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Research Paper

EVALUATION OF THE COMMERCIALLY PRODUCED SEA SAND SANDCRETE HOLLOW BLOCKS' COMPRESSIVE STRENGTH AND STRUCTURAL CONFORMITY: A case study of Sandcrete blocks produced in Sangana- Akassa, Nigeria

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ABSTRACT
This research paper is presented to ascertain the compressive strength of block samples that were obtained as well as the extent of structural compliance of commercially produced sandcrete blocks in Sangana- Akassa due to reports of poor sandcrete blocks available for builders. A 160 number of 225mm hollow sea sand sandcrete block samples were obtained from 10 sandcrete block producing companies in Sangana coordinates 4.3839^{0}N, 5.9938^{0}E. The hollow sandcrete block manufacturers provided samples of sea sand in addition to the hollow sandcrete blocks produced from sea sand. The sand samples underwent sieve analysis, and the resulting Sandcrete block samples' dimensions, density, and water absorption were measured. Tests of compressive strength were conducted at 7 and 14 days of curing age. Results suggest that the sea sand fine aggregates used were not acceptable for block manufacturing as the coefficient of uniformity of sand samples range from 0.71 – 1.89 while the coefficient of curvature lay within 2.57 to 4.80 which do not correspond to standard. As reported by the Nigeria Industrial Standard (NIS), none of the companies that produce sandcrete blocks satisfy the required minimum dimensions. The test findings additionally demonstrated that, with the exception of block industry M, which recorded 12.08%, all collected block samples had water abortion capacities below the 12% maximum recommended by NIS. The density exceeded the 1.5 g/cm^3 NIS stipulated, ranging from 1.59 to 5.05 g/cm^3. The average compressive strength at 14 days of curing age ranged from 0.21 N/mm^2 to 1.11 N/mm^2, which was lower than the 3.45 N/mm^2 that the NIS had stipulated. Block-producing enterprises were advised to adhere to the suggested standard dimensions by conducting regular inspections by the Nigerian Standard Organization.

Keywords*: Sandcrete block, Compressive strength, Sieve analysis, Water Absorption*

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I. INTRODUCTION

Every stakeholder in Nigeria is concerned about the frequent failure of buildings. There have been previous reports of building collapses in Nigeria that have claimed lives and destroyed property (Fakere et al., 2012). The need for building materials to meet minimal requirements stems from the worldwide concern over the abrupt collapse of buildings, particularly in Nigeria (Oyekan and Kamiyo, 2008).

Sometimes, cracks and other flaws cause the building to lose its aesthetic appeal even when it hasn't collapsed completely. This problem is partially caused by the poor quality of the Sandcrete blocks that were utilized to build the walling units. Since raw materials for its production are readily available in Africa, sandcrete blocks are widely employed in many countries worldwide. In Nigeria, 90% of homes are made with sandcrete blocks, making them the most often utilized walling material (Baiden and Tuuli, 2004).

Sandcrete blocks account for a significant portion of building construction costs throughout the majority of Nigeria (Oyekan and Kamiyo, 2008). For this reason, sandcrete blocks are an essential component in building construction. Cement, water, and natural sand are the ingredients of sandcrete blocks (Barry, 1969). Cement, which is used as a binder, is the most expensive component in the production of sandcrete blocks, according to Oyetola and Abdulahi (2006).

Sand (fine aggregate) and cement are combined in a certain ratio to form the fundamental composition of sandcrete blocks. Water is added to the mixture in different quantities to attain the required standard strength (Jackson and Dhir, 1998; Hamza and Yusuf, 2011; NIS 87:2007; Vallenger, 1971).

Sandcrete blocks can be used to build both load-bearing and non-load-bearing walls because, when manufactured in accordance with specified specifications, they have a moderate compressive strength that allows them to withstand seismic and vibration effects. For a considerable amount of time, sandcrete blocks have been produced throughout Nigeria without regard for local construction codes or high-quality workmanship (Oyekan and Kamiyo, 2008).

As a result, organizations have been established to regulate the manufacturing of sandcrete blocks; one such organization is the Standards Organization of Nigeria (SON). The Nigerian Standards Organization has created standards for sandcrete block testing in Nigeria to conform to international standards. In doing so, the Nigerian Industrial Standard (NIS 87:2007) was formulated, which allowed for the regulation of the production of sandcrete blocks.

