Evaluation of the geotechnical properties of lateritic soil in alimosho local government area of lagos state.

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Abstract

The study evaluated the geotechnical properties of lateratic soils in Alimosho Local government Area (LGA) of Lagos state. Six (6) local community development areas (LCDAs) were used to assess the geotechnical potential applications in road construction. Laboratory tests were conducted on soil samples to assess properties such as natural moisture content (NMC), particle size distribution(Sieve analysis), specific gravity(SG), Atterberg limits, compaction, California Bearing Ratio (CBR), and unconfined compressive strength (UCS). NMC ranged from 12.0 to 14.3%, and specific gravity values varied from 2.58 to 2.68, for the sieve analysis at 4.75 mm, ranges between 98.07 to 100% while at 0.075 mm, it ranged from 49.24 to 55.66%. indicating uniformity in fine-grained. Liquid limits ranged from 33.0 to 40.0%, with plasticity indices between 16.0 and 21.0%, indicating moderate to high plasticity. Maximum dry densities ranged from 1.44 to 1.79 g/cm³, with only five samples exceeding the 1.70 g/cm³ standard for subbase suitability. CBR values were generally below the Nigerian requirement for subbase (≥ 30% soaked), and UCS results ranged from 107 to 159 kPa, falling below the 200 kPa threshold. Soil classification using AASHTO and USCS systems indicated that samples like A2 and F1 (A-2-4 and CL) had moderate strength and plasticity, making them suitable for subbase use. In contrast, soils such as C3 and D3 (A-7-6 and CH) exhibited high plasticity and low strength, restricting them to subgrade use unless stabilized.The study concluded that most soils in alimosho LGA where unsuitable for subbase applications without stabilisation but may perform well in subgrade layers. Stabilisation methods such as lime and cement were recommended to improve plasticity and strength, particularly for high-plasticity soils like C3 and D3. This study contributes a framework for evaluating and improving lateritic soils, offering practical insights for road construction in Nigeria and similar regions globally.

Key words : Geotechnical properties, lateritic soil, soil, stabilization

1. INTRODUCTION

The stability and longevity of road infrastructure are significantly influenced by the geotechnical properties of construction materials (Amu et al., 2011. Yakubu et al., 2023). Lateritic soils, commonly used in road construction due to their widespread availability and cost-effectiveness, exhibit considerable variability in composition, compaction characteristics, and moisture content (Adams & Adetoro, 2014). Adiat *et al.*(2017) affirmed that without proper evaluation, their use can result in premature road failures, increasing maintenance costs by up to 60% over a road's lifecycle and posing significant safety risks for road users. In Alimosho Local Government Area, construction Engineers has assumed that its borrow pits materials are one of the best in lagos state, it was recommended and engineers from different places pick their borrow pits material as road fillings, subgrade even at subbase level but there are no substaintial proof to this claim. However, studies indicate that approximately 70% of roads constructed with untreated lateritic soil experience severe pavement deterioration within five years due to inadequate strength and high plasticity (Okonkwo et al., 2022). The rapid urbanization in Alimosho, with a population exceeding 3 million people, necessitates durable road infrastructure to support increasing vehicular and pedestrian traffic (Adekola et al., 2024; Yakubu et al., 2023). The absence of systematic geotechnical assessments raises concerns about the suitability of lateritic soils for sustainable road development.

This study seeks to address these challenges by conducting a comprehensive geotechnical evaluation of lateritic soils in Alimosho. Factors such as grain size distribution, compaction behavior, permeability, and strength characteristics were analyzed.

Preliminary finding suggests that Maximum Dry Density (MDD) values for lateritic soils in the region range between 1.44 g/cm³ and 1.79 g/cm³, with California Bearing Ratio (CBR) values varying from 18.5% to 39.2%, which is below the 30% minimum standard required for sub-base materials (Adunoye et al., 2019; Owolabi & Aderinola, 2014).

1.2. Lateritic Material

Lateritic soils, commonly known as laterites are iron- and aluminium-rich soils formed in tropical and subtropical regions due to intense weathering and leaching of parent rocks under hot and humid conditions (Adunoye et al., 2019; Thankam et al., 2017), The term "laterite", first coined by French geologists in the 19th century, originates from the Latin word "later," meaning brick, due to its tendency to harden upon drying (MacCarthy et al., 2014). It is widely spread in Africa, Southeast Asia, and South America, playing a crucial role in construction and geotechnical applications (Adunoye et al., 2019). Their unique composition and mechanical properties make them useful for road construction, foundation materials, and brick production (B, 2015). However, their engineering performance depends on factors such as stabilization, compaction, and drainage considerations (Yakubu et al., 2023).

Lateritic soils are classified based on their mineral composition, degree of weathering, and engineering properties (Amu et al., 2011; Thankam et al., 2017). Their reddish-brown to yellowish colour results from high iron content (Adunoye et al., 2019). It form through the leaching of soluble minerals and prolonged weathering, erosion, and moisture exposure over time. This process removes silica and bases, leaving behind iron- and aluminium-rich residues that influence their strength, permeability, and plasticity (Adams and Adetoro, 2014). Despite their natural abundance, lateritic soils require specific engineering modifications, such as stabilization with lime or cement, proper compaction, and moisture control, to enhance their durability and load-bearing capacity for road and structural applications (O. O. Amu and Salami, 2010).

1.3. Engineering Properties and Applications

Lateritic soils exhibit variable engineering properties depending on particle size distribution, compaction, permeability, and plasticity (Adunoye et al., 2019) . They generally have high strength in dry conditions but can become unstable when saturated, requiring proper stabilization techniques (Ehujuo & Zanders Akaolisa, 2019).

Compaction and Strength: Lateritic soils respond well to compaction, improving their load-bearing capacity (Adams and Adetoro, 2014). Amu et al. (2011) opined that optimum moisture content (OMC) and maximum dry density (MDD) vary significantly based on laterite composition, affecting their suitability for road subgrades and bases.

