Quality Assessment of Hollow Sandcrete Blocks In the South Western Part of Nigeria

Awofadeju Ayinde. S., Akanni Ayotunde O., Iyiola S.

Abstract*— The paper assesses the quality of hollow sandcrete blocks manufactured by block Industries in Osun, Oyo and Ekiti States the South Western part of Nigeria. Block samples were randomly collected from selected areas of the states; Osogbo, Ilesha, Ibadan, Ogbomosho, Aramoko and Ado-Ekiti. Sandcrete blocks were produced using 1:6 based on the requirements of the Nigerian Industrial Standards (NIS) 87:2000 standards. The blocks were subjected to wet and dry compressive test, dry density and wet density test. The aggregates were subjected to grading analysis and silt content analysis. The study revealed that all the sand aggregates used for the production of the blocks were substantially suitable for block making. The grading of the sand fall within the limit required by BS 882:1990. The results also showed that the compressive strengths for all the blocks tested were between 0.35N/mm2and 0.63N/mm2 which does not comply with the recommended standards (2.5N/mm2 to 3.45N/mm2 respectively) in (NIS) 87: 2000 series and 2.8N/mm2 in BS 6073-1:1981. It is concluded that sandcrete block in the South West part of Nigeria are of lower standard as a result of factors such as poor workmanship, mix ratio and method of curing, experience and skill of production crew etc, contributes to the poor quality of Sandcrete blocks and this made our blocks unsuitable for load bearing walls. Standardization of the block manufacturing processes and strict supervision of the industry by the professional body in Nigeria were recommended for improvement in the quality of block production.

***Index Terms*— strength, density, quality, Sandcrete block, standard**

I. INTRODUCTION

Food, clothing and shelter are the three basic necessities of life. But, it is rather unfortunate that human settlement condition in many developing countries is deteriorating as a result of low level of investment in the construction sector. In Nigeria today, there is an increase in the cases of building collapse where many lives were lost and properties were destroyed. One of the reasons for this is the lack of environmental quality of materials being used for human settlements.

Over 90% of physical infrastructures in Nigeria are constructed using sandcrete blocks [1],[8]. Materials used in making sandcrete blocks include aggregates, cement and water and it can be classified into three basic form; solid, hollow and cellular thus proving versatility to block work construction both in style and function. The properties of sandcrete block depends to a varying degree on the type and proportions of the constituent materials, the process of manufacture, the mode and duration of curing and the form and size of block itself [5],[1]. The global concern across the world and in Nigeria in particular demands that materials used for construction of buildings meet minimum requirement. In the year 2000, the Standard Organization of Nigeria (SON) developed a reference document which prescribed the minimum requirement and uses of different kinds of sandcrete blocks and other products, to prescribe the quality of materials; methods and procedure to be applied for production and testing of the final product in order to ensure compliance to prescribed standard. This first standard is known as NIS 87: 2000 and had been subsequently reviewed in 2004 and 2007 [9]. The properties of sandcrete hollow block include density, strength, dimensional change, durability, thermal conductivity, movement and chemical attack. [9] stated that in the hardened state, sandcrete has a high compressive strength and this strength increases with density. The range of minimum strength specified in NIS 87:2007 is between 2.5N/mm^2 to 3.45N/mm^2. [8] suggested that materials used for building construction meet minimum standard to address the issue of sudden building collapse which was attributed partly to the quality of sandcrete blocks used for walling units.

Although lots of policies and programmes have been put in place to alleviate the problems in block industries however, it's important to assess and properly monitor the production of sandrete hollow blocks from various manufacturers to provide quality and affordable housing especially in the South Western part of Nigeria. This paper focuses on the quality of sandcrete hollow blocks produced in South Western part of Nigeria. It will be studied and tested in other to know the quality of blocks produced with the view of enhancing the quality of the production.

II. MATERIALS AND METHODS

Materials

The materials used for making the sandcrete blocks were cement, sand and water. The cement used by most manufacturers was Dangote cement manufactured by the Dangote Cement Company of Nigeria. While few of them also use Elephant Portland cement and Burham cement. The water used is usually well water, water from stream or borehole water which satisfy minimum requirement for general civil engineering works.

