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Chemical Stabilization of Selected Laterite Soils Using Lateralite for Highway Pavement

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ABSTRACT

In this study, lateralite a chemical stabilizer locally produced in Nigeria was used to stabilize three selected laterite soil samples purposely to improve and proffer sustainable subgrade, subbase and basecourse materials for highway pavement based upon recommended practice of AASHTO classification system. Laboratory determination of basic soil properties along with liquid limit, plasticity index and particle-size distribution was employed. The liquid limit of the soil materials are 27, 38 and 36 while the values of their respective plasticity index are 9, 18 and 12. Wet sieve analysis was also employed on each of the three soil samples of which the first two soils are of granular materials with group classification of A-2-4(0) and A-2-6(1) by which the first soil type being silty gravel with sand material whilst the second is clayey gravel with sand material. The third soil sample is clayey soil material with group classification of A-6(3). Lateralite at varying percent of 6%, 8%, 10%, 12% and 14% were individually mixed with laterite soil samples in the laboratory. The reason is to allow increasing the strength and decreasing permeability qualities of the soil samples from natural state through laboratory tests. Also, to determine the values of optimum moisture content (OMC), maximum dry density (MDD), California Bearing Ratio (CBR), unconfined compression strength (UCS) and coefficient of permeability K. Values obtained at 14% lateralite addition to each of the three laterite soil samples respectively resulted to OMC of 17.8%, 17.30% and 20.4%; MDD of 1.644 Mg/m³, 1.672 Mg/m³ and 1.710 Mg/m³; unsoaked CBR of 110.75%, 110.75% and 125.25%; soaked CBR of 143.94%, 126.75% and 212%; uncured shear strength of 99.010 kN/m², 79.210 kN/m² and 185.644 kN/m²; cured shear strength of 155.631 kN/m², 140.811 kN/m²and 396.040 kN/m² and K values are 10^{-5}, 10^{-5} and 10^{-7}. Concerning strength and permeability of the soil samples qualities, it is significant in this study that A-6(3) natural clayey soil sample rated poor for highway material has been improved and better than silty or clayey gravel with sand soil that is rated good after lateralite the stabilizer has been employed similarly on the three laterite soils.

Keywords: *Locally, Nigeria, Strength, Permeability, Improved, Quality*

1. INTRODUCTION

Considering Nigeria roads, the subgrade that form the highway foundation, subbase and basecourse that are part of road pavement materials are majorly laterite that is not always good for the purpose intended (Akiije, 2014). Also in most locations, materials of high strength with good bearing capacity and of high durability are not readily available for highway pavement subbase or basecourse for the purpose of highway pavement design and construction. It is pertinent at this juncture to resort to the stabilization of the available laterite soils at adjacent or not far distance locations. Mustapha et al., (2014) reported on laterite as a soil group that is commonly found in the leached soils of the humid tropics and is formed under weathering systems that cause the process of laterization. Also, Achampong et al., (2013) reported that laterite is a soil formed by the concentration of hydrated oxides of iron and aluminium with the ratio of silica SiO_2 and sesquioxides $Fe_2O_3 + Al_2O_3$ less than 1.33 whilst between 1.33 and 2.0 are indicative of laterite soils, and those greater than 2.0 are indicative of non-lateritic soils. Osinubi and Eberemu (2006) worked on the effect of bagasse ash on the strength of stabilized lateritic soil in order to probe more into the potentials of laterite soils as a reliable and durable construction material for being readily available in Nigeria. They concluded that although clay impairs the strength of laterite-cement mortars but there are mix proportions of same having strength comparable to that of standard sand-cement mortars

Chemical and mechanical processes or combination of the two are due stabilization methodologies of soils that form subgrade, subbase and basecourse in the design and construction of highway pavements as claimed by Salahudeen and Akiije (2014), Akiije (2014), Mustapha et al., (2014) and Achampong et al, (2013). Reasons for the stabilization of the materials that formed the subgrade, subbase and basecourse for highway pavement include improvement of the soils in order to increase the strength, durability, load bearing capacity and to reduce the swelling and the coefficient of permeability. Whenever basecourse materials are not duly provided base upon AASHTO specifications and where unstabilized laterite materials are used it could lead to highway pavement surface premature failures due to excessive swelling, loss of strength and deformations. These deformations could be in form of corrugations, wavy, shoving, grooves, rutting different types of cracks, small or large deep crack arrangements.

The aim of this study is the stabilization of three different types of laterite soils using lateralite. Lateralite is a chemical stabilizer locally produced in Nigeria and it is a mineral compound selected in definite proportions and pulverized to the fineness of cement to induce a pozzolanic effect on sesquioxides-rich lateritic soils in general according to Meshida et al., (2011). The objective of this study includes:

1. To determine and compare the index properties of three selected laterite soils including physical, classification, strength and permeability.
2. To determine and compare the chemical, mineralogical and physico-chemical composition of lateralite a stabilizer and the three different types of laterite soil samples for pavement design and construction.
3. To determine and compare the strength and permeability qualities of the three different types of laterite soil samples when stabilized with lateralite at 6%, 8%, 10%, 12% and 14% percentages.

