Original Research Article

COMPARISON OF THE STRENGTH OF BLOCKS MADE FROM SHARP SAND CEMENT, LATERITE CEMENT AND RED EARTH CEMENT

ABSTRACT – Blocks are known to be one of the man-made building materials used for various construction purposes. Blocks can be made from different materials as far as it can stand the rest of strength. The major type of block used for the construction of walls in many buildings is the sand create block which is made from cement, sharp sand and water. Due to the high cost of construction materials such as cement and sharp sand, this study was done to investigate the use of other construction materials (laterite and red earth), therefore this study is focused on the use of other naturally occurring building materials to substitute the conventional ones in making of masonry blocks that could probably aid in reduction the cost of production of blocks to be used for construction purposes thereby also causing a reduction in the cost of construction of buildings and other engineering structures. Various tests such as sieve analysis and specific gravity test were carried out on the materials used for production of the blocks. A total of three (3) types of blocks were made with six (6) block samples made for each type making twenty (24) in total, each of the blocks were cured using the open-air curing method and the compressive strength test was carried out on the 7, 14, 21 and 28 curing day of two (2) different blocks from each of the block types made. All blocks made were 5-inch blocks. The test result indicated that the materials were suitable for block making. On crushing the blocks, it was discovered that the compressive strength of all did not meet up to the minimum recommended standard of 3.45N/mm^2 for individual blocks as recommended by the Nigerian Industrial Standard (NIS 87: 2000). The overall average strength for the block made with cement and sharp sand (sand Crete) ranged from 4.83 N/mm^2 to 9.97 N/mm^2, for those made with laterite it ranged from 3.27 N/mm^2 to 5.16 N/mm^2 while those made with red earth had compressive strength that ranged from 2.02 N/mm^2 to 3.16 N/mm^2.

Keywords **-** Comparing, Strengths, Blocks, Made, Different Materials.

I. INTRODUCTION

This project was obligated to present in one volume of the fundamental and practical information in the field of comparing the strength of blocks made from: cement and laterite soil, cement and red earth and cement and sharp sand which may be useful to people involved in civil and structural engineering and particularly those that found pleasure in the design and construction of buildings, bridges and culverts and related structures. Due to high cost of sharp sand in the market, the comparative analysis of stabilized laterite blocks, red earth blocks have revealed that one can definitely substitute the stabilized laterite blocks and red earth blocks in place of sand crete (sharp sand) blocks to reduce the cost of the entire building or used stabilized laterite blocks where there are no sand in such an area where the work is going to be sited. A great lot has been done throughout this work, although it is limited in scope to assess their suitability as standard concrete aggregates.

Improper use of these blocks leads to micro cracks on the wall after construction (Oyediran and Okosun, 2013. According to Bachar *et al*, 2014, in construction, high cost of building material has been the bane in developing countries of the world as a result of importation of most of the building materials. As the prices of building materials is increasing rapidly there is need to research local materials as alternatives or substitutes for the construction of functional but low-cost structural buildings and structures. Laterite soil and red earth are one of the major building materials which is being researched mainly because it is readily available and easy to access across the country (Nigeria).

This study is part of the continuity effort to investigate the characteristics of laterite soil and red earth, stabilized or unsterilized, reinforced or unreinforced, with the view to improving such characteristics. This study is specifically focused on the effect of replacement of conventional fine aggregate with laterite soil and red earth found in IHIALA LGA in the production of sand Crete blocks.

The aim of this study is to compare the strength of block made from cement with sharp sand, cement with laterite soil, and cement with red earth laterite sand. For this study: Determining some of the geotechnical properties of sharp sand, laterite and red earth nd evaluate its stability for use as a good building material, Determining the compressive strength of the blocks from varying fine aggregate, and to effect reduction to the rise in market price of fine aggregate, cement blocks to substitute laterite blocks.

For this study, blocks will be produced using three varying fine aggregates (sharp sand, laterite and red earth) mixed with cement at a ratio of 1:5. This study focuses on comparing the strength as blocks made using the three varying fine aggregate. The Civil Engineering laboratory of Chukwuemeka Odumegwu Ojukwu University, Uli campus was used for carrying out sieve analysis, specific gravity test and compressive strength test for 7-, 14-, 21-, and 28-days using moulds of 5 inches.

The significate of this study is that it helps to investigate and know the strength of blocks from the mixture of different materials other than the conventional ones (that is cement and sharp sand). it provides qualitative result on the strength of brick made from red earth sand cement, laterite soil and cement, so that engineers can know the correct mix and mix ratio in cases where conventional materials are not available. It will also reduce cost of construction when other low-cost materials like laterite are available and can readily be used.

Only, that this study is limited to sun dried bricks which are not hollow, they will be unburnt and allowed to dry outdoors under the sun and dry air. Other types of bricks like fly ash brick, concrete brick, and engineering bricks are not studied in this research.

