Sandcrete Block and Brick Production in Nigeria - Prospects and Challenges

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Abstract
Sandcrete blocks comprise of natural sand, water and binder. Cement, as a binder, is the most expensive input in to the production of sandcrete blocks. This has necessitated producers of sandcrete blocks to produce blocks with low OPC content that will be affordable to people and with much gain. The poverty level amongst West African Countries and particularly Nigerian has made these blocks widely acceptable among the populace so as to minimize the cost of construction works. Despite the cost benefit of sandcrete cost, the improper use of these blocks leads to microcracks on the walls after construction and this result to incessant collapse of buildings which has turned out to be a worrisome problem facing the construction industry in Nigeria. The main aim of this research is to evaluate how sandcrete blocks and bricks are produced for use in Nigeria, the laws and regulations guiding their production and the prospects and challenges facing the block production industry in Nigeria. A case study survey of about 15 block production factories was conducted to find out how block manufacturers produce sandcrete blocks and bricks for use in Nigeria. Three types of investigations, namely field survey (participant observation), literature review and interviews were carried out. This study found several factors are responsible for the collapse of buildings one of which is the use of poor quality of building materials such as blocks and bricks. It is therefore important to ensure that the production of this major masonry unit is not only standardized but regulated and adequately monitored to ensure quality.

Keywords: Sandcrete Blocks, Brick Molding, Block Molding, Construction Entrepreneurs, Nigeria.

1.0 Background to Study

Anosike (2011) opine that Sandcrete technology or Block molding is becoming the backbone of infrastructural development of every country. Block molding industry is one of the largest production sectors of the construction industry in Nigeria. Virtually every Local Government Area has one or more small or large scale block production factories. Block production is no doubt a lucrative venture, if properly managed. At present, numerous block molding firms have sprung up in Nigeria to meet with the requirements of construction and infrastructural development as there are no laid down guidelines as per who is qualified to produce blocks for use in Nigeria (Uzoamaka, 1977; Oyekan and Kamiyo, 2008; Abdullah et al., 2012). In practice, average technical expertise, materials, tools, machinery and all necessary infrastructures are all that are required to start producing blocks either for private use or for commercial purpose. Okoli et al. (2008) argue that apart from manufacturers and entrepreneurs who are producing blocks strictly for business purposes, quite a number of contractors and clients are also making blocks for use on their projects. Such contractors and clients employ block makers; provide them with all necessary materials and logistics to produce the block requirements of their building or infrastructural projects, with the sole aim of minimizing production cost and ensuring quality (Oluremi, 1990; Ogunsankin et al., 2011; Ko, 2011). Sandcrete blocks comprise of natural sand, water and binder. Oyetola and Abdulahi (2006) added that cement, as a binder, is the most expensive input in the production of sandcrete blocks. This has necessitated producers of sandcrete blocks to produce blocks with low OPC content that will be affordable to people and with much gain. The poverty level amongst West African Countries and particularly Nigerian has made these blocks widely acceptable among the populace so as to minimize the cost of construction works. The improper use of these blocks leads to microcracks on the walls after construction. The use of alternative cheaper local materials as stabilizer will greatly enhance the production of sandcrete blocks with the desired properties at low cost. It will also drastically reduce the cost of production and consequently the cost of construction works. A survey by raw materials research and development Council of Nigeria on available local building materials reveals that certain building materials deserve serious consideration as substitute for imported ones. Few of these materials includes: cement / lime stabilized bricks /blocks, sundried (Adobe) soil blocks, burnt clay bricks/ blocks, cast in-situ walls, rice husk ash (RHA), mud and straw, lime and stonecrete blocks.

Some of the problems faced in construction today can be linked to this masonry unit, which is a major construction material. Poor quality of building materials is one of the factors responsible for the collapse of buildings. Hornbostel (1991) posit that it is therefore imperative to ensure that the production of blocks and bricks are not only standardized but regulated and adequately supervised to ensure quality. Oyekan and Kamiyo (2011) added that this comes with great challenge in Nigeria due to the large size of the block manufacturing industry coupled with the fact that most of those involved in block production are not registered and are inadequately trained. Every industry has its own prospects and peculiar challenges which if identified and appropriately addressed will help bring about improvement for developmental purposes (Okpala, 1993; Oyekan, 2001; Rodriguez et al., 2008; Umaru et al., 2012). Producing good quality blocks comes with quite a number of challenges and prospects. It is therefore important to identify these prospects and challenges with a view to improving and raising the standard of our block industry in Nigeria for the overall benefit of the construction industry. This paper is therefore a research work on the production of sandcrete block and bricks in Nigeria with a view to identifying the prospects and challenges facing the block molding industry. A case study survey was conducted to find out how block manufacturers produce sandcrete blocks and bricks for use in Nigeria.

