STABILITY OF RED TROPICAL SOILS FROM IRRUA AND AGBOR AREA OF EDO AND DELTA STATE FOR ENGINEERING USE

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Abstract
Geotechnical characteristics and field performance of red tropical soil may be interpreted in the light of all or some of these parameters even their reaction to different stabilizing agents which includes genesis and pedological factors, degree of weathering, position in the topographic site, and depth of soil in the profile. A detailed investigation of the geotechnical properties of Irrua and Agbor soils in Edo and Delta State was done using cement and marble dust in order to access its suitability for road construction. 50kg of soil were collected from each of the study locations, from which various masses required for the Geotechnical analysis (i.e. the compaction test, California Bearing Ratio (CBR) test and Unconfined Compressive Stresstest) were measured. The CBR and UCS were determined after the addition of cement and marble dust at various percentages of 0%, 2%, 4%, 6%, 8%, 10% and 0%, 1%, 3%, 5%, 7% and 9% respectively. The result reveals that Agbor soil has CBR values for base and sub-base as 114.9% and 48.5% respectively and Compressive stress of 1,272.8 KN/m^2, while the Irrua soil has CBR values of 92.3% and 53.30% and a Compressive stress of 1466.8KN/m^2. By the standard provided by the Federal Ministry of Works and Housing, specification for Road and Bridges Construction, the Agbor and Irrua soils is best suited as base and sub-base materials, while not compromising standard.

Keywords: *Red tropical soil, geotechnical properties, stability, cement and marble dust, road construction*

1.0 Introduction

The unending quest and increase in soil utility for engineering works is expected as any country aspires towards improved infrastructural development. The relationship between all engineering infrastructure and their foundation soils is of paramount important for designers and contractors. Incessant occurrence of road pavement deterioration and building collapse mainly because their poor geotechnical and mechanical properties have made it imperative for a proper understanding of the geotechnical properties of soils (Garg, 2009).As far back as the eighteenth century, geologists identified that in warm, moist, temperate and tropical climates, water percolating through rock has a strong weathering action (Millard, 1993).Despite the great effort that has been made by previous studies to classify and differentiate tropical soils, a uniform nomenclature / classification system does not exist yet from these soils, hence the term " (lateritic clays" "lateritic gravels" and even "laterites" are still used by engineers to describe any reddish tropical soil (Northmore *et al.*, 1996). Fortunately, for engineering purposes it does not matter whether the classification is correct, but that the geological and engineering properties as predicted or derived from testing are reliable. Geotechnical characteristics and field performance of red tropical soil may be interpreted in the light of allor some of the following parameters even their reaction to different stabilizing agents i.e. Genesis and pedological factors (parent material, climate, topography, vegetation, period of time in which the processes have operated), degree of weathering (decomposition, sesquioxide enrichment and clay content, degree of leaching), position in the topographic site, and depth of soil in the profile (Gidigasu, 1976).

The soils used in road construction in West Africa are mostly residual red tropical soils which contribute to the general economy of the region where they are found (Lemoguna *et al.*, 2011). Residual soils (red tropical soils) are formed in-situ by chemical weathering and maybe found on rock level surfaces where action of elements has produced a soil with little tendency to move i.e. it holds the position of their formation without transporting, just above the parent rock. An essential feature for the formation of red tropical soil is the repetition of wet and dry seasons. Packs are leached by percolating rain water during wet season resulting in solutions containing leached anions which are brought to the surface by capillary action during dry season (Yamaguchi, 2005).Ferruginous and aluminous claysoils are frequent products of weathering in tropical latitudes (Anon, 1990). They are characterized by the presence of iron and aluminium oxides and hydroxides. Red tropical soil is a residual ferruginous clay-like deposit which generally occurs below a hardened ferruginous crust or hardpan.

The evaluation of the geotechnical properties of some red tropical soils from Irrua and Agbor, Southwest Nigeria was carried out by determining the individual strength of the soils using the basic geotechnical tests (compaction test, California bearing ratio, and unconfined compressive strength test) and stabilizing the soil using cement and marble dust at varying percentages in order to compare the results with available standard, so as to decipher the stabilized soils percentage (s) that will meet the requirements for engineering road constructions and to make suitable recommendations while the established standard is not compromised.

2.0 Geological Overview

The result of detailed geologic study of the area using information from borehole and outcrop sections revealed that the study area is underlain by three major formations; Bende – Ameki, Ogwashi-Asaba and Benin Formation. In Irrua where the Bendel–Ameki overlies about 5% landmass of Irrua, is characterized by laterites of at least 40ft thickness, while areas that are underlain by Benin Formation are often associated with laterites of less than 20ft thickness (Salufu and Ujuanbi,2015).

Agbor is overlain by the Ogwashi-Asaba Formation (Olobaniyi *et al.*, 2007), which in generally has at the top the red tropical soils composed of low silica – sesquioxide ratio clay and sand which is soft when wet and considerably hard when dry. (Andre-Obayanju *et al.*,2017). Benin sand was used to describe red tropical soils undertain by sands, sandy clays and ferruginous sandstone that mark the paleocene – pleistocene age. These sediments spread across the southern fringes of the Anambra Basin and mark the upper facies off flank of the Niger Delta. (Alayaki *et al.*, 2015).Reyment, (1965), reinstated the name Benin Formation to identify the reddish – brown – yellow, generally white sand often with clayey and pebbly horizons with type locality around Benin. Lithostratigraphically, the Benin Formation (Miocene to Recent) is characterized by 90% sand, conglomeratic gravels, clays, peat, and lignite deposited in a continental coastal plain (fluvial depositional setting (Nwajide, 2013).

