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Properties of Sorghum Husk Ash Blended Cement Laterized Concrete

F.N. Williams[1], I. Anum[2], R.B. Isa[3], M. Aliyu[4]

[1]*Department of Building, University of Jos, Jos, Plateau State, Nigeria*

[2]*Department of Building, Modibbo Adama University of Technology,Yola, Adamawa State, Nigeria.*

[3]*Department of Building, Federal University of Technology, Minna, Niger State, Nigeria.*

[1]frankwills1984@yahoo.com

***Abtract*— This study aimed at investigating the properties of sorghum husk Ash blended cement laterized concrete cured in water. The research work focused on the determination of chemical composition of sorghum husk ash (SHA), the specific gravity of SHA and geotechnical properties of Laterite used in preparing laterized concrete with a view to providing vital information regarding the physical properties as well as the behaviour of concrete obtained thereof. A total of 81 cubes were moulded, nine (9) cubes each varied SHA laterized concrete groups of 0%, 10% and 20% corresponding to 7, 14 and 28days hydration period at 0%, 10% and 20% cement admixture. Of The 81 cubes, 9 cubes at 0% 10% and 20% SHA the specific gravity of SHA was found to be 2.1, the bulk density is 1564kg/m3 and essential pozzolanic oxides (SiO2 + Al2O3 + FeO3) is 72.39, loss of ignition (Lol) is 0.1%. The specific gravity of Laterite was found to be 2.69, the bulk density value is 1145kg/m3, liquid limit, plastic limit and plastic index were 34.15%, 50.0% and 18.0% respectively. The maximum compressive strength at 28days was found to vary from 18.45 N/mm2 at 7 days, 25.66 N/mm2 at 14 days and 26.03 N/mm2 at 28 days.**

I. Introduction

The ever-increasing building cost in developing countries is a matter of serious concern that calls for the appraisal of the conventional building processes in seeking for alternative building materials and methods Adedeji (2005). He also added that currently, the cost of materials and labour is continually on the increase beyond the reach of many people in developing countries. It is observed that the rising cost of buildings in developing countries can therefore be attributed to a number of factors, which include high transportation cost, devaluation of national currency (Naira), inability of production companies to meet high demand for building materials, uncontrollable prices of building materials and particularly, the over-dependency on imported building materials that is constantly subject to inflation (Fasakin and Ogunsemi, 2003). Adedeji(2005) also asserts that locally sourced building materials, which are in abundance especially in developing countries and that would have facilitated sustainable development remain undeveloped to socially accepted and economic level owing to the primitive state of the economy and technological advancement. He also added that an alternative that can reduce the use of materials and minimise labour without necessarily adding to the cost of land that is already high, and which forms the focus of this research which will go a long way to ameliorate this problem.

The Nigerian Building and Road Research Institute-NBRRI (2003) asserts that building materials constitute a single largest input into housing construction and could contribute between 60-70% of the costs of housing. Berry et al (2009) affirmed that concrete is the most commonly used construction materials because of its outstanding strength, durability and availability of the raw materials; and thus averred that concrete is invariably the world most used manmade material in the building industry. But the costs of these building materials are high, One reason for the high material cost as stressed by Day (1990) is the common use of expensive materials such as clay, brick and cement in structures where these materials may not be necessary affirming that the energy requirement to manufacture such materials could account for over 50% of their production cost. Day (1990) emphasized that Ordinary Portland Cement (OPC) cost in particular is extremely high due to energy production requirement; high transportation cost; and artificial price fixing influence by non-technical factors. Alabadan et al(2005) also stressed that the construction industry relies heavily on cement for its operations in the development of shelter and other infrastructural facilities. He also stated that, it then becomes extremely difficult for majority of the people to own their own houses or many collapse structures in attempt to reduce cost. A way out is either by reducing the energy costs in the burning of clinker or by increasing the production of the composite cement. The later involves replacing a proportion of the clinker-high calorie consuming portion by other products that are suitable and do not require further heat treatment. Day (1990) thus w concluded that the use of locally produced building materials will definitely avert the high housing cost in the country.

