IOSR Journal of Mechanical and Civil Engineering (IOSR-JMCE)
e-ISSN: 2278-1684,p-ISSN: 2320-334X, Volume 12, Issue 1 Ver. II (Jan- Feb. 2015), PP 77-84
www.iosrjournals.org

Comparative Study of Geotechnical Properties of Abia State Lateritic Deposits

Arinze Emmanuel Emeka[1], Ibe, Kingsley Emeka[2],
Department of Civil Engineering, Michael Okpara University of Agriculture, Umudike, Abia State, Nigeria
Building Research Department, Nigerian Building and Road Research Institute, Ogun State, Nigeria

***Abstract**: This research work compared the geotechnical properties cum suitability of Amaoba (A), Ubakala (B), IsialaNgwa (C), Ohiya (D) and Timber Market Umuahia (E) lateritic deposits in Abia State, South-Eastern Nigeria. They were predominantly A-4 soils according to AASHITO, classification. Their natural moisture content, plasticity index, maximum dry density (MDD), Optimum Moisture Content (OMC), Specific gravity and Califonia Bearing Ratio (CBR) lies between 6.71-15.21%, 8.4-17.9, 1640-1800 Kg/M^3, 16.5-22.5%, 2.26-2.62 and 29-54% respectively. The results revealed that Amaoba laterite is the most suitable and that of Timber market is problematic and not suitable as a road construction material.*
***Keywords**: Laterites, Geotechnical tests, Construction Material, Comparative Analysis*

I. Introduction

Laterites are soil types rich in iron and aluminum, formed in hot and wet tropical areas. Nearly all laterites are rusty-red because of iron oxides. They form by intensive and prolonged weathering. Tropical weathering leading to laterite is a prolonged process of chemical weathering which produces a variety of resulting soil [4]. The laterite, do not conform with any accepted specifications but performed equally well when compared with adjourning sections of road using stone or other stabilized material as base [7].

Laterization

Although laterites are marked by an enrichment of iron and a decrease of silica together with a highly soluble alkalis and alkaline earths. But these characteristics composition and properties of laterites can differ. These differences are principally because of chemical and physical features of the parent rock. [3,8,9].

Two principal groups can be distinguished:
(a) Laterites on mafic (basalt, gabbo) and ultra-mafic rocks (Serpentine, periodotite, dinite): These rocks are free of quartz and show lower silica and higher iron contents.
(b) Laterites on acidic rocks: In this group ,not only granites and granitic gneiss but, numerous sediments as clays, shales and sandstones are included.

The table below shows main element percentages of rock from these two groups and their corresponding laterites according to [11].

Table 1.1

	SiO_2	Al_2O_3	Fe_2O_3	Fe_2O_3: Al_2O_3
Laterite	46.2	24.5	16.3	0.67
Granite	73.3	16.3	3.1	0.19
Laterite	39.2	26.9	19.7	0.73
Clay	56.5	24.4	5.3	0.22
Laterite	23.7	24.6	28.3	1.15
Basalt	47.9	13.7	14.9	1.09
Laterite	3.0	5.5	67.0	12.2
Basalt	38.8	0.7	9.4	14.1

These marked differences in chemical composition of laterites from different parents rock is an indication of the differences in geotechnical and structural properties of laterites. This work studies the geotechnical properties of four lateritic deposits in Abia State. Namely; Amaoba, Ubakala, Isiala-Ngwa, Ohiya and Timber Market all in South-Eastern Nigeria.

II. Materials And Methods

Distributed soil sample were collected from Amaoba, Ubakala, Isiala-Ngwa, Ohiya and Timber Market Umuahia and each of the samples were labeled A-E respectively. The following tests were carried out accordingly on each of the samples.

a. Sieve Analysis: According to ASTM C136-06 standard test method for sieve analysis of fine and coarse aggregates
b. Compaction: AASHTO T99 and T-180; Moisture-Density Relationship of soil Using proctor mould [10].
c. Specific Gravity: According to ASTM D854-14: Standard Test methods for specific gravity of soil solid.
d. Natural Moisture Content: According to ASTM D4643-08: Standard Test Method for determination of water (moisture) content of soil by microwave , oven heating
e. Califonia Bearing Ratio (CBR): According to AASHTO 193: Standard method of test for the California Bearing Ratio.

