Assessment of the Strength of Conventionally Produced Sandcrete Blocks and Burnt Bricks

Article · March 2018

DOI: 10.9790/1684-1502012430

2 authors:

Jegele Thompson

1 PUBLICATION 0 CITATIONS

Ariyo Adanikin

Elizade University

9 PUBLICATIONS 2 CITATIONS

IOSR Journal of Mechanical and Civil Engineering (IOSR-JMCE)
e-ISSN: 2278-1684,p-ISSN: 2320-334X, Volume 15, Issue 2 Ver. I (Mar. - Apr. 2018), PP 24-30
www.iosrjournals.org

Assessment of the Strength of Conventionally Produced Sandcrete Blocks and Burnt Bricks

Jegele[1], T.O. And Adanikin[2], A.
[1]*Department of Civil and Environmental Engineering, The Federal University of Technology, Akure, Ondo State.*
[2]*Department of Civil Engineering, Elizade University, Ilara-Mokin, Ondo State, Nigeria.*
Corresponding Author: Jegele

Abstract: The fact remains that housing has been universally acknowledged as the second most important human need after food. It has been of perennial interest to the world at large since its availability touches on one of the widest spectrum of human existence. Sandcrete blocks as building materials have become so popular in many parts of Africa that although similar to bricks in many respects, they both deserve to be treated separately. It is therefore worthy of note that for an engineer to select one of these materials (block and brick), the fitness or suitability of the chosen materials for the purposed structure must be considered.Tests carried out in this research include sieve analysis, Atterberg's limit tests (Liquid limit and plastic limit) were carried out on the materials (sand andlaterite)to be able to ascertain certain of their properties for their intended use. About ten pieces each of sandcrete block and burnt bricks were prepared for the study and density and compressive strength tests were carried out on them. Findings of the study shows the samples Liquid Limit to be 32%, Plastic Limit of 16.7%, density of the sandcrete block is 1947.47kg/m^3 while the density of the burnt brick is 1823.58kg/m^3.The average compressive strength of burnt brick (5.20N/mm^2) was found to be higher than that of sandcrete block (3.15N/mm^2).This shows that the compressive strength is directly proportional to the crushing load on the specimens and this is shown by the regression equation $y = 0.2129x+1.5; R^2 = 0.9817$ for the burnt bricks and $y = 0.14x + 0.7$; $R^2 = 0.9942$ for the sandcrete blocks.The study therefore concludes that burnt bricks just like sandcrete blocks is a good construction material and can be used for sustainable building construction.
Keywords: *Sandcrete blocks, Burnt bricks, Density, Compressive Strength and Sustainability.*

Date of Submission: 24 -02-2018 Date of acceptance: 15-03-2018

I. Introduction

In the last couple of years, the construction industries in Nigeria have witnessed a sharp controversy as regards the use of some construction materials over others. By far, the most controversial of them all is that of bricks and sandcrete blocks. While some contractors favour the use of burnt bricks, some openly criticized it in favour of hollow sandcrete blocks. As a matter of fact, economical use of materials is an important factor to be considered in choice making on construction materials. The right choice between burnt bricks and sandcrete blocks as regards their compressive strength is therefore as important as the safety of the structure itself.The importance of blocks and bricks as part of the local building materials that makes up the wall units, in a building or construction work cannot be overemphasized.

Sandcrete blocks are also known as dense block; they normally have density of 1820 to 2080kg/m^3. By specification, it is required that height of the block does not exceed the length or six times the thickness to avoid confusion with slabs or panels.They are used for load bearing internal wall, including work below ground level, dam-proof, and coarse- composite walls.The main aggregate use for blocks moulding in Nigeria is sand, and this should mainly pass through the 4.70mm zone of the B.S. test sieve.

