International Journal of Engineering Science Invention
ISSN (Online): 2319 – 6734, ISSN (Print): 2319 – 6726
www.ijesi.org Volume 2 Issue 5 ‖ May. 2013 ‖ PP.22-33

Strength Properties of Commercially Produced Sandcreteblock In Akure: Ondo State

E.O Aiyewalehinmi[1] and M.O. Tanimola[2]

Department of Civil Engineering, the Federal University of Technology, Akure

ABSTRACTS: *The purpose of this study is to verify whether purchased commercially producedSandcrete blocks contribute to collapsing of buildings in Ondo State. 18 sandcrete block industries were visited in Akure Metropolis in which six was randomly selected for the study.Eighteen SandCrete Blocks were randomly selected and purchased from the six selected Block Industries.Three blocks samples from each Block Industry including the soil sampleswere transported to department of Civil Engineering Geotechnical Soil Laboratory FUTA. The following Tests were carried out:Sieve Analysis, Silt Clay Analysis, Organic Content Analysis, and Compressive test The Compressive Strength Tests (CST) waslater conducted in the Materials Testing Laboratory "the Ministry of Works" Ondo State. The results confirmedthat the aggregates used for production were suitable for all the blocks that were purchased. However, the result of compressive strength for all theSandCrete blockswas below the Standard recommended by Nigerian Industrial Standard (NIS) 87:2000. The comprehensive strength of individual blocks was between 0.45mm^2 and 0.87mm^{2}against minimum recommended standards of 2.5N/mm^2. The analysis does not rule out being part of the problem (building collapsing).*

Keywords: *Sandcrete block, Soil, Silt clay, Sieve, compressive strength*

I. INTRODUCTION

The use of sandcrete blocks has gained popularity in Nigeria including Ondo State. They are widely used as walling units or partition, often as a load bearing walls. It hasbecomemore popular in Ondodue to availability of raw materials.Investors of Ondo State are moving away from the idea of molding blocks on sites due to rising labour costs and time, in line with this new development, most building owners orcontractors are willing to buy directly from the manufacturer instead of cast their own on site.The quality of sandcrete blocks manufacturedin Ondo Statevaries from one industry to another due todifferent mix ratioof individual industry. Owing high demand the quality produced by individual industry hasreduced drastically.

Dov. (1991) described sandcrete blocks as precast masonry units' assemblage and bounded by cementations'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 dimension of 225mm × 450mm × 150mmwith a wide range of 6inches and 9 inches.

In 1985, Nigeria government set up a committee to review the allowed minimum permissible compressive strength of SandCrete blocks in Nigeria. The committee takes into consideration the weights that can be easily handled by the craft persons. They explained further that sandcrete blocks pose intrinsic low compressive strength, indicating that they are susceptive to any natural disaster such as earth quakes or seismic activities. Moreover, sandcrete blocks are used for load bearingwalls and load bearing walls are those walls that support the entire structure, transmit the loads to ground surface (NIS 87:2000). Furthermore previous studies have shown that sandcrete blocks are produced in various standards some are below the recommended standards for the construction of buildings.Sandcreate block is engineering material which is required to meet the standard engineering material definition. Basedon Structuraland Geotechnical application plus material components, sandcrete blocks should be uniform in production then meeting engineering standard definition.Failure to meet the standard requirement is failure of construction management and regulatory authority.

Industry lack of commitment

The industry lack of commitment to (NIS 87:2000)standard requirement is a common problem affecting the whole sandcrete block industries in Nigeria. The weakness of Regulatory Authority in Nigeria opened ways for personal gains and business opportunity exploitation. Andam (2004) showed that commercially produced 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 was within range of 0.87N/mm^{2}as against minimum recommended standards of 3.5N/mm$^{2.}$ Ezeji (1997) showed that the relatives' proportions and number of components considerably affect the mixing rate with cement. Neville, (2000) identified that the comprehensive strength of a sandcrete materials increases cement contents with limit rate. This means the type of sand materials used, such as fineness, density, relative density and sharpness seems to have direct influence on easy mixing with cement. The time mixing sandcrete materials with cement, also the time lapse between mixing compaction appear to have direct impact on the strength. Increase in strength with age and curing temperature, also seems to contribute to stabilization of sandcrete blocks(see BS 882 (1992). All the information is available to them but they decided to ignore it for their own benefit.

Research Approachand sampling

The samples for the study were collected from six different locations in Akure, Ondo State. 18 sandcrete blocks were purchased all together, three samples from each manufacturing site including soil samples and transported to the University of Technology Akure (FUTA), Department of Civil engineeringGeotechnical laboratory to carry out soil test and Ondo State Ministry of works laboratory to conduct compressive strength tests.The purpose of quantities of sand samples purchased was basically to ascertain their suitability for the block and to verify whether these blocks are produced in line with the recommendation of BS 1377.Two types of samples are hollow blocks having a dimension of 225mm × 450mm × 150mm were selected for the study. It was discovered that few manufacturers had just two types of fine aggregate, soft/ fine and sharp sand.

