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Comparative Study on the Stabilization of Three Southwestern Lateritic Soil for Road Work using Pulverized Cow Bone (PCB)

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Abstract:- This paper investigates on the possibility of improving and comparing the engineering properties of three samples of lateritic soil from Ogun, Oyo and Osun with pulverized cow bone, a processed animal waste obtained from abattoirs, for road construction. The effect of PCB on the soil samples was assessed by adding 2-8% PCB at a 2% increment to the lateritic soil. The Atterberg limits(Liquid limit, Plastic limit, Plasticity Index) obtained were Ogun (57%, 21.16%, 35.84%), Oyo (51.4%, 25.19%, 26.21%) and Osun (29.4%, 14.68%, 14.72%). The high plasticity index of the Ogun state soil shows that the soil may be susceptible to cracking and shrinkage. Although the strength properties, California Bearing Ratio and Unconfined Compressive Strength of all the samples improved with increment in PCB additive from 0 - 8% PCB achieving the following peak (Soaked CBR, UCS) values with PCB stabilization; Ogun(15%, 93.37%), Oyo(19.65%, 95.19) and Osun(18%, 171.315%), the compaction result did not concur with the endless addition of PCB to the lateritic samples.

Keywords:- *Stabilization, Pulverized Cowbone (PCB), Lateritic soil,), Unconfined Compressive Strength (UCS), Additive, Highway.*

I. INTRODUCTION

The demand for acceptable transportation and highway facilities as well as economical highway construction materials that meets engineering and safety requirements is rapidly increasing with spikes in population and the maintenance cost of the existing or current transport facility. Highway engineers are tasked with the responsibility of providing viable, economical and sustainable solutions to this demand through thorough investigations into very suitable and/or substitute materials for Highway construction. As a result, continuous researches and investigations have been carried and are still being carried out by individuals, firms and institutions on means to improve the engineering properties and characteristics of soils. The most abundant and available soils most times possess some deficiency in their engineering properties to bear the expected traffic load.

In recent times, the use of soil in construction works or foundation purposes has been a cause of concern because the soils do not meet geotechnical engineering requirements hence the need for their stabilisation or improvement to meet the needed requirements. [17]; [19]; [45]. Soil with particle size passing the 75 µm sieve, are referred to as fines according to the Unified Soil Classification System [13] and [2], classification systems. The important properties of the soil such as soil composition, particle friction, compaction, moisture and type of soil in any soil are affected by the amount of fines content [26].Although varying from a soil sample to sample, the performance of the soil as a sub-base material is influenced by these engineering properties. Phase problems, such as minimum and maximum void ratios and porosity, are also influenced by the roles of fines content in soil [34].

Laterite soils as sustainable building materials are defined as materials that meet the requirements for present engineering use without presenting any adverse effect to future engineering [39]. They are environmentally friendly materials as they are readily available earth materials and naturally occurring. Due to the increasing cost of highway construction projects, laterite has been integrated in the past and recent projects. Laterite soil is a group of highly weathered soils formed by the concentration of hydrated oxides of iron and aluminium [47]. Alternative definitions have used the ratio of silica (SiO_2) and sesquioxides (Fe_2O_3 + Al_2O_3) where the ratios are less than 1.33 in lateritic soil. Laterite is a widely known and used construction material in building and road construction. In tropical parts of the world, lateritic soils are employed as a road making material and they form the subgrade of most tropical roads. The sub-base and base of low-cost roads carry low to medium traffic. Further, they are used in rural areas of Nigeria for building blocks and plastering [40].

The price of these materials has rapidly increased due to the spike in the cost of energy since the 1970s.[35]. the large dependence on these chemical stabilisers (cement, lime etc.); has kept the construction cost of stabilised roads high [35]. This has led to a hindrance in road construction in poor and underdeveloped nations and hence limited the mobility and accessibility of the high percentage of rural residents in these nations [6]. Hence, the use of animal waste such as pulverized cow bone for soil improvement will to a reasonable extent cut the cost of road construction and mitigate environmental hazards due to indiscriminate disposal of this waste.

This study seeks to evaluate and compare the effect of pulverized cow bone (PCB) on laterite soil at varying depths of 500mm, 750mm and 1000mm as stabilizers of sub-base for the construction of highway pavement.

Population increase, globalization, modernization and increased human mobility traversing from rural to urban areas have continued to impose heavy traffic load repetitions on state roads and federal highways. This has led to an increase in imposed traffic demands, in terms of highway construction and maintenance of existing highway pavements. Natural materials are now being considered sort after as suitable, environmentally friendly and economically viable stabilizers or construction materials for road developments. [4], stated that materials for civil engineering repair and construction works should be viable, easily accessible, economical and readily available. The use of local materials is of paramount importance to sustainability in construction because of its availability, cost-effectiveness and ability to protect the environment as well as resource conservation. Laterite as a locally available material looks promising as a better alternative to conventional pavement materials except for a few problems. Laterite soil consists of high plastic clay; the plasticity of laterite may result in cracks and damage on building foundations, pavement, highways or any other construction projects, thus the need for the stabilisation of laterite.

The utilization of agricultural products and animal wastes have been evaluated in some studies in laterite stabilisation for road construction purposes. [48], investigated the influence of millet husk ash (MHA) on the engineering properties of lateritic soil. The study provided a guide for the utilization of MHA as a lateritic soil stabilizer. It showed that instead of dumping millet husk arbitrarily and indiscriminately, constituting environmental hazards, it could be utilized to modify the index properties of the lateritic soil for road construction. Hence, waste material is converted to a useful source of wealth creation. [39], evaluated the geotechnical properties of soils stabilized with sawdust ash (SDA). There was a significant increase in the maximum dry density (MDD), optimum moisture content (OMC) and unconfined compressive strength (UCS).

The availability of good natural soil with suitable construction properties is diminishing. The bearing capacity is a very important criterion that qualifies a particular soil for use as a road construction material. Unavailability of suitable material or utilization of poor materials for construction works has led to the construction of road pavement with unsuitable or poor material, which has eventually led to failure or outright collapse of the road structure. Hence, it is pertinent to modify or improve the quality of soils or foundation construction materials to make the poor material suitable (improved) for civil engineering applications or construction purposes. To combat the nuisance of environmental pollution, especially in Nigerian meat markets and abattoirs where bones are littered in the environment limiting human activities, hence the use of pulverized bone ash in the stabilisation of the laterite material.

