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# Quality Assessment of Commercial Sandcrete Blocks in Minna Metropolis, Niger State

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## Abstract

*The spate of building collapse across the country over the years has raised questions about the quality of building materials and the need to investigate their suitability for construction. Sandcrete blocks are of interest been the most popular masonry unit widely employed in construction of walling units for building structures, hoardings of construction sites and foundations, in Nigeria. The aim of this study is to assess the quality of commercial Sandcrete blocks produced in Minna metropolis, Niger State, for compliance with existing standards: Nigerian Industrial Standard and Nigerian Building Code. The research was appraised through field surveys methods, sampling and laboratory experiments conducted on sixteen (16) selected block factories in Minna metropolis. A total of eighty (80) nine-inch blocks, five (5) each, were sampled from each factory and subjected to dimensional checks, water absorption and compressive strength tests. The results obtained from the laboratory experiments showed that the dimension, compressive strength and water absorption capacity of the sampled blocks were below standard specifications. The highlight of the field survey carried out showed discrepancies in the mix proportioning, curing practices and age of blocks utilized in the factories against those of the standards. Consequently, it was recommended that blocks produced in Minna should never be used for load bearing walls.*

**Keywords:** Nigerian Building Code, Nigerian Industrial Standard, Sandcrete Blocks, Quality Assessment

## 1.0 INTRODUCTION

The growth in the economy of the West African countries particularly Nigeria has led to an increase in activities within the construction sector, due to the continuous need for infrastructure in these countries. The demand for affordable housing is high and the ambition of people to own or access shelter is never a luxury but a necessity, to address this issue, attention has been drawn towards low-cost building materials. In Nigeria, Sandcrete blocks are the most popular, economic and frequently used masonry material for constructing walling units in residential, commercial and industrial buildings.

Sandcrete blocks are composite mixtures comprising of cement, fine aggregates and water, mould into different sizes [1]. It is widely used in Nigeria and virtually all African countries as walling units, for constructing drainages including works below ground level. They are available in Nigeria in different sizes and could be solid-filled or rectangular hollow piece, the hollow blocks are readily available and commonly used in Nigeria [2].

They could be used for constructing load bearing and non-load bearing structures and are also suitable for making partitions in buildings, hoarding of construction sites, fencing and creating barriers. Sandcrete blocks provides thermal, airborne and sound insulation in building and are better alternatives to the clay bricks, by virtue of their lightweight larger units for building structures can be made easily, thus making the operation and erection of building structures faster as they can be readily cut and shaped and also permit the ease of driving in screws and nails into them [3].

[4] observed that blocks have been manufactured in various part of Nigeria, without due reference to any specification to suit local building requirement or good quality work notwithstanding, the introduction of the Nigerian Industrial Standard for sandcrete blocks in the year 2000 [5]. The primary aim of developing the document is to control the quality of blocks by ensuring that all factories adhere to minimum stipulated requirement and as well serve as a standard reference document for producing Sandcrete blocks in Nigeria. In the year 2004 the document was reviewed; the last review was conducted in the year 2007 and it is known as [6]. It is the current standard document for Sandcrete blocks in Nigeria.

The current wave of the building collapse recorded in Nigeria has continued to raise concerns about the quality of commonly used building materials such as

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Sandcrete blocks and the need to constantly investigate their suitability for construction purposes because they account for over 90% of the physical infrastructure in Nigeria [7]. The quality of Sandcrete blocks is an important area of interest especially when utilized in the construction of load bearing walls. [6] recommends that the lowest compressive strength of individual non-load bearing blocks shall not be less than 2.5N/mm$^2$ and mean value of 3.45N/mm$^2$ for load bearing units.

However, previous studies conducted by [8-10] on sandcrete blocks in Minna Niger State all showed that the blocks were of poor quality and below the standard recommendations of the Nigerian Industrial Standard. The consequence of using sub-standard blocks in construction could manifest in form of crack development in buildings especially when employed in construction of load bearing units. In cases of high inundation, the porosity of blocks increases, consequently becoming weakened and eventually fail. [11] posited that the rapid increase in the cost and demand for cement has uncountable effect on the cost of building blocks which has made most commercial blocks producers to compromise the standards of production in an attempt to maximize profit and produce blocks that will be affordable to people.

One of the greatest challenges in Nigerian construction industry today is the attitude towards material testing to ascertain strength and performance of construction material under applied loads. The poverty level of the West African countries particularly Nigeria has made the use of substandard materials applicable and widely acceptable among the populace in order to minimize construction cost [12]. Consequently, the need to periodically and consistently assess and re-assess the quality of commercially produced blocks can never be over emphasized

## 2.0 MATERIALS AND METHODS

### *2.1 Materials*

The materials used for this research are commercial Sandcrete blocks produced in selected factories of Minna Metropolis, Niger State.