2.0 Literature Review

2.1 Blocks and Bricks Molding

Hollow sandcrete blocks have been in use in many nations of the world including Nigeria, playing a major role in the building industry (Dashan and Kamang, 1999; Al-Khalaf and Yousif, 1984; Morenikeji et al., 2015). Sandcrete blocks and bricks are masonry units manufactured from a mixture of cement, sand and water. They are largely used as walling materials in construction of shelter and other infrastructures. Oyetola and Abdullahi (2006) argued that sandcrete has been in use throughout West Africa for over 5 decades as a popular building material for preparation of building blocks and bricks. They posit that it is predominantly used and suitable for load and non-load bearing walls, or for foundations. The material constituents, their mix, presence of admixtures and the manufacturing process are important factors that determine the properties of sandcrete blocks. In Nigeria, 95% of walling materials in buildings are made of sandcrete blocks. Anwar et al. (2000) put forward that Sandcrete walls have adequate strength and stability, provide good resistance to weather and ground moisture, durable and easy to maintain. They also provide reasonable fire, heat, airborne and impact sound resistance. As material for walls, its strength is less than that of fired clay bricks, but sandcrete is considerably cheaper. Chandrasekhar et al. (2003) argued that Sandcrete is the main building material used for the construction of walls of most post-independent buildings in Nigeria. In many parts of Nigeria, Sandcrete hollow blocks are the major cost component of the most common buildings. The blocks are usually manufactured with the use of a vibrating machine (Falade, 1997; Cisse and Laguerbe, 2000).

A new technology developed in South Africa but now used in several parts of Africa known as hydraform technology is also used in manufacturing sandcrete blocks in Nigeria (Oyekan, 2001). Hydraform block, usually solid, is a type of sandcrete block that could be stacked together to form a wall without cement. HYDRA comes from Hydraulic indicating the hydraulic action in manufacturing blocks, while FORM comes from the formation of interlocking blocks. The main benefit of using Hydraform 'Interlocking' Block for a walling unit is that the interlocking blocks are dry stacked meaning no mortar is required in 70% of the structure. Nair et al. (2006) opine that the Hydraform interlocking blocks lock front and back, top and bottom eliminating the need for mortar joints in the super structures. Interlocking refers to the male and female ridges on the top and bottom as well as front and back of the Hydraform blocks. Ganesan et al. (2008) added that these ridges lock into one another to lock the blocks into place. Hydraform blocks lock on 4 sides, front and back; top and bottom which ensure each block is locked into place. The foundation is laid in mortar as normal; blocks from the first course up can be dry-stacked. The top 3-4 courses below the roof structure must be bedded in mortar (ring beam). This secures the wall ensuring each block is perfectly locked and in place. Original Hydraform Machines are only manufactured in South Africa (Abdullahi, 2006; Eze et al., 2005; Thwala et al., 2012).

Oyetola and Abdullahi (2006) shed light on the utilization of rice husk and rice husk ash as a partial replacement material or stabilizing agent in building works. Studies carried out to investigate some characteristics of aha husk ash/ordinary Portland cement concrete. Test results indicate that the compressive strength for all the mixes containing AHA increases with age up to the 14-day hydration period but decreases to the 28-day hydration period while the conventional concrete increases steadily up to 28-day hydration period. Further studies was carried out on rice husk as a stabilizing agent in clay bricks. In that study, clay bricks were produced with 0%, 1%, 2%, 3%, 4%, 5%, and 10% rice husk. Some of the bricks were burnt in an electric furnace to a temperature of 1005°C for about 3-4 hours. Compressive strength and absorption tests were carried out. It was concluded that the addition of husk reduces the compressive strength of the bricks and the husk clay bricks becomes lighter as the percentage of husk clay increases.

Oyekan and Kamiyo (2011) opine that hollow sandcrete blocks containing a mixture of sand, cement and water are used extensively in many countries of the world especially in Africa. In many parts of Nigeria, sandcrete block is the major cost component of the most common buildings. The high and increasing cost of constituent materials of sandcrete blocks has contributed to the non-realization of adequate housing for both urban and rural dwellers. Hence, availability of alternatives to these materials for construction is very desirable in both short and long terms as a stimulant for socio-economic development. In particular, materials that can complement cement in the short run, and especially if cheaper, will be of great interest. Oyekan (2001) argued that over the past decade, the presence of mineral admixtures in construction materials has been observed to impart significant improvement on the strength, durability and workability of cementitious products. The author added that in the areas prone to flood, hydrothermal properties of the buildings' construction materials are of importance. Also, energy requirements for residential and commercial buildings are known to be influenced by building design and by the materials used.