Sandcrete Blocks

Andam(2004) indicates that sandcrete blocks are unlike other building materials in terms of shape and intrinsic properties; is cubical in shape, rough and are widely assembled and used all over Nigeria, specifically for residential and non-residential buildings. This indicates that Sand Crete blocks are common all over Nigeria and they can be found in every local community in the Ondo State. Sandcrete blocks are rough in physical appearance; due to the nature and origin of pure morphological definition. Generally thereis no specific engineering materials standard definition for sandcrete blocks except the material components such as soil, aggregate, cement and water. In line with engineering definition sandcrete block is made from loose mixture of soil or aggregate, cement and water (damp mixture) and two common groups of sandcrete blocks are (Hollow and Solid blocks) these are available for purchase. Sandcrete block can be described as a permanent durable material produced from natural sandy soil or a modified soil. Or described as cohesive soil freshly molded to allow the unsupported handling or curing. Soil, cement and water remain permanently durable materials for producing sandcrete blocks. It seems the quality of sandcrete blocks commercially produced in Ondo State varies from one local government to another, the variance may likely related to methods of production and curing. Sandcrete blocks may likely contribute to the collapsing of building in Ondo State, although this statement cannot be justified due to other environmental factors that may well be considered. This unresolved problem prompts researchers to focus on quality of sandcrete component materials; method production and compressive strength and at the same time try to find out whether each manufacturer meets the predetermined Nigeria Industrial Standard (NIS 87; 2000).

Laboratory Tests

The following laboratory tests sand were carried out onsoil sample collected from each industry:

1. Sieve analysis
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.

Sieve analysis (Particle size analysis)

The sand samples were spread out in the Sun to evaporate or dry for a period of 24 hours before tests were carried out, using the sieve sizes grading according to BS 882(16) apparatus. The study follows the BS 812 (16 and 18) instruction procedures and recommendation.

3.1.1 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 the250ml 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. Adding NaCl solution to the cylinder containing Silt/Clay as a catalyst was to separate silt from sand. Each cylinder was covered with hand very tight and shake rigorously for about 15 minutes after which the mixture for 3 hours. The solution appeared clear (or clears yellow solution) this signifies that the test has been completed. The silt was settled and formed a layer which isused to determine the height of the sand, normally expressed in a percentage

Organic Content Test

NaOH solution was used for the organic content test. The apparatus was a transparent cylinder. A transparent cylinder was filled with sand and reasonable volume of distilled NaOH was added. The cylinders were tightly held by hand which was sealed and shaken vigorously and allow the cylinder to stand undisturbed for 24 hours.The presence of organic materials usually showsyellowish solution. It means that the suspended solution has settled down 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.

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 crushing machine used was 50kg capacity with 500g graduations. The length, breadth and height of the labeled blocks were taken and the volume calculated.

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 inBS3921 (water absorption approach 0.1%).

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

Each sample of sandcrete blocks was weighed in dried conditions and after the readings had been taken, each block was fully immersed in water for a period of 24 hours to make sure that they were fullysubmerged in the water. After 24 hours, each of the wet block samples was removed and weighed. The difference between the dry and wet was recorded(taken) andcalculated, using themathematical formula below.

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

3.2.0 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. Andram(2004) reported that thermal conductivity of sandcrete block decreased with increasing firing temperature while with high cements 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.

3.2.1 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.

$$\text{Crushing Strength} = \frac{\text{Maximum Load at Failure}}{\text{Cross Sectional Area of the block}}$$

4.1. FINE AGGREGATES (PARTICLE SIZE ANALYSIS

ANALYSIS OF RESULTS

The analysis of results of the soil samples investigated is shown in the figures1-6 below. As it can be seen in figures below; the results of each soil site analyzed showed that the soilor coarse samples used were suitable for all the blocks that were purchased. However, the compressive strengthstests obtained from all the 18 sandcrete blocksfell belowNIS Standard recommendation 2.5N/mm^2.

BS882:1992) indicates that 150µm size, the overall mass finer grading percentage limit must be between 0 – 15%. The outcome results of sieve analysis shows that sample A – F satisfy the overall grading and coarse grading limit. As it can be seen from the analysis of Sample A –F the percentage passing fall between the limit 0 -15%, shows that the sand is suitable for construction.

Despite the suitability of samples, there are some few problems observed in the analysis. The soils samples can be described as coarse- grained soil (sand) in that half of the coarse fraction is between No 4 (4.75µm) and 200 (0.75µm).

The figure 1.0 below shows the grain size distribution tests results obtained from the block industry site Location A

