



QUALITY ASSESSMENT OF COMMERCIAL SANDCRETE HOLLOW BLOCKS PRODUCED IN KAURA DISTRICT, ABUJA

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ABSTRACT

The study was carried out to assess the performance of commercially produced sandcrete hollow blocks in Kaura District, Abuja. One hundred and eighty (180), nine (9) inch sandcrete hollow blocks, eighteen (18) each from each factory, were collected from ten sandcrete block producing factories and subjected to compressive strength and Durability test, for compliance with existing standards: Nigerian Industrial Standard, Nigerian Building Code and British Standard. The 7 to 28 days' compressive strengths regardless of the block size ranges between 0.68 N/mm² to 3.06 N/mm². The results showed that only 40% of the blocks commercially produced within the Kaura District, Abuja meet the minimum specification of 2.5 N/mm² for non-load bearing as stipulated in Nigerian Industrial Standard NIS 87 (2000) and the 3.45 N/mm² NIS requirement for load bearing sandcrete blocks is not met by 100% of the industry. The density of blocks produced at different factories have densities which were within the value specified by BS 2028 (1968) and NIS 87 :2000. Test results also indicate that the total water absorption of all collected block samples was lower than the maximum value of 7 % as stipulated in BS 5628 and also lower than 12% requirement of NIS standard. According to this research, all the hollow sandcrete blocks examined are considered to be of low porosity.

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1.0 Introduction

Sandcrete hollow block is defined as a composite material that is molded into various sizes using a mixture of cement, fine aggregate, and water (NIS 444-1: 2003). Because the raw materials needed to produce sandcrete blocks are readily available, they are widely used around the world, particularly in Africa as walling units either as load bearing or non-load bearing walls. Sandcrete blocks have become widely used in the construction industry for use as load-bearing and non-load-bearing structures. Its many advantages stem from its unique properties, such as strength, density, water absorption, durability, affordability, and dimensional accuracy. A number of factors influence the quality of sandcrete blocks, such as the materials used in the production process, the amount of time the blocks are left to cure, and the size and form of the blocks (Akpokodje and Uguru, 2019). Despite the introduction of new materials like life bricks and modified clay blocks, sandcrete blocks seem to be an improvement over these materials. The building industry plays a significant role in the economy of developing nations such as Nigeria. Sandcrete blocks are widely utilized as walling units, and in Nigeria, they are used in the construction of over 90% of buildings (Baiden and Tuuli, 2004). In most part of Nigeria, Sandcrete blocks are one of the most expensive components of building structures. Sandcrete blocks are therefore an essential component in building construction in Nigeria especially with the rapid urbanization and expansion of its towns and city centers amid industrialization and commercial growth. However, it is well-established that most sandcrete blocks used in developing countries—particularly in sub-Saharan Africa—are of low quality (Anosike and Oyebade 2011). Previous studies conducted in Nigeria have also showed the very poor performance of these sandcrete blocks, whose strength and durability fall short of minimum requirement stipulated in the NIS: 1975 standard, making them unsafe for use in building construction (Agbi *et al.* 2020). For the purpose of using sandcrete blocks to construct both load-bearing and non-load-bearing walls, the Nigeria Industrial Standard specifies a minimum compressive strength of 3.45 N/mm², and 2.5 N/mm² respectively (NIS: 2000).

Numerous studies on the quality of sandcrete hollow blocks made by commercial block factories in Nigeria showed that most of their blocks had a 28-day dry strength between 0.50 to 1.5 N/mm² in Nigeria (Ejeh and

