COMPRESSIVE STRENGTH OF MARKETED SANDCRETE BLOCKS PRODUCED IN YOLA, NIGERIA

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ABSTRACT

Sandcrete blocks are widely used as walling units in Nigeria. This paper investigates the strength characteristics of sandcrete blocks in Yola ($8^0$36'47" N $12^0$19'14" E) metropolis. Two sets(150mm and 225mm) of Five Sandcrete blocks each were randomly selected from each manufacturer and soil samples were also obtained from source and transported to Civil engineering Laboratory, Federal University of Technology, Yola. Compressive strength test was carried out on the blocks at 28 days and sieve analysis was also carried out on the soil samples. The study confirmed that the quality of aggregates used is suitable for block making. The compressive strength of the Sandcrete blocks is below standard recommended by the Nigerian Industrial Standards (NIS) 87:2000. The compressive strength of individual blocks ranges from 0.12N/mm^2 to 1.46 N/mm^2 for the 150mm (6" width) and for the 225mm (9" width) ranges from 0.31 N/mm^2 to 1.36 N/mm^2 . The average compressive strength for all the blocks varied from 0.18 N/mm^2 to 1.38 N/mm^2. Blocks produced were also found to be unsuitable for use as load bearing walls. Proper curing and quality control was suggested to improve on the quality.

Keywords: Compressive Strength; Aggregates; Sieve Analysis; Quality Control; Curing.

INTRODUCTION

Sandcrete blocks are widely used in Nigeria as walling units. The quality of blocks produced however, differs from each manufacturer depending on the production method and constituent materials. This paper assesses the quality of sandcrete blocks produced in Yola. This involves sampling of sandcrete blocks from commercial manufacturers. The blocks were tested for compressive strength at 28 days. The result was compared with those recommended by the standards.

One can be reasonably be comfortable to a certain extent with the quality of cement and construction steel which are often produced by relatively big industries in the country with their in-house quality assurance systems. However, one cannot be certain in the same extent for the quality of sandcrete blocks and sawn timber which are produced by small-scale, often road side industries. Hence it is not surprising that buildings and structures fail to stand the test of time. Sandcrete blocks are walling units made from coarse natural sand or crushed stone dust mixed with binder and water and pressed to shape [1]. On setting and hardening, the blocks attain sufficient strength to be used as walling units [2]. The sandcrete blocks can be produced on a small scale with a maximum of four labour forces. They are produced as hollow blocks in three major sizes namely: 450 x 225 x 100mm, 450 x 225 x 150mm and 450 x 225 x 225 and are commonly known as four inches (4"), six inches (6") and Nine inches (9") blocks respectively. Sandcrete blocks are used for single leaf wall construction where the blocks are laid to overlap in one or more directions and set solidly in mortar. The blocks are laid in running or stretcher bond in which the units of successive courses overlap half their length [3], [4] reported that the

prevalence of poor quality control and the use of substandard building materials have been attributed as carsal factors for high failure rates of buildings in Nigeria.

Furthermore [5] as reported by [4] also argued that sandcrete blocks frequently fail to meet load-bearing specifications recommended by the Nigerian Federal Ministry of Works and it is not surprising to hear reoccurring cases of collapse under self weight of some of these blocks. The [6] reported a recent case of a collapsed building in which the sandcrete blocks did not show any appreciable hardness and that would be indicative of the use of substandard materials. [7] reported that a great number of buildings collapse weekly in the country, but did not receive public or official notice and some of those collapsed building showed that their load bearing walls were not of adequate strength to withstand the applied load on them. The rapid changes in the use of brick to block in Nigeria have encouraged the investigation in to the use of sandcrete blocks to be more elaborate [8]. This will aid in the long run in adoption of some currently untested local construction materials and methods in the country. [9] Reported that some of the factors influencing the strength of sandcrete blocks were the curing procedure, optimum water content and quality control. A survey in many African countries showed poor curing as a detrimental practice. Cement relies on the presence of water to hydrate, forming an interlocking skeleton of calcium silicate hydrate which gives the material its strength. If the block is dried prematurely full hydration will not take place. Good curing practice is not followed because either the manufacturers are not aware of the significance of good curing or they feel that the effort spent in providing curing conditions is not worth the possibility of increase in quality. A majority of manufacturers carry out watering of the blocks for duration of three consecutive days only. The molding of blocks at optimum water content results in blocks with the greatest strength [9]. The manufacturers are not normally fully aware of this requirement and consequently variable moisture contents are used at molding.