Since the manufacture of the first clay product (brick), it has passed from one civilization to another, experiencing modifications and improvement along the way. In Nigeria, the art of using bricks can be traced to the eighteenth century. By the beginning of the 19th century, the first British Governor of the then northern Nigeria, Lord Lugard had his house built with bricks in the village of Baro (Niger State)and such houses in towns like Kano, Kaduna, Ilorin and Baroare still intact and habitable. Compressive strength, weather resistance, water absorption, density, hardness, weight and thermal expansion are important physical properties of clay products (BS 3921). The raw materials and the manner and degree of burning influence the physical properties of the products.Clay products are burnt at temperatures greater than 900^{0}c and are therefore fire resistant. In addition, only clay products have a good insulation property, which contributes to its greater thermal comfort.The physical properties of clay which makes it suitable for the manufacturer of brick, are plasticity, tensile strength, fusibility and shrinkage amongst others. Clay must be plastic enough to permit to be shaped or moulded when mixed and they have sufficient tensile strength to maintain their shape after forming drying. Furthermore, clays must be readily fused together to form the final product when subjected to certain temperature ranges. It is the fusibility that results in a hard solid and substantially strong unit. Shrinkage is a property inherent to a greater or lesser extent in all clays and those possessing the tendency to shrink are preferred for clay products (1).

Sandcrete blocks are made up offine and coarse aggregates, water and binder which is usually cement. (2)stated that cement, as a binder, is the most expensive input in the production of sandcrete blocks and this has influenced producers of sandcrete blocks to produce blocks with low OPC content so as to make the sandcrete blocks affordable to people and increase their sales profit. The material constituents, their mix, presence of admixtures and the manufacturing process are important factors that determine the properties of sandcrete blocks. It is noteworthy that in Nigeria, 95% of walling materials in buildings are made of sandcrete blocks (3). Sandcrete blocks are also used in the task of transforming the actual load from the overlaying structural element to the foundation. Sandcrete blocks possess an intrinsic low compressive strength making then susceptible to seismic activity with research showing dismal results in the production of sandcrete blocks, which have exhibited compressive strength far below the standard requirement for the construction of houses (4).

The soil used for burnt brick is termed Laterite and it is defined as a red tropical soil: a reddish mixture of clayey iron and aluminium oxides and hydroxides formed by the weathering of basalt under humid, tropical conditions (5).Burnt bricks are smaller and twice as much or more is needed to build the same house size as the sandcrete cement blocks (6). This finding is also supported by (7) that burnt bricks used for building houses are small in sizes and therefore require a lot of labor works to construct such houses.It can be said that there is a huge misconception or little understanding of the limitations and advantages of the walling properties of burnt bricks over sandcrete blocks even as the burnt brick industry is not well organized and is technically unprepared with very little know-how about it amongst engineers, builders and homeowners.

The following are limitations and reasons of stakeholders in the building industry for their preference for Sandcrete blocks to burnt bricks and these are lack of design data on its use according to (8) arenon-availability of design and construction experts, initial cost of construction high, non-availability of the bricks on the market, irregularity in shape and color, smaller and appears weaker than the Sandcrete block, flaky and algae formation. The performance indicators used to evaluate the operation or functioning of burnt bricks as a building material include durability, strength, sustainability, and affordability and user satisfaction of burnt bricks. (9) stated that most soil in their natural condition lack the strength, dimensional stability and durability required for building construction. The above indicates that soils used for burnt bricks, if not properly tested, may lack the desired strength and hence its flimsiness. Merits of burnt bricks in building construction include brick being permanent as once it's built it remains weather proof and age proof. Also, burnt brick doesn't get tired like man-made materials, so it requires virtually no upkeep or repairs.Bricks also don't rust or erode, rot or decay, bend, twist or warp (10). Bricks also are non-combustible and don't support the spread of fire, making them ideal for building in bushfire-prone areas. Burnt bricks generally do not suffer any structural damage after a fire and can be re-used even as load bearing walls (11).

