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Quality Assessment of Hollow Sandcrete Blocks in Minna, Nigeria

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***Abstract*—**The properties of hollow sandcrete blocks produced in Minna, Nigeria are presented. Sandcrete block is made of cement, water and sand binded together in certain mix proportions. For the purpose of this work, fifty (50) commercial sandcrete block industries were visited in Minna, Nigeria to obtain block samples and aggregates used for the manufacture, and to take inventory of the mix composition and the production process. Sieve analysis tests were conduction on the soil sample from various block industries to ascertain their quality to be used for block making. The mix ratios were also investigated. Five (5) nine inches (9" or 225mm) blocks were obtained from each block industry and tested for dimensional compliance and compressive strength. The results of the soil test shows that the grading fall within the limit for natural aggregate and can easily are used to obtain workable mix. Physical examinations of the block sizes show slight deviation from the standard requirement in NIS 87:2000. Compressive strength of hollow sandcrete blocks in range of 0.12 N/mm^2 to 0.54 N/mm^2 was obtained which is below the recommendable value of 3.45 N/mm^2 for load bearing hollow sandcrete blocks. This indicates that these blocks are below the standard for load-bearing sandcrete blocks and cannot be used as load bearing walling units. The mix composition also indicated low cement content resulting in low compressive strength. Most of the commercial block industries visited does not take curing very serious. Water were only sprinkled ones or twice before the blocks were stacked and made readily available for sale. It is recommended that a mix ratio of 1:4 to 1:6 should be used for the production of sandcrete blocks and proper curing practice should be adhered. Blocks should also be cured for 14 days before making them available for consumers.

***Keywords*—**Compressive strength, dimensions, mix proportions, sandcrete blocks.

I. Introduction

BUILDINGS are constructed primarily to meet one of the physical needs of shelter. Shelter is the third human needs after food and water because it offers an appreciable protection for man and his belongings, other living things and nonliving things, equipment needs for his daily living. One of the major challenges and problems identified in the developing countries is provision of shelter. There is need to make housing affordable and accessible to the people to overcome this challenge [1], [2]. This situation can be addressed by paying attention to low-cost alternative building materials. Sandcrete blocks forms a significant cost component in building structures [3]. This makes sandcrete blocks a very important material in building construction. The word sandcrete has no standard definition, what most people have done was to define it in a way to suit their own purpose. Generally, sandcrete block can be described as a walling unit produced from sand, cement and water [1]-[4]. It is widely used in Nigeria as a walling unit. Blocks are used in the construction of wall and partitions. The range of minimum strength specified in [4] is between 2.5 N/mm^2 for non-load bearing blocks to 3.45 N/mm^2 for load bearing blocks. The dimensions for load bearing blocks shall be a length of 450mm, width of 225, height of 225mm, and web thickness of 50mm [4].

Hollow sandcrete blocks are used extensively in many countries of the world especially in Africa due to the availability of raw materials. In most part of Nigeria, sandcrete blocks forms one of the major cost component of building structures [3]. Sandcrete blocks possess a moderate compressive strength that make them to withstand any tragedy such as seismic or vibrating activities, if produced based on the standard requirement. Substandard blocks results into irregular cracks and improper finishing in buildings. Sandcrete blocks are available for the construction of load bearing and non-load bearing structure. Load bearing blocks must conform to building by law as regard to their crushing. Sandcrete blocks participate mainly in the task of transforming the actual load from the overlaying structural element to the foundation. Load bearing walls are acting as support for the whole structure to transmit the weight to the ground surface underneath it for stability [4]. For a long time in Nigeria, sandcrete block are manufactured in many parts of the country without any reference to suit local building requirement or good quality work [3]. In all production processes, the product has variability. The variability may be in the quality of the product as measured by its compressibility or it may be in its yield as measured in units or by the percentage of material produced in a given batch. There are however, some problems of variations in the quality of raw materials used, the mixing and molding procedures and the general quality of the finished product. These problems necessitated the need for the evaluation of sandcrete blocks in Minna to ascertain their suitability for construction work.

II. Materials and Methods

A. Materials

The materials used for this work are essentially sand and

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commercial sandcrete blocks produced in Minna, Nigeria.

B. Methods

Observations and laboratory tests were used in the course of the study. Observations carried out included the batching process, the curing method and the numbers of days blocks were cured before stacking. In the laboratory work, the following tests were carried out sieve analysis of sand, dimensional checks, and compressive strength test [4]. Five (5) sample blocks were obtained from each commercial producer.