Quality control is very significant in any manufacturing process. The blocks manufacturers are normally not aware of its significance. Consequently there is large degree of variation in quality even within the stock of a single manufacturer. In many African countries neither testing of the green compact nor those of the cured blocks are carried out [9].

Thus, production problems may not be identified at the early stage and hence substandard blocks produced. It is relatively common to find block producer in the study area reducing the amount of cement for mixing or substituting some of the amount with clay material. This is aimed at minimizing the cost of production and hence the potential of substandard quality blocks. [10] As reported by [8] revealed that the compressive strength of Sandcrete materials increases with increased cement content. Similarly, [11] pointed out that strength is not to be taken as indication of durability. Thus, properties of Sandcrete blocks may be influence by prevailing climatic conditions in an area. The quality of Sandcrete blocks produced also depends on the quality of fine aggregates [2].

In Yola, sand is easily obtained naturally from the banks of rivers in the environment. There are basically four major sources, the benue river, Girei, Ngurore and Fufore areas. The sand is manually collected in heaps by using shovels and later shoveled into tippers or dumptrucks and transported to a site. Fine aggregates (sand) should comply with [12] for Sandcrete blocks production.

MATERIALS AND METHODS

Two types of blocks 450x225x225 and 450x225x 150 (9" and 6") were used for this study. Commercial blocks industries were visited twice in four weeks. At the first visit the blocks produced were noted and booked. At the 27th day five blocks samples were randomly selected [13], and the blocks were moved to the laboratory for testing on the 28th day. All the blocks were weighed and tested for compressive strength using the compressive testing machine in accordance to [14]. Sieve analysis test was carried out on the sand samples to ascertain their suitability for block making in accordance to [15].

RESULTS AND DISCUSSION

SIEVE ANALYSIS

The result for the sieve analysis of the four major sources in the area is shown in table 1. All the samples A, B, C and D satisfy the overall grading limit according to [12]. And all samples fall within range and are of medium grading. The soils are suitable for construction work.

COMPRESSIVE STRENGTH

The results for the compressive strength of the 150mm and 225mm (6" and 9") is shown in table 2 to 7 and 8 to 13 respectively. Test results indicate that the unit compressive strength of the 150mm (6") Sandcrete blocks ranges between 0.12N/mm^2 to 1.46 N/mm^2. The average compressive strength of the five blocks (150mm) ranges between 0.18 N/mm^2 to 1.38 N/mm^2.

Similarly the result of the unit compressive strength of the 225mm (9") Sandcrete blocks ranges between 0.31 N/mm^2 to 1.36 N/mm^2. The average compressive strength of the five 225mm (9") blocks ranges between 0.41 N/mm^2 to 1.31 N/mm^2.

These values fall below the standard prescribed for load bearing Sandcrete blocks. The Nigerian industrial standard [13] specified that the lowest compressive strength of individual blocks shall not be below 2.5 N/mm^2 and average compressive strength of five blocks shall not be below 3.45 N/mm^2. The results also indicated poor quality control because even within the stock of a single manufacturer there is variation in strength. The blocks may not have undergone proper curing. It was noted that manufacturers leave the blocks in open air during the curing process and the water sprinkled on them is not so sufficient. The block manufacturers that were visited used potable drinking water which is recommended for construction work [16].

CONCLUSIONS AND RECOMMENDATIONS

From the study the following facts were obtained:

- The manufacturers do not carry out any form of testing on the Sandcrete blocks either before or at the end of production.
- Sandcrete block manufacturers do not adequately cure their blocks before selling to clients or customers.
- The compressive strength of individual blocks tested was below standards.
- The sand used for block manufacture are of medium grading and within the limit specified by [12].