II. Materials And Methods

The material used for the production of the hallow sandcrete blocks are sand, water and cement (OPC). All materials ranging from sand (fine aggregates) for cement were all obtained locally. The sand used is that passing through 2.36mm B.S. test sieve and is free from substances such as silt that can have deteriorative effect on the block to be produced. River sand is used extensively in preference to other sources of sand, particularly the type that is obtained on the ground surface along roadsides or from drains. The reason for this is that sand obtained from the river is already washed and therefore, contains less silt and other impurities than sand collected from drains, which may need washing before used.The cement used, which is the binder, is ordinary Portland cement (OPC) under the brand name of Dangote cement. The water used was ensured a drinkable free from impurities. In some specifications, the quality of water is covered by a clause stating that the mixing water should be fit for drinking. Water is necessary in concrete in that it react chemically with cement to form a paste, which binds the aggregate particles together. Such water must comply with the requirements of BS3148 (1975).

The Soil (clay) for the manufacturing of the brick was obtained from Ore-Irele road of Ondo state. The clay was won by using hand digger and shovel because of the little output needed. The dirts were cleared off the surface with the shovel and then dug out. Other impurities and the plant roots were removed and then scooped the clay into bags before being transported to the production site where it was grinded by using mortal and pestle into powdery form and certain amount of sand was added to increase the strength and rate of dryness of the brick. A portion of these materials was taken for liquid and plastic limit determination.The tests carried out for this research work include the following.

Sieve Analysis ofSoil Sample where the soil particles were made to pass through the sieve with opening of known sizes. The calculation was done by the expressions in eqn. (1) and eqn. (2).

(a) Retained Percentage (%) $= \frac{Weight\ Retained}{Total\ Weight} * 100$ ……... eqn. 1

(b) Passing Percentage (%)= 100 – Retained Percentage. …….. eqn. 2

Liquid Limit Determinationwas carried out and it can bedescribed as the moisture content at which a pat of soil placed in a brass cup, cut with a standard grove and then dropped from a height of 1cm will undergo a grove closure of 12.7mm when dropped 25 times. Simply put,it is the moisture content at which the soil stops acting as a liquid and starts acting as a plastic solid. That is, minimum moisture content at which the soil,will flow under its own weight. The experiment was repeated for four other times and some readings were obtained. The results obtained were documented and tabulated as shown in Table 3.

Plastic Limit Determinationis described asthe moisture content at which a given soilbecomes too dry to be in plastic stage as described by plastic limit test. It is arbitrarily defined as the water content at which a thread of soil, when rolled down to a diameter of 3mm will just crumble.As further moisture content is driven from the soil, resistance to large shearing stresses become possible until it acts as a brittle solid. The limit between plastic and brittle failure is the plastic limit.

Compressive Strength Testas definedfrom quality control point of view determines the quality of most bricks.For the purpose of this work the compressive test was performed for both hollow sandcrete blocks and burnt bricks on electric crushing machine.The equipment comprises a gear whichslowly elevated the platform on which the specimen of sandcrete block and burnt brick were placed for crushing. The bricks were properly and carefully placed in such a way to avoid one-side crushing. The crushing strength value was read from the indicator on the machine and the compressive strength (N/mm^2) of the two specimens was respectively determined from the expressions in eqn. (3)**:**

Compressive strength of block $= \frac{\text{Maximum Load at Failure (N)}}{\text{Cross -sectional area of block /brick (mm 2)}}$ ……….. eqn. 3

Density Test is as defined from the density of a material is the ratio of its mass to its volume. The type of aggregates that made up the material will mainly determine the density and other properties. Other properties such as compressive strength, durability, thermal conductivity and porosity e.t.c are dependent on density.The respective densities of the specimens were computed using the values of the volumes and the weights of sandcrete blocks and burnt bricks as shown by the expression in eqn.(4):

Density of specimen (kg/m^3) $= \frac{\text{Mass of specimen (kg)}}{\text{Volume of specimen (m3)}}$ ……….. eqn. 4

III. Results And Discussions

Results of Sieve Analysis of Sand

The major purpose of carrying out laboratory tests is to determine the suitability of the raw materials for the production of the hollow sandcrete blocks and burnt bricks and also the fitness of the finished products for the purpose for which they are met, that is, using hollow sandcrete blocks and burnt bricks as construction material in a given civil engineering project.

