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Effects of Sawdust and Palm Kernel Shell Ashes on Geotechnical Properties of Emure / Ise-orun Local Government Areas Soil, Nigeria.

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Abstract **- It is now of necessity that there is need for alternative materials (additives) of local means to conventional ones as stabilizing agents in order to improve on cost of construction in developing countries like Nigeria. Soil samples were taken from the study area and necessary laboratory tests conducted on them in order to analyse the effects of locally available additives (i.e. Palm Kernel Shell -PKSA and Sawdust - SDA Ashes) on the geotechnical properties of the soil samples. The tests results showed that Liquid Limit (LL), Plasticity Index (PI) and Maximum Dry Density (MDD) decrease and Plastic Limit (PL) increase as the quantities of the additives increase. These showed that the additives were able to stabilized the soil to some extent. Though the effects of the additives were not so felt due to the high content of the clayey in the soils. Furthermore, the PKSA additive has more effects on the soil samples than the SDA additive. Thus, it can be deduced that the additives should not be used in stabilizing soil with extremely high content of clay and water logged area in order to get good results from the process. Moreover, there is need for further study on this research work.**

Index Terms **- Liquid limit, Maximum Dry Density, Plasticity Index, Plastic Limit, Nigeria.**

I. INTRODUCTION

Over the years, cement and lime have been the two main material used for stabilizing soils. These materials have rapidly increased in prices due to the sharp increase in the cost of energy since 1970's. The over dependence on the utilization of industrially manufactured soil improved additives (cement, lime, etc.) have kept the list of construction of stabilized road and structure foundation financially high. This has continued to deter the developing and poor nations of the world from providing accessible roads and safe structures to their rural dwellers that constitute the higher percentage of their population and are mostly agriculturally dependent [4], [6], [7], [8], [9].

The past research works of likes of [2], [3], [4], [5], [6], [7], [8], [9], [10] and others showed the possibilities of using some agricultural waste materials for soil stabilization. Thus, the use of agricultural waste materials such as palm kernel nutshell and sawdust ashes (which could result in air and land pollution if not properly managed) will considerably reduce the cost of construction as well as reducing the environmental hazards they cause.

This study will make efforts of observing the effects of Palm Kernel Shell Ashes (PKSA) and SawDust Ashes(SDA) on geotechnical properties of Ekiti soil especially in Emure/Ise - Orun Local Government Area of the State. This will help in assessing the suitability of the stabilized soil for construction purpose and providing data for Engineers, Planners, Designers and Contractors.

II. MATERIAL AND METHODS

Study Area: The study area is Emure / Ise – Orun Local Government Area of Ekiti State in South-western part of Nigeria. It has approximately 1,109km^2 landed area and is located in south senatorial district of Ekiti State. It is located between latitudes of $7^0$27' and $7^0$30' North and longitude of $5^0$10' to$5^0$26' East. It lies south of Ado and Gbonyin Local Government Areas, East of Ikere Local Government Area and bounded by Akure Local Government Area in the East and South as shown in Fig. 1. It is in the humid tropical part of South-western, Nigeria [16].

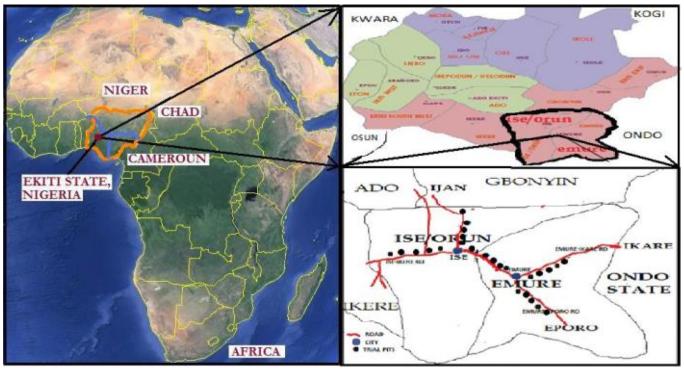

Fig. 1: Location of the Study area – Emure / Ise – Orun Local Government Area [12]

Geologically, Ekiti State (where the study area is situated) is underlain by metamorphic rocks of the Precambrian basement complex of Southwestern part of Nigeria, the great majority of which are very ancient in age. These basement complex rocks show great variations in grain size and in mineral composition. The rocks are quartz gneisses and schists consisting essentially of quartz with small amounts of white mizageous minerals. In grain size and structure, the rocks vary from very coarse-grained pegmatite to medium-grained gneisses. The rocks are strongly foliated and occur as outcrops [1], [13].

The soils derived from the basement complex rock are mostly well drained, having medium to coarse in texture. The geological nature of the study area and its increased urbanisation make it more vulnerable and of public health concern when it comes to water quality [1], [13].