III. Results and Discussions

The results obtained from this study are as follows.

A. Sieve Analysis

The results of sieve analysis of the sand carried out are shown in Table I. Test results shows that the grading of the sand fall within the limit required by BS 882: 1990 [5]. The sand particles generally satisfy the grading requirement of overall grading and fall in one of the classification of coarse grading, medium grading or fine grading. This clearly indicates that the quality of the aggregates used for the production of sandcrete blocks in Minna, Nigeria are of good quality in terms of grading and workable mix can easily be achieved to obtain high quality product [1]. This is in line with the earlier findings of [6] on the quality of fine aggregates in Minna, Nigeria.

B. Block Dimensions

The dimension of the hollow sandcrete blocks used can be found in Table II. The ranges of the block dimensions are length of 460mm, width from 210mm to 235mm, height from 200mmto 235mm, and web thickness from 40mm to 60mm. The length is higher than 450mm [4] by 10mm. This implies that the possibility of failure of the block section is higher when 460mm block is used resulting into more material waste as the failed section has to be removed completely during repairs. Recommended web thickness is 50mm. Most of the web thicknesses are less than 50mm. Block samples with smaller web thickness may save materials but this result into low compressive strength as the effective area available to carry the load is reduced. The recommended width of the block is 225mm. All the blocks except number 2 meet up with the minimum width requirement.

C. Mix Proportions

For all the hollow sandcrete blocks industries visited the mix proportions used were in the range of 1:7 to 1:16 (Table II); that is one part of cement to certain parts of fine aggregates. These values are far above the recommended mix proportion for load-bearing hollow sandcrete blocks [4]. There is inadequate cement in mortar mix thereby not capable of binding the fine aggregate together to obtain high strength as expected. Better mix ratios are therefore recommended. A value of 1:6 is recommended in [4] NIS 87: 2000 and 1:4 is mainly recommended for most mortar as rendering which by implication can also be used for sandcrete blocks [7], [8].

D. Compressive Strength

The result of compressive strength performed on the fifty (50) blocks industries are shown in (Table I). The values indicated are average from five block samples. The compressive strength of the sandcrete block ranges between 0.12 N/mm^2 to 0.54 N/mm^2. These values fell far below the standard prescribed for load bearing hollow sandcrete block. Nigeria Industrial Standard [4] specifies that the lowest compressive strength of individual load bearing block should not be less than 2.5 N/mm^2 and average compressive strength of five-load bearing blocks should not be less than 3.45 N/mm^2.

The result also indicated poor quality control in the sense that the strength result showed wide variation within the same lot. The block industry should normally use potable drinking water from tap, which is recommended for construction work [9]. To obtain good quality sandcrete block it is essential that the constituent material should be selected with care. Otherwise, segregation would occur and eventually result to low strength. Base on interview conducted with the manufacturers, it was observed that the curing was not properly done by the producer. The blocks were produced and left in the open air; the water sprinkled on them was not adequate. Most blocks sold had not been cured for 14 days because of high demand, resulting in low compressive strength. All the blocks were ready for sale at 3 to 5 days after casting. Mixing ratios were not base on the standard. The averages of various compressive strengths are plotted against block industries as shown in Fig. 1. Fig. 1 shows clearly the deviation of the value of compressive strength from standard and non-uniformity of the value of compressive strength obtained due to indiscriminate mix proportion used in the production of the blocks.