The scope of work in this study includes using AASHTO specification standards for the laboratory determination of liquid limit, plasticity index, particle-size distribution, optimum moisture content (OMC), maximum dry density (MDD), California Bearing Ratio (CBR), unconfined compression strength (UCS) and coefficient of permeability k. This study is limited to sourcing laterite soil sample materials from three different burrow pits in Ogun State of Nigeria. Significantly, this study is to establish the effectiveness of lateralite when used as a stabilizer for different types of laterite soil materials in design and construction of highway pavement.

2. MATERIALS AND METHODOLOGY

The values of Relative Density, Moisture Content, Bulk Density, Dry Density, Void Ratio, Degree of Saturation and Porosity were determined in the laboratory in accordance with the related test procedures as outlined in AASHTO T 100 (2010) to define mass-volume relations of the three soil samples. The values were determined based upon soil model being considered as three-phase systems that consist of air, water and solids.

According to Garber and Hoel (2010) a soil mass W of total volume V has three phases of air, water, and solids respectively as $W_a\ W_w\ and\ W_s$ along with $V_a\ V_w\ and\ V_s$. The volume V_v is the total volume of the space occupied by air and water, generally referred to as a void.

Wet sieve analysis was employed in accordance with the standard method AASHTO T 88 (2013). In the process, each 200 g oven dried broken laterite soil passing through 9.5 mm sieve size was washed with water over sieve designated No. 200 whilst combined silt and clay passed through. The materials remaining on sieve No. 200 was later oven dried at (100°C±5°C) for 24 hours and later at laboratory temperature subjected to nest of sieves 4.75, 2.00, 1.18, 0.6, 0.425, 0.212, 0.15 and 0.075 with shaking for 5 minutes. Mass retained on each sieve was measured and cumulative percentages passing were determined.

The determination of liquid limit of the three soils was carried on the natural in the laboratory by following the standard method of AASHTO T 89 (2013). Apparatus used included Casagrande's device, 0.425mm sieve, distilled water, mortar, pestle, grooving tool, balance, spatula , pans, glass plate and wash bowl. The liquid limit for each material of the three lateritic soils was determined as the moisture content at which soil flew together at the 25 drops by the closure groove of 12.7 mm using the Casagrande's liquid device. Determination of the plastic limit and the plasticity index of each of the three soil samples in the laboratory were done by the standard method of AASHTO T 90 (2008). Plastic limit for each soil sample was determined as the amount of moisture content at which the soil material crumbled when rolled into a thread of 3.18 mm diameter. The value plasticity index for each soil sample was determined by knowing the difference between the liquid limit and the plastic limit.

The Unconfined Compressive Strength and Shear Strength were determined in the laboratory in accordance with the related test procedures as outlined in AASHTO T 208 (2010) for each of the three laterite soil sample materials. During the test each of three soil samples in natural state was formed in a thin-walled tube and later trimmed to about 80 mm in length and the diameter measured. Each sample was placed in the compression machine and the loading head was lowered to the surface of the sample followed by setting the load and strain gauges at zero before starting the compression strength measurement. The strain and load dials at the indicated times were duly read and recorded as the machine was in operation until the specimen failed. Lateralite at varying percentages of 6%, 8%, 10%, 12% and 14% were individually mixed with laterite soil samples in the laboratory to follow similar steps as carried out on the natural soil.

Compaction tests were performed in the laboratory on the three laterite soil sample materials at natural state while following the standard Proctor test AASHTO T 99 (2010). Subsequently, lateralite at varying percentages of 6%, 8%, 10%, 12% and 14% were individually mixed with laterite soil samples in the laboratory to follow similar steps as carried out on the natural soil. The method used involved using a mould with 102 mm diameter which has a volume of 944 cm^3, a hammer weighing 2.5 kg having a striking face of 51 mm in diameter and a 3000 kg of the lateritic dry soil sample that passes No.4 (4.75 mm) sieve. The stabilized laterite soil-cement mixture sample was mixed with water and placed in three layers of about equal thickness and each layer is subjected to 25 blows from the hammer by falling freely through a distance of 305 mm in the mould. The compacted sample with the mould was measured and after which part of it was taken about the centre to oven dry for the purpose of determining the water content. Repeated operation continued by addition of more water in sequence of increment of 2% until the density decreases.

The California Bearing Ratio tests were performed in the laboratory on the three laterite soil sample materials at natural state while applying AASHTO T 193 (2000) methodology after the standard Proctor test. Successively, lateralite at varying percentages of 66%, 8%, 10%, 12% and 14% were individually mixed with laterite soil samples in the laboratory to follow similar steps as carried out on the natural soil. At optimum moisture content, each stabilized laterite soil-lateralite mixture sample was compacted in a mould of 152 mm diameter and 127 mm high and was put in water for four days with surcharge weight in place. Removing the sample from the water it was allowed to drain for a period of 15 min. The same surcharge was imposed on the sample and immediately subjected to penetration by forcing a 19.4 cm^2 plunger at the rate of 1.25 mm/min into the sample to a depth of 2.5 mm. The total loads corresponding to penetrations of 2.5, 5.0, 7.5, 10, and 12.5 cm were recorded.