Cement according to Sweson (1972) is the binding substance used in conjunction with defined aggregates for the production of concretes, mortar and other cement products for use in Civil and Building Engineering works. NBBRI (2003) confirmed that it is a major constituent material for the production of the buildings, with the exception of doors and windows, building components use cement in one form or the other. A cost breakdown of a residential building by NBRRI (2003) showed that about 82% of the building elements use cement for their production. Thus, this makes cement a prerequisite material and indeed a major player in housing and other infrastructural developments . According to Oluwakiyesi (2001), about 224million metric tons of cement is needed to meet the estimated deficit of housing in developing countries. The RMRDC (2001) stated that there exist an enormous gap between the production capacities of the cement manufacturing plants and the demand for the cement in developing countries. Fiakpa (2008) reported that for over the years, there has always been a shortfall in cement demand vis-a-vis the domestic production of the commodity in developing countries. He further asserted that this is due to the enormous gap that exist between the production capacities of the domestic cement manufacturers and demand of the cement, the country imports about 60% of cement annually, thus the cost of cement in developing countries especially in Nigeria is of the highest in the world; a 50kg bag of cement cost four times those of south Africa and Egypt and ten times that of the United States of America. The consequence of these challenges on the cement production, availability and costs as reviewed by Dadu et al (2010) is that the delivery of affordable housing in the country becomes a sheer dream.

II. Materials and Methods

The Laterite was obtained from julius berger borrowed pit at Maikunkele, Minna Niger state was sun dried and later exposed to a temperature of 100^0 C in order to remove all its moisture.

The sorghum husk ash was obtained from gidan kwano and gidan mangwaro village in chanchaga local government of Niger state. The ash was grinded and pulverized at federal polytechnic, bida, Niger state. The chemical analysis was done at the institute of Agricultural research and training, Ibadan Oyo state.

The sharp sand was obtained from mypa area of bosso local government and was transported to the Department of Building laboratory where the practical works were performed. The granite used was obtained from takun fada quarry along paiko road paikoro local government, Niger state.

The equipment used for the practical includes mould of 100mm x 100mm x 100mm size which was gotten from Department of Building laboratory. All other equipment including shovel, tamping rod, measuring pan, sieve of various size and a weighing balance to be used extensively, were gotten from building and civil Engineering Department, Federal University of Technology, Minna Niger state. It was discovered that the sorghum husk ash had an average specific gravity of 2.1 and chemical composition of $S_1O_2 + Al_2O_3 + Fe_2O_3$ gave 72.39% which shows the characteristics of pozzolana as shown in table 1. The ordinary Portland cement used has an average specific gravity of 3.21. The Laterite used has a specific gravity of 2.57, sand and granite aggregates used have a specific gravity of 2.53, and 2.69 respectively. The bulk density

of 1564.06kg/m^3 compacted and 1145.31 kg/m^3 uncompacted of Laterite, bulk density of 1368 kg/m^3 compacted 1148.4 kg/m^3 uncompacted of sharp sand and granite with bulk density of 1570.31kg/m^3 compacted and 1348.44 kg/m^3 uncompacted used falls under uniform grading, under the BS and ASTM requirements. The summary of the constituent materials are shown in table 2.

TABLE I. RESULT OF CHEMICAL ANALYSIS OF SORGHUM HUSK ASH

Chemical composition	Percentage composition (%)
SiO_2	49.5
Al_2O_3	7.95
Fe_2O_3	14.94
MgO	0.49
P_2O_3	2.45
SO_3	0.00
Cl	1.32
K_2O	9.46
TiO_2	1.12
V_2O_5	0.077
CaO	10.1
ZnO	0.13
BiO	0.11
Re_2On	0.02