Moisture Sensitivity: Due to high fines content, lateritic soils can absorb and retain water, reducing shear strength and stability (H.A.P. & J. O., 2019). Proper drainage systems are essential to prevent waterlogging and loss of bearing capacity (Ola, 1983).

Plasticity and Workability: Lateritic soils exhibit moderate to high plasticity, with liquid limits ranging from 30% to 50% (Adekola et al., 2024). Soils with higher clay content require stabilization with lime, cement, or fly ash to enhance durability and reduce shrinkage (B, 2015).

Suitability for Road Construction: Lateritic soils with CBR values above 30% are considered suitable for subbase layers, while those below require stabilization (Adams & Adetoro, 2014). Ehujuo and Akaolisa (2019) showed that lime-treated laterites exhibit improved compressive strength, making them viable materials for infrastructure development.

1.4 Engineering Applications of Lateritic Soils

Lateritic soils are extensively used in road construction, building foundations, embankments, and earthworks. Their durability and strength make them a preferred material in infrastructure projects. However, their high moisture sensitivity and plasticity necessitate engineering modifications to enhance their performance.

1. Road Construction

Lateritic soils serve as subgrade and subbase materials in road construction. Stabilized laterites with CBR values above 30% can function effectively in high-traffic roads, while untreated laterites may be susceptible to rutting and erosion (Adams & Adetoro, 2014).

2. Building Foundations

Due to their strength in dry conditions, lateritic soils can be used as foundation materials, but moisture fluctuations may cause instability. Proper drainage and compaction techniques are essential to maintain structural integrity (Salahudeen et al., 2019).

3. Brick and Pavement Blocks

Lateritic soils are widely used in brick-making and pavement blocks, where their cementation properties improve durability (Amu et al., 2011). Stabilized lateritic bricks are a cost-effective and sustainable alternative to conventional building materials.

1.4. Challenges and Stabilization Techniques

Although lateritic soils are widely used in construction, their engineering performance can be compromised by moisture fluctuations, high plasticity, and low CBR values. Stabilization techniques such as lime, cement, and geosynthetic reinforcement significantly enhance their load-bearing capacity and durability (Osinubi et al., 2009).

1. Lime and Cement Stabilization

Lime and cement are commonly used as stabilizer due to their ability to improve soil strength, reduce plasticity and enhence durability, (Faluyi *et al.,* 2023) highlighted that 6% of lime additional significantly enhenced the soil's compaction and California Bearing Ratio (CBR) values, making it suitable for use as pavement material

2. Mechanical Stabilization

Blending lateritic soils with sand, gravel, or crushed rock improves gradability and compaction properties, reducing plasticity and increasing strength (Gidigasu, 1976).

3. Geosynthetic Reinforcement

The use of geotextiles and geogrids enhances stability, load distribution, and erosion resistance, making lateritic soils more reliable for construction (Salifu et al., 2021).

1.6 Challenges and Stabilization Techniques

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2. MATERIALS AND METHOD

Alimosho Local Government Area (LGA) is the largest in Lagos State, with a population exceeding 3,082,900 (NPC, 2019). It consists of six Local Community Development Areas (LCDAs) and is geographically located at 6° 32' 39" N and 3° 15' 49" E. The area experiences a tropical savanna climate with distinct dry and rainy seasons and an annual precipitation of approximately 2,700 mm. Alimosho has diverse terrain and abundant lateritic soil, making it significant for construction. It is well-drained due to numerous natural water bodies, though some low-lying areas experience occasional flooding. The LGA serves as a connection between Lagos and Ogun states. Economically, Alimosho thrives on commerce, with major markets such as Ikotun and Igando. It also hosts various public and private institutions, including banks and hotels, contributing to its economic growth.

Fig. 1: Study area map of lagos state and Alimosho LGA.

2.1 Design of Study

This research was conducted by collecting representative lateritic soil samples from the six Local Community Development Areas (LCDAs) within Alimosho Local Government Areas. Three (3) soil samples were obtained from each LCDA, amounting to a total of 18 samples. These soil samples were sourced from both active and depleted borrow pits, as well as trial pits, at a depth of 0.2 meters (200mm) to ensure a comprehensive analysis of soil properties. Each LCDA contributed three (3) sacks of soil, with each sack weighing 30 kg.The LCDAs and their respective sample locations are listed below.

Table 1: The 6 LCDA showing the 18 locations of soil samples.

LCDA	Sample Locations	Code
Agbado/Oke-Odo LCDA	*Command area*	*A1*
	Ekoro	*A2*
	Aboru	*A3*
Alimosho LCDA	*Akowonjo*	*B1*
	Shasha	*B2*
	Ijegun	*B3*
Ayobo/Ipaja LCDA	*Ayobo-Agbado road*	*C1*
	Kande-ijon area	*C2*
	Megida	*C3*
Egbe/Idimu LCDA	*Idimu-ikotun road*	*D1*
	Isheri Olofin	*D2*
	Ogunrombi	*D3*
Igando/Ikotun LCDA	*Akesan*	*E1*
	Oba Dore	*E2*
	Igando-Isheri road	*E3*
Mosan/Okunola LCDA	*Gowon Estate*	*F1*
	Abisi Village	*F2*
	Baruwa-ipaja boundary	*F3*

A series of laboratory tests were conducted to comprehensively evaluate the geotechnical properties of the samples. These tests included Particle Size Distribution (sieve analysis), Atterberg Limits (consistency tests), Specific Gravity, Moisture Content, California Bearing Ratio (CBR), Compaction Characteristics, and Unconfined Compressive Strength (UCS). Standard testing procedures and equipment were employed to ensure accuracy and reliability of the result.

