



Reassessment of the Quality of Sandcrete and Concrete Hollow Blocks produced in Ado-Ekiti Metropolis

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ABSTRACT

This research is a laboratory test-focused on determining the compressive strength, impact strength and water absorption of controlled concrete and sandcrete blocks and that collected from different block industries within the Ado-Ekiti Metropolis. Infrastructural failure across the Nation has necessitated a prompt solution to problems in the building industry. Experimental tests were carried out on controlled sancrete (SHB), concrete block (CHB) and those collected from five different locations in Ado-Ekiti. The results revealed poor average compressive strength for samples collected (both 9 and 6 inches) and ranging from 0.33-1.5 N/mm² for 9 inch and 0.36-1.27 N/mm² for the 6-inch block. These range are below the minimum requirements of NIS 87:2007 standard which specifies 2.5-3.45 N/mm². The controlled samples of SHB and CHB yielded a good strength, low water absorption and a higher impact resistance compared to the samples collected. It was concluded that Federal Government should encourage the use concrete blocks through public awareness while empowering NIS and SON to sanction block industries who want to contribute to infrastructural damage due to non-compliance with code and specification of the manufacturing of sancrete block.

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INTRODUCTION

Concrete manufacturing involve consumption of ingredients like cement, aggregates, water and admixtures. Among all the ingredients, aggregates form the major part concrete. Conventional aggregate provide volume at low rate comprising up to 70% to 80% of the concrete volume.

Man's population continue to increase in sizes with higher demand for infrastructures to meet man's daily need. The use of sandcrete blocks in building industry have increased since research have shown that the durability and longevity of this masonry unit is greater than that of any other building material, as is evident in thousands of old block unit buildings around our neighborhoods and towns.

When designed and constructed properly, sandcrete blocks can last hundreds of years or more. More than 90% of physical infrastructures

are made with sandcrete blocks (baiden and tuuli, 2004).

NIS 87:2007 defines sandcrete blocks as composite materials made up of cement, sand and water, molded into different sizes and widely used all over the world. The quality of blocks produced however, differs from each industry due to the different methods employed in the production, the properties of the constituent materials, unskilled labour and greed (abdullahi, 2005).

Sandcrete blocks are those building units used in the construction of wall and partitions. They are produced in various sizes and weights. They can be easily handled by the bricklayer compared with bricks.

Sandcrete blocks are available for the construction of load bearing and non-load bearing walls. Load bearing blocks must conform to building by law as regards to their crushing and



the amount of solid mineral contained in the section e.g the total width of block. They also participate mainly in the task of transferring the actual load from the overlaying structural elements to the foundation. In this case the load bearing wall are those walls acting as supports for the whole structure to transmit the weight to the ground surface underneath for stability. Sandcrete blocks possess an intrinsic low compressive strength making them susceptible to any tragedy such as seismic activity.

Block is a composition of usually (1:6) mix of cement and sharp sand with the barest minimum of water mixture, and in some cases admixtures are added, molded and dried naturally. The block can therefore be made either in solid and hollow rectangular types (for normal wall) or decorative and perforated in different designs, patterns, shapes, sizes and types (for screen wall or sun breakers). In Nigeria, sandcrete blocks are widely used as walling units (load and non-load bearing). In the hardened state, sandcrete has a high compressive stress and this strength increase with density. The range of minimum strength specified in NIS 87:2007 is between 2.5N/mm² to 3.45N/mm².

For a long time in Nigeria, sandcrete blocks are manufactured in many parts of the country without any reference to suit local building requirements or good quality work and have led to the collapse of many buildings and fences in recent time (Wasiu et al). Sandcrete blocks are the most common and masonry walling units in Nigeria.

LITERATURE REVIEW

Quality is referred to as the compliance with specification (Anosike, 2011). It is also the totality of features required by a product to satisfy stipulated and implied needs. In a similar development (Ogunsanmi, 2011) identified quality as one of the three key elements for developing risk classification model for design and building projects. This implied that quality is a significant factor that cannot be undermined in the construction industries.