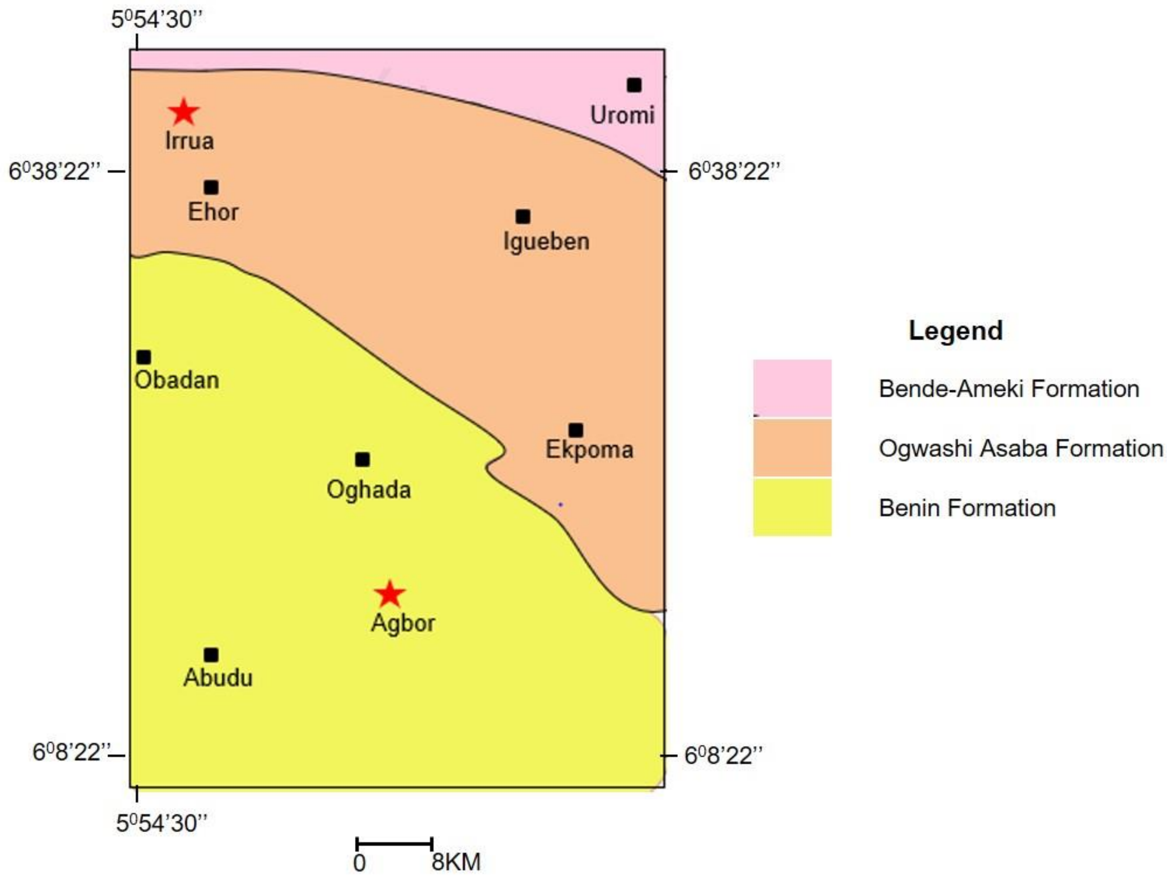


Figure 1: Geologic map showing sampled locations

3.0 Materials and Methods

3.1 Materials.

The materials used for this study include – laterite soil samples, marble dust, cement, and water. The marble dust is pulverized white calcitic marble purchased in 50kg bag at Freedom Quarry, Ikpeshi, Igarra in Edo State, while the cement is the ordinary Portland cement, which conforms to the British importer quality control standard. 50kg each of laterite samples were collected from the study locations.

3.2 Compaction Test

Compaction Test was carried out with the aim of determining the moisture density relationships and change in soils, increase unit weight, shear strength and reducing permeability. This makes the soil less susceptible to settlement underload, especially repeated loading. The standard compaction method also called proctor method was used. The apparatus consist of 2.5kg rammer, a known volume of mould with removable base and detachable collar, 3kg of air dried soil was used for the test and was repeated five times for each sample. The moisture content used was between 4%-20% of the weight of the sample was mixed thoroughly before compaction. Three layers of compaction were done for each trial and 25 blows were used to compact each layer. Graphs of dry density against moisture content were plotted to determine the optimum moisture content.

3.3 California Bearing Ratio (CBR)

The essence of the compaction test conducted on the two samples was to get the optimum moisture content to be used to compact equivalent samples in CBR mould. The California Bearing Ratio (CBR) is a measure of the supporting value of the sub-grade to deformation under the influence of vehicular load. The soaked and unsoaked CBR values for top and bottom of the two samples were determined according to the British Standard, BS 1377 (1975), while keeping the cement content constant at 2%, the procedure was then repeated for 0%, 1%, 3%, 5%, 7% and 9% marble dust. The entire procedure was then repeated for 0%, 4%, 6% and 8% cement content by weight of dry laterite soils.

A plot of load on plunger (KN) against penetration of plunger (mm) is done and the CBR values at 2.5mm and 5.0mm penetration is obtained from the graph.

CBR at 2.5mm penetration

$$= \frac{\text{load on plunger at 2.5mm} \times 100}{X}$$

CBR at 5.0mm penetration

$$= \frac{\text{load on plunger at 5.0mm} \times 100}{Y}$$

where X and Y are constants = 13.24 and 19.96, respectively.