2.2 Classification Tests and Method

The following tests (Table 1) were carried out on the soil samples to determine their properties as described below;

Table 2: Laboratory Determination of the moisture content

Step	Procedure	Formula	
1. Cleaning & Weighing	*Three weighing containers were cleaned and weighed to the nearest 0.01g.*	*M_1 = Weight of empty can (g)*	
2. Adding Wet Soil	*Freshly collected soil samples were crumbled and placed loosely in the cans. The cans with samples were weighed.*	*M_2 = Weight of can + wet soil (g)*	
3. Drying Process	*Samples were placed in an oven at 105–110°C for 24 hours.*		*In accordance with part 2 of BS 1377 (2016).*
4. Weighing Dry Soil	*The dried samples were weighed to the nearest 0.01g.*	*M_3 = Weight of can + dry soil (g)*	
5. Calculation	*The natural moisture content was calculated using:*	$W = \dfrac{M_2 - M_1}{M_3 - M_1} \times 100 \%$	
6. Final Moisture Content	*The average moisture content from three samples was recorded.*		

Table 3: Laboratory Determination of the specific gravity

Step	Procedure	Formula	
1. Weighing Bottle	*The glass density bottle and stopper were weighed.*	*M_1 = Weight of density bottle (g)*	
2. Adding Dry Soil	*Air-dried soil was transferred into the density bottle, and both were weighed.*	*M_2 = Weight of density bottle + dry soil (g)*	*In accordance to BS 1377 (2016)*

3. Adding Water	*Water was added to cover the soil, stirred to remove air bubbles, then filled completely. The bottle was weighed.*	M_3 = *Weight of bottle + soil + water (g)*
4. Weighing Bottle with Water	*The bottle was emptied, refilled with water, wiped dry, and weighed.*	M_4 = *Weight of bottle + water only (g)*
5. Calculation	*The specific gravity was determined using:*	$G_s = \dfrac{M_2 - M_1}{(M_4 - M_1) - (M_3 - M_1)}$

Table 4: Laboratory Determination of the particle sizes distribution (PSD)

Step	Procedure	Notes
1. Sample Preparation	*Soil sample passed through a series of sieves of different sizes.*	*Finer particles analyzed using a hydrometer.*
2. Weighing	*The retained material on each sieve was weighed.*	
3. Percentage Calculation	*The percentage passing through each sieve was calculated.*	*In accordance to BS 1377 (2016)*
4. Graph Plotting	*Data was plotted on a particle size distribution curve.*	*Soil classified as well-graded or poorly graded.*

Table 5: Laboratory Determination of Atterberg limits determination

Test	Procedure	Formula/Notes

Liquid Limit (LL)	*Soil was mixed with water to form a paste, placed in a Casagrande cup, and tested for groove closure at 30-35 blows.*	*LL is the moisture content at which soil changes from plastic to liquid state.*	
Plastic Limit (PL)	*Soil was kneaded and rolled into 3 mm threads until crumbling.*	*PL is the moisture content at which soil changes from plastic to semi-solid state.*	*In accordance to BS 1377 (2016)*
Plasticity Index (PI)	*Difference between LL and PL.*	*Plasticity Index (PI) = Liquid Limit (LL) - Plastic Limit (PL).*	

Table 5: Laboratory Determination of Compaction, California Bearing Ratio, and Unconfined Compressive Strength

Test	Procedure	Formula/Notes	
Compaction Test	*Soil was compacted in layers and tested for Maximum Dry Density (MDD) and Optimum Moisture Content (OMC).*	$\rho = \frac{M_2 - M_1}{1000}; \text{ and }, \rho\eth = \frac{100\rho}{(100+W)};$	
California Bearing Ratio (CBR)	*Soil was compacted, soaked for 4 days, then tested for penetration resistance at 2.5mm and 5mm.*	$CBR = \frac{Standard\ Load}{Measured\ Load} \times 100$	*In accordance to BS 1377 (2016)*
Unconfined Compressive Strength (UCS)	*Cylindrical soil specimens (38.1mm × 76.2mm) were tested under axial compression until failure.*	*UCS determined from stress-strain curves.*	

2. RESULTS AND DISCUSSIONS

### 2.1 PRELIMINARY (CLASSIFICATION) TEST

This subsection addressed the preliminary tests conducted on all the soil samples used for this work according to AASHTO M145 and AASHTO T99 which are often used for classification of road construction materials as shown in the table below is the summary of all the test result carried outon all the soil samples.

Table 7 : Preliminary tests results (Classification Tests) conducted on the soil samples.

| S/N | LOCATION | COMMUNITY | NATURAL MOISTURE CONTENT | SPECIFIC GRAVITY | PARTICLE SIZE ANALYSIS | | | ATTERBERG'S LIMIT TEST | | | AASHTO CLASSIFICATION |
					%GRAVEL ((>4.75mm)	% SAND(0.075-4.75mm)	% FINES (<0.075mm)	LIQUID LIMITS (LL) %	PLASTIC LIMITS (PL) %	PLASTICITY INDEX (PI) %	
1	A	A1	13.50	2.65	99.5	53.5	50.83	35	18	17	A-2-6
		A2	12.80	2.60	99.16	55.66	53.17	38	19	19	A-2-6
		A3	14.20	2.58	100	52.85	50.08	40	20	20	A-2-6
2	B	B1	12.00	2.62	98.78	56.37	51.66	33	16	17	A-2-6
		B2	13.00	2.67	100	49.24	49.30	36	17	19	A-7-6
		B3	12.70	2.64	99.98	58.33	57.23	34	16	18	A-2-6
3	C	C1	13.80	2.61	100	55.47	51.54	37	18	19	A-6
		C2	14.30	2.63	99.35	55.21	53.09	36	17	19	A-2-4
		C3	13.50	2.59	98.58	52.57	50.53	39	18	21	A-6
4	D	D1	12.60	2.68	98.07	56.85	54.96	34	15	19	A-6
		D2	13.80	2.66	98.37	57.75	54.22	39	19	19	A-7-6
		D3	13.90	2.57	98.64	50.99	50.6	40	20	20	A-2-6
5	E	E1	13.40	2.64	100	55.32	51.2	33	16	17	A-2-4
		E2	12.90	2.63	100	56.43	54.84	37	17	20	A-7-6
		E3	13.70	2.60	100	56.25	53.11	38	18	20	A-6
6	F	F1	12.50	2.62	98.14	57.74	54.11	36	18	18	A-2-6
		F2	12.30	2.65	100	56.4	57.45	34	16	18	A-2-6
		F3	12.70	2.59	99.12	54.13	48.06	38	17	21	A-6

