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Investigation into the Suitability of Sandy Soil Found within Ado-Ekiti Metropolis for Sandcrete Block Production in South Western, Nigeria

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Abstract **– The study examine the suitability of Ado-Ekiti Metropolis Sand for the production of sandcrete blocks. Five sand samples was collected from five different sand deposit site within the metropolis. The sandy soil was mixed with cement in ratio 1:8 to produce the sandcrete block in compliance with [11]. Test such as specific gravity, sieve analysis, compressive strength, absorption, impact and abrasion were performed on the sandcrete block samples. The result indicates that the sand sample obtained from all the location for grading test were well graded according to NIS specification for Grade L1. The specific gravity ranges from a lower limit of 2.17 and upper limit of 2.76 .the result of the impact varies from a lower limit of 9.6% and upper limit of 18.7%. The result of water absorption varied between 10.4% and 13.9% respectively for all the locations.The Abrasion test varied between 1.73% and 2.56% for all the locations. The compressive strength conducted on the sandcrete blocks for 3,5,7 and 14days ranges between 1.3N/mm^2 and 2.7N/mm^2 for all the location respectively and the silt test performed on all sample varied between 5% and 8.5%. Based on the test carried out the result obtained shows that Ado-Afao, Ado-Ijan and Ado- Iworoko sand deposit is the most suitable among the five sand deposit identified within the metropolis. It was concluded that those sand deposit site that were found suitable will create supply paucity, increase economic return to the land owners in these community and guide the producer of sandcrete block on the choice of quality material available within the metropolis.**

Keywords **– Sand, Blocks, Sandcrete, Ado-Ekiti, Compressive Strength.**

I. INTRODUCTION

Sand is a valuable resource and a main input in the construction industry in many parts of the world [5][8] Sand and gravel represent the highest volume of raw material used on earth after water[7]. Their use greatly exceeds natural renewal rates. Moreover, the amount being mined is increasing exponentially, mainly as a result of rapid economic growth in Asia [16].Soil is an important source of raw materials such as clay, sand, gravel and minerals. Soil is a natural resource made up of gravel, sand, clay, loam which constitutes the different types. Pit sand, river sand and gravel are components of soil which takes years to be formed but extracted in a matter of days [2]. Sands are crucial resources to economic development activities in developed and developing nations. Recovery from river channels, flood plains and glacial deposits as well as processing of those resources is costly but valuable in construction and industry [2].Sand is an underground geological resource formed from eroded mountain rocks carried by streams and rivers. According to [9], soil has many uses, it is needed for agriculture, as a habitat and in construction, but the genesis of cash economy brought many profit driven companies to be involved in its mining both legally and illegally with little or no regard to the environment. [15]gave the background to formation of sand deposits, legacy of the continental ice sheets that melted thousands of years ago. As the ice melted, fast moving river were formed leaving deposits of coarse sand. The river ran into the sea, large deltas were formed with layers of sand silt. Now there is no more ice and rivers but scattered deposits of sand which are used as important natural resources. Sand deposits are porous; water can pass through this geological material, making it a source of high quality water[15]. [2], discussed sand as commodities used in industry especially construction. In construction, the component are used either mixed with other material or as is, while in industry, sand are used in production of other materials like aggregates. Sand mostly quartz grains (Silicon dioxide) from weathering of granite rocks. The quartz grains accumulated in rivers, streams, deltas and beeches. Therefore quartz is very valuable as sand because of its silica content. The physical properties of sand particularly in abrasive property make their resource useful for traction on icy roads, roadways and rail road including sand blasting [2]. Sand is a cheap and heavy resource consisting of very small pieces of rocks and minerals, a result of weathering that forms beaches and deserts. [13] defined soil as a mineral which protect the environment, buffer to strong tidal waves and storms, habitat for crustacean species and marine organisms. This research seek to study the suitability of sandy soil in the studied location for sandcrete block productions for use as a raw material for block producer within this metropolis.

II. JUSTIFICATION

Sand has been used as a building material for decades globally across various continent of the world. As the population of the world continue to grow, so does the need for infrastructures. However, most of this infrastructural has been facing a lot of challenges which includes cracking, collapse etc in which the cause may have arises

from the type of sand material used for execution of the project. Sandy soil that will used be for construction must conform to specification. Organic impurities can affect the sand containing silica which may react with the akali in the cement causing the concrete to disintegrate. Rapid urbanization is a major cause for sand demand and is responsible for unsustainable extraction of sand from many illegal inland sand mining pits found in many part of Ado-Ekiti. The interaction between sand mining operations, citizen neighbours and government becomes more confrontational as a result of more sand excavation sites located in Ado-Ekiti. Conflict have centred on environmental and social issues such as noise, truck traffic, dust stream water quality, reclamation, biodegradation, pollution and visually unpleasant landscapes [6], and the citizens concern on the adequacy of regulating effort of the government to control these negative effects. Mining of sand occurs both on small and large-scale in major parts of the country. With an estimated 16 million housing Deficit [5][9] and infrastructural development in Nigeria, there will continue to be great demand for sand and other construction materials [8]. Ado-Ekiti has experienced rapid population growth and physical expansion especially since the mild 1980s due to the influx of people from different part of Ado - Ekiti. The study came up to identify the best location for the producer of sandcrete block within the metropolis.

