PRODUCTION PRACTICES OF SMALL-SCALE OF SANDCRETE BLOCK MANUFACTURERS IN OSUN STATE, NIGERIA

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Abstract

The study evaluates the production practices of small-scale sandcrete block production firms in Osun state, Nigeria, with a view to determining whether the practices would lead to the production of blocks which would meet the required standards, and what aspects of their production practices need to be improved. The study covered twelve (12) local government areas in the state. The research instruments used were a questionnaire, measuring tapes and a concrete slab of 300mmx300mmx50mm size. The instruments elicited information on the methods of production as well as sizes and quality of blocks produced. The results indicated that only 40.6% of the blocks tested passed the height drop test, 54.5% of the firms used a 1:12 ratio cement to sand mix instead of the recommended 1:8; 16.8% used 'rule of thumb' for batching, while 68.5% produced sub-standard sizes of sandcrete blocks. The study concluded that Nigerian Institute of Building, Nigerian Society of Engineers and the standard organization of Nigeria should be empowered to conduct verification tests and pay regular inspection visits to the firms.

Key words: Small-scale, Production Practices, Building Projects Failure, sandcrete Blocks, and Height Drop Test.

1. Introduction.

There are several materials used in building a house. These materials among others include sand, cement, aggregate, steel, metal, aluminium, timber and glass of various grades. The use or application of some of the materials listed above depends on the financial strength of the client, local conditions and practices of the environment where the proposed building is to be located (Ojo, 2015).The most popular among these materials in the construction industry is the sandcrete block. Sandcrete blocks are of various sizes: 225mm (9 inches), 150mm (6 inches), 125mm (5 inches) and 10mm (4 inches) (Foraminifera Market Research, 2014a). The sizes chosen for construction depend on whether they are to be used in load bearing and non-load bearing walls.

Before the introduction of sandcrete blocks, individuals moulded their own bricks using wooden compactors (a rod or strip). This method of production of bricks is still in use today, not only in rural areas but also in urban areas. Nevertheless, sandcrete blocks are the building material of choice in urban areas for all types of buildings. They are very popular as a long lasting and low maintenance investment for institutional and industrial buildings (Aitcin & Mindess, 2011). The sandcrete blocks are sourced from different kinds of producers: local manufacturers using metal moulds for manual production, small and medium firms using moulding machines with mechanical vibrators and large firms using multi-block modelling machines. Whether a firm is small, medium or large, the same materials are used for the production of sandcrete blocks but the ratio mix and methods of production differ.

There had been a great number of building project failure in Nigeria over the last ten years: there are cases of buildings and wall fences collapse as well as cracks in buildings and wall fences. Where blocks are stacked for a short period in the open air, during rainy season, they weather and disintegrate. Building project failure has been attributed to both natural and man-made phenomena. In Nigeria, studies carried out have shown that the use of substandard building materials, poor construction practices, lack of adherence to specifications by unqualified and unskilled personnel and non-enforcement of building codes or construction regulations have contributed immensely to most of the recorded cases of building project failures (Taiwo & Afolami, 2016). Sandcrete block production is always considered a lucrative business because the blocks are the most preferred building materials in building construction. Due to the regular building projects failure, continued demand for sandcrete blocks and establishment of more block making firms in the state, the analysis of the production practices of sandcrete block producing firms is therefore critical.

Thus, the objectives of this study were to: assess the production process of sandcrete blocks in the study area; examine the place of production of sandcrete blocks; assess the methods of curing adopted; and measure the sizes of blocks produced.

2. Standard Production Process of sandcrete Blocks.

Sandcrete blocks are produced with a mixture of sand, cement and water. The process consists of about six steps as explained below:

Step I: Batching: Batching is the measuring of the materials for the production of the blocks. There are two methods of batching: batching by weight and by volume. In most cases batching by volume is the practice by the small- scale firms. Batching by volume is carried out with the aid of head-pan or wheelbarrow. In the case of batching by weight, the raw materials are discharged into a weigh batcher, which measures the correct proportion of dry materials for the mix (http://www.arch.virginia.edu/build/concrete).

