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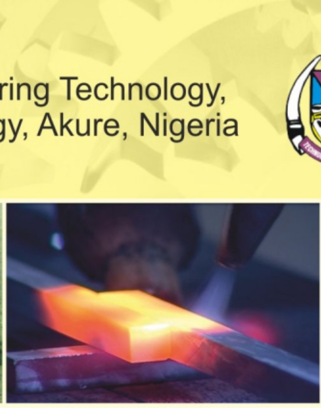


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Strength Properties of Commercially Produced Sandcreteblock in Ikeja: Lagos State

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silt clay,
Organic content.

A B S T R A C T

The purpose of this study is to verify whether purchased commercially produced sandcrete blocks contribute to collapsing of buildings in Lagos State. 20 sandcrete block industries were visited in Ikeja, in which ***six*** *was randomly selected for the study.* ***Eighteen*** *Sandcrete Blocks were randomly selected and purchased, three blocks from each Block Industry including the soil samples and transported to the Department of Civil and Environmental Engineering Geotechnical Laboratory FUTA where the following Tests were performed: Sieve, Silt Clay, and Organic Content Analysis. The Compressive Strength Tests (CST) was conducted at Materials Testing Laboratory "the Ministry of Works" Ondo State. The results showed that the soil aggregates used for the production of all the 18 blocks purchased were found suitable. However, the compressive strength for all the blocks was found (0.34 N/mm^2 and 0.377 N/mm^2) to be below the requirement (2.5 N/mm^2) of Nigerian Industrial Standard (NIS) 87:2000. This indicates that commercially produced sandcrete blocks may have contributed to the problem of building collapsing in Lagos State.*

1. Introduction

The use of sandcrete blocks has gained popularity in Nigeria including Lagos State. They are widely used as walling units or partition, often as a load bearing walls. Investors are moving away from the idea of molding blocks on sites due to rising cost of labour. As a result building investors consider buying directly from the block industries. In Lagos State, the qualities of sandcrete blocks manufactured vary due to the method of production employed by individual block industry. The qualities of sandcrete blocks produced generally in Nigeria have reduced due to demand and lack of control by government agencies. This study becomes necessary due to frequent occurrence of building collapsing in Lagos and other parts of the country. Dov. (1991) described sandcrete blocks as precast masonry units assembled and bounded by cementitious materials to form wall which can be either load bearing wall, enclosed wall or back up wall. According to BS 6073 (Specification for Precast Concrete Masonry Unit Part 1), three types of blocks are displayed and recognized and they are: solid, hollow and cellular. They are molded or produced in various sizes. Commonly used size is 450mm x 225mm X 150mm with a wide range of 6 inches to 9 inches. In 1985, Nigeria government set up a committee to review the allowable minimum permissible compressive strength of Sandcrete blocks in Nigeria which can be easily handled by individual craft person. The load bearing walls are those walls that can support the entire structure, transmit the load to ground surface (NIS 87:2000). According to NIS 87:2000; sandcrete blocks pose intrinsic low compressive strength, indicating that they are susceptive to any natural disaster such as earth quakes or seismic activities. Previous studies have shown that commercial sandcrete blocks are produced in various standards which are still below NIS recommendation standards for construction of buildings.

The deficiency found is that sandcrete block has no standard engineering definitions. The engineering definition of sandcrete is to suit the purpose of use. Sandcrete blocks are rough in physical appearance; due to the nature and origin of pure morphological definition. However, there is a general engineering materials standard definition of sandcrete blocks such as sand, cement and water. In addition, the application of Geotechnical methods such as sieve analysis, silt/clay content and bulk density appeared to have consolidated engineering definition of sandcrete blocks.