Nair et al. (2006) posit that in both temperate and tropical regions, thermal properties of building materials are of significant importance to the determination of the heating or cooling load within the building and hence the capacity of the mechanical equipment required in handling the load. This is necessary to provide a given level of thermal comfort within the building and over the annual climatic cycle. Substitution of any of these admixtures is aimed at enhancing at least one of the properties of the block. However, Yogenda et al. (1988) suggested that rice husk is a residue produced in significant quantity on a global basis. While it is utilized as fuel in some regions, it is regarded as a waste in others thereby causing pollution; due to problem with disposal. Hence, it is beneficial to adopt in an environmentally friendly manner, will be a great solution to what would otherwise be a pollutant. When burnt under controlled conditions, the rice husk ash (RHA) is highly pozzolanic and very suitable for use in lime-pozzolana mixes and for Portland cement replacement. Effect of RHA blended cement on the strength and permeability properties of concrete has been investigated by Ganesan et al. (2008). On sandcrete block, Cisse and Laquerbe (2000) observed that the mechanical resistance of sandcrete blocks obtained when unground ash resulted to increase in performance over the classic mortar blocks. Their studies on Senegalese RHA also revealed that the use of unground RHA enabled production of lightweight sandcrete block with insulating properties at a reduced cost. Okpala (1993) partially substituted cement with RHA in the percentage range of 30–60% at intervals of 10% while considering the effect on some properties of the block. The experiment showed that a sandcrete mix of 1:6 (cement/sand ratio) required up to 40% cement replacement and a mix of 1:8 ratio required up to 30%, are adequate for sandcrete block production in Nigeria. Hence, as a result of the high cost of procuring the rice husk required for producing large number of blocks needed for an average-size building, and in the light of the reducing agricultural activities in Nigeria, replacing cement with such high volume of RHA could be economically counterproductive for local sandcrete block manufacturers thereby defeating the main purpose of the substitution which is to reduce the unit cost of the block.

2.2 Quality of Sandcrete Blocks and Bricks

Quality is defined as "fitness for purpose" or compliance with specification (Anosike, 2011, Taylor, 2002). They authors argued further that it is the overall characteristics needed by a product or service to satisfy stipulated and implied needs. ISO 8402-1986 standard defines quality as "the totality of features and characteristics of a product or service that bears its ability to satisfy stated or implied needs". In addition, the manufacturing business dictionary, defined quality as a measure of excellence or a state of being free from defects, deficiencies, and significant variations, brought about by the strict and consistent adherence to measurable and verifiable standards to achieve uniformity of output that satisfies specific customer or user requirements. Ogunsanmi et al. (2011) identified quality as one of the three key elements for developing risk classification model for design and build projects. This therefore follows that quality is a significant factor that cannot be undermined in the construction of projects. Nunnally (2007) argued that quality management and quality assurance on the other hand have been adopted to include all aspects of producing and accepting a construction project which meets all required quality standards. He further asserts that quality management includes such activities as specification development, process control, product acceptance, laboratory and technician certification, training and communication. The author concluded that quality control, which is a part of the quality management process, is primarily concerned with the process control function. The Standard Organization of Nigeria (SON) established through Act 56 in 1971 is the sole statutory body that is vested with the responsibility of standardizing and regulating the quality of all products in Nigeria including sandcrete blocks. The Nigerian Industrial Standard (NIS) for sandcrete block is a standard reference document developed by the SON which prescribes the minimum requirement and uses of sandcrete blocks.

Abdullahi (2005) reported that sandcrete blocks are widely used in Nigeria, and other countries like Ghana, as walling units. The blocks are composed of cement, sand, and water, molded into a variety of shapes and sizes (Barry 1969). The quality of blocks, however, is inconsistent due to the different production methods employed and the properties of the constituent materials used. Blocks are those building units used in the construction of wall and partitions. They are of sizes and weights that can be easily handled by bricklayers, with the facing surface layer than that of a brick but conveniently dimensioned. Hodge (1971) opine that sandcrete blocks are available for the construction of load bearing and non-load bearing structures. He argued that load bearing blocks must conform to building regulations which stipulate the amount of solid mineral contained in section—i.e., the total width of block. Sandcrete blocks are also used in the task of transforming the actual load from the overlaying structural element to the foundation. However, the load bearing wall are referred to those walls acting as supports for the whole structure to transmit the weight to the ground surface underneath it for stability (NIS 87: 2000; Duncan et al., 2012).