A country's economy is adversely affected as buildings fail due to usage of substandard materials and people are rendered homeless. And to arrest the situation the following are proposed:

- Standards organizations in Nigeria established by the government should in conjunction with other non-governmental organizations jointly monitor and enforce the quality control process of sandcrete block making in Nigeria.
- The stakeholders should be enlightened on the dangers of usage of sub standard building materials and products.
- Manufacturers should ensure adequate curing of the blocks produced before selling to clients.

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Table 1: Sieve Analysis of Soil Samples

Sieve Size (mm)	Percentage Passing (%)			
	Sample A	Sample B	Sample C	Sample D
2.38	93.6	94.1	02.1	98.0
1.18	92.7	78.4	73.7	94.0
0.600	28.0	50.0	36.6	74.0
0.425	21.0	36.8	23.7	49.0
0.300	14.4	23.7	11.2	33.0
0.15	0.8	6.5	1.7	3.0
0.075	0.6	0.1	0.1	0.0

Table 2: Compressive Strength Results for Sand-Creed Blocks; Industry A

S/N	Age (days)	Size (mm)	Weight (kg)	Average Weight. (kg)	Crushing Load(KN)	Strength (N/mm²)	Average Strength. (N/mm²)
1.	28	450x225x150	16.9		60.43	1.34	
2.	28	450x225x150	18.4		63.14	1.40	
3.	28	450x225x150	16.5	17.2	59.08	1.31	1.38
4.	28	450x225x150	16.9		63.14	1.40	
5.	28	450x225x150	17.1		64.94	1.44	

Table 3: Compressive Strength Results for Sand-Creed Blocks; Industry B

S/N	Age (days)	Size (mm)	Weight (kg)	Average Weight. (kg)	Crushing Load(KN)	Strength (N/mm²)	Average Strength. (N/mm²)
1.	28	450x225x150	18.6		36.98	0.82	
2.	28	450x225x150	17.0		29.77	0.66	
3.	28	450x225x150	17.5	17.6	32.47	0.72	0.72
4.	28	450x225x150	17.4		31.47	0.70	
5.	28	450x225x150	17.4		31.12	0.69	

Table 4: Compressive Strength Results for Sand-Creed Blocks; Industry C

S/N	Age (days)	Size (mm)	Weight (kg)	Average Weight. (kg)	Crushing Load(KN)	Strength (N/mm²)	Average Strength. (N/mm²)
1.	28	450x225x150	17.2		58.63	1.30	
2.	28	450x225x150	16.8		58.63	1.30	
3.	28	450x225x150	17.8	17.2	65.85	1.46	1.34
4.	28	450x225x150	17.2		60.43	1.34	
5.	28	450x225x150	17.2		58.63	1.30	

Table 5: Compressive Strength Results for Sand-Creed Blocks; Industry D

S/N	Age (days)	Size (mm)	Weight (kg)	Average Weight. (kg)	Crushing Load(KN)	Strength (N/mm²)	Average Strength. (N/mm²)
1.	28	450x225x150	15.2		8.12	0.18	
2.	28	450x225x150	14.8		7.67	0.17	
3.	28	450x225x150	15.0	57.0	6.31	0.14	0.18
4.	28	450x225x150	15.0		7.62	0.17	
5.	28	450x225x150	14.9		5.41	0.12	

Table 6: Compressive Strength Results for Sand-Creed Blocks; Industry E

S/N	Age (days)	Size (mm)	Weight (kg)	Average Weight. (kg)	Crushing Load(KN)	Strength (N/mm²)	Average Strength. (N/mm²)
1.	28	450x225x150	16.5		20.30	0.45	
2.	28	450x225x150	16.6		25.26	0.56	
3.	28	450x225x150	16.1	16.9	22.10	0.49	0.49
4.	28	450x225x150	17.8		22.55	0.50	
5.	28	450x225x150	17.5		20.30	0.45	