Abubakar, 2008; Onwuka *et al.*, 2013., Ewa and Ukpata, 2013;). These studies identified several reasons for the production of low quality sandcrete hollow blocks by block producer to include inadequate curing, poor craftsmanship, and an improper cement to sand mix ratio. According to Anosike and Oyebade (2011), they found that the commercially manufactured sandcrete hollow blocks in Ota, Ogun State, Nigeria, and the Nigerian Federal Capital Territory, Abuja, did not meet the Nigeria Industrial Standard requirements for compressive strength. According to Ambrose *et al.* (2019), the compressive strength of blocks from 12 block-producing factories in the southern Nigerian state of Akwa Ibom had compressive strengths ranging from 0.19 and 1.32 N/mm². Related research conducted in Akure, Ondo State, Nigeria, found that 1.35 N/mm² was the maximum compressive strength of sandcrete blocks randomly sampled within the city. (Aiyewalehinmi and Tanimola, 2013). Similarly, Mohammed and Anwar (2014) found that samples of sandcrete blocks from block producers in Kano, Northern Nigeria, had compressive strengths ranging from 0.25 to 0.92 N/mm². This indicates that all of the sandcrete blocks were substandard and did not meet the Nigeria Industrial Standard requirements. One of the main causes of structural failures, which is recently on the increase in Nigeria, is the use of low quality sandcrete blocks Akeem and Umar (2013) and Agbi *et al.* (2020). Omoregie and Alutu (2006) stated that Poor-quality sandcrete blocks can collapse under its self- weight, which can result in structural failure. According to Ayedun *et al.* (2010), they stated that the persistent building failures in Lagos state can be attributed, in part, to the use of poor sandcrete blocks.

The Nigeria Building Codes stated that sandcrete blocks to be used for the construction of load bearing walls must be in accordance to NIS requirement. Several literature reviews have revealed that there is no information available about the compressive strength and durability test of sandcrete blocks produced commercially in Kaura District, Abuja Nigeria. The district is become more urbanized and populated. Therefore, this study is aimed at investigating the quality in terms of compressive strength and durability test of sandcrete hollow blocks produced commercially within Kaura District of Abuja, Nigeria. Findings from this study will help the appropriate authorities in monitoring the quality of the blocks produced in Abuja's Kaura District and its the surrounding areas.

2. Materials and Methods

2.1 Materials

The materials used for this study are commercial sandcrete hollow blocks produced in selected factories of Kaura District Abuja, Nigeria.

2.2 Method

This study was conducted using both field survey and laboratory experiment. After analysis, the findings from the field survey and lab experiment were compared to the British Standard, the Nigerian Building Code (NBC 2006), and the Nigerian Industrial Standard requirements for sandcrete blocks (NIS 87 2007).

2.2.1 Field Survey

A total of one hundred and eighty (180) machine-vibrated sandcrete hollow blocks were randomly selected and assessed for this study, sourced from ten (10) different manufacturers located in the Kaura District of Abuja, Nigeria. Eighteen (18) 9-inch blocks (450 x 225 x 225 mm) were collected from each of the block producer. To maintain confidentiality, the blocks obtained from each manufacturer were labelled and coded alphabetically from A to J, ensuring that the identities of the factories being assessed were not disclosed. It is important to emphasize that these labels are arbitrary and do not correspond to the names of the manufacturers or reflect the quality of the blocks produced by these factories.

2.2.2 Laboratory Experiment

The laboratory test carried out on the sandcrete hollow block samples include block measurement, Bulk density of sandcrete hollow blocks, compressive strength, and Durability test. The procedures used to carry out these tests are described as follows.

2.3 Sandcrete Blocks Acquisition

One hundred and eighty (180) pieces of 450 mm x 230 mm x 230 mm sandcrete hollow blocks were randomly selected from ten (10) sandcrete blocks producing factories within Kaura District of Abuja. All the blocks were collected after 3 days of production. All the blocks collected from the factories were taken to the Baze university civil engineering laboratory for continuous curing, compressive strength and durability test.



Figure 1: Sandcrete Hollow Blocks from Different Factories

2.3.1 Mix Ratio

The fieldwork observations showed that all of the block industries visited used the volumetric batching method which according to the block producer is faster and easier than batching by weight despite the fact that the weight batching method is more accurate. Regarding the water-to-cement (w/c) ratio, none of the block factories followed any approved guidelines. They all randomly add water to the mixture of cement and sand mostly on the basis of their individual visual assessments of the appropriate consistency needed for the mix. Investigation shows that hollow sandcrete blocks obtained from selected block factories ranges from 50 to 75 pieces of blocks from one bag of cement.