II. GEOLOGICAL SETTING OF THE STUDY AREA

The study area covers the following locations Asubiaro, Oshogbo LGA, Osun state (with latitude N 7° 46′ 6.324″ and longitude E 4° 32′ 52.788″), road-cut at about 1km south of Aiyetoro junction Itele Lafenwa, Ado-Odo/Ota LGA, Ogun state (with latitude E 003° 12.313” and longitude N 06° 37.004”) and Idi-Ayure LGA Odo Ona Kekere Ibadan, Oyo state (with latitude N 07° 18.102′ and E 003° 50.988′).

The topography of the areas can be described as undulating with Oyo and Osun study areas characterised by hills and valleys. The elevated terrains are the high-rise outcrop. The altitude of sampling points within the Oshogbo ranges between 300m and 320m, Lafenwa Aiyetoro 40m and 60m, and Ibadan 150m and 200m, all above sea level. Basement areas show a dendritic drainage pattern influenced by structural control. This study area is located in a tropical climate zone with clearly defined rainy (wet) and dry seasons. The rainy season occurs between March/April to September/October and November/December to February for the Harmattan or dry season. The annual rainfall data for the areas are Oshogbo 1241mm, Ogun 1591mm and Ibadan 1311mm with peaks usually in June. The mean annual temperature data for Oshogbo, Ogun and Ibadan are 26.1℃, 27.1℃ and 26.5℃ respectively with a mean relative humidity of 95.5%, 81% and 74%. Due to relative humid conditions. A greater proportion of the soil is ferruginous tropical red soil(laterites) associated with basement complex terrain.

Geologically these locations fall within areas underlain by the Precambrian basement complex rocks of southwestern Nigeria (Fig.1) which comprises igneous and metamorphic rock units such as gneisses, migmatites, biotite schists, hornblende-biotite, psammitic rocks, quartzites, metabasites, intrusive and associated masses including older granite ridges and pegmatites. Essentially, metamorphic rocks and igneous intrusions such as veins, dykes and pegmatites underlie the area. These rocks occur either directly exposed or covered by the shallow mantle of superficial deposits. Though the assemblages have been variedly classified, they may be broadly subdivided into the ancient gneiss-migmatite complex, the schist belts and the Pan-African intrusive series or the older granites plus minor rocks. Schist chemically weathers into the clay which is a poor sub-grade/subbase soil.

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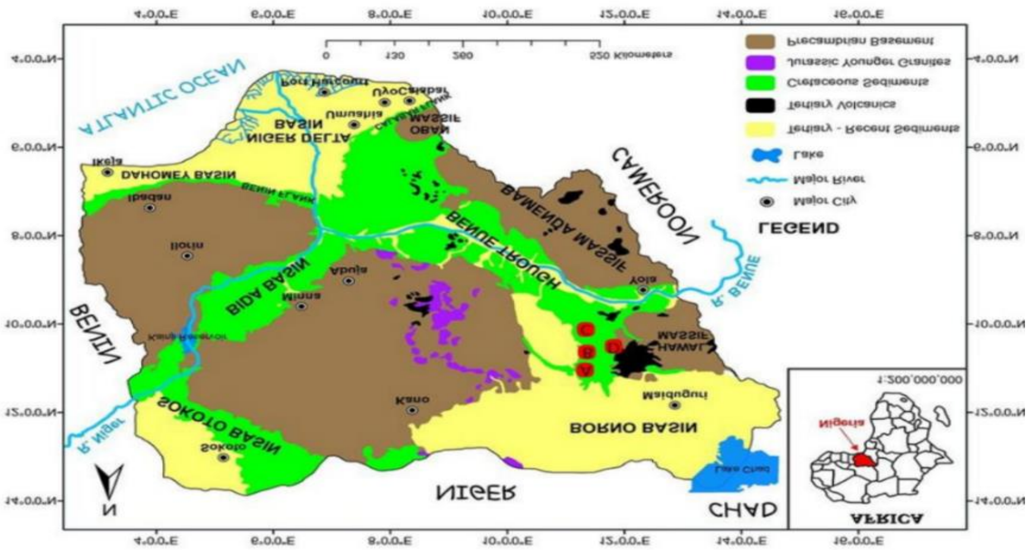

