Journal of Building Performance ISSN: 2180-2106 Volume 6 Issue 1 2015
http://spaj.ukm.my/jsb/index.php/jbp/index

AN APPRAISAL OF THE QUALITY OF SANDCRETE BLOCKS USED FOR CONSTRUCTION IN LAGOS METROPOLIS

I. G. Awolusi[1]*, A. A. Soyingbe[2], and O. O. Oyeyipo[3]
[1,2]*Department of Building, University of Lagos, Akoka, Lagos, Nigeria*
[3]*Department of Quantity Surveying, Bells University of Technology, Ota, Ogun State, Nigeria*
*Corresponding author: awolusibukun@gmail.com

Abstract
Sandcrete blocks have been in use in many parts of the world for a very long time. The prominence of sandcrete blocks as part of the local building materials that make up the wall units in a building or any construction work cannot be underestimated because houses are mostly built of blocks. This paper examines the quality of machine-vibrated hollow sandcrete blocks used on construction sites in Lagos metropolis. A total of sixty (60) units of machine-vibrated sandcrete blocks were sampled from ten (10) manufacturers within Lagos Mainland. Three (3) samples of 450mm x 225mm x 225mm blocks and another three (3) of 450mm x 150mm x 225mm blocks were selected from each of the 10 manufacturers to make the total of 60 blocks. Also, a total of forty (40) units of machine-vibrated sandcrete blocks were produced based on the requirements of the NIS 87:2004 standards for sandcrete blocks. The blocks obtained from manufacturers as well as those produced were tested to determine their quality in terms of three parameters which were the compressive strength, density and dimensional tolerance. The results obtained revealed that the compressive strength of the blocks obtained from manufacturers ranged from 0.21N/mm^2 to 1.26N/mm^2 for 225mm wide blocks and from 0.28N/mm^2 to 0.95N/mm^2 for 150mm wide blocks which are far below the minimum NIS requirements of 3.45N/mm^2 and 2.5N/mm^2 respectively. The densities of these blocks were found to be satisfactory with the requirements of the standard while the dimensions were inaccurate in terms of web thicknesses. It was recommended that the regulatory bodies should be empowered to control production processes and implement effective strategies such as mobile testing to ascertain the quality of sandcrete blocks.

Key words: Compressive strength, concrete block, quality, sandcrete block, standard

INTRODUCTION

Sandcrete blocks are composite materials made up of cement, sand and water, moulded into different sizes. They are widely used in Nigeria and virtually all African countries as walling unit. The quality of blocks produced however, differs from each industry due to the different methods employed in the production and the properties of the constituent materials. Ayeyemi (2008) stated that many factors have been identified for incessant building collapse in Lagos, but that critical step had not been taken to stop manufacturers of substandard sandcrete blocks whose product contributes a lot to the menace. It was also pointed out that these blocks produced by the manufacturers are sold at prices far below what a quality sandcrete block should cost. Oyekan (2007) observed that for a long time until perhaps few years ago these blocks were manufactured in many parts of Nigeria without due reference to any specifications either to suit local building requirements or for good quality work. It is however pleasing to observe that the situation is changing in Lagos state as there have been plans by stakeholders in the construction industry to restore the standards of sandcrete blocks as the Standard Organisation of Nigeria (SON) now has a document in place giving the specification for both the manufacture and use of these blocks in Nigeria (NIS 87:2004).

The rapid changes in the use of brick to block in Nigeria have encouraged the investigations into the use of sandcrete blocks to be more elaborate (Abdullahi, 2005). The popularity of sandcrete blocks and their extensive application as walling material in Nigeria and other developing countries cannot be overemphasised. The widespread use of these sandcrete blocks has therefore caused heavy demand for it and necessitated its high production. This should attract the interest of various stakeholders and players in the construction industry to standardize its production and use for its efficient applications as major building materials. Sandcrete block walls are usually not designed to support loads other than their own weight. However, one of the earliest warning signs of failure is often manifested by the formation of serious critical structural cracks long before the actual event. Recent structural collapses in Nigeria and elsewhere have raised serious concerns for more in-depth and intensified study on the mechanism of resistance of all components of the structure, as reported by Wenapere and Ephraim (2008).

The prevalent nature of building failures and collapses experienced in Lagos state in recent times has been generating a lot of problems in the construction industry and the society at large causing an alarming increase in the loss of lives and valuable properties. Ayedun, Durodola and Akinjare (2010) stated that in Lagos State, the incidents of building collapse in the past decades have resulted in the loss of many lives and properties worth several millions of Naira. They reported about 56 cases of building collapse in Lagos State between year 2000 and 2010. This problem has been attributed to the use of substandard materials such as sandcrete blocks. Ewa and Ukpata (2013) indicated that part of this problem is due to the poor quality of sandcrete blocks used as walling units. The quality of blocks produced, however, varies from one manufacturer to the other as a result of differences in method of production and the properties of the constituent materials.