Natural moisture content of the samples analysed, the NMC values varied between 12.0% to 14.3%, showcasing significant variability among locations. The lower NMC values, such as 12.0% for Sample B1 and 12.3% for Sample F2, indicate soils with lower moisture retention and higher particle density, often associated with coarser-grained soils or reduced organic content. These findings align with observations by Mirzababaei et al. (2019), who noted that coarser soils with low fines content tend to exhibit reduced moisture-holding capacity, thereby enhancing their compaction potential and stability under load. Conversely, higher NMC values, such as 14.2% for Sample A3 and 14.3% for Sample C2, suggest soils with finer particles or increased clay content, leading to higher water retention. Salifu et al. (2021) highlighted that such soils often require careful management during compaction due to their susceptibility to water-

induced leading swelling and shrinkage. This variability underscores the critical importance of understanding NMC as a determinant of engineering performance. Regional climatic conditions and soil composition also contribute to variations in NMC. For example, soils in wetter regions or with higher organic matter content typically exhibit higher NMC values due to their ability to absorb and retain water (Adejumo et al., 2020). This was observed in samples such as C2 and A3, where the natural moisture content exceeded 14%.
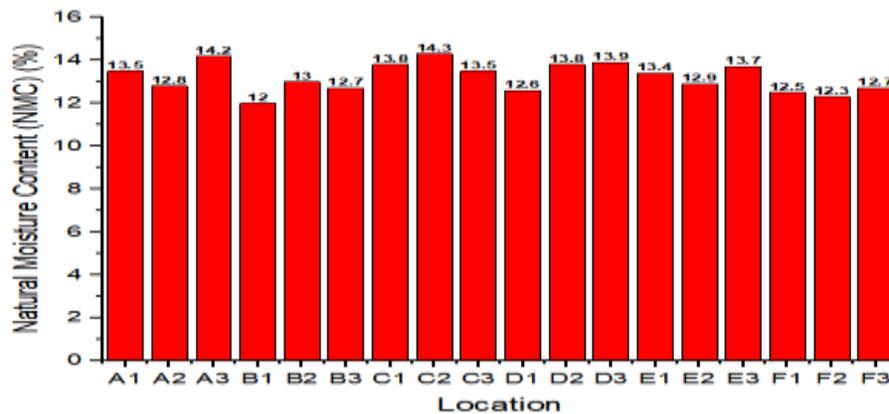
Fig. 2: Natural Moisture Content

The grain size distribution data provides a comprehensive assessment of the particle gradation characteristics of soils from various locations and their implications for geotechnical engineering applications. Particle sizes were systematically analysed using sieve analysis, based on established methodologies such as BS 1377-2:1990 and ASTM D422-63 (2016). These analyses revealed critical insights into the mechanical behaviour of the soils, particularly their compaction efficiency, permeability and suitability for structural loads in construction projects. A1 99.5, A2, A3 passed through 4.75 mm sieve,which means almost all particles are finer than gravel size and are mostly sand, silt, or clay-sized particles. While at 0.075 mm sieve A1 has its value as 53.5, A2 55.66, A3 52.85 this means more than half of the material is made up of very fine particles (silt and clay). This indicates that the materials are very fine-grained, not coarse and having high fines content (above 50%) means, poor drainage (water can't easily pass through), low strength under heavy loads and risk of swelling and shrinking with moisture changes .

   In Samples B1, B2, and B3 exhibited finer gradation profiles, with 98.78% to 99.98% passing the 4.75 mm sieve and 49.24% to 58.33% passing the 0.075 mm sieve. The higher percentage of fines in these samples suggests an increased potential for water retention and reduced shear strength. According to Gidigasu (1976) soils with such characteristics may be marginally suitable for sub-base applications and required careful compaction as well as drainage measures to enhance their performance.

   Samples C1, C2, and C3 exhibited even greater fines content, with 52.57% to 55.47% passing the 0.075 mm sieve and 50.08% to 51.54% passing the finer 0.063 mm sieve. These soils aligned with the classification of clayey silts under AASHTO M145, characterised by high plasticity and moisture sensitivity. Adunoye *et al*. (2018) recommended that stabilisation methods such as lime treatment are necessary to improve their load-bearing properties and mitigate moisture-related deformation. The soil samples from D1, D2, and D3 displayed the highest fines content with 50.99% to 57.75% passing the 0.075 mm sieve and comparable proportions passing the 0.063 mm sieve. Such gradation indicated poor drainage capabilities and high shrink-swell potential, which are critical limitations for subbase applications. Oyeniyi and Oloruntola (2020) emphasised that extensive stabilisation using lime or cement is essential to improve the engineering performance of soils with such characteristics. For Samples E1, E2, and E3, a significant proportion of fines was observed, with 55.32% to 56.43% passing the 0.075 mm sieve and 51.2% to 54.84% passing the 0.063 mm sieve. These soils exhibit moderate permeability but require treatment to handle heavy structural loads effectively. Salifu *et al*. (2021) highlighted the efficacy of stabilisation in enhancing the performance of similar soils under high-traffic