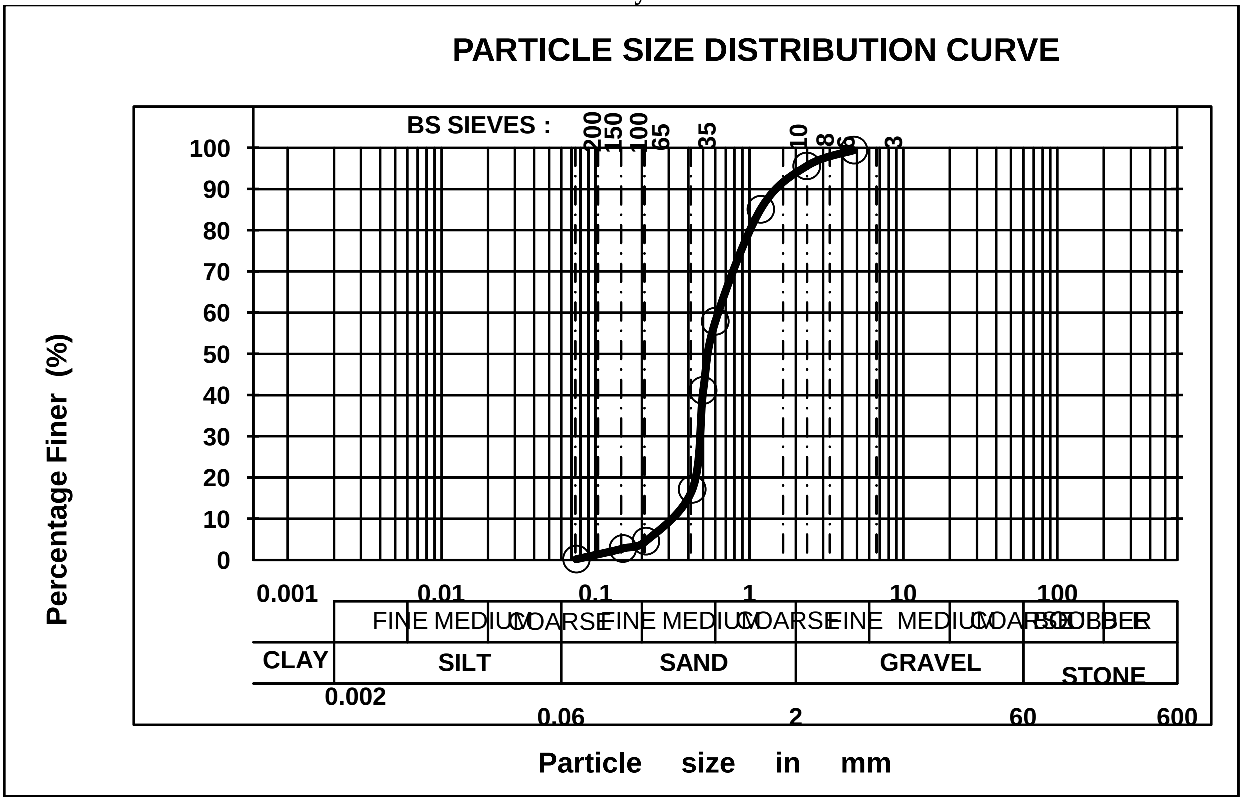


Figure 1.0 Grain size distribution for sandcrete blocks industry site (Location A)

D10 = 0.045, D30 = 0.03 5 and D60 =0.030
Cu= D60/D10 = 0.030/.045 = .07
Coefficient of uniformity (Cu) = .07
CC= $(D30)^2/D60xD10 = .035^2/0.03x0.045$ =.0.9
Coefficient of Curvature (CC) = 0.9

∴Cu<4 and CC is between 1 and 3, according to Bowles 1984 the soil is classified as poor grade sand.

The figure 1.1 below shows the grain size distribution tests results obtained from the block industry site Location B

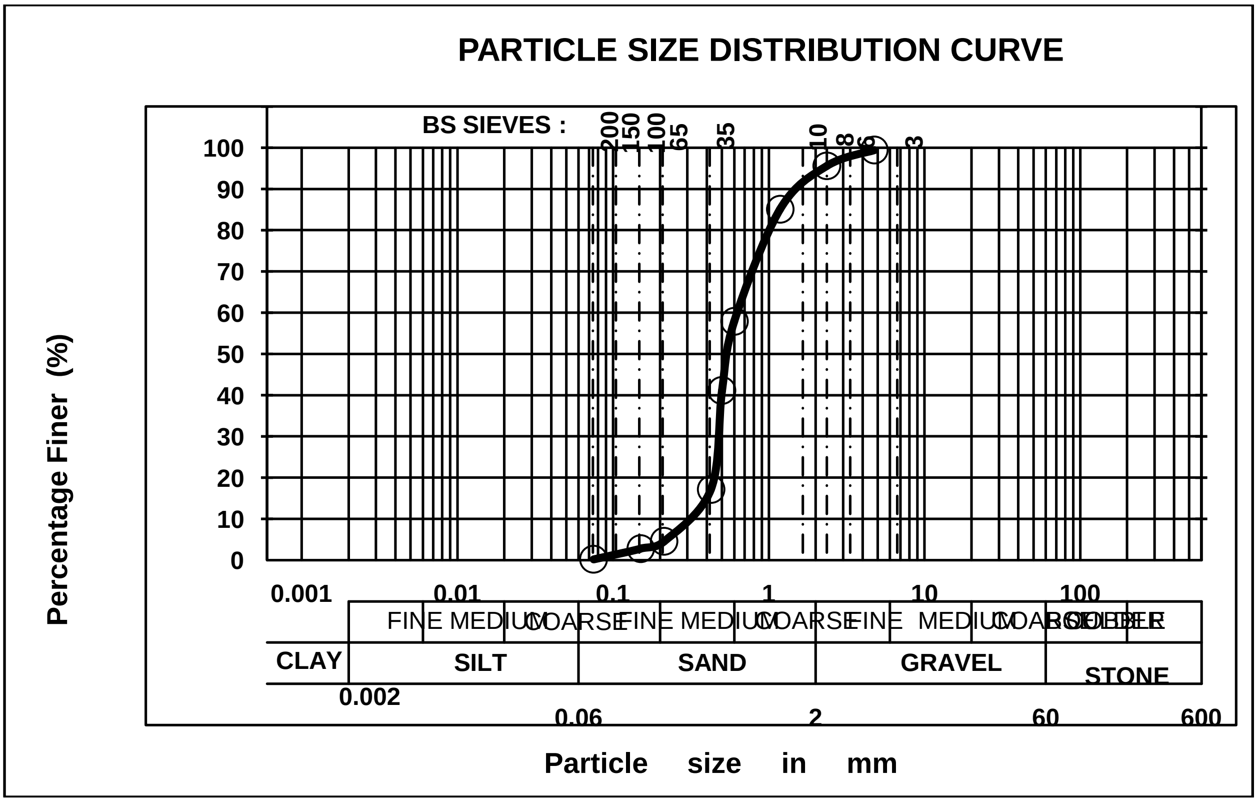


Figure 1.1 Grain size distribution for sandcrete blocks Industry (Location B)

