



ORIGINAL RESEARCH ARTICLE

ASSESSMENT OF THE LEVEL OF QUALITY CONTROL OF CEMENT AND SANDCRETE BLOCK MATERIALS AVAILABLE IN MAIDUGURI METROPOLIS

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ABSTRACT

Variations in material properties, such as strength or durability, material defects and substandard materials can affect the structure's performance. This study assesses the level of quality control of building materials (Cement, sand and blocks) available in Maiduguri Metropolis. Generally, it included the Survey and collection of data of the existing supply markets, samples collection, laboratory tests, and analyses of results were conducted. Observation made from the survey showed that the price of blocks 150mm and 225mm thick range from 450 - 500 naira and 550 - 650 naira respectively. The particle size distribution of the sand sample used in the sand combination shows that the sand fell mostly in zone 2 except one which fell in zone 3 in accordance with Federal Ministry of Works and Housing Design Manual (FMWH). The average dry density of the investigated sandcrete blocks ranged from 1777.10kg/m³ - 2098.67kg/m³. The average compressive strength of the 150 mm thick blocks ranged between 0.12 - 0.45N/mm². The maximum value 0.45N/mm² recorded is less than 85% of the recommended minimum strength. The findings on the hydration properties of cement are within the BS 449 standard. The results show that the quality control of the building materials in Maiduguri Metropolis is generally inadequate, with many suppliers and contractors are unaware or failing to adhere to standard specifications and regulations.

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1.0 Introduction

Stakeholders in the building industry require a coordinated approach to building material quality and testing due to its importance in risk management (AIB, 2013). In Nigeria, the construction industry is faced with challenges that hamper the standard of construction which often revolve around quality of materials and workmanship (Bamisile, 2004, Adenike, 2006, Anigbogu and Anunike 2014). However, specification standards and building regulations which are drivers of good construction standard are diffused with many challenges (Grema, 2006) The use of inappropriate materials is a reason for unsatisfactory quality in the building industry (Anigbogu and Anunike, 2014). Laboratory and field tests are not carried out by construction supervisors on raw materials and products; this is why inappropriate materials find their way to the sites. According to Opoko *et al.*, (2014), the penetration and proliferation of substandard and inappropriate materials into the building sites are linked to the lack of holistic quality management systems amongst stakeholders.

The standard of materials used in building contribute largely to the quality of infrastructure made (Sitota *et al.*, 2021). But according to (Alemika, 2015) poor quality of materials is one of the reasons for more than 50% of building collapses in Nigeria. Ayodeji (2011) noted that although regulatory bodies and standards organizations in Nigeria's building industry have implemented various measures, the overall standard within the industry still does not reflect these efforts. The adherence of manufacturers and suppliers to standards and regulations as regards the quality of materials supplied needs to be ascertained (Ambrose *et al.*, 2019).

Zeb *et al.*, (2015), Linda and Synek (2019), and Zulaijarmai *et al.*, (2021) cited that the high occurrence of building failure and collapse is mainly contributed to by the quality of materials used. thus, quality control is a vital part of material management, as materials make up a substantial portion of the total project cost. It is therefore pertinent to investigate and improve the level of quality control on building materials. Failure to investigate the quality of materials will certainly continue to result in building collapse (Ayodeji, 2011). Therefore, this study aimed to assess the level of quality control of building materials made available by suppliers and manufacturers to construction sites in Maiduguri. This would serve to show the level of quality of building materials from suppliers, considering the attention it has garnered from regulatory agencies, standard organizations, scholars, contractors, and clients.

2. Methodology

The methodology of this study generally included the survey of the existing supply markets, samples collection, laboratory tests, and analyses of results. The samples collections and laboratory tests were done in accordance with the specifying British and Nigerian standards (BS 812 - 1996, BS 4449 – 1997, SON 1997 and NIS 444-I, 2003) and analysed with respect to these specifications.

2.1 Materials and Procedure

The materials used in the experiment include cement, sand, and sandcrete hollow blocks, while the apparatus used are the crushing machine, oven, set of sieves, measuring tape and weighing balance. Sieve analysis test to determine the particle size distribution of the sands was conducted in line with (BS 812-103. 1:1985) and (SON, 2004).