3.4 Unconfined Compressive Stress

The samples were extruded following compaction, using mould 0.0381m in diameter and cut to a length of 0.0762m. The compacted samples were treated with various percentages of cement and marble dust for 8days, 12days, 20 days and 28days. Curing for each percent of marble dust and cement, wrapped in a water tight cellophane and placed in a bowl of water – ready for the unconfined compressive strength test.

The prepared samples were placed on a triaxial compression machine and compression done at a uniform strain rate of 0.005mm/min. The strains were recorded with their corresponding increase in stress, until sample sheared and the ultimate stress recorded. The compressive strength was calculated using;

$$\text{Stress (KN)} = \frac{\text{Stress Dial} \times 0.435\text{kg} \times 9.81}{1000}$$

Compressive stress (KN/m^2) = Stress (KN) / Area (m^2)

where 0.435kg per division = Proving ring constant

9.81 = Unit weight (in KN/ m^3).

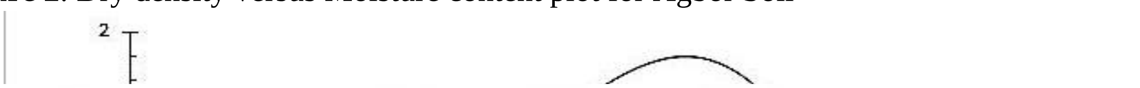
4. Results

The result of the compaction test, the California Bearing ratio and unconfined compressive stress analysis are presented in Tables 1- 10.

Table 1:Compaction Tests of Agbor and Irrua Soil

Agbor Soil					
Dry Density (g/cm^3)	1.86	1.95	1.99	1.95	1.85
Average moisture content (%)	8.99	11.07	13.49	15.52	17.88
Irrua Soil					
Dry Density (g/cm^3)	1.41	1.53	1.51	1.46	1.40
Average moisture content (%)	19.0	21.35	23.37	26.12	30.16

Figure 2: Dry density versus Moisture content plot for Agbor Soil



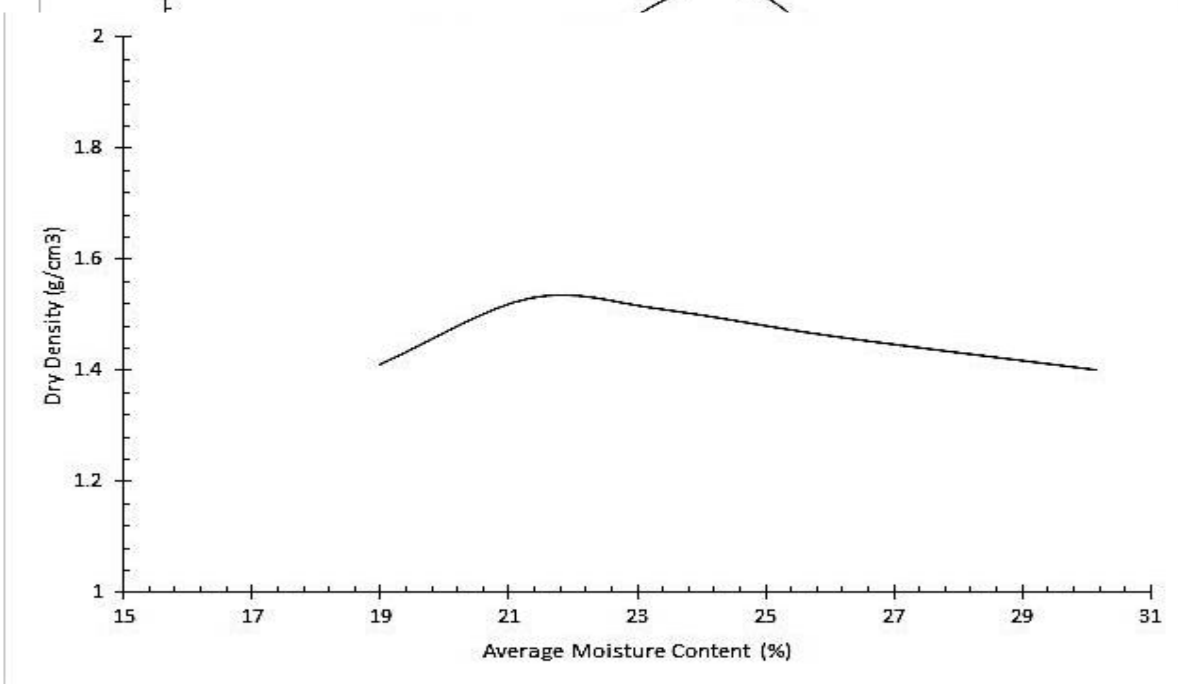


Figure 3: Dry density versus Moisture content plot for Irrua Soil

Table 2:CBR Testfor Agbor soil 4% Cement and 3% Marble Dust

Test on Bottom Unsoaked												
Force on plunger (KN)	0	0.40	0.81	1.26	1.84	1.97	2.30	2.74	3.14	4.05	4.87	8.32
Penetration (mm)	0.0	0.5	1.0	1.5	2.0	2.5	3.0	4.0	5.0	7.5	10.0	12.5
Test on top unsoaked												
Force on plunger (KN)	0	0.47	0.7	0.9	1.13	1.34	1.6	1.9	2.2	3.2	4.1	4.9
Penetration (mm)	0	0.5	1.0	1.5	2.0	2.5	3.0	4.0	5.0	7.5	10.0	12.5
Test on bottom soaked												
Force on plunger (KN)	0	2.0	2.9	3.4	4.5	6.3	6.6	7.9	9.8	15.9	32.6	64.9
Penetration (mm)	0	0.5	1.0	1.5	2.0	2.5	3.0	4.0	5.0	7.5	10.0	12.5
Test on top soaked												
Force on plunger (KN)	0	1.7	2.6	3.8	4.8	5.5	6.6	8.1	9.0	10.3	0	0
Penetration (mm)	0.0	0.5	1.0	1.5	2.0	2.5	3.0	4.0	5.0	7.5	10.0	12.5