The permeability of a soil is the property that describes how water flows through the soil according to Garber and Hoel (2010). It is usually given in terms of the coefficient of permeability (k), which is the constant of proportionality of the relationship between the flow velocity and the hydraulic gradient between two points in the soil. The falling head permeability test was used to examine in the laboratory three separate burrow pits with different types of laterites in accordance with the procedures as outlined in ASTM D7664 (2010). Using the standard procedures for falling head permeability test, lateralite at varying percentages of 0, 6, 8, 10, 12 and 14 were individually mixed with laterite soil samples in the laboratory.

3. RESULTS ANALYSIS AND DISCUSSION

Table 1 is showing the index properties results of the three selected natural laterite soil samples investigated in this study. The table shows that the three selected laterite soils are different in nature as being classified by AASHTO system as A-2-4(0), A-2-6(1) and A-6(3). The AASHTO classification system for the soil grouping was based upon the values obtained from the laboratory determination of liquid limit, plastic limit, plasticity index and wet sieve analysis percent passing No. 200 (0.075 mm). Soil A-2-4(0) has higher values of dry density, void ratio and porosity than soils A-2-6(1) and A-6(3). The group index value 0 for the soil A-2-4(0) is an indication that it has a better strength than the soil A-2-6(1) that has group index value 1 although the two soils are in the same soil group classification of symbol A-2. Soil A-2-4(0) and A-2-6(1) are both granular materials with the former being silty gravel with sand and the later soil is clayey gravel with sand whilst are of good rating for subgrade only. Soil A-6(3) is clayey soil having poor rating for subgrade.

Figure 1 shows that samples A-2-4(0), A-2-6(1) and A-6(3) are well graded laterite soils. Also, the value of grains of soil A-6(3)percent passing 0.075 mm sieve is higher than those of soils A-2-4(0), A-2-6(1).

Natural laterite soil strength and permeability tests results of the three samples on Table 3 are showing that the values of optimum moisture content, maximum dry density, unsoaked California bearing ratio, uncured, and cured shear strength of soil A-6(3) are at higher values than those of same of A-2-4(0), A-2-6(1) soils. However, the values of California bearing ratio and the coefficient of permeability of soil A-6(3) are lower than those of soils A-2-4(0) and A-2-6(1).

In Table 4, it obvious that the major mineral Components of lateralite are SiO_2, CaO, MnO, Al and Cl. Whereas, the major mineral components of the three selected laterite soils are SiO_2, Al_2O_3, CaO, Al and Cl. It is pertinent to note that Cd, Ni and Pb are not detected (ND) in lateralite and the three selected laterite soils. Nevertheless, SO_2^{2-} is present in lateralite, soils A-2-4(0) and A-2-6(1) but not detected in soil A-6(3).

In Table 4 are the strength and the permeability result values of the A-2-4(0), A-2-6(1) and A-6(3) laterite soils stabilized with lateralite at the optimum of 14% of admixture stabilization. The results of optimum moisture content, the maximum dry density, unsoaked California bearing ratio, cured and uncured shear strength at 14% lateralite stabilization of Table 4 are similarly like those of the natural soils of Table 2. Whereas, the value of soaked CBR of soil A-6(3) which is the least is now the highest and value of soil A-2-6(1) which is the highest is now the least. The coefficient of permeability of soil A-6(3) decreased to the best value among the three selected laterite soils from 10^{-6} to 10^{-7} while soils A-2-6(1) and A-6(3) values decreased from 10^{-4} and 10^{-3} respectively to the same value of 10^{-5}.

It is easily seen in Figure 2 that when each of the three selected soil samples was subjected to dynamic compaction by Proctor method they all behaved similarly as the percent value of their lateralite mixture for stabilization increased from 6% through 14%. Here, as the percent value of lateralite mixture is increasing the optimum moisture content is also increasing. In this facet, the optimum moisture content values of soil A-6(3) are higher than those of soil A-2-4(0) with the values of A-2-6(1) being the least. On the other hand as shown in Figure 3, as the percent value of lateralite mixture is increasing from 6% through 14% the maximum dry density is decreasing. The features show that the maximum dry density values of soil A-6(3) are higher than those of soil A-2-4(0) and the values of A-2-6(1) are found to be the least.

Figures 4 and 5 are respectively showing the result curves of the unsoaked and soaked California Bearing Ratio for the three selected laterite soils when stabilized with lateralite of 6% through 14% by mass. In the two figures the curves of CBR values for the three selected stabilized soils were increasing as the percent lateralite stabilizers were varying from 6% through 14%. It obvious from the two figures that as the percent values of the lateralite are increasing the CBR values of both the unsoaked and soaked are also increasing. Also, the features from the two figures show that the CBR values of soil A-6(3)

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are higher than those of soil A-2-4(0) while the values of A-2-6(1) are found to be the least.

