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Dimensional Compliance and Compressive Strength of Sandcrete Hollow Blocks Produced in Minna Metropolis

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ABSTRACT
The study was carried out to investigate the level of dimensional compliance of commercially produced sandcrete blocks in Minna metropolis and also determine the compressive strength of collected block samples. One hundred and sixty (160), nine (9) inch hollow sandcrete block samples were collected from ten sandcrete block producing companies. Fine aggregate samples were collected from the hollow sandcrete block companies along with the hollow sandcrete blocks. Sieve analysis was carried out on the soil samples. Density, water absorption and dimension of the collected Sandcrete block samples were determined. Compressive strength at 7 and 14 days curing age was also determined. Results indicate that the fine aggregates used were not suitable for block making as the coefficient of uniformity of soil samples range from 0.71 – 1.89 while the coefficient of curvature lie within 2.57 to 4.80 which do not conform to standard. None of the Sandcrete block production company met the required standard dimension as specified by Nigeria Industrial standard (NIS). Test results also revealed that the water abortion capacity of all collected block samples were below 12% maximum recommended by NIS except for block industry M which recorded 12.08%. The density was between 1.59 g/cm^3 – 5.05 g/cm^3, greater than 1.5g/cm3 specified by NIS. The average compressive strength was between 0.21N/mm2 - 1.11N/mm2 at 14 days curing age which was less than 3.45 N/mm^2 specified by NIS. It was recommended that block producing industries should be enforced by the standard organization of Nigeria to follow the recommended standard dimensions by carrying out routine check.

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

1 INTRODUCTION

The frequent failure of buildings in Nigeria is a concern to all stakeholders. In the past, incessant building failures have been reported resulting in the loss of lives and properties in Nigeria (Fakere *et al.,* 2012). The global concern for sudden collapse of buildings across the world and in Nigeria in particular demands that materials used for construction of buildings meet minimum requirement (Oyekan and Kamiyo, 2008). In some cases, even though the building has not totally collapsed, the aesthetic value is lost to cracks and other defects. Part of this problem is due to the poor quality of Sandcrete blocks used as walling units in buildings.

Sandcrete blocks are used extensively in many countries of the world especially in Africa due to the availability of raw materials used in its production. Sandcrete blocks are the most widely used walling unit in Nigeria; accounting for 90% of houses (Baiden and Tuuli, 2004). In most part of Nigeria, Sandcrete blocks form one of the major cost components of building structures (Oyekan and Kamiyo, 2008). This makes Sandcrete blocks a very important material in building construction. Sandcrete blocks comprise of natural sand, water and cement (Barry, 1969). Oyetola and Abdulahi (2006) reported that cement which serves as a binder is the most expensive input in the production of sandcrete block. Sandcrete blocks are essentially made of a mixture of cement and sand (fine aggregate) mixed in a specified proportion with a varying percentage of water added to the mixture to be able to produce the specified standard strength (Jackson and Dhir, 1998) (Hamza and Yusuf, 2011); NIS 87:2007; Vallenger, 1971). Sandcrete blocks when produced under standard requirements possess moderate compressive strength that makes them withstand seismic and vibrating effects and are available for the construction of load bearing and non-load bearing walls. 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 (Oyekan and Kamiyo, 2008). This has led to the creation of regulating bodies to monitor the production of sandcrete blocks; one of these regulating bodies is the Standards Organization of Nigeria (SON). The Standards Organization of Nigeria has formulated methods of testing sandcrete blocks in Nigeria to meet the international standard methods. By so doing, the regulation of the production of sandcrete blocks has been made possible with the formulation of the Nigerian Industrial Standard (NIS 87:2007).

Several research carried out regarding the quality of sandcrete hollow blocks produced by commercial block-making companies revealed that majority of their blocks had 28- day dry strength in the range of 0.50 to 1.5 N/mm^2 in Nigeria (Ejeh and Abubakar, 2008; Ewa and Ukpata, 2013; Onwuka *et al.,* 2013). Several reasons were given in these researches for the commercial production of substandard sandcrete hollow blocks. The main reasons given were poor cement to sand mix ratio, inadequate curing and poor workmanship.