	Unsoaked		**Soaked**	
	2.5mm	**5.0mm**	**2.5mm**	**5.0mm**
Bottom	23.88	15.73	47.89	40.05
Top	10.15	11.18	41.29	44.93

Table 3: CBR Test for Agbor Soil 6% Cement and 5% Marble Dust

Test on Bottom Unsoaked												
Force on plunger (KN)	0	0.63	1.28	1.73	2.41	3.06	3.75	4.92	6.18	8.29	10.48	13.92
Penetration (mm)	0.0	0.5	1.0	1.5	2.0	2.5	3.0	4.0	5.0	7.5	10.0	12.5
Test on top unsoaked												
Force on plunger (KN)	0	0.27	0.29	0.49	0.55	0.69	0.85	1.31	3.10	5.37	7.33	9.72
Penetration (mm)	0	0.5	1.0	1.5	2.0	2.5	3.0	4.0	5.0	7.5	10.0	12.5
Test on bottom soaked												
Force on plunger (KN)	0	4.59	9.07	12.72	15.75	18.49	21.06	26.80	30.95	40.32	49.42	58.08
43.97	0	0.5	1.0	1.5	2.0	2.5	3.0	4.0	5.0	7.5	10.0	12.5

Test on top soaked												
Force on plunger (KN)	0	2.08	4.81	7.60	10.53	13.34	16.13	21.32	25.8	34.7	43.97	52.37
Penetration (mm)	0.0	0.5	1.0	1.5	2.0	2.5	3.0	4.0	5.0	7.5	10.0	12.5

	Unsoaked		Soaked	
	2.5mm	5.0mm	2.5mm	5.0mm
Bottom	23.12	30.95	138.98	155.08
Top	5.20	15.34	100.75	129.11

Table 4: CBR Test Agbor Soil 8% Cement and 7%Marble Dust

Bottom Unsoaked												
Force on plunger (KN)	0	0.67	1.7	2.7	3.9	4.5	5.4	7.0	8.5	12.5	15.8	18.5
Penetration (mm)	0.0	0.5	1.0	1.5	2.0	2.5	3.0	4.0	5.0	7.5	10.0	12.5
Top Unsoaked												
Force on plunger (KN)	0	0.15	0.28	0.44	0.59	0.77	0.93	1.28	1.68	2.85	4.2	6.76
Penetration (mm)	0	0.5	1.0	1.5	2.0	2.5	3.0	4.0	5.0	7.5	10.0	12.5
Bottom Soaked												
Force on plunger (KN)	0	10.17	20.47	28.47	31.39	35.55	39.55	49.48	58.30	77.4	79.52	0
Penetration (mm)	0	0.5	1.0	1.5	2.0	2.5	3.0	4.0	5.0	7.5	10.0	12.5
Top Soaked												
Force on plunger (KN)	0	1.75	3.5	6.5	10.3	14.9	20.0	30.0	39.6	0	0	0
Penetration (mm)	0.0	0.5	1.0	1.5	2.0	2.5	3.0	4.0	5.0	7.5	10.0	12.5

	Unsoaked		Soaked	
	2.5mm	5.0mm	2.5mm	5.0mm
Bottom	34.11	43.02	266.30	292.07
Top	5.78	8.44	112.31	198.38

Table 5: CBR Test of Agbor Soil 10% Cement And 9% Marble Dust

Bottom Unsoaked												
Force on plunger (KN)	0	1.15	2.57	3.8	5.3	6.4	7.2	8.8	8.9	10.7	25.2	46.5
Penetration (mm)	0.0	0.5	1.0	1.5	2.0	2.5	3.0	4.0	5.0	7.5	10.0	12.5
Top Unsoaked												
Force on plunger (KN)	0	1.1	1.7	2.4	3.1	3.8	4.5	5.6	7.1	10.0	24.1	60.2
Penetration (mm)	0	0.5	1.0	1.5	2.0	2.5	3.0	4.0	5.0	7.5	10.0	12.5
Bottom Soaked												
Force on plunger (KN)	0	4.6	12.1	18.4	23.5	29.7	47.1	0	0	0	0	0
Penetration (mm)	0	0.5	1.0	1.5	2.0	2.5	3.0	4.0	5.0	7.5	10.0	12.5
Top Soaked												
Force on plunger (KN)	0	1.4	4.0	8.9	14.7	21.0	28.3	42.72	53.3	0	0	0
Penetration (mm)	0.0	0.5	1.0	1.5	2.0	2.5	3.0	4.0	5.0	7.5	10.0	12.5

	Unsoaked		**Soaked**	
	2.5mm	**5.0mm**	**2.5mm**	**5.0mm**
Bottom	48.91	44.39	224.21	0
Top	28.90	35.62	158.56	267.15

