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Stabilization of Nigerian Deltaic Laterites with Saw Dust Ash.

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ABSTRACT.

Soil improvement potential of saw dust ash was studied with regards to compaction and CBR characteristics of a deltaic laterite. The physical properties and engineering characteristics studied include the moisture content, Atterberg limits, compaction characteristics, CBR and unconfined compressive strength (UCS).

The values of CBR obtained in the tests are within the limits recommended by the Asphalt Institute for highway subbase and subgrade.

It is concluded that saw dust ash, an industrial waste, is a cheap satisfactory stabilizing agent for subbase in lateritic fills; although its performance can be improved by combining it with other bonding materials such as lime, and becomes an alternatives use of industrial waste to reduce the construction cost of road particularly in the rural areas of the country.

Keywords: Moisture content, Atterberg limits, Compaction, CBR, UCS, Saw dust ash.

INTRODUCTION.

Considering the various geotechnical characteristics of laterite, it is generally used as fills for road embankments in Nigeria. The Niger Delta Nigeria (see fig. 1) comprises of five broad geomorphological zones. The laterites of geological zone 1 (dry flat country) is selected for this study.

Distribution, classification, depth extent, general nature and formation of laterites in Nigeria have been studied by Faniran 1970, 1972, 1974 and 1978; Adekoya et al 1978. Although much work has been done on the geotechnical study of laterites (Ola 1978, 1980a, 1980b, Alao 1983 and Otoko 2014a) most especially in connection with foundation problems, little or no attention has been paid to the strength characteristics of compacted laterites (Omine and Yasufuku 2005; Oota and Iba 2009), let alone the stabilization of laterites with saw dust ash.

Even though laterites are successfully used as fills for road construction in Nigeria, failures of road pavements have been common since independence (Jegede 2000). However, the strength of laterite can be improved by stabilization technique (Amadi 2010, Okunade 2010, Oloruntola et al 2008, Amu et al 2011, Okafor and Okonkwo 2009, Otoko 2014b).

In this study, saw dust ash is utilized as cementitious material to stabilize the deltaic laterite. This knowledge is required in the understanding of the properties of tropical deltaic laterites for engineering design, particularly as they are being used as construction materials.

GEOMORPHOLOGY.

The project area of about 36,270 km^2 in Southern Nigeria lies between latitudes $4^0 15'$ and $5^0 47'$N and between longitudes $5^0 22'$ and $7^0 37'$E in the Rivers State. It is low lying, flat and riddled with an intricate system of natural water channels through which the River Niger reaches the sea. The area rises from 2m along the coast to over 60m above sea level farther inland.

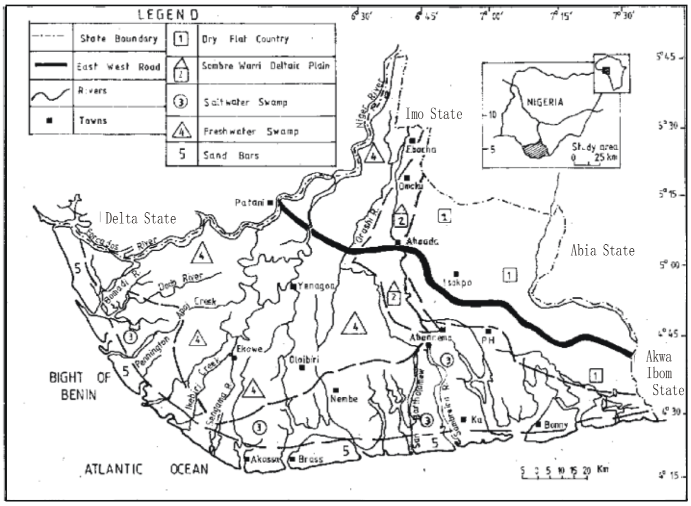

Figure 1: Map of study area (Rivers State) showing geomorphological zones

Five broad geomorphologic zones are recognized (fg.1) in the study area. These are: 1. A dry flat country (DFC), where laterites are abundant.

2. The Sombreiro-warri deltaic plane (SWP) with considerable amount of laterites.
3. A saltwater mangrove swamp area (SWS)
4. A zone of freshwater swamps and alluvial plains (FWS).
5. Beaches and bars which are predominantly sandy.

The laterites of geological zone 1 (dry flat country) is selected for this study.