In Figures 6 and 7, curves of relationship between UCS with strain for both uncured and cured natural laterite soils are depicted. It is noticeable that the values of UCS with strain at failure are not the same for both uncured and cured natural laterite soils. The values of UCS with corresponding strain for natural laterite soils A-2-4(0), A-2-6(1) and A-6(3) in Figure 6 are 50 KN/m², 47 KN/m² and 80 KN/m² with 1.4, 1.4 and 2 respectively. Whereas, the values of UCS with corresponding strain for stabilized laterite soils A-2-4(0), A-2-6(1) and A-6(3) with lateralite in Figure 7 are at higher values of 198 KN/m², 158 KN/m² and 371 KN/m² with 2.8, 2.8 and 2.8 respectively.

Figures 8 and 9 are showing curves of relationship between UCS and strain for uncured as well as air cured 14% soil-lateralite stabilization respectively. It is obvious in Figure 8 that the value of strain 2.8 at failure are the same for uncured 14% stabilized soil-lateralite samples A-2-4(0), A-2-6(1) and A-6(3) but their corresponding UCS are not the same for being 198 KN/m², 158 KN/m² and 371 KN/m² respectively. In Figure 9 the values of strain at failure for air cured soil samples A-2-4(0), A-2-6(1) are the same as 3 but that of soil sample A-6(3) is 2.8 with corresponding UCS values of 311 KN/m², 282 KN/m² and 792 KN/m² that are not the same.

In Figures 10 and 11, the curves of relationship between shear strength and percent laterite soil-lateralite stabilization from 0% through 10% for uncured as well as air cured samples respectively are portrayed. The values of cohesion of samples A-6(3) at natural and laterite soil-lateralite stabilization are higher than that of A-2-4(0) and the values of the later laterite soil sample are as well higher than that of A-2-6(1). The difference in values of shear strength at 14% of stabilization is very close between sample A-2-4(0) and A-2-6(1) but very wide to A-6(3). This is obvious as the values for uncured and cured samples shear strength respectively are 99 KN/m² and 156 KN/m² for soil A-2-4(0); 79 KN/m² and 141 KN/m² for soil A-2-6(1) whilst 186 KN/m² and 396 KN/m² for soil A-6(3).

The values of coefficient of permeability k, of the A-2-4(0), A-2-6(1) and A-6(3) laterite soils when stabilized with lateralite are in Table 5. At both natural and stabilized states, the value of k of soil A-6(3) is the least with decreased permeability quality than laterite soils A-2-4(0) and A-2-6(1). However, soil sample A-2-4(0) of higher permeability at natural soil state has equal k value to material A-2-6(1) as shown in Table 5 after laterite soil -lateralite stabilization.

Table 1: Index Properties of the selected laterite soils

S/N	Properties	A-2-4(0)	A-2-6(1)	A-6(3)
1	Water Content , %	19.72	23.43	29.10
2	Bulk Density, Mg/m^3	2.041	2.076	1.933
3	Dry Density, Mg/m^3	1.705	1.682	1.632
4	Specific Gravity	2.9	2.9	2.7
5	Void Ratio	0.701	0.694	0.655
6	Porosity n, %	41.21%	40.97%	39.57%
7	Degree of Saturation, %	81.60%	96.21%	76.08%
8	Liquid limit (LL)	27	38	36
9	Plastic limit (PL)	18	20	24
10	Plasticity index (PI)	9	18	12
11	Sieve analysis, percent passing 0.075 mm	29	31	47
12	Group index	0	1	3
13	AASHTO soil classification including group index	A-2-4(0)	A-2-6(1)	A-6(3)

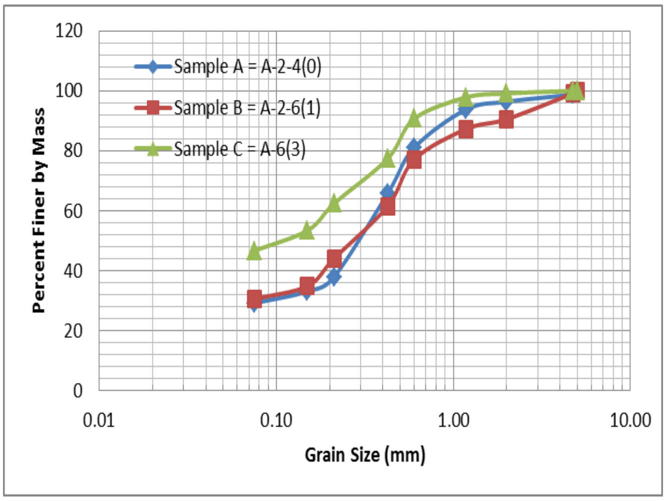

Figure 1: Grain size analysis for the three selected natural laterite soil samples