Tsado and Yewa (2013) reported that hollow sandcrete blocks produced by the block industries in Nigeria, and Minna, Niger State in particular are below the standard resulting into construction failure which may be due to various reasons of mix proportion and production process not carried out in accordance to NIS 87:2007.

Compressive strength of sandcrete blocks are determined on the as-cast surface which is a function of the area available to resist loads (Yusuf A, 2010). This study is therefore aimed at investigating the compliance level of sandcrete block factories in Minna metropolis with regards to dimension and strength.

2 MATERIALS AND METHODS

Sixteen (16) nine inch hollow sandcrete block samples were collected at 3 days curing age from 10 different block producing company. Soil samples used to produce each block sample were collected and the particle size distribution determined in accordance to BS 882: 1992. The method of compaction used to produce these blocks was the mechanical method. The overall dimension of the blocks as well as the web thickness was determined using a Vanier caliper in accordance to NIS. The density, water absorption and compressive strength were determined in accordance to the NIS testing methods at 7 and 14 days age of curing.

3 RESULTS AND DISCUSSION

3.1 PARTICLE SIZE DISTRIBUTION OF FINE AGGREGATE

The particle size distribution curve for the fine aggregate collected from ten (10) block producing factories are shown in Figure 1.

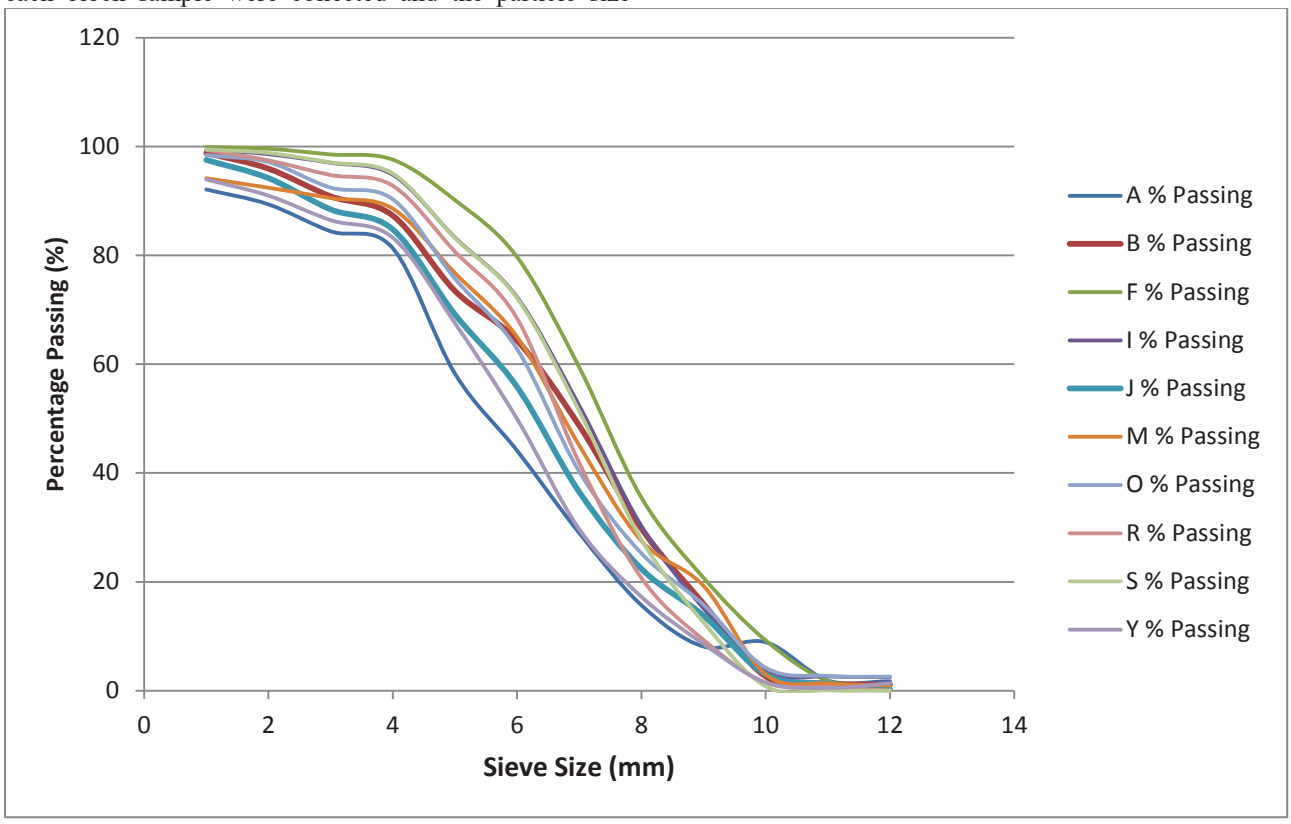

Figure 1: Particles size distribution graph of collected soil samples

Test results indicate that the fine aggregates used are not suitable for block making. The coefficient of uniformity of all soil samples range from 0.71 – 1.89 while the coefficient of curvature lie within 2.57 to 4.80. The coefficient of uniformity should be equal to or greater than 6 according to the unified soil classification system while the coefficient of curvature should be between 1 and 3. This implies that the sand used by all the sandcrete block companies are poorly graded because they do contain a wide range of grain size.

3.2 BLOCK DIMENSIONS

The dimension of hollow sandcrete blocks collected is presented in table 1. The recommended dimension for 9 inch hollow sandcrete block is 450x225x225mm with a web thickness of 50mm (NIS 87: 2007). The web thickness of all collected samples were less than 50mm which is the recommended web thickness for 9 inch hollow sandcrete block (NIS 87: 2007) except Block Company A which recorded 53.8mm. Block samples with

