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Assessment of Properties of Sandcrete Blocks Produced by Commercial Block Industries in Idah, Kogi State, Nigeria

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Abstract— *The quality of blocks produced varies from one manufacturer to another due to different methods or ways employed in the production and properties of the constituent materials. The aim of this research is to determine the properties of sandcrete hollow blocks produced by block industries in Nigeria, particularly in Idah, Kogi State by assessing the compressive strength and water absorption properties of sandcrete block from four different producers. The samples were obtained from each of the producers. Compressive strength and water absorption tests were conducted on the blocks while grain size distribution analysis was conducted on the sand samples. The test results revealed that the fine aggregates used are suitable for block making. Test results also indicate that the least unit compressive strength of the 150mm (6") sandcrete blocks was 0.99N/mm^2 while the average compressive strength of the blocks (150mm) blocks was 1.12 N/mm. Similarly, the least unit compressive strength of the 225mm (9") sandcrete blocks was 0.63N/mm^2 while the average compressive strength of the 225mm (9") blocks was 0.94 N/mm^2 these values fall below the standard prescribed for load bearing sandcrete blocks. The Nigerian industrial standard 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.Standardization of block manufacturing processes and strict supervision of the production were recommended as measures to improve the quality of sandcrete blocks manufactured by commercial block industries in Idah town in Nigeria.*

Keywords— *Sandcrete blocks, compressive strength, aggregates, curing*.

I. INTRODUCTION

Sandcrete blocks are products of fine aggregate, Portland cement and water in a prescribed mix ratio proportions. The strength of sandcrete blocks depend upon two major factors, namely: mix proportion and method of curing (Aiyewalehimi and Tanimola, 2013). The other factors include the quality of the constituents used and the mode of manufacturing (i.e hand mould and machine mould) according to NIS 87 (2007).

Sandcrete blocks are the most widely used in Building and Civil Engineering projects for various purposes in the construction of walls (i.e. load bearing and non – load bearing walls), to conveniently divided up space and to provide shelter for the security of lives and properties (Ewa and Ukpata 2013)

Sandcrete blocks are usually hollow or solid core and vary in sizes. The standard sizes that are commercially available in Nigeria in accordance with BS 6073 (2008) are:

- 450mm x 225mm x 225mm used for external walls
- 450mm x 225mm x 150mm used for internal walls
- 450mm x 225mm x 112.5mm used for partition only
- 102.5mm x 215mm x 60mm brick for erecting external and partition walls.

Other decorative blocks are available and used for fencing work, ventilation and other aesthetic works (FAO, 1988).

Sandcrete blocks provide thermal and sound insulation in buildings and because of its light weight, larger units for building structures can be made easily when compared with ordinary bricks thus making the operation of erecting building structures faster as they can be readily cut and shaped and also permits the ease of driving in of screws and nails into them Oyekan and Kamiyo (2011).

The production of sandcrete block started with hand – moulding techniques and natural curing in the past but development in modern technology now makes it possible to produce large quantities of these sandcrete blocks using semi – mechanized and fully automatic plants.

These blocks were made in many parts of Nigeria in the past without any reference to any specifications/standards for their quality control. There is great improvement now as the Standards Organization of Nigeria (SON) has published the NIS 87-2000 and NIS 2004 which are specifications both for the manufacture and use of these blocks in Nigeria. The specifications/standards for concrete and sandcrete blocks provide guide for manufacturing and testing of concrete/sandcrete blocks.

Previous researches in the production and properties of sandcrete blocks showed compressive strengths that fall below the requirement for the construction of houses (NIS 87-2000; Abdullahi 2005). This may probably be due to inferior quality of constituent materials.

Generally, compressive strength is the primary yardstick for evaluating the quality of structural members that resist compression. Sandcrete blocks are good in compression but cannot resist much tension as they tend to fail easily at the application of any slightest tensile load. Inasmuch as the water cement ratio, the particle size distribution and curing affect the final strength of sandcrete blocks, it is worthy of note here that the mode of production/workmanship also affect the compressive strength of sandcrete blocks. Through technological advancements, new aggregates are being created that maintain or even improve the performance of block (Aguwa, 2010 and Opeyemi et al, 2013)

Volume 1, Issue 3, pp. 8-11, 2017.