The Standard Organization of Nigeria (SON) was established through act 56 in 1971 and became the sole statutory body that is vested with the responsibility of standardizing and regulating

the quality of all products in Nigeria including sandcrete blocks. The Nigerian Industrial Standard (NIS) for sandcrete block is a standard reference document developed by the SON which prescribes the minimum requirements and uses of sandcrete blocks. These requirements include the quality of materials, the methods and procedures to employ for production and testing of the final products to ensure compliance to specification. The first standard for sandcrete blocks in Nigeria was developed in 2000 and known as NIS 87:2000; Standard for sandcrete blocks. In 2004, the document was reviewed and NIS 87:2004; Standard for sandcrete blocks became the country's standard reference document for sandcrete block. The last review done in 2007 from which NIS 87:2007; Standard blocks emerged as the latest standard reference document for sandcrete block production in Nigeria.

Due to the poor quality of blocks produced in Nigeria, many industries have diverted attention to the use of concrete blocks for durability and longevity.

Concrete can be converted into precast masonry units of suitable size to be used for walling. Use of such blocks is more appropriate in a region where bricks are costly, poor in strength and are not available. Depending upon the structural requirements of masonry units, concrete mix can be designed using available ingredients. The blocks can be cast to desired shape and size to facilitate construction of wall of requisite thickness and appearance. A thickness as low as 15cm is feasible for a load bearing wall and 10cm for a non-load bearing wall, adopting solid concrete blocks. A series of lean concrete mixes were developed at the central building research institute, using gap-graded concrete with 20mm coarse aggregate and fine aggregate. Pilot-scale trials and field applications have proved that the newly produced masonry unit has significant techno-economic potential. Concrete masonry blocks, their physical properties and strength in comparison with selected sandcrete blocks within Ado-Ekiti Metropolis.

Abdullahi (2005) studied the compressive strength of sandcrete blocks produced in some parts of Minna, Niger state,

Nigeria and discovered that they were below the minimum NIS standard requirement.

Many researchers in Nigeria have tested the quality of commercial sandcrete blocks produced within their locality and have discovered low compressive strength with high water absorption capacity. This have led to infrastructural failure. (Onwuika et al, 2013; Baiden and Tuuili, 2004; Anosike and Oyebade, 2012; Adeyemi et al, 2018; Anya and Osadebe, 2015; Ewa and Ukpata, 2013).

In the last couple of years, the construction industry has witnessed a high level of criticism and controversies over the issue of building collapse all over the country. The critical problem is the issue of using of substandard building materials and applied method of process. Although some contractors and engineers use the approved standard laid down in the British and Nigerian institute's codes, others deviate from this largely due to their own selfish aim for the purposes of maximizing profit. As much as economical use of materials is important, it is noteworthy that the safety of structures remains the most important. The significance of this research is to reduce conflict of building collapses in Nigeria building and construction, also wastage of materials, following the right code in molding, most of all achieve the strength which will last. This research will reveal the compressive strength, water absorption capacity and impact resistance of some commercial sandcrete blocks in circulation within Ado-ekiti and to propose ways of improvement of such blocks through adherence

to specification. The proposed methods of improvement will also increase the strength and durability of building elements.

MATERIALS AND METHODS

Materials use in this research includes; sand, cement, gravel (20 mm maximum size aggregates) and water. The physical properties of the binder (Dangote brand), fine and coarse aggregates are presented in Tables 1, 2 and 3 respectively. The 9 inches ($450\text{mm} \times 225\text{mm} \times 225\text{mm}$) and 6 inches ($450\text{mm} \times 225\text{mm} \times 150\text{mm}$) metal mold used are shown in Figures 1 and 2 respectively.

Materials are mixed according to National Building Code (NBC, 2006) in an open air. 9 and 6 inches' sandcrete blocks were molded and cured under laboratory conditions for 7 to 28 days and tested using a 2000kN capacity compression testing machine. The concrete hollow blocks were made following the requirement ratio for plain concrete (1:3:4) as shown in Figure 3. Samples of already made sandcrete blocks were also collected from different block industries within the Ado-Ekiti metropolis. Some of these areas include: Polytechnic (POL) road, Ilawe (IL) road, Ikere (IK) road, Adebayo (ADE) road and Basiri/Iyin (BI) road respectively. The 9 and 6 inches sandcrete blocks collected and those molded were tested for strength, impact resistance and water absorption capacity.