Table 2: Natural laterite soil strength and permeability tests results

S/N	Natural Laterite Soil	A-2-4(0)	A-2-6(1)	A-6(3)
1	Optimum Moisture Content (OMC) %	12.30	10.50	12.70
2	Maximum Dry Density (MDD), Mg/m^3	1.723	1.788	1.825
3	California Bearing Ratio (CBR) unsoaked, %	32.58	32.58	44.75
4	California Bearing Ratio (CBR) soaked, %	8	9	5.909
5	Uncured Unconfined Compressive Strength, q_u kN/m^2	50.200	47.190	79.840
6	Uncured Shear Strength, τ kN/m^2	25.100	23.595	39.92
7	Cured Unconfined Compression Strength, q_u kN/m^2	94.622	84.661	186.753
8	Cured Shear Strength, τ kN/m^2	47.312	42.331	93.376
9	Coefficient of Permeability, k cm/s	10^{-4}	10^{-3}	10^{-6}

Table 3: Mineral components of lateralite and the three selected laterites

S/N	Mineral Components	Lateralite Stabilizer	Laterite Burrow Pit A-2-4(0)	Laterite Burrow Pit A-2-6(1)	Laterite Burrow Pit A-6(3)
1	SiO_2 (%)	62.26	64.86	61.58	63.10
2	Al_2O_3 (%)	34.06	28.82	33.91	34.02
3	Fe_2O_3 (%)	0.059	0.06	0.051	0.053
4	CaO (%)	1.70	2.01	1.42	1.66
5	MgO (%)	0.682	0.29	0.74	0.571
6	Na_2O (%)	0.062	0.21	0.21	0.051
7	K_2O (%)	0.054	0.65	0.18	0.044
8	MnO (%)	0.008	1.3	0.007	0.05
9	Cd (mg/k)	ND	ND	ND	ND
10	Cu (mg/k)	0.003	0.002	0.002	0.519
11	Mn (mg/k)	0.006	0.006	0.005	0.426
12	Ni (mg/k)	ND	ND	ND	ND
13	Pb (mg/k)	ND	ND	ND	ND
14	Fe (mg/k)	0.041	0.043	0.036	1.676
15	Zn (mg/k)	0.002	0.003	0.003	4.935
16	Al (mg/k)	18.03	16.85	17.95	18.01
17	pH (mg/k)	13.56	12.70	12.70	7.05
18	SO_4^{2-} (mg/k)	340.0	36.0	40.0	ND
19	Cl (mg/k)	140.0	78.0	80.0	148.15

* ND: Not Detected

Table 4: Strength and permeability results of the soil-lateralite stabilization

S/N	14% Lateralite Stabilization	A-2-4(0)	A-2-6(1)	A-6(3)
1	Optimum Moisture Content (OMC) %	17.8	17.3	20.4
2	Maximum Dry Density (MDD), Mg/m^3	1.644	1.672	1.710
3	California Bearing Ratio (CBR) unsoaked, %	110.75	110.75	125.25
4	California Bearing Ratio (CBR) soaked, %	143.94	126.75	212.
5	Uncured Unconfined Compressive Strength, q_u kN/m^2	198.020	158.416	371.287
6	Uncured Shear Strength, τ kN/m^2	99.01	79.210	185.644
7	Cured Unconfined Compression Strength, q_u kN/m^2	311.265	281.621	792.079
8	Cured Shear Strength, τ kN/m^2	155.631	140.811	396.040
9	Coefficient of Permeability, k cm/s	10^{-5}	10^{-5}	10^{-7}

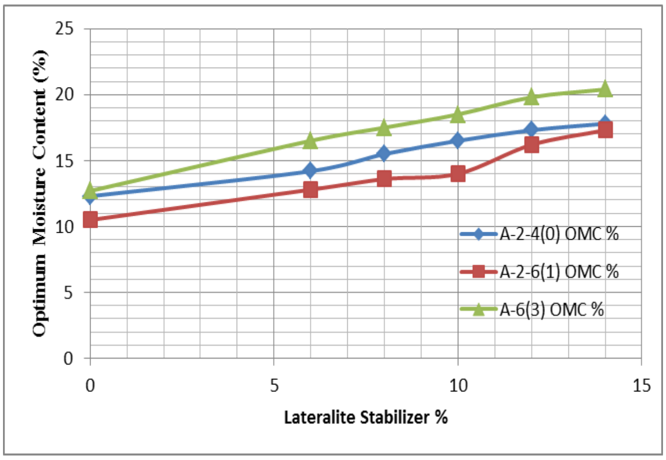

Figure 2: Curves of relationship between OMC and percent increase of soil-lateralite stabilization

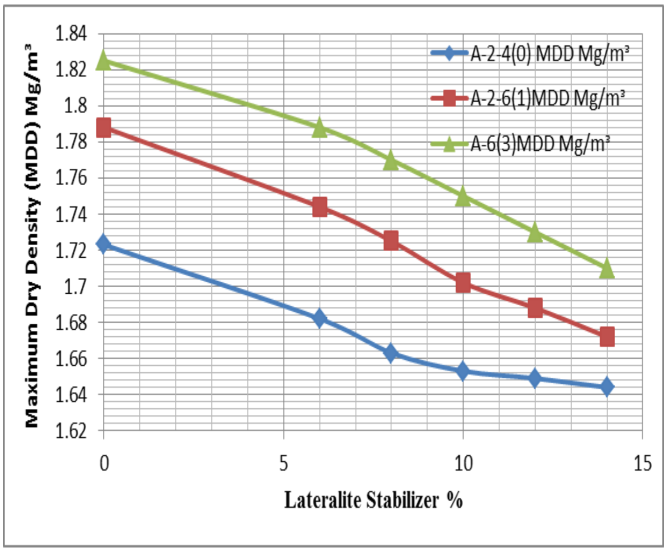

Figure 3: Curves of relationship between MDD and percent increase of soil-lateralite stabilization