This research is aimed at evaluating the quality of sandcrete blocks used for construction in Lagos metropolis. The dimensional tolerances, densities and compressive strengths of sandcrete blocks produced by block manufacturers in Lagos metropolis as well as those produced based on the required standards are determined. The compressive strengths of blocks produced by block manufacturers in Lagos metropolis are then compared with those produced based on the required standards. This study is expected to bring to the limelight the quality of the blocks which will give reliable data on which regulatory measures could be taken to standardize the production and use of sandcrete blocks.

PREVIOUS STUDIES

Abdullahi (2005) investigated the strength characteristics of Sandcrete blocks in Bosso and Shiroro areas in Minna, Nigeria. Compressive strength tests were conducted on the blocks and sieve analysis was also conducted on the soil samples. The test results revealed that the aggregates used were suitable for block making. The compressive strength of the sandcrete blocks was found to be below the standard recommended by Nigerian Industrial Standard (NIS) 87: 2000. The compressive strength of individual blocks was between 0.11N/mm^2 and 0.75N/mm^2 and the average compressive strengths of the blocks were between 0.14N/mm^2 and 0.66N/mm^2. Proper curing and suitable selection of constituent materials was suggested to improve on the quality of sandcrete blocks.

Afolayan, Arum and Daramola (2008) reported the compressive strengths and the statistical characteristics of sandcrete blocks collected from twenty five (25) different block industries in Ondo State, Nigeria. The results showed that the 450mm x 150mm x 225mm sandcrete blocks in circulation had an average strength of 0.55N/mm^2 while those of 450mm x 225mm x 225mm had an average compressive strength of 0.45N/mm^2. They observed that the values were lower than those stipulated by the relevant codes and standards. Although, the statistical analysis showed that the compressive strength of these blocks followed a normal distribution, the overall coefficient of variation stood at 0.54 for the 450mm x 150mm x 225mm blocks and 0.71 for the 450mm x 225mm x 225mm blocks. They concluded that the values were high and therefore indicate very poor quality control in the production processes. On the basis of the noted poor quality control, recommendations appropriate for improving the strength and effectiveness of sandcrete blocks production were made.

Ewa and Ukpata (2013) investigated the compressive strength properties of sandcrete blocks produced within the Calabar metropolis. Ten (10) blocks moulding sites were visited and twelve (12) sandcrete blocks were randomly selected from each site, and cured for 3, 7, 14 and 28days. The aggregates used for moulding the blocks were also collected and their particle sizes analysed. The results showed that the 28-day compressive strengths of sandcrete blocks produced in Calabar block industry range between 0.23N/mm^2 and 0.58N/mm^2. These values are below the minimum requirements of 1.75N/mm^2 by the Nigerian National Building Code (2006) for individual block, and 2.0N/mm^2 by the British Standard for non-load bearing walls.

Baiden and Tuuli (2004) examined the impact of quality control practices by suppliers on the quality of blocks produced in the Kumasi metropolis, Ghana. Sandcrete blocks were taken from suppliers and tested for compressive strength, bulk density, water absorption, and dimensional tolerances. Fine aggregate samples were also taken from the suppliers and tested for grading, silt, and organic matter content. The study confirmed that mix ratio, quality, and mixing of the constituent materials affected the quality of sandcrete blocks. Visual inspection rather than laboratory testing was adopted as the means of ascertaining the quality by a few of the staff of contractors who had no formal training in quality control. Mix ratios used ranged from as lean as 1:8 to as weak as 1:19 (cement: sand). Blocks produced were also found to be unsuitable for use as load bearing walls.

METHODS AND MATERIALS

For the purpose of this study, a total of sixty (60) units of machine-vibrated sandcrete blocks were selected using purposive sampling from ten (10) manufacturers within Lagos, Nigeria. Three (3) samples of 450mm x 225mm x 225mm and another three (3) of 450mm x 150mm x 225mm blocks were selected from each of the 10 manufacturers. The sampling was done to cut across key parts of

Lagos Mainland in order to give a good representation of the population of blocks used on construction sites in Lagos state. Also, a total of forty (40) units of machine-vibrated sandcrete blocks were produced based on the requirements of Nigerian Industrial Standard (NIS). Twenty (20) specimens each of 450mm x 225mm x 225mm blocks and 450mm x 150mm x 225mm blocks were produced. These blocks obtained from manufacturers and those produced based on the requirements of the standards were taken to the Materials/Concrete Laboratory of the Department of Civil and Environmental Engineering, University of Lagos for appropriate tests to determine their quality. Preliminary tests (i.e. particle size analysis, specific gravity test and moisture content test) were also conducted on the sand used for the block production to determine its suitability.