conditions. Samples F1, F2, and F3 showed a mixed gradation profile. At 4.75 mm, 98.14% to 100% of the soil passed through while at 0.075 mm, 54.13% to 57.74% passed through. While these soils may exhibit acceptable performance under light to moderate loads, their high fines content suggests that stabilisation may be required for applications involving significant stress (Mirzababaei *et al.*, 2019). In conclusion, the grain size distribution data highlighted substantial variability in soil properties across the sampled locations. Samples A1 to F3 the grain size distribution data highlighted substantial variability in soil properties across the sampled locations have high fines content, makes it less stable and moisture-sensitive. To make the soils suitable for road construction, stabilisation with lime or cement is essential to improve their strength, reduce water retention, and ensure long-term performance under load. These results highlighted the relevance of soil properties before using it in construction and the need for proper treatment to meet engineering requirements.
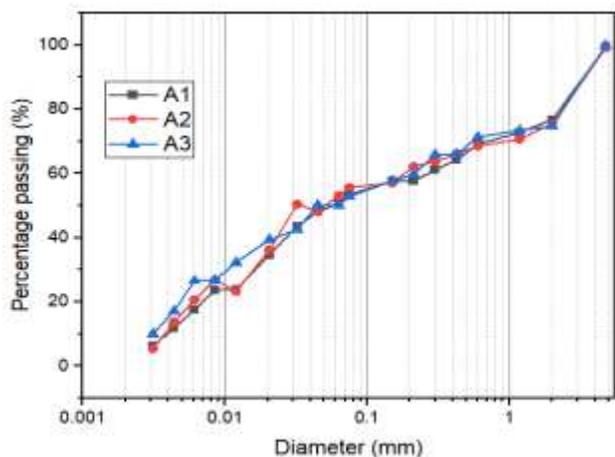
Fig. 3 :Particle size distribution of samples A1-A3
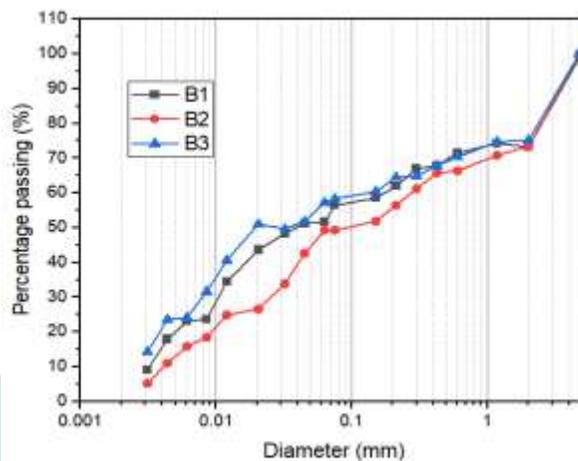
Fig. 4: Grainsize distribution of Samples B1-B3
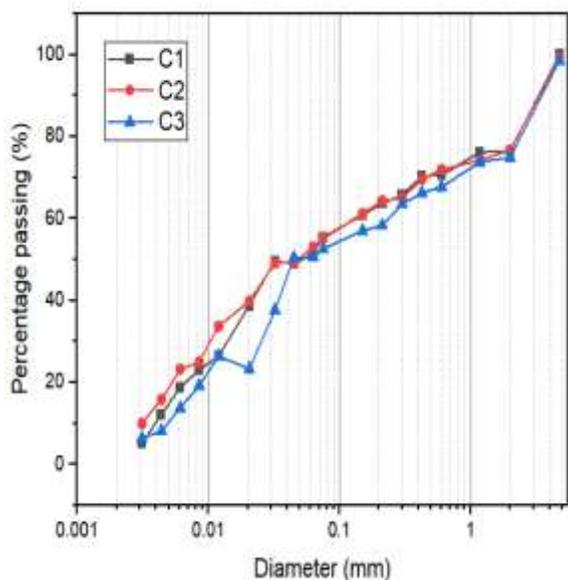
Fig. 5: Particle size distribution of samples C1-C3
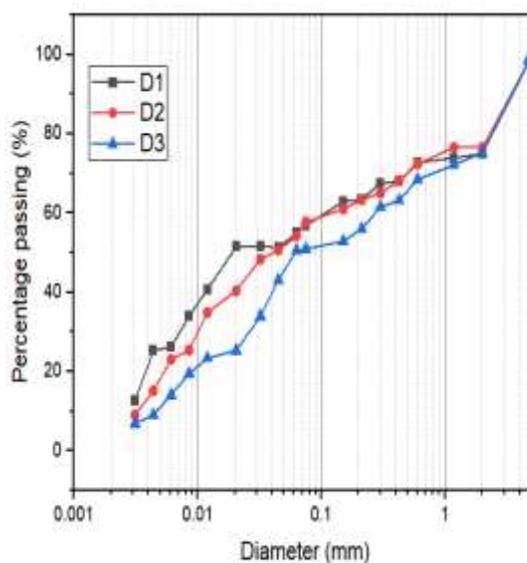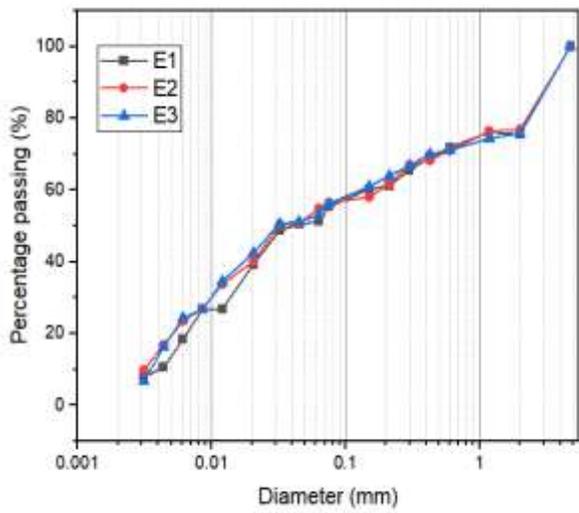

Fig. 6: Grainsize distribution of Samples D1-D3

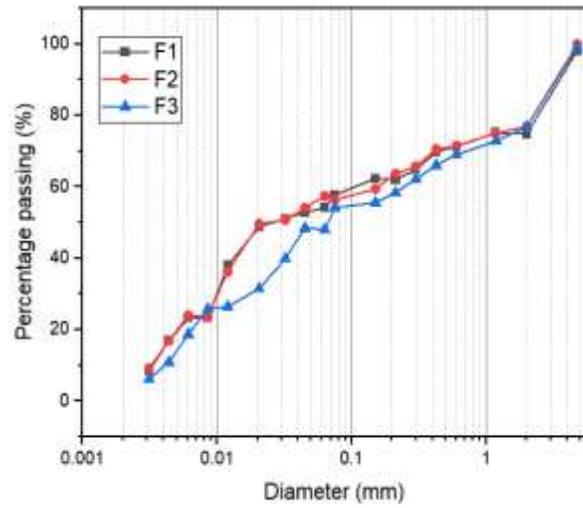**Fig. 7: Grainsize distribution of Samples E1-E3**   **Fig. 8: Grainsize distribution of Samples F1-F3**