II. LITERATURE REVIEW

In order to preserve and sustain the environment, the use of environmentally friendly building materials, commonly referred to as green building materials must be encouraged to promote the idea of sustainable building. One such green building material that meets the standards of achieving sustainable housing developments is compressed earth bricks. Sustainable building was defined by Rigassi 1995 as structures that are designed, built, renovated or operated in a resource-efficient manner. It is designed generally for the wellbeing of the environment as well as the occupants, using resources (energy, water, and other construction materials) in a more effective way. This should lead to a reduction of environmental impacts without compromising standards and aesthetics. The building industry has been reported to cause increased levels of pollution during the extraction, processing and transportation of raw materials. For instance, in the United Kingdom, it has been reported that dwelling and household usage accounts for 50% of all energy consumed and about 8% (350 PJ per year) is used to manufacture and transport building materials. (Adalberth K., 1996). Little, 2009 compared energy consumed as well as the amount of carbon emissions between Compressed Earth Bricks (CEB) and other conventional bricks. CEB was reported to generate about 22 kg

CO_2/ton with concrete blocks producing, 143 kg CO_2/ton, burnt clay bricks, about 200 kg of carbon dioxide (CO_2) per ton and perforated concrete blocks 280 - 375 kg CO_2 per ton. This implies that CEB uses about 10% of the input energy compared to the production of burnt clay and concrete masonry units. Earth bricks have numerous advantages both for man and the environment. With the present global concern about the environment and its sustainability, attention is beginning to shift to energy efficient and environmentally friendly construction materials. Based on this fact, earth construction remains the best and the most effective way of addressing the housing deficit and simultaneously reduce the environmental impact of building construction, as well as reducing the housing energy needs. Much more can be done in Africa to reduce the cost and increase accessibility of building materials whilst harnessing their ability to contribute to local economies and provide employment opportunities. Increasing affordable housing supply must equally be achieved in a way that is environmentally sustainable and does not affect local, international, and continent's ecosystems and natural resources in adverse manner.

Earth bricks, especially compressed earth bricks, are naturally available, economically viable, environmentally friendly and above all energy efficient to produce. It is an ideal material for sustainable construction, but despite the environmental advantages and cost benefits, it is frequently regarded as a building material for the underprivileged and often considered as second-class building material for low-income earners. This perception and non-acceptance by some governments are due to the inappropriate use by the so-called poor people. Low-income communities use earth materials in its simplest, natural form without any improvement. This has led to low acceptability amongst most social groups and resulted in earth materials not being widely recognized by authorities in many countries. Standard building codes and regulations for the use of these natural materials have therefore not been fully developed. With the recent trend in reviving the use of sustainable materials in construction, coupled with the research work in this regard and the aggressive promotion of this style of construction by international organizations (e.g., UN, UNIDO, WHO) earth material is now more acceptable for use in the realization of decent housing, especially in Africa. This is with an aim of bridging the housing deficit that exists in the world and this new trend and aesthetically pleasing architecture utilizing earth materials are now acceptable as a viable construction material in modern housing developments. It is now realized that the past negative perception is not necessarily about the material, but rather, how it is being used by different levels of society.

III. METHODOLOGY

This section present research methodology used in this study. The section talks about the materials, such as; sharp sand, laterite soil, cement, red earth, and water. Also, the experimental steps taken are described while taking available equipments/apparatus into considerations.

Test such as compressive strength was carried out as workability test while sieve analysis was carried out as preliminary test, since they contributed to the strength development of the block.

a.) Materials Used

Sharp Sand: They are particles that mainly comprise of silica or quartz, the lack cohesion in the presence of water and it also has limit swelling and shrinkage.

Laterite: Laterite is a layer of soil that contains aluminum and iron oxide minerals.

Red Earth: It is majorly formed as a result of the chemical weathering rocks, mainly silicates. Unlike sharp sand it has strong cohesion in the presence of water and also excessive swellings and shrinkage.

Cement: The cement used for this study is an Ordinary Portland Cement from Dangote industry.

Water: Ordinary portable water was used throughout.

b.) **Equipments/Apparatus**

Table 1: Equipment/Apparatus required

S/N	Apparatus/Equipment Needed	Number Required
1.	Compression machine	1
2.	Weighing balance	1
3	Sieves of different sizes	10
4	Mechanical sieves shaker	1

c.) **Experimental Design**

Table 2: Experimental design

			Number of Block Moulds				
S/N	Types of blocks	Mix Ratio	For 7 days	For 14 days	For 21 days	For 28 days	TOTAL
1	Cement +Sharp Sand	1:5	2	2	2	2	8
2	Cement +Red Sand	1:5	2	2	2	2	8
3	cement + laterite	1:5	2	2	2	2	8

d.) **Mix Design (Batching)**

This process was necessary to know the amount of materials that was used for each 5 inches mould.

Where;

Weight of 5 inches (450 mm × 225 mm × 125 mm) mould = 8.25 kg

Weight of mould of over full sand = 27.15 kg

Total weight of sand and cement = 27.15 – 8.25 = **18.9 kg**

Ratio = 1:5

Total ratio = 1 + 5 = 6

Wt. of cement for 1 block = $\frac{1}{6} \times 18.9$

Wt. of cement for 1 block = 3.15 kg

Wt. of cement for 8 blocks = 8 × 3.15 kg

Wt. of cement for 8 blocks = **25.2 kg**

Wt. of sand for 1 block = $\frac{5}{6} \times 18.9$

Wt. of sand for 1 block = 15.75 kg

Wt. of sand for 8 blocks = 8 × 15.75 kg

Wt. of sand for 8 blocks = **126 kg**

e.) **Method**

This includes the tests that were carried out on the materials to be used and also the test that was carried out on the blocks itself.

- **Sieve Analysis**

The sieve analysis test is used to determine the distribution of the coarser, larger-sized particles; it is widely used in the classification of soil. The distribution of different grain sizes affects the engineering properties of soil. This analysis was carried out on all the materials that was used except for cement.

i. A dry sample of mass 1000g of the soil is measured using the weighting balance and also the weight of each sieve is taken and recorded. The sieve was arranged in ascending order (sieve size of 2mm at the top and 63µm at the bottom with the plan below it). The soil sample was carefully poured into the top sieve.
ii. The sieve is then placed in the mechanical shaker and allowed to shake for 10 minutes.
iii. The stack of sieve is then removed from the shaker and then each sieve with the sample retained on it was weighted and recorded.