Furthermore, the soils samples were classified using American Association of state highway and transportation Officials (AASHTO) method.

III. Results And Discussion

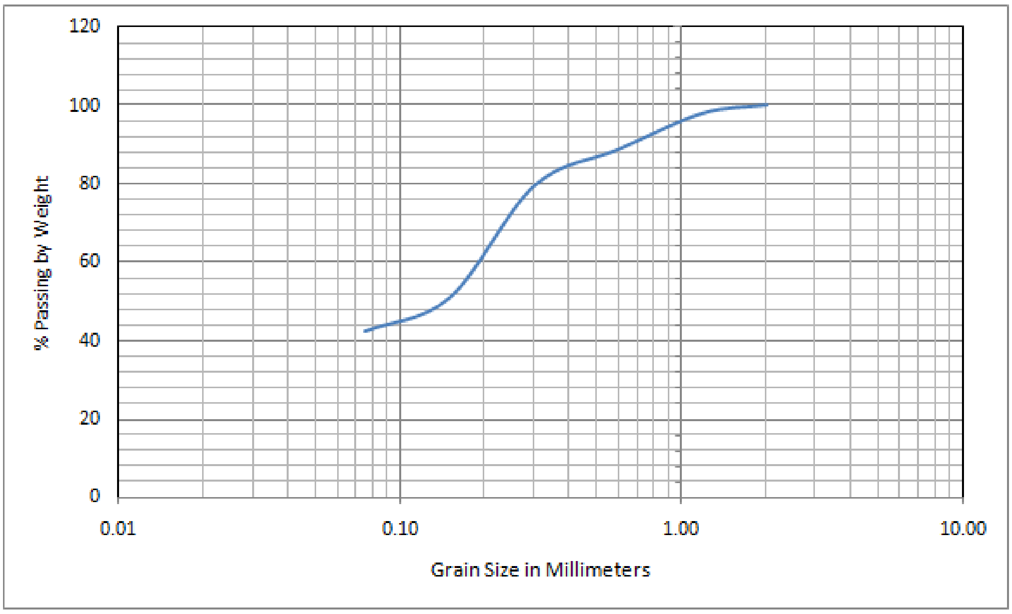
Table 1.2 shows the summary of the test results. The values represent the average for the three replicates of each sample test.

Table 1.2: Results of Laboratory Soil tests and deductions

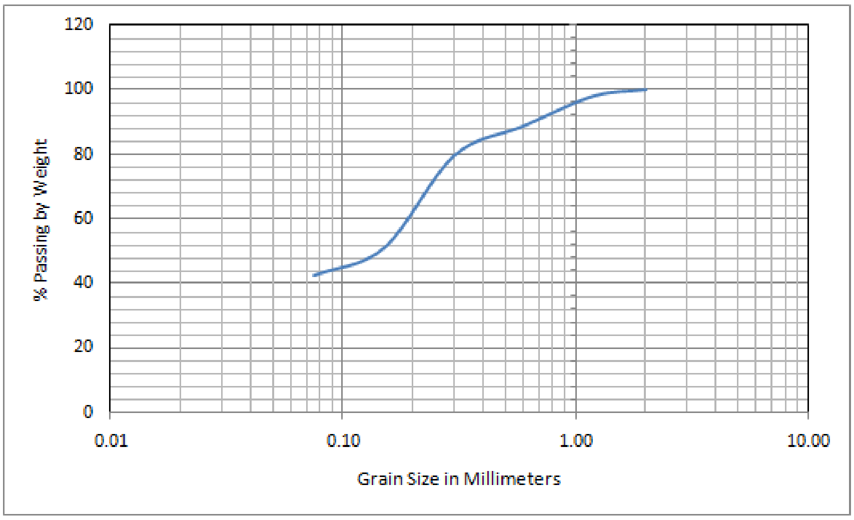
Test	SAMPLES				
	A	B	C	D	E
Classification	A-4(1)	A-4(0)	A-4(1)	A-4(1)	A-7-6(4)
Natural Moisture Content (%)	6.71	6.82	7.12	6.84	15.21
Liquid Limit	26.0	26.0	30.0	29.2	42.0
Plastic limit	16.6	17.1	21.4	17.2	24.1
Plasticity Index	9.4	8.4	8.6	10.0	17.9
Maximum Dry Density (Kg/M^3)	1790	1800	1640	1750	1720
Optimum moisture content (%)	16.5	18.3	22.5	16.5	21.9
California Bearing Ratio (CBR)%	54	33	33	33	29
Specific Gravity	2.28	2.45	2.62	2.27	2.26