CuO	0.021	$SiO_2+Al_2O_3+Fe_2O_3$	72.39
BaO	0.11		

TABLE II. SUMMARY OF PHYSICAL PROPERTIES OF CONSTITUENT MATERIALS

Parameters	SHA	Sand	Laterite	Granite
Specific Gravity	2.1	2.53	2.57	2.69
Bulk Density (kg/m^3)				
Uncompacted	1394	1148	1145	1348
Compacted	1649	1368	1564	1570
Moisture Content (%)		6.9	13.8	
Sieve analysis				
Fineness modulus		3.03	3.37	2.87
Coefficient of uniformit		2.70	9.64	1.42
Cu		1.32	2.1	1.204
Coefficient of curvatur				
Cc				

For the compressive strength test, concrete cubes of 100x100x100mm containing the constituent materials, aggregate, cement, sorghum and Laterite (0%, 10%, and 20% partial replacement). The specimens were cast and cured at room temperature in the laboratory for 7days, 14 days and 28 days. At the end of each curing periods, three specimens of each mixture were tested for compressive strength and the average was recorded appropriately.

III. RESULTS AND DISCUSSION

The control (0%) at 28 days had an average strength of 34.33N/mm^2, 0%LAT 10%SHA 34.06N/mm² 0%LAT/20%SHA of 25.83 N/mm² 10%LAT/0%SHA of 25.71 N/mm², 10%LAT/10%SHA of 25.21N/mm, 10%LAT/0%SHA of 25.06N/mm, 20%LAT/0%SHA of 29.01N/mm, 20%LAT/10%SHA of 27.18N/mm, 20%LAT/20%SHA of 25.03. From the result, it was observed that strength reduction was as a result of increase in percentage of Laterite and sorghum husk ash.

It was also observed that with increase in curing days, there was increase in density and compressive strength of the cubes as the curing age increased at room temperature as shown in tables 4 and 5. It was therefore noted that at 7 days strength for 0% Laterite is 23.07N/mm², 14 days strength 0% Laterite strength is 24.11N/mm²,7days strength for 10% Laterite is 17.80N/mm² while 28days strength is 29.57N/mm², for 7days strength of 20% Laterite is

13.67N/mm² while 28days strength is 19.67N/mm², 7days strength for 30% Laterite is 12.67N/mm² while 28days strength is 18.93N/mm²). This indicates that with increase in curing days, increase in compressive strength is expected.

TABLE III. WORKABILITY TEST

LAT. Content (%)	SHA Content (%)	SLUMP VALUES (mm)
	0	26.0
	10	26.5
0	20	26.7
	0	26.2
10	10	26.8
	20	27.2
	0	27.5
20	10	26.9

20	27.3

TABLE IV. SUMMARY OF DENSITY (DS-KG/M^3)

Lat. Cont. (%)	SHA Cont. (%)	Curing days		
		7	14	28
		DS	DS	DS
0	0	2516	2422	2389
	10	2489	2358	2348
	20	2548	2307	2309
10	0	2475	2566	2578
	10	2544	2587	2591
	20	2480	2561	2577
20	0	2507	2500	2545
	10	2509	2456	2478
	20	2315	2415	2491

TABLE V. SUMMARY OF COMPRESSIVE STRENGTH (CS-N/MM^2)

Lat. Cont. (%)	SHA Cont. (%)	Curing days		
		7	14	28
		CS	CS	CS
0	0	23.07	24.11	34.33
	10	22.71	20.13	34.06
	20	19.80	19.97	25.83
10	0	18.60	20.69	25.21
	10	17.68	24.97	25.71
	20	16.26	19.23	26.66
20	0	26.57	27.10	29.01
	10	19.72	21.20	27.18