D10 = .065, D30 = 0.03 5 and D60 =0.034
Cu= D60/D10 = 0.034/0.065 = 0.05
Coefficient of uniformity (Cu) = .05
CC =(D30)^2/D60xD10 = .05^2/0.034x 0.065 =1.13
Coefficient of Curvature (CC) = 1.13
∴Cu<4 and CC is between 1 and 3, according to Bowles 1984 the soil is poorly grade sand.

The figure 1.2 below shows the grain size distribution tests results
obtained from the block industry site Location C

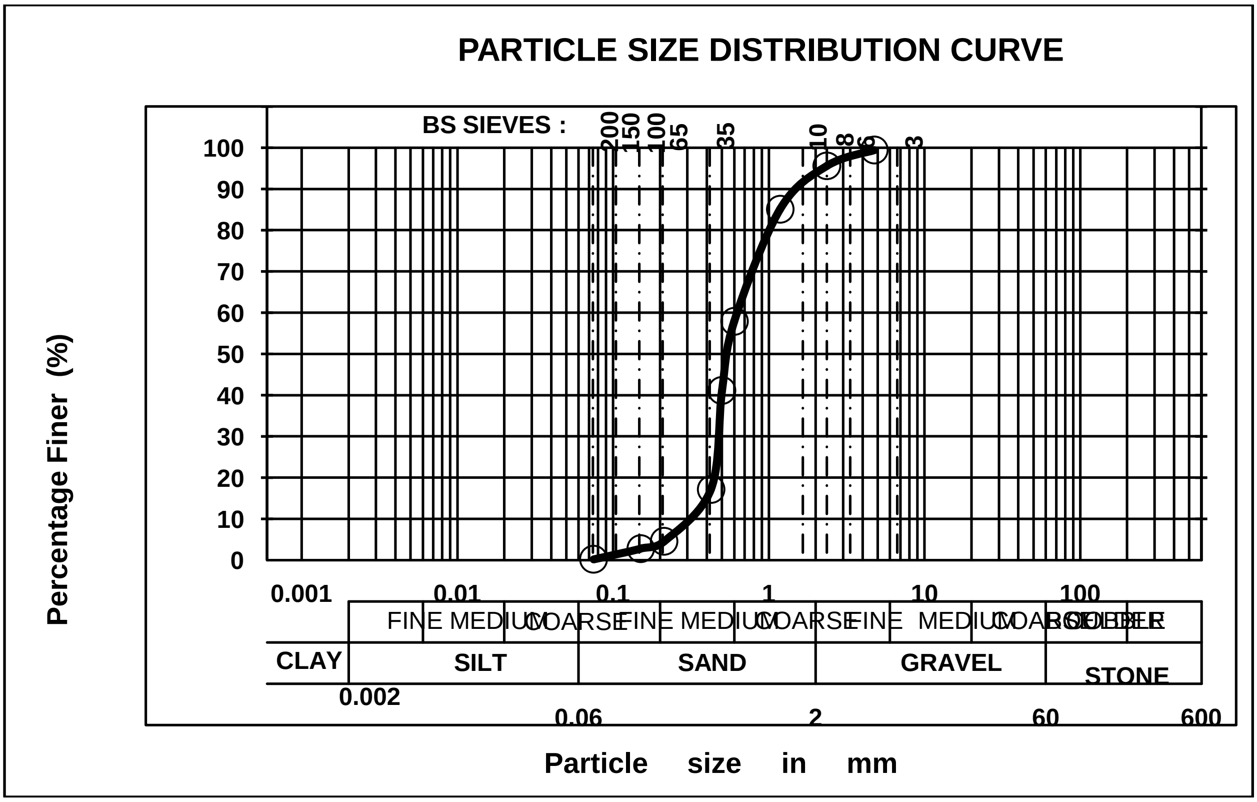


Figure 1.2 Grain size distributions for sandcrete blocks Industry site (Location C)

D10 = 0.040, D30 = 0. 035 and D60 =0.034
Cu= D60/D10 = 0.034/0.040 = 0.85
Coefficient of uniformity (Cu) = 0.85
CC =(D 30)^2/D60xD10 = 0.035^2/0.034x0.040 =0.09
Coefficient of Curvature (CC) = 0.42
∴Cu$<$4 and CC is between 1 and 3, according to Bowles 1994 the soil is poorly classified or poorly grade sand.