Sandcrete blocks possess an intrinsic low compressive strength making then susceptible to seismic activity. Previous research has shown dismal results in the production of sandcrete blocks, which have exhibited compressive strength far below the standard requirement for the construction of houses (Oyekan and Kamiyo, 2008). Sandcrete blocks have been used for a long time throughout Nigeria (NIS 87:2000). The importance of the blocks as part of local building materials in the building and construction industry cannot be overemphasized. Bricks are alternatives to sandcrete blocks. However, the clay suitable for making high strength bricks is not available everywhere in Nigeria and the clay bricks produced and presently used in construction are not uniform in quality. Anosike and Oyebade (2012) put forward that the rapid changes in the use of bricks to block in Nigeria have encouraged the investigations into the use of sandcrete blocks to be more elaborate. It was also realised that in some places in Ondo and Ekiti States in Nigeria were occupied by rivers, which make it easier to obtain river sand rather than clay for making blocks. Also, in Minna communities, sand is easily obtained from borrow pits and riverbeds situated in the environment which enhance the use of sand for block making. The word ‘sandcrete’ has no standard definition; what most workers have done was to define it in a way to suit their own purpose. The word for it in some local dialect means brick earth and the name ‘sandcrete’ is merely a translation of the use to which these blocks are put. Sandcrete blocks are often too crude to reveal the nature and origin of sandcrete exhibiting the same physical properties. Though sandcrete varies widely, one feature remains constant: the same amount of combined silica in proportion to the alumina present, and it is in this respect that sandcrete differ from clay (Baiden and Tuuli 2004).

2.3 Standardization and Regulation of Quality

In Nigeria, the fulcrum of Standardization and Regulation of quality for all products is vested in the Standards Organization of Nigeria (SON). Established by Act No. 56 of 1971 and with three amendments in 1976, 1984 and 1990, SON as a corporate body have the sole responsibility for National Policy on Standards, Standards Specification, Quality Control and Metrology, Manufactured Industrial and imported products and services. The Act No. 20 of 1976 which amended the previous one conferred on the Honorable Minister of Industry the power to declare Mandatory Industrial Standards in Respect of products or processes recommended by the Nigerian Standards Council (UNESCO 2008). The Act No. 32 of 1984 changed the name of the agency to Standards Organization of Nigeria (SON) from Nigeria Standards Organization (NSO). This was aimed at eliminating conflicting identity with the then Nigerian Security Organization. Finally, the Act No. 18 of 1990 conferred on SON partial autonomy from the Ministry of industry. This amendment gave far-reaching transformation to the Organization succession and a common seal, and may sue or be sued in its corporate name. The statutory functions of Standards Organization of Nigeria by section 3, subsections (1) of 1971 Act No. 56 are as follows:
(a) To organize test and do everything necessary to ensure compliance with standards designated and approved by the Council.

(b) To undertake investigations as necessary into the quality of facilities, materials and products in Nigeria, and establish a quality assurance system including certification of factories, products and laboratories.

(c) To ensure reference standards for calibration and verification of measures and measuring instrument.

(d) To compile an inventory of products requiring standardization.

(e) To compile Nigeria Industrial Standards.

(f) To foster interest in the recommendation and maintenance of acceptable standards by industry and the general public.

(g) To develop method for testing of materials, supplies and equipment including items purchased for use of departments Government of the Federation or State and Private establishment.

(h) Register and regulate standard marks and specification.

(i) To undertake preparation and distribution of standard samples.

(j) To establish and maintain such number of Laboratories or other institutions as may be necessary for the performance of its functions under this Act.

(k)To compile and publish general scientific or other data.

2.4 Standard Requirements

The Federal Building Code (First edition, 2006) stipulates that the application of all materials and components used in the construction of buildings must be such that will achieve aesthetics, durability, functionality, character and affordability (Afolayan et al., 2008; Anosike, 2011). Locally available building materials should be integrated for their additional advantages of availability, identity, job creation and affordability. The National Building Code stipulates as follows:

Sandcrete Blocks: shall mean a composite material made up of cement, sharp sand and water.

i. Blocks shall be molded for sandcrete using metal (wood) molds of:
450mm x 225mm x 150mm
450mm x 225mm x 225mm
450mm x 225mm x 100mm

ii. They are usually joined by mortar which is a rich mix of sandcrete.

Aggregate: This include both coarse and fine, from natural sources, blast furnace slag, crushed clay and furnace clinker.

Sand: shall be of approved clean, sharp, fresh water or pit sand, free from clay, loam, dirt, organic or saline water of any description and shall mainly pass 4.70mm test sieve. If lagoon sand is used this must be properly washed to the approval of the supervisor.

Mix Proportion: Mix used for blocks shall not be richer than 1 part by volume of cement to 6 parts of fine aggregate (sand) except that the proportion of cement to mix-aggregate may be reduced to 1:4 ½ (Where the thickness of the web of the block is one 25mm or less).