- **Specific Gravity Test**

Specific gravity is the ratio of the unit weight of solids to the unit weight of water at any temperature. The aim of this test is to determine the specific gravity of the soil fraction passing the 75µm sieve size downward and distilled water.

i. Clean and dry the density bottles thorough and the weight with the stopper in it was taken and recorded as W1, a sample of mass 10 to 20g was measured.
ii. The measured sample of 10g was poured into each density bottle using the funnel, the weight of the bottle with the sample and the stopper was measured and recorded as W2.
iii. 10ml of distilled water was measured using the volumetric cylinder then poured into the bottle; this was done for both density bottles. It was then left for about 2 hours to allow sample soak completely. Again, the bottles were filled completely with distilled water and kept for about 5 minutes. Each bottle with the content and the stopper was weight and recorded as W3.
iv. The content was poured out of the bottles and then cleaned thoroughly. I filled the empty bottle with only distilled water and weighted it, then recorded the weight as W4.

- **Atterberg Limit Test**

The Atterberg limit test consists of the liquid limit, plastic limit and shrinkage limit test. Atterberg limit can be used to express the consistency (that is degree of firmness) of cohesive soil such as clay. This test was carried out on the red earth alone. Liquid limit can be defined as the water content where the soil changes from plastic to a viscous fluid state. Plastic limit is defined as the water content at which a soil will just begin to crumble when rolled into a thread approximately 3mm in diameter. Little quantity of dried soil was sieved (using 600µmm sieve) and then placed in a porcelain dish, small amount of distilled water was added to it until it formed a paste.

i. For the liquid test: Five empty moisture cans were then weighed and recorded. A portion of the moist soil was placed into the liquid limit device at the point where the cup rests on the base; it was spread through the cup to form a horizontal surface. The grooving tool was then used to make a clean cut. The number of drops was then recorded and a sample was taken and placed into the moisture can. This process was repeated 5 times with little increase in water content. The cans with the soil in it are then weighed and left in the oven for at least 24 hours and afterwards weighed.
ii. For the plastic limit test: Three empty moisture cans weighed. A portion of the moist soil is placed on the glass plate to form an ellipsoidal mass, which was then rolled with the palm into a thread having a uniform diameter until it crumbles. The crumbled thread is then placed into the moisture can. The specimen is weighed and left in the oven for at least 6 hours and afterwards weighed.

- **Compressive Strength Test**

The Compressive strength of a material is its ability to withstand any gradually applied load acting on it. The compressive strength test was carried out on the blocks. The test was carried out to determine the strength of the blocks. The machine used for this test is the compression machine.

i. After the machine is turned on, the area is set and the condition of the machine is checked. The block is then placed in the machine, which is placed between two pieces of plywood in order to spread the effect of the crushing load applied on the block. The machine then starts the crushing process.

IV. RESULTS AND DISCUSSION

This section deals with the analysis of data obtained from the various test carried out on the various materials used and the blocks itself in accordance to the methodology explained in chapter 3.

A.) Preliminary Test Result (Sieve Analysis)

a.) Test Results Carried Out on Sharp Sand

Table 3 below shows the results for the sieve analysis and the specific gravity test carried out on a small portion of sharp sand that was used for making some of the blocks.

Table 3: Result for Sieve Analysis Carried Out on Sharp Sand

Sieve Size (mm)	Sieve mass (g)	Mass of sieve + soil retained (g)	Soil retained (g)	Percent Retained (%)	Percentage Passed
2	538.5	684.5	146	14.6	85.4
1.18	493.5	557	63.5	6.35	79.05
0.6	476	650	174	17.4	61.65
0.425	453.5	591.5	138	13.8	47.85
0.3	437	591	154	15.4	32.45
0.212	407.5	537.5	130	13	19.45
0.150	400.5	500.5	100	10	9.45
0.075	371	432	61	6.1	3.35
0.063	381.5	395	13.5	1.35	2
Pan	390.5	410.5	20	2	0