2.3.2 Mode of Block Production

Based on observations made in the field, the majority of block producers produced blocks using vibrating block moulding machines and mechanical sandcrete mixers. However, a few factories used manual laborers to mix and mold their blocks.

2.3.3 Block Measurement

The dimensions of the blocks were determined as stipulated in NIS 87:2007. The samples were prepared by scraping off any unnecessary material that had adhered to the surface of the blocks, and then measuring tapes were used to determine the blocks' length, breadth, and depth. The block dimensions obtained were compared with the standard requirement for dimensions as provided by the NIS 87:2007 and Nigeria Building Code 2006. The block dimensions obtained were used to calculate the gross area, net area, gross volume and net volume.

2.3.4 Density of Sandcrete Hollow Blocks

The purpose of the test is to determine the unit weight of the hollow sandcrete blocks. The test was conducted as specify in BS 2028 (1968). The density of the block is given by the following equation:

$$\text{Density (Kg/m}^3\text{)} = \frac{\text{Weight of the Block}}{\text{Block's Net Volume}} \quad (1)$$

2.3.5 Compressive Strength

A compressive testing machine was used to carried out the compressive strength of the blocks in the Baze University Abuja, Nigeria, after the necessary curing days of 7, 14, 21, and 28 days. The compressive strength test was carried out on the hardened blocks at 7, 14, 21, and 28 days of age to determine the load-bearing capacity of the hollow sandcrete block samples, which was carried out as stipulated in BS 6073 Part 1, (1981). For each block factory, 3 blocks were crushed to obtain the average strength using the following Equation

$$\text{Compressive strength (N/mm}^2\text{)} = \frac{\text{Crushing load}}{\text{Net area of block}} \quad (2)$$



Figure 2: Crushing of Block using the Universal Compression Machine

2.4 Durability Test Evaluation on Sandcrete Hollow Block

The bulk properties that were determined to be very relevant to the investigation into sandcrete's durability from randomly selected factories include the following.

2.4.1 Block Dry Density

The block's density is a useful indicator for assessing its quality. The dry density test was conducted carefully as stipulated in (BS 6073: Part 2, 1981) by weighing the block samples after they were oven-dried at $105 \pm 5^\circ\text{C}$ for 24 hours as shown in plate 3 and the dimensions of the block samples were taken with an accurate steel tape. The dry density was then calculated using the formulae in Equation

$$\text{Block Dry Density (kg/m}^3\text{)}, \quad \ell d = \frac{M}{V} \quad (3)$$

where, ℓd = Dry density

M = Mass of dry block sample

V = Volume of block sample.



Figure 3: Block samples oven dry in oven for 24 hours

The density obtained in each case was expressed to the nearest kg/m^3 .

2.4.2 Total Water Absorption (TWA)

The total water absorption test of the block samples was conducted by cold immersion method, which was carried out as specify in BS 3921, 1985. Block samples are first oven-dried for 48 hours, and then they are

immersed in cold water, as Plate 3 illustrates. The block samples were dried in oven to constant weight, thereafter they were immersed in water for 24 hours. The weights of the wetted blocks were then measured. The percentage water absorption was calculated from the formula in Equation 2.

$$\text{Total Water Absorption} = \frac{W_w - W_d}{W_d} \times 100 \quad (4)$$

where

TWA = percentage water absorption (%)

W_w = mass of wet sample

W_d = mass of dry sample



Figure 4: Sandcrete Hollow Blocks immersed in Water for 24 Hours

The result was expressed as a percentage of the original dry mass of the specimen to the nearest 0.01% the dry mass.