III. Study Location

Ado-Ekiti an ancient city in Nigeria is located between latitude 7^0 034' and $7^0$041' North of the equator and longitude $5^0$011' and $5^0$016' east of the Greenwich meridian. Geologically, Ado Ekiti lies entirely within the Cambrian basement complex rock group, which underlies much of Nigeria. It falls within koppen's 'a' climatic belt that is tropical wet climate. It has a population of 313,650 according to 2006 population estimation. An area of 293km2, Density of 1,070.6inh/km2.The inhabitant are Ekiti-Yoruba sub ethnic group.

IV. Material and Method

Sand used as fine aggregate was obtained from the following Five location within Ado-Ekiti province. Ado-Afao, Ado-Ijan, Ado-Ikere, Ado-Ilawe, Ado-Iworoko Ekiti. Sufficient quantity was collected and heaped in the laboratory. Materials like pebbles, cobbles and other unwanted objects were removed from the pile by picking and sieving in wire mesh size 4.75mm after sun drying the sand to remove the any moisture. The cement was ordinary Portland cement produced by Dangote Cement Company Nigeria purchased from retail outlet in Ado-Ekiti, while tap water was used in mixing. Various physical tests were conducted on the materials for their characterization and assessment which conforms to BS 12.

V. Specimen Preparation and Testing

Nominal mixes of 1:6 (cement: sand) ratios by volume was used. The volume batching was so adopted as it is common practice in most construction sites in Nigeria. A water cement ratio of 0.5 was used for the mixtures.

Hand mixing was used and it involved the measurement of the sand and cement which were thoroughly Mixed on an impermeable hard surface, using shovel and trowel, until a uniform color was achieved.

Followed by a measured quantity of water based on water cement ratio of 0.50. The mix was thoroughly done until it appeared uniform in color and consistent. Before casting of specimens, they were then cast in a cube mold (100mm), covered with polythene bags and left for 24hours. The specimens were removed from the molds and cured by sprinkling water on the sample until their testing ages at 14, days accordance to[14]. The compressive strength test was done using CONTROL CR2-030 Testing Machine of capacity 2000 KN and prior to the test, the specimens were weighed on a balance. Three specimens were used to compute the mean value in each of the testing age from the mixture.12 cubes were cast, for the investigation of the density, compressive strength, impact, abrasion, water absorption properties of the sandcrete blocks.

VI. Experimental Procedure

(i) Sieve Analysis: of the sand samples were carried out in accordance with [1] procedure.

500 grams of oven-dried sample of soil was accurately weighted. This was soaked and washed through the 0.075mm sieve. The residue was dried in the oven for 18 hours. At the end of this period, the soil was poured into a set of sieves arranged in descending order and the arrangement placed on the Endecotts Sieve shaker serial number 8488. The shaker was agitated for 10 minutes. The soil retained on each sieve was weighted and the weight recorded against the sieve size. The percentage retained and passing each of the sieves was calculated. The percentage passing each sieve is then plotted against the particle size

(ii) Specific gravity: Is the ratio of the density of the solid to the density of the reference substance

Mass of bottle only as (m1g) was determined as the initial weight using weighing balance. The sample was poured inside the bottle in a quater and the weight taken as (m2g). Distilled water was then added to the sample inside and stirred. The sample inside the bottle was filled with water, the body of the density bottle was clean to remove any water and weighed as (m3g). Thesample inside the bottle was then poured away,rinsed and then refilled with water and then weighed to determine (m4g). The specific gravity is then calculated as

$$Gs = \frac{M_2 - M_1}{(M_4 - M_1) - (M_3 - M_2)}$$

(iii) Compressive strength (CS): This test was performed to investigate the performance of the blocks after the normal curing age.This is the maximum load per cross sectional area of the material. This was done using CONTROL CR2-030 Hydraulic compression machine. Failure load divided by the area in (N/mm^2)

(iv) Silt Test: Fill 1% solution of common salt and water in the measuring cylinder up to 100ml mark.Now add sand to be tested to this solution till the level of the salt solution shows 150ml mark.Shake the mixture of sand and salt solution well and keep it undisturbed for about 1hr. The silt being of finer particles than sand, will settle above the sand in a form of layer. Measure the thickness of this silt layer.