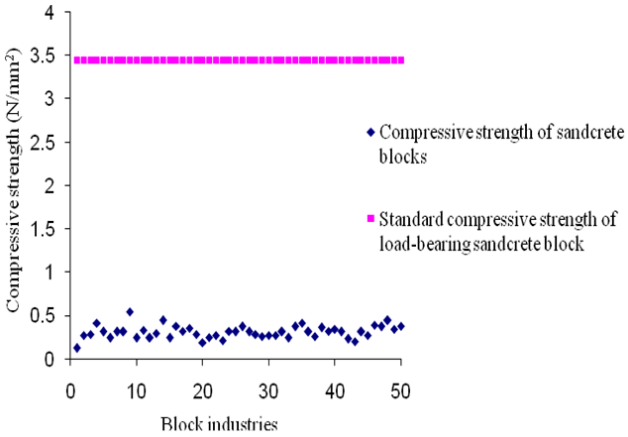

Fig. 1 Comparison of compressive strength with the standard

TABLE I
SIEVE ANALYSIS OF SAND

BS sieve size (mm)	% Passing						BS sieve size (mm)	% Passing							
	1	**2**	**3**	**4**	**5**	**6**		**7**	**8**	**9**	**10**	**11**	**12**		
5.00	81.68	85.58	84.68	84.80	84.60	83.92	5.00	87.36	88.54	96.82	97.3	97.52	96.98		
3.35	76.12	82.06	77.10	83.08	77.78	78.90	3.35	83.94	84.58	94.28	92.9	90.8	93.14		
2.36	69.29	75.90	62.39	80.68	65.02	71.03	2.36	78.72	80.04	86.4	88.4	69.46	88.44		
2.00	66.32	71.62	55.90	79.16	58.78	66.64	2.00	71.44	76.62	81.34	85.04	58.22	85.56		
1.18	52.35	54.02	35.45	67.86	38.62	47.99	1.18	55	66.46	61.76	71.28	36.34	72.4		
0.850	42.22	43.80	26.14	58.54	29.90	36.16	0.850	42.58	56.84	49.4	62.9	27.22	63.28		
0.600	27.60	32.56	16.43	44.30	21.10	23.83	0.600	35.64	41.86	35.36	50.72	19.42	50.72		
0.425	17.53	23.82	10.72	31.60	14.88	16.02	0.425	32.64	28.26	25.02	38.06	14.08	37.84		
0.300	10.71	17.72	7.31	22.42	9.86	11.31	0.300	18.58	18.28	17.86	24.28	10.6	24.48		
0.150	2.74	9.70	3.82	10.88	3.32	3.22	0.150	9.56	6.34	8.52	8.22	5.42	8.64		
0.075	0.92	5.04	2.53	5.98	1.46	1.19	0.075	1.88	2.90	4.20	4.32	2.72	4.96		
Pan	0.00	0.00	0.00	0.00	0.00	0.00	Pan	0.00	0.00	0.00	0.00	0.00	0.00		
	13	**14**	**15**	**16**	**17**	**18**		**19**	**20**	**21**	**22**	**23**	**24**		
5.00	84.5	94.7	86.94	85.96	93.20	92.16	5.00	87.66	91.30	90.58	82.64	85.58	85.46		
3.35	74.72	91.64	79.28	85.00	89.80	88.56	3.35	83.68	88.36	84.20	75.56	82.06	82.72		
2.36	58.84	83.76	67.52	80.48	82.86	81.32	2.36	76.12	81.58	76.48	63.74	75.91	79.82		
2.00	49.82	78	60.72	77.50	77.64	76.28	2.00	72.12	76.94	64.00	58.6	71.63	78.6		
1.18	29.34	56.54	40.20	61.80	59.64	59.56	1.18	57.66	60.80	55.26	36.6	54.04	69.00		
0.850	20.32	44.18	29.82	51.88	47.26	48.46	0.850	48.86	51.10	44.70	26.7	43.82	60.72		
0.600	12.68	31.14	19.86	37.36	32.06	35.62	0.600	37.44	35.90	29.22	16.6	32.59	48.32		
0.425	7.76	22.22	13.12	24.36	20.14	25.28	0.425	25.54	21.78	20.10	10.72	23.86	34.18		
0.300	4.48	16.1	8.32	13.80	11.92	17.94	0.300	14.62	12.14	15.68	7.34	17.66	23.48		
0.150	2.12	8.58	2.74	4.20	3.80	8.04	0.150	5.40	4.06	10.90	3.68	9.65	10.68		
0.075	1.76	3.74	0.72	1.72	1.38	3.68	0.075	2.08	1.42	4.12	2.42	4.99	5.2		
Pan	0.00	0.00	0.00	0.00	0.00	0.00	Pan	0.00	0.00	0.00	0.00	0.00	0.00		