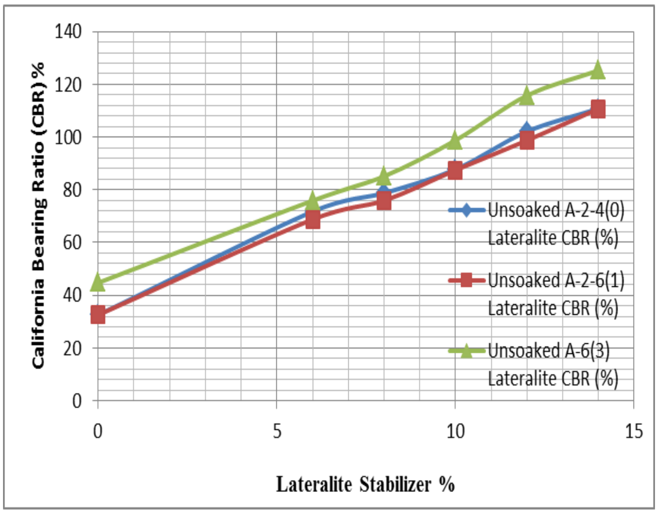

Figure 4: Curves of relationship between CBR and percent increase of unsoaked stabilized soil-lateralite

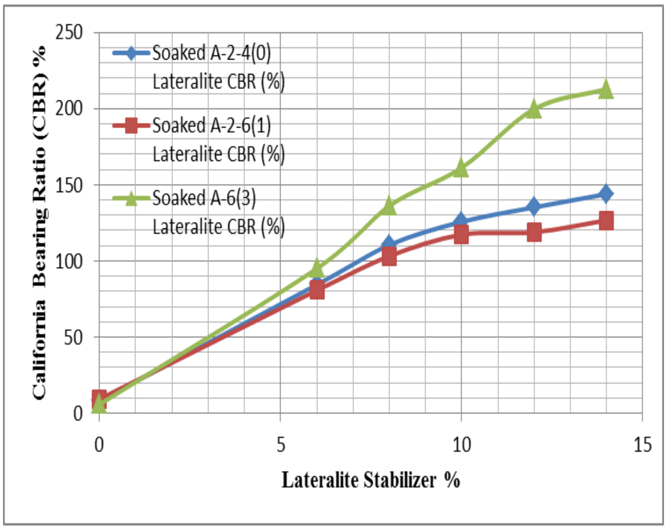

Figure 5: Curves of relationship between CBR and percent increase of soaked stabilized soil-lateralite

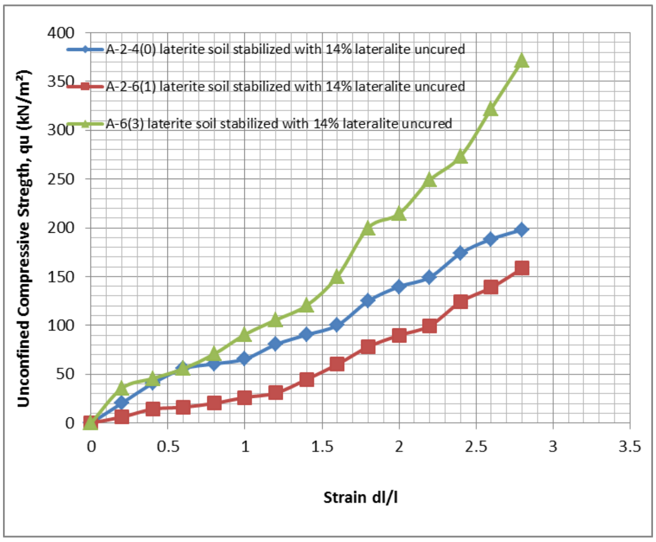

Figure 8: Curves of relationship between UCS and strain for uncured 14% soil-lateralite stabilization