Table 1: Sieve Analysis of Sand

S/N	Sieve Number	Weight Retained(gm)	%Retained	%Passing
1	9.5	0.00	0.00	100
2	4.76	8.10	5.60	94.40
3	2.36	22.40	15.40	84.60
4	1.18	50.60	34.80	65.20
5	0.60	90.20	62.0	38.00
6	0.30	114.20	78.50	21.50
7	0.150	135.6	93.20	6.80

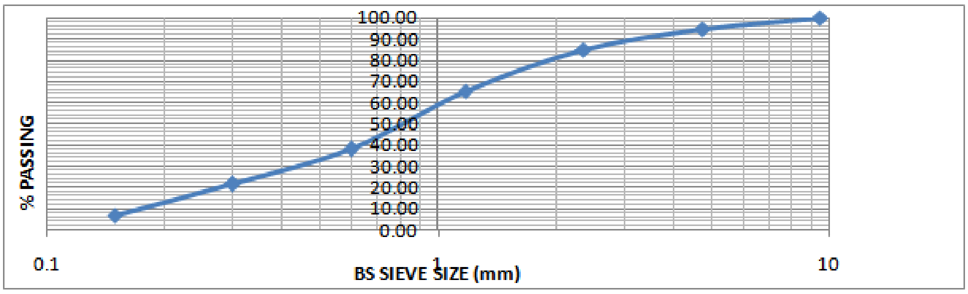

Figure 1: Sieve Analysis Curve for Sand Sample

Table2: Specification for Fine Aggregate and Crush Stone Dust and Sand

B.S sieve	Zone 1	Zone 2	Zone 3	Zone 4
9.5-	100	100	100	100
4.76	90-100	90-100	90-100	90-100
2.36-7	60-95	75-100	85-100	95-100
1.18-14	30-70	55-90	75-100	90-100
600-25	15-34	35-59	60-79	80-100
300-52	5-20	8-30	12-40	15-50
150-100	0-10	0-10	0-10	0.15

Silt content = 0-10%

Table 1 gives the necessary data relating to the grading of sand, from which information relating to sieve number,weight retained,percentage retained and percentage passing can be obtained. Presented in table 2 are the specifications for aggregate that will be suitable for block making in which any result that falls into any of the four zones is appropriate for construction work (block making).The sieve analysis result of the research work reveals that the particle size distribution of sand used is well graded as the results obtained comply with the grading limit of zone 2 and therefore, they are suitable for construction work.

The Results of Liquid and Plastic Limit

The results obtained for liquid limit and plastic limits test carried out on clay sample as basic raw material for the production of the brick are respectively presented in Table 3 and Table 4.

Table 3: Determination of Liquid Limit of Soil

Test No	1	2	3	4	5
Container Number	**36**	**6**	**8**	**5**	**50**
Wet Soil + Container (gms)	23.6	23.0	24.7	22.2	24.8
Dry Soil + Container (gms)	21.6	23.0	24.7	22.2	22.8
Container Empty(gms)	16.0	15.5	16.1	15.5	16.0
Dry Soil (gms)	5.6	5.6	6.5	5.1	6.8
Loss of Water (gms)	2.0	1.9	2.1	1.6	2.0
Moisture Content (%)	35.5	33.9	31.4	31.4	29.4
Number of Bumps	11	17	27	37	49