Fig 1: Generalized geological map of Nigeria

Fig. 2: Asubairo Oshogbo LGA Osun state sampling area

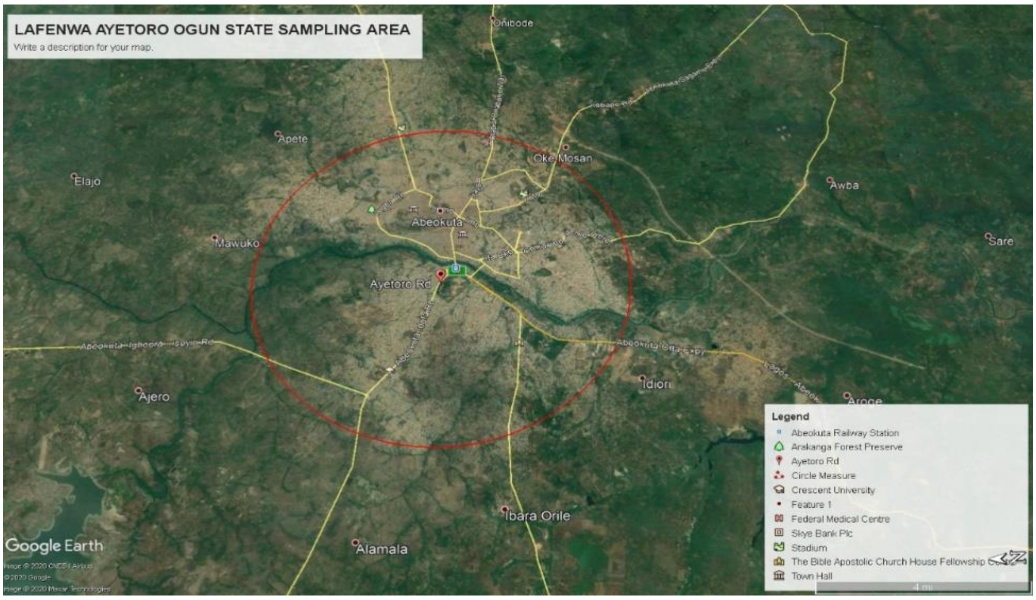

Fig 3: Lafenwa Aiyetoro Ogun state sampling area 2

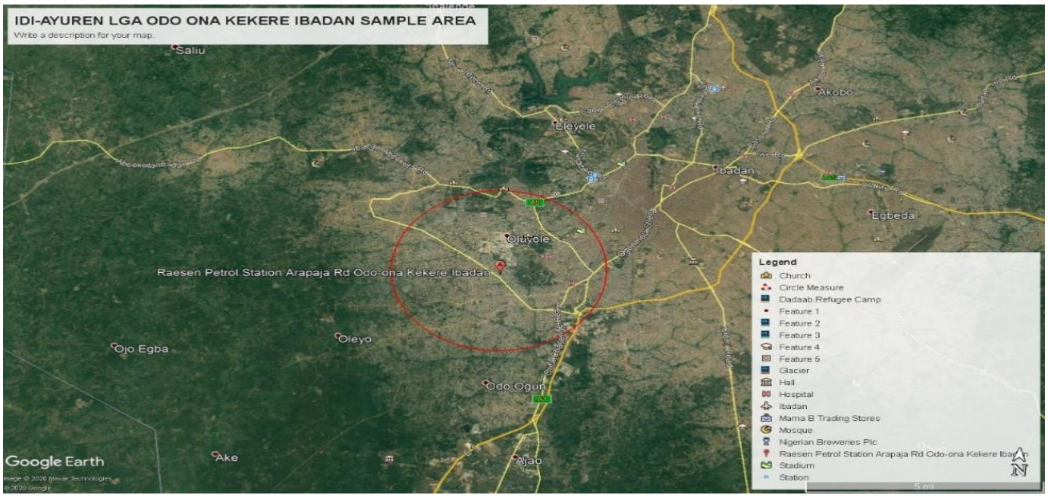

Fig. 4: Idi-Ayuren LGA Odo Ona Kekere Ibadan Oyo state sampling area 3

III. MATERIALS AND METHODS

A. *LATERITIC SOIL*

The research on the lateritic soil samples is carried out due to its abundant availability and its many geotechnical engineering applications in Nigeria. The laterite soils for this study were at depths representative of the soil stratum and not more than 1000mm below the natural ground at each sample collection point. The sample collection depths were 500mm, 750mm and 1000mm below the ground surface. The three different laterite samples considered for this research were gotten from pits in Idi-Ayuren LGA Odo-Ona Kekere Ibadan in Oyo state, Asubairo LGA Osun state and Lafenwa Aiyetoro LGA in Ogun state, Nigeria. The pits were excavated by diggers and shovels, and soil samples were collected into polyethene bags to prevent the exchange of moisture between samples. The samples were labelled according to their depths and location then left to air dry to eliminate existing moisture in the soils. The samples collected were disturbed had distinct physical features in terms of texture and colouration from field observations.

B. *PULVERIZED COW BONE*

The cow bone was obtained from Ikotun governor road abattoir and at Olayemi butcher, both located around the outskirt of Lagos state. The bone was sun-dried for 8 months to remove the excess fats and oil in it, to enable the bone to be pulverized to powder form. The bone was then ground at a grinding mill at Bariga market in Lagos State, Nigeria. The pulverized cow bone obtained was stored in an air-tight container to prevent the addition of moisture to it before testing.

C. *METHODS*

The following laboratory tests were performed on raw laterite samples as well as its pulverized cow bone stabilized counterpart excluding the preliminary Grain size analysis test: Atterberg limits test, Shrinkage test, swelling test, Compaction test, Specific gravity, California Bearing Ratio (CBR) and the Unconfined Compressive Strength test (UCS).

IV. RESULTS/ DISCUSSION

A. *PROPERTIES OF NATURAL SOIL*

a) OGUN STATE

S/N	Properties	Results
1	Colour	Reddish Brown
2	Percentage passing sieve No 200 (%)	29.14
3	Liquid Limit (%)	57.00
4	Plastic Limit (%)	21.16
5	Plasticity Index (%)	35.84
6	Linear Shrinkage (%)	10.00
7	Specific Gravity	2.61
8	AASHTO Classification [GI]	A-2-7
9	Unified Classification System	Clayey Sand (SC)
10	Maximum Dry Density (Mg/m^3)	1.80
11	Optimum Moisture Content (%)	14
12	California Bearing Ratio (%) (soaked)	4.32
13	California Bearing Ratio (%) (un-soaked)	13.00
14	Unconfined Compressive Strength (KN/m^2) at 7 days	58.12

Table 1: Properties of natural soil

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b) OYO STATE

S/N	Properties	Results
1	Colour	Brick brown
2	Percentage passing sieve No 200 (%)	22.27
3	Liquid Limit (%)	29.40
4	Plastic Limit (%)	14.68
5	Plasticity Index (%)	14.72
6	Linear Shrinkage (%)	6.00
7	Specific Gravity	2.51
8	AASHTO Classification [GI]	A-2-6
9	Unified Classification System	Clayey Sand (SC)
10	Maximum Dry Density (Mg/m^3)	1.834
11	Optimum Moisture Content (%)	10.7
12	California Bearing Ratio (%) (soaked)	5.60
13	California Bearing Ratio (%) (un-soaked)	6.35
14	Unconfined Compressive Strength (KN/m^2) at 14 days	162.96

Table 2: Properties of natural soil

c) OSUN STATE

S/N	Properties	Results
1	Colour	Pale Brown
2	Percentage passing sieve No 200 (%)	9.45
3	Liquid Limit (%)	51.40
4	Plastic Limit (%)	25.19
5	Plasticity Index (%)	26.21
6	Linear Shrinkage (%)	7.00
7	Specific Gravity	3.00
8	AASHTO Classification [GI]	A-2-7
9	Unified Classification System	Well-graded Sand with clay (SW-SC)
10	Maximum Dry Density (Mg/m^3)	1.890
11	Optimum Moisture Content (%)	9.00
12	California Bearing Ratio (%) (soaked)	7.35
13	California Bearing Ratio (%) (un-soaked)	6.52
14	Unconfined Compressive Strength (KN/m^2) at 14 days	159.7

Table 3: Properties of natural soil

Oxide	SiO_2	Cao	K_2O	Fe_2O_3	MgO	Al_2O_3	SO_3	Na_2O_3	MnO
PCB	88.97	0.93	0.66	0.39	0.34	0.14	0.06	0	0