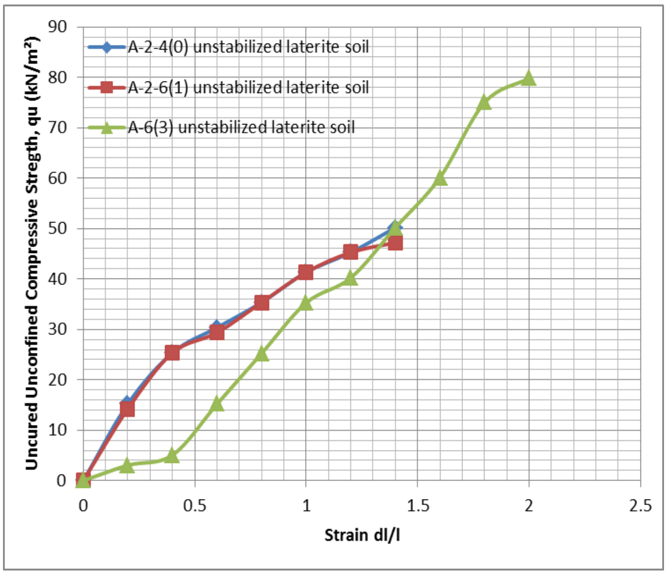

Figure 6: Curves of relationship between UCS and strain of uncured natural laterite soil

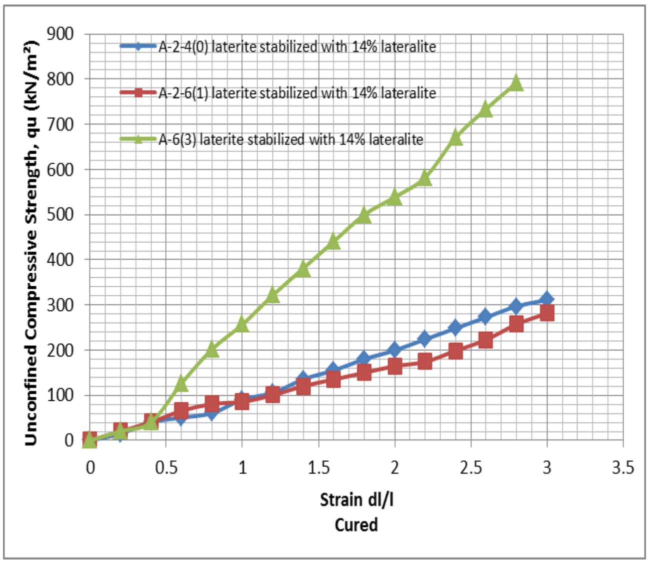

Figure 9: Curves of relationship between UCS and strain for air cured 14% soil-lateralite stabilization

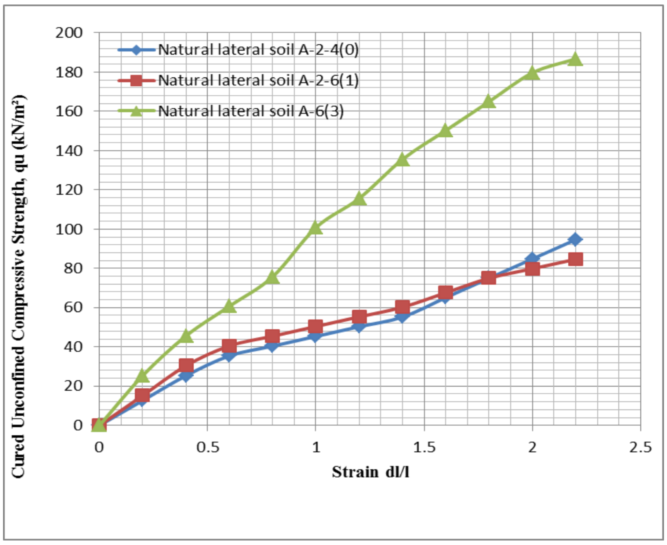

Figure 7: Curves of relationship between UCS and strain of air cured natural laterite soil

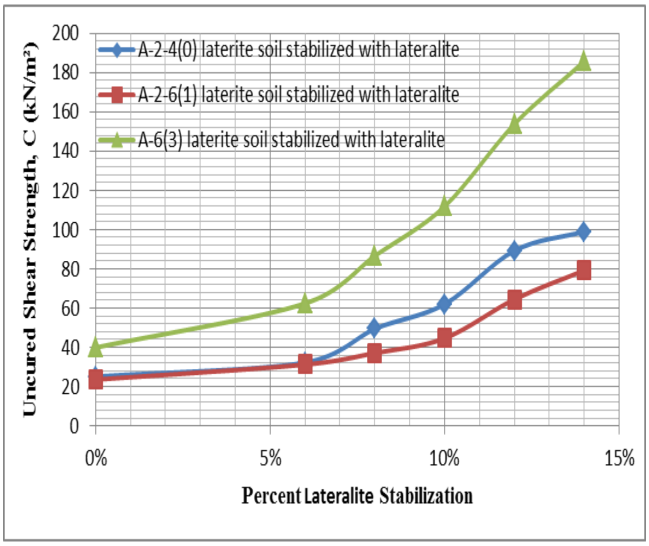

Figure 10: Curves of relationship between shear strength and percent of uncured soil-lateralite stabilization