smaller web thicknesses may save materials but this reduces the effective area required to resist loads. The recommended width for 9 inch hollow sandcrete block is 225mm (NIS 87: 2007). All the blocks meet up with the minimum width requirement. The recommended length for 9 inch hollow sandcrete block is 450mm. Only three block making factories conform to this but do not satisfy web thickness requirement. This implies that all factories sought to reduce the volume of material used to mould a block and this consequently reduces the compressive strength of sandcrete hollow blocks.

Table 1: Dimension of collected 9 inch hollow block samples

Block Industry	Block No	Length (mm)	Average Length (mm)	Breadth (mm)	Average Breadth (mm)	Height (mm)	Average Height (mm)	Web Thickness (mm)	Average Web (mm)
A	1	357	354.8	234	232.2	210	211.2	55	53.8
	2	356		233		210		54	
	3	351		232		211		53	
	4	357		230		212		54	
	5	353		232		213		53	
B	1	360	358.6	222	231.4	223	223	33	33
	2	357		235		225		32	
	3	356		235		224		33	
	4	342		234		221		32	
	5	378		231		222		35	
F	1	375	365	245	234.4	222	221.6	47	45.4
	2	357		230		220		46	
	3	357		231		221		45	
	4	361		221		222		47	
	5	375		245		223		42	
I	1	447	456.8	234	235.2	228	225.6	40	39.6
	2	460		237		227		39	
	3	447		236		227		38	
	4	463		235		221		40	
	5	467		234		225		41	
J	1	470	452.4	245	248.2	213	214.2	45	40.8
	2	460		225		207		35	
	3	452		265		216		38	
	4	434		265		223		44	
	5	446		241		212		42	
M	1	364	359.6	239	233.8	230	226.4	50	48.8
	2	358		230		225		48	
	3	356		231		230		49	
	4	364		239		224		50	
	5	356		230		223		47	

O	1	360	398.4	230	237.6	220	218.2	45	43.2
	2	455		227		215		46	
	3	447		241		215		45	
	4	365		239		220		45	
	5	347		251		221		35	
R	1	372	372	233	231	220	224	42	39.8
	2	357		230		220		42	
	3	368		231		220		39	
	4	390		232		240		41	
	5	373		229		220		35	
S	1	358	364.6	225	230.6	208	217.6	43	45
	2	370		235		233		45	
	3	357		236		208		44	
	4	368		233		216		43	
	5	370		224		223		50	
Y	1	465	464	240	240.6	220	223	43	43.4
	2	467		243		220		45	
	3	459		235		221		38	
	4	460		245		226		45	
	5	469		240		228		46	

3.3 WATER ABSORPTION CAPACITY

Table 2 presents the water absorption capacity for the collected block samples. The water absorption capacities of all collected block samples were below the maximum value of 12% specified by NIS: 87:2007 except block company M which recorded 12.08%. High water absorption capacity may be due to insufficient cement in the sandcrete mix, poor mix ratio, inadequate curing or inadequate compaction.