Table 6: CBR Test of Irrua Soil 6% Cement and 5% Marble Dust

Bottom Unsoaked												
Force on plunger (KN)	0.0	0.25	0.41	0.48	0.54	0.61	0.73	0.84	0.95	1.16	1.43	1.55
Penetration (mm)	0.0	0.5	1.0	1.5	2.0	2.5	3.0	4.0	5.0	7.5	10.0	12.5
Top Unsoaked												
Force on plunger (KN)	0	0.96	0.21	0.25	0.29	0.38	0.38	0.48	0.55	0.75	0.93	1.09
Penetration (mm)	0	0.5	1.0	1.5	2.0	2.5	3.0	4.0	5.0	7.5	10.0	12.5
Bottom Soaked												
Force on plunger (KN)	0	1.54	2.8	4.0	5.3	6.5	7.7	9.9	12.0	15.0	18.9	20.8
Penetration (mm)	0	0.5	1.0	1.5	2.0	2.5	3.0	4.0	5.0	7.5	10.0	12.5

Top Soaked												
Force on plunger (KN)	0	0.74	1.75	3.0	4.7	6.4	7.6	9.9	11.5	14.3	15.1	0
Penetration (mm)	0.0	0.5	1.0	1.5	2.0	2.5	3.0	4.0	5.0	7.5	10.0	12.5

	Unsoaked		**Soaked**	
	2.5mm	**5.0mm**	**2.5mm**	**5.0mm**
Bottom	4.02	46.22	42.36	50.22
Top	2.56	27.67	48.30	57.64

Table 7: CBR Test Irrua Soil 8%Cement and 7%Marble Dust

Bottom Unsoaked												
Force on plunger (KN)	0.0	0.29	0.30	0.48	0.49	0.56	0.67	0.73	0.82	1.0	1.23	1.60
Penetration (mm)	0.0	0.5	1.0	1.5	2.0	2.5	3.0	4.0	5.0	7.5	10.0	12.5
Top Unsoaked												
Force on plunger (KN)	0	0.95	0.22	0.27	0.29	0.33	0.38	0.44	0.51	063	0.78	0.89
Penetration (mm)	0	0.5	1.0	1.5	2.0	2.5	3.0	4.0	5.0	7.5	10.0	12.5
Bottom Soaked												
Force on plunger (KN)	0	2.49	4.21	5.80	7.28	8.5	9.7	13.6	15.2	19.2	22.4	24.78
Penetration (mm)	0	0.5	1.0	1.5	2.0	2.5	3.0	4.0	5.0	7.5	10.0	12.5
Top Soaked												
Force on plunger (KN)	0	2.52	4.3	4.9	6.3	7.6	8.2	9.4	9.5	10.9	0	0
Penetration (mm)	0.0	0.5	1.0	1.5	2.0	2.5	3.0	4.0	5.0	7.5	10.0	12.5

	Unsoaked		**Soaked**	
	2.5mm	**5.0mm**	**2.5mm**	**5.0mm**
Bottom	4.2	42.74	64.50	76.66
Top	25.56	25.75	56.56	40.39

Table 8: CBR Test of Irrua Soil 10% Cement and 9%Marble Dust

Bottom Unsoaked												
Force on plunger (KN)	0.0	0.62	1.08	1.47	1.84	2.2	2.4	3.04	3.6	4.76	5.76	6.60
Penetration (mm)	0.0	0.5	1.0	1.5	2.0	2.5	3.0	4.0	5.0	7.5	10.0	12.5
Top unsoaked												
Force on plunger (KN)	0.0	0.42	0.71	0.95	1.2	1.4	1.55	1.9	2.2	3.06	3.4	4.60
Penetration (mm)	0.0	0.5	1.0	1.5	2.0	2.5	3.0	4.0	5.0	7.5	10.0	12.5
Bottom Soaked												
Force on plunger (KN)	0.0	1.42	3.1	5.0	8.5	9.1	11.3	15.9	19.5	23.7	24.6	25.8
Penetration (mm)	0.0	0.5	1.0	1.5	2.0	2.5	3.0	4.0	5.0	7.5	10.0	12.5
Top Soaked												
Force on plunger (KN)	0.01	1.4	3.1	4.9	5.9	11.3	15.9	19.5	23.3	24.5	25.6	
Penetration (mm)	0.0	0.5	1.0	1.5	2.0	2.5	3.0	4.0	5.0	7.5	10.0	12.5

	Unsoaked		**Soaked**	
	2.5mm	**5.0mm**	**2.5mm**	**5.0mm**
Bottom	4.02	46.22	42.36	50.22
Top	2.56	27.67	48.30	57.64

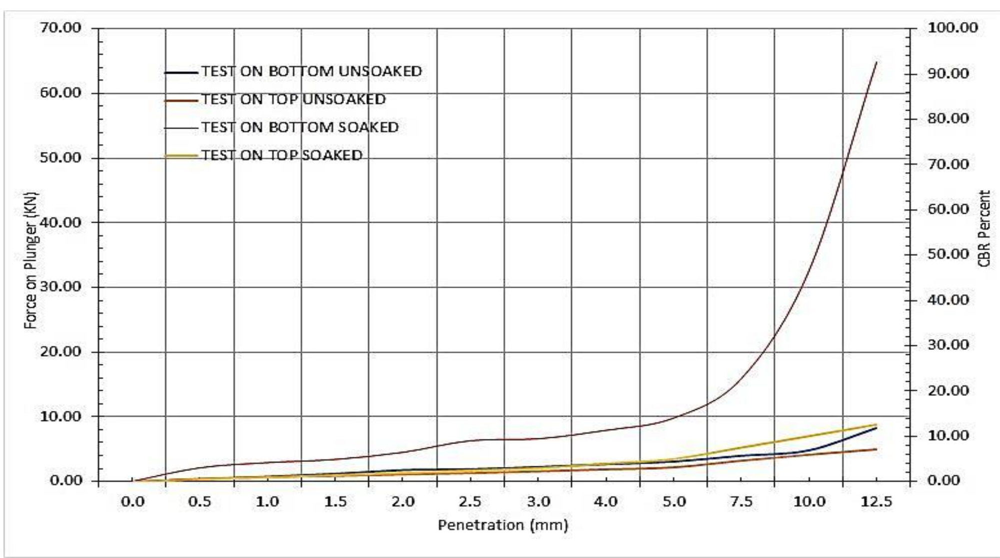


Figure 4: CBR - Force versus Penetration at 8% Cement and 7% Marble Dust for Agbor Soil