Step II: Mixing: After batching, the next step is mixing of the materials together. Mixing could be done manually or mechanically. For the small scale firms, the mixing is done manually. Sand and cement are mixed thoroughly before water is added to it. It is recommended that the water should be drinkable, and the same water content should be maintained in the subsequent batches, so that there would not be any differences in quality.

Step III: Filling the Moulds: After mixing, the next step is the filling of the moulds with the mixed materials.

Step IV: Compaction: After filling the moulds, the material is compacted to remove voids inside the mixed materials. This enhances the quality and durability of the blocks. The compacted blocks are then pushed out of the moulds onto a flat wooden pallet and placed in a prepared location.

Step V: Curing: This is the wetting of the sandcrete blocks with water. The application may be done by watering can, rubber hose or buckets, or simply splashing water on the blocks byhand. Most producers in Nigeria use water hoses (Ezeji, 1994).The quality of sandcrete blocks is improved by water curing (Foraminifera Market Research, 2014b

Step VI: Stacking: This is the arrangement of the blocks one on top of the other, ready for sale or use.

2.1 Building Project Failure

In project management, it is required that the deliverables should meet the objectives and goals outlined in the baseline project plan. The project should also be of equality that meets

the customer's requirement and needs (Ojo, 2015). Some building projects fail to live up to their promises and produce disappointing outcomes on or before completion. Oloyede, Omoogun and Akinjare (2010) adduced the causes of building failure to the following: improper design, incompetent contractor, faulty construction methodology, non-compliance with specifications/standard by developers/contractors; use of substandard materials and equipment. Their data showed that non-compliance with specifications/standards of incompetent contractor and use of substandard materials and equipment were the three most prominent causes of building collapse witnessed in Nigeria. For Taiwo & Afolami (2011), the most significant contributors to building collapse were lapses on the part of the built environment professionals and the town planning authorities, bad construction practices, and the use of substandard building materials. Builders cutting corners because of corruption is another major cause of building collapse in Nigeria (Pennwell Corporation, 2016).

3. Methodology

This study was derived from a survey designed to assess the production practices of small-scale sandcrete block producers in Osun State. The State is located in the southwest of Nigeria, within the lowland humid tropical rainforest. It is characterized by wet and dry seasons. For the purpose of this study, random sampling method was used to select four local government areas from each of the three senatorial districts making a total of twelve local government areas for the study. See Table 1.

There were about 650 small-scale registered sandcrete block firms located in the study area. Primary data was obtained using structured and unstructured questionnaire, interviews and measuring of the blocks produced by the firms visited using a measuring tape. Twenty-five percent of the population of block-making firms was chosen from the total population as sample using systematic random sampling technique from each of the local government areas studied. This makes up a total sample population of 182 firms to which the questionnaire was administered. The questionnaire which had been subjected to content validity was designed to elicit information on the production practices of the industry. A total of one hundred and forty-three (143) copies of questionnaire were returned and found useful, which represents a return rate of 79.4%. Interviews were conducted to complement the questionnaire survey.

Table 1: Local Government Areas Covered and Questionnaire Administered.

Senatorial District	**L.G.A**	**No. Administered**	**No Retrieved**
Osun West	Iwo	15	12
	Ede	15	11
	Irewole	15	12
	Ayedaade	15	13
Osun East	Ife- Central	15	11
	Ife East	15	11
	Ilesa West	15	13
	Ilesa East	15	12
Osun Central	Osogbo	16	12
	Olorunda	16	13
	Ila	15	12
	Boripe	15	11
Total		**182**	**143(%=79.4)**

Source: Field Survey, 2016

The firms were also visited to physically observe their production practices. One block was purchased from each of the firms studied. The blocks were subjected to a height drop test

(HDT). The block was raised up to a height of about 1.220m (4'.0") above a portable concrete base of 300mm (12") x 300mm (12") x 50 mm (2") and dropped. This served as a quick test of strength. The data collected were analysed using simple descriptive statistic techniques such as frequency and percentage.

4. Results and Discussion

4.1 Demographic Characteristics of the Respondents.

Table 2 presents the respondents' background. The male respondents outnumbered their female counterparts (95.8% versus 4.2%). This finding shows that male respondents dominate the industry under study.55.9% of the respondents were 50 or older, indicating that firm owners were matured.

