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COMPARISON DISTILLED WATER AND CASSAVA WASTE WATER AS AN ADMIXTURE SANDCRETE BLOCKS

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Abstract: The Compressive Strength of Commercially Produced Sandcrete blocks available in the material market in Nigeria fall below minimum requirements of Nigerian Industrial Standard (NIS 87:2000) 2.5N/mm^2. The purpose of this study was to develop a new sandcrete blocks made from Cassava waste water to replace Normal sandcrete blocks made from distilled water using the same materials and methods. 48 sandcrete block samples size 450mm X 150mm X 225mm were cast and controlled. The tests performed include: Sieve Analysis, Water absorption, Specific gravity and Compressive Strength. The Findings revealed that the Sandcrete blocks made from cassava waste water attained compressive strength at day 28 (4.06)N/mm^2 while the Normal distilled water sandcrete blocks attained the compressive strength at day 28 (1.03)N/mm^2. This indicates that cassava sandcrete blocks satisfy while the distilled failed to satisfy NIS 87: 2000 and BS 3921 requirement. It suggests that Cassava Sandcrete block is a durable building and construction material.
Keyword: Sieve Analysis, Water Absorption, Specific Gravity, Cassava, Compressive Strength.

I INTRODUCTION

Sandcrete block is an important building and construction material that is widely used as walling units in Nigeria, Ghana and many other countries in the World. Sandcrete blocks are composite material made up of cement, sand and water, moulded into different sizes (Borchelt, 2002). The quality of blocks produced commercially differs from one industry to the other, due to the different methods employed in the production (Dov 1991).

Sandcrete blocks are used for walling units and partitions, the sizes and weights must be conveniently dimensioned easily handled by the Artisans. Sandcrete blocks are supposed to be used for the construction of load bearing and non-load bearing structures (Hodge 1971). Therefore Load bearing blocks must conform to building and construction regulation (CODE). The present Sandcrete blocks available in building and construction material market in Nigeria are below the Nigerian Industrial Standard (NIS). The purpose of this study is to development a cassava sandcrete blocks as an alternative to distilled sandcrete blocks for load bearing and non load-loading structures or walling units. In this case the load bearing wall are those walls acting as supports for the whole structure to transmit the weight to the ground surface underneath it for stability.

1.1 Sandcrete Blocks

Sandcrete block possesses an intrinsic low compressive strength making then susceptible to any tragedy such as seismic activity. Sandcrete blocks are composite material made up of cement, sand and water, molded into different sizes (Borchelt 2002). It is widely used in Nigeria and other countries like Ghana, Irish as walling unit. The quality of blocks produced however, differs from each industry due to the different methods employed in the production and the properties of the constituent materials. They are used in the construction of walls, partitions, walling one-storey building, schools, houses and so on. The importance of sandcrete block is a locally building and construction material produced and used widely for building construction. Previous researchers have identified that commercially available sandcrete blocks in Nigeria fall below minimum compressive strength 0.5-0.97N/mm^2 which is well below 2.5N/mm^2 and 3.45N/mm^2 the NIS requirement. According to (Hodge 1971), Sandcrete blocks are available for the construction of load bearing and non-load bearing structures do not conform to building code and regulations. Sandcrete blocks have been widely used for building and construction projects in Nigeria. However it is observed that the alternate suitable clay bricks are not available in every Local Government in Nigeria. The clay bricks commercially produced presently available in the building and construction material market in Nigeria are not uniform in both quality and compressive strength. This suggests that there is a need for more improvement and control in building and construction materials in Nigeria.

1.1.1 Admixtures

According to ACI 212.3R-10, “Report on Chemical Admixtures for Concrete,” an admixture or combination of admixtures may be the only feasible way to achieve the desired performance from a concrete mixture in some cases. There are many kinds of chemical admixtures that can function in a variety of ways to modify the chemical and physical properties of sandcrete blocks. This study exploited cassava waste water as an admixture to improve the durability and compressive strength of sandcrete blocks in Nigeria.