Where, Volume of sample, V_1 (ml), Volume of silt after 1hr, V_2 (ml). Percentage of silt by volume = (V_2/V_1)x 100

(v) Water absorption (WA)

The water absorption property of a specimen determines the extent to which the test piece is susceptible to seepage of water through its pores when immersed in water. This test focused on the change in weight of the specimen that this provided a useful measure of the durability of bricks building materials.All the samples at the end of soaking in water and before soaking were weighed; the weights were noted (W2) and (W1) respectively. Specimen were then immersed totally in water at normal temperature for 24 hours.[3]

$$W = \frac{\text{mass after soaking} - \text{mass before soaking}}{\text{Mass after soaking}} \times 100$$

(vi) Abrasion Test: two separately weighed samples of the sandcrete blocks was brushed using iron file. The same effort and number of motion was used on each sample, then the final weight of each sample was taken AB=W2-W1/W1*100.Where w1 is the Initial weight and W2= weight of sample after brushing

(vii) Impact test: the initial weight of the sandcrete block sample was taken and then allowed to fall from a height of 2m. After the fall, the final weight of the specimen was recorded. The test was repeated two time

VII. Results and Analysis

Sieve Analysis Test: from table 1,the grading test shows that the material from all the location are well graded material.

Specific Gravity Test: from table1 above. The specific gravity of five location varied between 2.17 and 2.76 which fell within the range of 2.55 and 4.6 which was recommended for lateritic soils and also suitable for masonry units.

Silt Test: from table 1, the results varied between 5% to 8%. The result show that only soil sanple from Afao and Ijan were within the specified range while other sample fell out of the specified limit

Compressive Strength Test: from table 1 and figure 1, the compressive strength of materials sampled from five different location within the metropolis varied between 0.5 to 2.05 and 1.0 to 2.40 and 1.3 to 2.7N/mm2 for 3days, 7days and 14days respectively for all the locations according to [14] for non-load bearing walls. The strength analysis reveal that as the age of the blocks increases the more the strength gain by all samples from each location. However, it is noteworthy that, Ado-Afao soil sample and Ijan and Iworoko met up with [14] specification for non-load bearing wall while locations soil fail to meet up with the required strength specified.

Abrasion Test: from table 1, the results varied between 1.73% to 2.56%. The result show that only soil sample from Afao and Iworokoi were showing faily low value indicating a good resistance strength of the material the while other sample tend toward higher value indicating a poor resistance of the material to abrasion.

Impact Test: from table 1, the results varied between 9.57% to 18.7%. The result show that only soil sample from Afao was showing a fairly low value indicating a good resistance strength of the material to breaking during construction work while other samples tend toward higher value indicating a poor resistance of the material to sudden fall a distance during construction at site.

Absorption Test: from table 1, the results varied between 10.4% to 13.9%. The result show that only soil sample from Afao that was showing a satisfactory value indicating a good resistance strength of the material to water while other sample tend toward higher value indicating a poor resistance of the material to water absorption according [7] method of Testing Sandcrete Blocks which specify 12% minimum.

Density: from table 1, the results varied between $1640kg/m^3$ to $1950kg/m^3$ The result show that only soil sample from Afao, Ijan and Iworoko locations were showing a satisfactory value indicating a good strength of the material while other samples tend toward lower value indicating a poor strength of the material. According to [11] specification which specify 1800kg/m Minimum.

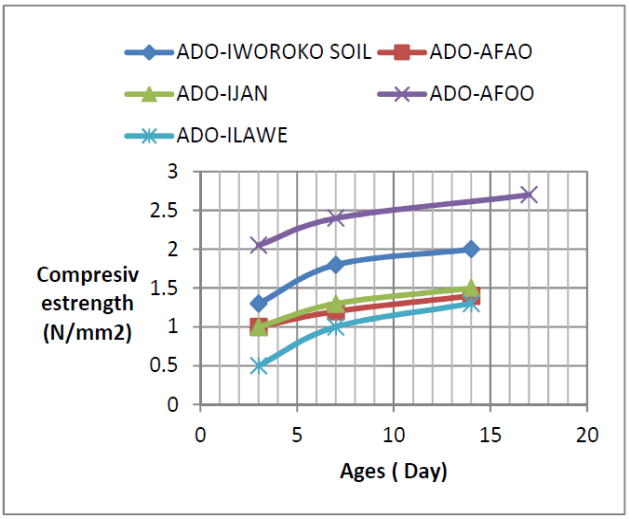

Fig.1. Showing the graph of compressive strength against Age of curing of sandcrete blocks of all the location within the metropolis

Table 1: Showing the summary of laboratory work.