2.2 Survey and Sample Collection

Reconnaissance survey vis-a-vis physical inspection and oral interview was conducted across the ten wards in Maiduguri Metropolis, to locate the available block industries, cement, and their modes of operation. From the survey done, the study area was divided into ten smaller units, and one block industry was selected per unit: making a total of ten sample block industries. The block industries produce only 450×150×225 (6") and 450×225×225 (9") sizes of block. Six blocks' samples were taken randomly from the batch to ensure representativeness of each of the ten selected block industries. Blocks are made from a homogeneous material with minimal variability. Hence, six samples chosen at random might be sufficient to capture the material's properties. Three pieces each of 450×150×225 (6") and 450×225×225 (9") sizes of block were obtained, making a total of 60 block samples.

The block strength is assessed by measuring the crushing strength of the sample as calculated using Equation 1.

$$C_s = \frac{L_{max}}{A_c} \quad 1$$

Where: C_s = compressive strength (N/mm²), L_{max} = maximum load (N), and A_c = contact cross sectional area (mm²).

2.3 Survey of Cement and Procedure

The cements were obtained from major distributors in Maiduguri. The two major brands of cement sold in Maiduguri, which are Ashaka and Dangote, were used for the study, and were coded as C1 and C2. The brand names of cement have 3X, master block, 32.5N/mm², 42.5N/mm².

3. Results and Discussions

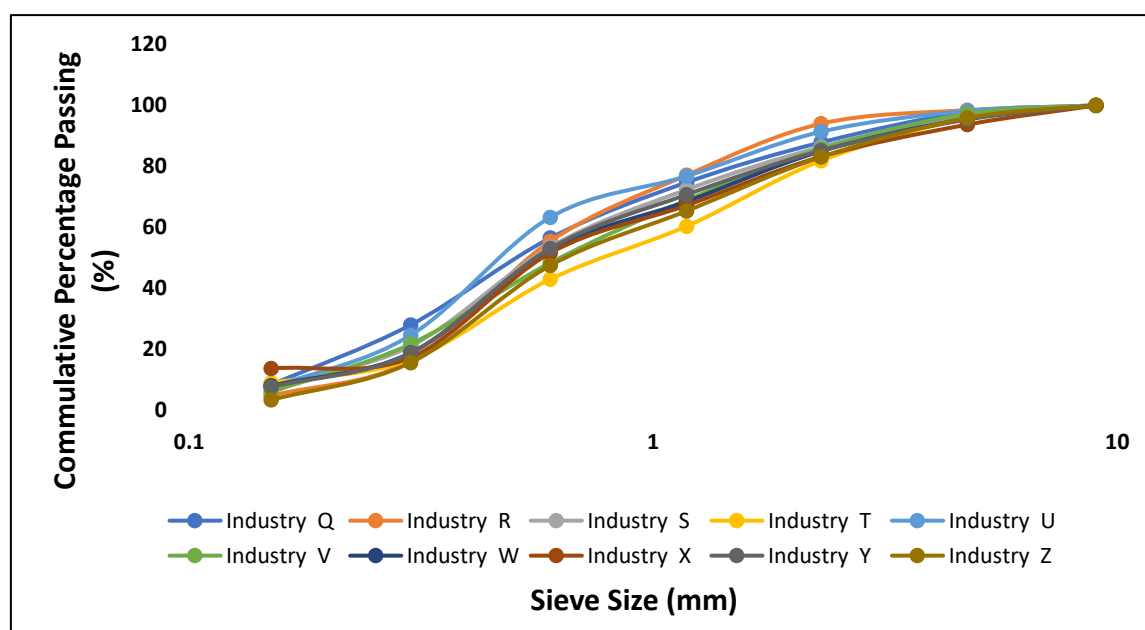
Ten industries were selected from major wards in Maiduguri and the summary of the information collected are shown in Table 1. However, the general observation made from the survey showed that the price of blocks ranged from 450 to 500 naira for 150mm, and 550 to 650 naira for 225mm. Cost of production, demand, supply and other economic factors are responsible for the variations in price. Raheem *et al.*, 2012) estimated that the cost of a piece of 225mm sandcrete hollow block of mix ratio of 1:6 would be 675 naira. It can thus be deduced according to (Sule, 2016) that blocks are produced to meet market demand as against required quality.