Table 7: Compressive Strength Results for Sand-Creed Blocks; Industry F

S/N	Age (days)	Size (mm)	Weight (kg)	Average Weight. (kg)	Crushing Load(KN)	Strength (N/mm²)	Average Strength. (N/mm²)
1.	28	450x225x150	16.5		16.69	0.37	
2.	28	450x225x150	17.3		24.35	0.54	
3.	28	450x225x150	17.2	16.9	19.84	0.44	0.49
4.	28	450x225x150	16.5		24.35	0.54	
5.	28	450x225x150	16.8		24.35	0.54	

Table 8: Compressive Strength Results for Sand-Creed Blocks; Industry A

S/N	Age (days)	Size (mm)	Weight (kg)	Average Weight. (kg)	Crushing Load(KN)	Strength (N/mm²)	Average Strength. (N/mm²)
1.	28	450x225x225	25.8		86.30	1.34	
2.	28	450x225x225	24.5		81.79	1.27	
3.	28	450x225x225	25.4	24.8	86.30	1.34	1.31
4.	28	450x225x225	23.5		81.14	1.26	
5.	28	450x225x225	25.0		88.87	1.36	

Table 9: Compressive Strength Results for Sand-Creed Blocks; Industry B

S/N	Age (days)	Size (mm)	Weight (kg)	Average Weight. (kg)	Crushing Load(KN)	Strength (N/mm²)	Average Strength. (N/mm²)
1.	28	450x225x225	22.8		41.22	0.82	
2.	28	450x225x225	23.1		42.50	0.66	
3.	28	450x225x225	23.2	23.2	48.30	0.72	0.72
4.	28	450x225x225	23.5		51.52	0.70	
5.	28	450x225x225	23.3		42.50	0.69	

Table 10: Compressive Strength Results for Sand-Creed Blocks; Industry C

S/N	Age (days)	Size (mm)	Weight (kg)	Average Weight. (kg)	Crushing Load(KN)	Strength (N/mm²)	Average Strength. (N/mm²)
1.	28	450x225x225	24.1		32.84	0.51	
2.	28	450x225x225	23.4		19.96	0.31	
3.	28	450x225x225	23.8	23.7	22.54	0.35	0.41
4.	28	450x225x225	24.4		35.42	0.55	
5.	28	450x225x225	23.0		19.96	0.69	

Table 11: Compressive Strength Results for Sand-Creed Blocks; Industry D

S/N	Age (days)	Size (mm)	Weight (kg)	Average Weight. (kg)	Crushing Load(KN)	Strength (N/mm²)	Average Strength. (N/mm²)
1.	28	450x225x225	23.4		19.96	0.31	
2.	28	450x225x225	24.4		35.42	0.55	
3.	28	450x225x225	24.0	23.9	32.20	0.50	0.42
4.	28	450x225x225	23.0		23.83	0.37	
5.	28	450x225x225	24.0		24.42	0.38	

Table 12: Compressive Strength Results for Sand-Creed Blocks; Industry E

S/N	Age (days)	Size (mm)	Weight (kg)	Average Weight. (kg)	Crushing Load(KN)	Strength (N/mm²)	Average Strength. (N/mm²)
1.	28	450x225x225	24.5		45.72	0.71	
2.	28	450x225x225	24.5		45.08	0.70	
3.	28	450x225x225	24.5	24.9	45.08	0.70	0.73
4.	28	450x225x225	24.5		48.94	0.76	
5.	28	450x225x225	24.5		48.94	0.76	

Table 13: Compressive Strength Results for Sand-Creed Blocks; Industry F

S/N	Age (days)	Size (mm)	Weight (kg)	Average Weight. (kg)	Crushing Load(KN)	Strength (N/mm²)	Average Strength. (N/mm²)
1.	28	450x225x225	23.0		38.00	0.59	
2.	28	450x225x225	24.5		38.88	0.59	
3.	28	450x225x225	25.5	24.2	48.94	0.76	0.65
4.	28	450x225x225	25.5		47.66	0.74	
5.	28	450x225x225	25.0		38.00	0.59	