The specific gravity results provided valuable insights into the mineralogical composition and engineering behaviour of the studied soils. The values ranged from 2.57 (D3) to 2.68 (D1), with most samples falling within the typical range of 2.5 to 2.8 for construction materials. This variability reflects differences in the soils' mineral content, which significantly influences their compaction, permeability, and load-bearing capacity. The tests were conducted in accordance with BS 1377-2:1990 and ASTM D854, which outline standardised procedures for determining the specific gravity of soils under laboratory conditions. These standards ensure the reliability and consistency of the results while providing a basis for comparison with typical engineering thresholds.

The test results highlight that while some samples like A1–A3, B2, D1, D2 etc may be directly usable for subbase or base layers under proper compaction, Osuji and Akinwamide (2017) reported similar specific gravity values ranging from 2.5 to 2.7 in lateritic soils from Ado-Ekiti, Nigeria, highlighting their suitability for subgrade and subbase applications. the majority of the soils have high fines content and varying mineralogy, making them less ideal in raw form.To ensure their safe and durable use in road construction, Stabilisation (lime or cement)is critical. Compaction and moisture control are necessary and Drainage considerations should be integrated into design.
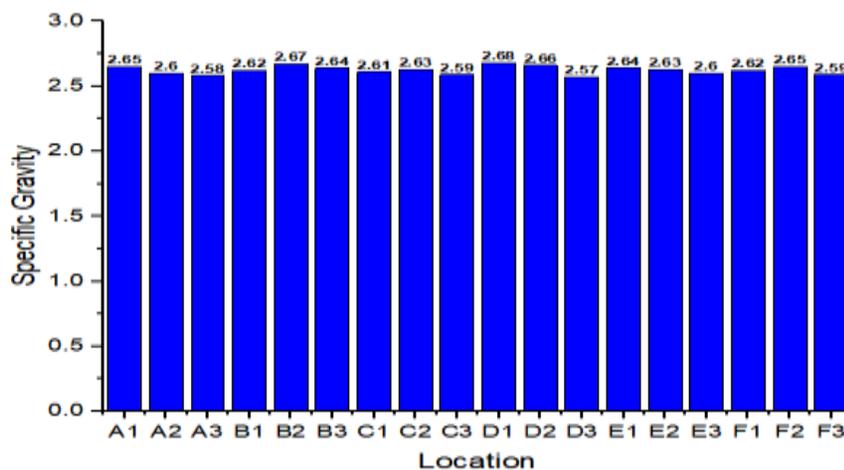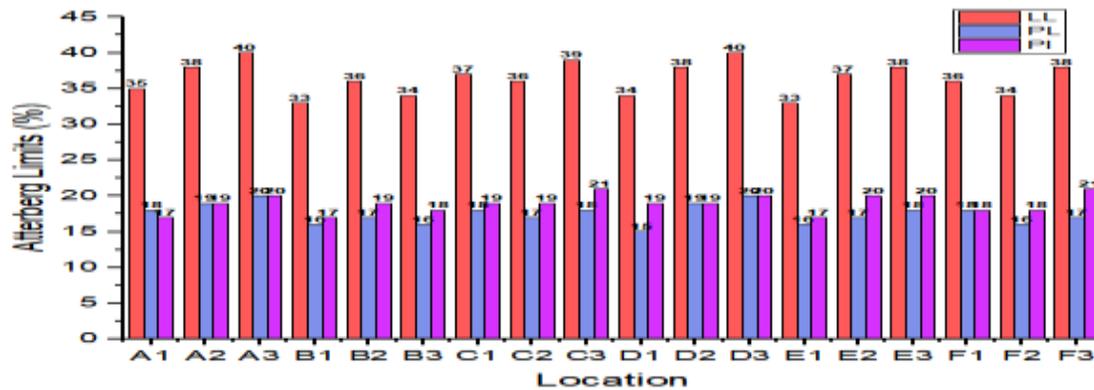

Fig. 9: Specific Gravity

The Atterberg limits, comprising liquid limit (LL), plastic limit (PL), and plasticity index (PI), provide vital insights into soil plasticity and behaviour under varying moisture conditions (Table 4.4, Figure 4.9). These parameters are fundamental for assessing soil suitability for engineering applications, particularly in construction and roadworks. The tests were conducted in accordance with BS 1377-2:1990, which outlines the methods for determining LL, PL, and PI. However, the standard does not prescribe specific threshold values, requiring a comparison with empirical findings to assess engineering performance.

Across all samples, LL values ranged from 33% (B1 and E1) to 40% (A3, D3), PL values varied between 15% (D1) and 20% (A3, D3), and PI values spanned 16% (D1) to 21% (C3, F3). Such variability underscores the influence of clay content and mineral composition on soil behaviour.

Fig. 10: Atterberg Limits

The Atterberg limits, comprising liquid limit (LL), plastic limit (PL), and plasticity index (PI), provide vital insights into soil plasticity and behaviour under varying moisture conditions(Table 4.4, Figure 4.9). These parameters are fundamental for assessing soil suitability for engineering applications, particularly in construction and roadworks. The tests were conducted in accordance with BS 1377-2:1990, which outlines the methods for determining LL, PL, and PI. However, the standard does not prescribe specific threshold values, requiring a comparison with empirical findings to assess engineering performance.

Across all samples, LL values ranged from 33% (B1 and E1) to 40% (A3, D3), PL values varied between 15% (D1) and 20% (A3, D3), and PI values spanned 16% (D1) to 21% (C3, F3). Such variability underscores the influence of clay content and mineral composition on soil behaviour.