Strength Requirements: Sandcrete blocks shall possess resistance to crushing as stated below and the 28day compressive strength for a load bearing wall of two or three story building shall not be less than:- average strength of 6 blocks, lowest strength of individual block 2.00 N/mm2 (300psi), 1.75N/mm2 (250psi).

Molding: The 28 day compressive strength of a sandcrete block for load bearing wall of two or three story buildings shall not be less than the values given above and shall comply with the existing NIS specification for sandcrete blocks.

Compaction: Two methods to be applied depending on the availability of materials (tools) are;

1. By approval (standard) machine compaction.
2. My metal mold (hand) compaction.

Production/Processing: The sandcrete block shall be cast using an appropriate machine with cement/sand ratio of 1:6 measured by volume. Where hand mixing is carried out, the materials shall be mixed until an even color and consistency throughout is attained. The measure shall be further mixed and water added through a fire hose in such sufficient quantity as to secure adhesion. It shall then be well rammed into molds and smoothed off with a steel face tool (Okoli et al., 2008).

Curing: After removal from machine, the blocks shall be left on pallets under cover in separate rolls, one block high, with a space between each block for at least 24 hours and kept wet by weathering through a fire watering hose (Anosike, 2011). The blocks may then be removed from the pallets and the blocks may be stacked during which time the blocks shall be kept wet. The blocks may be stacked not more than 5 blocks high under cover at least seven (7) days before use after the previous period.

Physical Requirement: Special sizes and shapes of blocks and bricks 11.25mm (i.e. 4½”) thick or less shall be solid with grove and tongued joints. Blocks of greater thickness, than 11.25mm (i.e. 4½”) thick shall be hollow of used above damp proof course. Hollow blocks shall be more than 50mm thick. Hollow blocks shall be used only where vertical steel reinforcement is to be fixed (Eze et al., 2005).

2.5 Standard Enforcement

Oyekan and Kamiyo (2008) argued that the Federal Building Code stipulates that for the control of building works in Nigeria, there shall be established in all Federal, State and Local Government Urban Development Agencies, a Code Enforcement Division/Unit in their Development Control Departments to carry out the following functions:

1. Enforce the provisions of the Code through the appropriate registered professionals.
2. Implement the provisions of the Code to secure the intent thereof.
3. Request, so far as is required in the discharge of official duties, receive the assistance, and cooperation of other officers in all Government Ministries, Departments, Parastatals, Police and other Law Enforcement Agency.

2.6 Standard Production Methods

Nunnally (2007) suggested that sandcrete blocks, usually hollow, are manufactured with the use of a vibrating machine for large scale production and hand mold for small scale production. Baiden and Tuuli (2004) added that the type of hollow sandcrete blocks commonly produced and used for construction of buildings in Nigeria are made of a standard mix proportion of 1:6 cement-sand ratio; that is, one part by volume of cement to six parts by volume of coarse sand. The sizes of blocks produced are 225 x 225 x 450mm and 150 x 225 x 450mm with one-third of their volume void, and the solid core blocks of size 100 x 225 x 450mm used mainly as non-load bearing partition walls. In the manufacture of the blocks, hand mixing is generally employed and the materials are turned over a number of times until an even color and consistency are attained (Goncalues and Bergmann (2007). Water is usually added through a fire hose and it is further turned over to secure adhesion. It is then rammed into the machine moulds, compacted and smoothed off with a steel face tool. After removal from the machine molds, the blocks are left on pallets under cover in separate rows, one block high and with a space between 2 blocks for the curing period. They are kept wet during this period by watering daily. After curing, the blocks are stacked and stored ready for transportation to project sites for use. Hydraform blocks are composed of soil and mixed with 8-10% cement. In producing hydraform blocks, laterite soil or "Murrum" is preferred. Generally you can use soil with 5-35% clay and silt content. It is advisable never to use black cotton soil as it contains highly reactive clay and the blocks will crack when they dry. Uzoamaka (1977) opine that black cotton soil also contains high amounts of organic material not suitable for block production. Dashan and Kamang (1999) posit that the Hydraform 220mm block is mostly dry-stacked (except for foundations, ring beam and lintels) and is suitable for any walls in the structure. The Hydraform 140mm block is a semi dry-stacked block. Slurry is made from fine sand and cement and poured into the cavities of the 140mm blocks. This locks the structure together creating a firm wall. The most common application would be internal. The Hydraform 220mm block is mostly dry-stacked (except for foundations, ring beam and lintels) and is suitable for any walls in the structure. The 140mm block functions similar to the 220mm block as a dry-stacked block but can save you up to 15% in material costs. The disadvantage would be the cornering, which must be plastered to achieve the required load strength (BSI 1992; Nair et al., 2006; ASTM 2004). Hydraform walls creates a smooth finish that can be left as a face brick finish for outside walls and plastered on internal walls. Hydraform recommends that outside face brick walls are treated with a water repellent to protect the outer surface. Paint can be applied directly to the smooth wall or to the plastered Hydraform wall. There are approximately 37 blocks in one square meter of wall. "Green" (fresh) Hydraform blocks are stacked and covered with black plastic to avoid moisture loss. The blocks are then watered daily to create a greenhouse effect, allowing the cement to harden and the blocks to strengthen. Hydraform recommends 250micron black plastic for curing. Cure your Hydraform blocks for a minimum of 7 days and allow the block to dry for another 7 days before building. This will ensure strong good quality blocks. Hydraform recommends that blocks are cured under black plastic for a minimum of 7 days. Allow the blocks to dry for a further 7 days before building. Blocks will achieve maximum strength after 28 days. Hydraform recommends a minimum of 8% cement which once properly cured should yield a Min 7MPa block. This means 12 parts soil to 1 part (UNESCO 2008).