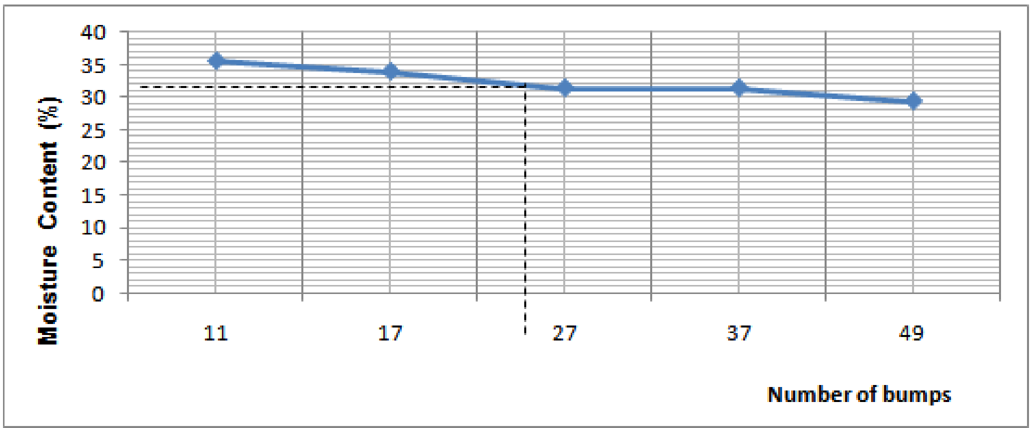

Figure 2: Liquid Limit Curve of Clay Soil

Liquid limit, L.L is the moisture content that corresponds to 25 bumps. From figure 2 the L.L is found to be = 32%

Table 4: Plastic Limit Determination

Container Number	11	13
Wet soil +Container (gms)	20.0	19.9
Dry Soil + Container (gms)	19.4	19.3
Container Empty (gms)	15.6	15.9
Dry soil (gms)	3.8	3.4
Loss of Water (gms)	0.6	0.6
Moisture Content (%)	15.8	17.6

Plastic limit(P.L) = $\frac{15.8 + 17.6}{2}$= 16.7%

P.L of 16.7% gives the minimum moisture content at which the soil was rolled into a thread of 3mm diameter without breaking.

From the Casagrande plasticity chart on soil classification, it follows that,

L.L < 35% --------- Low Plasticity

L.L 35-50% ------ Medium Plasticity
L.L > 50 ------------ High Plasticity
The result from Table 3 of L.L = 32% revealed that the clay sample is of low plasticity. The effect of the low plasticity on heating process performed on the formed brick is that, temperature need not to be too high for the removal of moisture as compared to when the plasticity is high. It then follows that the plasticity of the clay must not be considerably high so as to obtain brick unit of good strength.

Laboratory Test on the Finished Products (Sandcrete Blocks and Burnt Bricks)

In the course of the test, density test and compressive strength test were carried out on the finished product (sandcrete blocks and burnt bricks).

Density Test

The density of a material is the ratio of its mass volume. The type of aggregates that made up the material will mainly determine the density and other properties. Other properties such as compressive strength, durability, thermal conductivity and porosity e.t.c are dependent on density.The prepared sandcrete blocks and burnt bricks were taken at random after they have been dried to constant weight and after the bricks have been burnt and allowed to cool for dimension measurement.The respective densities of the specimens were computed using the values of the sandcrete blocks and burnt bricks volumes and weights according to the relations below:
Density of specimen (kg/m^3) = mass of specimen (kg) divided by volume of specimen (m^3).

Table 5: Weight and Density of Sandcrete Block and Burnt Bricks

Curing Age (Days)	Weight (kg)		Density (kg/m^3)	
	Sandcrete Block	**Burnt Bricks**	**Sandcrete Block**	**Burnt Bricks**
7	20.32	11.3	1904.82	1801.60
14	20.80	13.48	1949.81	1814.3
21	20.90	13.59	1959.19	1829.1
28	21.08	13.74	1976.06	1849.3
Average Value	**20.78**	**13.03**	**1947.47**	**1823.58**