Constituents of sandcrete blocks

The materials used for the sandcrete blocks were cement, sand and water. These materials are described as follows:

Cement: The cement used was Ordinary Portland Cement and was delivered in the original sealed bags of the manufacturer.

Sand: The sand used was river, crushed sand, clean, sharp and free from clay, loam, dirt, organic or chemical matter of any description. The particle size analysis of the sand sample used for the block production is presented in the table below.

Table 1: Particle size analysis of sand sample used for block production

BS Sieve size (mm)	Mass Retained (g)	Mass Passing (g)	Percentage Retained (%)	Percentage Passing (%)
6.3	0.00	200.00	0.00	100.00
5.0	0.00	200.00	0.00	100.00
3.2	0.00	200.00	0.00	100.00
2.0	1.14	198.86	0.57	99.43
1.18	16.79	182.07	8.40	91.04
600µm	65.41	116.66	32.71	58.33
425µm	36.01	80.65	18.01	40.33
300µm	44.60	36.05	22.30	18.03
212µm	27.13	8.92	13.57	4.46
150µm	7.60	1.32	3.80	0.66
63µm	1.32	0.00	0.66	0.00

Initial Mass Used = 200g

The results of the sieve analysis of the sand used for the block production show that the sand satisfies the requirements of the standards. The sand particles passed through the 3.2mm BS sieve with the greatest percentage of 32.71% retained on sieve 600µm. This shows that the sand is mostly of medium grading. Considering the various percentages retained on the different sieves sizes i.e. 1.18mm: 91.04% (75-100%), 600µm:58.33% (60-79%) 300µm:18.03% (12-40%) 150µm:0.66% (1-10%), the sand therefore falls in Zone 3 of the Grading Zones (BS 882:1978) for the grading requirement for fine aggregate in NIS 87:2004. Since the soil consists of 99.34% coarse material and 0.66% fines according to the sieve analysis table, the soil is therefore a Uniform Medium SAND.

Water: The water was potable water obtained from the tap in the laboratory.

Mix Proportion

The mix proportion of the composite materials used for the block production was 1: 6 (i.e. one part of cement to six parts of sand) and was by volume batching.

Table 2: Mix proportion of the composite materials

Material Component	Cement	Sand
Proportion by Volume	1	6

Testing of block samples

Five (5) whole blocks that have been cured for 7days were selected at random from specimens of the blocks produced and the dimensions measured to the nearest 1mm. Each of the blocks was weighed in the weighing balance and the weight was recorded. The metal plates were placed above and below the bed faces of the block to be tested and the block specimen was carefully placed between the plates of the compression-testing machine. Load was then applied to the opposite faces of the block. The load was applied gradually and axially without shock at a uniform rate till failure occurred. The maximum or failure loads of the blocks were recorded and the dry density and compressive strength were then calculated. The blocks produced were also tested at ages 14, 21 and 28days curing. For the blocks obtained from manufacturers, the blocks were those prepared to be dispatched to users of the blocks and a set of three (3) samples was tested using the testing procedure highlighted above.

RESULTS AND DISCUSSIONS

This section contains the presentation of results as well as the discussion of the results for the assessment of both the sandcrete blocks obtained from the manufactures and those produced in the laboratory.

Dimensional tolerance

The dimensions of the sandcrete blocks obtained from the manufacturers were measured to the nearest 1mm in the order of Length x Width x Height and were found to be 450mm x 225mm x 225mm and 450mm x 150mm x 225mm for 225mm and 150mm wide hollow sandcrete blocks respectively. Both sizes of blocks had web thickness of 38mm at the bottom bed face which tapered to the top bed face to web thickness of 30mm. These web thicknesses are lower than those stipulated in (NIS 87:2004) with minimum web thicknesses of 50mm and 37.5mm for 225mm and 150mm wide blocks respectively. These results show that the dimensions of the blocks produced by the manufacturers are not accurate and do not comply with the requirements of the standards.

Table 3: Dimensional tolerances of sandcrete blocks

Block Width	Web Thickness (mm)		
	NIS	Manufacturers'	Laboratory produced
225mm	50	30-38	30-38
150mm	37.5	30-38	30-38

The dimensions of the sandcrete blocks produced were also measured to the nearest 1mm in the order of Length x Width x Height and were found to be 450mm x 225mm x 225mm and 450mm x 150mm x 225mm for 225mm and 150mm wide hollow sandcrete blocks respectively. Both sizes of block had web thickness of 38mm at the bottom bed face which tapered to the top bed face to web thickness of 30mm. However, these web thicknesses are lower than those required in the standards but were still adopted for the research because the moulds available had these web thicknesses.