Table I: Summary of Surveyed Information from Block Industries

Industry/Location	Size of Block	Price per block in Naira	Curing Period (Days)/Method	Source of sand	Brand of Cement
Q/Bulumkutu	225	550	3/sprinkling	River/Outlay	Dangote 3x (42.5N)
	150	450	3/sprinkling	River/Outlay	Dangote 3x (42.5N)
R/Abuja Talaka	225	600	3/sprinkling	River/Outlay	Dangote 3x (42.5N)
	150	500	3/sprinkling	River/Outlay	Dangote 3x (42.5N)
S/Damboa Road	225	650	3/sprinkling	River/Outlay	Dangote 3x (42.5N)
	150	550	3/sprinkling	River/Outlay	Dangote 3x (42.5N)
T/Polo Road	225	550	3/sprinkling	River/Outlay	Dangote 3x (42.5N)
	150	450	3/sprinkling	River/Outlay	Dangote 3x (42.5N)
U/Lagos Street	225	650	3/sprinkling	River/Outlay	Dangote 3x (42.5N)
	150	550	3/sprinkling	River/Outlay	Dangote 3x (42.5N)
V/Baga Road	225	550	3/sprinkling	River/Outlay	Dangote 3x (42.5N)
	150	450	3/sprinkling	River/Outlay	Dangote 3x (42.5N)
W/Ruwan Zafi	225	600	3/sprinkling	River/Outlay	Dangote 3x (42.5N)
	150	500	3/sprinkling	River/Outlay	Dangote 3x (42.5N)
X/Dalori	225	550	3/sprinkling	River/Outlay	Dangote 3x (42.5N)
	150	450	3/sprinkling	River/Outlay	Dangote 3x (42.5N)
Y/Mairi Kuwait	225	650	3/sprinkling	River/Outlay	Dangote 3x (42.5N)
	150	550	3/sprinkling	River/Outlay	Dangote 3x (42.5N)
Z/Fori	225	650	3/sprinkling	River/Outlay	Dangote 3x (42.5N)
	150	550	3/sprinkling	River/Outlay	Dangote 3x (42.5N)

3.1 Particle Size Distribution of Sand

The particle size distribution of the sands used in the block production was obtained individually from each industry. The sieve analysis of the sands, results as mixed for the sample production is summarised in Figure 1. Most of the grading values of the sharp sands were in zone 2 classification, except for industry U which fell in zone 3. This implies that the sand from industry U was finer than those of the other industries. However, the samples implied that the sands could singly be used satisfactorily to produce strong blocks. Workability is influenced by multiple factors including water-cement ratio and aggregate grading.

**Figure 1:** Particle Size Distribution of Sands

3.2 Dry Density and Dry Compressive Strength

The computed values of the densities of the sampled sandcrete blocks are summarised in Table 2. SON, (2004) specified a minimum density of 1500kg/m³ for sandcrete hollow blocks. As seen from the table, the average dry density of the investigated sandcrete blocks ranged from 1777.10kg/m³ to 2098.67kg/m³. When compared to the specified minimum density, the samples' densities ranged from 18% to 40% higher. This indicates that the samples conformed to the required standards. However, few individual samples representing less than 2% of the sampled blocks fell below the minimum density by 0.62%. While the compressive strength analyses of the sandcrete block samples are shown in Table 3. and 4, respectively.

From Table 3, the average compressive strength of the sampled 150mm blocks ranged from 0.12 to 0.45N/mm² which is less than 85% of the recommended minimum strength of 2.5Nmm². This steep deviation shows that it cannot be used for type B non-load bearing blocks; even the highest recorded value of 0.61N/mm² is still very much below standard. Also, the coefficient of variation higher than 20% was recorded in 60% of the industries. Most codes of practice for concrete specify a coefficient of variation of 20% and below. Whereas, from Table 4, the average compressive strength of the sampled 225mm ranged from 0.03 to 0.66N/mm² which is less than 81% of the recommended minimum strength of 3.45N/mm². This steep deviation shows that it cannot be used for type A load bearing blocks and type B non-load bearing blocks; even the highest recorded value of 0.81N/mm² is still very much below standard. Also, the coefficient of variance higher than 20% was recorded in 70% of the industries. Most codes of practice for concrete specify a coefficient of variation of 20% and below. The implications of this would lead to unsafe and project failure.