### *2.2 Methods*

The method adopted for carrying out this study include field survey and laboratory experiments. The analysis of the result obtained from the field survey and laboratory experiment was compared with the standard specifications of the Nigerian standard for Sandcrete blocks [6] and [13]. The correlations and discrepancies observed informed the conclusion of the study.

#### *2.2.1 Field Survey*

The field survey involved collection of a total of eighty (80) nine inches hollow Sandcrete blocks five (5) each from sixteen (16) selected manufacturing factories in Minna metropolis and also direct observation of the processes and techniques engaged amongst the manufacturers in the production process such as batching method, curing method, mix proportion, age of blocks and quality assurance.

#### *2.2.2 Laboratory Experiment*

The laboratory experiment conducted on the block samples include block measurement, water absorption capacity and compressive strength tests. The procedures adopted in conducting these experiments are detailed as follows.

### *2.3 Block Measurement*

The standard measuring procedure as specified in [6] was observed to obtain the dimensions of the sampled blocks. The samples were prepared by scraping off outcrops and redundant materials adhering to the surface before the length, width, and depth was measured using a measuring tape. The thickness of shells and web was measured by means of a Vernier calliper.

The block dimensions obtained were compared with the standard specification for dimensions as provided by the [6] and [13].

### *2.4 Water Absorption Capacity*

The sandcrete block samples where sun dried until there was no further loss in their dry weight. The block samples were then weighed in their dry state to obtain dry mass ($M_1$). The blocks were then fully immersed completely in clean water under room temperature for 24hours after which the block samples were removed and reweighed to obtain the wet mass ($M_2$) as per [14]. The procedure was repeated on all other samples and the water absorption capacity was computed from Equation 2.

$$W_c = \frac{M_2 - M_1}{M_1} \tag{2}$$

Where: $W_c$ = Water absorption capacity
$M_1$ = Mass of dry block before immersion
$M_2$ = Mass of wet block after immersion

The mean value of three (3) blocks obtained for each factory was regarded as the water absorption capacity and shall not exceed 12% [6].

### *2.5 Compressive Strength Test*

The compressive strength of the block samples was determined by crushing as per BS 5628:1 (1992) [15], this was carried out on all blocks obtained from the different factories. The blocks were weighed and a metal plate was placed underneath the block and gently placed between the plates of the crushing machine, another plate was also placed at the top of the block, thus to ensure uniform distribution of the load around the surface area of the block. The machine was switched on and load was applied at a constant rate until failure. The maximum load at which failure occurred was read and recorded, the load at failure was taken as the maximum load at which the specimen fails to produce any further increase in the indicator reading on the testing machine. The compressive strength of each block sample in N/mm² was calculated from Equation 3 as shown below.

$$= \frac{Maximum\ load\ at\ failure\ (N)}{Cross\ sectional\ Area\ of\ block\ (mm^2)} \qquad (3)$$

The mean value obtained was taken as the compressive strength of blocks from each factory and shall not be less than 3.45N/mm² for load bearing hollow Sandcrete blocks and 2.5N/mm² for non-load bearing hollow Sandcrete blocks produced mechanically [6].

## 3.0 RESULTS AND DISCUSSION

### *3.1 Field Survey*

The results obtained from the field survey include, batching method, mix proportion, mode of production, source and composition of materials, mixing method, curing method, age of blocks and quality assurance. These results are presented in Table 1.

**Table 1:** Details of Sandcrete Block Production Procedure

| Factory | Batching Method | Mix Proportion | Blocks Per Bag | Curing Period (days) | Age (days) | Test on Materials |
|---|---|---|---|---|---|---|
| A | Volume | 1:19 | 46 | 3 | 3 | No |
| B | Volume | 1:18 | 42 | 3 | 3 | No |
| C | Volume | 1:16 | 42 | 3 | 4 | No |
| D | Volume | 1:16 | 40 | 3 | 4 | No |
| E | Volume | 1:18 | 45 | 2 | 3 | No |
| F | Volume | 1:16 | 42 | 2 | 3 | No |
| G | Volume | 1:16 | 40 | 3 | 3 | No |
| H | Volume | 1:14 | 36 | 3 | 3 | No |
| I | Volume | 1:18 | 45 | 3 | 4 | No |
| J | Volume | 1:18 | 45 | 3 | 3 | No |
| K | Volume | 1:16 | 42 | 3 | 3 | No |
| L | Volume | 1:18 | 45 | 2 | 3 | No |
| Q | Volume | 1:16 | 42 | 3 | 4 | No |
| R | Volume | 1:16 | 40 | 2 | 4 | No |
| S | Volume | 1:16 | 40 | 3 | 3 | No |
| U | Volume | 1:16 | 40 | 4 | 4 | No |

**Table 1:** Field Survey

### *3.2 Moulding method*

All the block manufacturing factory visited produced Sandcrete blocks mechanically using the typical electrical vibrating machine of the Rosacommetta type.