The time mixing sandcrete with cement and also the time lapse between mixing compaction appear to have direct impact on the strength. Increase in strength with age and curing temperature, seems to have contributed to stabilization of sandcrete blocks. Neville (2000) identified that compressive strength of a sandcrete block increases with cement contents at a limit rate.The type of sand materials used, such as fineness, density, relative density and sharpness seems to have direct influence on easy mixing with cement. Ezeji (1997) indicates that the proportion and number of components seems to affect the mixing rate with cement. Similarly, Andram (2004) showed that commercial sandcrete blocks exhibit compressive strength far below standard recommendation for construction. He went further to indicate that the maximum compressive strength of commercially produced sandcrete blocks

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was within the range of 0.97N/mm2as against minimum recommended standards of 2.5N/mm 2. In line with this finding, the investigation becomes necessary in order to determine the organic test to verify the absence or presence of organic matter or acid that could work against the compressive strength of commercially produced sandcrete blocks in Lagos as recommended by BS 882(1992).

2.0 Research Approach and Sampling.

The samples used for this study were collected from six different locations in Lagos State. 18 sandcrete blocks samples were purchased all together, three samples of from each manufacturer including soil samples and transported to the Department of Civil and Environmental Engineering soil laboratory at the University of Technology Akure (FUTA) and Ondo State ministry of works laboratory to conduct both sieve analysis and compressive strength tests. Andam (2004) indicates that blocks are unlike other building materials in terms of shape and intrinsic properties; is cubical in shape, rough and are widely used in Nigeria, specifically for residential and non-residential buildings. SandCrete blocks are common used all over Nigeria and they can be found in every local community including the Lagos State.

2.1 Sampling

Many sites were visited and different manufacturers were interviewed, after the interview, a random sampling method was applied to select the six different locations. Eighteen sandcrete blocks including the soil were purchased from these six different locations and samples sizes are (225 × 450 × 150) 6 inches blocks were brought to Akure for laboratory examination. The purpose of collecting quantity of sand samples was basically to ascertain their suitability for the blocks and to verify whether the blocks are produced in accordance with BS 1377. Two types of samples are hollow blocks having a dimension of 225mm × 450mm × 150mm. It was discovered that some manufacturer had two types of fine aggregate, soft/ fine and sharp sand.

\2.2 Focus of the study

It appears that the quality of sandcrete blocks commercially produced in Nigeria differs from one State to another due to methods of production and curing. Sandcrete blocks mighty have contributed to the collapsing of building in Nigeria which is not fully considered a factor because most researchers attached their findings with economic factor. On the other hand, there are other needed to be taken into consideration such as environmental factor etc. However, this study focuses on quality of materials and methodology used in producing the material and at the same time, tries to find out whether manufacturers take on board Nigeria Industrial Standard (NIS 87; 2000) regulation.

2.3 Sandcrete Blocks

Neville (2000) showed that a block is made from loose mixture of soil or aggregate, cement and water (damp mixture), compacted to form dense block before dehydration. They went further to subdivide block into two distinct groups, Hollow and Solid Sandcrete blocks and defined sandcrete blocks as permanent durable materials which are produced from natural sandy soil or a modified soil. Cohesive soil is freshly molded to allow the unsupported handling or curing. They concluded that block may be greater than 100mm and 230mm. However, soil cement block remained permanent durable materials, produced from naturally modified soil containing sufficient fines to allow cohesion on densification sufficient to all unsupported handling of freshly molded blocks. Sandcrete blocks are made from sand, cement and water, cement is seen as the binding agent.

3.0 Laboratory Tests

The laboratory tests were carried on the following:

1 Sieve analysis of sand
2 Determination of the silt/ clay content
3 Determination of the organic impurities/content of the sand.
4 Determination of bulk density of the blocks.
5 Determination of the compressive strength of the blocks.

3.1 Fine Aggregate Testing

The following tests were carried out using natural sand samples collect from each site:

a Grading by sieve analysis
b Silt/clay content analysis, and
c Organic content analysis

3.1.1 Sieve analysis (Particle size analysis)

The samples were spread out in the Sun to evaporate or dry for a period of 24 hours before the test on them was carried out, using the sieve sizes grading according to BS 882(16) apparatus. The digital weighing balanced was adjusted to zero in order to include the weight of the pan. The empty pan used was weighed before filling it with sand and weighed. The study follows the instructions and procedure and recommendation BS 812 (16 and 18..