	25	**26**	**27**	**28**	**29**	**30**		**31**	**32**	**33**	**34**	**35**	**36**		
5.00	81.08	76.14	84.62	92.38	88.36	83.16	5.00	84.39	79.89	75.47	81.25	88.36	86.99		
3.35	72.6	64.96	77.34	89.66	86.55	79.83	3.35	74.53	73.91	70.31	75.06	86.54	83.56		
2.36	61.72	52.24	63.88	84.26	81.33	74.64	2.36	60.77	66.26	65.55	66.04	81.32	76.53		
2.00	56.96	45.8	57.42	68.08	78.06	71.36	2.00	54.86	61.49	63.22	61.37	78.06	72.65		
1.18	39.82	26.36	40.36	62.92	67.57	59.54	1.18	37.10	44.62	54.24	43.38	67.56	55.31		
0.850	30.94	16.52	32.2	49.68	62.01	51.33	0.850	28.03	34.75	45.15	34.58	62.00	44.20		
0.600	20.2	7.2	22.12	38.74	52.07	40.27	0.600	18.19	24.02	29.65	25.61	52.06	31.73		
0.425	11.7	3.38	15.8	33.48	40.45	28.86	0.425	11.65	16.33	15.75	19.04	40.44	21.73		
0.300	6.54	2.36	11.22	21.66	29.35	17.03	0.300	6.67	11.06	7.40	13.63	29.33	14.55		
0.150	2.12	0.84	5.94	15.8	11.14	5.16	0.150	1.82	4.29	2.74	4.48	11.12	6.68		
0.075	1.4	0.36	3.7	7.84	3.430	2.06	0.075	0.69	0.92	1.32	1.40	3.43	3.05		
Pan	0.00	0.00	0.00	0.00	0.00	0.00	Pan	0.00	0.00	0.00	0.00	0.00	0.00		
	37	**38**	**39**	**40**	**41**	**42**		**43**	**44**	**45**	**46**	**47**	**48**	**49**	**50**
5.00	88.37	86.94	97.22	90.34	92.26	97.36	5.00	92.26	94.08	98.86	95.36	96.28	97.18	91.32	91.36
3.35	87.22	82.77	93.72	87.40	88.58	93.12	3.35	88.58	86.20	94.08	90.76	93.78	91.44	86.51	89.47
2.36	83.87	75.93	84.04	85.54	79.36	84.06	2.36	81.36	72.30	84.02	82.98	86.12	80.56	86.44	80.26
2.00	80.06	71.61	78.32	80.24	74.30	78.00	2.00	76.36	64.26	77.72	78.54	80.88	74.76	79.34	75.42
1.18	62.59	56.13	56.24	60.86	54.64	55.88	1.18	58.64	40.18	66.94	61.68	66.18	52.12	62.70	54.67
0.850	52.26	45.98	44.00	49.80	42.30	42.98	0.850	44.36	29.18	55.70	51.78	54.20	37.10	47.96	42.27
0.600	41.27	33.08	30.68	38.06	29.22	28.96	0.600	37.88	19.48	43.18	40.48	40.52	20.52	40.05	30.23
0.425	32.23	23.70	20.98	29.60	20.40	19.86	0.425	32.62	13.32	34.34	31.14	30.88	12.08	27.61	19.64
0.300	25.51	16.83	14.50	23.48	14.66	14.22	0.300	28.86	9.46	27.94	23.24	23.44	7.26	24.37	14.76
0.150	16.19	8.39	6.30	16.52	7.94	7.24	0.150	22.14	4.44	19.04	11.04	14.44	4.66	15.63	7.98
0.075	9.21	4.08	3.18	13.60	4.68	3.62	0.075	2.88	1.20	14.52	4.86	10.06	3.94	14.50	4.89
Pan	0.00	0.00	0.00	0.00	0.00	0.00	Pan	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00