Density

Table 4 and Figure 1 show the densities of the sandcrete blocks obtained from 10 manufacturers. The mean values of the density of blocks from manufacturers computed by finding the average of the densities of a set of three (3) blocks had a lowest value of 1808.8kg/m^3 by blocks from manufacturer G and the highest value of 2044.2kg/m^3 by blocks from manufacturer D for 225mm wide blocks. The mean density of 150mm wide blocks ranged from 1732.5kg/m^3 by manufacturer J to 2083.3kg/m^3 by manufacturer G. However, the variations shown in the values of density of blocks of the same size and manufacturer and those of one size when compared to the other size from the same manufacturer are within tolerable limit. These values are of course greater than those stipulated in the standard for both load bearing and non-load bearing units of sandcrete blocks and therefore comply with the requirements of the standards.

Table 4: Density of blocks obtained from manufacturers

Sample No.	Manufacturer's Identity	Dry Weight (kg)		Dry Density (kg/m^3)		Mean Dry Density (kg/m^3)	
		225mm	150mm	225mm	150mm	225mm	150mm
I		20.0	15.6	1968.75	1969.70		
II	A	20.4	16.1	2008.12	2032.83	2008.1	2007.6
III		20.8	16.0	2047.50	2020.20		
I		20.2	15.7	1988.43	1982.32		
II	B	20.3	15.8	1998.28	1994.95	1978.6	1986.5
III		19.8	15.7	1949.06	1982.32		
I		20.1	14.0	1906.79	1767.68		
II	C	20.7	14.4	1963.71	1818.18	1932.1	1784.5
III		20.3	14.0	1925.77	1767.68		
I		20.7	15.8	2037.65	1994.95		
II	D	21.0	15.3	2067.18	1931.82	2044.2	1961.3
III		20.6	15.5	2027.81	1957.07		
I		18.8	16.5	1850.62	2083.33		
II	E	18.6	16.3	1830.93	2058.08	1853.9	2083.3
III		19.1	16.7	1880.15	2108.59		
I		18.9	16.3	1792.96	2012.35		
II	F	19.1	15.0	1811.93	1851.85	1811.9	1905.4
III		19.3	15.0	1830.90	1851.85		
I		18.8	15.2	1783.47	1830.77		
II	G	18.9	16.1	1792.96	1939.17	1808.8	1879.0
III		19.5	15.5	1849.88	1866.91		
I		21.6	15.8	1977.34	1903.04		
II	H	21.2	15.6	1940.73	1878.95	1952.9	1874.9
III		21.2	15.3	1940.73	1842.82		
I		20.3	16.1	1998.28	2032.83		
II	I	20.1	15.3	1978.59	1931.82	2040.9	1986.5
III		21.8	15.8	2145.93	1994.95		
I		20.2	14.0	1916.28	1728.40		
II	J	20.2	13.8	1916.28	1703.70	1903.6	1732.5
III		19.8	14.3	1878.34	1765.43		

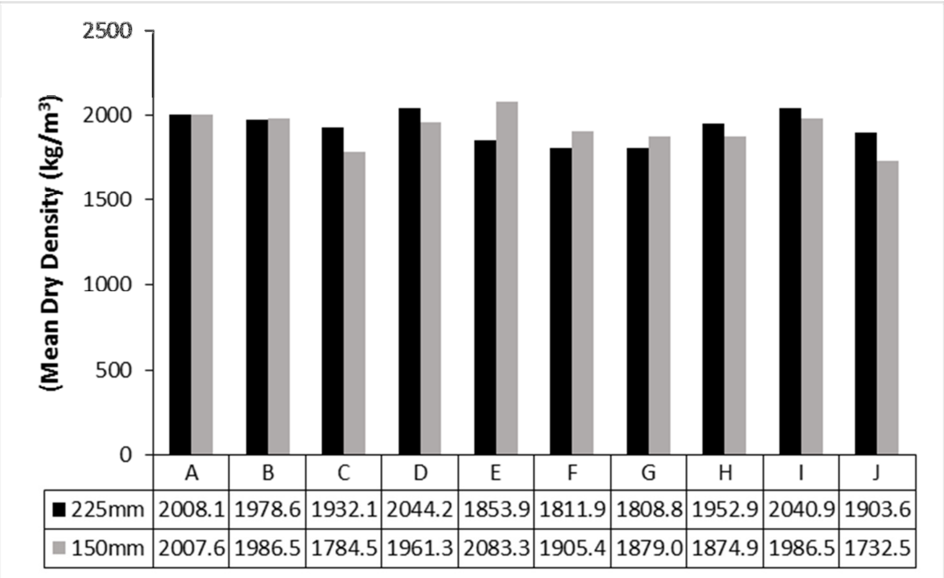


Figure 1: Mean Dry Density of blocks obtained from manufacturers

The densities of the sandcrete blocks produced as computed using the readings obtained in the experimental tests are presented in Table 5 and Figure 2 below.