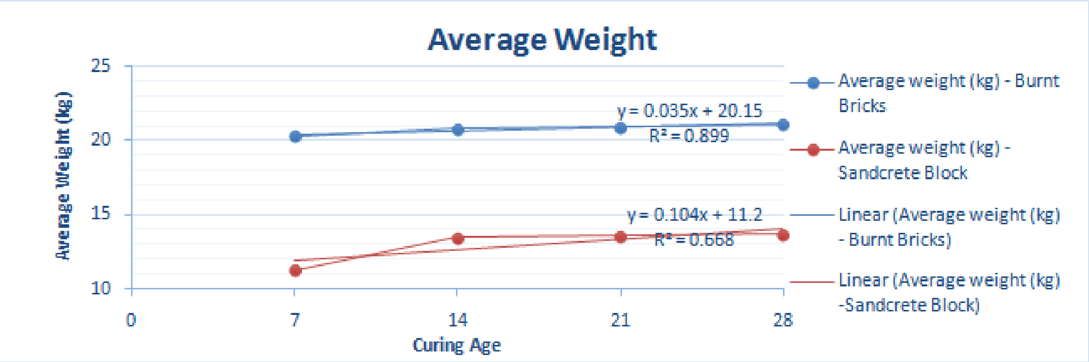

Figure 3: Average Weight Results of Sandcrete Blocks and Burnt Bricks

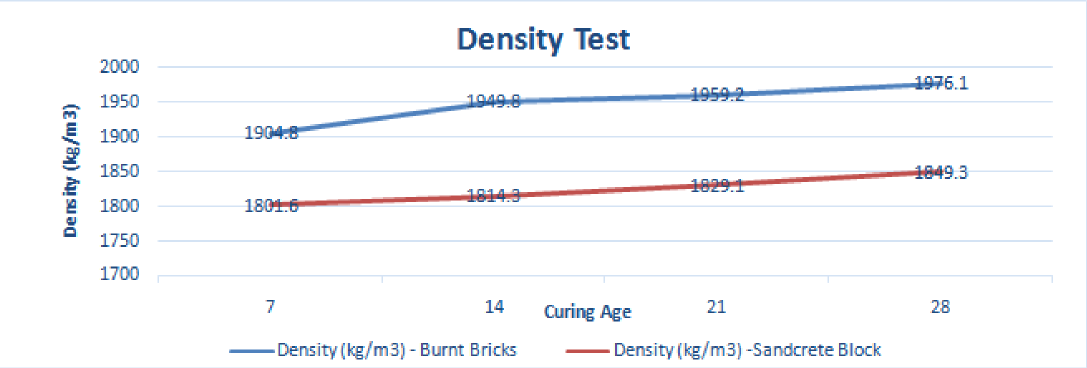

Figure 4: Density Results of Sandcrete Blocks and Burnt Bricks

From table 5, the average density for the four samples of sandcrete block 1947.47kg/m^3, while that for burnt brick is 1823.58 kg/m^3. The density of special masonry as ranging between 1200 – 2400kg/m^3therefore both the sandcrete blocks and burnt bricks satisfy this condition and therefore can be used for construction purpose.

Compressive Strength Test

Compressive strength of a material is defined as the ratio of the experimental failure load, P in compression to the reloaded cross-sectional area of the material.Presented in Table 6 are the average compressive strength tests obtained for selected test samples of sandcrete block and burnt bricks respectively.

Table 6: Average Compressive Strength of Hollow Sandcrete Blocks

Curing Age (Days)	Failure Load (KN)		Compressive Strength (N/mm^2)	
	Sandcrete Block	**Burnt Bricks**	**Sandcrete Block**	**Burnt Bricks**
7	76	125	1.6	3.11
14	132	140	2.78	4.45
21	172	180	3.63	5.58
28	218	200	4.60	7.72
Average Value	**149.5**	**161.3**	**3.15**	**5.20**