TABLE II
PROPERTIES OF SANDCRETE BLOCKS

S/NO	Compressive strength (N/mm^2)	Mix Proportion	Block size (mm)
1	0.12	1:7	L= 460, B= 235, H= 200, W= 41
2	0.27	1:7	L= 460, B= 210, H= 230, W= 50
3	0.28	1:7	L= 460, B= 230, H= 230, W= 50
4	0.41	1:7	L= 460, B= 230, H= 220, W= 60
5	0.31	1:7	L= 460, B= 230, H= 235, W= 50
6	0.24	1:7	L= 460, B= 225, H= 230, W= 45
7	0.31	1:8	L= 460, B= 225, H= 230, W= 45
8	0.31	1:14	L= 460, B= 230, H= 210, W= 48
9	0.54	1:12	L= 460, B= 230, H= 210, W= 48
10	0.24	1:14	L= 460, B= 230, H= 210, W= 48
11	0.33	1:12	L= 460, B= 230, H= 210, W= 48
12	0.24	1:12	L= 460, B= 230, H= 210, W= 48
13	0.29	1:12	L= 460, B= 230, H= 210, W= 48
14	0.44	1:12	L= 460, B= 230, H= 210, W= 48
15	0.24	1:16	L= 460, B= 230, H= 220, W= 45
16	0.38	1:16	L= 460, B= 230, H= 210, W= 50
17	0.32	1:12	L= 460, B= 230, H= 215, W= 42
18	0.35	1:13	L= 460, B= 232, H= 220, W= 45
19	0.28	1:10	L= 460, B= 230, H= 235, W= 45
20	0.19	1:12	L= 460, B= 230, H= 215, W= 60
21	0.25	1:12	L= 460, B= 230, H= 225, W= 60
22	0.27	1:14	L= 460, B= 230, H= 230, W= 45
23	0.21	1:16	L= 460, B= 230, H= 230, W= 40
24	0.32	1:12	L= 460, B= 235, H= 215, W= 45
25	0.31	1:12	L= 460, B= 230, H= 220, W= 43
26	0.37	1:10	L= 460, B= 230, H= 225, W= 50
27	0.31	1:10	L= 460, B= 235, H= 220, W= 50
28	0.28	1:12	L= 460, B= 230, H= 220, W= 55
29	0.26	1:12	L= 460, B= 230, H= 220, W= 50
30	0.27	1:12	L= 460, B= 235, H= 220, W= 40
31	0.27	1:14	L= 460, B= 235, H= 220, W= 45
32	0.31	1:12	L= 460, B= 235, H= 215, W= 40
33	0.24	1:13	L= 460, B= 230, H= 210, W= 55
34	0.37	1:10	L= 460, B= 235, H= 220, W= 45
35	0.41	1:12	L= 460, B= 235, H= 220, W= 50
36	0.31	1:11	L= 460, B= 235, H= 225, W= 60
37	0.26	1:12	L= 460, B= 230, H= 230, W= 45
38	0.36	1:12	L= 460, B= 230, H= 220, W= 40
39	0.32	1:14	L= 460, B= 235, H= 220, W= 48
40	0.34	1:15	L= 460, B= 235, H= 215, W= 50
41	0.31	1:15	L= 460, B= 230, H= 215, W= 46
42	0.23	1:19	L= 460, B= 230, H= 210, W= 54
43	0.20	1:14	L= 460, B= 230, H= 210, W= 36
44	0.31	1:16	L= 460, B= 230, H= 220, W= 48
45	0.27	1:13	L= 460, B= 230, H= 220, W= 45
46	0.39	1:14	L= 460, B= 230, H= 220, W= 46
47	0.37	1:16	L= 460, B= 230, H= 220, W= 38
48	0.44	1:12	L= 460, B= 235, H= 215, W= 48
49	0.34	1:14	L= 460, B= 235, H= 215, W= 50
50	0.38	1:13	L= 460, B= 235, H= 200, W= 50

Note: L= Length, B= Breadth, H= Height, and W= Web

IV. CONCLUSIONS

From the result and data obtained in this work, the following conclusions were drawn:

1. The grading of the aggregates used in the manufacture of sandcrete blocks in Minna is in accordance with the specification in BS 882:1990 and is therefore recommended for block making.
2. The dimensions of the sandcrete blocks do not comply with the standard specify in NIS 87: 2000. This has the potential of reducing the quality of the sandcrete blocks. Appropriate block dimensions should be used as specify

in [4].

3. The mix proportions used by the manufacturers are far higher than the recommended values. This means that there is less cement in the cement-mortar matrix leading to low compressive strength.mix proportion of maximum of 1:6 (one part of cement to six parts of fine aggregate) should be used for the production of sandcrete blocks.
4. The sandcrete blocks are being cured by spraying with water in the open and curing is done for maximum of 5 days before the blocks are made available for sale. Proper curing practice should be adhered to and blocks should be cured for 14 days before they are made available for sale.
5. The average compressive strength of individual block industries was ranges from 0.12 N/mm^2 to 0.54 N/mm^2. These values are below the required standard. Sandcrete blocks of minimum compressive strength of 3.45 N/mm^2 should be used as walling units in load bearing walls in building structures.

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