Samples A1, A2, and A3 showed LL values of 35%, 38%, and 40%, respectively, with PI values of 17%, 19%, and 20%. These results align with Osuji and Akinwamide's (2017) findings for lateritic soils in Ado-Ekiti, Nigeria, where LL values ranged from 34% to 42%, highlighting their moderate to high plasticity. Soils in this range typically require stabilisation with lime or cement for enhanced shear strength and reduced moisture sensitivity.

Samples B1, B2, and B3 recorded LL values of 33%, 36%, and 34%, with corresponding PI values of 17%, 19%, and 18%. These soils, with relatively lower plasticity, demonstrate better stability under moisture fluctuations. Similar trends were reported by Amadi et al. (2012) for lateritic soils in Minna, Nigeria, where PI values below 20% indicated suitability for subbase applications with minimal treatment.

Samples C1, C2, and C3 exhibited LL values of 37%, 36%, and 39%, with PI values of 19%, 19%, and 21%, respectively. The elevated PI for C3 suggests greater susceptibility to shrink-swell behaviour, corroborating findings by Salifu et al. (2021), who noted that PI values above 20% necessitate chemical treatment to mitigate volume changes and improve durability.

Samples D1, D2, and D3 showed LL values of 34%, 38%, and 40%, with PI values of 19%, 19%, and 20%, respectively. The higher plasticity of D3, combined with its elevated LL, indicates significant moisture sensitivity. Gidigasu (1976) observed similar behaviour in tropical soils, emphasising the importance of stabilisation for such materials.

Samples E1, E2, and E3, with LL values of 33%, 37%, and 38%, and PI values of 17%, 20%, and 20%, represent moderate plasticity, suitable for subgrades but requiring treatment for high-traffic applications. Likewise, Samples F1, F2, and F3, with LL values of 36%, 34%, and 38%, and PI values of 18%, 18%, and 21%, highlight the variability in soil plasticity across different locations.

The Atterberg limits data reveal that soils with PI values exceeding 20%, such as A3, C3, and D3, are more prone to shrink-swell behaviour and require stabilisation to meet engineering demands. Conversely, soils with lower PI

values, such as B1 and D1, exhibit better stability and require minimal treatment for use in subgrades and subbases. These findings, when integrated with other geotechnical parameters like compaction and specific gravity, provide a comprehensive framework for designing effective soil improvement strategies to ensure optimal performance in road construction and other structural applications.

2.2 DETERMINATION OF THE GEOTECHNICAL PROPERTIES TESTS.

This subsection examined the geotechnical properties of the soil samples and below is the summary of the test result carried out.

Table 10: Summary of all geotechnical properties test results.

S/N	LOCATION	COMMUNITY	COMPACTION		UNCONFINED COMPRESSIVE STRENGTH.		CALIFORNIA BEARING RATIO	
			MDD (g/cm³)	OMC (%)	UCS (kPa)	COHESSION (kPa)	Unsoaked CBR (%)	SOAKED CBR (%)
1	A	A1	1.44	13.1	159	79.5	26.3	18.1
		A2	1.70	12.5	121	60.5	34.4	27.2
		A3	1.45	14.1	112	56.0	25.8	18.3
2	B	B1	1.67	11.2	128	64.0	37.5	27.2
		B2	1.46	12.8	188	94.0	19.2	16.4
		B3	1.78	12.1	121	60.5	39.2	27.5
3	C	C1	1.63	13.5	148	74.0	29.4	23.2
		C2	1.62	14.5	120	60.0	29.9	20.4
		C3	1.59	13.3	128	64.0	18.5	13.3
4	D	D1	1.76	12.1	113	56.5	38.8	26.3
		D2	1.68	13.7	107	53.5	22.9	17.4
		D3	1.62	13.5	139	69.5	33.5	24.5
5	E	E1	1.73	13.5	159	79.5	21.7	15
		E2	1.68	12.8	138	69.0	28.2	21.5
		E3	1.59	13.3	124	62.0	28.7	20.2
6	F	F1	1.78	11.8	141	70.5	37.7	29.2
		F2	1.79	11.5	162	81.0	38.6	28.3
		F3	1.67	12.5	141	78.5	29.8	21.2

a.   **The compaction characteristics (MDD and OMC)** behaviour of the soil samples were discussed with emphasis on their suitability for subbase and subgrade applications.The compaction characteristics of the soil samples were evaluated using standard laboratory procedures in accordance with BS 1377-4:1990. These tests provided critical insights into the Maximum Dry Density (MDD) and Optimum Moisture Content (OMC), two parameters that directly affect soil strength and stability. While BS 1377-4 did not specify thresholds for MDD, engineering best practices and published research were used to interpret the results, particularly considering the Nigerian General Specifications for