20	18.45	25.66	26.03

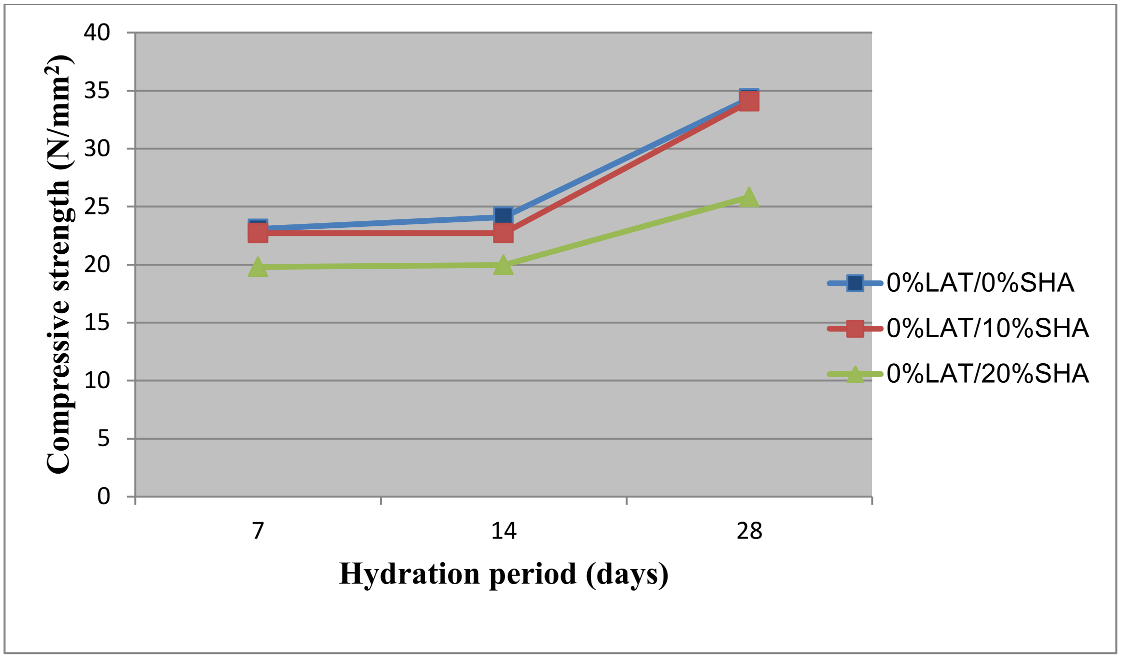

Figure 1. Plot of Compressive strength for 0%Lat/0%-20%SHA

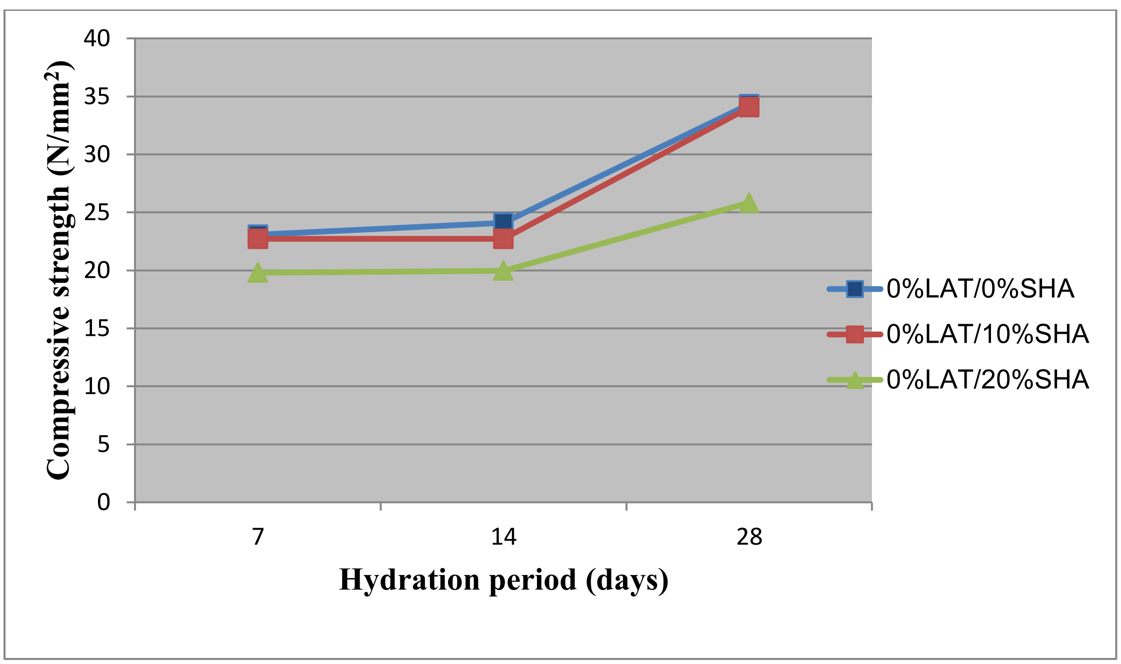

Figure 2. Plot of Compressive strength for 10%Lat/0%-20%SHA

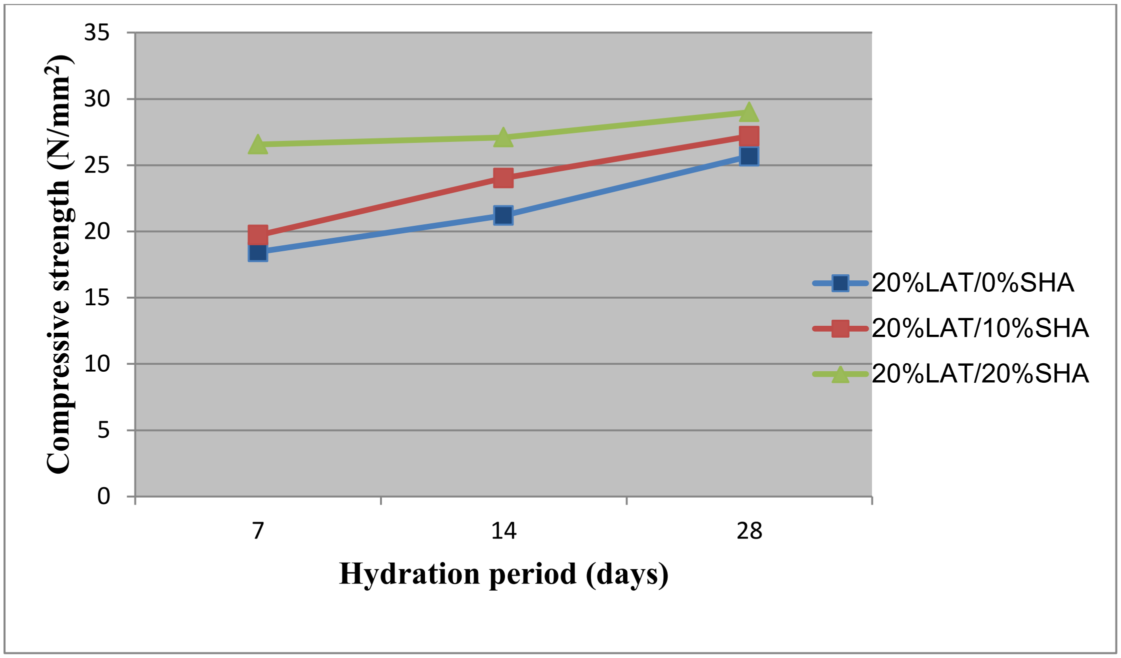

Figure 3. Plot of Compressive strength for 20%Lat/0%-20%SHA

IV. Conclusion

The results presented demonstrates that the blends of Laterite and Sorghum Husk Ash(SHA) possessed good pozzolanic characteristics and therefore suitable in partial replacements of Ordinary Portland Cement in concrete mixtures. It is thus concluded, that Laterite and SHA canbe utilised in partial replacement of ordinary portland cement upto 20% in general concrete construction and when high strengths at early ages are not a requirement. Emphasis is laid on the need to persuade the existing Portland Cement factories and Building research institute to undertake pozzolana production as a new line. Therefore, the establishment of blending plants for the production of portland pozzolana cements is recommended in view of the economic, engineering and environmental benefits and the readily availability of Laterite and Sorghum. Countries should adopt pozzolanas because they set slowly and therefore, develop very low heat of hydration. This makes them very useful for non-structural construction in hot countries. Also, Pozzolanas are more suitable for use in hot countries than in cold because higher pozzolanic activity can be developed in hot countries than in cold by the same materials. It is therefore imperative for developing countries to adopt the use of pozzolanas.