Methods

a. Survey analysis

Laboratory experiments, work study and field survey were adopted to carry out this study. The survey method entails the use of questionnaire which was administered on the owner of each of the block industries where Sandcrete samples were taken. In all, a total of 120 questionnaires were administered raising queries about the background of the manufacturer, materials of production, production size and capacity, sales

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and pricing, quality control and regulations and factors affecting production. Data collected were analyzed and discussed. The field survey covered Oyo state, Osun state and Ekiti State in the South-West, Nigeria. Two major towns were selected in each state with 40 samples of Sandcrete blocks (225mm) randomly procured from different block manufacturing industries in each town making a total of 240 blocks. In Osun State, Osogbo and Ilesha were selected; Ogbomosho and Ibadan were selected from Oyo state while Aramoko and Ado- Ekiti were selected from Ekiti State.

A number of sandcrete blocks were fabricated at industries located in each of the town which serves as control sample. The mix ratio of 1:6 was adopted in accordance with the procedures in NIS 87:2007.

b. Sieve analysis

Sieve analysis test was also conducted on the aggregates used to ascertain the suitability of the aggregate that was used for the production of the sandcrete block in accordance with BS 882 1992.

c. Compressive test

The blocks were weighed and the compressive test was determined when the blocks were wet and dry using the compression testing machine in accordance with BS 6073 1981. Compressive test is the ratio of crushing load to the gross area of the block. The blocks were crushed after 3, 7, 14, 28 days of curing. The density for both the dry and wet sandcrete block were also determined

III. RESULTS AND DISCUSSION

The results from the survey and various test carried out were analyzed and the assessment were based on NIS standard requirements. These results are presented below.

a. Fine aggregate

Coarse and soft sand were used by block manufacturers in Osogbo, Ilesha, Ibadan, Ogbomosho and Aramoko with only Ado Ekiti using coarse and stone dust.

The results of sieve analysis presented in Fig.1-Fig.6 show that the materials (aggregate) used in producing the blocks in all the industries were suitable because they have percentage silt content by volume ranging from 0.04% to 0.40%. Therefore the silt content complies with the standard that is, not exceeding 6% according to BS882 1983. The soil (materials) can be described as well-graded containing a wide range of particle size because they have a curve spreading evenly across.

b. Cement

All the blocks were produced mechanically with either Dangote cement, Elephant Cement or Burham cement. All the cement brands satisfied the requirements of BS 12 1996 as shown in [2]. The cement/sand ratio being used by the various industries ranges from 1:10 - 1:15 which is against the specified code from NIS 87:2007. This is because the block manufacturers are rather particular about profit than the quality of their output.

c. Water

All the block industries visited in all the states used one of well water, borehole or water from the stream for their production.

d. Test on raw materials

There was no quality checks carried out on the constituent materials used in block production in all the sites visited before production.

e. Method employed in production

All the manufacturers did not use standard measures in batching sand. Batching of constituent materials is by volume (using wheel barrow to measure the sand). They all employed the manual method of mixing. To produce a homogenous and uniform material, machine mixing would have been preferable for that volume of materials to be mixed. The water is also gradually added to arrive at satisfactory consistence in all the industries visited in the states. If added in excess, the output of the blocks won't be good because part of the materials in the mould would stick to it. The addition of water beyond the specified 0.45 water: cement ratio contributes to prolonged setting time and causes reduction in strength.[4] Machine was used by all the industries visited to compact their blocks.

Also, poor method of curing is a contributing factor to the low strength recorded. Good curing allows for complete hydration of cement and this improves the strength of the blocks. The blocks produced in the various industries were not properly cured. Curing was done under direct sunshine by spraying water on moulded blocks daily for two to five days instead of 28days before the blocks were sold. It was not necessarily categorized into wet and dry stages in the entire site visited thereby resulting to inadequate strength development.

f. The Result of Fabricated Block Density and Compressive Strength Test

The fabricated density and compressive strength test results showed the densities and compressive strength of the standard fabricated concrete blocks from industries at Osogbo (Osun State) Ogbomosho (Oyo State) and Ado-Ekiti (Ekiti State), and was presented in Table 1. This showed that the fabricated sandcrete block which is a pilot test have the lowest density and the highest density of 1833kg/m^2 and 2475kg/m^3 respectively after 28 days of curing. An average density of 2120kg/m^3 was gotten for the whole industries. It shows that the highest and lowest compressive strength obtained are 2.81N/mm^2 and 2.54N/mm^2 respectively on the 28th day with an average compressive strength of 2.70N/mm^2. This fell within the range of minimum strength (2.5 N/mm^2 to 3.45 N/mm^2) specified in NIS 87: 2007

g. Results of Density Test.

