
Compressive strength of manual and machine compacted sandcrete hollow blocks produced from brands of Nigerian cement

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Abstract: This research investigated and compared the strength of manual with machine compacted sandcrete hollow blocks using Dangote and Elephant (Ordinary Portland) cement brands in Nigeria. Thirty two (32) samples were moulded from the two brands of cement i.e. sixteen (16) from each cement brand for both manual and machine compaction methods and were cured for 7, 14, 21, and 28 days respectively. The result revealed that the 28th day average compressive strength of the block produced manually with the Dangote and Elephant brands of cement were 2.83N/mm² and 2.89N/mm² respectively, while the 28th day average compressive strength of machine compacted blocks from Dangote and Elephants brands of cement were 2.96N/mm² and 3.03N/mm² respectively. This result revealed that machine compacted blocks have a higher compressive strength than the manually compacted blocks. The result obtained for all the samples of the sandcrete blocks were within the Nigeria Industrial standard (NIS 87:2000) specification.

Keywords: Sandcrete Blocks, Compressive Strength, Manual Compaction, Machine Compaction, Ordinary Portland Cement

1. Introduction

Housing is one of the requirements of man; the ambition of all people to own or have access to decent shelter is not a luxury but a necessity. Different Materials are used around the globe for housing especially for walling [1].

Freestanding walls and building structures with load bearing walls are common in Nigeria because they are simple to construct and easily affordable. Sandcrete skin panels and blocks can sometimes be used to provide aesthetic value to buildings and also, when adequately prepared, to control moisture infiltration and wind action. This utility value of Sandcrete in comparison to its cost and its adaptability to climatic factors is responsible for its wide application; most especially in small to medium buildings in countries within tropical rainforests where a considerable amount of precipitation and high average temperatures are predominant [2].

Sandcrete blocks are widely used in Nigeria as walling units and over 90% of houses in Nigeria are being constructed of sandcrete blocks. This makes sandcrete blocks a very important material in building construction [3]. Sandcrete

blocks have been manufactured manually and mechanically to meet the need of building due to the discovery of cement. This was done without putting into consideration the strength and durability of the blocks [4].

These sandcrete blocks are manufactured in many parts of Nigeria without reference to any specifications either to suit local building requirements or for good quality work [4]. The situation in Nigeria has since changed as Standards Organization of Nigeria (SON) now has specifications for both the manufacture and the use of blocks in Nigeria.

Quality and standardization of sandcrete blocks are of paramount importance in the study of building components as housing is one of the basic requirements of man. This will serve as basis for measurement, reflecting the level of development attained by a nation.

2. Sandcrete Blocks

According to Nigeria Industrial standard- NIS 87:2000 [5], Sandcrete block is a composite material made up of cement, sand, water, moulded into different sizes. Sandcrete blocks can be made either in solid and hollow rectangular types.

These sizes are usually 450mm X 225mm X 225mm (Hollow) for load bearing walls and 450mm X 150mm X 225mm (Hollow) for non-load bearing walls. The hollow blocks have a void that runs from top to bottom and occupy around one third of the volume of the blocks. However, solid Sandcrete block does not have any void in it. Figure 1 shows sketches of a hollow and solid Sandcrete block. They are of sizes and weights that can be easily handled by the bricklayer, with the facing surface layer larger than that of a brick but conveniently dimensioned [6]. In the hardened state, sandcrete has a high compressive strength and this strength increases with density. The range of minimum strength of sandcrete specified in the Nigeria Industrial Standard NIS 87:2000 [5] is between 2.5N/mm² to 3.45N/mm². However, the strength of sandcrete blocks is inconsistent due to the different production methods employed, duration of curing, sizes of blocks and the properties of constituent materials [6].

Sandcrete blocks are relatively cheap when compared to other construction materials. Sandcrete blocks provide excellent resistance to damage without the added cost of protection devices. They do not rust, decay, or provide a home for damaging insects as other building materials can. They do not contain any material that is hazardous to the environment [7].

Many things are considered in the production of Sandcrete blocks such as the quality of the materials, its mixing ratio, method of mixing, molding process and duration of curing [8].