3.1.2 Silt/clay content test

According to BS 812(16 and 18)'s recommendations. One measurement liter cylinder used was cleaned and dry after use through the experiment 50ml of 1% sodium chloride (NaCl) solution was poured into the 250ml BS measuring cylinder. More sand is added into the cylinder to reach 100ml mark and more solution of sodium chloride (NaCl) is also added and filled cylinder up to the 150ml for their total volume. The purpose of adding (NaCl) solution to the cylinder containing Silt/Clay was to act as a catalyst to separate silt from silt from the sand. Each cylinder was covered with hand very tight and shakes rigorously for about 15 minutes and leaves the mixture for three hours. The solution appeared clear yellowish colour to show that the test has been completed. The silt was able to settle and formed a layer which was used to determine the height of the sand, normally expressed in percentages.

3.1.3 Organic Content Test

NaOH was use as solution for the test. The apparatus was a transparent cylinder. A transparent cylinder was filled with sand and reasonable volume of distilled NaOH was added. The cylinder was tightly held by hand which sealed and shaken vigorously and allow the cylinder to stand undisturbed for 24 hours. The presence of any organic indicated discoloration of the solution. That means the resulting suspended solution was settled above the sand. The reddish brown or dark red solution showed the presence of acid. These results showed a clear yellow solution, which means that the sand is suitable for construction work.

3.1.4 Testing of Sandcrete blocks.

The tests carried out on each of the sandcrete purchased, include bulk density, water absorption and compressive Strength. The sandcrete block samples were labeled and weighed individually in dry condition. The weight of the machine used was 50kg capacity with 500g graduations. The length, breadth and height of the labeled blocks were taken and the volume calculated.

3.1.5 Water Absorption

Water is used to set – up the chemical reaction to harden the cement to form the finished block. Similarly, water is used to mix cement and sand, and also used for curing molded blocks. The absorption rate is defined as the weight of water absorbed when the unit is partially immersed for 1minute in water as indicated in BS3921 (water absorption approach 0.1%).

A = 100(wet mass – dry mass)/dry mass.

In this consideration, each sample of sandcrete blocks was weighed in dried conditions and after the readings had been taken, each these block was fully immersed in water for a period of 24 hours to make sure that they were fully submerged in the water. After 24 hours, the wet block samples were removed and weighed. The difference between the dry and wet were taken, and then calculated, using the above mathematical formula.

A = (100(WET MASS – DRY MASS))/DRY MASS)(BS 1921, 1985 AND ASTM C140)

3.1.6 Thermal Conductivity

Thermal Conductivities of sandcrete block depend on the bulk density of the block. Sandcrete blocks thermal atmosphere temperature is very high also the interior temperature is high. Andam (2004) reported that thermal conductivity of sandcrete block decreased with increasing firing temperature while with high cement content poses low thermal conductivity and high thermal resistance. The outcome of this study shows that that minimum thermal conductivity agreed with the condition of maximum crushing strength.

3.1.7 Compressive Strength

Each of the eighteen block samples was crushed to determine individual compressive strengths. Compression testing machine was utilized; each block was weighed and carefully set between the centres of the plates of the compression testing machine before crushing. The crushing /failure load of each block was recorded and the compressive strength was determined. The formula below was used to determine the Crushing Strength.

4.0 Analysis of Results

The results of the investigation carried out on the 18 sandcrete blocks to determine their qualities and compressive strength were analyzed on the basis of the following. As can be seen on the tables and figures below; the results demonstrated that the aggregates used were suitable for all the blocks that were purchased. However, the result showed the compressive strengths of all the commercially sandcrete blocks purchased in Ikeja.

Neville (2000) shows that the presence of silk/clay appear in high percentage would affect the production or properties of sandcrete, the quantity of water present will promote rapid evaporation, leaving numerous pores in this respect, sandcrete block produced will be weaker. Figure 9 shows that the soil sample fall between a range of 0.16 and 0.95.This shows that some soil samples are above the range of recommended by the BS 1992 (0-5%). The presence of silt/clay exceed this range will affect the initial and the final setting and at the same time will affect the strength. Furthermore, local stresses such as shrinkage cracking will be increased due to the incineration of clay. Expansion will occur due to absorption of water. See BS 3184. Samples 2A, 0.66, 2B, 0.64, 2C, 0.53, 3A=0.54, and 6A, 0.95 appear to above the recommended value by BS 1992(0-5%).