Table 2: Densities of the Sandcrete Block Samples

Industry	Sample (mm)	Average Density (kg/m ³)	Recommended Density (kg/m ³)	Difference (%)
Q	150	2040.08	1500	36
	225	2068.61	1500	37.91
R	150	2050.99	1500	36.72
	225	2098.67	1500	39.91
S	150	1849.94	1500	23.33
	225	2007.73	1500	33.85
T	150	1904.82	1500	26.99
	225	2074.02	1500	38.27
U	150	1833.05	1500	22.20
	225	2050.53	1500	36.70
V	150	1790.86	1500	19.39
	225	2028.39	1500	35.23
W	150	1839.46	1500	22.63
	225	1962.55	1500	30.84
X	150	1777.1	1500	18.47
	225	2001.45	1500	33.43
Y	150	1888.08	1500	25.87
	225	1927.43	1500	28.50
Z	150	1889.71	1500	25.98
	225	1823.26	1500	21.55

The compressive strength of 225mm blocks varied significantly across industries, with industry Z achieving the highest average compressive strength of 0.66 N/mm² with a covariance of 23%, while industry T recorded the lowest average compressive strength 0.25N/mm² with a covariance of 24%. Notably, industry Z used the lowest mix ratio of 1:8, which may have contributed to its higher compressive strength, whereas other industries used higher mix ratios ranging from 1:9 to 1:11, potentially resulting in lower compressive strengths. The results suggest that the mix ratio plays a significantly role in determining compressive strength, with lower mix ratios (more cement) tend to produce blocks with higher strengths. However, the covariance values indicate variability ins block production, impacting reliability. The findings highlight the importance of optimizing mix ratios and quality control measures to produce sandcrete blocks with consistent and satisfactory compressive strengths

Table 3: Compressive Strength Results for 150mm Sandcrete Block Samples

Industry	Average (N/mm ²)	Strength	Standard Deviation	Coefficient Variation (%)	of
Q	0.45		0.10	23	
R	0.12		0	0	
S	0.35		0.19	54	
T	0.20		0.06	29	
U	0.38		0.17	45	
V	0.17		0.03	19	
W	0.02		0.02	141	
X	0.08		0.08	101	
Y	0.12		0	0	
Z	0.32		0.06	18	

Table 4: Compressive Strength Analyses for 225mm Sandcrete Block Samples

Industry	Average (N/mm ²)	Strength	Standard Deviation	Coefficient Variation (%)	of
Q	0.63		0.21	33	
R	0.50		0.03	6	
S	0.54		0.05	10	
T	0.25		0.06	24	
U	0.45		0.12	26	
V	0.58		0.17	29	
W	0.42		0.11	27	
X	0.46		0.05	12	
Y	0.27		0.13	47	
Z	0.66		0.15	23	

3.3 Cement Survey and its Laboratory Tests

The brands of cement sold in Maiduguri include Dangote 3x and Ashaka. They are both Standards Organisation of Nigeria (SON) certified and are of grades 42.5N and 32.5N respectively. BUA cement is also supplied to Maiduguri but is scarce and majorly on demand. It was not available as at the period of this research. The Dangote brand was more widely used by block making industries. The fineness, consistency, soundness, initial and final setting times of the sampled cements were obtained and analysed in conformity with (NIS 444-I, 2003 and BS 812, 1996). The results are summarised in Table 5.

Table 5: Hydration Properties Cement

Cement	Fineness	Consistency	Initial Set	Final Set	Soundness
C1	2.87%	29.5%	98mins	208mins	0.8mm
C2	1.73%	29%	97mins	206mins	0.5mm
Specifications	≤10%	26 – 33%	≥60mins	≤600	≤10mm

The fineness test was conducted in line with (SON, 1997 and BS 4449, 1997) and it can be seen from Table 5, that the average fineness for C1 is 2.87% and C2 is 1.73%, indicating more than 95% finer. These values are far below the specified limit of 10% residue, implying that the cements C1 and C2 conform to the standards. The consistency of cement according to the standards as shown in the Table 5; it indicated that C1 and C2 are within the acceptable consistency limits. The setting time of Ordinary Portland Cements, as specified by the standards states an initial set time of not less than 60 minutes, and a final set time of not more than 600 minutes. From Table 5, it can be observed that the initial set times of 98 and 97 minutes for C1 and C2 shows that C1 is 38 minutes more than the initial set time limit and C2 is 37 minutes more than the limit. Also, the final set time of 208 and 207 minutes for C1 and C2 shows that C1 is 392 minutes less than the final set time limit and C2 is 394 minutes less than the limit.