Total:			**1000**	**100**	

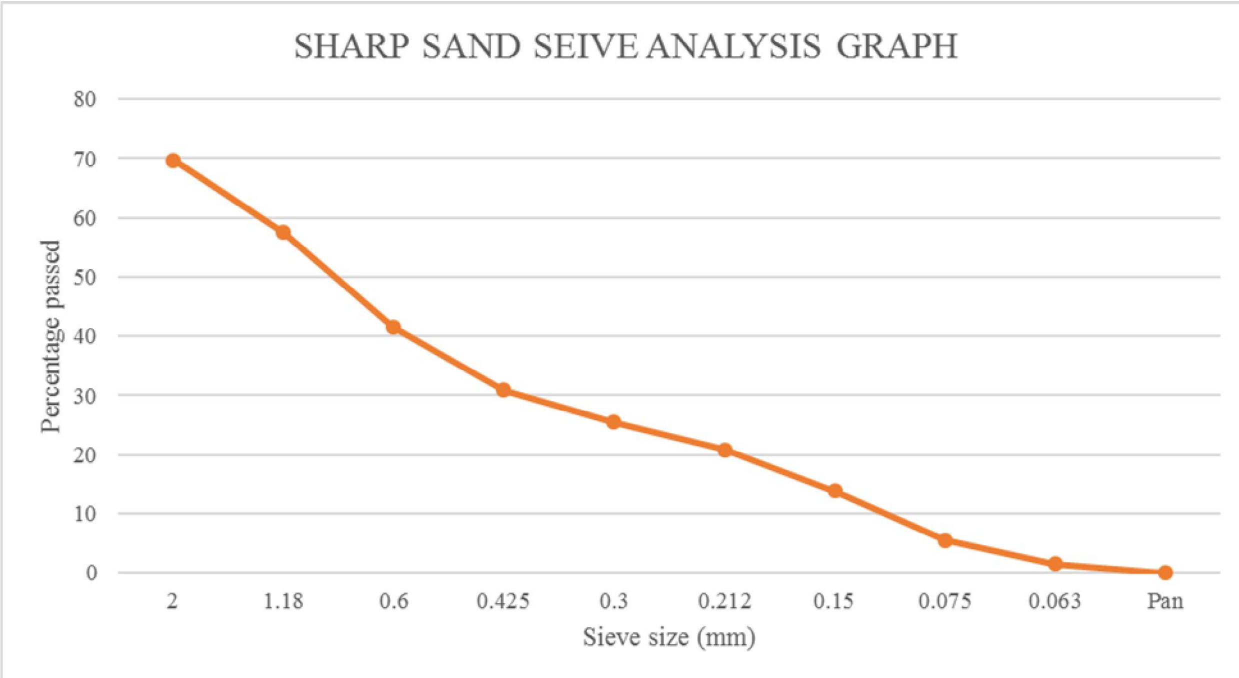

Fig 1: Chart on Sharp sand Sieve Analysis

Table 4: Result for Specific Gravity Test on Sharp Sand

Specimen Number	**1**	**2**
W1 = Mass of empty wash bottle + stopper (g)	23.0	21.5
W2 = Mass of wash bottle + stopper + dry soil (g)	34.0	31.5
W3 = Mass of wash bottle + stopper + dry soil + water (g)	80.5	77.5
W4 = Mass of wash bottle + stopper + water (g)	74.5	70.5
Specific Gravity (Gs)	2.2	3.3

Specific gravity (Gs) $= \frac{w2 - w1}{(w2 - w1) - (w3 - w1)}$

Average specific gravity $= \frac{2.2 + 3.3}{2} = 2.75$

Therefore, the specific gravity of the soil (Gs) = **2.75**

b.) Test Results Carried Out on Laterite

Table 5 below shows the result for the sieve analysis and the specific gravity test carried out on a small portion of the laterite that was used for making some of the blocks.

Table 5: Result for Sieve Analysis of Laterite

Sieve size (mm)	Sieve mass (g)	Mass of sieve + soil retained (g)	Soil Retained (g)	Percent Retained (%)	Percentage passing
2	538	1199.5	661.5	66.15	33.82
1.18	491	570.5	79.5	7.95	25.9
0.600	476	564	88	8.8	17.1
0.425	437.5	476.5	39	3.9	13.2
0.300	449.5	486	36.5	3.65	9.55
0.212	419.5	448.5	29	2.9	6.65
0.150	400	425	25	2.5	4.15
0.075	367.5	395.5	28	2.8	1.35
0.063	381.5	384.5	3	0.3	1.05
Pan	390.5	401	10.5	1.05	0
Total			**1000**	**100**	

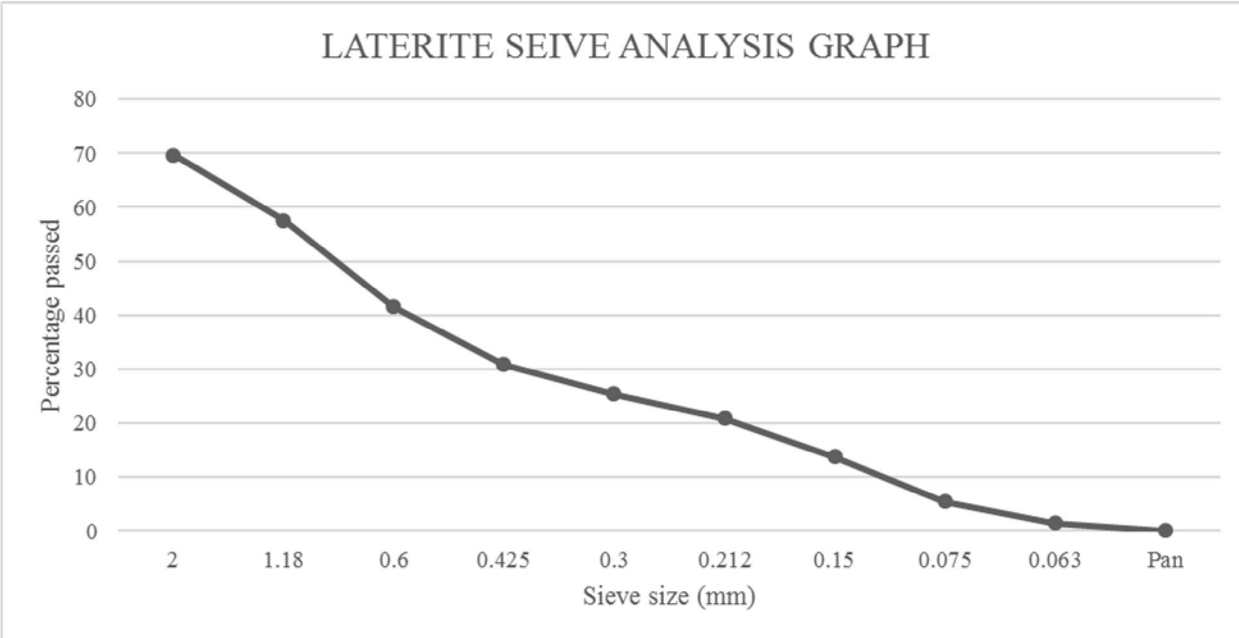

Fig 2: Chart on Laterite Sieve Analysis

Table 6: Result for Specific Gravity Test on Laterite

Specimen Number	**1**	**2**
W1 = Mass of empty wash bottle + stopper (g)	21.0	24.0
W2 = Mass of wash bottle + stopper + dry soil (g)	31.0	34.0
W3 = Mass of wash bottle + stopper + dry soil + water (g)	76.5	79.5
W4 = Mass of wash bottle + stopper + water (g)	71.5	74.5
Specific Gravity (Gs)	2.0	2.0