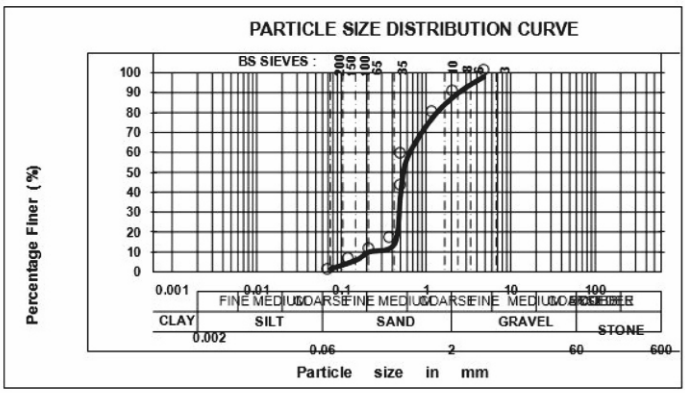

Figure 1.0: Grain size distribution for Sandcrete blocks (Location A)

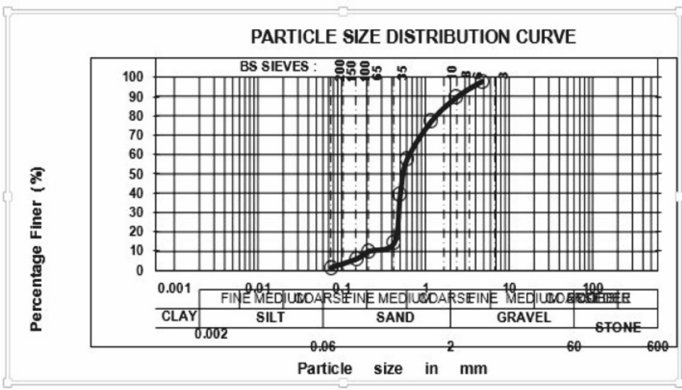

Figure 2.0: Grain size distribution for Sandcrete block (Location B)

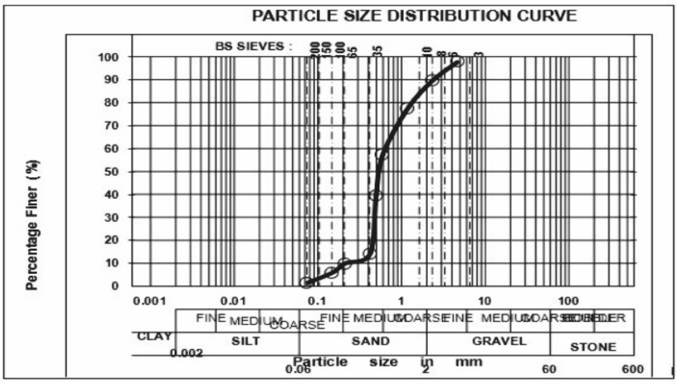

Figure 3: Grain size distributions for Sandcrete blocks (Location C)

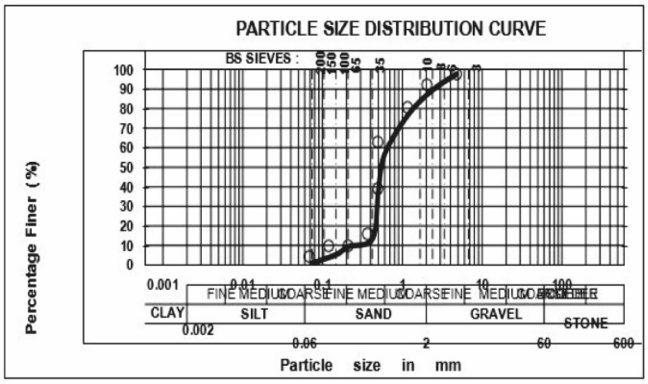

Figure 4: Grain size distribution for Sandcrete blocks (Location D)