3.0 **Research Methodology**

Three types of investigations, namely field, literature review and interviews were carried out in this work. About 15 block production factories within Nigeria were visited. The survey was made in order to find out the block firms' mode of production, mix ratios, infrastructure requirement and other relevant information pertaining to block production in Nigeria. Several literatures relevant to the subject matter where reviewed. This includes laws and regulations guiding the production of sandcrete blocks and bricks in Nigeria. Data collection for compilation and use were from secondary sources which include books, journals, library, the internet and relevant previous research works. Sandcrete block entrepreneurs, their technical staffs, relevant government officials, professionals and some other stake holders involved in one way or the other in the block production industry in Nigeria were interviewed to get relevant information relating to block production enterprise in Nigeria.

4.0 Discussion of Findings

A total of 15 small and large scale block molding industries were visited in Lagos, Ota and Shagamu, in the western part of Nigeria. The summaries of findings from the block molding industries visited are as follows:

4.1 Block Manufacturers Association

The outcome of this study revealed that in most localities in Nigeria, block manufacturers form local associations or unions whose aims are mainly to help foster unity and understanding amongst members. Study shows that most of these associations are not more than social clubs. Quite a number of them are not registered with the Cooperate Affairs Commission (CAC) and therefore have no legal backing. Nevertheless, Government Agencies such as SON and Ministry of Commerce and Industry, in collaboration with some private organizations reach out to block manufacturers through these associations and unions. They organize seminars and workshops for them to educate and update them on latest techniques and technology available in the block industry and the importance of ensuring quality, amongst other things.

4.2 Block Producers

This study finds that block producers in Nigeria can be categorized into private and commercial purpose producers.

Private-use Producers: They are those who produce blocks strictly for private use. Some clients and contractors engage in the business of making blocks for private use on their buildings and infrastructural projects. Such clients and building contractors employ block makers; provide them with materials and all other necessary logistics to produce the block requirement of their projects for the purpose of ensuring quality and reducing cost. Such blocks are usually produced on the project site. On small projects the manual method of mixing and molding are predominately used while on large scale projects mixers and block molding machines are employed.

Commercial Producers: They include both small and large scale producers. Small scale producers use manual method of mixing and molding while large scale producers employ mixers and block molding machines. In this case, the purpose of making the blocks is for commercial purposes whereby people who could not produce on their own patronize them for buying.

4.3 Raising Production Capital

Raising capital for any kind of business is usually a major challenge. This study reports that small scale block producers who produce blocks for personal use depend mostly on personal savings to raise capital, while those who produce for commercial purposes raise capital from both personal savings and short term loans. Contractors who produce blocks for use on their projects usually make use of part of their advance payment and subsequent payments received on valuations to finance their block production unit on site. Large scale commercial producers mostly make use of private savings, mortgages, and short and long term loan.

4.4 Land Acquisition

The result from this study shows that one of the first challenge after raising capital to start a block business in Nigeria is securing a suitable location to sight the block molding factory. For private-use producers, the project site is where the production unit is located with few exceptions. In the case of commercial producers, securing a suitable land becomes the first obstacle business owners need to overcome. One of the factors that influence where small and medium scale commercial block producers locate their block factories in Nigeria is proximity to a new town development area. Other factors include the availability of adequate land size within a desired area and cost. A plot of land of 18m x 36m is sufficient to start a small or medium scale block industry in Nigeria.

4.5 Raw Materials

This study finds that sandcrete block is a composite material made up of Portland cement (binder), sharp sand and water. The material constituents, their mix, presence of admixtures and manufacturing process are important factors that determine the properties of sandcrete blocks and bricks. Cement, as a binder, is the most expensive input into the production of sandcrete blocks. There are different materials used in sandcrete block production. They are discussed below as found in this study.