FIELD AND LABORATORY PROCEDURE

Laterite was collected at the depth of 1m within the premises of the Rivers State University of Science and Technology, Port Harcourt. The natural moisture content was determined immediately in the civil engineering laboratory of the University. After air drying for one week, other soil properties determined include specific gravity, Atterberg limits, linear shrinkage, unconfined compressive strength (UCS), compaction, California bearing Ratio (CBR) and shear strength. For the compaction test, soil samples were divided into five layers, each layer receiving 10blows in a 1000cm^3 mould of 44.5N rammer falling from a height of 0.45m. This was done for 0, 2, 4, 6, 8 and 10% saw dust content; while CBR and UCS were determined in accordance to BS 1377 (1991).

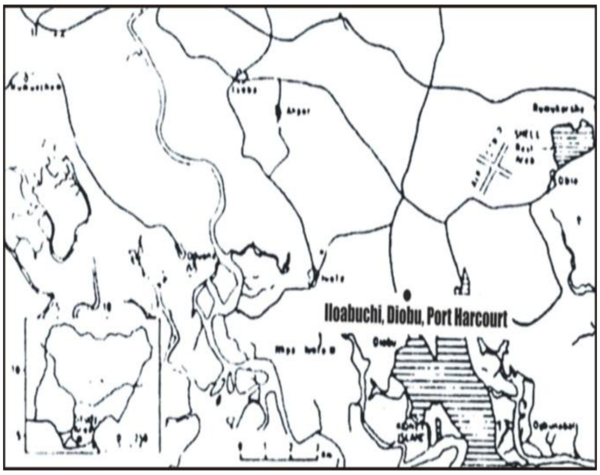

Figure 2: Map of the Niger Delta, Nigeria, showing the location of Iloabuchi, Diobu, Port Harcourt.

Saw dust was obtained from Timber sawmill along Iloabuchi street, Diobu, Port Harcourt. Saw dust are actually by-products of sawmills generated by saving timber. It is the loose particles or wood chippings obtained by sawing hardwood into useable sizes (see fig. 3a). Clean saw dust not having much bark and so not much organic content was air dried, burnt and passed 75µm sieve that was used for the laboratory work (see fig. 3b).

Figure 3a: Saw dust

. **Figure 3b:** Saw dust ash.

Table 1: Chemical Composition of Saw Dust.

Fe_2O_3	1.7%
Al_2O_3	2.7%
SiO_2	85%
MgO	0.25%
CaO	3.5%
Loss in ignition	4.3%

Table 2: Physical Properties of Saw Dust.

S/N	Property		Value
1	Particle size distribution (mm)	4.75	100
		2.0	95
		0.6	81
		0.425	48
		0.21	30
		0.075	9
2	Specific gravity		2.05

RESULTS AND DISCUSSION.

Variation of liquid limit with saw dust ash and plasticity index with saw dust ash are shown in fig. 4 and fig. 5 respectively. Fig. 4 shows that the liquid limit is inversely proportional to the saw dust ash content. This is probably because the saw dust ash has less affinity for water. Similar relationship was obtained for the plasticity index (fig. 5).

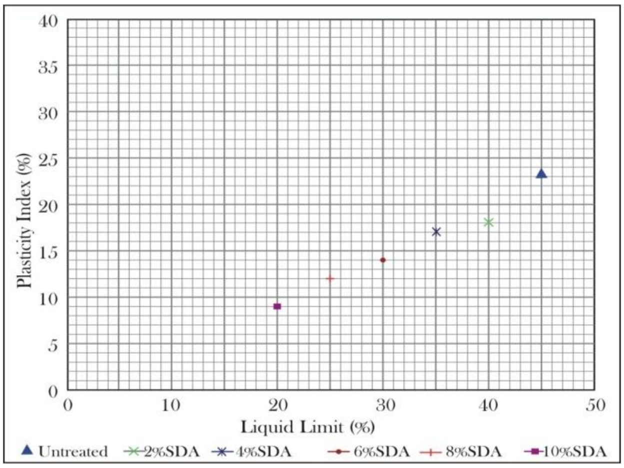

Figure 4: Variation of liquid limit and plasticity index with saw dust ash content