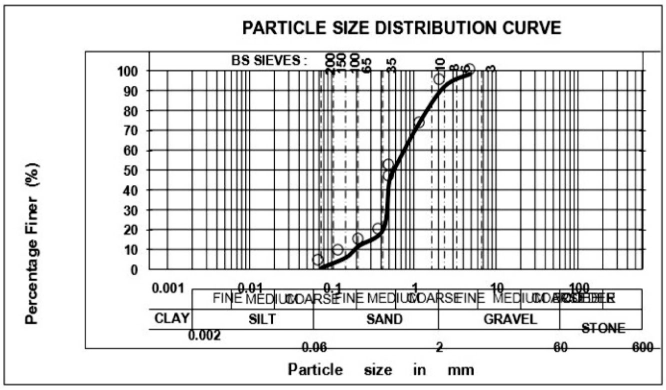

Figure 5: Grain size distribution for Sandcrete blocks (Location E)

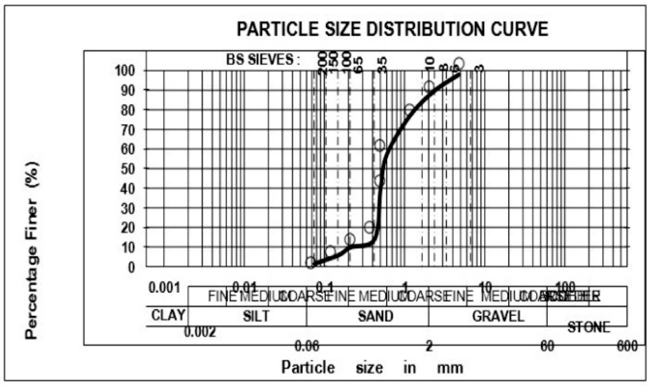

Figure 6: Grain size distribution for Sandcrete blocks (Location F)