Several studies have been carried out on the production and uses of sandcrete hollow blocks ranging from the low cost production to improved production output. Eze-Uzoamaka (1997) investigated the effect of sand – cement ratio on compressive strength of sandcrete blocks. The results revealed that ratios between 6 and 13 fall within practical and economic limits and within this range, the strength of blocks decreased with increasing sand – cement ratio for a given water cement ratio. A probable explanation being that the cement paste was not adequate to coat the sand used (for high cement ratio), and therefore could not adequately bind them together.

In the specification for sandcrete blocks by the Nigeria Code of Practice (NIS) 87-2000, three types of blocks are commonly available. These are:

- Dense aggregate concrete blocks for general use in building for load bearing or non – load bearing external use.
- Light weight aggregate concrete block for load bearing or non – load bearing external and internal use if protected b y rendering or other effective manner.
- Light weight aggregate concrete block for internal non – load bearing wall and partition.

The aim of this research is to assess the level of compliance with the statutory building regulations and standard by block manufacturers by determining the compressive strength and water absorption properties of sandcrete hollow blocks produced by block industries in Idah, Kogi State, Nigeria.

II. Materials and Methods

For the purpose of this study, four (4) commercial sandcrete block industries were visited in Idah Local Government Metropolis. Ten (10) samples of 450x225x225 mm blocks and another ten (10) numbers of 450x225x150 mm produced by four different block manufacturers were paid for and monitored at the industries where they were been produced and their manufacturing processes were carefully observed without any interference.The sand (fine aggregate) used to produce the blocks was observed as (sharp sand) and samples collected from the block manufacturers for grain particle sieve analysis to ascertain their suitability for block making. The cement used was obtained from the open market and produces by the Dangote Portland Cement PLC in conformity to BS 12 (1991) for ordinary Portland cement. The blocks were weighed and tested for compressive strength using the compression-testing machine in accordance with after 28 days of curing.

The water source for each block industry was noted. The compressive strength results obtained were compared with three available standards namely the National Building Code of Nigeria (2006) as well as the Nigerian Industrial and British Standards. The block industries have been identified as Industry “A”, “B”, “C” and “D”. All the laboratory tests were carried out in the Concrete Laboratory of the Civil Engineering Department, Federal Polytechnic, Idah Kogi State.

III. Results and Discussion

The field result and the laboratory results of the tests conducted are presented as follows:

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 BS 882 (1992). And all samples fall within range and are of medium grading. The soils are suitable for construction work.

TABLE 1: Sieve analysis of sand sample

Sieve Size (mm)	Percentage Sample A	Passing Sample B	(%) Sample C	Sample D
2.23	94.7	93.5	80.0	97.2
1.18	91.6	77.3	72.8	93.2
O.600	27.1	51.1	35.8	75.4
0.425	22.1	37.6	24.1	48.3
0.300	13.9	22.8	11.1	34.0
0.15	0.9	6.4	1.8	3.1
0.075	0.9	0.2	0.2	0.2

Source: Field Work 2015

The analysis of results of the soil samples investigated is shown in the Fig. 1. As it can be seen in figures below; the results grain Size analysis of sand from sites A, B, C and D analyzed showed that the Sand samples used were suitable for all the blocks purchased for the study.

