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Quality Control Analysis on Hollow Sandcrete Block Production for Building Construction in Hong Metropolitan

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Abstract

Quality control analysis on hollow sandcrete blocks involve insuring compliance with standard and workmanship in production of the hollow sandcrete blocks. The material is produced from ordinary Portland cement, fine aggregate, and water, mixed in appropriate proportion and moulded into hollow forms with different sizes, mostly rectangular in shape, normally bonded using mortar in stretcher bond during construction works. Reports on social media and journals on collapse of buildings in Nigeria has agitated the need to analyze the quality standard of hollow sandcrete blocks commonly used for building constructions in the area of research and the nation as a whole.

Keywords: *Quality, Analysis, Control, Sandcrete, Block, Production.*

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Background of the Study

The quality of building material is governed by the degree to which the material meets standard construction requirements and expectations with time. Sandcrete blocks material quality is influenced by factors such as: the constituent material, process adopted in production, duration of curing, forms and sizes. Most a times, sandcrete blocks used for building construction in Nigeria is found to be substandard evident by frequent collapse of buildings in the country. This phenomenon has necessitated the need for quality analysis control on the sandcrete blocks. Quality analysis control of sandcrete blocks is the practice of checking standard of production compliance, prevention of faults in the production, and not be rejected by consumers. Factors that often Influence the quality of sandcrete blocks during production that are not easily noticeable or often ignored usually affect immediate and ultimate strength of the sandcrete blocks. After several weeks of experimental observation, and under controlled condition, the following factors are observed to have affected the overall strength of sand create block**s: -** Types of cement used, Degree of compaction, and Quality of fine aggregate used. Building sandcrete blocks come in variety of sizes, some being made to suit the owners' handling conveniences. Such sandcrete blocks are not standard as they are not factory product, compliant sandcrete blocks are produced to meet standard sizes. Blocks in this category are made in accordance with B.S 6073 Portland and 21981 or a similar standard as explained by (Ohio, 2021).

Load bearing and non-load bearing walls of buildings in Nigeria and perhaps other parts of Africa are built with hollow sandcrete blocks. Hollow sandcrete blocks are produced from ordinary Portland cement, fine aggregate, and water; mixed in an appropriate proportion and produced into various sizes, mostly rectangular in shape. The commonest being 450mm x 225mm x 225mm, 450mm x 150mm x 225mm, 450mm x 125mm x 225mm, and 450mm x 100mm x 225mm. The first two are referred to as hollow sandcrete blocks which appear with two holes that run from top to bottom and occupied one-third volume of the block while the last two are produced without holes and are called solid sandcrete blocks. Sandcrete blocks are normally bonded using mortar in stretcher bond during construction works in Nigeria (Jatau, 2021).

Statement of the Problem

Allowing block production industries to continue operating without functional regulating mechanisms to ensure quality compliance as stated in the standard code of practice of the building construction industry in Nigeria may be one among the causes of building problems such as that of the day in day out reports on local/international media and journals on collapse of buildings in different parts of the country. This problem has agitated the researcher on the need to analyse the quality of hollow sandcrete blocks being the most popular material available and commonly used by building professionals in the Nigerian building industry. Hence, the analysis on quality of hollow sandcrete blocks in selected blocks production industries in the area of the study.

Research Objectives

The main objective of the research is to analyse the quality control of hollow sandcrete blocks produced in Hong metropolitan; specifically, to:

1. Investigate the mix ratio used for production of hollow sandcrete blocks.
2. Investigate the forms and sizes of the hollow sandcrete blocks.
3. Investigate the compressive strength of the hollow sandcrete blocks.
4. Investigate the quality of the materials used for the production of the hollow sandcrete blocks.
5. Investigate the curing period of the hollow sandcrete blocks.

Research Question

1. What is the mix ratio used for production of hollow sandcrete blocks in Hong metropolitan?
2. What are the forms and sizes of the hollow sandcrete blocks production in Hong metropolitan?
3. What is the compressive strengths of the hollow sandcrete blocks produced in Hong metropolitan?
4. What are the qualities of the materials used for the production of the hollow sandcrete blocks in Hong metropolitan?
5. What is the curing period of the hollow sandcrete blocks produced in Hong metropolitan?