1.2 CASSAVA

Cassava is an important root crop in Africa, Asia, South Africa and India,providing energy for about 500 million people. Cassava roots are potentially toxic due to the presence of cyanogenic glycosides especially Linamarin. Physiological deterioration occurs in cassava roots, 2-5 days after harvesting followed by microbial deterioration 3-5 days later. Cassava farming population has empirically developed several processing methods for stabilizing cassava and reducing its toxicity. Additionally the roots contain large quantities of the anti-nutrient factor cyanide and it changes in cassava into cyanogenic glycosides, linamarin and lotaustralin. Fermentation of cassava processes uses local technology without mechanical energy support or requirement it is basically physical energy. During the fermentation there is disintegration of tissue structure results of linamarin with linamarase; which is located in the cell walls and subsequent hydrolysis to glucose and cyanohydrins, which easily breakdown to ketone and hydrocyanic acid (HCN). HCN is produced on an industrial scale and is a highly valuable. The purposes of this study are: to determine the economic advantage of sandcrete blocks produced using cassava waste water, compare the compressive strength of sandcrete hollow blocks produced using cassava waste water and distilled water Sandcrete blocks, compare water absorption rate of sandcrete hollow blocks produced using cassava water as an admixture and distilled water Sandcrete blocks and suggest the potential usability of the recycled cassava waste water.

1.3 PROPERTIES OF SANDCRETE BLOCKS

1.3.1 Porosity

Presence of admixtures may increase, decrease or maintain the porosity of the main material depending on the aggregate sizes. When exposed to persistent flooding, a highly porous block could absorb much water, consequently become weakened and eventually fail. The volume of liquid absorbed by a porous medium is an indication of its pore volume and it is a good approximate measure of its porosity. Hence, porosity □ is obtained with the relation.

$$\square = \frac{Vf}{V} \times 100\% \quad (1)$$

1.3.2 Permeability

The term "permeability" is often loosely used to cover a number of different properties. In this study, it is defined as the property of a porous medium which characterizes the ease with which a fluid will pass through it under atmospheric pressure. Darcy's law for fluid flow in a permeable medium expresses permeability in terms of measurable quantities and states that the steady state rate of flow is directly proportional to the hydraulic gradient H^2

$$K = \frac{\square H^2}{2th} \quad (2)$$

1.3.3 Sorptivity

In using blocks for external walls in tropical humid climate, water resistance ability of the blocks must be considered in order to minimize penetration of moisture or rain water into the interior of the building. Many times, block work is used in the construction of channels for drainage. Blocks used for drainage or similar purpose must have low water absorption value. The absorption of water rate under capillary action is directly proportional t.

$$A'' = S\sqrt{t} \quad (3)$$

1.3.4 Thermal properties

Thermal properties of most cementitious materials are found to change with the presence of admixtures (Cisse and Laguerbe, 2000; Okpala, 1993). Changes found depend on the admixture's grain structure or interstitial arrangement within the main material and other micro structural parameters including the volumetric fraction of each constituent, the shape of the particles, and the size distribution of the particles. In predicting the thermal performance of buildings, it is necessary to consider the dynamic effects of this variation. The Thermal conductivity measures the quantity of heat that flows through a material per unit time. From the Fourier's steady-state heat conduction equation, thermal conductivity is determined using the equation below.

$$K = \frac{Q}{A}\frac{\Delta x}{\Delta T} \quad (4)$$

II HYDROCYANIC ACID

Hydrogen cyanide (HCN), sometimes called prussic acid, is an inorganic compound with the chemical formula HCN. It is a colorless, extremely poisonous liquid that boils slightly above room temperature, at 25.6 °C (78.1 °F). HCN is produced on an industrial scale and is a highly valuable precursor to many chemical compounds ranging from polymers to pharmaceuticals. Hydrogen cyanide is a linear molecule, with a triple bond between carbon and nitrogen. A minor tautomer of HCN is HNC, hydrogen isocyanide. Hydrogen cyanide is weakly acidic with a pKa of 9.2. It partially ionizes in water solution to give the cyanide anion, CN^-. A solution of hydrogen cyanide in water (HCN), is called **HYDROCYANIC ACID**. The salts of the cyanide anion are known as cyanides.