### *3.3 Batching Method*

Batching by volume was utilized in all sixteen (16) manufacturing factories visited. Batching was done using the wheel barrow to measure the required volume of sand depending on the mix ratio adopted in each factory.

### *3.4 Mix Proportion*

It was observed that none of the manufacturing factories used the standard mix ratio of 1:8 specified by [6]. The mix ratio adopted in all the factories visited ranged between 1:14 -1:18 to produce 38-45 nine-inch blocks per bag of cement. None of the block factories used the recommended water-cement ratio of 0.6. Addition of water was moderated by the operator to achieve a workable mix without any compensation for bulking.

### *3.5 Mixing Method*

Mixing was done manually in all the selected manufacturing factories using shovels and spades. It was observed that the volume of materials mixed is usually very large, resulting in inconsistent mixing. This leads to a reduction in quality of the blocks as cracks soon appear on some of the fresh blocks.

**Table 2:** Composition of Fine Aggregates used in Selected Factories

| | Composition of Fine Aggregates (%) | | |
|---|---|---|---|
| Block Factory | Sharp Sand | Fine Sand | Granite Fines |
| A | 100 | 0 | 0 |
| B | 60 | 40 | 0 |
| C | 100 | 0 | 0 |
| D | 100 | 0 | 0 |
| E | 100 | 0 | 0 |
| F | 80 | 20 | 0 |
| G | 100 | 0 | 0 |
| H | 40 | 20 | 40 |
| I | 100 | 0 | 0 |
| J | 100 | 0 | 0 |
| K | 60 | 20 | 20 |
| L | 100 | 0 | 0 |
| Q | 60 | 0 | 40 |
| R | 60 | 0 | 40 |
| S | 80 | 20 | 0 |
| U | 100 | 0 | 0 |

### *3.6 Source and Composition of Materials*

Ordinary Portland Cement of grade 42.5 was observed to be utilized in the selected factories for producing blocks. Majority of the factories used the sharp sand obtained from rivers and streams only as fine aggregates while the rest combined fine sand with granite fines in varying proportion to produce the blocks. Table 2 presents the proportion of fine aggregates utilized in the selected factories for producing blocks. Potable water from boreholes and taps was used to produce and cure the blocks. Figure 1 illustrates the sources of water utilized in proportion.

### *3.7 Curing Method and Period*

Curing was done in all the block manufacturing factories by spurting the blocks with water twice daily in an open area and for a period of 2-3 days. None of the manufacturing factories complied with the 7days curing period in a covered area as recommended by [6].

### *3.8 Quality Assurance*

None of the factories was owned or operated by professionals and as a result do not conduct any quality assurance test on the composition materials or the finished products. Personnel were untrained and there was no supervision or regulation of their activities resulting in unwholesome practices amongst the workers in the production process.

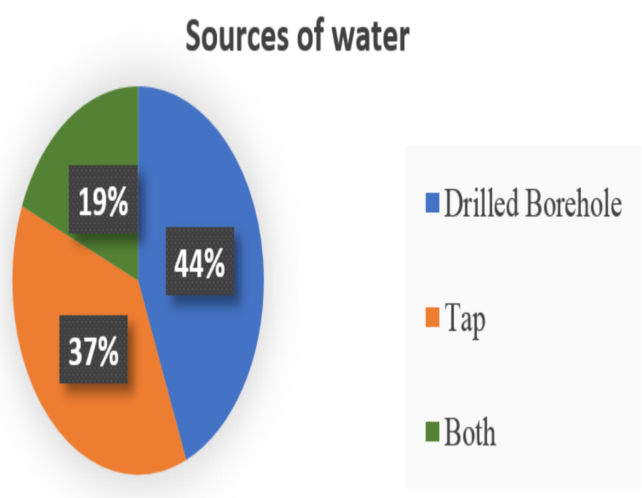


**Fig. 1:** Sources of Water used in Selected Factories

### *3.9 Block Dimensions*

The result of this test as shown in Table 3 shows that the minimum dimensions in terms of length, width and depth of all block factories are within the specified dimensional tolerance by [6] in terms of length, breadth and height.