Research Significance

The research beneficiaries include:

1. Building clients.
2. Building industry professionals.
3. The general public.

The clients of buildings can identify quality hollow sandcrete blocks production industries to make purchases from. The building industry professionals are made to recall quality control measures enforced and abide by them. There is awareness for the general public on dangers associated with building problems that causes the frequent collapses of buildings in different parts of the country due to negligence on quality control on hollow sandcrete blocks use for building construction.

Literature Review

Quality control analysis on sandcrete blocks refer to all the activities done with the aim of producing and delivering sandcrete blocks that met or exceeded customers' expectations as expressed in standard code of practice, contract documents, and other published sources. These activities among others include; inspection and control of the production processes to ensure that they met standard planning and control- specified processes are being followed satisfactory. That is to say that there must be in-process inspection to ensure that products produced meet up the required specifications, inspection, and testing for standard performances. In the analysis, issues can come up that may require a charge in the technical design report during the construction stage or other stages. The building construction industry in Nigeria is faced with such problems which impair the standards of building construction. These problems are mostly hinged on the quality of materials planning, and processing that

can be controlled by appropriate regulation standards (BS882:2002). To address such problems, many researches have been conducted to examine the quality of sandcrete blocks used in Nigerian building construction industry. The sandcrete block is a composite material made up of cement, sand (fine aggregate), and water moulded in to different forms and sizes. According to the author, sandcrete blocks are rectangular and have various sizes. The commonest are 450mm x 225mm x 225mm, 450mm X 150mm x 225mm, 150mm x 125mm x 225mm, and 450mm x 100mm x 225mm. Sandcrete blocks appear with holes which run from top to bottom and occupy about one third volume of the block (Ohio, 2021).

Sand (fine aggregate) is the product of natural or artificial disintegration of rocks and minerals that formed an important constituent of most soil and is extremely abundant as a surface deposit along the rivers on the shores of lakes and seas and in regions. The quality of sand has a great influence on the quality of sandcrete blocks as it constitutes between 75-90% of the blocks by height. The quality of sand is affected by its source, its grading, and storage condition. Fine aggregate for sandcrete blocks should be clean and free from deleterious matters and comply with the requirements of BS882. Whereas Cement is a binder that binds materials to harden stages. It is obtained by burring together in definite proportion a mixture of lime, silica, aluminum and iron oxide at high temperature. It is an extremely ground material having adhesive and cohesive properties, it is the active portion of the binding medium of sandcreate blocks. The ordinary Portland cement from the West Africa cement plants; e.g. the Ashaka cement and the Dangote cement in Nigeria has the properties confining to (B.S 12 2024); they are of good quality for sandcrete blocks production and general construction works in Nigeria. Water (H_2 O) is used for mixing the cement and the fine aggregates, to wash aggregates, and for curing of the sandcrete blocks after production. The water actively participates in the chemical reactions between the cement and the fine aggregates, and helps to form strength resulting in cement (Joan, 2024).

Table 1: The block industries

S/No.	Block Industries	Sizes and Forms	Curing Period
1.	Yirmah Industry A	450mmx225mmx225mm Rectangular	3 Days
2.	Magirah Industry B	450mmx225mmx225mm Rectangular	3 Days
3.	Kwatam Industry C	450mmx225mmx225mm Rectangular	3 Days

The above sandcrete blocks samples were carefully moulded according BS 6073, the sandcrete blocks were produced using vibration moulding machine. The mix ratio was 1:6 (cement, fine aggregate). Curing was done using spraying machine three times daily (morning, afternoon, and evening) for three days before selling to consumers. The curing was employed to maintain satisfactory moisture content and allow proper hydration and hardening of the sandcrete blocks. The method of curing employed can greatly affect the properties of sandcrete bocks, since the blocks are laid over a wide surface. According to the Nigerian Institute of Standard (NIS 87: 2014), sandcrete blocks cured and the area covered for 7 days. In view of the above, this study will investigate the mix ratio, curing period, forms/sizes, and the compressive strength of the hollow sandcrete blocks produced from the three block industries under study.