2.1 Hydrocyanic Acid in Cassava

Cassava is a perishable commodity with a life span less than 3 days after harvest. Processing provides a means of producing shelf stable products (thereby reducing losses), adding value at a local rural level and reducing the bulk to be marketed (Phillips et al., 2005). As urban population expand, the demand for more convenience and shelf-stable foods increases. Some cassava foods, such as Garri, tapioca, and attieke, are highly prized by urban populations, and these have managed to retain their markets. Imported food products are important urban foods but there is still a high demand for traditional foods, although they are often considered less acceptable for some class of people because they are worried about the quality and safety (Sanni et al., 2007). In Africa, cassava is currently utilized for two main purposes: human food and industrial usage. Estimates for the percentage of cassava used for industrial utilization range from 5 to 16% while the rest used directly for human consumption. Most of cassava's industrial utilization is for animal feed. About 10% of its industrial demand consists of high quality cassava flour used in biscuits and other confectioneries, dextrin, pre-gelled starch for adhesives, and starch for pharmaceuticals and seasonings. The cyanogenic glucosides of cassava (Linamarin and Lotaustralin) on hydrolysis releases hydrocyanic acid (HCN). Cassava is often classified as "bitter or sweet" according to the amount of cyanide present. However, several studies have shown that bitterness or sweetness could not be exactly correlated with the level of cyanogenic glucosides.

2.5.2 Fermentation of Cassava

In industry, as well as other areas, the uses of fermentation progressed rapidly after Pasteur's discoveries. Between 1900 and 1930, ethyl alcohol and butyl alcohol were the most important industrial fermentations in the world. But by the 1960s, chemical synthesis of alcohols and other solvents were less expensive and interest in fermentations waned. Cassava being the sole source of hydrogen cyanide which dissolves on solution to produce hydrocyanic acid is fermented .The roots were peeled, washed and immersed in water in a clean plastic container and another was grated and put in a muslin bag and submerged in water in a clean plastic container. The temperature of both containers was maintained constantly at of 30 oC. The fermentation process of the cassava grated cassava tubers was observed. The fresh, peeled tubers were suspended in water and allowed to ferment for 96hours by the natural micro flora. After successful fermentation; the produced cassava water was collected and carried to the department of Civil and Environmental Engineering Concrete Laboratory, the Federal University of Technology, Akure, for the production of sandcrete block.

III Method of Approach and Analysis

3.1: Sandcrete Block Production

In this study two types of sandcrete blocks were produced. The first type is 100% distilled water, cement, and sand. Similarly, the second type is 100% cassava waste water, cement, and sand. These two types of sandcrete blocks were produced to see if there is any difference between the two. Sieve analysis test was also carried out on the soil samples to ascertain their suitability for block making in accordance to BS 1377. All sandcrete blocks produced are hollow blocks made of the same material, same mechanical mixing process and vibrating machine. The standard mix proportion was the same and took place at the same time. The sizes of the block produced are the same (150 x 225 x 450) mm (6inches), the types of hollow sandcrete blocks commonly used for building construction in Nigeria. The slump was rammed into the machine moulds, compacted and smoothed off with a steel face tool. This process was performed for (on) both. After removal from the machine moulds, the blocks were put/ left on pallets under cover in separate rows, one block high and with a space between 2 blocks for the curing period. They are kept wet during this period by watering daily. All tests were carried out on day 7, 14, 21 and 28. On each day three samples from each type were teste. All tests were conducted in accordance with BS 3921, 2028 and NIS 2000, 87: 2000 and 2004 requirements.

3.1.1 Mixing

The mixing was done mechanically so as to get good proportional mix of the constituent materials for the Sandcrete blocks production. All the materials for the Sandcrete block which is cement, fine aggregate, 100% cassava waste water and 100% distilled water, both were measured and ensured they were well mixed before pouring into the mould.

3.1.2 Curing

Proper curing methods were utilized to ensure that the blocks attained self strength as observed for day 7, 14, 21 and 28.