The figure 1.3 below shows the grain size distribution tests results obtained from the block industry site Location D

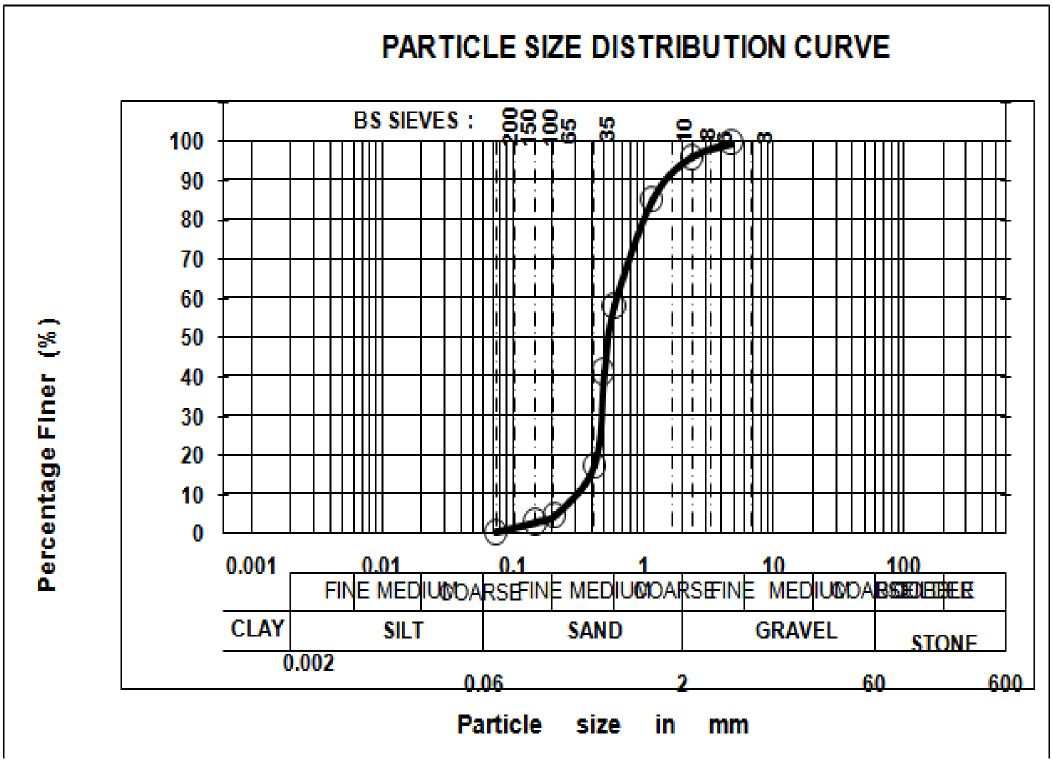


Figure 1.3 grain size distribution of Industry site (Location D)

Figure 1.3 grain size distribution of Industry site (Location D)

D10 = 0.055, D30 = 0.035 and D60 =0.034
Cu= D60/D10 = 0.034/0.055 = 0.062
Coefficient of uniformity (Cu) = 0.062
CC= $(D\ 30)^2$/D60xD10 =0 .035^2/0.034x0.055 =0.066
Coefficient of Curvature (CC) = 0.0.066
∴Cu<4 and CC is between 1 and 3, according to Bowles 1994 the soil is poor grade sand.

he figure 1.4 below shows the grain size distribution tests results obtained from the block industry site Location E