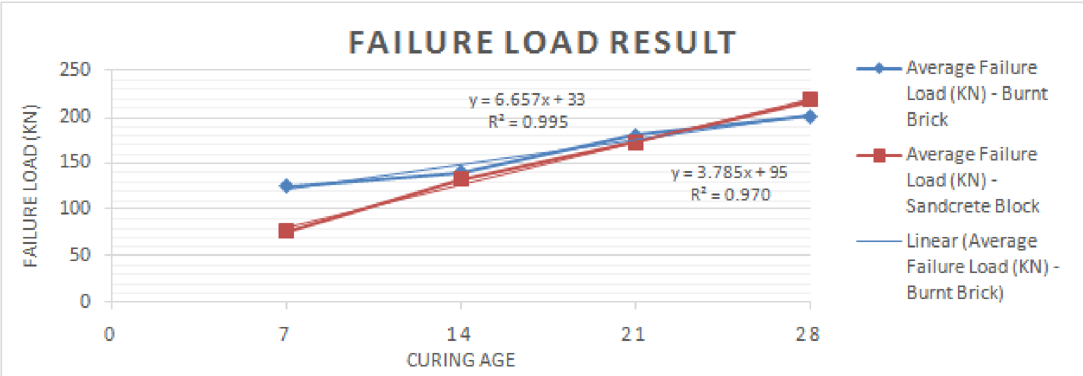

Figure 5: Failure Load Test Results of Sandcrete Blocks and Burnt Bricks

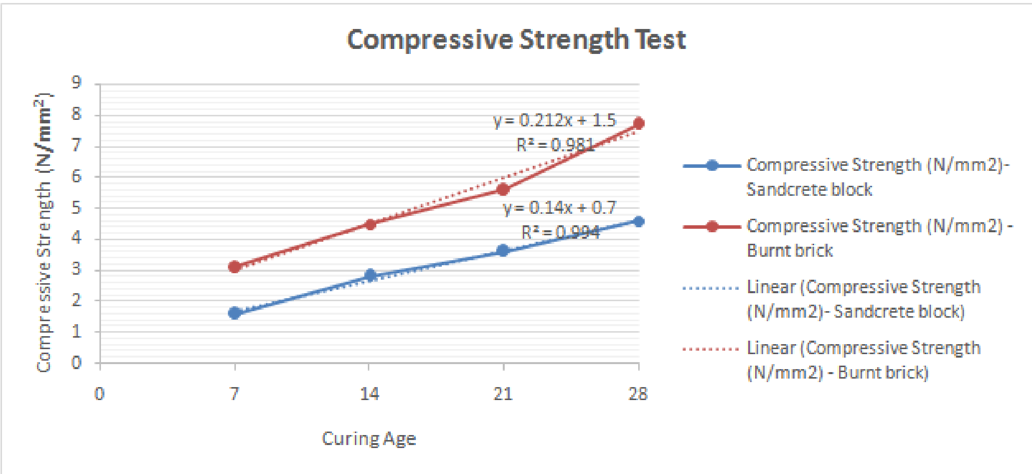

Figure 6: Compressive Strength Test Results of Sandcrete Blocks and Burnt Bricks

The result shows that the compressive strength of the hollow sandcrete block increases with age at curing (Table 6) and also, the compressive strength of burnt brick is higher than that of sandcrete blocks for all sample tested. This then implies that there is beneficial effect from the use of burnt bricks.It could also be seen that the weight of all bricks tested was lower than that of blocks. Thisfollows that if the use of bricks is employed, there would be reduction in the dead load that would be transferred to the soil.

It could be seen from Figure5 and 6 that the compressive strength of hollow sandcrete block increases with age at curing. Consequently,blocks to be used for any construction work should be left for a number of days after production for strength gain.It could be observed from figures 5 and 6thatthe average compressive strength increases with average failure load for burnt bricks and hollow sandcrete blocks respectively. This shows that the compressive strength is directly proportional to the crushing load on the specimens and this is shown by the regression equation $y = 0.2129x + 1.5$; $R^2 = 0.9817$ for the burnt bricks and $y = 0.14x + 0.7$; $R^2 = 0.9942$ for the sandcrete blocks.Figure 5 and 6 alsoindicates that density increases with average weight for both sandcrete blocks and burnt bricks. Figureshows that the density of block is higher than that of burnt bricks while Figure reveals vividly that the compressive strength of burnt bricks is more than that of similar ones made from sandcrete.