Sample Collection and Analysis: Soil samples were collected at random from trial pits in the Study area using method of disturbed sampling as shown in Fig. 1. After collection, soil samples were stored in polythene bags to prevent loss of moisture contents. The samples were then taken to the laboratory where the deleterious materials such as roots were removed. The samples were air dried, broken down with mortar and pestle and passed through a set of sieve (*i.e. from Sieve No. 10 (18.75mm) to Sieve No. 1 (0.075mm)*) to remove large particles. Moulding of test specimens was started as soon as possible after completion of identification. All tests were performed according to standard methods contained in [11]. Their properties were studied and determined to ensure that all relevant factors would be available for establishment of correlations among them.

The tests carried out on each of the selected samples are Particle size distribution, Atterberg limits (i.e. Liquid Limits (LL), Plastic Limit (PL) and Plasticity Index (PI)) and Compaction (i.e. Optimum Moisture Content (OMC) and Maximum Dry Density (MDD)). The results were compared to the standard specified values and grouped in accordance with [14] and [15].

III. RESULTS AND DISCUSSION

From Table I, the results show that all the soil samples had very high percentages finer than 0.0075 fractions (i.e. >35%), which varied between 39.6% and 49.6%. Hence, general rating as sub-grade in accordance with [14] is fair to poor materials. They have significant constituent materials of mainly clayey soils while some are silty or clayey gravel and sand. It is also observed that the Liquid Limit (LL), Plasticity Index (PI) and Maximum Dry Density (MDD) values varied from 51.38% to 62.89%, 28.56% to 35.54% and 1911.27Kg/m^3 to 2462.15Kg/m^3 respectively. These soil samples met the required specification for subgrade course materials (i.e. LL ≤ 80%, PI ≤ 55% and MDD > 1760kg/m^3) but did not met specification for base and subbase course materials (i.e. LL ≤ 35% and PI ≤ 12%). Thus, they could be suitable for subgrade course materials and are grouped into A-2-6, A-6 and A-7 (A-7-5 or A-7-6) in AASHTO classification system [14].

Table I: Summary of the Tests Results of Untreated Soil Samples

SOIL SAMPLE	PARTICLE SIZE DISTRIBUTION			ATTERBERG LIMITS			MDD (Kg/m^3)	OMC (%)
	> 4.25mm (%)	4.25 - 75μmm (%)	< 75μmm (%)	LIQUID LIMIT(%)	PLASTIC LIMIT(%)	PLASTICITY INDEX (%)		
A	12.2	48.2	39.6	55.31	23.15	32.16	2201.87	14.05
B	16.2	34.2	49.6	57.99	22.85	35.14	1911.27	17.08
C	12.2	47.2	40.6	59.73	24.35	35.38	2462.15	11.62
D	17.2	39.6	43.2	62.31	26.70	35.61	2266.86	10.74
E	22.2	35.2	42.6	48.36	19.80	28.56	2202.07	10.20
F	18.0	42.0	40.0	62.89	26.40	39.49	2020.40	10.95
G	15.8	41.8	42.4	57.01	22.76	35.14	2167.36	11.32
H	17.0	42.8	40.2	62.24	26.70	35.54	2195.04	9.88
I	18.2	40.8	41.0	51.38	22.45	28.93	2044.00	12.50
J	20.0	31.6	48.4	57.02	24.10	32.92	2200.00	9.10

From Table II and Figures II to V, it is observed that the LL and PI values for SDA and PKSA treated soil samples are above 35% and 12% respectively. These show that there is still presence of high content of clayey materials in the soils. Though, the results show that PKSA additive has more effects on the soil samples than SDA additive.