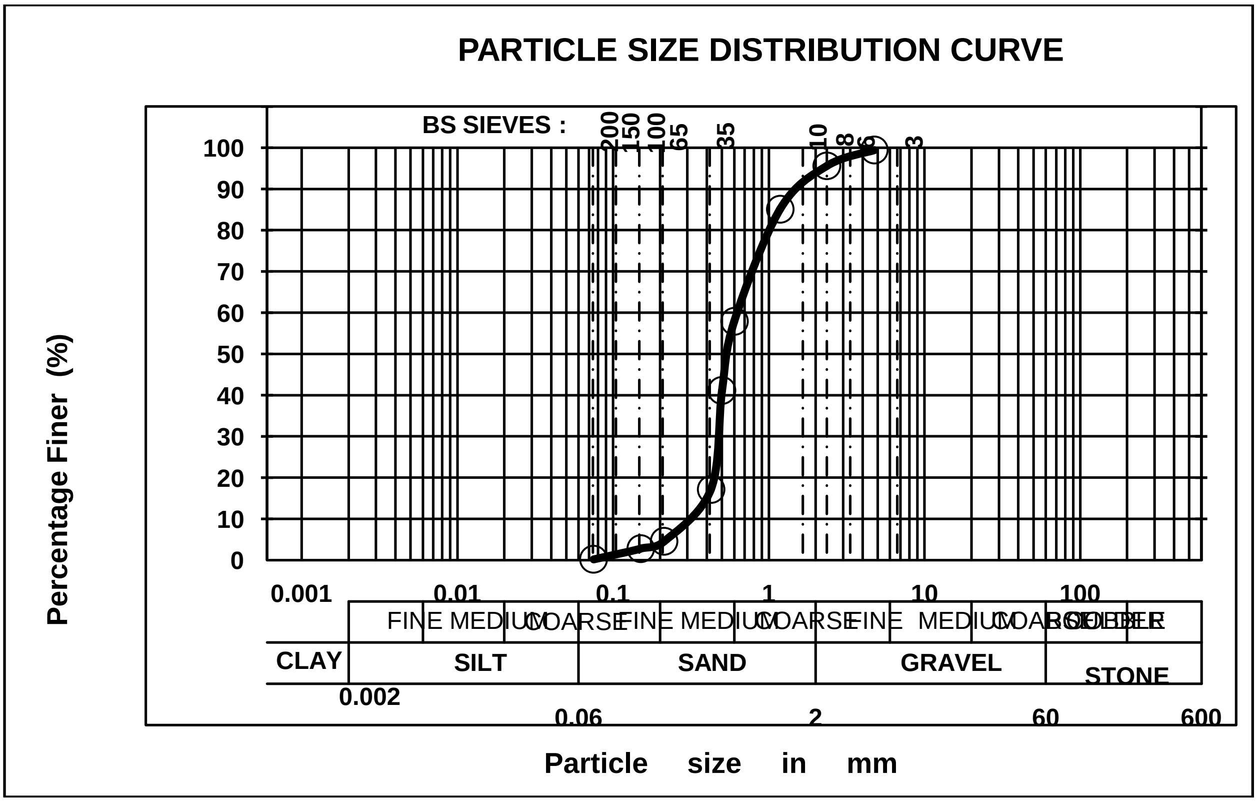
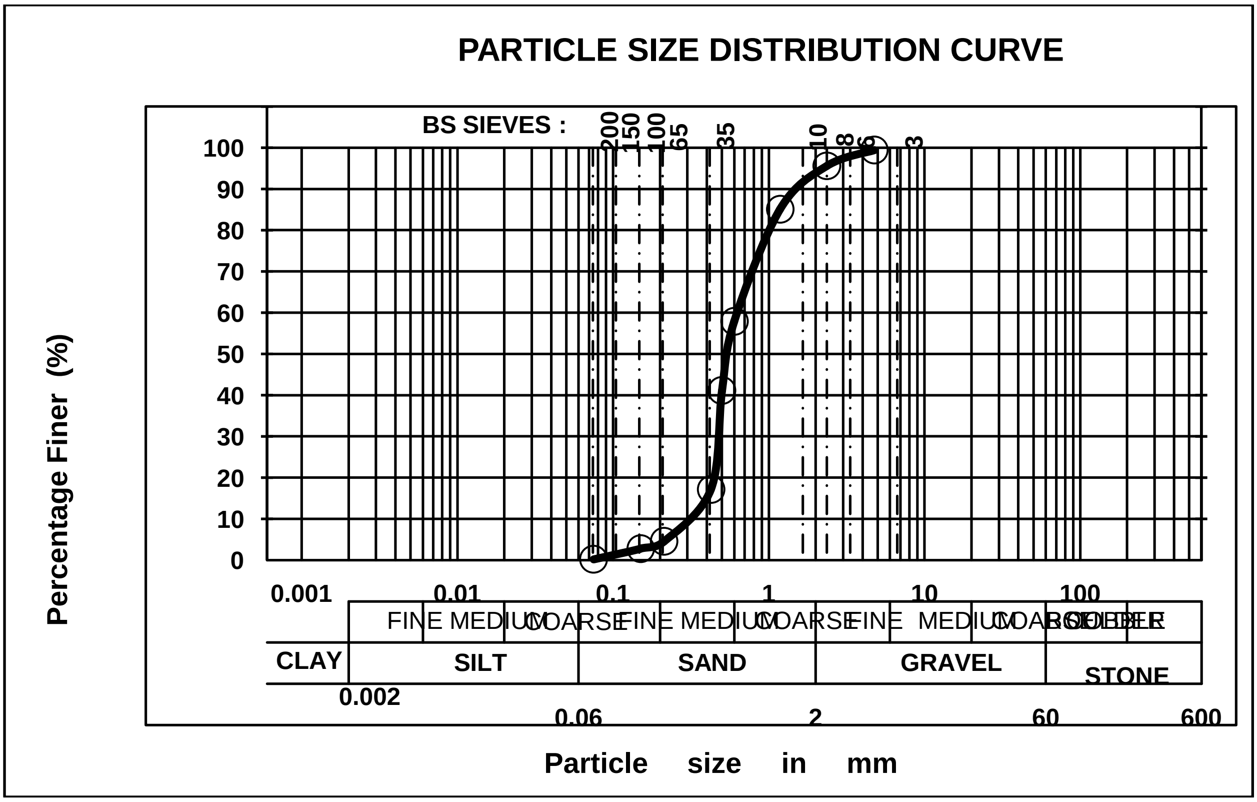


Figure 1.4 Grain size distributions for sandcrete block Industry (Location E)

D10 = 0.055, D30 = 0.03 5 and D60 =0.034
Cu= D60/D10 = 0.034/0.055= 0.062
Coefficient of uniformity (Cu) = 0.062
CC = (D 30)^2/D60xD10 =0.035^2/0.034x0.055 =0.066
Coefficient of Curvature (CC) = 0.066
∴Cu<4 and CC is between 1 and 3, according to Bowles 1984 the soil can be described as poor grade sand.

The figure 1.5 below shows the grain size distribution tests results obtained from the block industry site Location F



D10 = 0.065, D30 = 0.035 and D60 =0.034
Cu= D60/D10 = 0.034/0.065 = 0.052
Coefficient of uniformity (Cu) = 0.05
CC $=(D30)^2/D60xD10 = 0.035^2/0034x0.065 = 0.06$
Coefficient of Curvature (CC) = 0.06 ∴Cu<4 and CC is between 1 and 3, according to Bowles 1994 the soil is classified as poor grade sand.

Silt /Clay Content Test

The Table 1.0 below presents the result of the silt/clay content tests for all soils samples were carried out in accordance with BS812 (16 and 18). The height of the settled layers is expressed in percentages according to the height of soil. It appears the presence of the silt height and soil height fall between 0.02 and 0.5 percent. BS882:1992 claims that the presence of Silt/Clay exceed the range between (0 -5%) will affect the initial and final setting time and the Strength of the block. The local stresses and shrinkage cracking will also increase due to the inclination of clay to expand on absorbing water (see BS3148).