The analyses of both dry and wet density test are presented in Table 2 and Table 3 respectively. From Table 2, dry density at 28th day ranges from 1716 kg/m^3 to 2283kg/m^3, with industries at Aramoko and Osogbo showing better densities development of 2283kg/m^3 and 2247kg/m^3 respectively. Table 3 reveals that the wet densities of all the industries on the 28th day ranges from 1781kg/m^3 to 2461kg/m^3, with industry at Aramoko having the highest increase in density of 2461 kg/m^3 while industry at Ado Ekiti has the lowest increase in density of 1781kg/m^3. Analysis of this result is presented in Fig.7 and Fig. 8 for dry and wet density test respectively. Both the dry and wet density compared favourably well with the average density of standard fabricated sandcrete blocks according to (NIS) 87: 2007.

h. Result of Compressive Strengths

The dry compressive strength at 28th days range from 0.35N/mm^2 to 0.49N/mm^2 with industry at Osogbo and Ogbomosho showing better strength development of 0.49N/mm^2 and 0.35N/mm^2 for Ado Ekiti respectively as shown in Table 10. Table 11 shows that the wet compressive strength at 28th days range from 0.18N/mm^2 to 0.63N/mm^2.The compressive strength of pilot test is far above the range of that of commercial block which is very low to the Standard specification. The primary factors influencing the compressive strength of cement are type and gradation of aggregate, degree of compaction, amount of water used, and moisture content and temperature of the units at test period. [10]

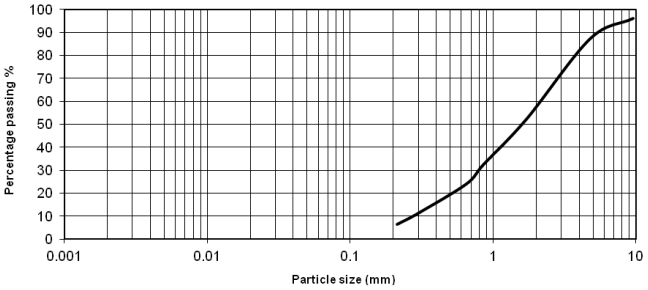

Fig. 1. Graph showing Size Distribution of Aggregate (Sand) Sample from Osogbo.

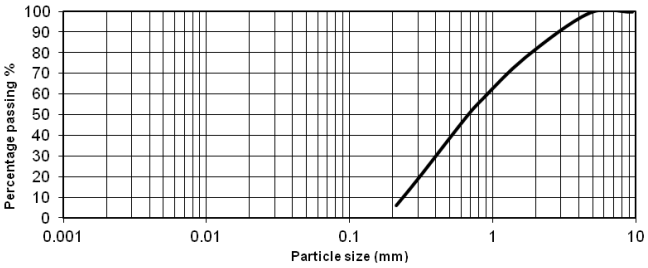

Fig. 2. Graph showing Size Distribution of Aggregate (Sand) Sample from Ilesha.

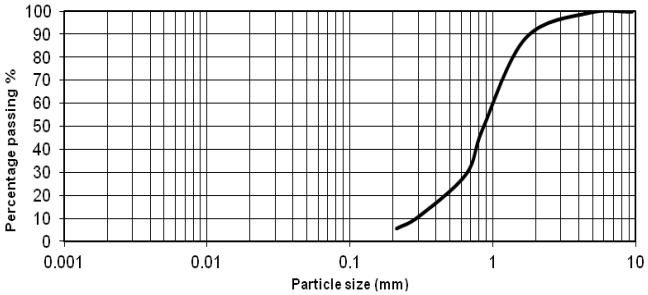

Fig. 3. Graph showing Size Distribution of Aggregate (Sand) Sample from Ibadan.