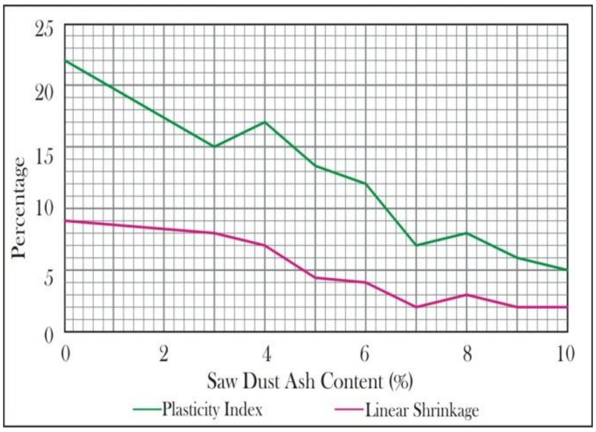

Figure 5: Rate of variation of plasticity index and linear Shrinkage with saw dust ash content index

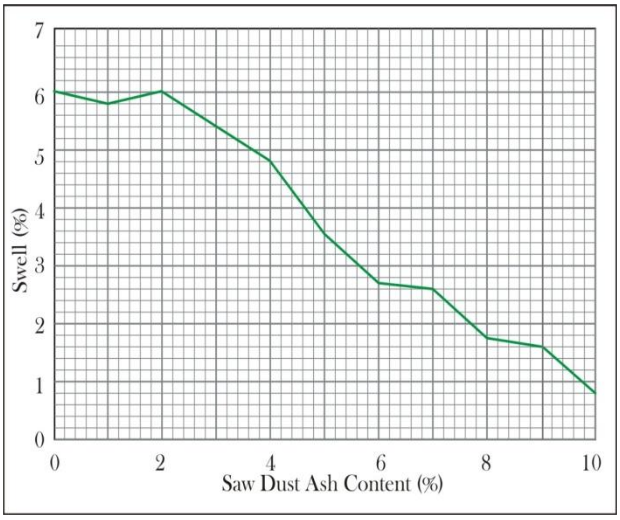

Figure 6: Influence of saw dust ash on swelling of deltaic laterite

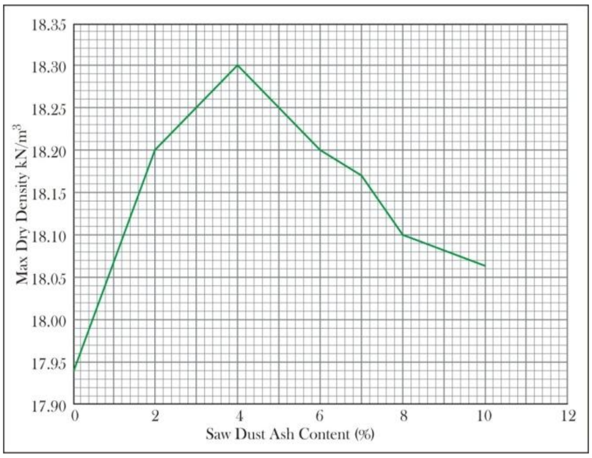

Figure 7: Variation of the maximum dry unit weight with saw dust ash content

The specific gravity of the laterite was found to be 2.68, which is within the range of 2.6 and 3.4

reported for laterites. However, mixing the laterite with the saw dust ash, reduced the unit weight of the soil-saw dust ash as shown in fig. 7. In other words, fig. 7 shows that the dry unit is inversely proportional to the saw dust ash content, after the peak value at 4% saw dust ash content; while the optimum moisture content is directly proportional to the saw dust ash content after 4% saw dust ash content (fig. 8).

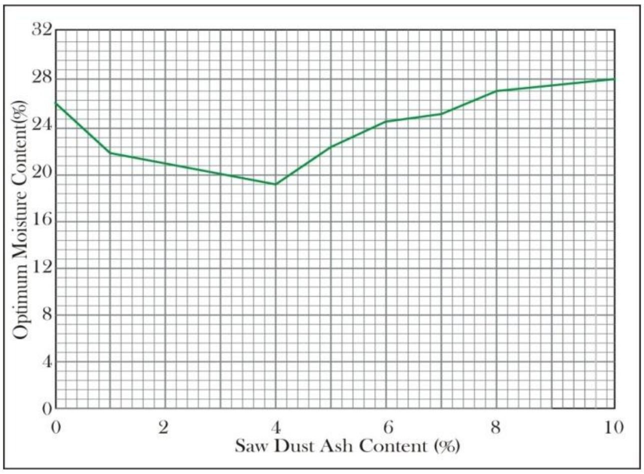

Figure 8: Variation of optimum moisture content with saw dust ash content.