3.2 LABORATORY TESTS

All tests were carried out at the department of Civil and Environmental Engineering Concrete Laboratory the Federal University of Technology, Akure, (FUTA) Ondo State.

IV ANALYSIS OF RESULTS

4.1. Specific gravity test

The application of specific gravity was employed; the values obtained the tests are used in the calculation below to determine the specific gravity of fine-grained soil. This result obtained from the calculation is within block range or limit of NIS and BS.

Specific gravity of soil particles $Gs_1 = \frac{M2-M1}{(M4-M1)-(M3-M2)}$	$\frac{409-269}{(579-269)-(664-409)} = \frac{140}{55} = 2.55$

4.2 Sieve Analysis results

4.2.1 Sieve Analysis

The sieve Analysis tests were carried out on sand samples so as to ascertain its particle size distribution. The result of sieve analysis is shown in the figure 4.1 below. The result shows fine grain sand with more than 90 percent passed through. It shows that the soil is well graded indicates that the sand is good for the of sandcrete blocks (Cc=15mm).

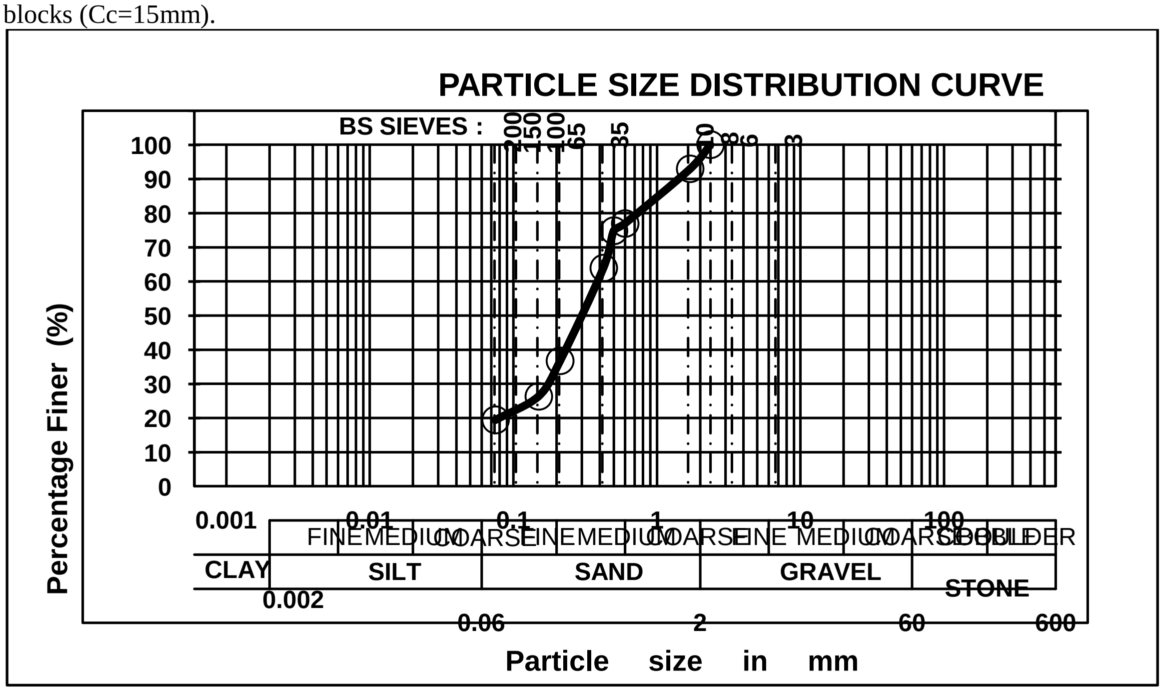

Figure 4.1 Particle size distribution (PSD) of Sample used

4.2.1 Silt/Clay test

Silt clay content test result obtained was 9.33% . the result is within the silt clay context limit.

4.2.2 Moisture Content

The tests result obtained from the average moisture content was 8.19% which is below NIS maximum requirement 12%.