Table 2: Water absorption capacity of collected 9 inch hollow sandcrete block samples

Block Industry	Average Weight of Dry Block (Kg)	Average Weight of Wet Block (Kg)	Water Absorption Capacity (%)
A	23.02	25.17	9.34
B	23.34	25.32	8.48
F	21.27	22.86	7.48
I	21.45	23.27	8.52
J	22.54	22.68	5.23
M	21.35	23.93	12.08
O	19.13	22.00	8.52
R	22.76	25.03	9.91
Y	22.1	23.92	8.23
S	24.21	26.35	8.83

3.4 COMPRESSIVE STRENGTH TEST

The result for the compressive strength of the sandcrete blocks collected is presented in Figures 2 and 3. The results show an increase in the compressive strength of the collected hollow sandcrete blocks with increase in curing age. The average compressive strength of hollow sandcrete blocks collected at 14 days curing age ranges from 0.21 N/mm^2 - 1.11N/mm^2. These values fall below the NIS recommended value of 3.45 N/mm^2 for load bearing hollow sandcrete block. This may be due to reduced web thickness of the sandcrete blocks. For block industry B, it was observed that quarry dust was used as fine aggregate and the average compressive strength of the hollow sandcrete blocks from this industry was the highest (1.11 N/mm^2), this is probably due to the strong bond that forms between the Quarry dust (granite dust) and the cement and it is also due to the fact that the quarry dust fills in the void spaces present in the hollow sandcrete blocks. The average density of the collected sandcrete blocks ranges from 1.5g/cm^3 – 5.048g/cm^3 which is in compliance with the NIS standard value of not less than 1.5g/cm^3.

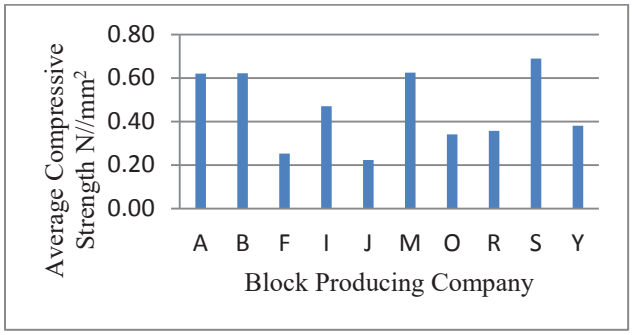

Figure 2: Compressive strength of collected sandcrete block samples at 7 days curing age

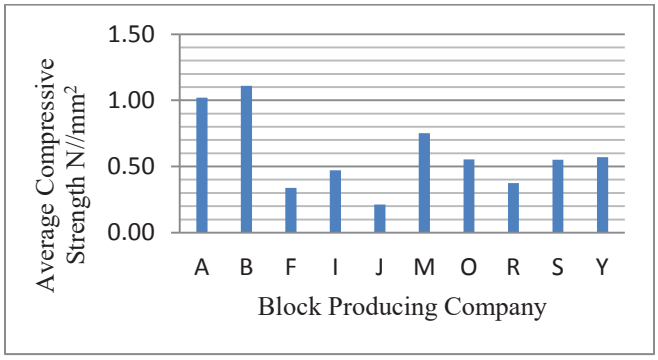

Figure 3: Compressive strength of collected sandcrete block samples at 14 days curing age

4 CONCLUSION

The following conclusions were drawn from the results obtained in this research

1. The grading of the aggregates used for the block production in all the industries under study is not within the limits specified in BS 882: 1992, the aggregates therefore are not suitable for block making.
2. The blocks collected from the block making industries do not comply with the block dimensions as specified in NIS 87:2007 and thus could be the cause of building defects such as cracks and other deformations.
3. The average compressive strength of the blocks is below the NIS recommended value of 3.5N/mm^2. This is the case as the net area required to resist loads is reduced and the volume of material required to support loads is also reduced.

It is recommended that all stakeholders responsible for regulating building construction practice such as Council for the Regulation of Engineering in Nigeria (COREN), Nigeria Society of Engineers (NSE), Association of Builders e.t.c liaise with the association of sandcrete block producers to help in regulation some of the sharp practices in the industry.

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