Table 2: Demographic Characteristics of the Respondents

Variable	Frequency (N 143)	Percentage (%)
Gender		
Male	137	95.8
Female	6	4.2
Total	**143**	**100.0**
Age Group (Years)		
18-25	3	2.1
26-49	60	42.0
50 & Above	80	55.9
Total	**143**	**100.0**
Highest Qualification		
Pry. Schl. Leaving Certificate	27	18.9
WASC/SSCE/TC II	52	56.4
C&G	10	7.0
OND	24	16.7
HND/First degree	30	21.0
Others	-	-
Total	**143**	**100.0**
Work Experience (Years)		
1-5	43	30.0
6-10	34	23.8
11-15	32	22.4
16-20	14	9.8
Above 21	20	14.0
Total	**143**	**100.0**
Forms of Ownership		
Sole or Individual	134	93.7
Cooperative Society	9	6.3
Government	-	-
Total	**143**	**100.0**

Source: Field Survey, 2016

Concerning the highest qualification of the respondents, the study shows that 54.6% of the respondents had a Senior Secondary School leaving certificate / Teacher Grade II Certificate, 21% had a HND or a Bachelor's degree, 18.9% had Primary School Leaving Certificate, 16.7% had Ordinary National Diploma, while 7% had City and Guild or certification by the National Board for Technical and Business Education. It can be inferred that the low level of education of the majority affected the areas of specialization of the respondents. 30% of the respondents had 1–5 years of working experience, 23% had 6–10

years' experience, 22.4% had 11-15 years' experience, 9.8% had 16-20 years of working experience while 14% had above 21 years of working experience. The above finding indicates that the work is lucrative because there are many new entrants into the business. This agrees with FMR (2014a) that block making is always considered a lucrative business. This is due to the fact that blocks and bricks are materials that people use to build houses, and they are always in continuous demand. Table 2 indicates that majority of the firms studied (93.3%) are owned by the individuals while the rest are owned by the cooperative societies.

4.2 Sandcrete Block Production Processes of in the Study Area

Table 3 presents the production processes used by sandcrete block firms in the study area. It is shown that all the firms (100%) batched by volume. 83% of the firms used wheel barrow for batching while 16.8% of the firms used a 'rule of thumb' for batching. These findings show that workers pour cement onto a heap of sand without measuring by weight. This method is common mostly among people using hand moulds. For the sandcrete mix, 54.5% of the firms used ratio 1:12, that is, a bag of cement to 24 head pans of sand while 45.5 used ratio 1:8. All the firms mixed their materials manually using shovels. In addition, 80%of the firms used undrinkable water to mix the materials.

Concerning production equipment, 83.2% of the respondents used block making machines for the production of the blocks while 16.8% used hand moulds. The same set of respondents that batched by rule of thumb used hand moulds for their production. Hand-moulded blocks tend not be well compacted because the manufacture involves no vibration. In the case of curing, 83.2% of the respondents cured the blocks produced while 16.8% of the respondents did not. They produced the blocks on the site where the blocks would be used and left the curing to the clients. Where the clients failed to cure the blocks, the bricklayers used the blocks uncured.

Table 3: Methods of Production

Variable	Frequency	Percentage (%)
Batching		
By volume		
Head Pan	0	0
Wheel barrow	119	83.2
Rule of thumb	24	16.8
By weighing	0	0
Total	**143**	**100**
Mechanical **(**Mixer)	0	0
Manual (shovel)	143	100.0
Total	**143**	**100**
Production		
Mechanical (machine)	119	83.2
Manual (Hand mould)	24	16.8
Total	**143**	**100**
Curing		
Cure	119	83.2
Do not cure	24	16.8
Total	**143**	**100**
Block Size		
Standard (High Quality)	58	40.56
Varied (Low Quality)	85	59.44
Total	**143**	**100**

Source: Field Survey, 2016

This reduces the strength of the blocks. The finding shows that those that used 'rule of thumb' batching and manual mixing were the same groups produced blocks on clients' sites and did not return to cure the blocks produced. This method will no doubt affect the quality of blocks produced as the production of sandcrete blocks requires constant monitoring to produce blocks that have the required properties (Cavette, 2014).