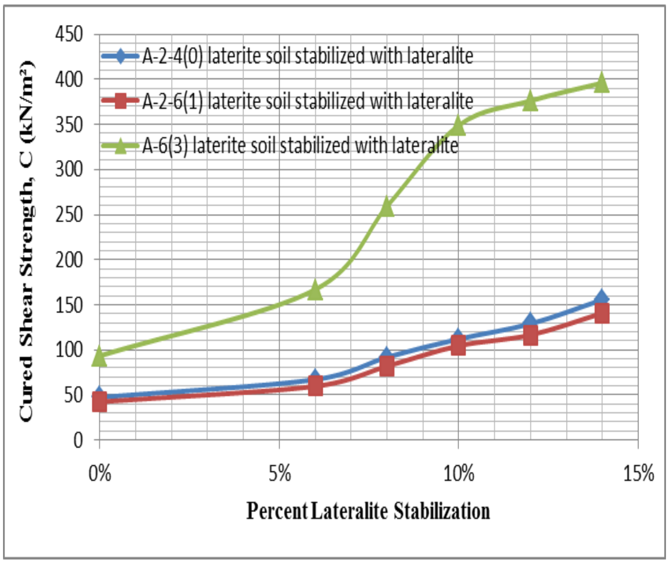

Figure 11: Curves of relationship between shear strength and percent of cured soil-lateralite stabilization

Table 5: Permeability properties of the selected laterite soils with soil-lateralite stabilization

Description	A-2-4(0)	A-2-6(1)	A-6(3)
0% lateralite	1.00E-04	1.49E-03	1.00E-06
6% lateralite	1.00E-05	1.00E-05	1.00E-07
8% lateralite	1.00E-05	1.00E-05	1.00E-07
10% lateralite	1.00E-05	1.00E-05	1.00E-07
12% lateralite	1.00E-05	1.00E-05	1.00E-07
14% lateralite	1.00E-05	1.00E-05	1.00E-07

4. CONCLUSIONS AND RECOMMENDATIONS

Laboratory experiments were carried out on three laterite soil samples by investigating their basic properties, Atterberg limits, grain size analysis, Proctor test, strength tests, permeability tests and physico-chemical compositions. Further laboratory tests were also carried out by chemical stabilization of the three selected laterite soil samples using Nigeria made stabilizer called lateralite on proportion of 6%, 8%, 10%, 12% and 14%. The following are the accomplished conclusions and able recommendations.

1. By American Association of State and Highway Transportation Officials (AASHTO) system of soil classification, the three selected laterite soil samples are classified as A-2-4(0), A-2-6(1) and A-6(3) based upon the index property values of the soils as shown in Table 1.
2. Based upon index properties of the three selected laterite soils, it could also be concluded that the better the soil among the selected laterite soil samples the lower the water content together with the percentage of grains passing 0.075 mm sieve size and the higher the dry density, void ratio and porosity.
3. The soil sample classified as A-2-4(0) could be recommended as silty gravel with sand and could be rated generally as subgrade good material. A-2-6(1) is clayey gravel with sand and could also be rated good as subgrade material. A-6(3) is clayey soil that could be rated poor as subgrade material.
4. Lateralite that is privately produced in Nigeria as a mineral compound selected in definite proportions as shown in Table 2 and pulverized to the fineness of Portland cement has been identified in this research as a stabilizer of natural laterite soils for it improved the materials of groups A-2-4(0), A-2-6(1) and A-6(3) in strength and decreased their permeability potential.
5. Surprisingly, laterite soil A-6(3) that is rated poor by AASHTO classification system has become better pavement material than lateritic soils A-2-4(0) and A-2-6(1) with better rating after being stabilized with lateralite similarly as shown in Figures 4 and 5 depicting CBR values.
6. Laterite soil A-6(3) has more of fine materials than soils A-2-4(0) and A-2-6(1) as shown in Table 1, the more of fine soil of former soil must have contributed to reduced permeability of same with value 10^{-7} and the two later soils with value 10^{-5} each.
7. It is shown in Table 2 that the values of Fe and Zn are 1.676 mg/k and 4.935 mg/k respectively for soil A-6(3). Whereas it is also shown in Table 2 that the values of Fe and Zn are 0.043 mg/k and 0.003 mg/k respectively for soil A-2-4(0). Also in Table 2, the of the values of Fe and Zn are 0.036 mg/k and 0.003 mg/k respectively for soil A-2-6(1).
8. Suffice to say that the larger presence of metals Fe and Zn in laterite soil A-6(3) than those of laterite soils A-2-4(0) and A-2-6(1) must have contributed to the more strength gaining with higher value as the percentage of the proportion of lateralite is increasing.
9. The hydrogen ion concentration, pH of laterite soils -2-4(0) and A-2-6(1) are both with value of 12.7 each that is bases. On the other hand the laterite soil sample A-6(3) has pH of 7.05 that is neutral.
10. Unsoaked A-6(3) attained the CBR value of 80% at 7% of soil-lateralite stabilization whereas A-2-4(0) and A-2-6(1) attained same value at 9% of soil-lateralite stabilization. This is an indication that lateralite is an economical stabilizer in this facet when used for soil A-6(3).
11. The use of lateralite is hereby recommended as a laterite soil stabilizer particularly where found economical for use on natural soil such as A-6(3) considered poor as a subgrade material in highway pavement design and construction.

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