Below are the graphs of sieve analysis, Atterbery limits, compaction and CBR

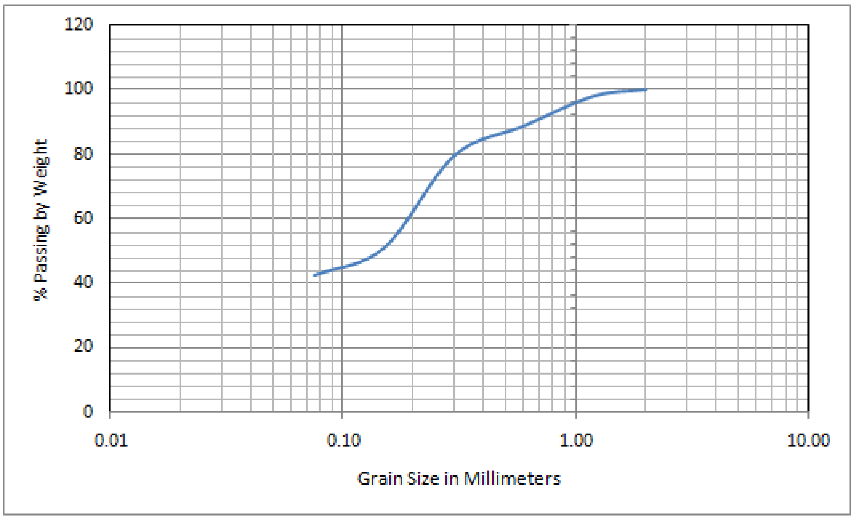
Sieve Analysis Sample A



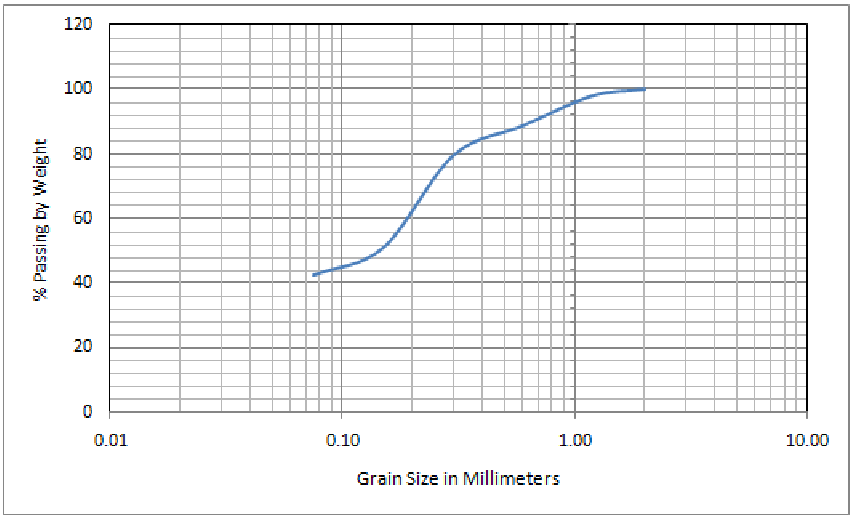
Sieve Analysis Sample B



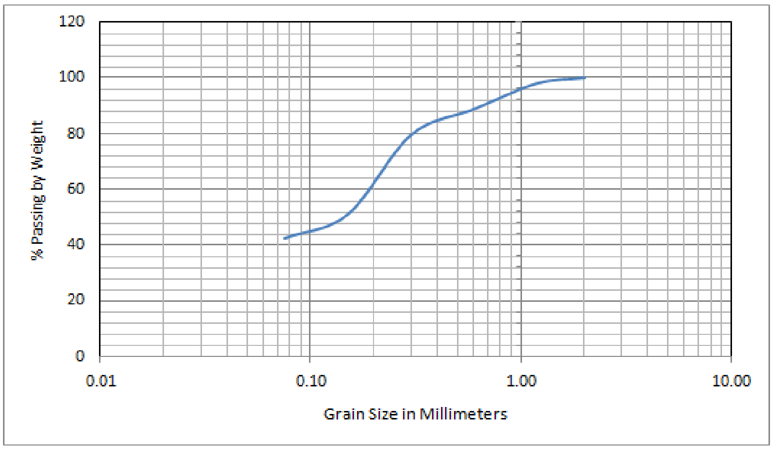
Sieve Analysis Sample C

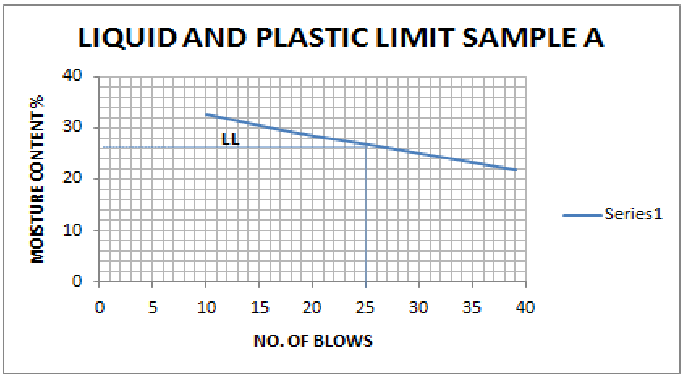


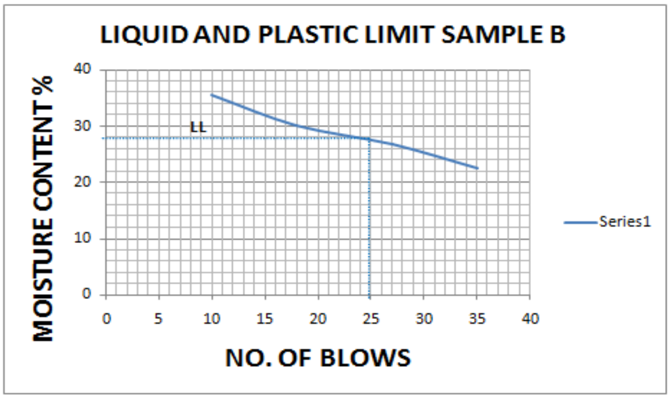
Sieve Analysis Sample D

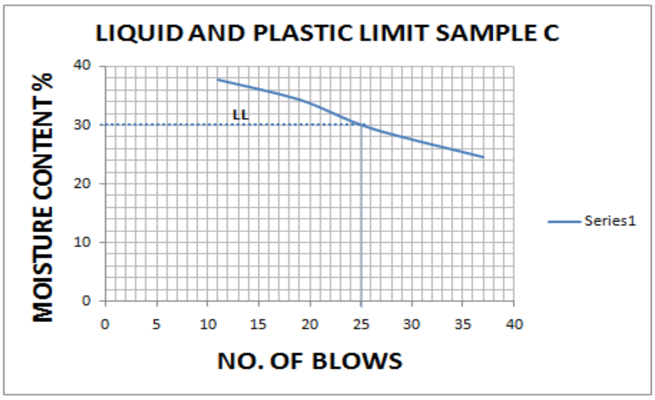


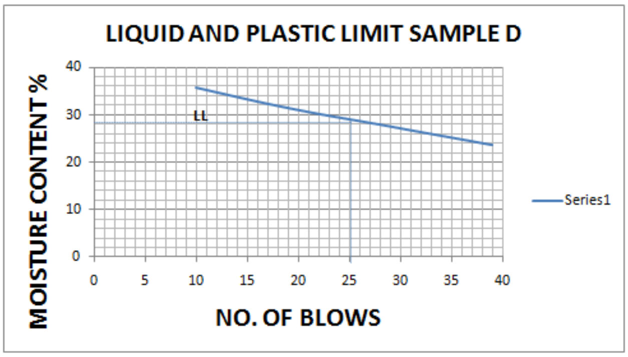
Sieve Analysis Sample E

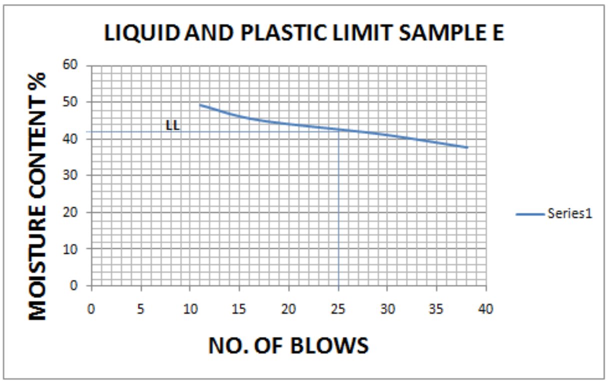




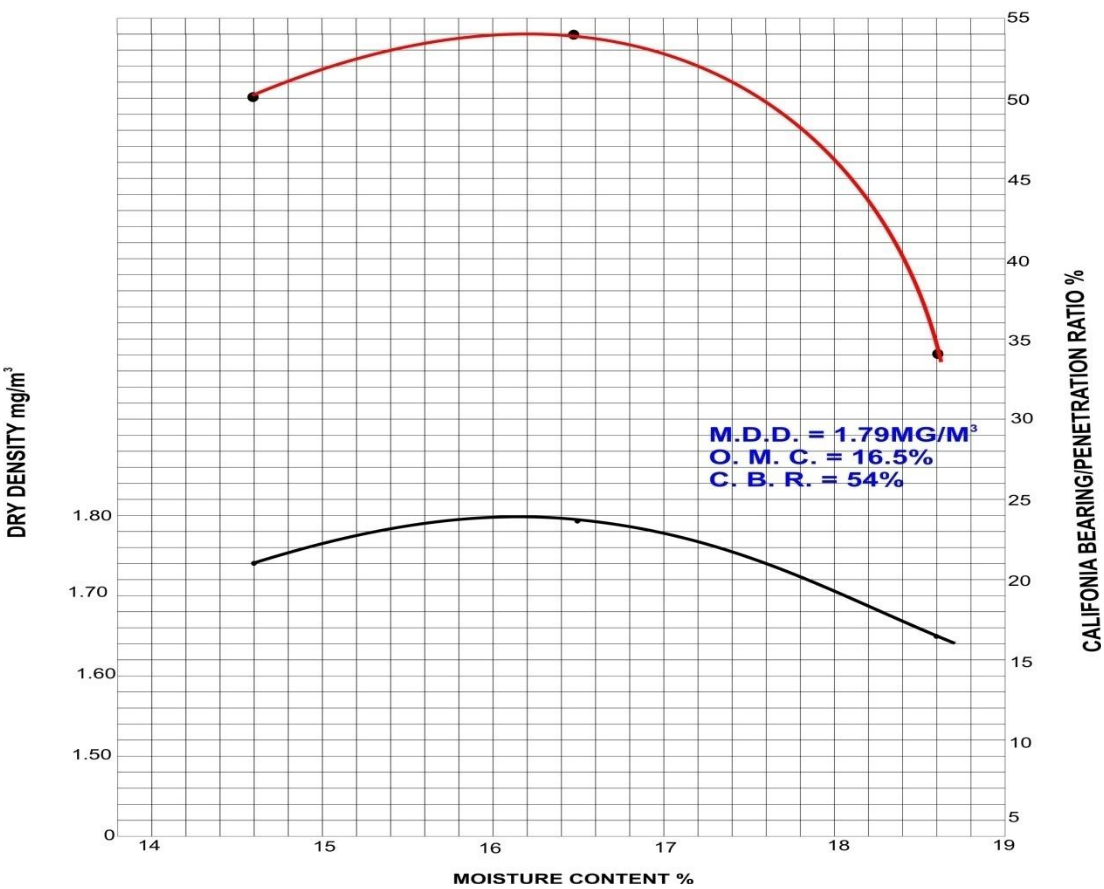




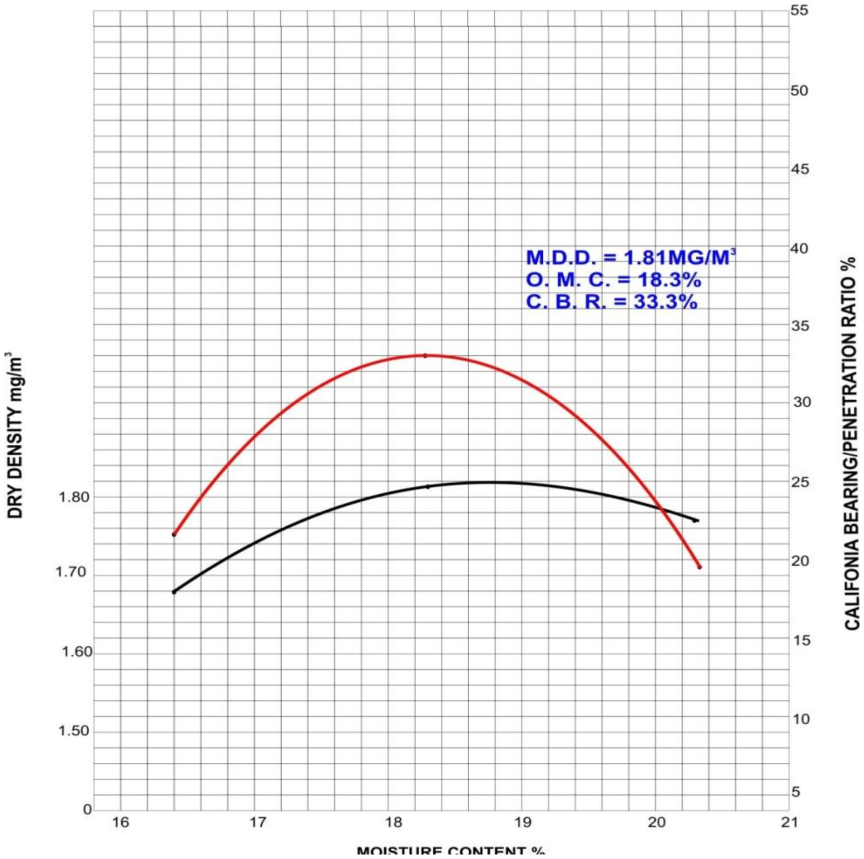




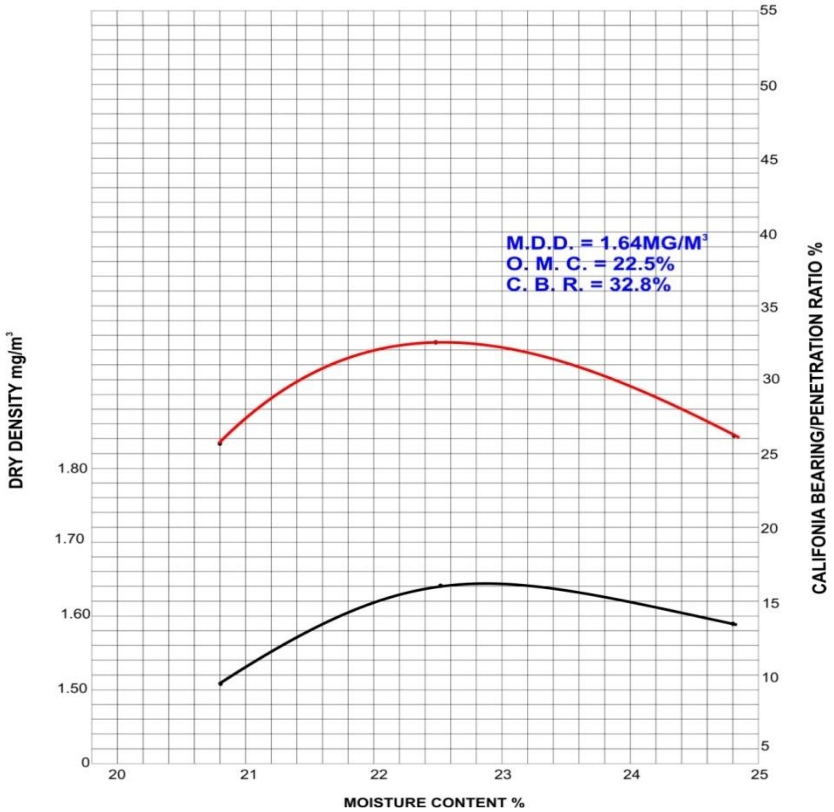
COMBINED COMPACTION/CDR TEST/MOISTURE CONTENT SAMPLE A



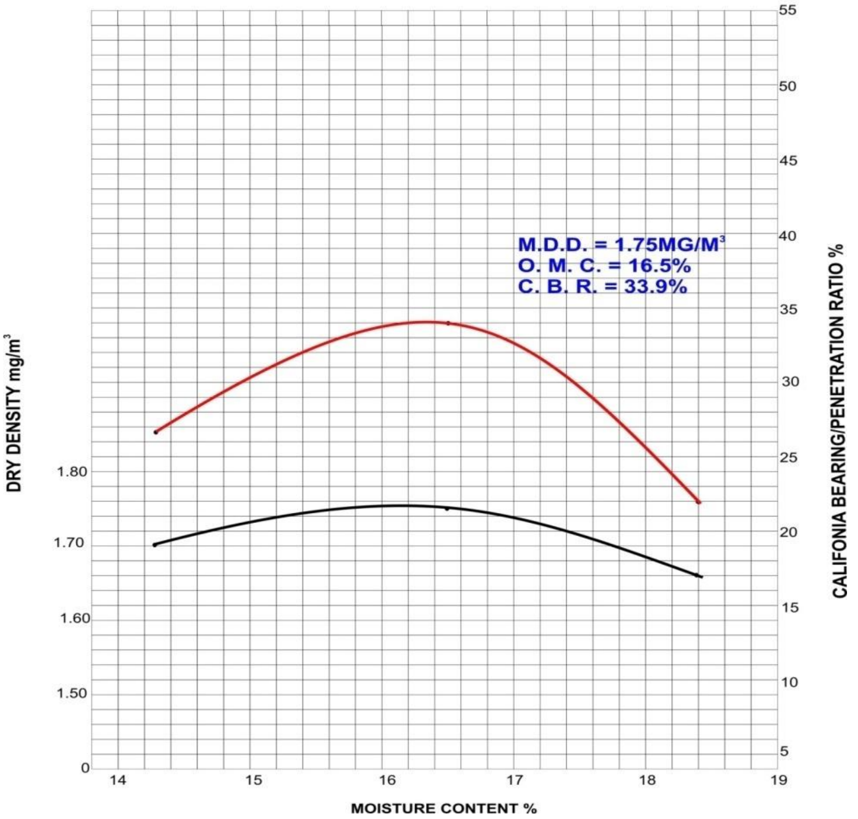
COMBINED COMPACTION/CDR TEST/MOISTURE CONTENT SAMPLE B