Table 5: Density of blocks produced (1:6 mix proportions)

Sample No.	Age of Block (day)	Dry Weight (kg)		Dry Density (kg/m^3)		Mean Dry Density (kg/m^3)	
		225mm	150mm	225mm	150mm	225mm	150mm
I		21.6	17.8	2126.25	2247.47		
II		21.4	18.3	2106.56	2310.61		
III	7	21.1	17.5	2077.03	2209.60	2086.9	2209.6
IV		21.2	17.0	2086.87	2146.46		
V		20.7	16.9	2037.65	2133.84		
I		22.6	17.7	2224.68	2234.85		
II		22.2	17.3	2185.31	2184.34		
III	14	23.0	17.6	2264.06	2222.22	2203.0	2189.4
IV		22.8	16.8	2244.37	2121.21		
V		21.3	17.3	2096.71	2184.34		
I		21.2	17.1	2086.87	2159.09		
II		22.7	17.1	2234.53	2159.09		
III	21	20.0	17.0	1968.75	2146.46	2002.2	2146.5
IV		18.6	17.2	1830.93	2171.72		
V		19.2	16.6	1890.00	2095.96		
I		20.9	16.7	2057.34	2108.59		
II		21.5	18.1	2116.40	2285.35		
III	28	21.7	17.4	2136.09	2196.97	2102.6	2176.8
IV		21.5	17.6	2116.40	2222.22		
V		21.2	16.4	2086.87	2070.71		

From Table 5 above, the density of the 225mm wide block has the lowest value of 1830.93kg/m^3 at age 21days and the highest value of 2264.06kg/m^3 at 14days for individual block. The mean value of a set of five 225mm wide blocks ranged from 2002.2kg/m^3 at 21days to 2203.0kg/m^3 at 14days. The 150mm wide blocks have values of density of individual block ranging from 2070.71kg/m^3 at 28days to 2310.61kg/m^3 at 7days with the mean values between 2146.5kg/m^3 at 21days and 2209.6kg/m^3 at 7days. Also from Figure 2 below, the density of the blocks did not vary with the age of the blocks as no trend of variation was observed. This means that the density of a sandcrete block is not dependent on the age of the block. However, there are differences in the values of the density of the blocks which are within tolerable limit and could be due to some other factors such as the level of compaction of the block and the vibration time during production.

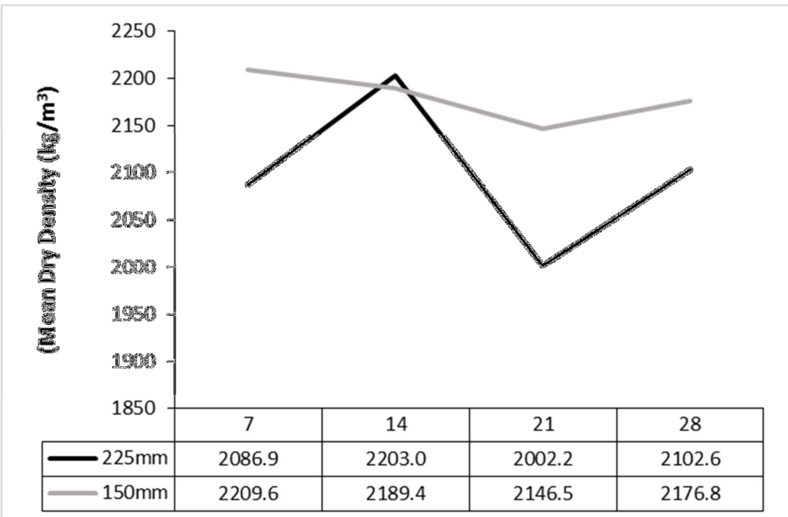


Figure 2: Mean Dry Density of blocks produced (1:6 mix proportions)

These values of density obtained clearly comply with the requirements of the standards. Both the lowest and highest values of density are higher than 1500kg/m^3 and 625kg/m^3 which are the minimum values of density required for load bearing and non-load bearing blocks respectively. All these show satisfactory results in comparison with the requirement of the standards.

