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Analyses of some Geotechnical Indices of the Federal Polytechnic, Ado-Ekiti Lateritic Soil used for Bricks

Bamidele I. Faluyi[1], Adeyemi E. Adetoro[2]
[1]Department of Computer Science, [2]Department of Civil Engineering
The Federal Polytechnic, Ado – Ekiti, Nigeria, West Africa

ABSTRACT
The need to overcome housing problems for the populace in a Third world country like Nigeria through the use of cheap and available construction materials is the ulterior motive of this study. It sought to analyze some geotechnical indices of the lateritic soils to be used for the production of the alternative material (e.b. Bricks). Soil samples were taken from three locations within the study area to laboratory for Atterberg Limits and Particle Size Distribution tests. Results showed that the Liquid Limit (LL), Plasticity Index (PI) and Plastic Limit (PL) values varied from 37.80 to 46.00%, 15.00 to 20.30% and 17.50 to 28.00% respectively for all the soil samples. Their clay, sand and gravel also ranged from 36.4 to 56%, 33.2 – 51.6% and 5.6 – 10.4% respectively. The soil samples were generally as silt – clay and grouply classified A - 6 / A – 7 materials with mainly clayey constituent materials. All the soil samples would be good for brick making due to large quantities of clay and sand with very little gravel. There is need for further study on other geotechnical indices of those soils in order to further ascertain their suitability.

Keywords: *Atterberg Limits; Brick; Geotechnical Indices; Particle Size Distribution; Sub grade.*

I. INTRODUCTION

There is rapid population growth in the urban areas. This situation has led to high demand of residential buildings. The problematic housing situation in Nigeria- alike in many developing countries has been attributed to the rapid urban growth and the non-performance of the construction industry in the housing sector to meet the demand for housing.

The major factors that contribute to the housing problems are the inadequate application of technologies and depletion of natural resources. Only very wealthy Nigerians and the international community in Nigeria can afford to buy houses in the urban core. Consequently, the urge to find alternative materials to existing conventional ones and the need to reduce the cost of building construction has compelled researchers to intensify works on laterite bricks with a view to investigate its usefulness wholly both as a construction material and partly as a substitute for fine aggregate component of sandcrete blocks. It is therefore important to fully explore and utilize all available local building materials as well as possible production of materials for construction from our industrial and agricultural wastes [3].

Walling materials constitute an essential element in building construction. It is estimated that materials for wall usually cover about 22% of the total cost of a building. The choice of walling material is a function of cost, availability of material, durability, aesthetics and climatic condition. The quality of bricks is a function of the method employed in the production and the properties of the constituent materials [2].

Lateritic brick is one of the alternative products that Nigerian Building and Road Research Institute (NBRRI) introduced into the construction industry due to the fact that laterite is readily available in Nigeria and that it requires little quantity of cement so it is cost effective. Laterite is generally found in the tropical and sub-tropical countries. Laterite has been found useful as sub-base or base materials in road construction. Nowadays, improved technology is encouraging people to use lateritic interlocking blocks as an alternative for sandcrete blocks in building houses because they do not require cement mortar in bonding the blocks during construction, thereby

further reducing the building cost . Most tropical laterite soils are composed predominantly of kaolinite clay mineral with some quartz. In some cases, they contain swelling clay mineral types e.g. vermiculite, hydrated halloysite, and montmorillorite ([7], [8], [9]).

Thus, it is necessary to examine laterite as an alternative construction material. Engineering properties and performance of the materials, possibilities of introducing the use of our local material such as laterite which will assist in construction of low-cost housing, yet more durable in order to specify it for appropriate application. Research is required to test the performance of laterite bricks as a walling unit [1].

Past research works of [1], [3], [10] and [11] among others showed that one of the better ways to affirm lateritic bricks as alternative material for house construction is through proper analyses of geotechnical indices of the lateritic soil used.

This study intends to assess some geotechnical indices of lateritic soil used bricks within the Federal Polytechnic, Ado-ekiti. The tests carried out were Atterberg Limits and Particle Size Distribution. These would help in classification and analyses of mechanical properties of the lateritic soil.