2.4.3 Total Volume Fraction Porosity (TVP)

The term porosity refers to the total amount of voids and pore structure within a block sample. The total volume fraction porosity of the sandcrete blocks was determined by direct measurement of the weight gain on saturation with water of an initially dry block after evacuation to remove air from the pore network (Jackson and Dhir, 1996). The water absorption is expressed as before in weight percent. The value of the water absorption may be converted to volume basis porosity by using the following relationship (Jackson and Dhir, 1996):

$$n = \frac{(TWA)\rho}{100 \rho_w} \quad (5)$$

Where

n = volume fraction porosity

ρ = dry block density (kg/m^3)

ρ_w = density of water (kg/m^3)

TWA = water absorption (%)

2.4.4 Wet and Dry Compressive Strength

The wet and dry compressive strength test was carried out to determine the load bearing capacity of the hollow sandcrete block samples, which was carried out in accordance to BS 6073 Part 1, (1981). Compressive strength was obtained for each sample using the formula in Equation (6).

$$\text{Compressive strength } (N/mm^2) = \frac{\text{Crushing load}}{\text{Net area of block}} \quad (6)$$

For the wet compressive strength test, block samples were pre-soaked for 24 hours while for the dry compressive strength blocks samples were oven dried to constant mass.

3. Results and Discussion

3.1 Mix Ratio

Table I show the number of sandcrete hollow blocks obtained from one bag of cement according to what was revealed by various manager of the selected block making factories within Kaura District Abuja, Nigeria. None of the block factory adopted the NIS approved cement-sand mix ratio of 1:6 or 1:8, Hence, all the block factories failed to meet the NIS approved recommendations for sandcrete blocks. The number of blocks from one bag of cement ranges between fifty (50) to seventy-five (75). The price of a 450 mm x 225 mm x 225 mm ranges between four hundred and fifty naira to Five hundred naira. It was observed that the more expensive the blocks are, the less the number of blocks produced from one bag of cement and the better the quality.

Table I: Number of Blocks from one Bag of cement from various factories

Factory	A	B	C	D	E	F	G	H	I	J
Number of Blocks	55	65	70	55	50	75	50	55	50	75

3.2 Block Measurement

The dimensions of the hollow sandcrete blocks obtained from selected manufacturers within Kaura District of Abuja were measured to the nearest 1mm in the order of Length x Width x Height and hollow dimension which were found to varies. The test result indicates that all block factories have minimum dimensions that fall within the stipulated dimensional tolerance in accordance to (NIS 87: 2007) with respect to height, breadth, and length. These findings also reveal that the blocks' dimensions are not precise and do not meet standard requirements. This is caused by the use of deformed molds and incorrect machine mold tuning, which can result in an increase or decrease in the dimensions of hollow sandcrete blocks.

3.3 Density of Hollow sandcrete Blocks

The calculated densities of the tested sandcrete hollow blocks obtained from 10 manufacturers are shown in Table 2. From the 10 randomly selected factories, the mean density of blocks from selected block producer ranges between 1434.3 Kg/m³ and 2123. Kg/m³. These values meet the 1500 Kg/m³ BS 2028:1996 recommendation for an average of three blocks except the density of Industry A with 1434.3 Kg/m³ at 7 days curing.

Table 2. Density of blocks obtained from manufacturers

S/N	Industry	Average Density of Hollow Sandcrete Blocks (Kg/m ³)			
		7 Days	14 Days	21 Days	28 Days
1	A	1434.3	1821.0	1712.0	1962.5
2	B	1529.6	1648.4	1617.5	1691.8
3	C	1515.7	1979.8	1874.9	1907.1
4	D	1683.0	1656.1	1656.06	1756.2
5	E	1987.4	1988.6	1930.0	2035.2
6	F	1871.2	1799.0	1865.8	1810.3
7	G	2062.5	2055.1	2111.3	2047.8
8	H	1831.9	1740.4	1832.4	1868.8
9	I	1991.1	1995.9	2087.01	2123.6
10	J	1741.9	1646.7	1697.1	1766.1

All the density is also above the minimum value of 1500kg/m³ recommended for first grade sandcrete blocks by NIS 87:2000 while all densities of hollow sandcrete blocks were within the range specified for sandcrete blocks, hence hollow sandcrete blocks produced at randomly selected industries could be suitable for construction as load bearing blocks.