Fine aggregate (sand): The quality of sand used vary from one locality to the other, but generally aggregate use include both coarse and fine, from natural sources, blast furnace slag, crushed clay and furnace clinker. Usually sharp river quartzite sand free of clay, loam, dirt and any organic or chemical matter is the ideal. The two predominate types of sand used are white sand and colored sand. In some cases the sands are not completely free from materials such as dust, silt, tree roots etc. Such sand are sieved to remove the organic materials in them before use. Some manufacturers make use of stone-dust to improve the quality of their blocks. Sources of sand include pits, rivers and sea. Figure 1 below shows the sand aggregate used in sandcrete block making in Nigeria.


Figure 1: Sand (Aggregate)

Cement: The cement widely used in Nigeria is the Ordinary Portland Cement (OPC) and the Dangote Cement with properties conforming to BS 12 (British Standards Institution, 1971). Figure 2 below shows one the brand of cement used in block making in Nigeria.


Figure 2: Portland cement (Binder)

Water: In Nigeria, block manufacturers make use of any type of water available. This includes water from streams, rivers, wells and boreholes. Fresh, colorless, odorless and tasteless potable water that is free from organic matter of any kind is the ideal. Figure 3 shows the kind of water used in block making in Nigeria.

Figure 3: Water for works

4.6 Material Transportation and Storage

Those interviewed for this study revealed that sand is transported to production sites with tippers of 5, 10, 15, 20 or 30 tons capacity. Sand is stored in the open on the ground on site, from where it is transported by head pans or wheel barrows to where it will be used. Cement in bags of 50kg is transported to site with trucks, tippers or trailers depending on the quantity bought. Cement is stored in a dry store on raised wooden pallets. A store is also provided for the storage of tools, diesel, pallets and other useful items. In small scale block making firms, the cement store doubles as production tools, pallet and diesel store. In Nigeria, some block manufacturers buy water delivered to site with water tankers for production purposes, while others sink wells or make provision for boreholes on site. Water for production is usually stored in elevated plastic or steel tanks or in block underground or surface reservoirs.

4.7 Molds, types and sizes

Sandcrete blocks are molded using mainly metal molds:

There are two main types of blocks molded in Nigeria. They are solid and hollow blocks. The sizes in length x breath x height include:

1. 450mm x 225mm x 225mm (hollow)
2. 450mm x 150mm x 225mm (hollow)
3. 450mm x 225mm x 225mm (solid)
4. 450mm x 150mm x 225mm (solid)
5. 450mm x 100mm x 225mm (solid)

4.8 Mode of Production/Mix Ratio

In this study, it was reported that batching by volume is adopted by block manufacturers. They use wheel barrows, head pans and paint buckets (for water). The mix ratio varies from 1 bag of cement to 3 to 7 wheel barrows of sand. The amount of water required is usually determined by trial and error. This ranges from 2 to 4 paint buckets of water or 3 to 5 wheel-barrows of water depending on the moisture content of the sand. Small scale manufacturers use manual method of mixing while large scale manufacturers use mixers. The general procedure for mixing is as follows. Measure sand and cement unto a concrete platform on the ground. Mix with shovel about three times. Add water the fourth time and then turn the whole mix about two times. Most of the block producers use molds. The equipment is prefabricated steel or wooden mold box of the requisite dimension with one end open and removable steel or wooden plate resting at the bottom.

4.9 Compaction

This research finds that two methods of compaction are found to be used depending on the scale of production, availability of tools and cost effectiveness of the production. These methods include machine compaction and hand compaction. Machine compaction is employed for large scale and commercial production, while hand compaction is used on small scale production for small scale projects. However, the procedure for molding is as follows: mixture is poured into mold, vibrated, rammed and de-molded immediately. Cure after 24 hours. The block molding machine used by the large scale producers is the Rosacometta type which vibrates the block during filling and or compaction. One block is produced at a time. One bag of cement produces between forty and fifty blocks. Figure 4 shows the process of block making through machine compaction.

