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Comparison between Strength Properties of Lateritic Soils Stabilized with Banana Leaf Ash and Oil Palm Frond Ash

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***Abstract* - Comparison between the strength properties of lateritic soils stabilized with Banana leaf ash and oil palm frond ash was evaluated. Preliminary laboratory tests such as Moisture Content, Specific gravity, Atterberg Limit, British Standard Compaction, California Bearing Ratio, Unconfined Compressive Strength and AASHTO classification were carried out to assess the fundamental properties of the lateritic soil. The result showed that the soil was classified according to AASHTO as an A-7-5 soil. Strength tests such as Compaction, California Bearing Ratio and Unconfined Compressive Strength were carried out on the soil samples mixed with the additives in percentages of 2,4,6,8 and 10 by weight of the soil. Result of compaction showed that highest values of maximum Dry Density (MDD), California Bearing Ratio (CBR) and Unconfined Compressive Strength (UCS) were obtained at 4% banana leaf ash content while these strength characteristics were obtained at 6% oil palm frond ash content.**

Keywords: Comparison, Strength Properties, Lateritic Soil, Banana Leaf Ash, Oil Palm Frond Ash.

I. INTRODUCTION

Lateritic soils are formed from the leaching of parent sedimentary rocks (sandstones, clays, limestones); volcanic rocks (schists, gneiss, migmatites); and mineralized protores which leaves the more insoluble irons, predominantly iron and aluminum (Smith and Smith, 1998). The reaction zone where rocks are in contact with water from the lowest to the highest water table is progressively depleted of the easily leached ions of sodium (Na++), potassium (K+), calcium ` `(Ca++) and magnesium (Mg++), (Bureau of Reclamation, 1998).

Lateritic soils cover about one third of the earth's continental land area with the majority of that in the land areas between the tropics of Cancer and Capricorn, (Bureau of Reclamation, 1998).

One of the major causes of road accident is bad road which is usually caused by wrong application of constructional materials especially laterite as base and sub-base material by construction companies (Oke et al., 2009a; Nwankwoala et al., 2014). For a material to be used as either a base course or sub-base course depends on its strength in transmitting the axle-load to the sub-soil and or sub-grade. The characteristics and durability of any constructional material is a function of its efficiency in response to the load applied on it (Oke et al., 2009b; Nwankwoala and Amadi, 2013).

Lateritic soils in its natural state generally have low bearing capacity and low strength due to high clay content. The strength and stability of lateritic soil containing large amounts of clay cannot be guaranteed under load in the presence of moisture (Alhassan 2008). The use of lateritic soils consisting of high plastic clay content results in cracks and damage to pavement, roadways, foundations or any civil engineering construction.

The need to improve the strength and durability of lateritic soil in recent times has become imperative, this has geared researchers towards using stabilizing materials that can be sourced locally at a very low cost (Bello, Ige, & Hammed 2015). Therefore attentions are being focused on either agricultural or industrial wastes (Amu, Basiru, & Coker, 2011). In cases where sourcing for durable soil may prove economically unwise, the viable option is to stabilize the available soil to meet the specified requirements of construction (Mustapha, 2005 & Osinubi, 1999).

II. MATERIALS & METHODS

The lateritic soil samples used for this study were collected at the old borrow pit in Igede Ekiti in Irepodun/Ifelodun Local Government Area, Ekiti State, Nigeria.

They were collected at depths representative of the soil stratum and not less than 1.2m below the natural ground level. They were kept safe and dry in bags and were later air dried in

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pans for two weeks to allow partial elimination of natural moisture which may affect the analysis.

The Banana Leaf Ash and Fresh Oil Palm Fronds ash used for this study were obtained locally from the burning of dry banana leaves and oil palm fronds sourced from different plantation farms around Ijan-Ekiti town in Ekiti State. The leaves and fronds were completely burnt under atmospheric condition, sealed up in plastic bags and transported to the laboratory. The ashes were then passed through British Standard 75-micron sieve and kept to be mixed with the lateritic soil samples in the appropriate percentages.

The following preliminary tests such as particle size distribution, Atterberg limit, British Standard (BS) compaction, unconfined compressive strength (UCS) and California bearing ratio (CBR) were carried out on the natural lateritic soil samples to obtain its basic properties. Thereafter, compaction, unconfined compressive strength and California Bearing Ratio (CBR) tests were carried out on the lateritic soils samples separately mixed with the two additives in proportions of 2% to 10% in accordance with British Standard Methods of testing soil for Civil Engineering purposes (British Standard Institution, 1990 & Head, 1992).