Figure. 1: 9 inches hollow block metal mold



Figure. 2: 6 inches hollow block metal mould

Table 1: Properties of grade 42.5 Ordinary Portland Cement (OPC)

S/N	Physical test	Expt. values	Reference: BS 12, 1971
1	Fineness (retained on 90 μ m sieve) (%)	6.90	≤ 10
2	Specific gravity	3.15	-
3	Density (Kg/m ³)	1450	-
4	Vicat Set. time (minutes)	Init. Set. time = 92 Fin. Set. time = 266	≥ 45 ≤ 375

Table 2: Physical properties of fine aggregate

S/N	Physical test	Expt. values	Reference: BS 12, 1971
1	Fineness modulus	2.85	2.3 – 3.0
2	Specific gravity	2.65	2.63 – 2.67
3	Apparent specific gravity	2.68	-
4	Water absorption (%)	0.55	-
5	Coefficient of uniformity (Cu)	2.18	≤ 4
6	Coefficient of curvature (Cc)	1.14	1 – 4

[Wasiu and Baba, 2020]

Table 3: Physical Properties of Coarse Aggregates

S/N	Physical test	Expt. values	Reference: BS 12, 1971
1	Aggregate impact value (AIV) (%)	14.3%	$\leq 25\%$
2	Specific gravity	2.75	2.5 – 3.0
3	Apparent specific gravity	2.69	-
4	Water absorption (%)	0.61	-
5	Coefficient of uniformity (Cu)	1.57	≤ 4
6	Coefficient of curvature (Cc)	1.05	1 – 4

[Wasiu and Baba, 2020]



Figure 3: Freshly molded concrete hollow block (CHB) and sandcrete hollow blocks (SHB)

RESULTS AND DISCUSSION

Compressive Strength of Hollow Blocks

The compressive strength of each sample Sandcrete Hollow block was determined using the 2000kN compression testing machine in the ABUAD Concrete Laboratory. The weight of the block samples was recorded and tested at 7, 14, 21 and 28 days respectively. The loading rate for the Sandcrete and Concrete blocks are respectively 6,900kN/sec and 13,500kN/sec. Tables 4 and 5 shows the compressive strength test results for SHB (Sandcrete hollow blocks), CHB (Concrete hollow blocks) and blocks from different locations (SHB only) in Ado-Ekiti, Nigeria. The CHB specimen tends to have higher strength value than SHB of the same size. The coarse aggregates present in the CHB mix gave additional strength and increase resistance to applied load. Figures 4 and 5 shows the plot of the compressive strength of against the curing age. The figures revealed an increase in strength with curing age for all specimens. From the graph, Sandcrete blocks (9 inch) collected from Bashiri (BI) block industry have the lowest compressive strength of 0.33MPa and with Ilawe block industry recording the highest compressive strength of

1.5MPa. The laboratory control samples (SHB) yielded a better strength of 2.47MPa which is in consonance with NIS 87: 2007 which specifies strength range of 2.5-3.45MPa. The concrete blocks (CHB) on the other hand recorded an average strength of 6.16MPa at 28 days curing. Similarly, for the 6 inch Sandcrete blocks samples collected; the lowest compressive strength of 0.36MPa was recorded in Ilawe (IL) with the highest being 1.27MPa recorded in Ikere (IK) block industry and the laboratory produced sample yielded 2.24MPa. The 6 inch concrete blocks (CHB) produced gave an average strength of 4.73MPa. These values of strength obtained both for the 9 and 6 inches sandcrete blocks (SHB) were far below the standard specification of NIS 87:2007 and as such yielded a poor quality product. These results are also in consonance with the results obtained by other researchers in Nigeria. But, strengths of samples of SHB and CHB produced as control are within specification. The low compressive strengths of the collected sandcrete samples is attributed to poor practices and greed to maximize profit by adopting mix ratio that are out of the standard practice in Nigeria. This out of standard mix limit the cement content

in the sancrete blocks produced thereby lowering the strength beyond acceptable range. This corrupt practices by block industries owners have led to collapse of walls, fences and even an entire

building. Poorly graded sand from burrow pit have also contributed to the low compressive strength. Also, the block industries owner never bother on testing soil samples before use.