Specific gravity (Gs) = $\frac{w2-w1}{(w2-W1)-(w3-w4)}$

Average specific gravity = $\frac{2+2}{2} = 2.0$

Therefore, the specific gravity of the soil (Gs) = 2.0

c.) **Test Results Carried Out on Red Earth**

Table 7 below shows the result for the sieve analysis, specific gravity, plastic and liquid limit test carried out on a small portion of red earth that was used for making some of the blocks.

Table 7: Results for Sieve Analysis of Red Earth

Sieve size (mm)	**Sieve mass (g)**	**Mass of sieve + soil retained (g)**	**Soil Retained (g)**	**Percent Retained (%)**	**Percentage passing**
2	538.5	841.5	303	30.3	69.7
1.18	493.5	615	121.5	12.15	57.55
0.6	476	636.5	160.5	16.05	41.5
0.425	453.5	559.5	106	10.6	30.9
0.3	437	491.5	54.5	5.45	25.45
0.212	407.5	453	45.5	4.55	20.9
0.15	400.5	471.5	71	7.1	13.8
0.075	371	454	83	8.3	5.5
0.063	381.5	421.5	40	4	1.5
Pan	390.5	405.5	15	1.5	0
Total			**1000**	**100**	

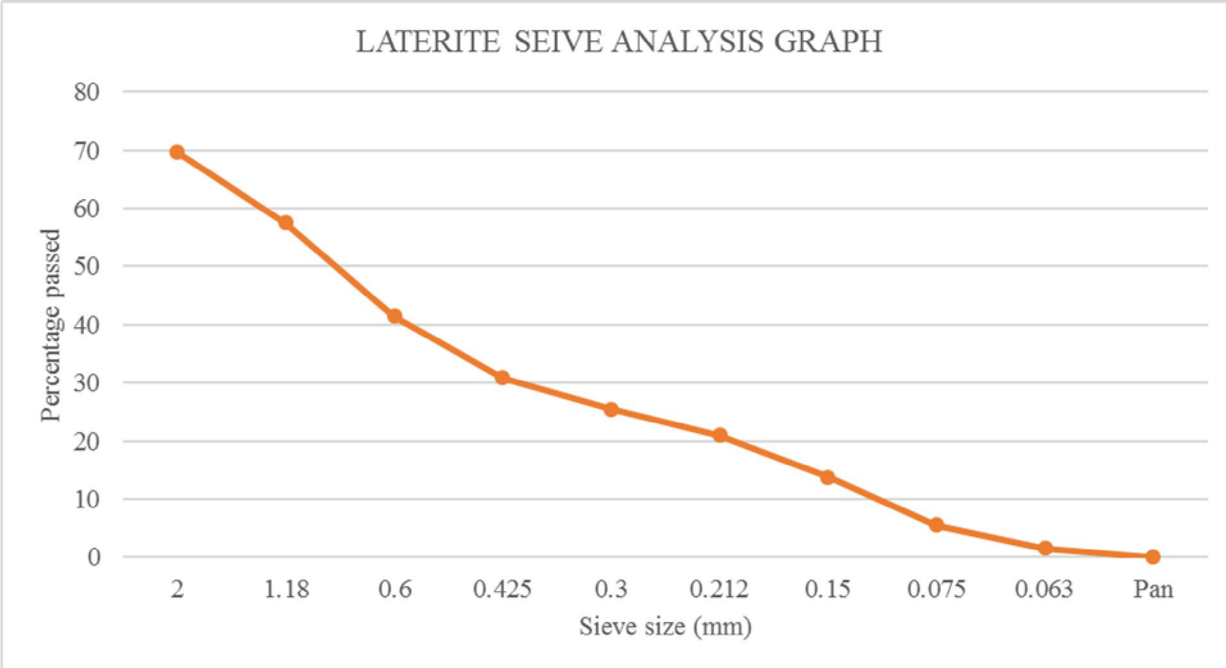

Fig 3: Chart on Red Earth Sieve Analysis

Table 8: Result for Specific Gravity Test on Red Earth

Specimen number	**1**	**2**
W1 = Mass of empty wash bottle + stopper (g)	16.0	16.0
W2 = Mass of wash bottle + stopper + dry soil (g)	33.5	34.0
W3 = Mass of wash bottle + stopper + dry soil + water (g)	81.0	76.0
W4 = Mass of wash bottle + stopper + water (g)	70.0	70.0
Specific Gravity (Gs)	2.7	1.5

Specific Gravity (Gs) = $\frac{w2-w1}{(w2-w1)-(w3-w4)}$

Average specific gravity = $\frac{2.7+1.5}{2} = 2.1$

Therefore, the specific gravity of the soil (Gs) = 2.1

B.) **Workability Test Result (Compressive Strength)**

The tables and graphs below show the results of the compressive strength test carried out on each of the blocks, it shows the variation in strength of the various types of blocks made based on the materials used. For most of the blocks the compressive strength falls below the recommended minimum value of 3.45 N/mm^2 for individual blocks as recommended by the (NIS 87:2000).