Area of the Research

The area of the study was Hong, the headquarters of Hong Local Government Area of Adamawa state in Northeastern Nigeria, which lies between latitude 9° and 10° North and longitude 12° and 13°East, occupying total land area of about 2,419.11km^2 with population of about 195,880 (FRN, 2006) censuses. Hong shared boarders with Borno State to the North, Gombi Local Government Area by the West, and Song Local Government Area by the South, Maiha Local Government Area by the Southeast, and Mubi North and South Local Government Areas by the Eastern side. Hong is dominated by an ethnic group known as Kilba, Kilba is a socially integrated ethnic group union by kin-ethnic groups like: Bura, Babir, Marghi, Chibok, Hona, Holma, Higgi, Batta, Mbula, Nzanyi, Fali, Gude, Kopre and even Kanuri from Borno State. All these ethnic groups melted socially and assimilated into what is known today as Hoba, popularly called Kilba. The Kilba race is peace loving people and specialized farmers in Northern Nigeria; they are chief producers of groundnuts, rice, geneacorn, beans, cassava, millet, sugarcane, cocoayam, tigernuts, bambaranuts, benseeds, sweet potatoes and many more. Hong has residential buildings made up of individual families' residential compounds, which are walled and linked with pathways and un-tarred roads providing access to the people of the area. Below is the map of the area of the study.

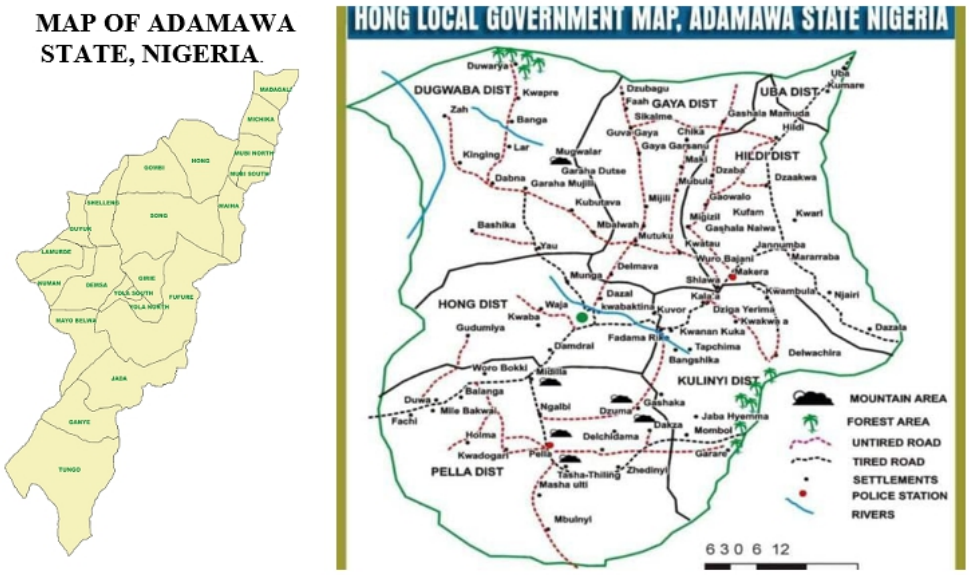


Figure 1: Map of Adamawa State, Nigeria

Materials and Method

For the purpose of the research, primary and secondary data were used. The primary data are those obtained by the researcher via questionnaire on sizes and mix ratios, materials quality, curing periods, and the secondary data are obtained from crushing strength carried out on randomly selected samples of sandcrete blocks produced by the block production industries A, B and C in the area of the research, the main Instrument for data collection was crushing

strength machine. The procedure used to determine the compressive strength of the sandcrete blocks using the crushing strength machine is by placing the sandcrete block sample on the machine and then load was applied. As the applied load increases gradually, there was corresponding increase in the compression till the sample fractured. The fractured sample is removed from the machine. The machine stopped and the readings taken, that was how all the samples were crushed. The compressive strength of the sandcreate block was calculated using formula:

Compressive strength = Crushing load ÷ Effective surface area of sandcrete block …. (1)
The effective surface area = Total surface area of the sandcrete block - Area of hollow…. (2)
Example; Effective surface area of the sandcrete block = (455 x 150) mm^2 – 2(160x85) mm^2 = 41,050 mm^2.