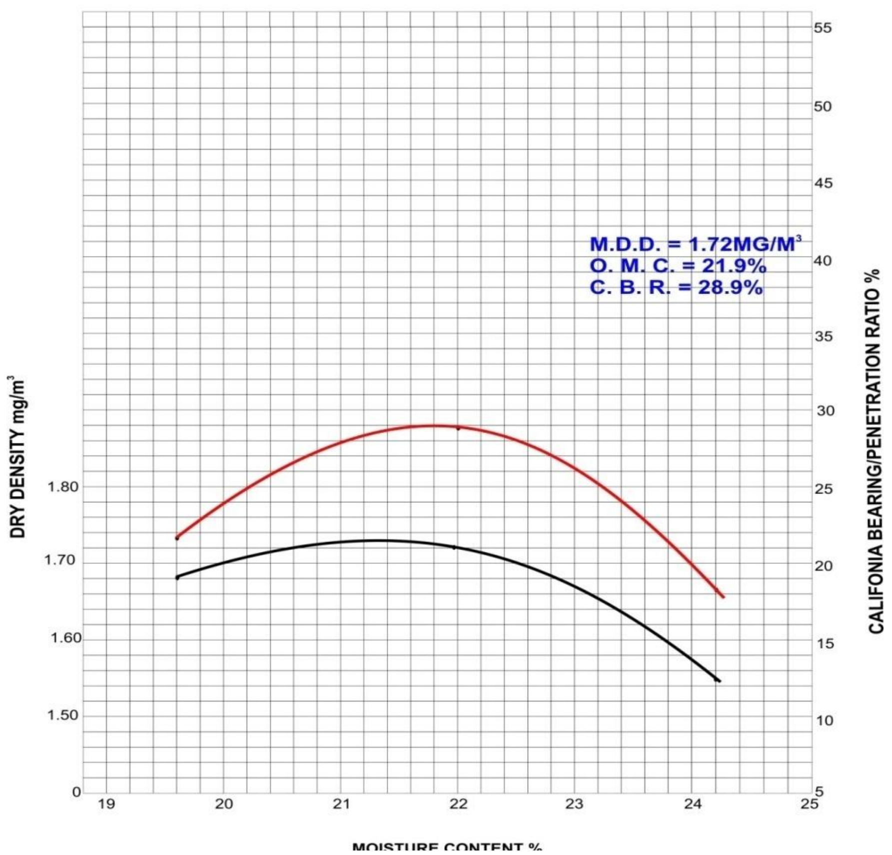
COMBINED COMPACTION/CDR TEST/MOISTURE CONTENT SAMPLE C



COMBINED COMPACTION/CDR TEST/MOISTURE CONTENT SAMPLE D



COMBINED COMPACTION/CDR TEST/MOISTURE CONTENT SAMPLE E



a. Mechanical Sieve Analysis: American Association of State Highway and Transportation Officials (AASHTO) classification of soils show that sample A to Sample D are A-4 soils with their group index lying between 0 and 1. Sample E is classified as A-7-6 with group index of 4.This implies that samples A to D are fairly suitable adequate whereas sample E is poor (FGN, 1997).
b. Natural Moisture Content: The natural Moisture content ranges from 6.71-15.21.

These were considered adequate

Specific gravity: The values of the five samples are above 2.2 specified by (FGN, 1997) and were considered adequate.