Compressive Strength

Table 6 and Figure 3 present the compressive strengths of the sandcrete blocks obtained from manufacturers. The compressive strength of 225mm wide blocks obtained from the manufacturers ranged from 0.21N/mm^2 to 1.26N/mm^2 which are far below the minimum value of 3.45N/mm^2 required by NIS 87:2004. The 150mm wide blocks obtained from the manufacturers also gave very low values ranging from 0.28N/mm^2 to 0.95N/mm^2 which are also far below the minimum value of 2.5N/mm^2 required by the standards. The standards require that the mean compressive strength obtained from a set of five (5) blocks of 225mm and 150mm wide blocks must not be less than 3.45N/mm^2 and 2.5N/mm^2 respectively. The standards further state that the compressive strength of individual load bearing blocks shall not be less than 2.5N/mm^2 for machine-compacted blocks (NIS 87:2004).

Table 6: Compressive Strength of blocks obtained from manufacturers

Sample No.	Manufacturer's Identity	Crushing Load (KN)		Comp. Strength (N/mm^2)		Mean Comp. Strength (N/mm^2)	
				225mm	150mm	225mm	150mm
I		10	10	0.22	0.28		
II	A	5	10	0.11	0.28	0.26	0.38
III		20	20	0.44	0.57		
I		30	10	0.66	0.28		
II	B	20	10	0.44	0.28	0.52	0.28
III		20	10	0.44	0.28		
I		20	20	0.43	0.57		
II	C	10	10	0.21	0.28	0.36	0.38
III		20	10	0.43	0.28		
I		50	20	1.11	0.57		
II	D	30	30	0.66	0.85	0.89	0.76
III		40	30	0.89	0.85		
I		50	40	1.11	1.14		
II	E	50	30	1.11	0.85	1.26	0.95
III		70	30	1.55	0.85		
I		10	15	0.21	0.42		
II	F	10	10	0.21	0.28	0.21	0.32
III		10	10	0.21	0.28		
I		10	20	0.21	0.54		
II	G	20	10	0.43	0.27	0.36	0.36
III		20	10	0.43	0.27		
I		70	10	1.44	0.27		
II	H	50	10	1.03	0.27	1.10	0.36
III		40	20	0.82	0.54		
I		20	10	0.44	0.28		
II	I	50	20	1.11	0.57	0.74	0.47
III		30	20	0.66	0.57		
I		40	15	0.85	0.42		
II	J	40	10	0.85	0.28	1.00	0.32
III		60	10	1.28	0.28		

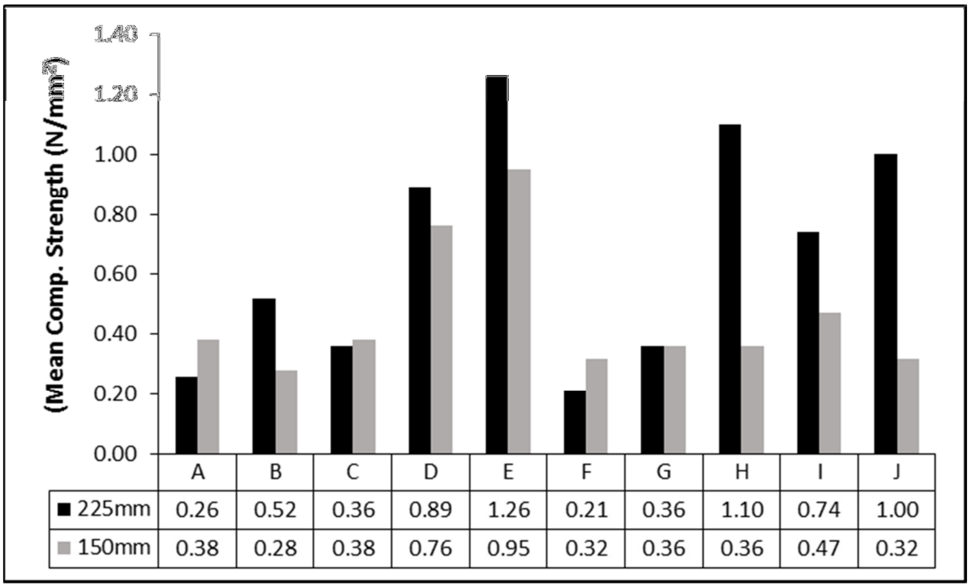
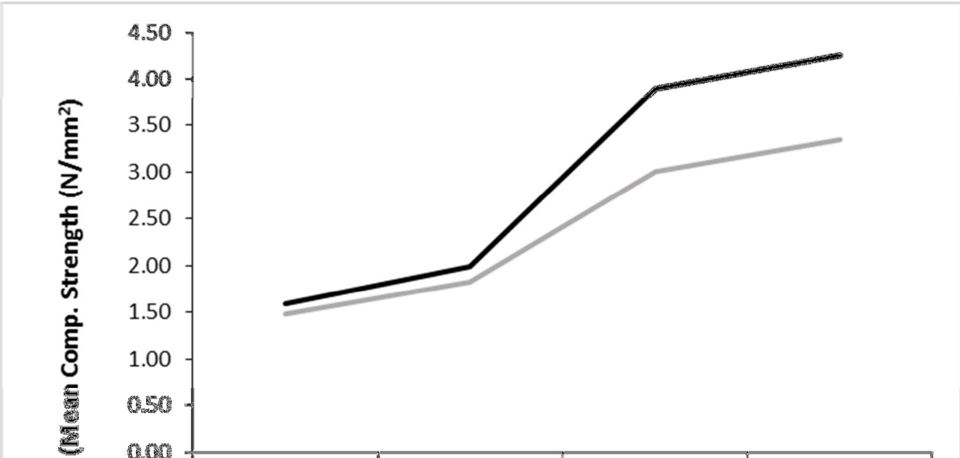