However, none of the factories met the minimum required web thickness of 50mm as specified except factory L and R recording a mean web thickness of 53.88 and 54.43mm respectively. Use of distorted moulds and improper tuning of the machine moulds are the primary causes of reduced web thickness. Reducing the web thickness may save material and cost but the volume and effective area available for resisting loads is essentially reduced consequently decreasing the density and compressive strength of the blocks.

**Table 3:** Mean dimension of sampled sandcrete blocks

| Block Industry | Mean Length (mm) | Mean Width (mm) | Mean Height (mm) | Mean Web Thickness (mm) |
|---|---|---|---|---|
| A | 458.0 | 231.2 | 230.6 | 38.60 |
| B | 456.2 | 228.2 | 230.6 | 40.68 |
| C | 459.4 | 229.6 | 230.0 | 36.25 |
| D | 458.6 | 228.8 | 230.0 | 39.46 |
| E | 457.0 | 230.8 | 228.6 | 41.27 |
| F | 453.8 | 228.6 | 228.2 | 40.01 |
| G | 453.8 | 225.2 | 226.0 | 40.02 |
| H | 455.0 | 225.2 | 230.0 | 40.27 |
| I | 457.2 | 229.4 | 230.6 | 36.81 |
| J | 459.6 | 229.6 | 229.6 | 37.62 |
| K | 456.0 | 227.0 | 226.8 | 36.97 |
| L | 460.6 | 231.5 | 230.5 | 52.01 |
| Q | 457.6 | 227.8 | 227.0 | 36.46 |
| R | 460.0 | 230.0 | 230.0 | 54.43 |
| S | 457.2 | 227.6 | 231.2 | 37.62 |
| U | 457.0 | 229.4 | 230.0 | 40.06 |

### *3.10 Water Absorption Capacity*

The mean water absorption capacity of blocks from the selected factories is summarized in Figure 2. The mean water absorption capacities of all sampled blocks exceeded the standard value of 12% specified by [6] except those from block-factories B, H, K and U.

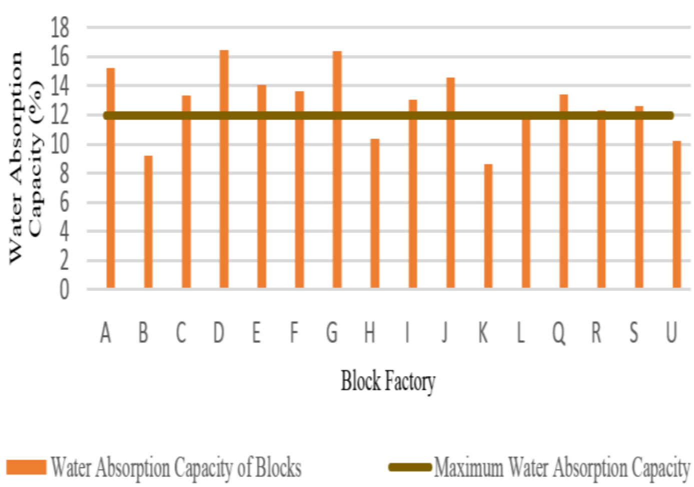


**Fig. 2:** Mean Water Absorption Capacity (%)

The mean water absorption capacity of the blocks ranged between 8.61-16.44%, blocks from D recording the highest water absorption capacity of 16.44% and K recording the least value of 8.61%. Poor mix ratio, inadequate curing, inadequate compaction and poor aggregate gradation are the causes of high-water absorption capacity of blocks.

### *3.11 Compressive Strength*

The mean compressive strength of five (5) blocks from each factory is summarized in Figure 3

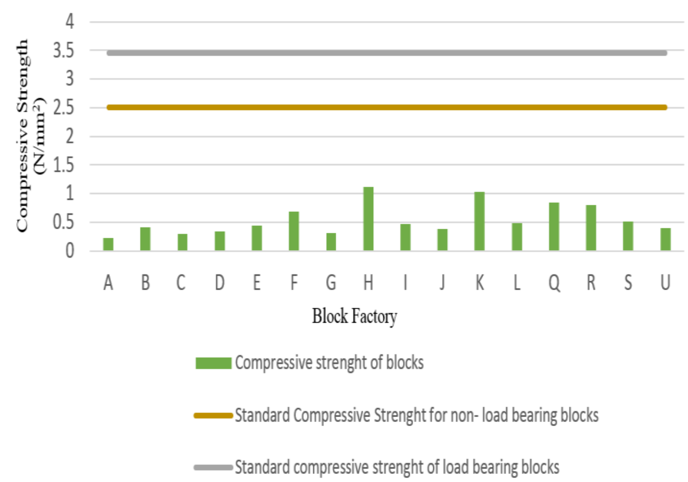


**Fig. 3:** Mean Compressive Strength (N/mm$^2$)

The compressive strength of individual blocks ranged between 0.18- 1.26N/mm$^2$ and the mean compressive strength of five (5) blocks for each factory ranged between 0.27-1.12N/mm$^2$. Blocks from factory H recorded the highest mean compressive strength of