III. RESULTS AND DISCUSSION

a) Preliminary Test

Results of preliminary laboratory tests conducted on the natural lateritic soils are presented in Table 1. The table shows that the soil is classified as A-7-5 ("fair to poor soil") according to ASHTO classification system. This cannot be used in road construction unless it is treated. The table also shows that Maximum Dry Density (MDD) and Optimum Moisture Content (OMC) are 1.89kg/m3 and 9.9% respectively while the California Bearing Ratio (CBR) and Unconfined Compressive Strength values are 10.81% and 181.20kn/m2 respectively.

TABLE–1

Results of Preliminary Tests

Properties	Values
Natural Moisture Content (%)	14.2
Specific Gravity	2.45
Liquid Limit (%)	45.0
Plastic Limit (%)	30.0
Plasticity Index (%)	15.0
Maximum Dry Density (kg/m^3)	1.89
Optimum Moisture Content (%)	9.9
California Bearing Ratio (%)	10.81
Unconfined Compressive Strength (Kn//m^2)	181.20
AASHTO Classification	A-7-5

b) Strength Properties (Lateritic Soil Samples mixed with Additives)

i) Compaction Properties

Table 2 shows the results of compaction properties on the lateritic soil samples with the additives. The results show that MDD increased from 1.89kg/m3 (for natural soil) to maximum value of 2.00kg/m3 at 4% content of Banana leaf ash and reduced on further addition of the ash. Addition of oil palm frond ash followed the same trend with the maximum of MDD of 2.20kg/m3 at 6%.

TABLE-2

Results of Compaction Tests

% Content	Soil Sample + Banana Leaf Ash		Soil Sample + Oil Palm Frond Ash	
	MDD (kg/m^3)	OMC (%)	MDD (kg/m^3)	OMC (%)
0	1.89	9.9	1.89	9.9
2	1.94	10.2	1.92	12.0
4	2.00	10.0	2.04	12.3
6	1.96	12.2	2.20	11.8
8	1.92	13.3	1.94	14.2
10	1.90	14.4	1.96	15.6

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ii) California Bearing Ratio (CBR) Properties

Table 3 shows the results of CBR for the studied soils mixed with the ashes of banana leaf and oil palm frond. Values of CBR for both additives increased from 10.81% for natural soil samples to reach the maximum of 28.42% at 4% banana leaf ash content and 30.20% at 6% oil palm frond ash content. After these maxima have been reached, the values of CBR began to fall to 13.00% and 14.22% at 10% banana leaf and oil palm frond contents respectively.

TABLE-3

Result of CBR Tests

% Content	Values of CBR in percentages	
	Soil Sample + Banana Leaf Ash	Soil Sample + Oil Palm Frond Ash
0	10.81	10.81
2	26.28	27.04
4	28.42	28.26
6	18.32	30.20
8	16.40	18.18
10	13.00	14.22

iii) Unconfined Compressive Strength (UCS) Properties

Table 4 shows the results of UCS for the studied soils containing the ashes of banana leaf and oil palm frond. Values of UCS increased from 181.20kN/m2 (natural soil) to maximum of 212.22kN/m2 at 4% banana leaf ash content and 217.12kN/m2 at 6% oil palm frond ash content. The results further showed that the values decreased from this maximum to 172.26kN/m2 and 186.40kN/m2 at 10% for both ashes of banana leaf and oil palm frond respectively.

Table-4

Results of Unconfined Compressive Strength Tests

% Content	Values of Unconfined Compressive Strength (kN/m^2)	
	Soil Sample + Banana Leaf Ash	Soil Sample + Oil Palm Frond Ash
0	181.20	181.20
2	201.14	208.15
4	212.22	210.18
6	198.62	217.12
8	206.18	210.16
10	172.26	186.40

IV. CONCLUSION

Studies on the comparison of strength properties of lateritic soils stabilized with the ashes of banana leaf and oil palm frond have been carried out. The results of the various analyses conducted show that highest values of Maximum Dry Density (MDD), California Bearing Ratio (CBR) and Unconfined Compressive Strength (UCS) were obtained at 4% banana leaf ash content while these strength characteristics were obtained at 6% for oil palm frond ash content.

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