Table 4: Oxide composition of the pulverized cow bone powder

B. COMPARATIVE VARIATIONS OF COMPACTION RESULTS

A comparative look at the compaction results for the three states showed that Osun state attained the highest maximum dry density (MDD) value at 1.89mg/m3 in its natural state (0% PCB), with Oyo in second at 1.85mg/m3 at 4% PCB and Ogun in third at 1.834 mg/m3 at 2% PCB as shown in fig 4.12. The optimum moisture content also showed Ogun state having the highest recorded moisture content at 15.2% at 2% PCB, Osun state in second at 12% OMC at 2% PCB and Oyo state with 11.3% OMC at 4% PCB as shown in fig 4.13. The relationship in the OMC and MDD results shows that the Osun state soil sample exhibits the best compaction properties amongst the soil samples with a high MDD and a reasonably low OMC in its natural state, with the Oyo state soil sample in second with its peak MDD at 4% PCB and the Ogun state sample being a highly plastic cohesive soil possessing lots of fine clay particles exhibits the worst compaction properties amongst the soil samples with its peak MDD and OMC at 2% PCB.

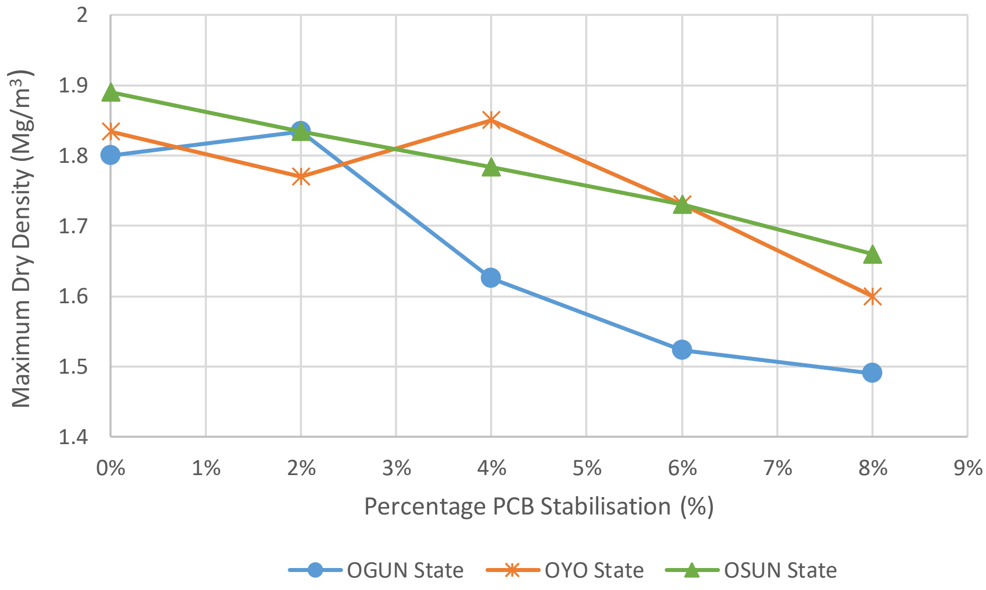

Fig. 4: Samples variations in MDD with PCB additive.

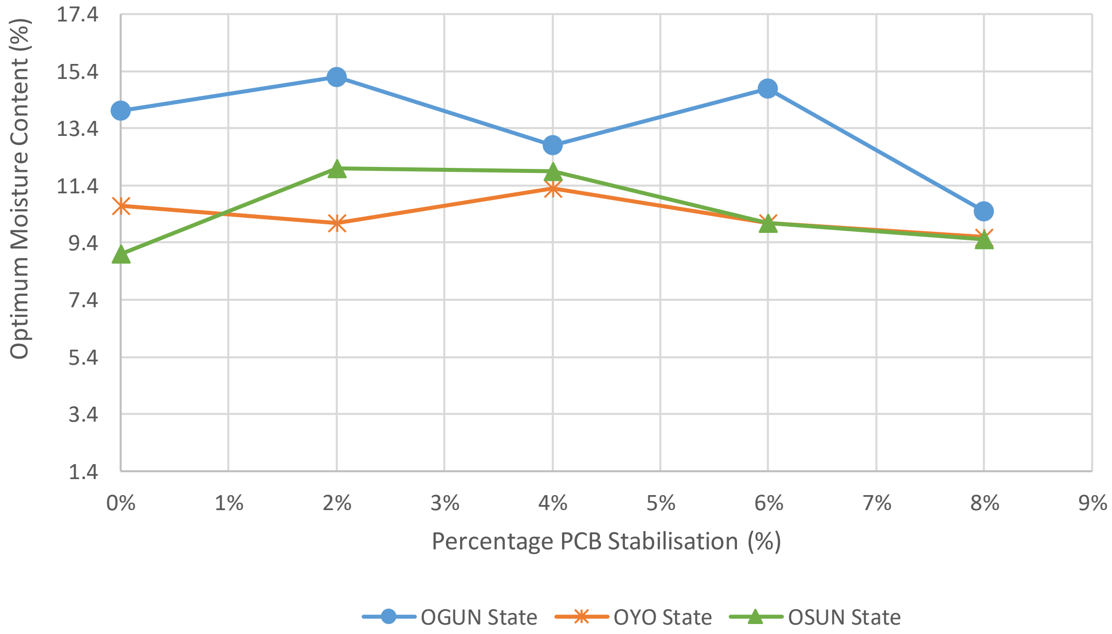

Fig. 5: Samples variations in MDD with PCB additive.

C. *EFFECT OF PULVERIZED COW-BONE ON CALIFORNIA BEARING RATIO*

a) OGUN STATE

Fig. 6 below, gives a graphical and comparative look at the results for both the soaked CBR (CBRs) and Unsoaked CBR (CBR) tests of this soil sample. It can be observed that both the CBRs and CBRu both increased with the increment of PCB additive to the lateritic soil which agrees with the findings of [3], which indicate that pulverized cow bone improved the CBR of the lateritic soil.