Figure 3: Mean Compressive Strength of blocks obtained from manufacturers

The compressive strengths of the sandcrete blocks produced and tested at different ages are presented in Table 7 and Figure 4 below. The table shows that the values of compressive strength of the 225mm wide blocks ranged from 3.77N/mm^2 to 4.87N/mm^2 with a mean value of 4.25N/mm^2 while that of the 150mm wide blocks ranged from 2.84N/mm^2 to 3.69N/mm^2 with a mean value of 3.35N/mm^2 after28 days curing.

Table 7: Compressive strength of blocks produced (1:6 mix proportions)

Sample No.	Age of Block (day)	Crushing Load (KN)		Comp. Strength (N/mm^2)		Mean Comp. Strength (N/mm^2)	
		225mm	150mm	225mm	150mm	225mm	150mm
I		80	50	1.77	1.42		
II		100	80	2.21	2.27		
III	7	70	50	1.55	1.42	1.59	1.48
IV		60	40	1.33	1.14		
V		50	40	1.11	1.14		
I		80	80	1.77	2.27		
II		70	60	1.55	1.70		
III	14	100	50	2.21	1.42	1.99	1.82
IV		110	60	2.44	1.70		
V		90	70	1.99	1.99		
I		180	110	3.99	3.13		
II		200	120	4.43	3.41		
III	21	190	100	4.21	2.84	3.90	3.01
IV		150	110	3.32	3.13		
V		160	90	3.54	2.56		
I		190	100	4.21	2.84		
II		180	130	3.99	3.69		
III	28	200	120	4.43	3.41	4.25	3.35
IV		220	130	4.87	3.69		
V		170	110	3.77	3.13		



	7	14	21	28
225mm	1.59	1.99	3.90	4.25
150mm	1.48	1.82	3.01	3.35

Figure 4: Mean Compressive Strength of blocks produced (1:6 mix proportions)

Figure 4 also illustrates that the compressive strength of the sandcrete blocks increases with the age of curing as the trend can be clearly observed in the figure. The mean value of compressive strength obtained even after 21days curing clearly exceeds the 3.45N/mm^2 required by the standards for 225mm wide load bearing blocks while individual blocks were also found to have compressive strength not less than 2.5N/mm^2. On the other hand, the mean compressive strength of the 150mm wide blocks also exceeds 2.5N/mm^2 required by the standards. These values obtained comply in all respects with the requirements of NIS 87:2004 standards for sandcrete blocks.

CONCLUSIONS AND RECOMMENDATIONS

The study investigates the quality of sandcrete blocks used for construction in Lagos metropolis in terms of compressive strength, density, and dimensional tolerance. Based on the findings of the investigations and analyses carried out, the following conclusions are made:

The compressive strengths of sandcrete blocks produced by the manufacturers are far below and do not comply with the minimum requirements of the standards. This low quality could be attributed basically to the inappropriate mix proportions used by these manufacturers. These are often accompanied by other factors such as poor quality of constituent materials in which the sand is in some cases mixed with soft sand (such as clay) to improve its binding ability. Other factors such as poor curing and bad production methods also play major role in the low quality of blocks.

The densities of the sandcrete blocks produced by these manufacturers satisfy the requirements of the standards while the web thicknesses of the blocks do not comply with the requirements of NIS 87:2004. This is as a result of the fact that the correct moulds are not used for the production of the blocks.