Table 9: Unconfined Compressive Strength for Irrua soil at different percentages of Cement and Marble Dust

Strain (%)	**Maximum**	**Compressive**	**Strength (KN/m²)**
	1st Test	2nd Test	3rd Test
At 6% and 5%			
0.0	0.0	0.0	0.0
0.5	208.7	600.0	70.4
1.0	713.0	1104.3	182.6
1.5	1241.4	1310.3	646.6
2.0			879.3
2.5			1111.1
3.0			1389.8
3.5			1754.2
4.0			1848.7
At 8% and 7%			
0.0	0.0	0.0	0.0
0.5	275.7	182.6	313.0
1.0	713.0	500.0	1208.7
1.5	1327.6	1060.3	1853.4
2.0	1801.7	1431.0	1956.9
2.5	2119.7	1641.0	
3.0		1754.2	
3.5		1898.3	
At 10% and 9%			
	1st test	2nd test	3rd test
0.0	0.0	0.0	0.0
0.5	408.7	521.7	313.0
1.0	687.0	1234.8	1373.9
1.5	939.7		1913.8
2.0	1232.8		

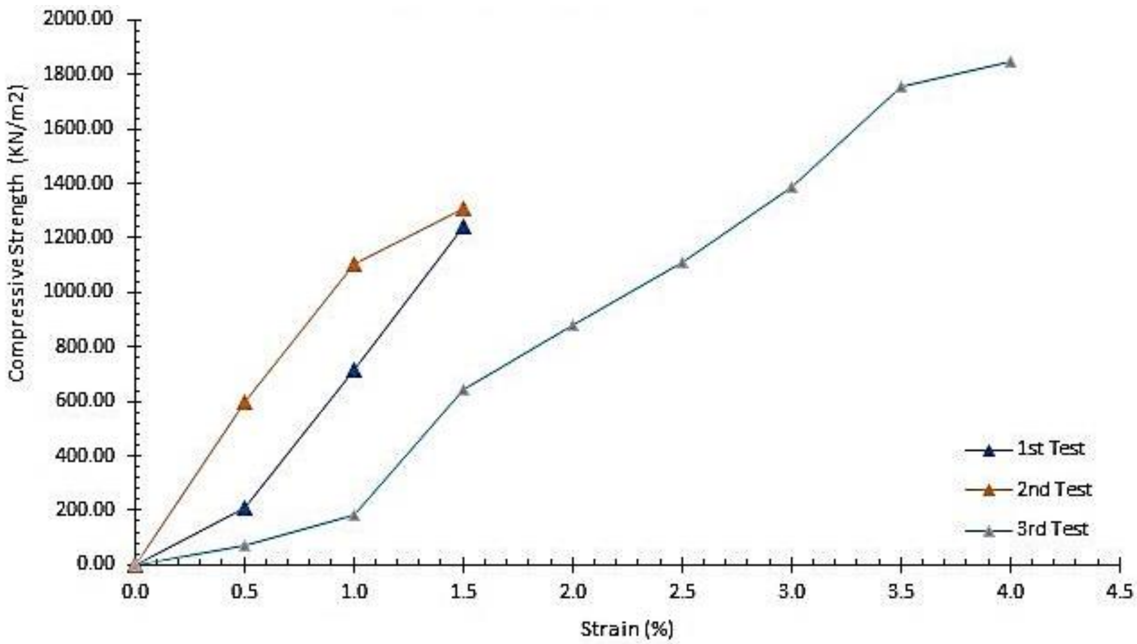


Figure 5: Unconfined Compressive Strength forIrrua Soil at 6% Cement and 5% Marble Dust