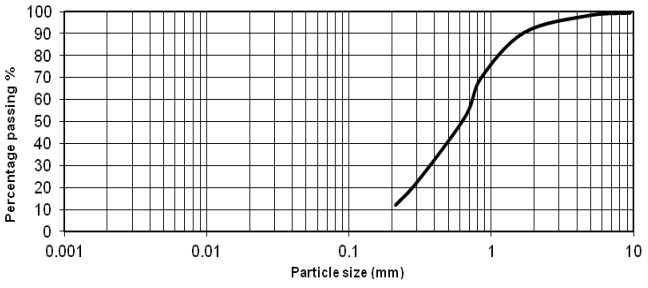

Fig. 4. Graph showing Size Distribution of Aggregate (Sand) Sample from Ogbomoso.

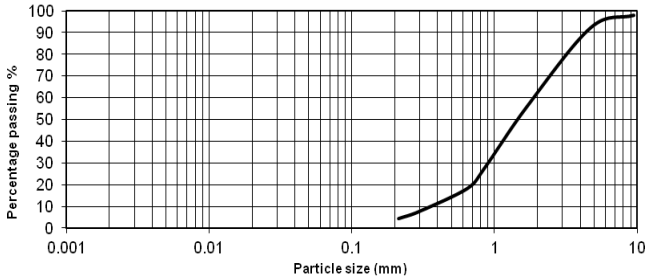

Fig. 5. Graph showing Size Distribution of Aggregate (Sand) Sample from Aramoko - Ekiti.

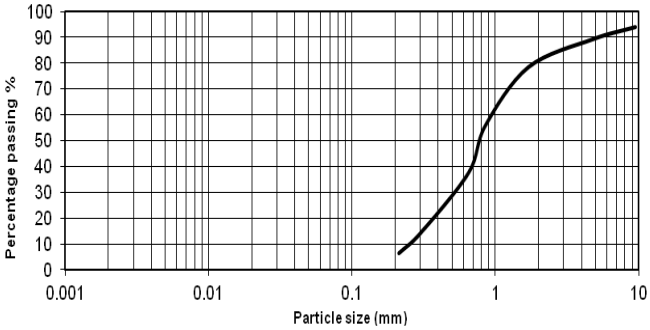

Fig. 6. Graph showing Size Distribution of Aggregate (Sand) Sample from Ado – Ekiti

Table 1: Density and Compressive Strength of Fabricated Sandcrete Blocks at 28th Day of Curing.

Industry	Density Kg/m^3	Gross area mm^2	Crushing Load (N)	Crushing strength (N/mm^2)	Average Density Kg/m^3	Average Strength (N/mm^2)
OSOGBO (OSUN STATE	2268	69920	195000	2.79		
	2402	69920	190000	2.72	2383	2.73
	2475	69920	187000	2.67		
OGBOMOSO (OYO STATE)	2044	67500	180000	2.67		
	2257	67500	185000	2.74	2176	2.74
	2227	67500	190000	2.81		
ADO-EKITI (EKITI STATE)	1853	70835	180000	2.54		
	1724	70835	195000	2.75	1803	2.63
	1833	70835	185000	2.61		
AVERAGE	2120	69418	187444	2.7	2120	2.7

Table 2: Dry Densities of Sandcrete Blocks in Kg/m^3

Days	3	7	14	21	28
INDUSTRY	Dry density in Kg/m^3				
OSOGBO	1966	2255	2303	2272	2247
ILESA	1788	2125	2142	2148	2094
IBADAN	1968	1979	2032	2049	2008
OGBOMOSHO	1956	1939	1995	2000	1939
ARAMOKO	2338	2324	2450	2356	2283
ADO EKITI	1632	1673	1807	1744	1716

Table 3: Wet Densities of Sandcrete Blocks in Kg/m^3

Days	3	7	14	21	28
INDUSTRY	Wet density in Kg/^{3}				
OSOGBO	2131	2264	2296	2328	
ILESA	1902	2044	2184	2242	2205
IBADAN	1979	2095	2077	2086	2064
OGBOMOSHO	1975	2128	1990	2041	1986
ARAMOKO	2413	2552	2521	2468	2461
ADO EKITI	1642	1748	1754	1769	1781