Table 4: Compressive Strength of 9 Inch SHB from different locations and CHB

Days	POL	BI	IK	IL	ADE	Expt. SHB	Expt. CHB
(MPa)							
7	0.44	0.22	0.66	1.06	0.44	1.18	3.51
14	0.53	0.29	0.79	1.15	0.57	1.59	5.09
21	0.62	0.32	0.97	1.23	0.66	2.00	5.69
28	0.66	0.33	1.19	1.50	0.70	2.47	6.16

Table 5: Compressive Strength of 6 Inch SHB from different locations and CHB

Days	POL	BI	IK	IL	ADE	Expt. SHB	Expt. CHB
(MPa)							
7	0.48	0.27	0.9	0.18	0.24	0.63	3.95
14	0.48	0.36	1.02	0.27	0.27	1.48	4.40
21	0.59	0.42	1.12	0.31	0.36	1.96	4.41
28	0.6	0.48	1.27	0.36	0.42	2.24	4.73

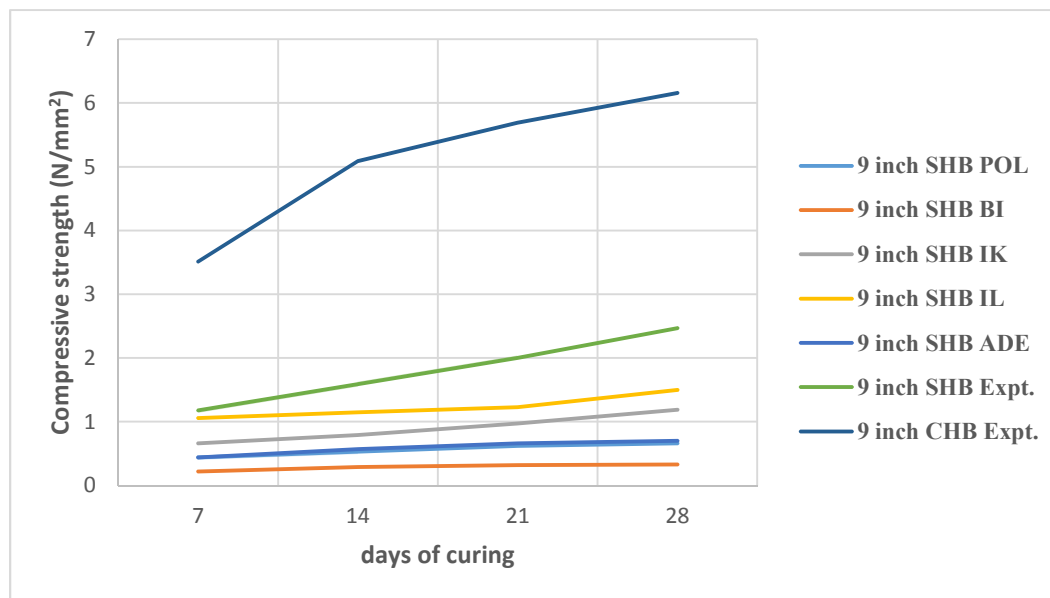


Figure 4: Compressive strength of 9 inch samples collected, SHB and CHB samples molded

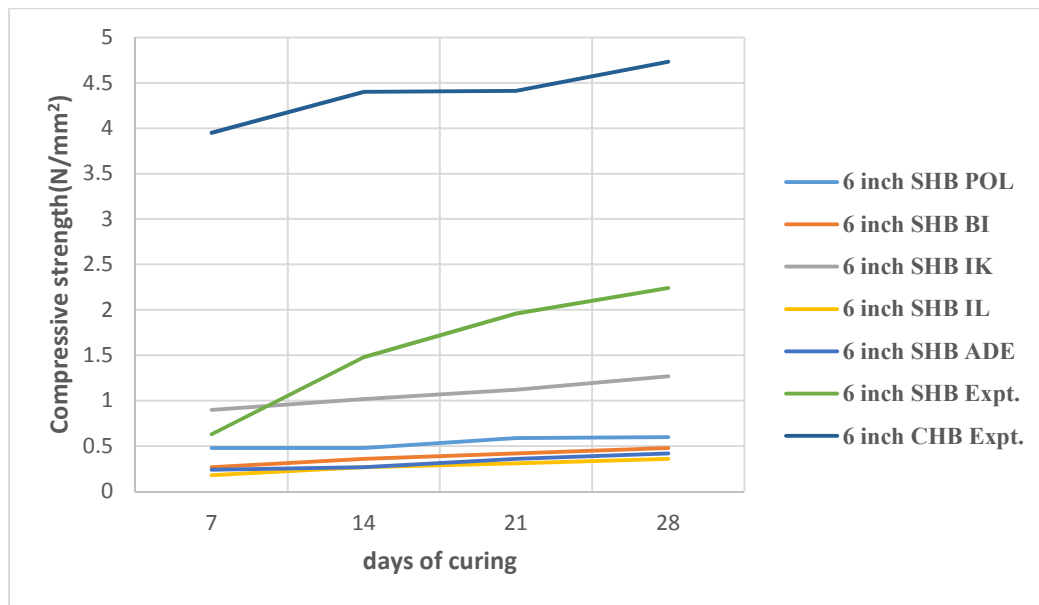


Figure 5: Compressive strength of 6 inch samples collected, SHB and CHB samples molded