IV. Conclusion

The results of this work show clearly that bricks have higher compressive strength than blocks as construction materials.Also, because bricks are materials devoid of any hollow unlike sandcrete block, it is very solid and this further makes it a material with a better strength than those of blocks.If bricks are well manufactured and fired, it gives building a better aesthetics view than that of similar ones made of sandcrete blocks. Despite all these benefits, it is quite known that buildings and structures constructed with blocks are more common in Nigeria than those made of bricks. This may probably be as a result of cost of good quality bricks. As it has been pointed out in this work, the cost of a unit of brick is more than that of a block of similar unit.This therefore shows the influence the cost of a material could have on the choice or otherwise of a particular material for construction works.Lastly, it is worth of note to say that the high cost of burnt bricks could conclusively be traceable to the scarcity of good clay material that could be used as its raw material. As such, few manufacturers are found to be involved in the manufacturing of bricks, which now leads to its high cost of production. Nevertheless, considering strength aesthetic values, the use of bricks for construction works should be employed in Nigeria.

References

[1]. Adeola, J.O., (1997). *A Review of Masonry Block/Brick types used for Building in Nigeria.*M.Eng Thesis, University of Benin, Nigeria.
[2]. Oyetola, E.B&Abdullahi, M (2006). The Use of Rice Husk Ash in Low-Cost Sandcrete Block Production. *Leonardo Electronic Journal of Practices and Technologies*. 8, 58-70.
[3]. Sholanke, A.B., Fagbenle, O.I.,Aderonmu, A.P &Ajagbe, M.A (2015). Sandcrete Block and Brick Production in Nigeria - Prospects and Challenges**.** *IIARD International Journal of Environmental Research*. 1(4), 1-17.
[4]. Oyekan, G.L. &Kamiyo, O.M. (2008). Effects of Granites Fines on the Structural and Hygrothermal Properties of Sandcrete Blocks. *Journal of Engineering and Applied Sciences.* 3(9), 735-741.
[5]. Wikipedia (2017). Laterite. https://en.wikipedia.org/wiki/Laterite (Accessed, 26th December, 2017).
[6]. Damptey, E.O. (2006). *Building Sustainably for Good Indoor Climate in Three Residential Areas of Accra, Ghana*. KTH, School of Architecture and the Built Environment. SOM-EX 06-21.
[7]. Danso, H. (2013). Building Houses with Locally Available Materials in Ghana: Benefits and Problems. *International Journal of Science and Technology*. 2(2), 225-231.
[8]. Danquah A.J. (2009).*Production of Affordable but Quality Housing for the Low Income Urban Dweller.* Promoting the Use of Local Building Materials. BRRI, Kumasi-Ghana.
[9]. Riza, F. V., Rahman, I. A., & Zaidi, A.M.A. (2011). Preliminary Study of Compressed Stabilized Earth Brick (CSEB). *Australian Journal of Basic and Applied Sciences*. 5(9), 6-12.
[10]. Thinkbrick (2017). http://www.thinkbrick.com.au/why-brick (Accessed 26thDecember, 2017).
[11]. Danquah, J.A.,Abrokwah, P.O.,Twumasi, A &Ankrah, J.S (2015). Appraisal of Burnt Bricks as A Building Material in Ghana. *International Journal of Scientific Research and Education.*3(1), 2814-2826

Jegele. "Assessment of the Strength of Conventionally Produced Sandcrete Blocks and Burnt Bricks." IOSR Journal of Mechanical and Civil Engineering (IOSR-JMCE) , vol. 15, no.2, 2018, pp. 24-30