4.3 Sizes of sandcrete Blocks Produced

Table 4 presents the various sizes of sandcrete blocks produced by the firms studied. The researcher and the field workers purchased a block each from the firms, measured the length, width, height and thickness which surrounds the two internal holes contained by the block as shown in Figure 1. After leaving the place of purchase we subjected the blocks to a height drop test (HDT) by dropping the block from a height of 1.220m (4'.0") onto the hard surface of a concrete slab with the dimensions300mm x 300mm x 50mm.The findings from the measurements show that 31.47% of the respondents adhered to only the external dimensions of the blocks but reduced the thickness of the blocks, while 25.17% made blocks of the correct length and width but reduced the height by 12mm (1/2 inch) as well as the thickness. These irregularities in the block dimensions cause confusion among the clients and the producers. Some clients would report that their block moulder moulds between forty-five and fifty 230mm (9'') blocks of from one bag of cement while others would say theirs produced between thirty and thirty-five blocks from a bag using similar ratio. These disparities are caused by block makers using moulds of different sizes. Another finding is that firms used different mix ratios, that is, the ratio of sand to cement; if the mould were of standard dimensions; the ratio is important in order to achieve the desired quality. Most of the firms did not keep to the standard ratio of 1: 8 instead, they preferred 1:12 or 1:14.

The result of the height drop test shows that 59.44% of the blocks tested failed the test while 40.56% passed the test. This agrees with the Nigerian Institute of Building release that the increase in cement price and cement in the mix for block moulding, setting, plastering and for concrete would be compromised if clients could not go beyond budget or provide extra fund to catch up with the inflationary trend (Alao, 2011). Many projects failed due to inappropriate technical methodologies, lack of formal technical standards, and poor technical judgment (McManus Wood-Harper, 2007). A project is considered a failure when it has not delivered what was required, in line with expectation. (Mind Tools, 2014) The Director-General of the standard Organization of Nigeria opined that the problem of building project failure was not lack of availability of standards to follow but consumers' attitude and operators' unwillingness to accept and implement available standards (Echenim, 2009). Clients, stakeholders and experts in the building industry should advocate adherence to quality standard atevery stage of work from measuring out quantities to production of building materials for use by builders.

Table 4: Sizes of Blocks Produced by the Firms

Frequency	Percentage (%)	T1	T2	T3	T4	T5	H1	H2	H3	H4	LH	WH	HT	Remarks
45	31.47	50	50	50	50	50	155	155	130	130	460	230	230	Standard
62	43.36	25	38	25	25	25	190	190	178	178	460	230	230	Sub-standard
36	25.17	38	45	38	38	38	168	168	155	155	460	230	215	Sub-standard
143	**100.0**													
T1-T5= thicknesses; H1-H4 = Holes; LH = Length; WH = Width HT = Height														

Source: Field Survey, 2016

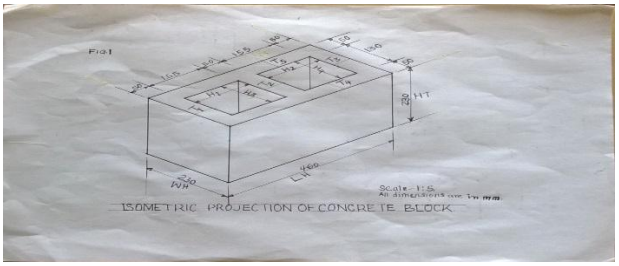

Fig. 1: Isometric Projection of sandcrete Block

5. Conclusion and Recommendations

The increasing needs of Nigerians to build residential buildings, institutional buildings, religious buildings, factories and offices to accommodate the Nigeria's large population have made sandcrete block moulding a very lucrative business. Despite the fact that the materials are locally sourced and available, the percentage (59.4) of low quality blocks produced was higher than that of high quality blocks (40.6%) produced. The ratio used, method of mixing the materials (manual=100%) and the quality of water added to the materials affect the quality of the blocks produced. With the presence of Nigerian professional bodies such as the Nigerian Institute of Building and the Nigerian Society of Engineers, and regulatory agencies such as the Standards Organization of Nigeria, the quality of sandcrete blocks should be monitored to ensure that they are good quality and recommended dimensions. It is therefore recommended that the professional bodies should be empowered to conduct quality verification tests, pay regular inspection visits to the firms and establish building materials testing agency.

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