4. Conclusion

The study assessed the level of quality of cement and sandcrete block materials available in Maiduguri Metropolis, revealing that the quality of building materials in the metropolis is inadequate. Key findings include inadequate compressive strength, with average strengths below the recommended minimum and some samples as low as 0.12 N/mm². There was also significant variability in block production, with high coefficients of variation in compressive strength. Additionally, blocks were cured for only 3 days, which may not be sufficient to achieve optimal strength. While sand quality mostly conformed to standards, some industries used

finer sand than required. However, cement quality was found to be satisfactory, with physical properties meeting standards, indicating that cement is not the primary issue.

REFERENCES

- Accident Investigation Bureau, AIB. 2013. Annual Safety Report. Abuja: Ministry of Aviation. pp. 1–34.
- Adenike, A. 2006. Impact of Material Quality on Building Performance. Lagos: Building Research Institute, pp. 10–45.
- Alemika, EO. 2015. Prevalence patterns and consequences of insecurity in Nigerian cities. *Annals of the Social Science Academy of Nigeria*, 20: 16 - 46.
- Ambrose, EE., Etim, RK., and Koffi, NE. 2019. Quality Assessment of Commercial Produced Sandcrete Blocks in Part of Akwa Ibom State, Nigeria. *Nigerian Journal of Technology*, 38(3): 586 – 593.
- Anigbogu, NA., and Anunike, EB. 2014. Standard of Materials Specifications, Their Implementation and Enforcement on Building Construction Projects in Nigeria. *ATBU Journal of Environmental Technology*, 7(1): 1-13.
- Ayodeji, O. 2011. An Examination of the Causes and Effects of Building Collapse in Nigeria. *Journal of Design and Built Environment*, 9(1): 37–47.
- Bamisile, A. 2004. Building Production Management. Lagos: Foresight Press. pp. 5–60.
- British Standards Institution. 1985. BS 812-103.1: Testing Aggregates – Method for Determination of Particle Size Distribution. London: BSI. pp. 1–12.
- British Standards Institution. 1996. BS 812: Specification for Portland Cement. London: BSI.
- BS 4449:1997. Specification for Carbon steel bars for the reinforcement of concrete: British Standards Institution.
- Grema, M. 2006. The Quality of Construction Materials in Nigeria. Kano: Sahel Press. pp. 22–50.
- Linda, V. and Synek, J. 2019. Quality Control in Building and Construction. *IOP Conference Series: Materials Science and Engineering*. 471(2019): 1-7.
- NIS 444-1:2003. Composition, Specification and Conformity Criteria for Common Cements, Standards Organisation of Nigeria.
- Opoko AP., Ezema IC., and Ediae OJ. 2014. Implementation of Quality-Management Procedures in the Production and Utilisation of Cement Stabilized Laterite Interlocking Blocks in Nigeria. *Covenant Journal of Research in the Built Environment (CJRBE)*, (1)1: 53-60.
- Raheem, AA., Akintayo, OA., and Olanrewaju, OS. 2012. Economic Appraisal of Sandcrete Blocks Production in Nigeria. *Building and Road Research Journal*, 10(2): 55–62.
- Sitota, B., Emer, TQ., and Woyesa, A. 2021. Assessment on Materials Quality Control Implementation of Building Construction Project and Workability: A Case Study of Ambo University. *Journal of Xidian University*, 1(8): 138 – 155.
- Standards Organisation of Nigeria SON. 1997. NIS 367: Specification for Portland Cement. Abuja: pp. 1–15.
- Standards Organisation of Nigeria SON. 2004. NIS 87: Specification for Sandcrete Blocks. Abuja: pp. 1–16.
- Standards Organisation of Nigeria. 2004. Nigerian Industrial Standard: Standard for sandcrete blocks NIS 87:2004) Lagos, Nigeria: Standards Organisation of Nigeria. pp. 1–15.
- Sule, A. 2016. Demand Versus Quality. A Study on Block Production in Nigeria. *Journal of Engineering and Applied Sciences*, 11(5): 1127–1132.

- Zeb, A., Malik, S., Nauman, S., Hanif, H., and Amin, MOS. 2015. Factors Affecting Material Procurement, Supply and Management in Building Projects of Pakistan: A Contractor's Perspective. Proceeding of International Conference on Innovations in Civil and Structure Engineering. Istanbul (Turkey), pp. 170 -175
- Zulaijarmai, BG., Esumobi, G., Muhammad, M., Ahmad, U. N., and Elvis, CN. 2021. Benefit of Quality Assurance and Control in Construction Industry. International Journal of Innovative Research and Development, 10(10): 12-16.