Table 1.0 Silt /Clay content tests for all the Industry

Sample No	Name of the Industry	Height of Sand (mm)	Height of Silt/Clay (mm)	Height of Silt /Height of Sand 100%
A	Block Ind. FUTA Rd Akure Location A	95.5	0.15	0.16
B	Block Industry, Ilesha garage, Akure Location B	90.5	0.51	0.56
C	Blocks industry Oke Odu Ijare Road Location C	88.5	0.06	0.07
D	Block Industry Oke Odu Ijare Road LocationD	92.0	0.62	0.07
E	Block Industry Dami Location E	98.5	0.02	0.02
F	Block Industry, Aule Rd., Akure Location E	97.5	0.54	0.50

In relation to Organic Content Test, all samples gave clear solution which shows that all samples are free from organic materials and other chemical compound that can affect the strength of all the purchased sandcrete blocks.

Table 1.1 BULK DENSITY

Site location	Purchased blocks	Vol. each block mm^3	Weight of dry block kg	Weight block immersed water (kg)	Change in weight (Ww-Wo) (kg)	Bulk density (kg/mm^3)	Average bulk density (kg/mm^3)
A	1	0.010147	18.71	19.95	1.24	1843.80	1884.86
	2	0.010147	19.37	20.10	0.73	1908.84	
	3	0.010147	19.30	20.08	0.78	1901.95	
B	4	0.010147	18.28	19.10	0.82	1801.43	1791.25
	5	0.010147	18.28	19.05	1.02	1776.79	
	6	0.010147	19.30	19.15	0.93	1795.52	
C	7	0.010147	18.22	17.33	1.22	1587.58	1617.80
	8	0.010147	16.11	18.50	1.48	1677.26	
	9	0.010147	17.02	17.30	1.18	1588.57	
D	10	0.010147	16.95	17.37	0.67	1670.36	1670.36
	11	0.010147	16.95	17.30	0.75	1630.94	
	12	0.010147	17.35	18.41	1.06	1709.78	
E	13	0.010147	18.02	19.04	1.02	1775.81	1749.53
	14	0.010147	17.09	18.01	0.92	1684.16	
	15	0.010147	18.15	19.07	0.92	1788.62	
F	16	0.010147	16.01	17.09	1.08	1577.73	1582.66
	17	0.010147	16.01	17.08	1.07	1577.73	
	18	0.010147	16.16	17.15	0.99	1592.51	

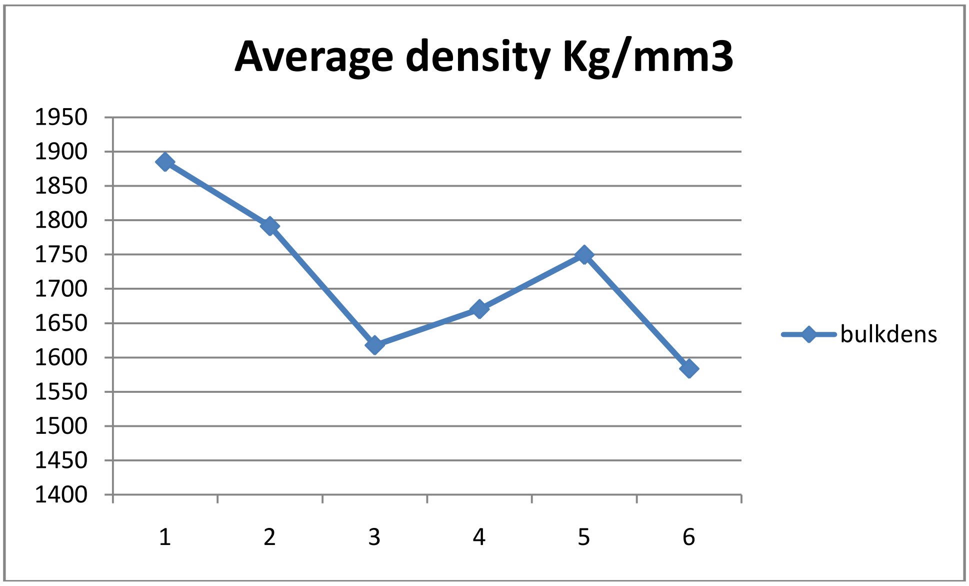


Figure 1.6 Average bulk densities of sandcrete six locations

The Result of the Bulk Density of the blocks is illustrated in the Table 1.2 above. The result shows that the bulk density of the individual Sandcrete block ranges between 1577.73kg/m^3 to 1908.84kg/m^3. The difference between the dry and wet weights was taken. The results of these tests are shown on the table above. The weight before immersion ranges from 16.01kg to 19.37.60kg and Bulk density changes range from 0.73kg/mm to 1.48kg/mm. The average Bulk Density of the tested is also shown in the table. The water absorption capacities are not totally different from the recommended value (see ASTM 140 recommendation).