Sand deposit location	Silt test performed on samples %	Sieve analysis %passing (mm)			Compressive strength of sandcrete block (N/mm^2)			Density Kg/m3	Impact%	Abrasion%	Absorption test%	Specific gravity of samples
		2.0	0.6	0.075	3	7	14	@14days	@14days	@14days	@ 14days	
Ado-Iworoko	6.7	88.2	75.4	6.4	1.3	1.8	2.0	1820	10.3	1.75	11.5	2.76
Ado-ikere	6.5	90.6	82.5	5.9	1.0	1.2	1.4	1650	12.27	1.99	13.2	2.60
Ado-ijan	5.3	90.6	79.8	7.1	1.0	1.3	1.5	1800	13.24	2.34	12.9	2.38
Ado-afao	5	89.1	77.5	6.6	2.05	2.40	2.7	1950	9.57	1.73	10.4	2.17
Ado –Ilawe	8	83.3	74.6	5.2	0.5	1.0	1.3	1640	18.7	2.56	13.9	2.17

VIII. CONCLUSION

This research is providing information on the quality of sandy soil material deposited within this metropolis for commercial value, good quality construction of sand Crete block and easy location of deposit site for the buyers in this locatio Based on the test carried out the result obtained shows that Ado-Afao sand deposit has the highest strength compared to other location within the metropolis. However, Ado-Ijan and Ado- Iworoko sand deposit also fell within the standard specified for non load bearing wall. It was concluded that those sand deposit site that were found suitable will create more supply capacity, increase economic return to the land owners in these community and guide the producer of sandcrete block on the choice of quality material available within this Locality.

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REFERENCES

[1] BS 1377(1990),Method of test for civil Engineering purposes
[2] Draggen S,(2008) : Encyclopedia of Earth. Sand and gravel. Washington DC
[3] Ekpunobi, UE(2009). Phytochemical analysis andutilization of Niga palm of the Niger delta region of Nigeria for production of commercial sugar and other Products, a PhD dissertation presentation to pure and industrial chemistry department. Faculty of Natural Science Nnamdi Azikiwe University, Awka. 2009; 21–27,52–54,77–93.
[4] Erskine, W.D. and Green, D. (2000). Geomorphic effects of extractive industries and their implications for river management: the case of the Hawkesbury–Nepean River, New South Wales. In Brizga, S. & Finlayson. B. (Eds.), River Management: The Australian Experience (pp 123–149). Chichester, UK: Wiley.
[5] Ezekiel, E. (2010). Nigeria needs N45 trillion to tackle housing deficit-FMBN. Nigerian Business Forum, 18 Nov.
[6] Garrod and Willis (1999), Economic Valuation of the Environment: Methods and Case StudiesEnvironmental and Resource EconomicsVolume 21, Issue 1 , pp 101-102
[7] GEAS (2014), Unep Global Environmental Service.
[8] Gob, F., Houbrechts, G., Hiver, J.M. and Petit, F. (2005). River dredging, channel dynamics and bedload transport in an incised meandering channel (The River Semois Belgium), River Research and Applications, 21, 791–804.
[9] Isah, R. (2011). Nigeria: Making housing fund contribution national agenda. [Online] Available at: http://allafrica.com/ stories/201106240782.h tml(JULY 18, 2015).
[10] Mwangi S 2007: Management of River Systems in East Africa. Nairobi: Macmillan. National Policy on National Resources Conservation and Development. Government Paper Number 1 of 1990: Gaborone: Government Printers
[11 NIS 87, Standard for Sandcrete Blocks, Nigerian Industrial Standard Approved by Standard Organization of Nigeria(SON), 2004.
[12] Omole, D and Ajakaiye, O. (1998). Environmental Externalities and Sustainable Urban development: who bears environmental costs, In: Adeniji, K. and Ogu, V.I. (Eds), Sustainable physical development in Nigeria, Ibadan: Nigerian Institute of Social and Economic Research, 115-132?
[13] Saviour NM 2012: Environmental impacts of Soil and Sand Mining: A Review. International Journal of Science, Environment and Technology. 1, 3, 125-134.
[14] SON (2007), Specification for Sandcrete Block Part 1(Non-Load Bearing)
[15] Stebbins M (2006): Can Gravel Mining and Water Supply Wells coexist. University of Maine. United Nations Conference on Environment and Development Report
[16] UNEP and CSIRO, 2011. Resource Efficiency: Economics and outlook for Asia and the Pacific. United Nations Environment Programme

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