To get the compressive strength in the tables below, it is mathematically expressed as;

Compressive strength = *Crushing force / Area* of 5^I block

Area of 5^I block = Length × Width

Area of 5^I block = 450 mm × 225 mm

Area of 5^I block = 101250 mm^2

Table 9: Compressive Strength of The Blocks After 7 Days of Curing

S/N	Block Type (1:5)	Crushing Force (KN)	Compressive Strength (N/mm^2)	Average Compressive Strength (N/mm^2)
1.	**Cement + Sharp sand**	510.1 508.9	5.04 5.03	5.04
2.	**Cement + Laterite**	370.4 369.3	3.66 3.65	3.66
3.	**Cement + Red earth**	265.5 263.5	2.62 2.60	2.61

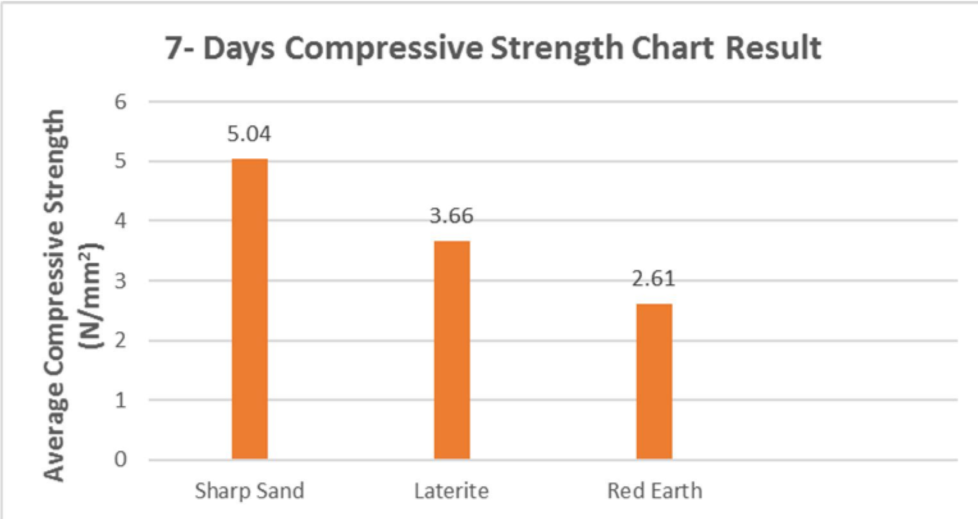

Fig 4: 7- Days curing compressive strength result

After curing the blocks for seven (7) days the block made with Cement and Sharp Sand has the highest average compressive strength of 5.04 N/mm^2 which shows an increase of 46% compared to the standard 3.45 N/mm^2 (NIS 87, 2000). While those made with the mixture of Cement and Laterite is 3.66 N/mm^2 and Red Earth has the lowest average compressive strength of 2.61 N/mm^2, compared to the sharp sand mix, there is a percentage increase and decrease in strength of 6% (increase) and 24% (decrease) between the average compressive strength of the blocks made with Laterite mix and Red Earth, NIS standard respectively.

Table 10: Compressive strength of the blocks after 14 days of curing

S/N	Block Type (1:5)	Crushing Force (KN)	Compressive Strength (N/mm^2)	Average Compressive Strength (N/mm^2)
1.	**Cement + Sharp sand**	511.4 509.3	5.05 5.03	5.04
2.	**Cement + Laterite**	331.9 330.2	3.28 3.26	3.27
3.	**Cement + Red earth**	205.6 202.7	2.03 2.00	2.02

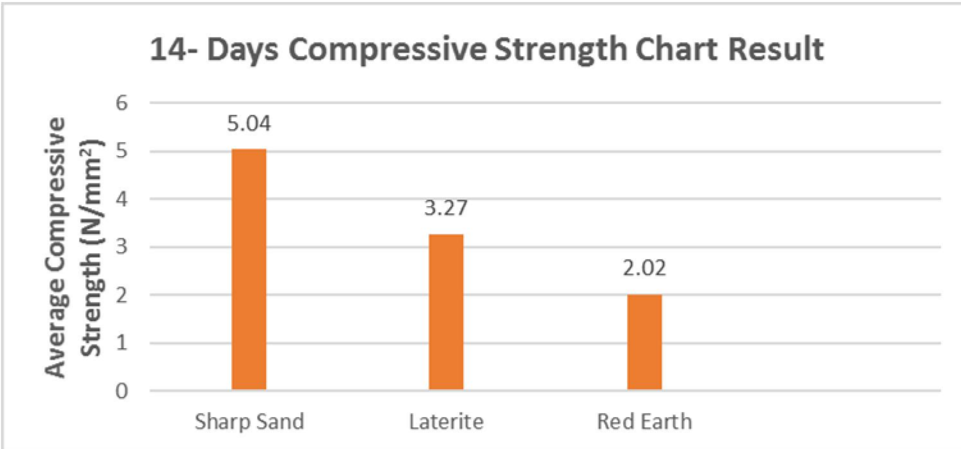

Fig 5: 14- Days Curing Compressive Strength Result

After curing the blocks for fourteen (14) days the block made with cement and sharp sand still has the highest average compressive strength of 5.04 N/mm^2 which shows similar increase of 46% compared to the standard 3.45 N/mm^2 (NIS 87, 2000) like 7 - days. While those made with the mixture of Cement and Laterite is 3.27 N/mm^2 and Red Earth has the lowest average compressive strength of 2.02 N/mm^2. Compared to the sharp sand mix, there is a percentage decrease in strength of 5% and 41% between the average compressive strength of the blocks made with Laterite mix and Red Earth, NIS standard respectively. The blocks made with cement and laterite still has a greater average strength than those made with cement and red earth.

