggregate

The fine aggregate (sand) used for this research work was source from Otamiri River in Ihiagwa in owerri west local government area of imo state.

2.1.5 Water

The water used in this work was suitable for drinking and as such was free from impurities. It was obtained from a tap of a borehole in federal university of technology owerri (FUTO), in accordance to BS EN 1008.

2.2 METHODS

2.2.1 Batching of constituent Materials

Batching of the constituent material was done by weight with 50% of RHA and 50% of SDA in OPC-RHA-SDA concrete, with a mix ratio of 1:2:4 and a water to cement ratio of 0.6. The RHA and SDA were partially used to replace ordinary Portland Cement at different percentages of replacement VIZ:

2.3 Concrete mix design

The concrete used in this work was made using cement, sand, gravel and water the concrete mix ratio was 1:2:4

2.4 Casting of Samples

The molding of the beams and cylinders followed the procedure contained in 1881:1983 methods for making and curing of the samples. The dimension of the concrete beams and cylinders cast were as follow, Beam: (150mmx150mmx600mm). Cylinder dimension: Radius=0.075m, height=0.3m. Four mixes were prepared using different percentages, 0% (control), 5%, 10% and 15% RHA and SDA. The concrete was mixed, placed and compacted in three layers. Each layer receives a compaction of 25 blows. The samples were demolded after 24 hours and kept in a curing tank for 28, 90 and 150 days as required.

2.5 Testing of Samples

The flexural strength test and the tensile strength test on the concrete cubes and cylinders were carried out with the flexural crushing machine (third point loading) at FUTO laboratory in owerri Nigeria, this was done according to BS 1881, while tensile test was carried out using the tensile crushing machine in accordance with BS 1881.The sample was weighed before being put in the flexural test machine and the tensile strength machine. The machine automatically stops when the failure occurs and displays the failure load. Other test carried out are the Sieve analysis test, Bulk density test of the RHA and SDA, slump test, specific gravity test, Chemical composition test of RHA and SDA to determine the oxide composition.

3. RESULTS AND DISCUSSIONS

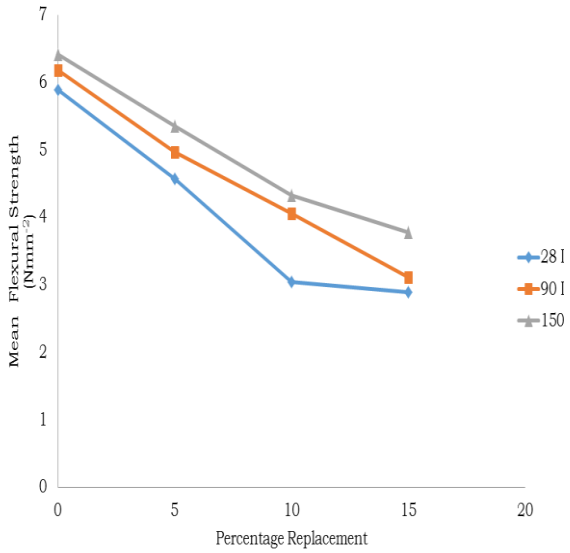
3.1 The results of Flexural Strength Test

The results of the flexural strengths test of the concrete beams at various curing ages are shown in table 2 below.

Table 2 : Flexural Strengths of OPC-RHA – SDA Concrete Beams

Percentage Replacement (%)	Flexural Strengths (N/mm^2)		
	28 Days	90 days	150 days
0	5.89	6.18	6.41
5	4.57	4.97	5.35
10	3.04	4.06	4.32
15	2.89	3.11	3.78

Figure 1 : Graph of the Effect of RHA and SDA on Flexural Strength of OPC-RHA-SDA Cement Composite.



Effect of replacement of OPC with RHA and SDA on flexural Strength of concrete beam

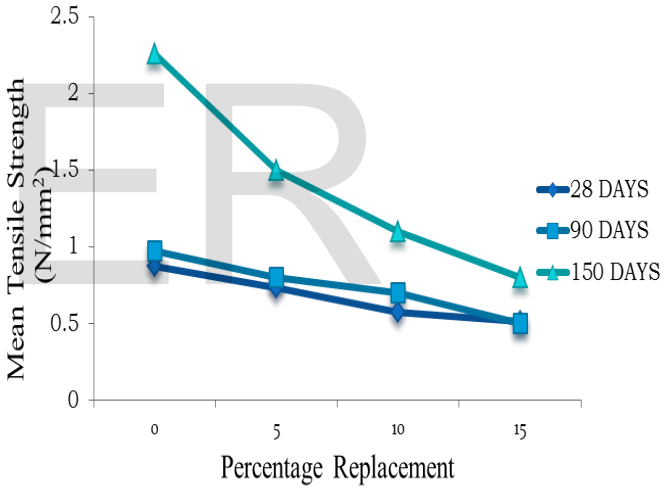
3.2 The results of Tensile Strength Test

The results of the Tensile strength test of the concrete beams at various curing ages are shown in table 3 below.

Table 3 : Tensile Strength of OPC- RHA – SDA Concrete Cylinders

Percentage Replacement (%)	Split Tensile Strengths (Nmm-2)		
	28 Days	90 days	150 days
0	0.87	0.97	2.26
5	0.73	0.80	1.50
10	0.57	0.70	1.10
15	0.51	0.50	0.80

Figure 2 : Graph of the Effect of RHA and SDA on Tensile Strength of OPC-RHA-SDA Cement Composite.



The results obtained above indicated that the flexural strengths and tensile strength of the OPC-RHA-SDA composites increased as the curing age increased but reduced with higher amount of RHA-SDA percentage replacements. The maximum flexural strength occurs at 150 days for 0 %(Control concrete), 5%, 10% and 15% were 6.41 Nmm^{-2}, 5.35 Nmm^{-2}, 4.32 Nmm^{-2} and 3.78 Nmm^{-2} respectively while maximum tensile strength occurs at 150 days at 0% , 5%, 10% and 15% were 2.26 Nmm^{-2}, 1.50 Nmm^{-2}, 1.10 Nmm^{-2} and 0.80 Nmm^{-2} respectively. OPC-RHA-SDA concrete with 5% replacement is suitable for concrete work.

4. CONCLUCTIONS

The flexural strength and tensile strength at 5% replacement and 150 days curing age of the blended cement concrete can be said to compare with that of the control. The flexural strength and tensile strength decreased with increased percentage replacement with highest strength obtained at 5% replacement level. However, the flexural and tensile strengths increased with curing age.

ACKNOWLEDGEMENT

Diboyesuku Ibitroko Donald is sincerely thankful to Engr. Dr L.O. Ettu, Engr. Dr L. Anyaogu and members of my family for their supports.

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