A. Study Area

The study area is within the Federal Polytechnic, Ado Ekiti along Ado – Ijan Ekiti road, Ado – Ekiti Local Government Areas (LGA), Ekiti State, and South western part of Nigeria. It is around Latitude 7.6056° N and Longitude 5.2886° E as shown in Fig. 1. *The geology of Ekiti State where the study area is situated consists of old plains broken by steep sided outcropping dome rocks and underlain by metamorphic rocks of the Precambrian basement complex of Southwestern Nigeria, which are very old. These showed serious changes in grain size and mineral composition. The rocks are quartz gneisses and schists consisting mainly quartz with small amounts of white mizageous minerals. They vary from very coarse-grained pegmatite to medium-grained gneisses in grain size and structure. They are strongly foliated and occur as outcrops. The soils derived from the basement complex rocks are mostly well drained, having medium to coarse in texture* ([6], [10]).

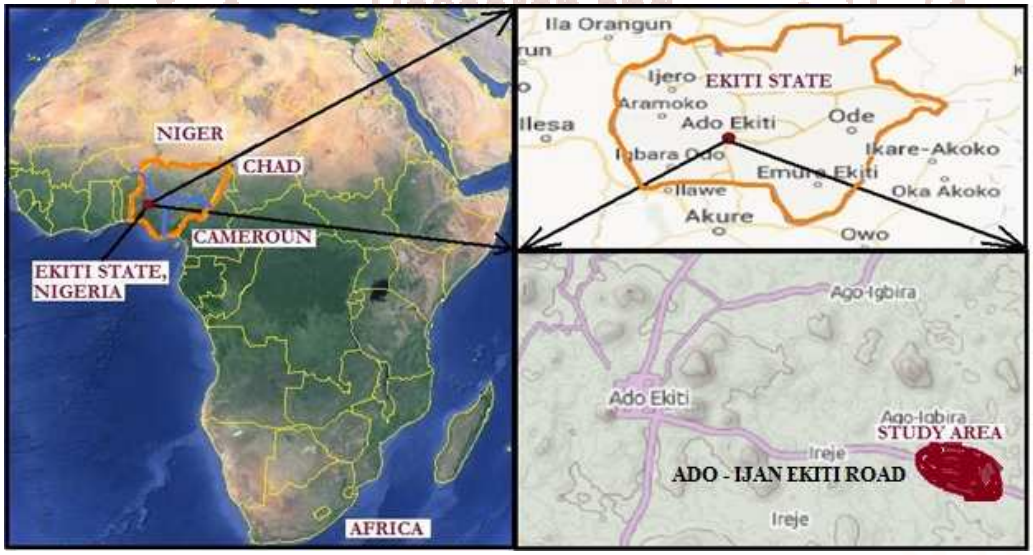

Figure 1: Location of the study area

B. Atterberg Limits Tests

These tests comprise of Liquid Limits (LL), Plastic Limit (PL) and Shrinkage Limit tests. Plasticity Index can be determined from the limits using the formula PI = LL – PL. Another name for this set of tests is *Consistency Limits Tests*. The tests usually showed spontaneous reactions of soil samples with water, which are used for soils' classification and analyses of mechanical properties of road fill materials. The results were graded / classified in accordance with [4] and other standards [10].

C. Particle Size Distribution Test

This test is used for analyses of soil particles distribution. Soil particles were grouped into sizes and

relative proportion by weight (i.e. clay, sand and gravel fraction). It is usually used for road fill material. The results are usually classified with reference to [4] and other classification methods [10].

II. Materials and Methods

Lateritic soil samples were obtained by using cutlass (for clearing access path to the sample locations), digger (for digging the earth surface) and shovel was used to excavate the loose soil to the required depth (> 0.80m). Then polythene sample bags were used to collect the lateritic soil samples to retain the original qualities of the soil at random from three locations within the study area. The samples were then taken to the laboratory where the deleterious materials such as roots were removed. The details of the soil samples were as shown in Table 1. Moulding of test specimens was started as soon as possible after completion of identification. Their attributes were also examined. All tests were performed to standards in accordance with [5]. The results were then compared with the standard specified values and grouped in accordance with [4].

TABLE 1: THE DETAILS OF THE SOIL SAMPLES

SAMPLE CODE	LOCATION	DESCRIPTION
A	1	School Gate
B	2	Rector's Village
C	3	Abuja Hostel

III. Results and Discussion

Table 2 and Figure 2 showed Particle size analysis test results for the soil samples obtained from the locations in the study area. It is observed that all the soil samples have large quantities of clay or silt (i.e. > 14%). Sample A (47.6%) has required sand (i.e. 43 < A < 51%), while samples B (51.6%) and C (33.2%) have more and less than required sand (i.e. B > 51% and C < 43%). None of the soil samples has the required quantities of gravel (i.e. 32 to 37%). These were supported by the plots in Figure 2, which showed that all the soil samples graphs were outside the upper and lower limits of the particle size distribution. These results portrays that there are large quantities of clay, fine and coarse sands in the samples, which make the soils good enough for brick making purpose.