Table 11: Compressive Strength of The Blocks After 21 Days of Curing

S/N	Block Type (1:5)	Crushing Force (KN)	Compressive Strength (N/mm^2)	Average Compressive Strength (N/mm^2)
1.	**Cement + Sharp sand**	487.5 490.0	4.81 4.84	4.83
2.	**Cement + Laterite**	351.3 350.0	3.47 3.46	3.47
3.	**Cement + Red earth**	224.4 222.1	2.22 2.19	2.21

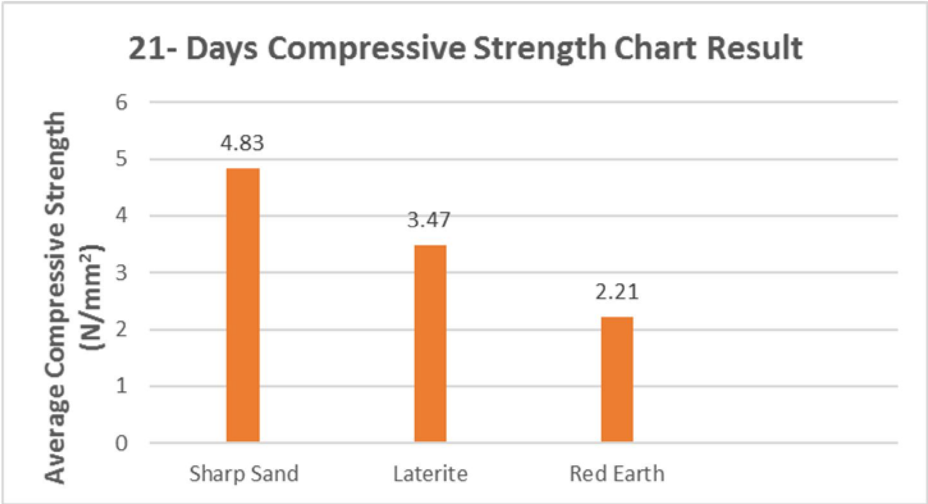

Fig 6: 21- Days Curing Compressive Strength Result

After curing the blocks for 21- days the block made with Cement and Sharp Sand has the highest average compressive strength of 4.83 N/mm^2, which is smaller than the 7 and 14 days curing compressive strength result and shows increase of 40% compared to the standard 3.45 N/mm^2 (NIS 87, 2000). While those made with the mixture of Cement and Laterite is 3.47 N/mm^2 and Red Earth has the lowest average compressive strength of 2.21 N/mm^2. Compared to the sharp sand mix, there is a percentage increase and decrease in strength of 0.58% (increase) and 36% (decrease) between the average compressive strength of the blocks made with Laterite mix and Red Earth, and NIS standard respectively.

Table 12: Compressive strength of the blocks after 28 days of curing

S/N	Block Type (1:5)	Crushing Force (KN)	Compressive Strength (N/mm^2)	Average Compressive Strength (N/mm^2)
1.	**Cement + Sharp sand**	994.8 1022.4	9.83 10.10	9.97
2.	**Cement + Laterite**	524.7 520.8	5.18 5.14	5.16
3.	**Cement + Red earth**	318.9 320.4	3.15 3.16	3.16

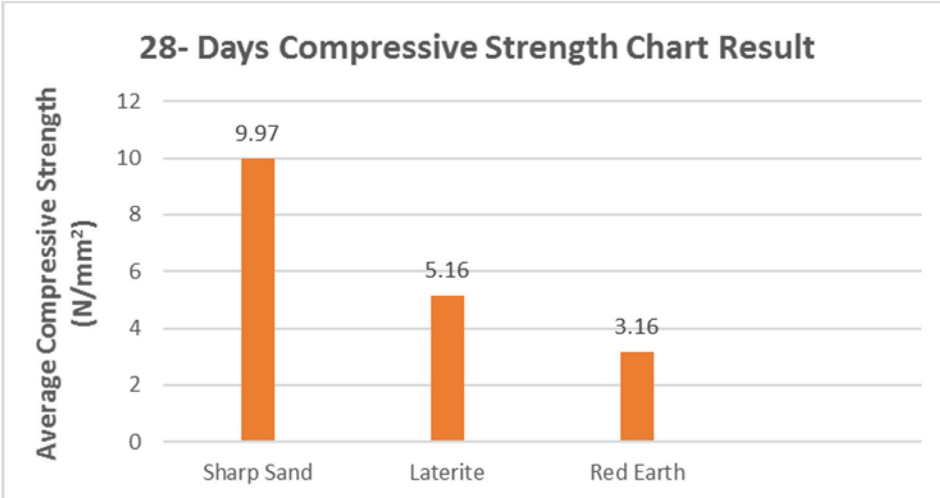

Fig 7: 28- Days curing compressive strength result

After curing the blocks for 28- days the block made with cement and sharp sand still has the highest average compressive strength of 9.97 N/mm^2 compared to the rest, which shows an increase of 189% compared to the standard 3.45 N/mm^2 (NIS 87, 2000). While those made with the mixture of Cement and Laterite is 5.16 N/mm^2 and Red Earth has the lowest average compressive strength of 3.16 N/mm^2. Compared to the sharp sand mix, there is a percentage increase and decrease in strength of 49.5%(increase) and 8% (decrease) between the average compressive strength of the blocks made with Laterite mix and Red Earth, and NIS standard respectively. The blocks made with cement and laterite still has a greater average strength than those made with cement and red earth.