Table 4: Dry Compressive Strength of Sandcrete Blocks in N/mm^2

Days	3		7		14		21		28	
INDUSTRIES	Failure loadin g (N)	Crushing Strength (N/mm^3)	Failure loading (N)	Crushing Strength (N/mm^3)	Failure loading (N)	Crushing Strength (N/mm^3)	Failure loading (N)	Crushing Strength (N/mm^3)	Failure loading (N)	Crushing Strength (N/mm^3)
OSOGBO	7333	0.1049	9333	0.1335	20667	0.2956	2300	0.3289	34000	0.4863
ILESA	3000	0.0429	6000	0.0858	19333	0.2765	21667	0.3099	30333	0.4338
IBADAN	6667	0.0988	9333	0.1383	19667	0.2914	22000	0.3259	27667	0.4099
OGBOMOSHO	8333	0.1235	10667	0.158	22333	0.3309	25333	0.3753	33000	0.4889
ARAMOKO	6000	0.0877	7333	0.1072	19000	0.2778	23667	0.346	28667	0.4191
ADO EKITI	7000	0.0988	8000	0.1129	19667	0.2776	18333	0.2588	25000	0.3529

Table 5: Wet Compressive Strength of Sandcrete Blocks in N/mm^2

Days	3		7		14		21		28	
INDUSTRIES	Failure loading (N)	Crushing Strength (N/mm^2)	Failure loading (N)	Crushing Strength (N/mm^2)	Failure loading (N)	Crushing Strength (N/mm^2)	Failure loading (N)	Crushing Strength (N/mm^2)	Failure loading (N)	Crushing Strength (N/mm^2)
OSOGBO	9000	0.1287	12000	0.1716	23667	0.3385	23667	0.3957	27667	0.5387
ILESA	6333	0.0906	8000	0.1144	23333	0.3337	23333	0.3528	24667	0.4100
IBADAN	6667	0.0988	8667	0.1284	20333	0.3012	20333	0.3210	21667	0.3852
OGBOMOSHO	6667	0.0988	9000	0.1333	20333	0.3012	20333	0.3753	25333	0.6272
ARAMOKO	7667	0.1121	10000	0.1462	22333	0.3265	22333	0.3606	24667	0.4630
ADO EKITI	8000	0.1129	7000	0.0988	21667	0.3059	21667	0.3294	22667	0.3200

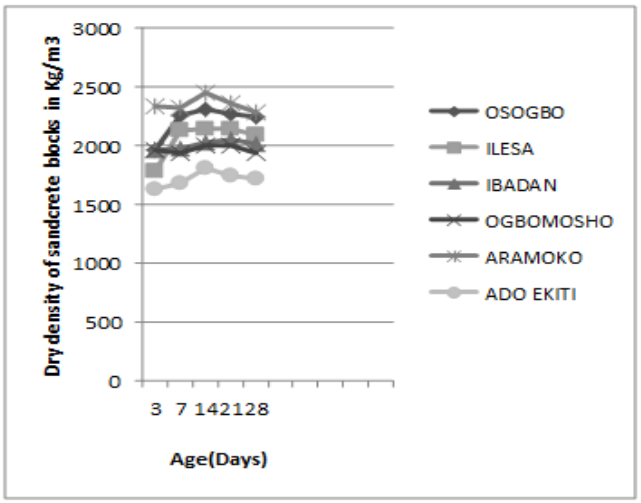

Fig. 7: Graph of Dry Density of Sandcrete Block against the number of curing days for blocks from various sites

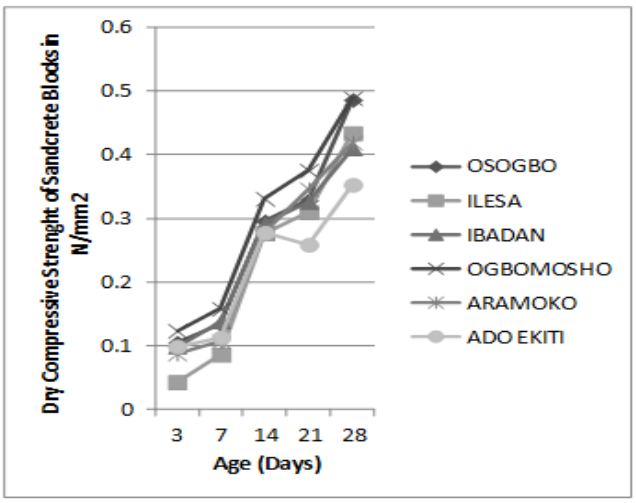

Fig 9: Graph of Dry Compressive Strength of Sandcrete Block against the Number of Curing Days for Blocks from Various Sites