Atterberg Limits: The values of liquid limit (LL) and plasticity indices from samples A, B and D ranges from 26.0-29.2 and 16.60-17.2 respectively. Therefore samples A, B and D meet with (FGN,1997) standard for embankment, sub-base and base course, whereas samples C and E with Liquid Limit (LL) and plasticity index ranging(PI) from 30-42 and 21.4-24.1 respectively falls below the specifications of (FGN, 1997)

Compaction Properties: From table 1.2, the maximum dry density (MDD) and optimum moisture content (OMC) of the samples ranges from 1640-1800 Kg/m^3 and 16.5-22.5% respectively. These values are considered good according FGN 1997 specification
(FGN, 1997) standard is that sub base and base course should have CBR of not less than 30 and 80% respectively. This implies that samples A, B, C and D are adequate for subgrade, Subbase and general fills but not good as a base course material. Worst still, sample E is not suitable for any of the usage stated above

IV. Conclusion

The research revealed that samples A, B, C and D a generally suitable for subgrade subbase and backfill material using (FGN, 1997) as a yardstick. Having meet up to standard in most of the geotechnical test carried out.

The CBR value of sample A made it far more suitable than other samples as a road construction material. It is also suitable for base course material.

This research is an eye opener for many contractors that uses sample E as a borrow pit material. Sample E falls below the (FGN,1997) standard in most of the soil test carried out and therefore not suitable as a road construction material unless stabilized.