At 0% PCB, the loss in CBR (%) between the unsoaked and soaked CBR is significant giving a drop from 13% to 4% showing the soil has poor subgrade soaked CBR strength in its natural state as it is below the minimum specification of 5% CBR for use of soil as subgrade material [23] specifications. With the addition of PCB to the soil, the soil strength improved as seen with the increase of CBRu and CBRs results moving from 13 – 37% and 4 – 15% for addition of PCB between 0 – 8% in 2% increment. Although there is an increase in strength of the soil, the disparity in strength or loss in strength between the unsoaked and soaked CBR is still significant with an average loss in

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strength of 58.4%. This loss in strength indicates that the soil performs poorly in terms of its bearing capacity in the presence of excess moisture even when compacted and that it is a clayey soil of high strength and high moisture affinity.

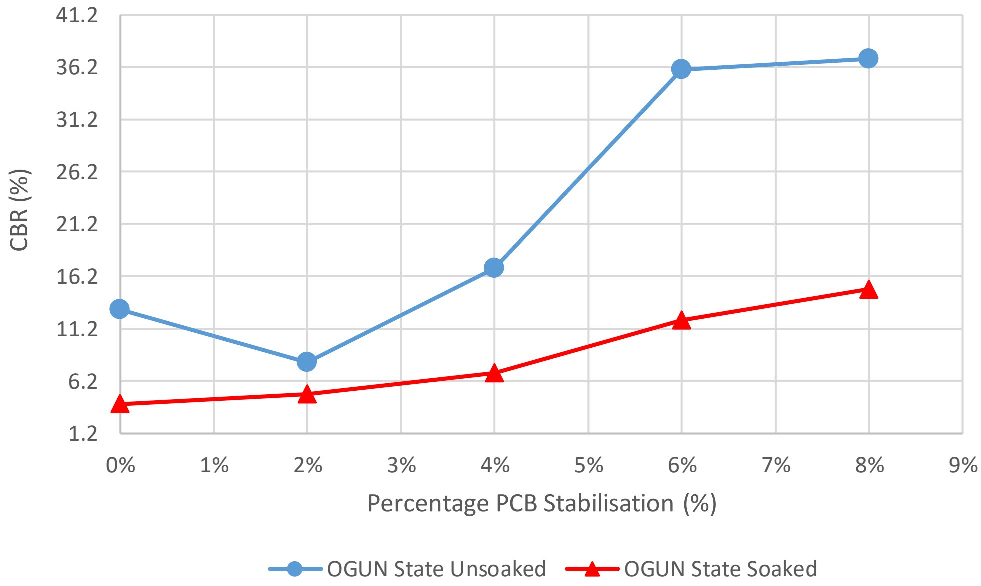

Fig 6: Ogun state Unsoaked and Soaked CBR results variation with PCB additive.

b) OYO STATE

The CBR results as shown graphically in fig.7, below shows the results for both the soaked CBR (CBRs) and Unsoaked CBR (CBR) tests of the Oyo soil sample. Observations from the results showed that both CBR results increased with the increment of the PCB additive in the lateritic soil, which aligns with the findings of [3], which indicate that pulverized cow bone improved the CBR of the lateritic soil.

At 4% PCB, there is a significant loss in CBR (%) strength of about 44%, generally, all CBRu and CBRs results exceeded the 5% CBR subgrade use as specified in [23] specifications. The loss in CBR strength decreased with PCB increment and the average of total losses was calculated as 10.6% which is little. The Oyo state soil sample can then be said to have coarse particles with moderate moisture affinity.

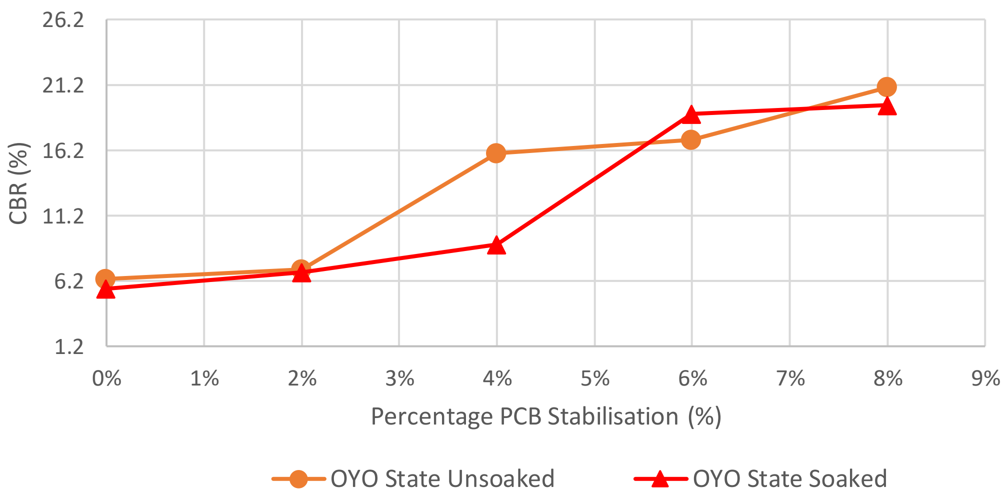

Fig. 7: Oyo state Unsoaked and soaked CBR results variation with PCB additive.

c) OSUN STATE

Fig 8. Shows the graphical representation of the results for both the soaked and unsoaked California Bearing Ratio (CBR) tests carried out on the Osun state lateritic soil sample. It can be observed that the results for both samples show an increase in CBR (%) strength with increment of Pulverized Cow Bone (PCB) additive to the soil, which also agrees with findings of [3].

At 0% and 2% PCB, the soaked CBR results (7.35% and 9% respectively) were higher in value than that of the unsoaked CBR (6.52% and 8% respectively), this shows that the combination of moisture and an increase in PCB fines aided in increasing the strength of the soil up to a certain point between 0 - 4% PCB additive. At 4% the unsoaked CBR strength results exceed that of the soaked CBR, although the loss in CBR strength begins earlier as indicated on the graph and increases from 2% PCB increment to 8% PCB addition, the average of total losses in CBR strength (%) was calculated as 10.2%. The increase in unsoaked CBR strength showed that the strength of the coarse particles which is significant in this sample outweighs the effect of water on the fines content.