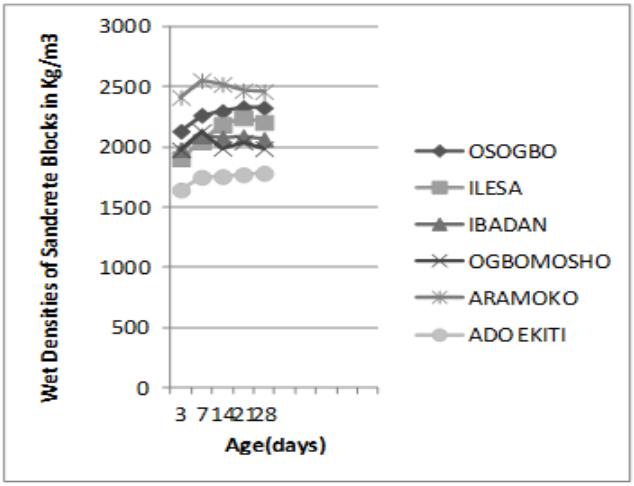

Fig. 8: Graph of Wet Density of Sandcrete Block against the number of curing days for blocks from various sites

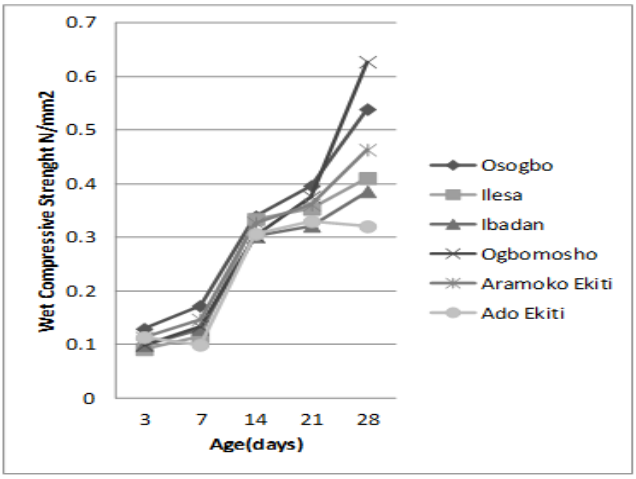

Fig. 10: Graph of Wet Compressive Strength of Sandcrete Block Against the Number of Curing Days For Blocks From Various Sites

IV. CONCLUSIONS

From the various survey analysis and test carried out, the study has shown that the compressive strengths of sandcrete blocks produced in the South Western part of Nigeria fall below acceptable standards. This is also confirmed by [12].This is because the producers are not actually adhering to the standard process of production specification for mix ratio and proper curing as is required for Sandcrete blocks. All the selected sites satisfied the condition for the percentage of all constituent by volume in the sample of aggregate collected from industries.

There is a better improvement in the densities of the industries at Osogbo, Ilesha, Ibadan and Aramoko while Ado Ekiti has the least densities and is not up to standard. Strength recorded for all the industries (both dry and wet compressive strength of the block produced) falls below the recommended value of (2.70N/mm^2) while the value for the fabricated block which is the control experiment fall within the recommended values in NIS 87:2007.

V. RECOMMENDATIONS

From the conclusion drawn above, the following recommendations are presented. Education and regular enlightenment of the sandcrete block manufacture's on importance of adhering to standard specifications should be carried out on regular basis. The Nigeria Standard Organisation and other affiliated bodies like the Nigerian Society of Engineers, the Builder Society of Nigeria and the Engineering Regulation Monitoring should periodically monitor the production of block industries in the states and strict penalties should be meted out to erring producers to improve the quality of commercially available Sandcrete blocks for construction works.

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