References

[1] Adedeji, Y. M. D., (2005): Sustainable Low-cost Housing Technology in Cities: Accelerated Construction Initiatives Option. Journal of Land use and Development Studies Vol. 1, No. 1, 2005.

[2] Adepegba, D. (1990). Nigeria: Pozzolana - the cheap alternative to Portland cement. The paper presented at the Seminar on Local Materials for Housing, Third International Seminar of the African Network of Scientific and Technological Institutions (ANSTI), Civil Engineering Subnetwork, held at the University of Mauritius, Reduit, and March 1990. ANSTI is a UNESCO sponsored Network.

[3] Berry, M., Cross, O., Stephens, J (2009): Changing the environment; An Alternative Green Concrete Produced without Portland cement. In; press World of Coal Ash conference (WOCA). 4-7 May 2009 Lexington Kentucky, USA.

[4] BS 1881: Parts 102: 1983 *Methods for Determination of Slump.* 389 Cheswick High Road, London, British Standard Institute.

[5] BS 1881: Part 103; 1993 *Methods for Determination of Compacting Factor.* 389 Cheswick High Road, London, British Standard Institute.

[6] BS 1881: Part 108: 1983 *Method for Making Test Cubes from Fresh Concrete.* 389 Cheswick High Road, London, British Standard Institute.

[7] BS 1881: Part 111: 1983 *Method of Normal Curing of Test Specimens (20^{o}c) method.* 389 Cheswick High Road, London, British Standard Institute.

[8] BS 1881: Part 114: 1983 *Method for Determination of Density of Hardened Concrete.* 389 Cheswick High Road, London, British Standard Institute.

[9] BS 1881: Part 116: 1983 *Method for Determination of Compressive Strength of Concrete cubes.* 389 Cheswick High Road, London, British Standard Institute.

[10] Dadu, D. W., Garba, M. M., Zubairu, I. K., Bustani, S. A., (2010). Investigations into The pozzolanic Activities of Volcanic D|eposits from the Jos Plateau: Interim Report on Chemical Characteristics. *In*: Laryea, S. S., Leiringer, R. And Hughes, W. (Eds). Procs *West Africa Built Environment Research (WABER) Conference, 27-28 July 2010, Accra Ghana.* Pp. 395-402.

[11] Day, B., (1990): Program in Engineering for Developing Communities; Viewing the Developing World as a classroom of the 21st century Colorado, USA.

[12] Fiakpa, L. (2008): The Cement Barrier Crumbles. Thisday Sunday, Jan 20. 3, pp28-29.

[13] Neville A.M and Brooks J.J (1997). Concrete Technology, 2nd edition, London, Longman Puplishers.

[14] Nigerian Building and Road Research Institute (2003): Enhancing Domestic Production of Building Materials, Nigerian Building and Road Research Institute, Abuja. In:

[15] Oluwakiyesi, T. (2001): Nigerian Cement Industry; unbinding Potentials. In; Press to Retrieve Capital Management Limited, 2010.

[16] Sweson E. G., Austrain Cement Industry Federation (1972): Portland Cements in Building Construction. Canadian Building Digest, Toronto, National Research Council of Canada.

[17] Testing methods for pozzolanas. (2008). Retrieved 30th October 2011 from http://www.appropedic.org/Testing_methods_for_pozzolanas(Practical_actionbrief).

[18] Testing methods for pozzolanas. (2008). Retrieved 30th October 2011 from http://www.appropedic.org/Testing_methods_for_pozzolanas (Technical_actionbrief).