Numerous investigations on the quality of these blocks (Ejeh and Abubakar, 2008; Ewa and Ukpata, 2013; Onwuka et al., 2013) show that the majority of the sandcrete hollow blocks produced by commercial block production enterprises for River sand and Sea sand in Nigeria had a 28 days strength in the range of 0.50 - 1.5 N/mm^2).

These studies identified a number of causes for the industrial manufacturing of inferior sandcrete hollow blocks. The primary causes cited were inadequate curing, poor craftsmanship, and an improper cement to sand mix ratio. According to Tsado and Yewa (2013), the production of hollow sandcrete blocks by Nigerian block industries, specifically in Sangana - Akassa, falls short of standards, leading to construction failure. This could be caused by a variety of factors, including mix proportion and production processes that are not followed in compliance with NIS 87:2007. According to Yusuf (2010), the compressive strength of sandcrete blocks is a function of the load-bearing area and is determined by the as-cast surface. Therefore, the purpose of this study is to examine the degree of compliance with size and strength standards of sandcrete block companies in Sangana-Akassa metropolitan.

II. METHODOLOGY

16 number of 225mm hollow sandcrete blocks samples were procured from ten distinct Sangana-based block production companies at three days of curing age. Each block sample was created using sand samples that were gathered and subjected to a particle size distribution analysis at the Niger Delta University Laboratory in compliance with BS 882: 1992. These blocks were made by vibrating and using a mechanical compaction process. According to NIS, a Vanier caliper was used to measure the blocks' overall dimensions as well as the thickness of the web.

At 7 and 14 days after the start of the curing process, the density, water absorption, and compressive strength were measured using the NIS testing procedures.

III. RESULTS AND DISCUSSION

3.1 PARTICLE SIZE DISTRIBUTION OF FINE AGGREGATE

Figure 1 displays the fine aggregate particle size distribution curve that was collected from ten (10) block production facilities.