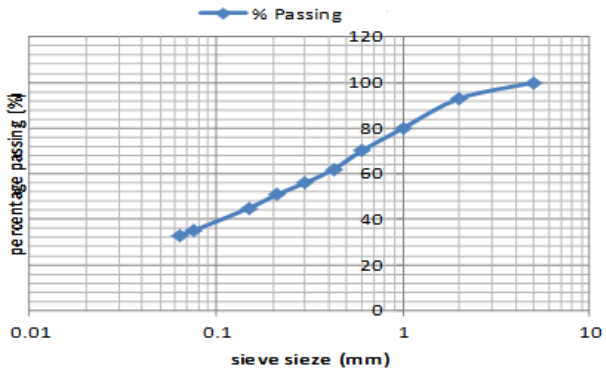

Fig. 1 Particle size distribution of the fine aggregate

Source: Field Work 2015

Water absorption test results

The results of water absorption of samples of blocks from selected block producers A, B, C and D at 28days are presented in tables 2, 3, 4 and 5 below. The corresponding water absorption of block produces for A, B; C and D are 10.12%, 9.26%, 10.72% and 9.40% respectively. The result revealed that the samples of the block from block producers A, B, C and D have very high water absorption; this may be due to improper mixing operation and inadequate mix ratio. However, the maximum water absorption obtained from block producer C (10.72%) is not above the minimum requirement of the NIS 87-2004

TABLE 2: Results of water absorption a 28 days from block producer, A

BLOCKS	1	2	3	Total	Average weight (g)	% water absorbed
Initial weight before absorption (g)	336	337	335	1008	336	$\frac{370-336}{336} \times 100$
Final weight after absorption (g)	369	370	371	1110	370	= 10.12%

Source: Field Work 2015

Volume 1, Issue 3, pp. 8-11, 2017.

TABLE 3: Results of water absorption a 28 days from block producer, B

BLOCKS	1	2	3	Total	Average weight (g)	% water absorbed
Initial weight before absorption (g)	324	323	325	972	324	$\frac{354-324}{324} \times 100$
Final weight after absorption (g)	353	354	355	1062	354	= 9.26%

Source: Field Work 2015

TABLE 4: Results of water absorption a 28 days from block producer, B

BLOCKS	1	2	3	Total	Average weight (g)	% water absorbed
Initial weight before absorption (g)	345	344	346	1035	345	$\frac{382-345}{345} \times 100$
Final weight after absorption (g)	381	383	382	1146	382	= 10.72%

Source: Field Work 2015

TABLE 5: Results of water absorption a 28 days from block producer, C

BLOCKS	1	2	3	Total	Average weight (g)	% water absorbed
Initial weight before absorption (g)	350	351	352	1053	351	$\frac{384-351}{351} \times 100$
Final weight after absorption (g)	383	384	385	1152	384	= 9.40%

Source: Field Work 2015

The blocks bought from different producers were crushed in universal compression testing machine to determine their compressive strength in accordance to NIS 87-2004. The crushing load was recorded and the compressive strength was obtained from the following equation:

$$fc = {}^{P}/_{a}$$

Where *fc* = the compressive strength
P = crushing load
A = cross-sectional area of the specimen

The results of compressive strength of samples of block from block producers A, B, C and D for the compressive strength of 150mm and 225mm (6" and 9") at 28 days are as presented in tables 6, 7, 8 and 9. Test results indicated that the least unit compressive strength of the 150mm (6") sandcrete blocks was 0.99N/mm^2 while the average compressive strength of the blocks (150mm blocks) was 1.12 N/mm^2. Similarly, the least unit compressive strength of the 225mm (9") sandcrete blocks was 0.63N/mm^2 while the average compressive strength of the 225mm (9") blocks was 0.94 N/mm^2. These values fall below the standard prescribed for load bearing sandcrete blocks. The Nigerian Industrial Standard 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.

Table 6: Compressive Strength Results for Block Industry A

			150mm			225mm		
			S1	S2	S3	S1	S2	S3
1	Crushing Load	KN	39.3	44.2	48.4	54.1	47.6	50.6
2	Sectional Area	mm^2	35100	35100	35100	59480	59480	59480
3	Compressive Strength	Nmm^{-2}	1.12	1.26	1.38	0.91	0.63	0.85
4	Mean CS	Nmm^{-2}		1.25			0.80	