Figure 2 shows a typical housing development in a semi-urban area in Nigeria.

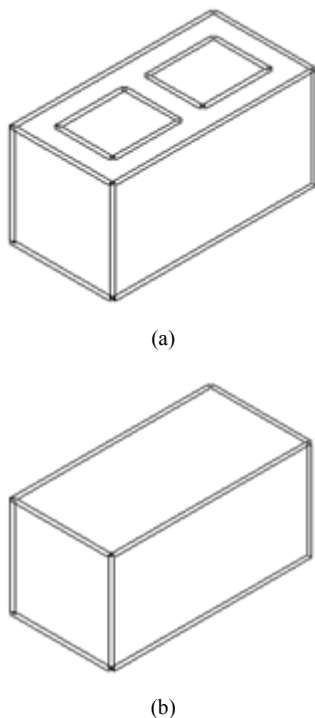


Figure 1. (a) Hollow Sandcrete Block (b) Solid Sandcrete Block.

3. Cement Manufacturers in Nigeria

The following companies manufacture cement in Nigeria:



Figure 2. Typical housing development (predominantly of sandcrete blocks) in a semi-urban area in Nigeria [2]

1. Cement Company of Northern Nigeria Plc: They are the producer and marketer of Sokoto BUA brand of cement in Nigeria. They are located at Km 10, Kalambaina Road, Sokoto, Sokoto State, Nigeria.
2. Dangote Group: The Head office of Dangote Group is located at 1 Alfred Rewane Road, Falomo Ikoyi, Lagos, Lagos State, Nigeria. They are the manufacturer of Dangote brand of cement in Nigeria.
3. Eastern Bulkcem Company Limited: Their Head office is located at 11, Awolowo Road, Flat 5 Block 2, Ikoyi, Lagos, Lagos State. They are the manufacturer of Eagle Cement in Nigeria.
4. Lafarge Cement WAPCO Nigeria Plc: They are the manufacturer of Elephant brand of cement in Nigeria. Their Head office is located at Km 64, Lagos/Abeokuta Expressway, Ewekoro, Abeokuta, Ogun State.

4. Methodology

The material constituents, their mix, manufacturing process, curing are paramount important factors that determine the strength of sandcrete blocks.

4.1. Materials Used

The following materials were used in producing the sandcrete blocks used in this research work:

4.1.1. Sand

Sand which is an extremely needful material for any

construction is the product of natural or artificial disintegration of rocks and minerals. Clean sharp sand, free from waste stone and impurities were used in the production of the sandcrete blocks used in this research work.

4.1.2. Cement

Ordinary Portland cement (OPC) – Dangote and Elephant cement brands which conformed to NIS 444 – 1: 2003 as evidenced by the certification mark NIS 444 -1 :2003 (Dangote Cement),and ISO 9001: 2008 (Elephant Cement) on the product bags were used.

4.1.3. Water

Portable water which is free from suspended particles, salts and oil contamination were used throughout this study as specified by [5].

4.2. Mixing

In this study, the manual method of mixing was used for both the machine compacted and manual compacted blocks. The cement and sand were mixed in a dry form and water was added in spray form in moderate proportions to allow the cement to hydrate and excess of water was avoided that would have caused shrinkage and distortion of block on drying. Water cement ratio used in this research work was 0.5. The mix ratio was 1:6 (one part of cement to six part of sand) as specified by [9]. Curing was done manually.

4.3. Compaction Methods

A vibrating compacting machine was used in compacting 50% of the blocks while the remaining 50% blocks were compacted manually with the aid of a wooden rod.

The blocks were of sizes 450mm x 150 mm x 225 mm and were manufactured with Dangote and Elephant Cement brands.

4.4. Curing

Curing was employed to maintain satisfactory moisture content and allow proper hydration and hardening of the sandcrete blocks. The blocks were cured for the whole period of the 28 days during which they were tested for their

compressive strengths.

4.5. Determination of the Compressive Strength of Block Samples

The Compressive strength tests were carried out at 7, 14, 21, and 28 days of moulding the sandcrete blocks using ELE2000KN compressive testing machine.