Figure 4: Machine compaction

4.10 Curing

In this study, we found that the blocks are molded on wooden pallets. The method generally adopted for curing is sprinkling the exposed blocks with water 24 hours after de-molding. They use long rubber hoses with nozzles. Ninety percent of the manufacturers spray their blocks once a day for a period of not more than three days. They do this because they are always in a haste to dispose of the blocks, cut cost and economize space. After removal from the mold, the blocks are manually transported on pallets to an open area and left on pallets under cover in separate rolls, one block high, with a space between each block for at least 24 hours. The blocks are then kept wet by weathering through a fire watering hose or by buckets. The blocks are then removed from the pallets and stacked during which time the blocks are kept wet to attain maximum strength. The stacked blocks are not more than 5 blocks high. It is recommended that the blocks remain under cover at least seven (7) days before they are used, but this is often not the case as block firms are found to sell blocks 3-4days after production due to high demand and pressure from buyers. Figure 5 shows blocks transported on pallets from production shed to curing section. Figure 6: Blocks at curing section. Figure 7: Wetting of blocks at curing section. Figure 8: Stacked cured blocks ready for transportation to site.

Figure 5: Blocks transported on pallets from production shed to curing section.

Figure 6: Blocks at curing section.

Figure 7: Wetting of blocks at curing section.


Figure 8: Stacked cured blocks ready for transportation to site.

4.11 Transportation of Blocks to Project Sites

The study found that in Nigeria, blocks are mostly transported to project sites with the use of small trucks that carry between 50 and 150 blocks at a time to avoid breakages. Wooden carts on two wheels pushed manually are also employed to transport smaller quantities, especially when the block production site is close to the project site and the quantity required is small. The blocks are loaded and offloaded manually. It is a usual practice for block firms to transport the blocks to project sites for the buyers. The cost of such transportation is added to the cost of the block. Small firms that cannot afford to own a truck for transportation usually rent one when needed. Figure 9 shows a typical truck offloading blocks for use on site.


Figure 9: Offloading blocks for use on site.

5.0 Conclusion of the Study

Sandcrete technology or block molding is becoming the backbone of infrastructural development of every country. Ensuring quality is one of the major challenges confronting the sandcrete block making industry in Nigeria. The structure of most block production industries in Nigeria shows that production workers are mostly illiterates or semi-literates who are trained on the job rather than acquiring formal technical training, prior to being employed in the industry. Such structure is not a good sustainable structure for the overall benefit of the industry. Such unfortunate anomaly can be corrected by government with policies and incentives capable of attracting graduates to the industry. With graduates forming the backbone of our block production industry, such move will not only help to improve the standard in the industry but also bring about new innovations for the overall benefit of the construction industry. Though government has enacted adequate laws and guidelines to standardize and regulate production of blocks to ensure quality, there are little or no practical measures in place to ensure that such guidelines are adhered to by block manufacturers. Presently the responsibility of making sure that blocks to be used on construction projects are of good quality rests solely on the shoulders of the relevant supervisory professionals on projects. Government should begin to look more into block production practices in order to enhance quality with the aim of reducing building collapse. Quality control should be introduced to assist block producers produce strong and durable blocks at minimum cost. Government regulatory agencies saddled with the responsibilities of ensuring quality and standard, limit them to organizing seminars and workshops to sensitize block manufacturers on ways of ensuring quality in the industry, which should not be. Government regulatory agencies need to take other necessary measures of ensuring quality such as mandating manufacturers to carry out compressive tests on their blocks from time to time as a mandatory quality control measure needed to secure a quarterly government certification that will enable them continue in operation. Block manufacturing though a business venture, should not be left in the hands of quacks or people who are only in it for business purposes.

Another challenge block producers contend with is the issue of bad weather. Freshly made wet blocks on pallets, require being left in the open field under the sun to cure. During raining season production and sales usually fall due to the rain. Apart from low production and poor sales usually experienced by block manufacturers during raining season, they also often incur losses as the rain sometimes destroy newly wet blocks yet to cure. Block producers also contend with the issue of bad roads which often times is responsible for breakages when transporting blocks from production yards to project sites. Though with good quality blocks, breakages are likely to be avoided, nevertheless with good roads breakages will be completely avoided or brought to the barest minimum. Several research findings have shown that the quality of sandcrete blocks produced in many parts of Nigeria are substandard. This is due mainly to the use of wrong mix ratios, poor quality of constituent material such as sand and the use of inadequately trained production workers. More so, in order to meet with the pressure of high demand from customers or clients, manufacturers oftentimes don't allow blocks to cure properly before transporting them to the construction site where they are needed for use. Such inadequately cured blocks are substandard as they have not attained the required strength before use. Using such blocks as load bearing walls could result in devastating consequences for a structure. Project supervisory team must stand up to their responsibilities of ensuring quality on projects by rejecting substandard blocks for use in Nigeria. The 3-tiers of Government, Policy Makers, Quality Control and Regulatory Agencies together with Professional Bodies all have their roles to play in ensuring that sandcrete blocks and bricks produced and used in Nigeria are of standard quality. Quality Control Monitoring Agencies must begin to take appropriate proactive measures in making sure that the production of substandard blocks are not allowed in the country.

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