3.4 Compressive Strength

The results of the average compressive strength test carried out on hollow sandcrete block samples from the 10 randomly selected block industries within Kaura District Abuja captured in this study at, 7, 14, 21, and 28 days of curing is shown in table 3. whereas the graph in Figure 1 illustrates the increase of the compressive strength of hollow sandcrete blocks with the age of curing for different block factories.

Table 3: Average Compressive Strength of Hollow Sandcrete Blocks (N/mm²)

Average Compressive Strength of Hollow Sandcrete Blocks (N/mm ²)					
S/NO	Block Label	Day7	Day 14	Day 21	Day 28
1	A	1.93	1.96	2.12	2.22
2	B	1.22	1.39	1.61	1.70
3	C	0.85	1.10	1.31	1.38
4	D	1.46	1.84	2.07	2.22
5	E	2.41	2.71	2.83	3.06
6	F	0.88	0.96	1.09	1.18
7	G	2.48	2.68	2.76	2.84
8	H	1.68	2.04	2.24	2.50
9	I	2.09	2.34	2.84	3.04
10	J	0.68	0.91	1.11	1.19

The compressive strengths of all the selected block industry range from 0.66 N/mm² to 3.06 N/mm². This is similar with the findings of previous studies by Odeyemi *et al.* (2018) and Ewa and Ukpata (2013). According to studies by Ewa and Ukpata (2013), several block manufacturers in Calabar produced sandcrete blocks of varying quality. They described the differences in compressive strength to the properties of the constituent materials used in the production sandcrete blocks. The findings show that, of the hollow sandcrete blocks produced commercially in the Kaura District of Abuja, only 40% meet the Nigeria Industrial Standard NIS 87 (2000) minimum specification of 2.5 N/mm² for non-load bearing after 28 days of curing for industry E, G, and H I, with 2.71 N/mm², 2.68 N/mm², 2.50 N/mm², and 2.84 N/mm², respectively, and that 100% of the industry does not meet the required Nigeria Industrial Standard requirement for load loading sandcrete blocks of 3.45 N/mm². Similar findings were made by Onwuka *et al.* (2013), Yusuf *et al.* (2017), and Aiyewalehinmi and Tanimola (2013), and who found that the compressive strength of sandcrete blocks from different parts of Nigeria consistently falls short of the 2.5 N/mm² and 3.5 N/mm² requirement by the Nigeria Industrial Standard and Standards Organization of Nigeria for load-bearing walls and non-load-bearing walls, respectively. The low quality of the sandcrete blocks produced by factories B, C, F, and J may be as a result of the poor fine aggregate (granite dust 1 and 2), mix ratios used by these block producers. Blocks from factory E recorded the highest mean compressive strength of 3.06 N/mm² while those from factory F recorded the least value of 1.18 N/mm² after 28 days of curing

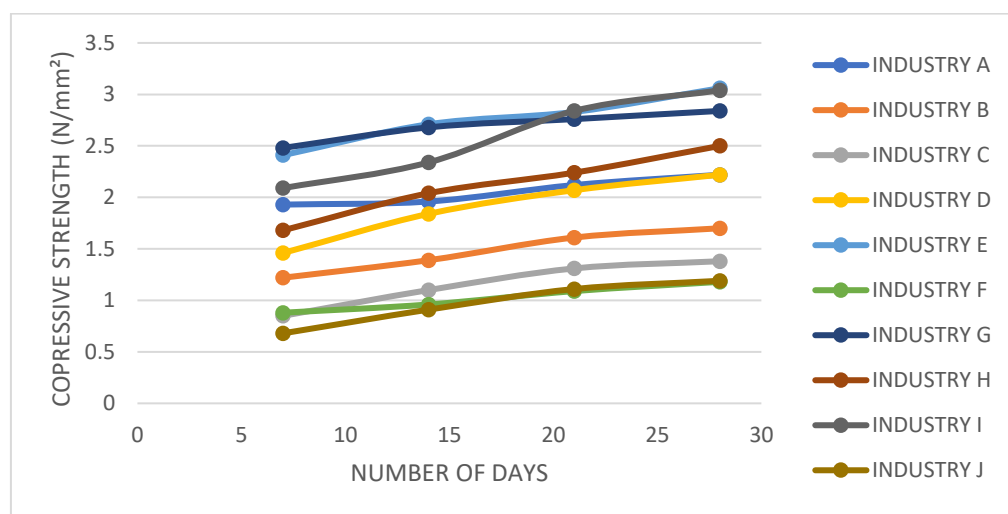


Figure 5: Compressive strength of collected sandcrete block samples at different days of curing age