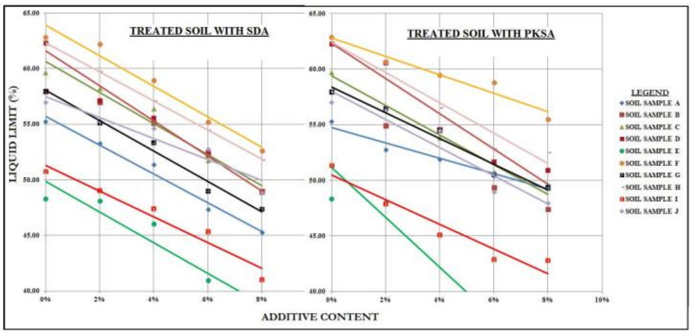

Fig. II: Graphs of the Liquid Limits Tests for the Treated Soil Samples

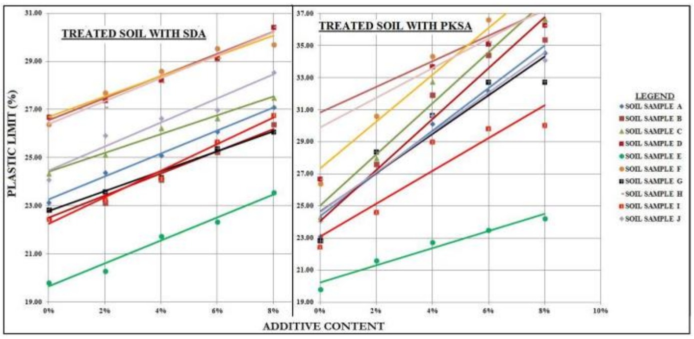

Fig. III: Graphs of the Plastic Limits Tests for the Treated Soil Samples

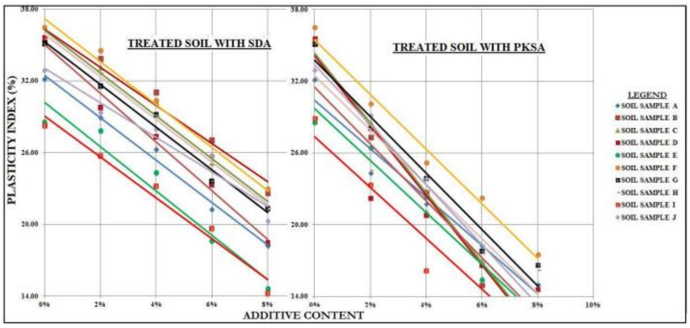

Fig. IV: Graphs of the Plasticity Index Tests for the Treated Soil Samples

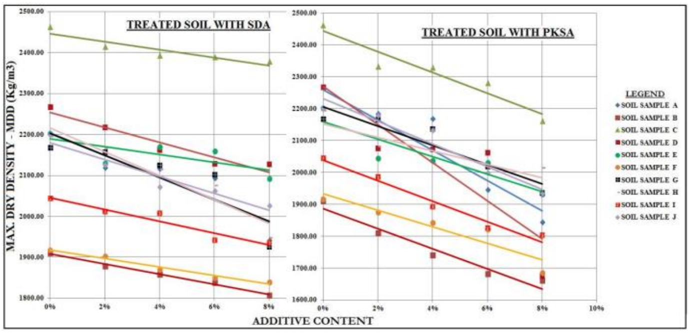

Fig. V: Graphs of the Maximum Dry Density Tests for the Treated Soil Samples.

The results also showed that LL, PI and MDD decrease and PL increase as the quantities of the additives (i.e SDA and PKSA) increase. These show that the additives were able to stabilized the soil to some extent. Though the effects of the additives were not so felt due to the high content of the clayey in the soils.