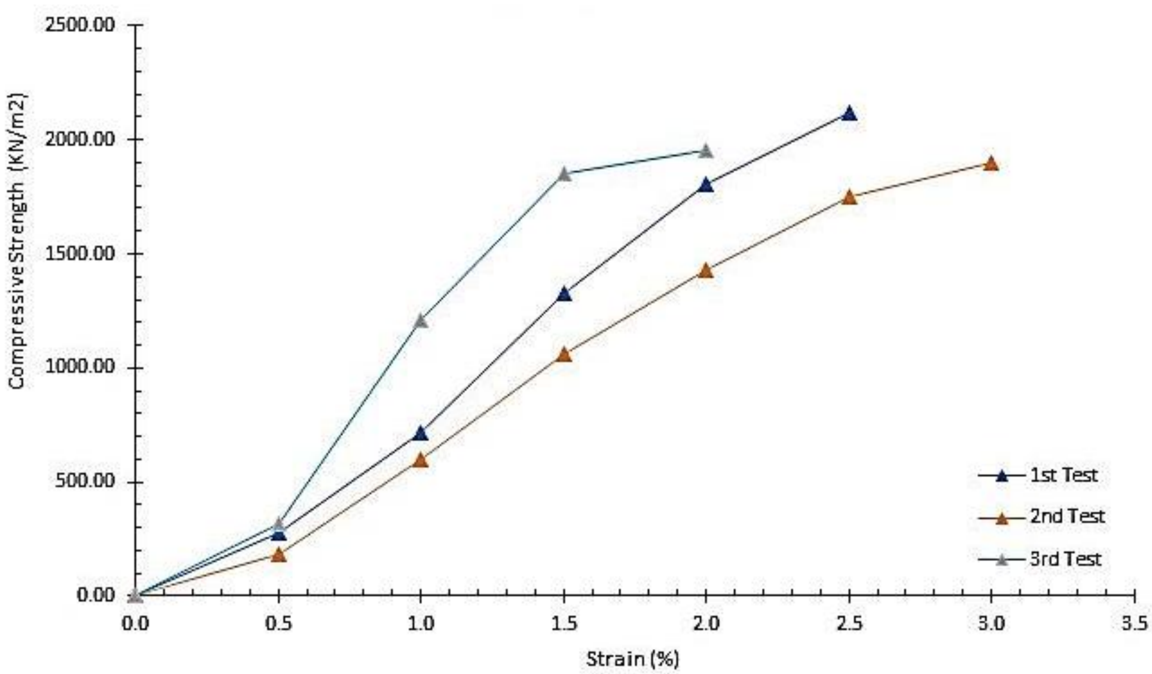


Figure 6: Unconfined Compressive Strength for Irrua Soil at 8% Cement and 7% Marble Dust

Table 10:Unconfined Compressive Strength for Agbor Soilat different percentages of cement and marble dust

Strain (%)	**Maximum**	**Compressive**	**Strength (KN/m^2)**
	1st test	2nd test	3rd test
At 6% and 5%			
0.0	0.0	0.0	0.0
0.5	352.52	252.33	222.84
1.0	927.68	1120.64	738.44
1.5		1640.72	1776.84
At 8% and 7%			
0.0	0.0	0.0	0.0
0.5	2.59.8	315.4	385.9
1.0	1061.3	742.2	890.6
1.5	1743.7	1504.6	1269.2
2.0	1876.2		1629.7
2.5			1750.7
At 10% and 9%			
0.0	0.0	0.0	0.0
0.5	348.8	311.7	137.3
1.0	801.5	701.3	426.7
1.5	1103.6	1184.6	717.4
2.0			831.4
2.5			945.4
3.0			1112.4
3.5			1329.5

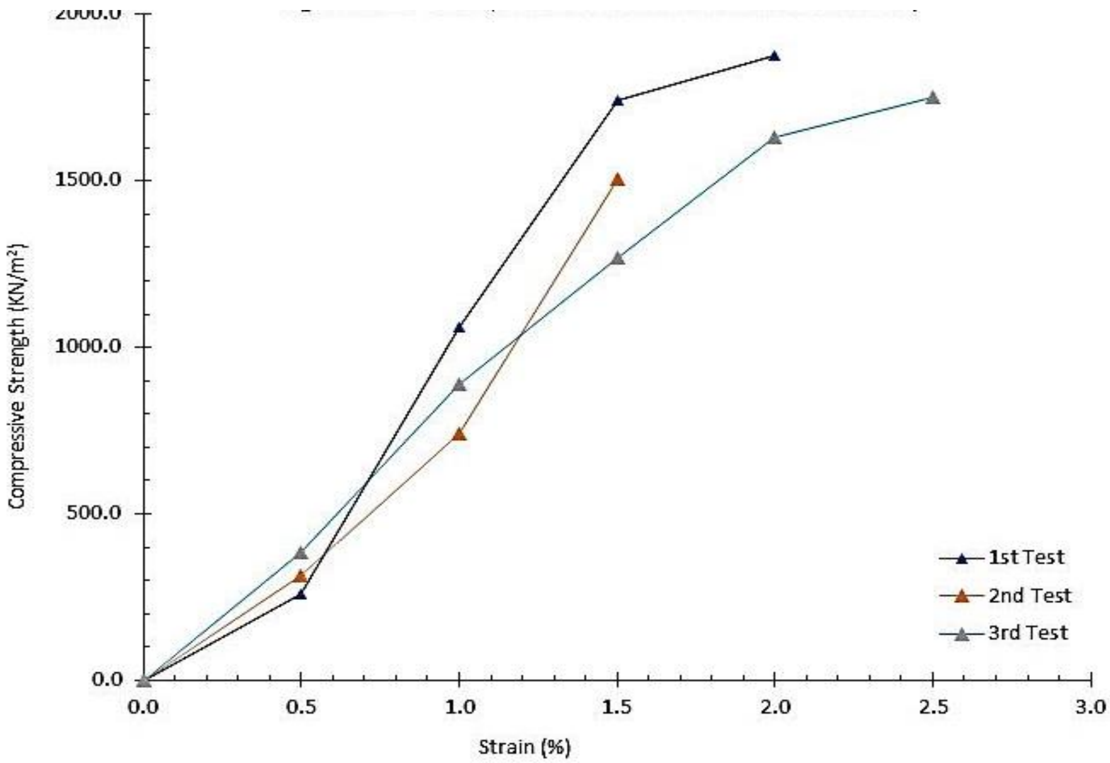


Figure 7: Unconfined Compressive Strength for Agbor Soilat 8% Cement and 7% Marble Dust