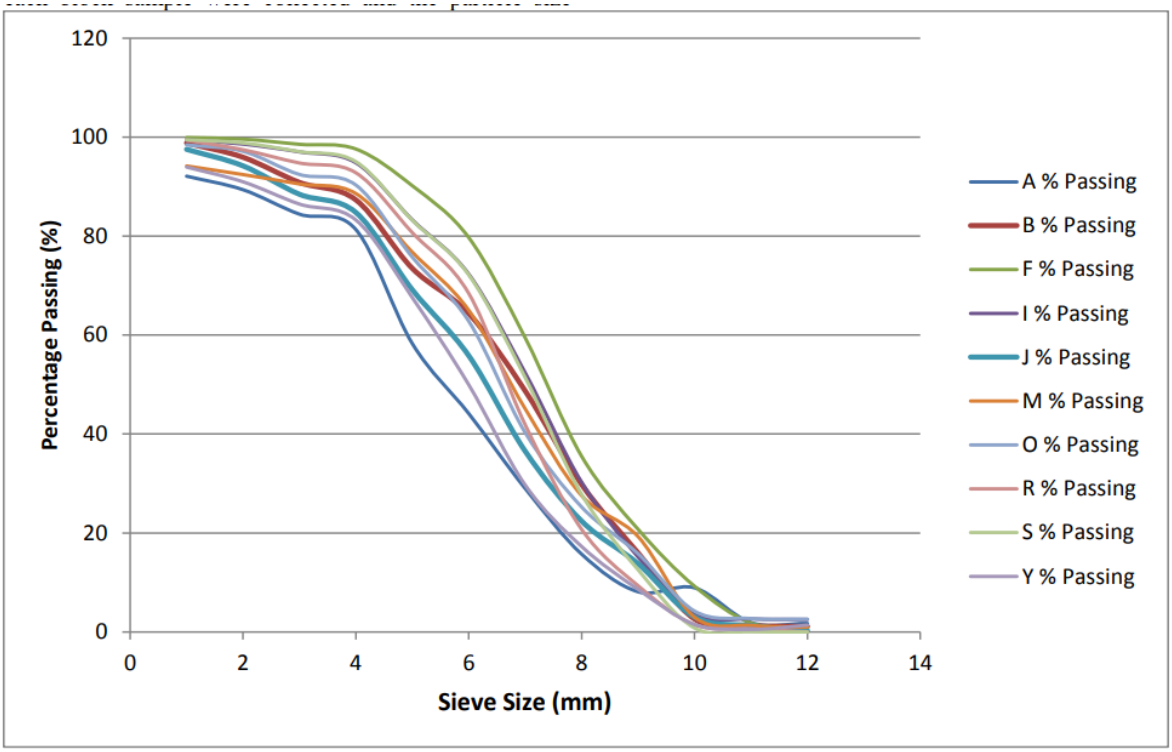

Figure 1: Particle Size Distribution Chart of the Sand Samples Collected

The fine aggregates utilized are unsuitable for block construction, according to test results. All sand samples have a coefficient of homogeneity between 0.71 and 1.89 and a coefficient of curvature between 2.57 and 4.80.
According to the unified soil classification system, the coefficient of uniformity should equal or exceed 6 whereas the coefficient of curvature should fall between 1 and 3.
Given that there is a large variance in the grain size of the sand used by all sandcrete block companies, it is implied that the sand is not well graded.

3.2 BLOCK DIMENSIONS

Table 1 displays the dimensions of the hollow sandcrete blocks that were obtained. According to NIS 87: 2007, a 225mm hollow sandcrete block should measure 450 x 225 x 225 mm, with a 50mm web thickness.
With the exception of Block Company A, which recorded 53.8mm, all samples that were collected had web thicknesses less than 50mm, which is the acceptable web width for 225mmh hollow sandcrete blocks (NIS 87: 2007). Smaller web thicknesses in block samples could save materials, but this lessens the effective area needed to withstand weights. According to NIS 87: 2007, a 225mm hollow sandcrete block should have a width of 225mm. Every block satisfies the minimal width prerequisite. A 225 mm hollow sandcrete block should be 450 mm long. Only three manufacturers that make blocks meet this criterion, however they don't meet the web thickness requirement. This implies that every manufacturing facility made an effort to reduce the amount of material required for block molding, hence decreasing the compressive strength of the block.

Table 1: Dimensions of 225mm block samples from various industries

NAME OF BLOCK INDUSTRY	SAMPLE ID. NO.	BLOCK LENGTH (mm)	Breadth of block (mm)	Height of block (mm)	Web thickness of block (mm)
	A1	353	234	210	53
	A2	357	232	210	54
	A3	351	230	213	54
	A4	356	232	212	53
A	A5	357	233	211	55
Average	**An**	**354.8**	**232.2**	**211.2**	**53.8**
	B1	360	222	223	33
	B2	357	235	225	32
	B3	356	235	224	33
	B4	342	234	221	32
B	B5	378	231	222	35
Average	**Bn**	**358.6**	**231.4**	**223**	**33**
	F1	375	245	222	47
	F2	357	230	220	46
	F3	357	231	221	45
	F4	361	221	222	47
F	F4	375	245	223	42
Average	**Fn**	**365**	**234.4**	**221.6**	**45.4**
	I1	447	234	228	40
	I2	460	237	227	39
	I3	447	236	227	38
	I4	463	235	221	40
I	I5	467	234	225	41
Average	**In**	**456.8**	**235.2**	**225.6**	**39.6**
	J1	470	245	213	45
	J2	460	225	207	35
	J3	452	265	216	38
	J4	434	265	223	44
J	J5	446	241	212	42
Average	**Jn**	**452.4**	**248.2**	**214.2**	**40.8**
	M1	364	239	230	50
	M2	358	230	225	48
	M3	356	231	230	49
	M4	364	239	224	50
M	M5	356	230	223	47
Average	**Mn**	**359.6**	**233.8**	**226.4**	**48.8**
	O1	360	230	220	45
	O2	455	227	215	46
	O3	447	241	215	45
	O4	365	239	220	45
O	O5	347	251	221	35
Average	**On**	**394.8**	**237.6**	**218.2**	**43.2**

	R1	372	233	220	42
	R2	357	230	220	42
	R3	368	231	220	39
	R4	390	232	240	41
R	R4	373	229	220	35
Average	**Rn**	**372**	**231**	**224**	**39.8**
	S1	358	225	208	43
	S2	370	235	233	45
	S3	357	236	208	44
	S4	368	233	216	43
S	S5	370	224	223	50
Average	**Sn**	**364.6**	**230.6**	**217.6**	**45**
	Y1	465	240	220	43
	Y2	467	243	220	45
	Y3	459	235	221	38
	Y4	460	345	226	45
Y	Y5	469	240	228	46
Average	**Yn**	**464**	**260.6**	**223**	**43.4**