Table 1.2.: Compressive Strength

Location of block industry	Blocks No	Surface area of the block (mm^2)	Crushing loading	Compressive Strength of the block (N/mm^2)	Mean Compressive Strength (N/mm^2
Location A	1A 2B 3C	45100 "	20.2 38.1 24.0	0.45 0.84 0.53	0.61
Location B	4A 5B 6C	45100	18.40 39.20 26.40	0.52 0.87 0.59	0.66
Location C	7A 8B 9C	45100	29.00 25.40 28.10	0.64 0.56 0.62	0.61
Location D	10A 11B 12C	45100	27.50 28.10 26.10	0.61 0.62 0.58	0.60
Location E	13A 14B 15C	45100	28.10 29.10 25.50	0.62 0.64 0.57	0.61
Location F	16A 17B 18C	45100	30.10 26.20 29.10	0.67 0.58 0.65	0.63

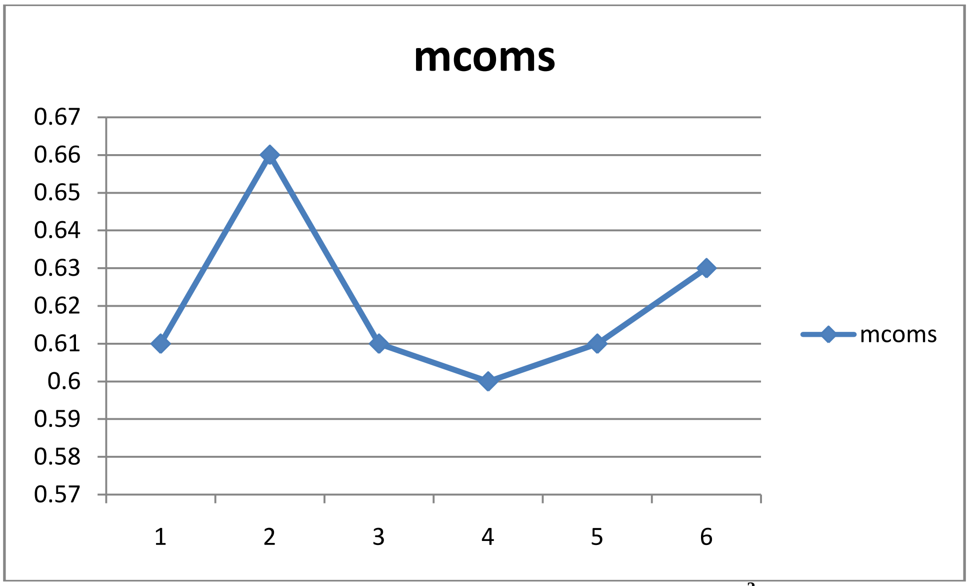


Figure 1.7: Mean Compressive Strength N/mm^2

The Table 1.2 and figure 1.7 above show the compressive results of the individual sandcrete blocks. As can be seen from the table, the mean values range from $0.60N/mm^2$ to $0.66N/mm^2$. These values fell below the recommended value by (NIS 87:2000) for individual sandcrete blocks ($2.5N/mm^2$). It also indicated in BS 2028 (see BS 2028), that 5 commercial sandcrete blocks should not be less than $3.25N/mm^{2.}$ Although only three blocks were purchased from each industry site but if industry A is mixed with Industry B the results mighty have been considered very close $3.21N/mm^{2.}$ The industry owners are different their cases must be treated differently. As shown in the Table 1.2. 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, may also contribute to building collapsing in Akure..

IV. CONCLUSION AND RECOMMENDATION

The sieve analysis of the sample soil particlesthat were purchased from industrial sites indicated that they weresuitable for the production of sandcrete blocks and also good for construction according to (BS 882: 1992). More also 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 and inadequate curing methodology. The findings show that the compressive strength of all sandcrete blocks is very low with the degree of variability. It was observed the curing method used by the manufacturers. They do not apply the application in accordance with BS 3148: 1980 regulations. Other reason for the failure is that they are 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

Appropriate curing method should be introduced, adopted, encouraged and improved. COREN and NSE should collaborate with Federal and State governments to encourage producers to produce sandcrete blocks in accordance with specified standard and dimensions. COREN, NSE, Federal and State governments should encourage professional Construction Engineers to visit all the block factories to give room for effective

BIBILIOGRAPHY

[1]. Andam, K. A. (2004): Bricks, Blocks and the Future Administrative Capital of Ghana, http://www.knust.edu.gh/administrative/vcspeeches/ghana%20ACADEMY%20F%20ART%AND%20SCIENCE.pdf.

[2]. Bowles, I.E. (1984): Physical and Geotechnical Properties of Soil, Second edition, Consulting Engineer/Software Consultant, Engineering Computer Software.

[3]. British standard institution (1982): Specification for precast concrete masonry units part1 BS6073 London.

[4]. British Standard Institution, (1983): Specification for Air cooled Blast Furnace Slag Aggregates for use in construction BS1047 London.

[5]. British Standard Institution, (1990): BS1377. Methods of Testing for soils: for Civil Engineering purposes. British Standard Institution, London, England.

[6]. British Standard Institution, (1992): BSD882. Specification for Aggregate from Natural Source for concrete. British Standard Institution, London, England.

[7]. British Standard Institution, (1993): BS3148. Method of test for water for making concrete. British Standard Institution, London, England.

[8]. Dov. K. (1991): Design and construction failures, McGraw-Hill Inc. United States of America.

[9]. Ezeji, K. (1993): Building Construction Vol. 1: Fancy Publications Limited, Idumota, Lagos.

[10]. Neville, A.M. (2000): Properties Aggregates. Pearson education, Asia, London, England.

[11]. NIS 87, 2000: Nigeria Industrial Standard for sandcrate block. Standards Organisation of Nigeria, Lagos, Nigeria.

.

.