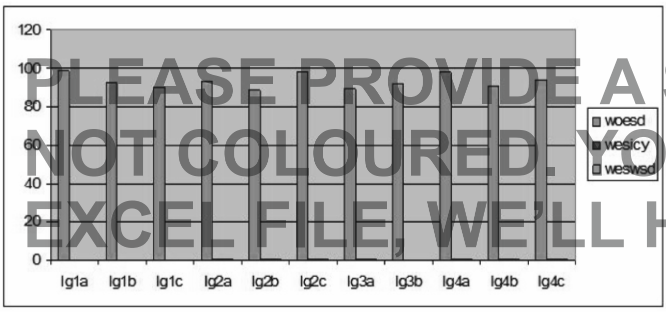

Figure 7: Silt/ Clay for soil sample locations

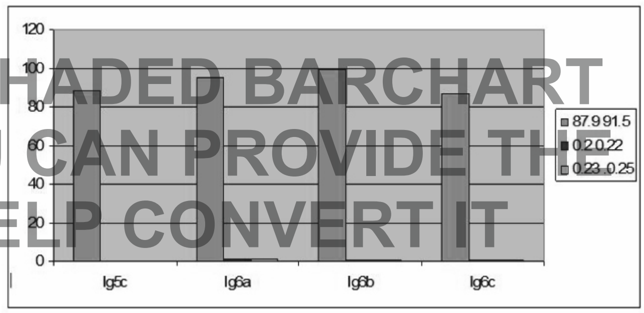

Figure 8: Silt /Clay above recommendation

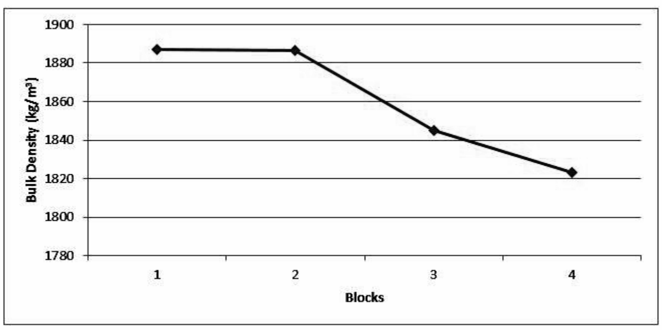

Figure 9: Bulk density

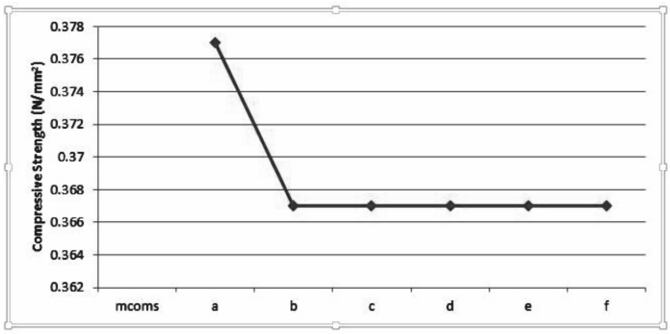

Figure 10: Compressive Strength N/mm^2

The Result of the Bulk Density of the blocks is illustrated in the figure 9. The result shows that the bulk density of the individual Sandcrete block ranges between 2300kg/m^{3}to 2400 kg/m^3. The change in weight ranges from 23.28kg to 24.60kg and Bulk density ranges from 0.02 to 0.1. The average Bulk Density of the tested is shown on the table. The mean of bulk density is also shown on the table 10.SAMPLE $2^{A,} 2^{B,} 2^{C,} 4^{A,} 4^{B}$, and 4^{C} were fully immersed in water for a period of 24 hours. After 24 hours, these immersed blocks were removed and weighted. The difference between the dry and wet weights was taken. The results of these tests are shown on the table above. The water absorption capacities are not totally different from the recommended value (see ASTM 140 recommendation).

Figure 10 above show the compressive results of the individual sandcrete blocks. As can be seen from the Figure, the value ranges from 0.367N/mm^2 to 0.377N/mm^2. These value fall below the recommended value by (NIS 87:2000) for individual sandcrete blocks (2.5Nmm^2) .It is also indicated in BS 2028 (see BS 2028), that 5 commercial sandcrete blocks should not be less than 3.25N/mm$^{2.}$ As shown in the figure 11 the whole 18 blocks fell below standards, this problem may be associated with mix ratio different from previous researchers finding 1.6 and 1.8. The consequence of the mix ratio on the compressive strength of the blocks can work against the workability of the strength the material.

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5. Conclusion and Recommendation

The test from the sieve analysis showed that soil particles are suitable for the production of sandcrete blocks and also good for construction according to (BS 882: 1992). From observation the water used by these industries for the production of all these sandcrete blocks was clean and clear. The type of water used for the production was the same type of water recommended for construction work by (BS 3148: 1980). The curing method or drying method adopted by these industries which was done by spraying or wetting for several days may have contributed to the weakness of the blocks. The control tests indicate that the poor qualities of these blocks may be associated with poor mix ratios and low level of compaction, inadequate curing methodology. The findings also show that the compressive strength of sandcrete blocks collected from six manufacturing sites is very low with the degree of variability. From observation the curing method used by the manufacturers, shows no indication that the application applied was in accordance with BS 3148: 1980 regulations. Other reasons for the failure of these blocks, they exposed in open air and in most cases the water sprinkle on them was inadequate. All sandcrete blocks samples purchased from the manufacturer have attained or reached 28 days, at this stage these blocks should have attained high compressive strength.

Recommendation

It may be necessary to take a simple laboratory site tests in advance before selecting the purchasing sites. It is suggested that curing culture should be improved, appropriate curing method should be encouraged. COREN and NSE should collaborate with Federal and State governments to encourage the Manufacturer to follow NIS, BS and CST requirement and regulations in accordance with specified standard and dimensions. It may be necessary for COREN and NSE to encourage them to use the following factors: a) Proportion of the constituent (mix proportion), b) Initial mechanical compression imparted to the green block (degree of compaction), c) Amount of water (water – cement ratio), and d) Fine aggregate (size, grade, texture and shape characteristics). COREN, NSE, Federal and State governments should assign professional Construction Engineers on and impromptu visitation to all the block factories to give room for effective compliance with the instruction.

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