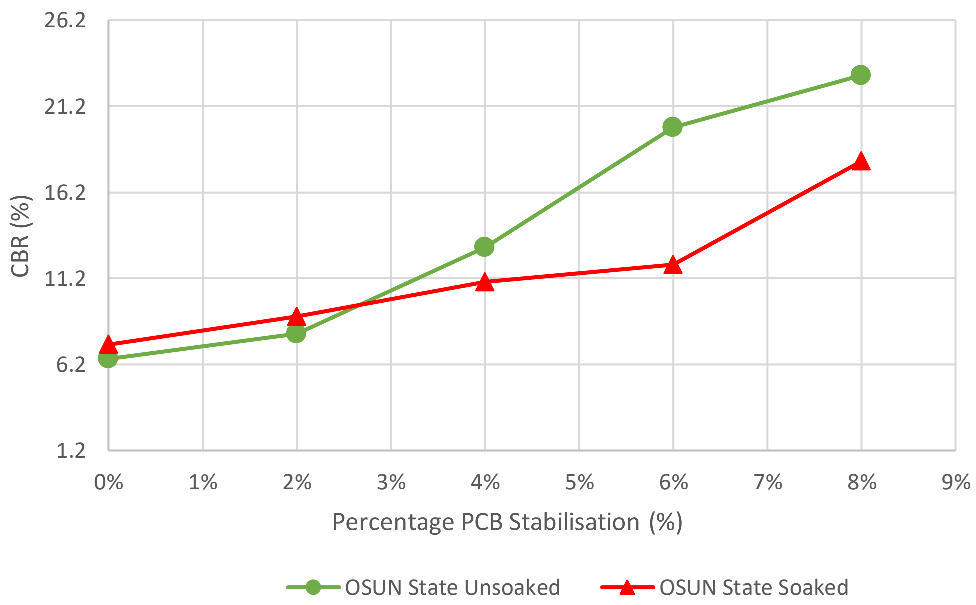

Fig. 8: Osun state Unsoaked and soaked CBR results variation with PCB additive

D. COMPARATIVE VARIATIONS OF SOAKED CALIFORNIA BEARING RATIO RESULTS

The results of the soaked California bearing ratio (CBR) tests on all three state samples treated with different percentages of pulverized cow bone (PCB) are shown in fig. 9. The results showed that an increment in the percentage of PCB increased the soaked CBR of all three lateritic soil samples, although the degree of increase with PCB increment varied differently for each of the three samples. Whilst the Ogun state lateritic soil sample gave the least strength in CBR, ranging between 4 -15% in value. Both the Oyo and Osun state samples showed remarkable CBR strength variations with PCB percentage increments, with the Osun sample having the greater CBR values of 7.35%, 9% and 11% than the Oyo state sample's 5.6%, 6.85%, and 9% respectively from 0 - 4% PCB at an increasing proportion of 2% PCB. The Oyo lateritic soil sample exceeded the Osun lateritic soil sample in CBR strength values from 4% - 8% PCB additions to the soil. The low CBR strength exhibited by the Ogun state lateritic soil sample in contrast to the other two samples shows that the strength presented by the significant amount of coarser material present in both the Oyo and Osun state lateritic soil samples outweigh the effect of water on the significant fines content (as shown by its high plasticity index) present in the Ogun state lateritic soil sample.

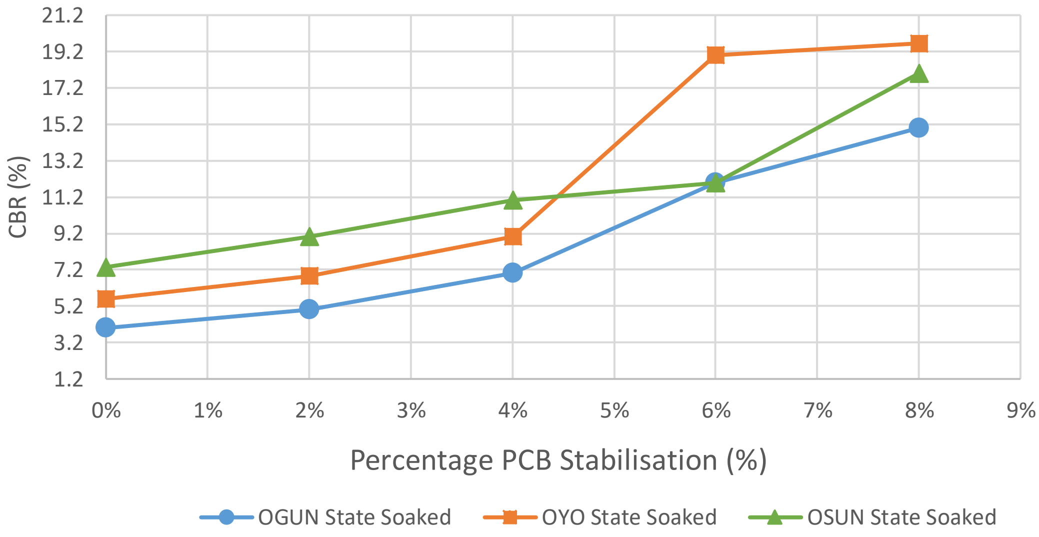

Fig. 9: Comparative variations of Soaked California Bearing Ratio results.

E. EFFECT OF PULVERIZED COW BONE ON UNCONFINED COMPRESSIVE STRENGTH

a) OGUN STATE

Results of the Unconfined Compressive Strength (UCS) indicate a deviation from the norm when compared to the results of other engineering parameters. These results are shown graphically in fig.9 The UCS results show the shear strength of the soil after air curing for 7, 14 and 28 days. The 7 days of curing ultimately decreased in value with an increase in PCB additions and achieved the lowest UCS strength values with a peak strength value of 80.838 KN/m^3 at 2% PCB. The highest UCS strength values were achieved at 28 days of air curing. The peak strength achieved was 93.373 KN/m^3 at 2% PCB stabilisation, the increase in the UCS values is due to the increase in cohesion between the fine PCB particles and the lateritic soil and hence the bonding of the soil increases, therefore increasing the Unconfined Compressive Strength.[5]. The reduction in UCS value after peak strength is reached with an increment of pulverized cow bone is due to the effect of water on the bonding forces between particles. At 4%, the adverse effect of water on the bonding forces between PCB and the lateritic is significant. The subsequent increase in UCS values shows that the continual increment of the PCB additive to soil improved the shear strength of the soil.