Source: Field Work 2015

Table 7: Compressive Strength Results for Block Industry B

			150mm			225mm		
			S1	S2	S3	S1	S2	S3
1	Crushing Load	KN	42.8	39.3	35.8	52.8	49.4	57.1
2	Sectional Area	mm^2	35100	35100	35100	59480	59480	59480
3	Compressive Strength	Nmm^{-2}	1.22	1.12	1.02	0.88	0.83	0.96
4	Mean CS	Nmm^{-2}		1.12			0.89	

Source: Field Work 2015

Table 8: Compressive Strength Results for Block Industry C

			150mm			225mm		
			S1	S2	S3	S1	S2	S3
1	Crushing Load	KN	48.1	37.9	36.5	60.7	44.0	74.4
2	Sectional Area	mm^2	35100	35100	35100	59480	59480	59480
3	Compressive Strength	Nmm^{-2}	1.37	1.08	1.04	1.02	0.74	0.80
4	Mean CS	Nmm^{-2}		1.20			0.85	

Source: Field Work 2015

Table 9: Compressive Strength Results for Block Industry D

			150mm			225mm		
			S1	S2	S3	S1	S2	S3
1	Crushing Load	KN	34.7	45.9	43.5	55.3	57.1	54.7
2	Sectional Area	mm^2	35100	35100	35100	59480	59480	59480
3	Compressive Strength	Nmm^{-2}	0.99	1.31	1.24	0.93	0.96	0.92
4	Mean CS	Nmm^{-2}		1.18			0.94	

Source: Field Work 2015

Volume 1, Issue 3, pp. 8-11, 2017.

From the results obtained above, it can be clearly seen that none of the producers complied with the allowable mix ratio standard for sandcrete blocks. In fact, most of them only spread the hip of sand and add cement without the adoption of any specific ratio. It was also observed that none of them followed the appropriate method of curing by immersing the blocks in curing tank for the design period but instead they spray the blocks with water twice a day morning and evening and they start selling out the blocks from the third day of curing instead of minimum of one weak.

Considering the site supervision and procedure of the tests conducted it is important to make the following observations and conclusion on the nature and quality of the Sandcrete blocks produced in Idah, Kogi State of Nigeria.

The compressive strengths of sandcrete blocks produced in all the selected industries (A, B, C and D,) at 28 days are much lower than the minimum value of 2.5 N/mm^2 specified by the Nigerian Industrial Standard. The overall average dry development strength value is 1.12 N/mm^2. All the sand particles used by industries A, B, C, and D fall within acceptable standard of the grading curve of BS 882 (1992).

Most of block manufacturing industries investigated did not use standard measures in batching sand used, Instead of using gauge-box, wheelbarrows or head pans, they shovel the sand around, spread cement on and rely on visual inspection or "experience" to know when an adequate quantity of sand had been measured. Water was arbitrarily added to the cement and sand mix in all the industries selected. Curing was performed by sprinkling water on the blocks every morning and evening for two to seven days. The source of Water used for the mixes were by supply from commercial water tanker. The number of 450mm x 225mm x 225mm hollow sandcrete blocks produced per 50kg bag of ordinary Portland cement varied from 25 to 28 and 35 to 40 for 450mm x 225mm x 150mm hollow sandcrete blocks.

The results obtained from the water absorption tests are tolerable with an average of 9.4% which falls below the upper limit of 11% specified in NIS 87-2004.

IV. CONCLUSION

The paper has assessed the strength of commercial sandcrete blocks produced in Idah, Kogi State of Nigeria. The block producers do not take quality control serious; they do not adhere to the standard specification for mix ratio as is required for sandcrete blocks production. They also do not conform to the standard method and duration for curing as they do it haphazardly by spraying water with a hose twice a day for a period of three days or more. However, the water absorption capacities of the block samples were within tolerable limit.

V. RECOMMENDATIONS

It is therefore recommended that workshops/seminars should be organized periodically to enlighten the producers of sandcrete blocks on importance of adhering to standard specifications and strict penalties should be meted out to erring producers by the Nigerian Industrial Standard Organization and professional bodies such as CORBON, COREN or Governmental agencies.

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