Table II: Summary of the Tests Results of Treated Soil Samples

SOIL SAMPLE	ADDITIVE CONTENT (%)	SAWDUST ASHES(SDA)					PALM KERNEL SHELL ASHES(PKSA)				
		LIQUID LIMIT(%	PLASTIC LIMIT(%)	PLASTICITY INDEX (%)	MDD (Kg/m³)	OMC (%)	LIQUID LIMIT(%	PLASTIC LIMIT(%)	PLASTICITY INDEX (%)	MDD (Kg/m³)	OMC (%)
A	0%	55.31	23.15	32.16	2201.87	14.05	55.31	23.15	32.16	2201.87	14.05
	2%	53.33	24.40	28.93	2119.01	12.45	52.77	28.40	24.37	2184.45	11.37
	4%	51.38	25.10	26.28	2115.95	13.91	51.92	30.15	21.77	2169.31	10.25
	6%	47.37	26.10	21.27	2093.23	14.09	50.46	32.20	18.26	1946.59	13.60
	8%	45.32	27.10	18.22	1941.74	14.61	49.56	34.55	15.01	1844.80	14.20
B	0%	57.99	22.85	35.14	1911.27	17.08	57.99	22.85	35.14	1911.27	17.08
	2%	57.02	23.15	33.87	1879.10	15.39	54.95	27.60	27.35	1810.10	14.71
	4%	55.15	24.10	31.05	1858.48	15.85	54.62	31.90	22.72	1739.65	10.43
	6%	52.27	25.25	27.02	1838.79	16.91	49.37	34.40	14.97	1680.87	12.00
	8%	49.01	26.40	22.61	1808.02	17.26	47.42	35.35	12.07	1661.45	13.60
C	0%	59.73	24.35	35.38	2462.15	11.62	59.73	24.35	35.38	2462.15	11.62
	2%	58.29	25.15	33.14	2413.28	10.47	56.58	28.00	28.58	2332.54	13.45
	4%	56.46	26.25	30.21	2392.74	10.91	53.88	32.75	21.13	2329.31	11.83
	6%	51.81	26.65	25.16	2388.55	11.69	50.77	35.25	15.52	2280.39	13.74
	8%	49.00	27.50	21.50	2378.05	12.00	49.33	36.65	12.68	2161.89	14.15
D	0%	62.31	26.70	35.61	2266.86	10.74	62.31	26.70	35.61	2266.86	10.74
	2%	57.17	27.40	29.77	2217.47	9.90	60.59	38.35	22.24	2075.13	11.38
	4%	55.57	28.25	27.32	2162.66	11.77	54.52	33.70	20.82	2072.65	9.50
	6%	52.46	29.15	23.31	2128.77	11.97	51.71	35.10	16.61	2062.09	11.88
	8%	48.89	30.45	18.44	2127.89	12.31	50.92	36.30	14.62	1675.44	14.36
E	0%	48.36	19.80	28.56	2202.07	10.20	48.36	19.80	28.56	2202.07	10.20
	2%	48.13	20.30	27.83	2129.33	8.62	48.07	21.60	26.47	2044.63	10.90
	4%	46.09	21.75	24.34	2170.08	9.53	45.13	22.75	22.38	2038.00	7.85
	6%	40.99	22.35	18.64	2159.43	12.09	38.91	23.50	15.41	2032.01	10.12
	8%	38.15	23.55	14.60	2091.78	13.60	36.50	24.20	12.30	1933.53	13.47
F	0%	62.89	26.40	36.49	1917.66	10.95	62.89	26.40	36.49	1917.66	10.95
	2%	62.24	27.70	34.54	1902.40	9.45	60.72	30.60	30.12	1875.56	11.29
	4%	58.96	28.60	30.36	1870.88	10.16	59.52	34.35	25.17	1844.00	8.48
	6%	55.26	29.55	25.71	1850.45	11.10	58.86	36.60	22.26	1822.47	9.94
	8%	52.64	29.70	22.94	1839.84	11.82	55.52	38.00	17.52	1685.72	12.46
G	0%	57.99	22.85	35.14	2167.36	11.32	57.99	22.85	35.14	2167.36	11.32
	2%	55.15	23.60	31.55	2156.28	9.32	56.46	28.40	28.06	2164.92	12.65
	4%	53.35	24.20	29.15	2124.55	11.26	54.52	30.65	23.87	2137.00	8.01
	6%	49.00	25.40	23.60	2102.10	11.69	50.55	32.75	17.80	2018.83	11.08
	8%	47.38	26.10	21.28	1925.42	12.00	49.37	32.75	16.62	1936.71	13.49
H	0%	62.24	26.70	35.54	2195.04	9.88	62.24	26.70	35.54	2195.04	9.88
	2%	59.78	27.10	32.68	2165.13	8.29	60.60	36.00	24.60	2083.34	14.36
	4%	57.17	28.15	29.02	2114.22	8.66	56.60	33.70	22.90	2028.63	8.76
	6%	54.52	29.15	25.37	2075.86	10.24	52.89	35.25	17.64	2019.29	12.38
	8%	51.81	30.45	21.36	1948.35	11.34	52.53	36.30	16.23	2015.93	15.61
I	0%	50.72	22.45	28.27	2044.00	12.50	51.38	22.45	28.93	2044.00	12.50
	2%	49.01	23.25	25.76	2012.31	10.16	47.92	24.60	23.32	1985.84	16.67
	4%	47.37	24.15	23.22	2007.31	10.63	45.13	28.98	16.15	1892.89	10.27
	6%	45.32	25.66	19.66	1941.71	11.10	42.92	29.83	13.09	1824.08	15.20
	8%	40.99	26.78	14.21	1934.64	12.38	42.82	30.05	12.77	1802.61	17.08
J	0%	57.02	24.10	32.92	2200.00	9.10	57.02	24.10	32.92	2200.00	9.10
	2%	55.33	25.95	29.38	2126.00	8.35	56.27	27.10	29.17	2180.14	14.34
	4%	54.65	26.66	27.99	2072.09	9.43	54.52	30.65	23.87	2132.44	8.66
	6%	52.77	27.01	25.76	2062.81	9.44	48.97	32.00	16.97	2000.26	13.36
	8%	48.89	28.56	20.33	2026.37	10.90	47.99	34.10	13.89	1934.60	13.64

IV. CONCLUSION AND RECOMMENDATION

This study has revealed that it is possible to use SDA and PKSA as stabilizing agents. This will go a long way in reducing agricultural and industrial wastes in the environment. The additives can increase the strength and stability of the soil in the study area. However, this is to an extent, as the effects of the additives were not so felt on soils with high content of clay. The results of the compaction tests show that additions of the additives enhance the mechanical properties of soil in the study area. The coarse particles increase after the soil samples were treated with the additives. Thus, it simply means that there is reduction in the percentage of the clay content of the soil. However, there is no difference between the treated and untreated soil samples as both were still generally rated as fair to poor for subgrade course materials. This is due to the high clay content of the soil in the study area.

Thus, it can be deduced that the additives should not be used in stabilizing soil with extremely high content of clay and water logged area in order to get good results from the process. Moreover, there is need for further study on this research work.

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