WATER ABSORPTION TEST

To obtain the absorption capacity of each sample, their initial dry weight, $W_1(g)$ was recorded using the weigh balance. The samples was then soaked in water for 24 hours and weighed as $W_3(g)$. The water absorption is thus calculated from;

$$\frac{(W_3 - W_1)}{W_1} \times 100$$

The results for the water absorption is presented in Tables 6 and 7. From the Tables, the water absorption was higher for the 6 inch SHB. The range is about 3.4 -21.3% with Bashiri (BI) block industry recording the highest value. The control sancrete blocks recorded a low absorption of 4.4% and the CHB 5.2%. This indicates a good quality control of production. The water absorption for the 9 inch sandcrete blocks (SHB) ranges between 6.3-14.2% while the controlled samples of SHB and CHB ranges between 5.4-5.9%. Generally, the average water absorption of the 9 inch sancrete blocks are much lower than the 6 inch sancrete blocks.

IMPACT TEST

Impact test is simply a measure of the brittleness of the material in particular its sensitivity to the notch effect. The impact test was performed by lifting the sample to a height of approximately 1m and then released. The largest part of sample after release was recorded as W_2 . If the initial weight of the sample is W_1 , the loss of weight is calculated from;

$$\frac{(W_1 - W_2)}{W_1} \times 100$$

The loss of materials measured by impact test in Tables 6 and 7 revealed poor resistance of SHB units to impact load except for Ikere (IK) block industry with above average impact (56.5% i.e loss at impact of 43.5%). Most blocks produced within the Ado-Ekiti metropolis are of poor quality. This assertion is line with results obtained from the compressive strength tests. The Controlled specimens have better impact resistance.



Table 6: Impact resistance and Water absorption for 6 inch SHB and CHB

6 inch	SHB					Expt.	Expt.
	POL	BI	IK	IL	ADE	SHB	CHB
W_1	17.4	15.5	17.7	18.3	16.8	18.2	19.3
W_2	2.5	2.3	10	7.1	3.6	8.3	15
W_3	20.3	18.8	18.3	19.6	18.2	19	20.3
% loss	85.6	85.2	43.5	61.2	78.6	54.4	22.3
W_a (%)	16.7	21.3	3.4	7.1	8.3	4.4	5.2

Table 7: Impact resistance and Water absorption for 9 inch SHB and CHB

9 inch	SHB					Expt.	Expt.
	POL	BI	IK	IL	ADE	SHB	CHB
W_1	22.5	23.5	24	24.9	22.3	21.9	22.2
W_2	2.8	3.4	6.7	8.2	4.5	9.2	15.1
W_3	25.7	25.2	26.2	26.6	23.7	23.2	23.4
% loss	87.6	85.5	72.1	67.1	79.8	58.0	32.0
W_a (%)	14.2	7.2	9.2	6.8	6.3	5.9	5.4

CONCLUSION

The following conclusions can be made from the research:

1. The average compressive strength of sandcrete blocks manufactured in Ado-Ekiti metropolis are below standard with high water absorption and low impact resistance capacity. This may lead to infrastructural failure if not addressed in a swift manner;
2. Due to ignorance and greed, most sandcrete block manufacturer do not comply with the NIS 87: 2007;
3. The use of concrete blocks can be encouraged while addressing non-compliance with the production of sandcrete block;
4. There is need for the Federal Government to empower the NIS and SON to sanction or blacklist those block industries not keeping to standard practices of production of sandcrete blocks;
5. Block industries owner are to set up a mini laboratory unit for testing their products before entering into the market. This will help to prevent sub-standard units which can pave way to cracks and even to collapse. They are to engage in practice of searching for the best burrow pits for their fine aggregates (river sand);
6. The control samples produced yielded a better average compressive strength, high impact resistance and low water absorption which are in consonance with standard specification of NIS. This is an indication that block industries owner can actually do same if the SON, NIS are empowered to sanction poor quality.

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