4.2.3 Water Absorption Rate

Figure 4.2 below shows the results of water absorption rate obtained from the tests conducted on distilled water and cassava waste water sandcrete blocks. As can be seen from the figure the absorption rate varies from day 7 to day 28. At day 7, the water absorption rate varies from 1.8% cassava sandcrete block samples to 3.2% distilled sandcrete block samples. Similarly, At day 14 the water absorption rate varies from 2% to 4.0%. Likewise, at day 21, it varies from 2.4% to 4.5% and at day 28 the water absorption rate varies from 3.8% to 5%. As be seen from the figures below the absorption rate fall below NIS and BS maximum recommendation 12% However using Cassava waste waster as admixture water absorption is very low. It means that cassava sandcrete block samples retain water water than normal sandcrete block samples. The water present in mortar would be ratained longer in cassava samples than the normal samples. Cracks may not appear for number of years due to lower water absorption rate.

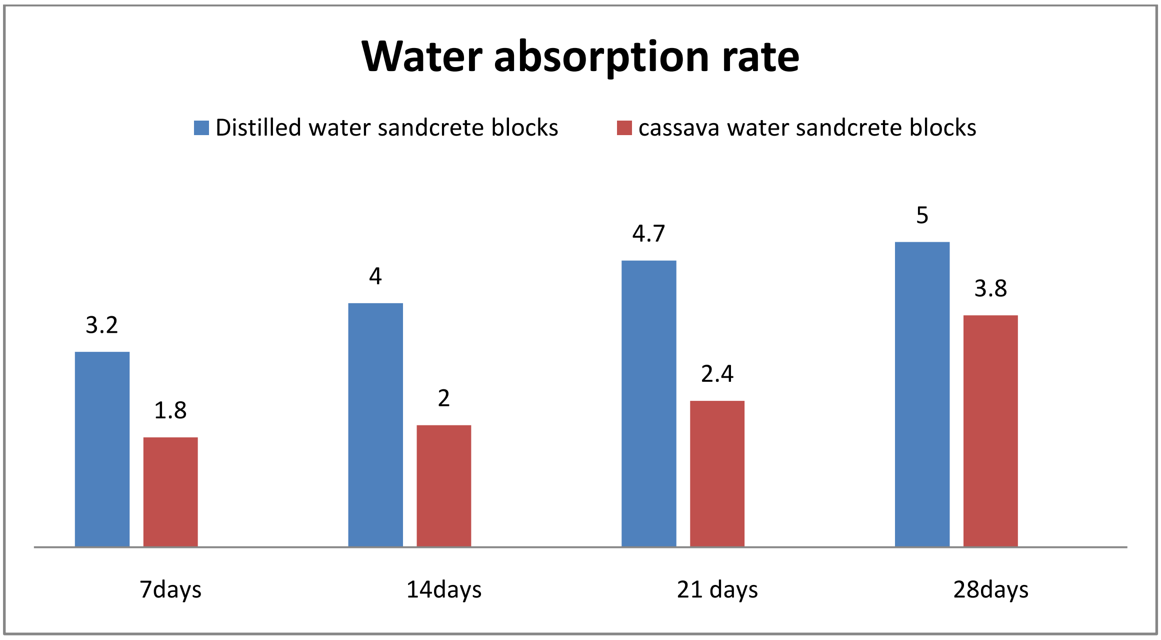

Fig 4.2b: Showing the rate of water absorption of Sandcrete block.