3.5 Dry Density of Sandcrete Hollow Block

Table 4 shows the result of the block dry density, total water absorption and total volume porosity of hollow sandcrete blocks produced at selected block industries in Kaura District, Abuja after 28 days of curing ranges between 1604.47 Kg/m³ and 2082.07 Kg/m³, with an average density of 1864.18 Kg/m³.

Table 4: Total Water Absorption (TWA) and Total Volume Porosity (TVP) Test Result

S/NO	Block Label	Dry weight (kg)	Weight after soaking for 24hrs (kg)	Water Absorption (%)	Block Dry Density (Kg/m ³)	Total Volume Porosity (%)
1	A	19.03	19.82	4.13	1998.05	8.26
2	B	18.98	19.93	4.99	1589.85	7.93
3	C	18.92	19.88	5.11	1768.77	9.04
4	D	19.00	19.9	4.76	1862.19	8.86
5	E	18.85	19.85	5.30	1989.93	10.55
6	F	19.18	19.9	3.75	1869.28	7.01
7	G	20.14	21.01	4.33	2082.07	9.03
8	H	19.46	20.6	5.87	1794.58	10.54
9	I	20.04	21.11	5.33	2030.25	10.81
10	J	21.14	22.22	5.04	1769.65	8.92

The values of the sandcrete block for all the selected industries falls within the recommended values of density for type “A” blocks according to BS 2028 (1970), and also falls within the minimum specification of 1500 Kg/m³ recommended for first grade (type “A” - load bearing block) sandcrete blocks by Nigeria Industrial Standard NIS 87: 2000.

3.6 Total Water Absorption

Table 4 shows the results obtained from the test of total water absorption conducted on sandcrete hollow block for the selected factories of Kaura District Abuja, Nigeria after 28 days of curing. All industries assessed met the requirement stipulated by NIS 87:2007, which specify a maximum water absorption rate of 12%. It can be noted that the factory F and H has the least and highest water absorption of about 3.75 % and 5.87 % respectively. It was observed that all the block factories used quarry dust as fine aggregate makes the average absorption to drop. This is probably due to the strong bond that is formed between the cement and the quarry dust (granite dust), which also fills in the voids space in the hollow sandcrete blocks and indicates that the sandcrete hollow blocks are more compact. Also, when compared against the standard specify by BS 2028 (1970) Part 1, all the block factories exhibited a low total water absorption, as their values fell below the specified acceptable range of 7%. Thus, all the hollow sandcrete blocks produced by the selected factories passed the water absorption test.

3.7 Total Volume Porosity (TVP)

Table 4 shows the results obtained from the test of total volume porosity conducted on sandcrete hollow block for the selected factories of Kaura District Abuja, Nigeria after 28 days of curing. Neither FMW, NIS, nor BS Code have specified any particular TVP standards. But materials with a TVP higher than 30% are considered very porous, according to Jackson and Dhir (1996). The values for all hollow sandcrete blocks for the selected factories compared well with those of like materials; Clay bricks 0 - 30%; Concrete blocks 4 - 25%; calcium silicate bricks 6 -16% (Jackson and Dhir, 1996). Materials with total volume porosity above 30% are considered to be of high porosity (Keralli, 2001). All the hollow sandcrete blocks evaluated during this research can therefore be considered to be of low porosity since the value obtained is below 30% that is, it ranges between 7.93 % and 10.81 %.