1.12N/mm$^2$ while those from factory A recorded the least value of 0.27N/mm$^2$. Granite fines was observed to be partly replaced for sharp sand in factory H, K, Q and R, hence blocks from these factories had better compressive strength than those produced from mixture of sharp sand and plaster sand only. This is due to the strong bonds that forms between granite and cement. However, these values are far below the standard specification of [6] which stipulates that the lowest compressive strength of individual non-load bearing Sandcrete blocks shall not be less than 2.5N/mm$^2$ and average compressive strength of five (5) blocks shall not be less than 3.45N/mm$^2$. These values are also below the requirement of the Nigerian Building Code [13] which recommends a minimum compressive strength of 2.0N/mm$^2$ for individual blocks.

The results indicate poor quality control practices amongst the manufactures as the compressive strength of the blocks were not just below the standard value for load bearing and non-load bearing blocks but also there was a huge variation in the compressive strength of blocks within the same stock of a single manufacturer. This could be attributed to inconsistent mixing due to the manual mode of mixing employed in all the factories considering the large volume of materials usually involved. The result also indicates non-adherence to the stipulated mix proportion of (1:8) as blocks produced in factory H with the strongest mix of (1:14) had the highest compressive strength against those produced from factory A with the weakest mix of (1:19). Curing, a mechanism for continuous hydration of cement essential for strength development was improperly and inadequately done, the blocks were only cured for 2-3 days in an open area against the stipulated 7 days in a covered area. The reduction in the web thickness of the blocks also contributed to the poor compressive strength of the blocks as the area available for resisting load was effectively reduced in the process. Similar trends were also observed in other parts of the country and reported [2, 16, 17]

## 4.0 CONCLUSION

From the analysis of the results obtained from the field survey and laboratory experiments conducted on the selected block factories, the following conclusions were drawn;

1. Block manufacturers in the study area are ignorant of the existence of any standard specifications for Sandcrete blocks. This resulted in unwholesome practices amongst the manufacturers in the production process.
2. The mix proportion used in all factories were poor ranging between 1:14-1:19 against the standard mix ratio of 1:8 and none of the factories cured the blocks properly before supplying them to customers for use in construction.
3. There was no quality assurance on the blocks as none of the factory conducted any test on the composition materials or the finished product also the management of the factories were left in the hands of untrained personnel with less education about standard production procedures.
4. The dimensions of the collected blocks from all factories were within acceptable limits in terms of length, width and height. The web thickness of most of the blocks however, was not up to the required standard value due to use of deteriorated moulds and improper tuning of the machine moulds consequently the volume and area available for resisting loads was effectively reduced leading to a decrease in the density and strength properties of the blocks.
5. The water absorption capacities of the sampled blocks were above the specified maximum value of 12% except those from factory B, H, K and L. This can be attributed to the poor mix ratio and inadequate curing practices. These blocks are therefore less durable and more susceptible to failure from high rate of water permeability.
6. The compressive strengths of the collected blocks are far below the standard requirements of [6] and [13], are therefore of poor quality and thus, not suitable for construction purposes. The use of these blocks would lead to cracks on walling units especially in buildings were the roof-load is to bear on the walls and in extreme cases of inundation would lead to a total collapse

## RECOMMENDATIONS

From the conclusions reached, the following recommendations are apt

1) Proper quality control management techniques such as improved curing practice, use of appropriate mix ratios, adequate compaction timing and use of mechanical mixers should be enforced by the regulatory bodies on the block manufacturers.
2) The Standard Organisation of Nigeria (SON), the Nigerian Society of Engineers (NSE) and other concerned regulatory bodies should be saddled with the responsibility of ensuring that the blocks employed in construction conforms with standard specifications. Penalties and sanctions should be meted out to defaulters to serve as a deterrent to others.
3) The use of admixtures in the production of Sandcrete blocks such as laterite, granite fines, quarry dust and saw dust has been found to improve the properties and optimize cost of producing Sandcrete blocks. The use

of these admixtures should therefore be encouraged in the production of Sandcrete blocks.

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