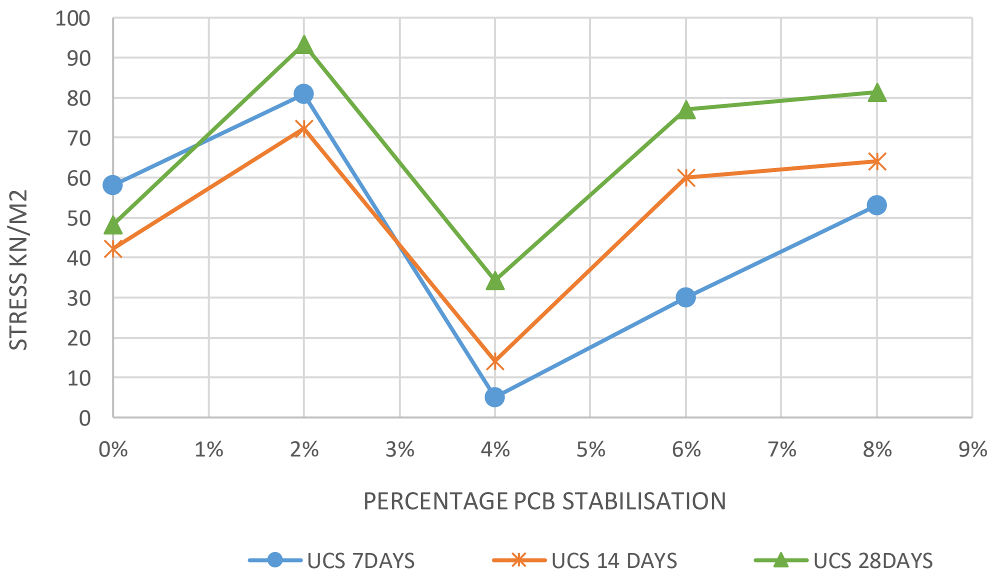

Fig 10: Ogun state Unconfined Compressive Strength variations with PCB additives.

b) OYO STATE

The Unconfined Compressive Strength results for the Oyo state stabilised soil sample is shown in fig.10 The UCS results show a general reduction in the shear strength of the soil with an increase in the PCB additions to the soil. This reduction in strength was observed in all three drying stages

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of the samples (7, 14 and 28 days). The highest strength for all curing stages occurred at 0% PCB, with the peak UCS value obtained at 14 days of curing at 162.96 KN/m^3 followed by a subsequent decrease in value with increment additions of PCB additive up to 8%. This is due to the increment in PCB fines in the soil which causes an increase in the water content within the soil mass, this causes a decrease in the shear strength of the soil and hence a drop in the UCS values as water harms the bonding forces between PCB and the lateritic soil. [36] discovered that the unconfined compressive strength is a function of the water content in the void of the soil. This supports the reduction in UCS values with increasing fines in the lateritic soil.

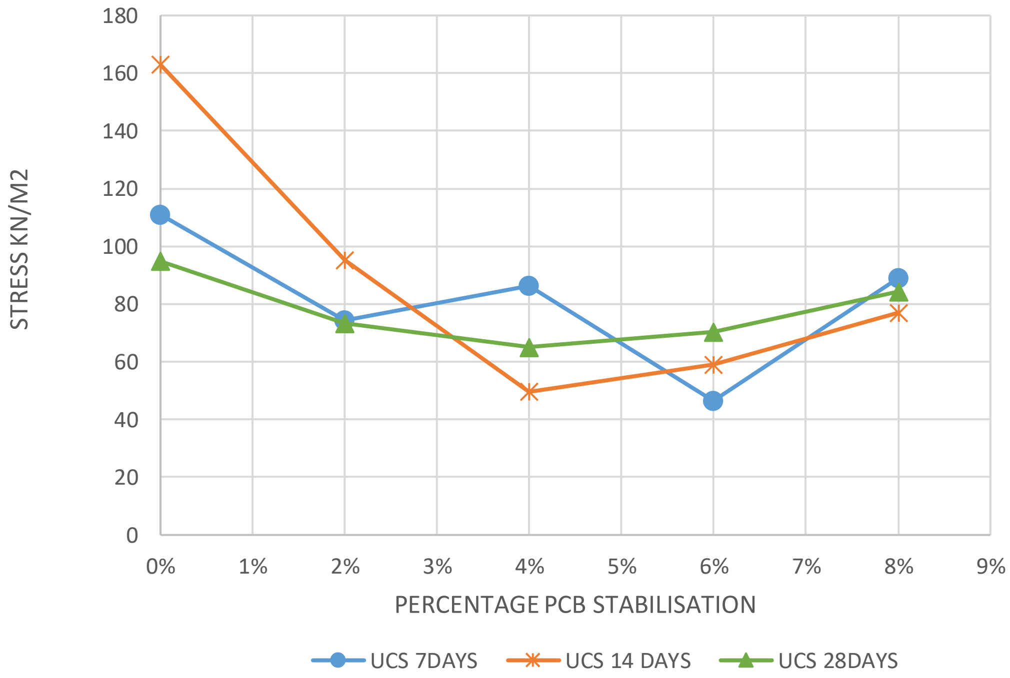

Fig. 11: Oyo state Unconfined Compressive Strength variations with PCB additives.

c) OSUN STATE

Fig 12. indicates graphically the Unconfined Compressive Strength tests results carried out on the Osun state lateritic soil sample and air-cured for 7, 14 and 28 days. The results show that at 0% PCB, the 14 days shear strength is highest with a value of 159.7 KN/m^3 while the 28 days shear strength of 54.32 KN/m^3 is the lowest, this observation indicates that the presence of some moisture within the natural soil mass aids in improving the shear strength of the soil after as shown by the higher 7 and 14 days UCS values. Also observed, was a decrease in the UCS values and a subsequent increase of the values with an increase in PCB at a 2% increment. At 0 - 4% PCB, the UCS values for both the 7and 14 days curing stages fall below the shear strength values for the natural soil, while the 28 days shear strength values increased from 2% PCB additions and achieved the highest UCS shear strength value at 8% PCB at 171.315KN/m^3. This summation agrees with findings in [3] which established the consistent improvement in the UCS of the lateritic soil following the addition of PCB. This improvement in shear strength with an increment in PCB fines additions shows that the addition of these fines increased the cohesion within the soil mass and hence the bonding forces increases thereby leading to the increment in UCS values with increased proportions of PCB additives.