3.8 Dry and Wet Compressive Strength

The values of the average 28-day curing of the wet and dry compressive strength and as well as the corresponding ratios between these strengths for all the sandcrete blocks from the selected factories in Kaura District, Abuja is given in Table 5.

Table 5: Ratio of Dry and Wet Compressive Strength of Hollow Sandcrete Blocks

Ratio of Dry and Wet Compressive Strength				
S/NO	Block Label	Dry Compressive Strength (N/mm ²)	Wet Compressive Strength (N/mm ²)	Ratio
1	A	2.23	1.13	1.97
2	B	1.67	0.95	1.76
3	C	1.43	0.81	1.77
4	D	2.25	1.14	1.97
5	E	3.08	1.62	1.90
6	F	1.17	0.84	1.39
7	G	2.88	1.27	2.27
8	H	2.52	1.03	2.45
9	I	3.11	1.50	2.07
10	J	1.27	1.06	1.20

The dry compressive strength (DCS) values across all industries range from 3.11 N/mm² to 1.27 N/mm², with factory I exhibiting the highest DCS and Industry J the lowest. In terms of wet compressive strength (WCS), the values range from 0.81 N/mm² to 1.62 N/mm², with Industry C and E having the lowest and the highest respectively.

3.8 Ratio of Dry and Wet Compressive Strength

The ratio of dry and wet compressive ranges between 1.39 and 2.45 with factory G, H, and I, having higher value of 2.0 as shown in table 5. The findings revealed that the higher and broader the ratio between mean dry compressive strength and wet compressive strength, the lower can the degree of inter granular bonding be expected to be. It can be concluded that the reduction in ratio for 70 % of the block factories is directly attributed to the use of granite fines and corresponding cement quantity. This must have transformed the weaker and more porous sandcrete blocks fabric into a far denser, more homogeneous and more impermeable matrix. The values obtained fall within the range of recommended values in literature that the ratio of the mean dry and wet compressive strength sandcrete hollow blocks should not be greater than 2, Keralli (2001). Therefore, the experimental results obtained for 70% of the factories fall well within this limit.

4. Conclusion

The following conclusions were reached following an assessment of the result obtained from the field survey and the laboratory tests conducted on the selected block factories:

- i. Most block producers in the study area are not aware of the existence of any standard specification for sandcrete blocks production. As a result, the producer engaged in unhealthy activities during the production process.
- ii. There was no quality assurance on the blocks as none of the producer block factory carried out any test on the constituent materials.
- iii. The 28-day compressive strength of commercially available sandcrete blocks obtained from the ten selected block factories in Kaura District, Abuja ranges between 1.19 to 3.06 N/mm². Only 40% of the hollow sandcrete blocks commercially produced within the Kaura District, Abuja meet the minimum specification of 2.5 N/mm² for non-load bearing as stipulated in Nigeria Industrial Standard NIS 87 (2000) for industry E, G, H I with 2.71 N/mm², 2.68 N/mm², 2.50 N/mm², and 2.84 N/mm², respectively and 100% of the industry do not meet the required NIS standard for load loading sandcrete block of 3.45 N/mm².
- iv. The density of hollow sandcrete blocks produced at different block factories have densities which were within the value specified by BS 2028 (1968) and NIS 87 :2000
- v. The water absorption values of commercially available hollow sandcrete blocks obtained from ten block factories in Kaura District, Abuja were lower than the maximum value of 7 % as stipulated in BS 5628 and also lower than 12% requirement of NIS standard.
- vi. All the hollow sandcrete blocks examined during this research are considered to be of low porosity. To ensure that best practices are continually followed during the production process, manufacturers should place a high priority on continuous education and training of their staff. This includes formal training on mix ratios, curing techniques, and quality control measures. Furthermore, it is imperative that producers adhere strictly to established standards and specifications for sandcrete block production.

Regulatory bodies should enforce compliance, with penalties imposed on those who fail to meet the prescribed requirements. The government should conduct regular, unannounced inspections of sandcrete block manufacturing facilities to ensure compliance with standards. This would serve as a deterrent against non-compliance and promote the consistent production of high-quality blocks across the industry.

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