TABLE 2: PARTICLE SIZE ANALYSIS TEST RESULTS FOR THE SOIL SAMPLES

SIEVE	% PASSING			LIMITS		SOIL CLASSN.			SOIL TYPE
No. (mm)	A	B	C	LOWER	UPPER	A	B	C	
12.5	100	100	100	100	100				
9.5	92.8	99.6	99.6	87	97	8.8	5.6	10.4	GRAVEL
4.75	88.4	97.6	96.8	65	82				
2.36	84	94	89.2	50	65				
1.18	78	85.6	78.8	36	51				
0.6	67.6	75.6	69.2	26	40	47.6	51.6	33.2	SAND
0.3	52	64	62	18	30				
0.15	40.8	48.8	57.6	13	24				
0.075	36.4	42.4	56	7	14	36.4	42.4	56	CLAY

Generally, the quantities of clay present in the soils were in order of C > B > A. The quantities of sand present in the soils follow the order of B > A > C. While C > A > B were in order for the gravel quantities of the soils. All the soil samples have percentages passing 0.075mm fractions greater than 35% (i.e. > 35%).

Thus according to [4], all the soil samples could be generally classified as silt – clay materials. Moreover, could be grouply classified to be within the ranges A-4 to A-7.

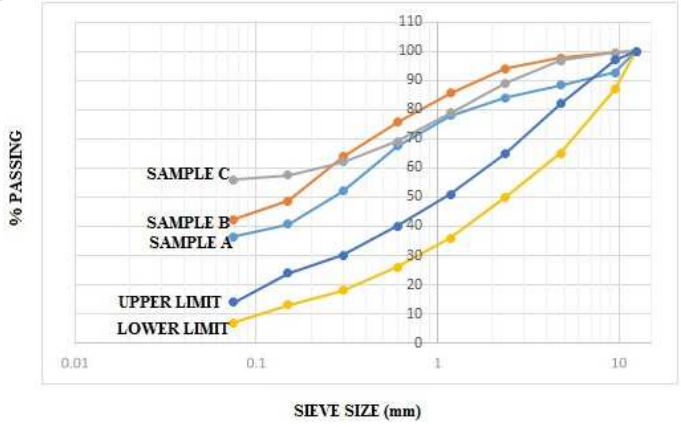

Figure 2: Particle Size Graphs for the soil samples and limits

TABLE 3: ATTERBERG LIMIT TESTS RESULTS FOR THE SOIL SAMPLES

ATTERBERG LIMITS	SAMPLES CODE		
	A	B	C
LIQUID LIMIT (%)	46.00	37.80	43.00
PLASTIC LIMIT (%)	28.00	17.50	28.00
PLASTICITY INDEX (%)	18.00	20.30	15.00

From Table 3, it is generally observed that the Liquid Limit (LL), Plasticity Index (PI) and Plastic Limit (PL) values varied from 37.80 to 46.00%, 15.00 to 20.30% and 17.50 to 28.00% respectively for all the soil samples. The Liquid Limit (LL) values for the soil samples A and C were greater than 40%, while that of sample B was less than 40%. While all the soil samples have the Plasticity Indices (PI) values greater than 11%. Hence, according to [4], soil samples A and C could be grouply classified as A – 7 soil. Thus, they have significant constituent materials of clayey soils with sub grade general rating of fair to poor. While soil sample B can be grouply classified as A – 6 soil. It also has significant constituent materials of clayey soils with sub grade general rating of fair to poor.

IV. Conclusion

The analyses of some geotechnical indices of lateritic soils used for production of bricks within the Federal Polytechnic, Ado-ekiti have shown that all the soil samples were generally classified as Silty or Clay materials with mainly clayey constituent materials. They were grouply classified as A – 6 and A – 7 soils. And generally rated as fair to poor sub grade materials. All the soil samples would be good for brick making due to large quantities of clay and sand with very little gravel. There is need for further study on other geotechnical indices of those soils in order to further ascertain their suitability.

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