This study has also revealed that any block produced based on the requirements and conditions stipulated in NIS 87:2004 standards for sandcrete blocks or other relevant standards will always comply with the minimum required values. These blocks so produced will not be substandard but will be of high quality that can structurally sustain both its self-load and the imposed load when used as walling units in the construction of buildings.

In order to ensure that quality sandcrete blocks are produced by manufacturers in Lagos metropolis, the following recommendations are put forward:

The organizations responsible for setting and enforcing the minimum standard requirements should rise up to their billing and devise strategies aimed at ensuring that these standards are met in all respects by the manufacturers. The regulatory organisations e.g. SON should introduce and effect the mobile testing of sandcrete blocks to ascertain the quality of these blocks. This will undoubtedly give a more efficient and reliable way of determining the actual quality of blocks produced by these manufacturers as the issue of testing specially-prepared samples will be eliminated. Additionally, there should be proper sanction against any manufacturer found selling blocks of quality below the minimum required standards.

The price of cement should be regulated and made reasonable in order to encourage block manufacturers to be honest with their production activities and desist from cutting corners. Alternatively, the partial replacement of cement with other materials such as Rice Husk Ash (RHA) as recommended by Oyetola and Abdullahi (2006) in their study on "The Use of Rice Husk Ash in Low-Cost Sandcrete Block Production" can be promoted. An optimum replacement level of 20% was obtained and this can help to reduce the cost of production as long as quality is not compromised.

The regulatory and enforcement bodies should be empowered to check and control production processes, the overall quality of the sandcrete blocks, and then recommend manufacturers to be certified as well as blocks to be destroy and those to be certified. These aforementioned strategies if adopted will reduce and eventually eradicate the problems of incessant building collapse and failures caused as a result of the use of substandard sandcrete blocks.

Areas of further research

The compressive strengths of mix proportions such as 1:8 and 1:10 cement and sand can also be investigated as these mix proportions will give lower cost of production to the manufacturers if found to comply with the required standards. The analysis of the sand obtained from different sources should also be carried out to determine their effects on the strengths of the sandcrete blocks. The development of cost models which will give a quality-cost relationship that will guide against the use of substandard blocks is another subject of further research work already being undertaken in this field.

References

Abdullahi, M. (2005). Compressive strength of sandcrete blocks in Bosso and Shiroro areas of Minna, Nigeria. *AU Journal of Technology*, 9(2), 126-132.

Afolayan, J. O., Arum, C., & Daramola, C. M. (2008). Characterization of the compressive strength of sandcrete blocks in Ondo State, Nigeria. *Journal of Civil Engineering Research and Practice,* 5(1), 15-28.

Ayedun, C. A., Durodola, O. D. & Akinjare, O. A. (2010). An empirical ascertainment of the causes of building failure and collapse in Nigeria. *Mediterranean Journal of Social Sciences,* 3(1), 313-322.

Ayeyemi, D. (Ed.) (2008, July 1). Standard sandcrete block costs 184NGN, says lecturer. "*Property News*". Nigerian Compass. P27.

Baiden, B.K., & Tuuli, M.M. (2004). Impact of quality control practices in sandcrete block production. *Journal of Architectural Engineering*, 10(2), 53-60.

Barry, R. (1999). *The construction of buildings.* (7th Edition), I, 67-70. Blackwell Science, Oxford England.

Ewa, D. E. & Ukpata, J. O. (2013). Investigation of the compressive strengths of commercial sandcrete blocks in Calabar Nigeria. *International Journal of Engineering and Technology*, 3(4), 477-482.

Mamlouk, M. S. and Zaniewski, J. P., (2006). *Materials for Civil and Construction Engineers*. Pearson Prentice Hall, Upper saddle River, USA. Pp 267-273.

Nigerian Industrial Standard (NIS 87:2004). *Standard for sandcrete blocks*, standards organisation of Nigeria, Lagos, Nigeria.

Oyekan, G. L. (2007). Effect of admixtures of the compressive strength of sandcrete blocks. *Proceedings of the 32nd Conference on our world in Concrete and Structures*: Singapore, 28-29 August, 2007.

Oyetola, E. B., & Abdullahi, M. (2006). The use of Rice Husk Ash in low-cost sandcrete block production. *Leonardo Electronic Journal of Practices and Technologies,* 8(1), 58-70.

Roberts, J., Tovey, A., and Fried, A., (2001). *Concrete Masonry Designer's Handbook.* (2nd Edition). Spon Press. Taylor and Francis Group, London. Pp 7-19.

Wenapere, A. D., & Ephraim, M. E. (2009). Physico-mechanical behaviour of sandcrete block masonry units. *Journal of Building Appraisal,* 4(4), 301-309.