References

[1]. American Association of State Highway and Transportation Officals (1982). AASHTO materials, Part II, Washington, D. C.
[2]. American Society for Testing and Material (2004). ASTM Standards, Vol. 04.08 West Conshohocken, P. A.
[3]. Balan E. (2007) "Inheritance Vs. Neoformation of Kaolinite during lateritic soil formation. A case study in middle Amazon. Clays and Clay minerals 55, 253-259.
[4]. Davis A. D., Bacon, W. G.; Osborne R. C. (2004). "The past and the future of Nickel laterites; PDAC International Convention.
[5]. FGN 1997 Government of the Federal Republic of Nigeria. General Specification (Road and Bridges) Vol. II
[6]. Grace, H. (1991) "Investigation of Kenya and Malawi using dug of laterite as bases for bituminous surfaced roads. Journal of Geotechnical and Geological Engineering Springer Netherland.
[7]. Idowu S. O, Adeyemi, G. O. and Dada, S. S. (2010) "Permeability and Grain Size Characteristics of Shagamu and Ibadan-Toll-Gate Lateritic Soils in Southern Nigeria. Journal of Environmental Sciences and Resources Management pp. 86-94.
[8]. Malengreau N. and Sposito G. (1997) "Short Time Dissolution Mechanisms of Kaolinite tropical soils"Geochin.Acta 6l, 4297-4307.
[9]. Mefarlene M. J. and Bowden D. J. (1992) "Mobilization of aluminium in the Weathering Profiles of African Surface in Malwi EJSS.
[10]. Proctor R. R. (1993) Design and Construction of Rolled Earth Dams "Engineering News Record, Vol 3. 245-248, 286-289, 348-351, 372-376.
[11]. Schellmann W. (2008) "An Introduction to laterite products and Processes of intensive rock weathering Baukasten Ersteut.