Table 2: Types of blocks, actual size and Normal size

Type of blocks	Actual size	Normal size
	Length, height, width (mm)	length, height, width(mm)
Dense aggregate	440×215×215	450×225×255
	440×215×215	450×255×250
Light, weight, aggregate	440×215×140	450×225×150
Block: Load bearing	440×140×65	450×150×75
Non- load bearing	450×215×40	450×225×50
Light weight blocks	440×215×65	450×225×75

The industries produce 60 - 70 blocks per bag of cement for 6" and 45 - 50 blocks per bag for 9" sandcrete blocks. The mix ratio adopted is ½ part of cement and 6 parts of sand and two buckets of water during rainy season, while five buckets of water are used for dry seasons. The source of water is stream. The production process is either manually using metallic mould or mechanical using machine molding. Water is sprinkled over the surface of the blocks to maintain satisfactory moisture content and allow proper hydration and hardening. The curing techniques is manually using plastic buckets or containers morning and evening for 3 days. This method of curing employed can greatly affect the properties (strength and shrinkage) of the blocks, because the blocks are laid over a wide surface. According to NIS 87:2014, sand create blocks are to be heated in a covered area for 7 days.

Compressive Strength Test Results

Table 3: Yirmah Block Industry (Industry A).

S/N	Sample number	Size (mm)	Gross Area (m^2)	Volume (m^2)	Weight (kg)	Failure load (KN)	Density (kg/m^3)	Strength (N/mm^2)	Average strength (N/mm^2)
1	A1	450mmx225 mmx225mm	101250	0.02278	22.69	4.70	996	0.046	AI+A2+A3/3
2	A2	450mmx225 mmx225mm	101250	0.02278	21.81	6.10	957	0.060	0.06
3	A3	450mmx225 mmx225mm	101250	0.02278	23.48	6.40	1031	0.063	
4	A4	450mmx225 mmx225mm	101250	0.02278	24.57	21.80	1079	0.215	**A4+A5+A6/3**
5	A5	450mmx225 mmx225mm	101250	0.02278	23.89	18.60	1049	0.184	**0.19**
6	A6	450mmx225 mmx225mm	101250	0.02278	24.33	18.20	1068	0.179	
7	A7	450mmx225 mmx225mm	101250	0.02278	23.89	22.10	1036	0.22	**A7+A8+A9/3**
8	A8	450mmx225 mmx225mm	101250	0.02278	24.05	21.20	1036	0.21	**0.22**
9	A9	450mmx225 mmx225mm	101250	0.02278	23.43	25.60	1029	0.25	

The table 3 above, batch one (A1-A3) shows the average crushing strength is $0.06N/mm^2$. For batch two (A4-A6) the average crushing strength 0.19N/mm and finally the batch three (A7-A9) is $0.22N/mm^2$. The maximum average crushing strength in batch three (A7-A9) is $0.22N/mm^2$ and compare to British standard $3.50N/mm^2$ is not standard for load bearing walls.

Table 4: Magirah Block Industry (Industry B).