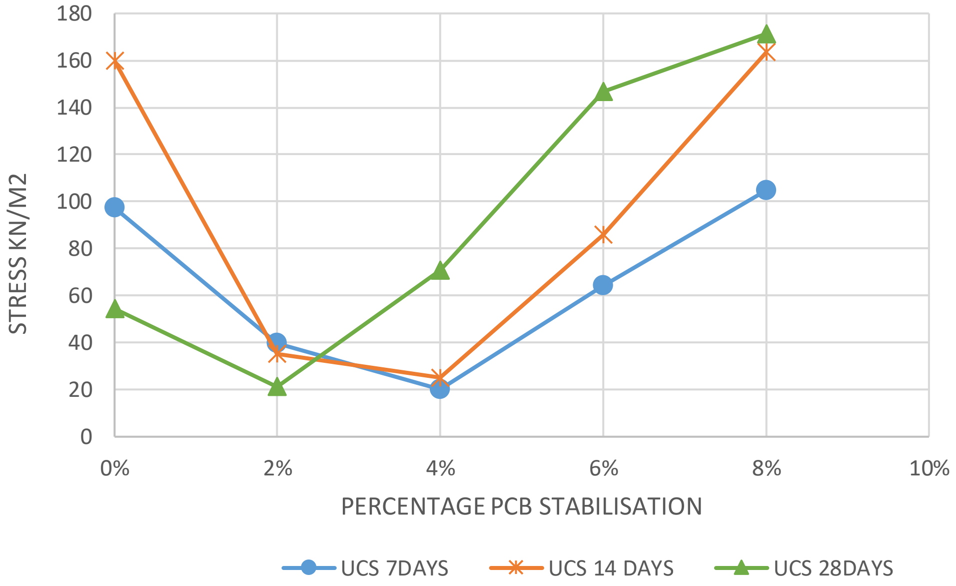

Fig. 12: Osun state Unconfined Compressive Strength variations with PCB additives

F. COMPARATIVE VARIATIONS OF UNCONFINED COMPRESSIVE STRENGTH RESULTS

Fig.13, shows a graphical variation of the maximum strengths achieved for all lateritic soil samples treated with pulverized cow bone stabiliser. At 0% Oyo state lateritic soil sample achieves its peak strength at 162.96 KN/m^3 and decreases with the increment of PCB additive. The Ogun state lateritic soil sample ranged at shear strength values between 65.13 KN/m^3 to 94.82KN/m^3, achieving a peak strength at 2% PCB stabilisation. The Osun state lateritic soil sample shows an increase of UCS values with increment in PCB additives with a maximum value of 171.315 KN/m3 achieved at 8% PCB. Observations show that the Osun state lateritic soil shearing strength is improving with increasing PCB stabilisation and offers the highest strength as a subgrade for road work.

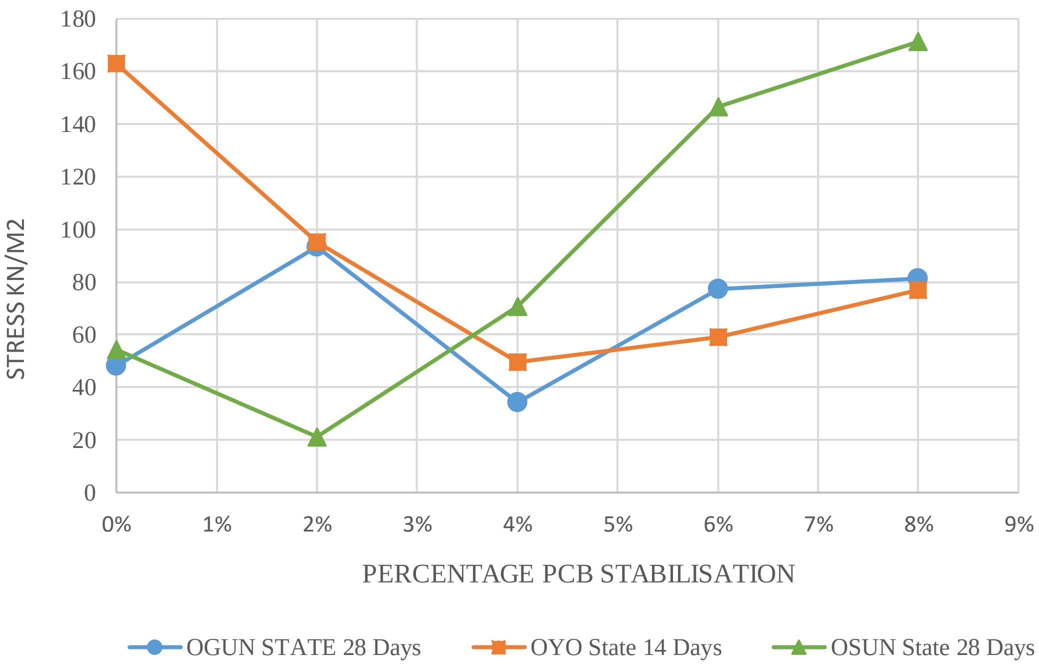

Fig 13: Comparative variations of Unconfined Compressive Strength results.

V. CONCLUSION

As a result of this study, the conclusions drawn are as follows:

- The geotechnical analysis of the natural samples showed that the Oyo and Osun state samples exhibited good engineering properties for use as subgrade in road works with soaked CBR values of 7.35% and 5.60 respectively, which are above the set minimum of 5%. The Ogun state sample exhibited poor engineering properties for subgrade with a CBR of 4%.
- The strength properties for all samples improved with increment in PCB additive from 0 - 8% PCB with the following peak (Soaked CBR, UCS) values obtained from stabilisation with PCB; Ogun(15%, 93.37%), Oyo(19.65%, 95.19) and Osun(18%, 171.315%).
- Though the desired enhancement in the strength properties of all samples was achieved, several deficiencies obtained from the Atterberg limits, plasticity index, and compaction properties of the lateritic soil samples puts a limit to the optimum stabilisation ratio of the samples beyond which the suitability of the lateritic soil as subgrade material would be compromised as; Ogun (2% PCB), Oyo (4% PCB) and Osun (0% PCB).
- The Unconfined Compressive Strength values obtained for all three stabilized soil samples all fell below the 750KN/m^3 minimum set for highway subgrade.
- The Osun state lateritic soil sample provided the best engineering index and improved strength properties amongst the three soil samples.

RECOMMENDATION

The findings of this study show that Pulverized Cow Bone (PCB) can be used to stabilize lateritic soils for use as subgrade in road works, however, variations in lateritic soil properties also lead to a variation in the optimum stabilisation strength of different samples of lateritic soil used in highway construction.

Therefore, further studies should be conducted to create a classification system for lateritic soils based on their applications for road works and highway construction as well.

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