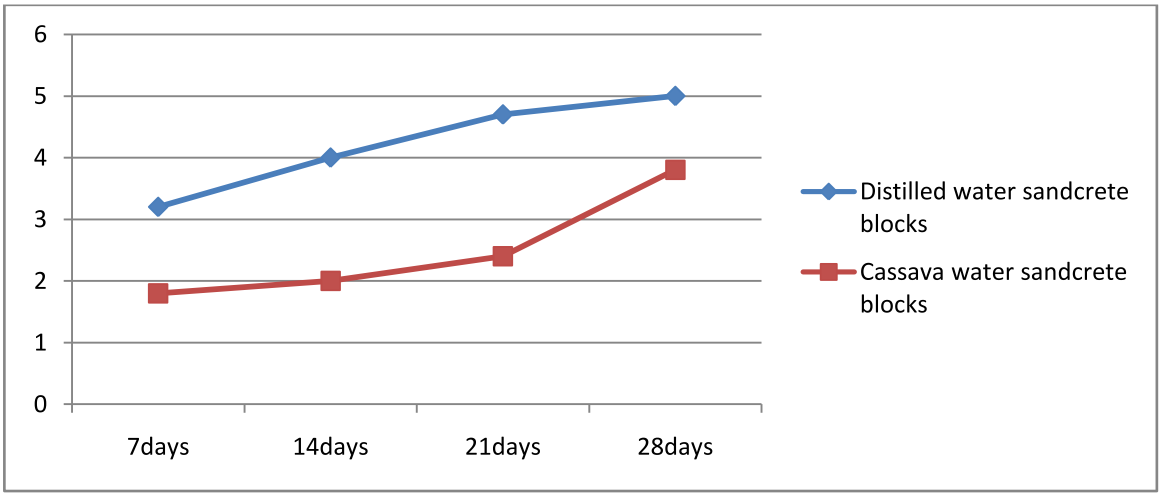

Fig 4.2b: Water absorption rate against the block Age

4.3 COMPRESSIVE STRENGTH TEST

The compressive strength of the samples obtained is shown in the figures 4.3a and 4.3b below, day 7, day 14, day 21, and day 28. Test results indicate that the unit compressive strength for Normal Sandcrete Block samples fall below the recommendation line of NIS and BS for day (7, 14, 21 and 28), while Cassava waste water sandcrete block samples attained higher than the maximum NIS and BS recommendation. The Compressive Strength values are indicated in the figures 4.3a and 4.3b. As can be seen in the figures 4.3a and 4.3b, the values obtained from Normal or distilled sandcrete blocks (0,61, 0.76, 0.99, 1.03) N/mm^2 fall below the NIS and BS requirements. Whereas cassava waste water admixture attained day 7, 14, 21, and 28 attained values as shown bracket (1.11, 3.03, 3.22 and 4.06) N/mm^2 satisfy the NIS and BS requirements. In comparison according to Figures 4.3a to 4.3b and 4.2a, 4.2b the results showed that cassava waste water sandcrete blocks attained higher compressive strength and absorbed or retained less water than distilled or normal sandcrete blocks. It shows that cassava sandcrete block may resist cracking for number of years if used for building construction.