The tests were carried out at the Concrete Laboratory of the Institute of Technology, Kwara State Polytechnic, Ilorin, Kwara State, Nigeria. 32 cube samples were investigated for their strengths.

4.6. Computation of Compressive Strength of the Sandcrete Blocks

In obtaining the compressive strength of the sandcrete blocks in N/mm² the crushing loads recorded were divided by the effective area of the block. Equation 1 was used in calculating the compressive strength and Equation 2 gives the effective surface area of the sandcrete block.

$$\text{Compressive strength} = \frac{\text{Crushing load}}{\text{Effective surface area of block}} \quad (1)$$

$$\text{Effective surface area of block} = \text{Total Surface Area of block} - \text{Area of hollow} \quad (2)$$

$$\text{Effective surface area of the sandcrete block} = (455 \times 150) \text{ mm}^2 - 2(160 \times 85) \text{ mm}^2 = 41,050 \text{ mm}^2$$

5. Results and Discussion

Table 1 shows the Compressive strength of manually compacted sandcrete blocks produced from Dangote and Elephant brands of cement while Table 2 shows the Compressive strength of machine compacted sandcrete blocks produced from Dangote and Elephant brands of cement. The test carried out indicated that the average compressive strength of the sandcrete block compacted manually from Dangote brand of cement at 7, 14, 21 and 28 days of production ranges between 2.32N/mm² to 2.83N/mm².

Table 1. Compressive strength of Manually compacted sandcrete blocks produced from Dangote and Elephant cement

| Serial Number | Period of Test (days) | Mean Compressive Strength of blocks made from Dangote Cement (N/mm ²) | Mean Compressive Strength of blocks made from Elephant Cement (N/mm ²) |
|---------------|-----------------------|---|--|
| 1 | 7 | 2.32 | 2.61 |
| 2 | 14 | 2.58 | 2.82 |
| 3 | 21 | 2.59 | 2.65 |
| 4 | 28 | 2.83 | 2.89 |

Table 2. Compressive strength of Machine compacted sandcrete blocks produced from Dangote and Elephant cement

| Serial Number | Period of Test (days) | Mean Compressive Strength of blocks made from Dangote Cement (N/mm ²) | Mean Compressive Strength of blocks made from Elephant Cement (N/mm ²) |
|---------------|-----------------------|---|--|
| 1 | 7 | 2.23 | 2.26 |
| 2 | 14 | 2.52 | 2.64 |
| 3 | 21 | 2.83 | 2.77 |
| 4 | 28 | 2.96 | 3.03 |

The average compressive strength of the sandcrete blocks produced mechanically with same brand of cement at age 7,

14, 21 and 28 days ranged between 2.23N/mm² to 2.96N/mm². The average compressive strength of sandcrete blocks produced manually with the Elephant brand of cement at age 7, 14, 21 and 28 days of production ranges between 2.61N/mm² to 2.89N/mm². The average compressive strength of the sandcrete blocks produced mechanically with Elephant brand of cement at age 7, 14, 21 and 28 days ranges between 2.26N/mm² to 3.03N/mm².

These values falls within the specified minimum compressive strength of 2.5N/mm² and 3.45N/mm² for sandcrete blocks prescribed by NIS 87: 2000 for load bearing and non-load bearing walls for the 28days result.

It was observed that the Elephant brand of cement has the higher compressive strength than the Dangote brand of cement in compressive strength and the machine compacted sandcrete blocks are higher in strength than the manual compacted sandcrete blocks after curing for 28days. This can be attributed to the fact that the machine has a higher vibration impact on the sandcrete blocks than the manually applied hand rammers. It was also observed that the sandcrete blocks increases gradually in compressive strength at each curing stage.

6. Conclusion

The following conclusions were made from this research work:

1. The 28th day strength of the sandcrete blocks produced with Elephant cement are higher in strength compared to that of Dangote cement, and the Machine compacted sandcrete blocks have higher compressive strength than the Manually compacted sandcrete blocks;
2. As the curing age increased, there was an increase in the compressive strength of the Sandcrete blocks.

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