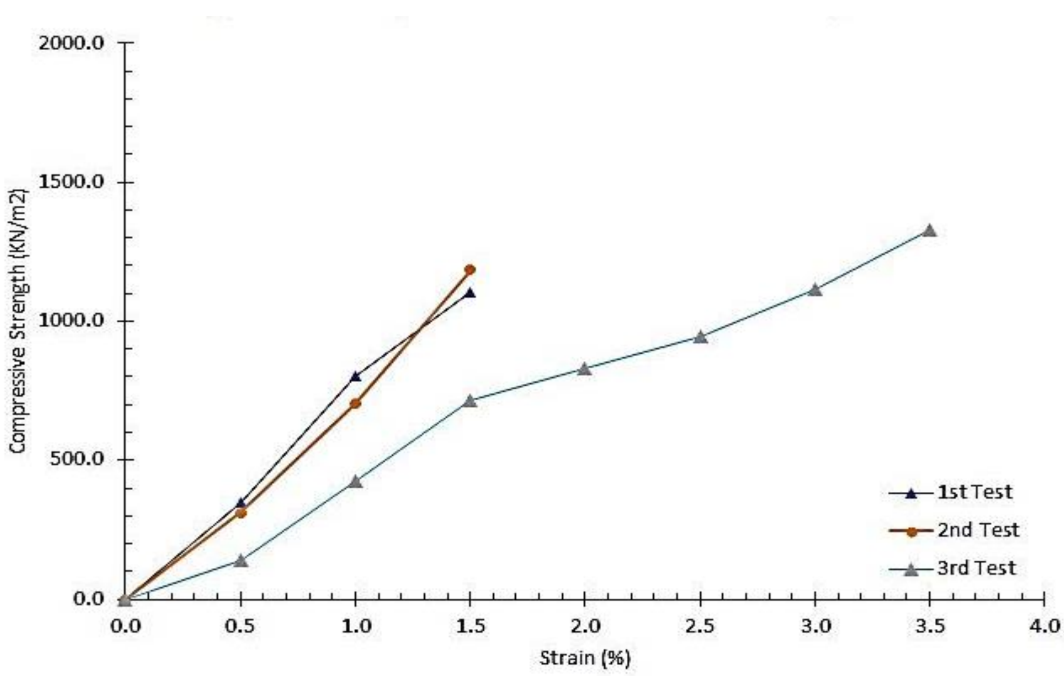


Figure 8: Unconfined Compressive Strength for Agbor Soil at 10% Cement and 9% Marble Dust

5.0 Discussion

The result obtained from the plots of dry density versus average moisture content (Tables 1), the values for the optimum moisture content and maximum dry density for Agbor and Irrua soils were found to be 13.20%; 1.87g/cm^3 and 21.70%; 1.54 g/cm^3 respectively (figures 2 and 3). The CBR test for both Irrua and Agbor soils at 0% are 1.36% and 0.59% which indicates that in their natural state the geotechnical properties of soil are far too low to meet the required standard for use either as a sub-base or base material for road construction,which agrees with the findings of Ugbe (2011). This study reveals that the CBR values of untreated soils cannot be utilized to construct durable roads, except they are stabilized with the appropriate materials. Tables 3-10, are the stabilized outcome of the soils at the specified percentages of cement and marble dust for both the CBR test and the Unconfined Compressive Strength test and the corresponding plots to help in the interpretation of the geotechnical properties in figures 4-8. For Agbor soil, the CBR values at (4&3, 6&5, 8&7 and 10&9)% cement and marble dust are 48.5%, 114.93%, 155.3% and 32.2% (figures 3-6). Following the Federal Ministry of Works and Housing (1997) CBR specification for sub-base and Base material of 30% and 80% respectively. By implication, 48.5% and 32.2 % are suitable as a sub-base material while 114.93% and 155.3% as a Base material. Similarly, Irrua soil at (6&5, 8&7 and 10&9)%cement and marble dust with CBR values 53.0%, 53.2% and 92.3% respectively (figures 7-8) with the stabilized soils at (6&5 and 8&7)% as sub-base materials and (10&9)% as Base material.

This result agrees with the findings of Andre – Obayanju *et al.,* (2017), that red tropical soils are suitable for sub-base and base materials, only if it is stabilized either by mechanical stabilization or chemical stabilizers such as lime, cement, fly ash, marble dust amongst others to meet the required standard.

The compressive stress values for Agbor soil at (6&5, 8&7, and 10&9)% cement & marble dust are 1272.8KN/m^2, 1710.5 KN/m^2 and 1290.0KN/m^2 respectively and cured for twenty (20), twelve (12) and eight (8) days accordingly. Conversely, the compressive stress values for Irrua soil are 1466.8KN/m^2 and 1218.9KN/m^{2}for the same percentages as that of Agbor soil but cured for twenty-eight (28) days, twenty (20) days and twenty (20) respectively.

Soils from Agbor and Irrua soils are both suited as a sub-base material for road construction since it conforms to the Federal Ministry of Works and Housing (1977) compressive stress specification for sub – base as 1030KN/m^2.

5.0. Recommendation

Agbor soil at 4% &3%; 6% & 5% cement and marble dust with CBR values of 48.5% and 114.9% are recommended for Sub-base and Base materials, while for the Irrua soil, 53.0% and 92.3% CBR values are recommended for sub-base and Basematerials at (6&5 and 10&9)% cement and marble dust respectively.

Similarly, the recommended compressive stress for both Agbor and Irrua soils are 1272.8 KN/m^2 and 1466.8 KN/m^2 both at (6&5) % cement and marble dust. The recommendations made were strictly based on economic reasons, since it is much cheaper at lower percentages while not compromising the standard and still producing the desired result.

6.0. Conclusion

This study reveals the geotechnical properties of red tropical soils from Edo and Delta State. From the result of the Analysis and in accordance with the Federal Ministry of Works and Housing recommendation for road base and sub-base, both soils, when stabilized can be used for road construction as sub-base and base materials.

7.0. Acknowledgement

We sincerely appreciate the input and supervisory role by late Professor T.U.S Onyeobi of blessed memory. The Civil engineering geotechnical laboratory staffs of University of Benin is highly acknowledged for the assistance in the geotechnical analysis during this study.

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