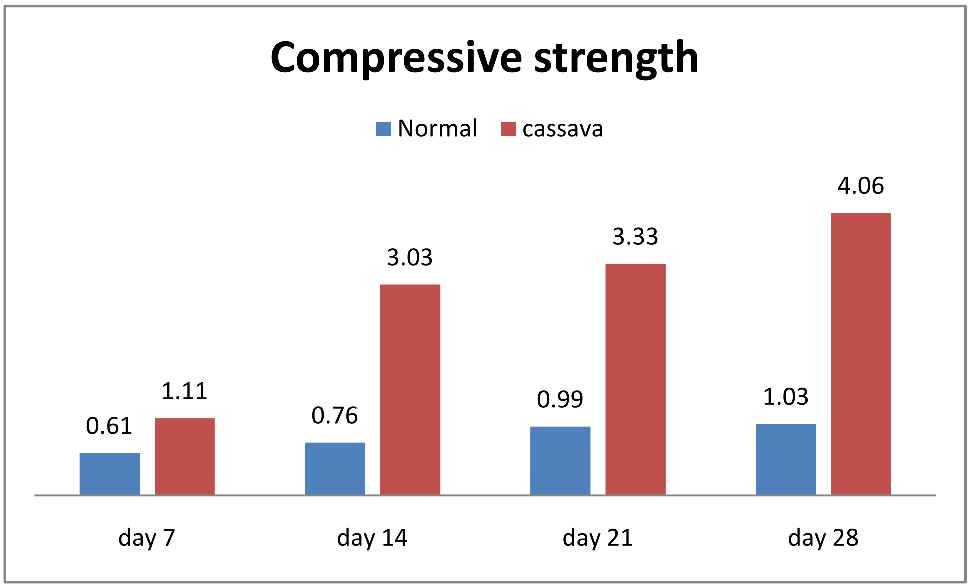

Figure 4.3a Compressive strength captured at day 7,14, 21 and 28

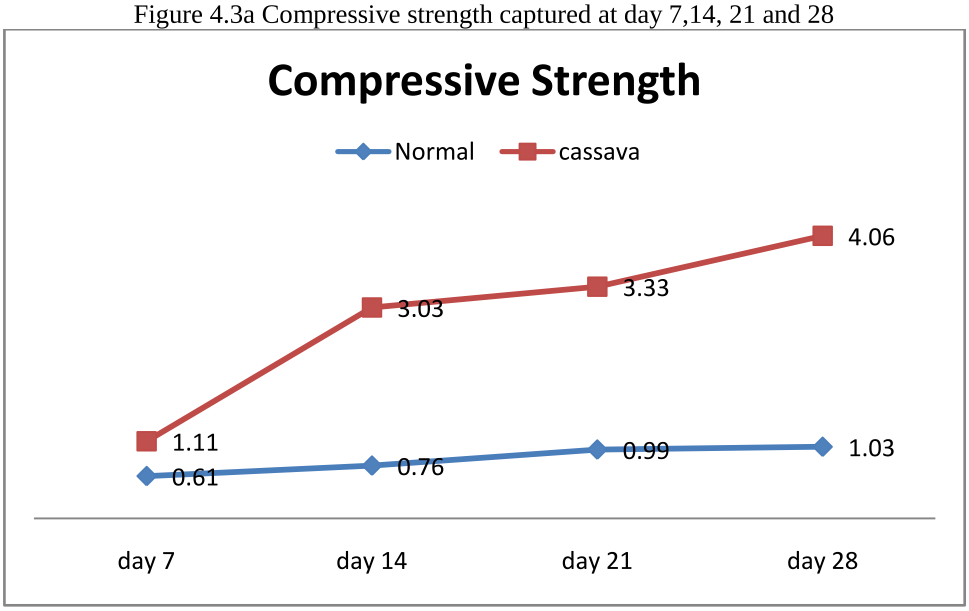

Figure 4.3b Compressive strength captured at day 7,14, 21 and 28

V CONCLUSIONS AND RECOMMENDATIONS

The cassava waste water sandcrete blocks at the age of day 14 and 21 have successfully satisfied the Nigerian Industrial Standard which specifies that the lowest compressive strength of individual blocks should not be less than 2.5 N/mm$^{2.}$ At the same time at day 28 the cassava waste water sandcrete blocks attained higher compressive strength (4.06) N/mm^2 above NIS and BS recommendations 3.5N/mm^2 and absorb less water

(3.8%). The result obtained on the distilled water Sandcrete blocks shows a compressive strength at day 28(1.03) N/mm^2 below the NIS requirement and also absorb more water than Cassava blocks. All tests results conducted showed that the sandy soil components mixed with cement, water and admixture with Cassava waste water is suitable for the production of the sandcrete blocks and also good for construction of a building according to NIS 87: 2004 and NIBBR 2006. The study suggests that sandcrete blocks be used for building construction or for any structure. Cassava waste water serves as a repellant to water absorption of Sandcrete blocks and also displays a whitish aesthetic nature.

5.2 RECOMMENDATIONS

Majority of sandcrete blocks commercially produced in Nigeria have failed to meet the requirement standard set down by NIS, NIBBRI and BS. This suggests that there is a need for improvement in this area. More research, more studies are required to develop new alternative sustainable local product to replace old product at lower costs. There is a need for good Government policies to support and encourage effective education and research on waste management, safe disposal and recycling.

From the analysis of Cassava waste water sandcrete block samples suggest that the cassava waste water be used as an admixture in sandcrete hollow block production. It is easily assessable, cheap and highly functional.

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