3.3 . WATER ABSORPTION CAPACITY

Table 2 shows the block samples water absorption capability. With the exception of block firm M, which recorded 12.08%, all collected block samples had water absorption capacities below the maximum amount of 12% defined by NIS: 87:2007. Inadequate compaction, improper mix ratio, insufficient drying, or insufficient cement in the sandcrete mix can all contribute to high water absorption capacity.

Table 2: Results of Water-absorption test on the Sandcrete blocks

NAME OF BLOCK INDUSTRY	Dry weight of the block (kg)	Weight of the block after soaking for 24Hrs in water	Water Absorption (%)
Industry A	23.020	25.170	9.340
Industry B	23.340	25.320	8.480
Industry F	21.270	22.860	7.480
Industry I	21.450	23.270	8.520
Industry J	22.540	22.680	5.230
Industry M	21.350	23.930	12.080
Industry O	19.130	22.000	8.520
Industry R	22.760	25.030	9.910
Industry S	22.100	23.920	8.230
Industry Y	24.210	26.350	8.830

3.4 : Compressive Strength

Figures 2 and 3 display the findings of the compressive strength test conducted on the resulting sandcrete blocks.

The results showed that the compressive strength of the obtained hollow sandcrete blocks increased with the curing age. Hollow sandcrete blocks collected at 14 days of curing age had an average compressive strength that ranges from 0.21 N/mm^2 to 1.11 N/mm^2. These values are less than the 3.45 N/mm^2 NIS suggested value for load-bearing hollow sandcrete blocks.

This might be the result of the sandcrete blocks' thinner webs. The use of quarry dust as fine aggregate was noted for block industry B, and the hollow sandcrete blocks from this industry had the highest average compressive strength (1.11 N/mm2). This is likely because the quarry dust (granite dust) and cement form a strong bond and because the quarry dust fills in the void spaces in the hollow sandcrete blocks.

The sandcrete blocks that were collected had an average density that falls between 1.5 to 5.048 grams per cent, meeting the NIS standard value of 1.5 grams per cent.

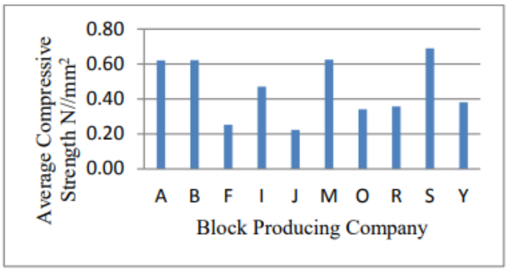

Figure 2: Compressive strength of collected sandcrete block samples at 7 days curing age

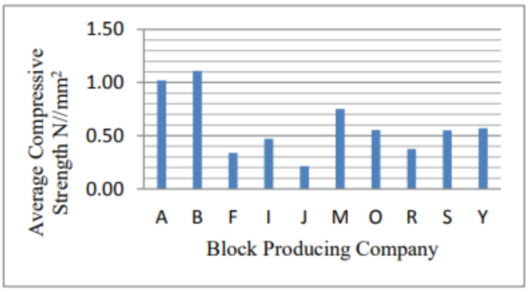

Figure 3: Compressive strength of collected sandcrete block samples at 14 days curing age

IV. CONCLUSIONS

The findings of this investigation motivated the following conclusions:

1) Considering the aggregates used in all of the categories under investigation do not meet the grading requirements outlined in BS 882: 1992, they are not appropriate for use in block making.

2) Building defects including cracks and other deformations potentially arise while the blocks obtained from the block-making industries do not meet the block dimensions as described in NIS 87:2007.

3) The blocks' average compressive strength is less than the 3.5N/mm2 specified by the NIS. This is because there is a reduction in both the net area needed to resist loads and the volume of material needed to support loads. To assist in regulating some of the sharp practices in the industry, it is advised that all parties involved in building construction regulation, such as the Council for the Regulation of Engineering in Nigeria (COREN), the Nigeria Society of Engineers (NSE), the Association of Builders, etc., communicate with the association of sandcrete block producers.

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