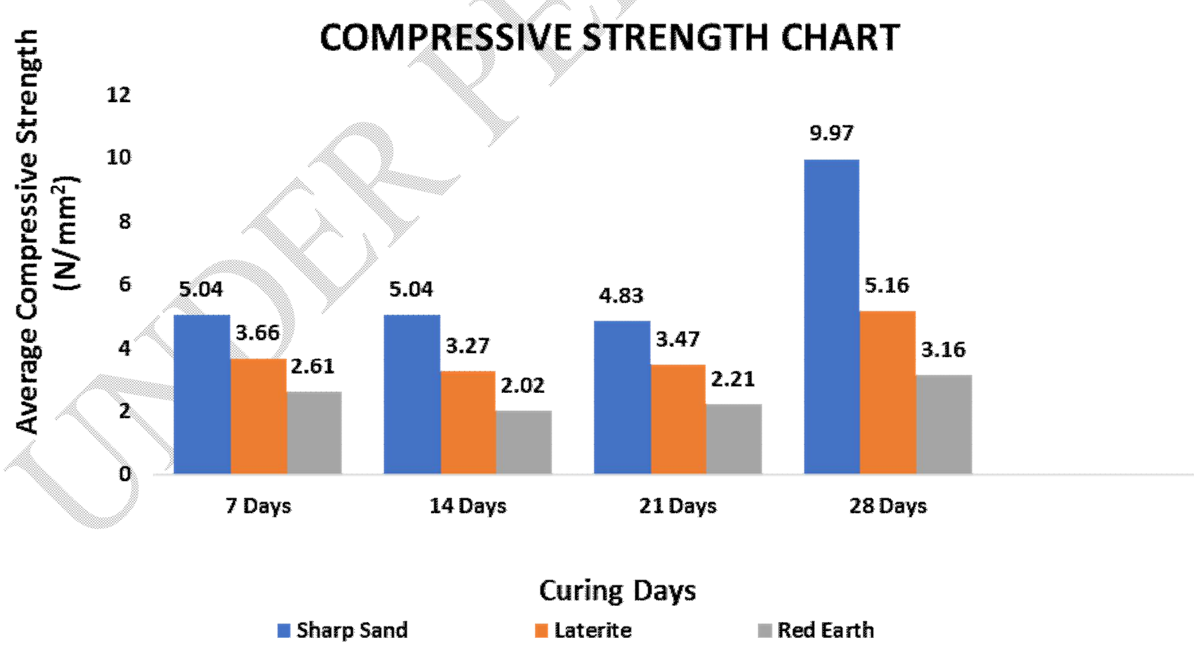

Fig 8: Chart on Compressive strength of Blocks

During the curing periods, there was insufficient curing of the blocks from the 14^{th} day to the 28^{th} day. The insufficiency of curing the blocks was due to lack of experience. The average strength of the blocks after 28, 21 and 7 days of curing had the best compressive strength with all passing the recommended minimum value of 3.45 N/mm^2 by NIS (87:2000), with only the block made from red earth of the 7- and 21-days curing being below the minimum at 2.61 N/mm^2 and 2.21 N/mm^2 respectively. Unlike the 28-, 21- and 7-days results, the 14 days result was all below 3.45 N/mm^2 except the block made from sharp sand being above at 5.04 N/mm^2. Similar to the 7 days result.

V. CONCLUSION AND RECOMMENDATIONS

The aim of this study was to investigate the production of blocks with the use of the mixture of different materials other than the conventional ones (i.e., cement and sharp sand) gotten and then testing for its compressive strength to know if it meets up to the standard of 3.45 N/mm^2 for individual blocks as recommended by the Nigerian Industrial Standard (NIS 87:2000). The overall average strength for the block made with cement and sharp sand (sand Crete) ranged from 4.83 N/mm^2 to 9.97 N/mm^2, for those made with laterite it ranged from 3.27 N/mm^2 to 5.16 N/mm^2 while those made with red earth had compressive strength that ranged from 2.02 N/mm^2 to 3.16 N/mm^2. The study shows that the strength of blocks increases with increase in curing days, if and only if curing is carried out properly. And of all the block type, the sharp sand (Sand Crete) block had the greatest compressive strength, and those made with red earth and laterite can be used as a substitute for sand Crete blocks if appropriate mix ratio is used even though the compressive values for the individual blocks made with red earth, laterite did not meet up the sand crete blocks, they are still considered to have reasonable strength with proper curing.

From the conclusions, I therefore recommend the following;

i. Bulk density test should be carried out on blocks made with material other than cement and sharp sand to know if they can be used for non-load bearing partitions.
ii. Improved curing practice, use of appropriate method of curing of at least seven days should be enforced by NSE and COREN on the block producers.
iii. Effective supervision must be exercised on the production site to ensure these of appropriate mix ratio, appropriate curing and adherence to right compaction time. Government should enforce it in the manufacturers, stating the penalty of noncompliance with the rule.
iv. Compliance to the use of appropriate and recommended building materials and reasonable batching practice for block production should be strongly enforced by NSE and COREN.

The use of appropriate mix ratio for block production so that appropriate compressive strength can be attained.

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