S/N	Sample number	Size(mm)	Gross Area (m^2)	Volume (m^2)	Weight (kg)	Failure load (KN)	Density (kg/m^3)	Strength (n/mm^2)	Average strength (N/mm)
1	B1	450mmx225 mmx225mm	10125	0.02278	24.99	14.10	1097	0.139	**BI+B2+B 3/3**
2	B2	450mmx225 mmx225mm	10125	0.02278	25.03	17.80	1099	0.176	**0.15**
3	B3	450mmx225 mmx225mm	10125	0.02278	24.43	15.00	1072	0.148	
4	B4	450mmx225 mmx225mm	10125	0.02278	24.81	18.30	1087	0.18	**B4+B5+B 6/3**
5	B5	450mmx225 mmx225mm	10125	0.02278	24.66	17.90	1083	0.18	**0.20**
6	B6	450mmx225 mmx225mm	10125	0.02278	25.01	25.70	1098	0.25	
7	B7	450mmx225 mmx225mm	10125	0.02278	25.22	16.70	1107	0.16	**B7+B8+B 9/3**
8	B8	450mmx225 mmx225mm	10125	0.02278	25.10	20.20	1102	0.20	**0.21**
9	B9	450mmx225 mmx225mm	10125	0.02278	25.76	27.20	1087	0.27	

The table 4 above, batch one (B1-B3) shows the average crushing strength is 0.15N/mm. for batch two (B4-B6) the average crushing strength 0.20N/mm and finally the batch three (B7-B9) is 0.21N/mm. The maximum average crushing strength in batch three (B7-B9) is 0.21N/mm and compare to British standard 3.50N/mm^2 is not standard for load bearing structures.

Table 5: Kwatam Block Industry (Industry C).

S/N	Sample number	Size(mm)	Gross Area(m^2)	Volume (m^2)	Weight (kg)	Failure load (KN)	Density (kg/m^3)	Strength (N/mm^2)	Average strength (N/mm)
1	C1	450mmx225mmx225mm	101250	0.02278	22.99	17.60	1014	0.17	C1+C2+C9/3
2	C2	450mmx225mmx225mm	101250	0.02278	23.11	20.00	998	0.19	0.18
3	C3	450mmx225mmx225mm	101250	0.02278	22.75	17.40	975	0.17	
4	C4	450mmx225mmx225mm	101250	0.02278	21.59	77.40	975	0.28	C4+C5+C6/3
5	C5	450mmx225mmx225mm	101250	0.02278	22.23	31.00	975	0.31	0.27
6	C6	450mmx225mmx225mm	101250	0.02278	19.87	23.40	972	0.23	
7	C7	450mmx225mmx225mm	101250	0.02278	22.83	24.70	1002	0.24	C7+C8+C9/3
8	C8	450mmx225mmx225mm	101250	0.02278	23.31	25.10	1023	0.25	0.32
9	C9	450mmx225mmx225mm	101250	0.02278	23.21	24.30	1019	0.24	

The table 5 above, batch one (C1-C3) shows the average crushing strength as 0.18N/mm. for batch two (C4-C6) the average crushing strength is 0.27N/mm and batch three (C7-C9) is 0.32N/mm. The maximum average crushing strength in batch three (C7-C9) is 0.32N/mm and compare to British standard 3.50N/mm^2 is not standard for load bearing structure.

Discussion

The tables above indicated the various average compressive strength for the selected block industries in the areas of the study. It was observed that the average compressive strength of industry A the maximum average crushing strength is 0.22N/mm. for industry B the maximum average crushing strength is 0.21N/mm and for industry C the maximum average crushing strength is 0.32N/mm. It was observed that the average crushing strength of the selected industries are substandard compared to British standard 3.50N/mm^2, similarly, it does not meet the requirement for load bearing according to BS 6082 as explained by (Arum, 2018).

Conclusion

This research work considered the quality analysis control measures on hollow sandcrete block produced in Hong metropolitan Area of Adamawa State. Particularly compressive strength test of sandcrete blocks suitable for building construction. Based on the result of the tests and other data obtained, it is concluded that the blocks produced in the area of the research is substandard because the producers did not comply with the Nigeria Institute of Standard (NIS) and the British standard (BS) specifications and did not utilize international standard BS 6073 code of practice.

Recommendation

It is recommended that building construction professionals, most especially those engaged on sites should always test the strength of sandcrete block at project site before recommending or allowing it for usage. In addition, the Government should enforce strict compliance with NIS 87: 2016 guide lines for all sancrete block production industries or outlets in the area of the research and possibly the other parts of the nation as a whole.

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