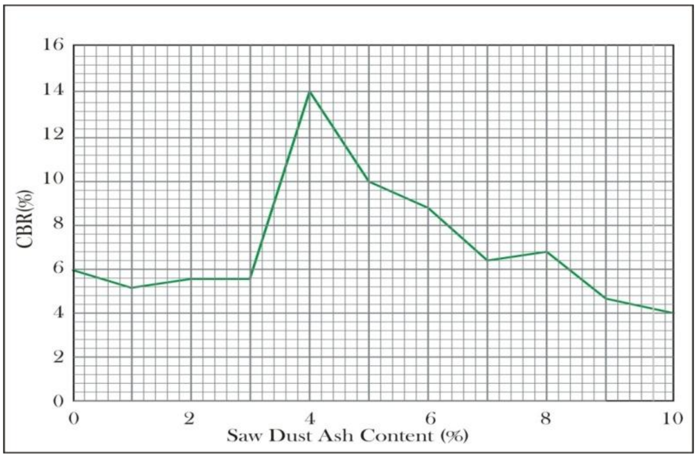

Figure 9: Variation of CBR of deltaic laterite with saw dust ash content.

The inverse proportionality of the maximum dry unit weight with saw dust ash content may be due to the lower specific gravity of the saw dust ash; while the direct proportionality of the optimum moisture content with saw dust ash may be as a result of water needed for hydration. There are all in agreement with (Gidigasu 1983).

Fig. 9 shows the variation of CBR with saw dust ash. From the figure, it is clear that the values of CBR obtained in the tests are within the limits recommended by the Asphalt Institute (1962): a CBR of 7% to 20% and from 0 to 7% for highway subbase and subgrade material respectively; on which bases the sample can be used as subbase material.

Fig. 10 show the variation of unconfined compressive strength (UCS) with saw dust ash content. From the results of the UCS, it is clear that the sample can be classified as from medium soft to stiff, based on (Das 2000) consistency classification of clayey soil: 0-25 kN/m^2 - very soft; 25-50 kN/m^2 - soft; 50-100 kN/m^2 - medium soft; 100-200 kN/m^2 - stiff; 200-400 kN/m^2 - very stiff and above 400 kN/m^2 hard clay.

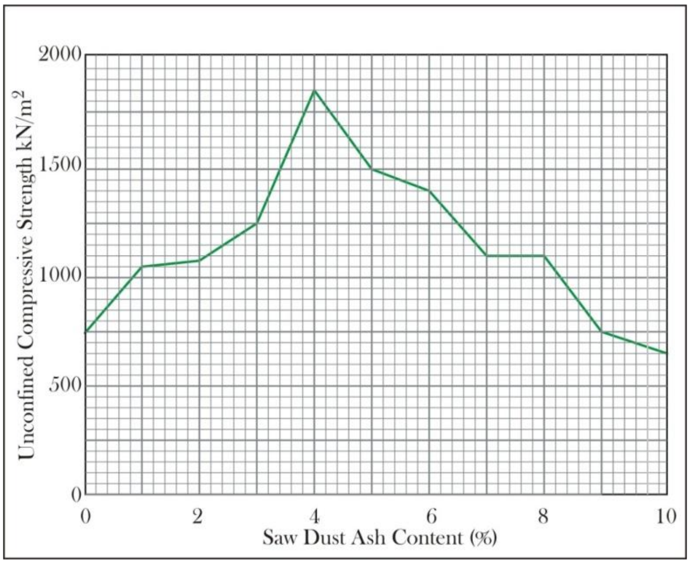

Figure 10: Variation of unconfined compressive strength with
saw dust ash content.

CONCLUSIONS.

The physical properties and engineering characteristics of a Nigerian deltaic laterite is studied; which includes moisture content, Atterberg limits, compaction characteristics and unconfined compressive strength.

The addition of saw dust ash improved the properties of the deltaic laterite, making it good for subbase material.

Optimum values of unsoaked CBR and unconfined compressive strength were achieved at 4% saw dust ash content.

It is concluded that saw dust ash is a cheap satisfactory stabilizing agent for subbase in lateritic fills. However, peak values of unsoaked CBR and UCS of 14% and 1850 kN/m^2 respectively at 4% saw dust ash content, can be improved upon by combining it with other bonding materials such as lime, even though they satisfy standard specifications; and becomes an alternatives use of industrial waste to reduce the construction cost of road particularly in the rural areas of the country.

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