subbase materials, which stipulate a minimum MDD of 1.70 g/cm³ for subbase suitability. The results indicate variability in compaction behaviour across samples, reflecting differences in soil composition and gradation.
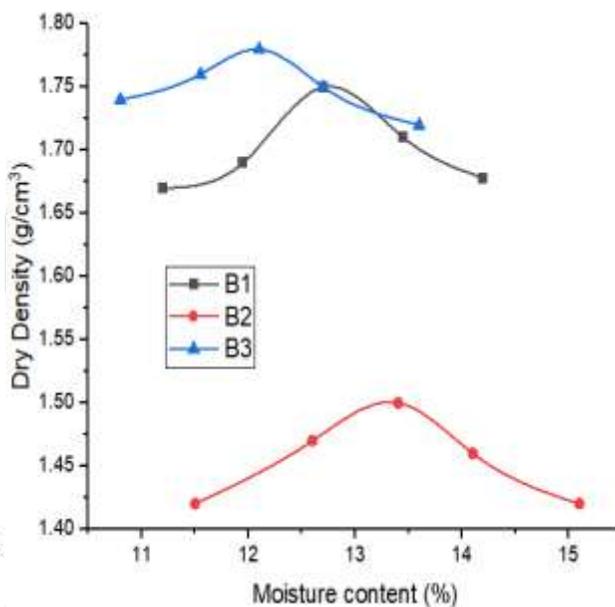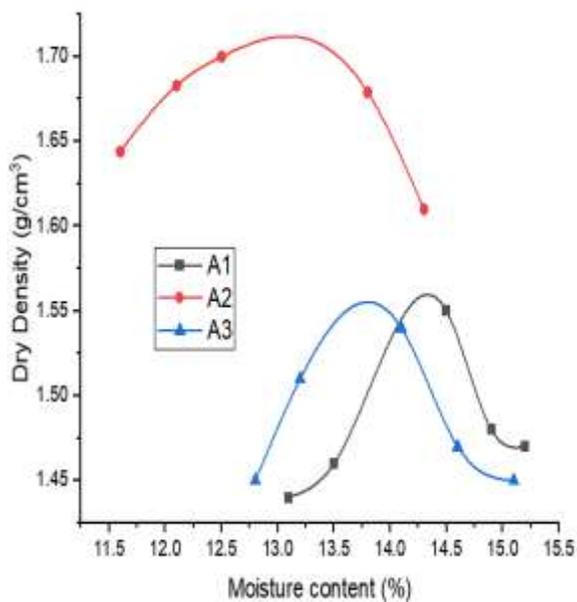

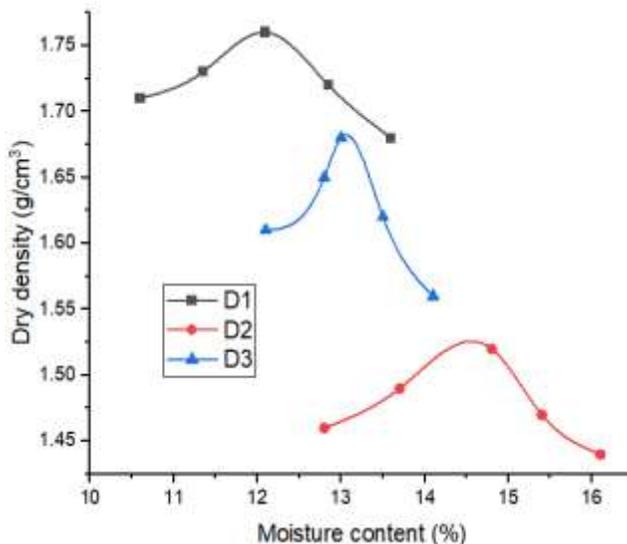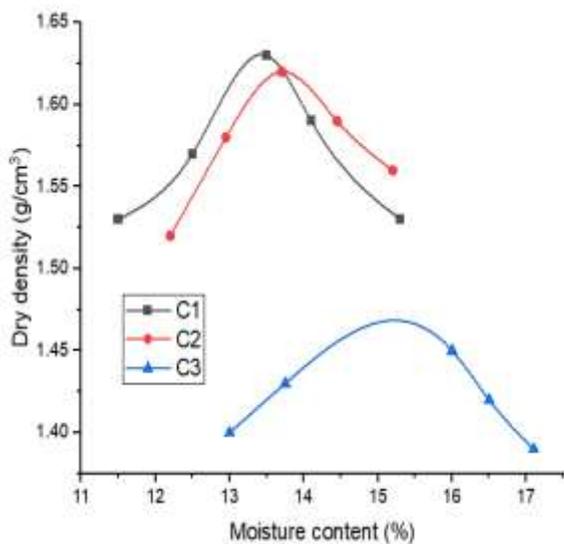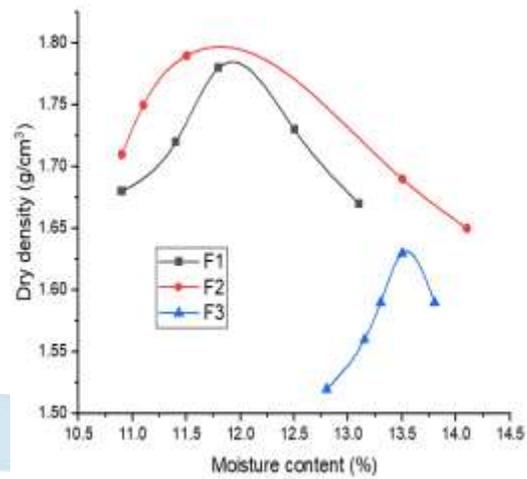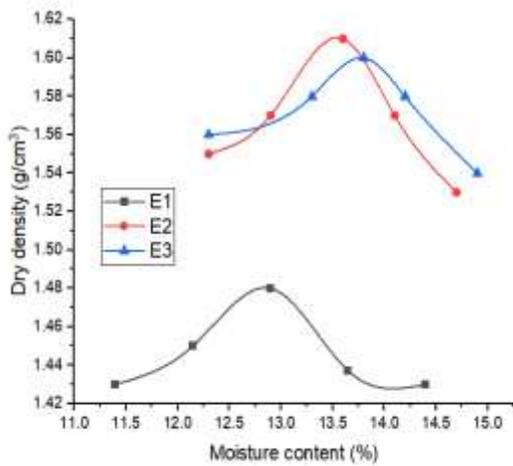**Fig.11: Compaction Characteristics of Samples A1-A3   Fig. 12: Compaction Characteristics of samples B1-B3**

Fig 13:Compaction Characteristics of samples C1-C3   Fig 14:Compaction Characteristics of samples D1-D3

Fig 15:Compaction Characteristics of samples E1-E3   Fig 16: Compaction characteristics of Samples F1-F3

Samples A1, A2, and A3 showed peak dry densities of 1.55 g/cm³ (A1 at 14.5%), 1.70 g/cm³ (A2 at 12.5%), and 1.54 g/cm³ (A3 at 14.1%). While A2 meets the threshold for subbase suitability, A1 and A3 fall short, likely due to higher fines content affecting their compaction potential. Adejumo *et al*. (2020) observed that soils with MDD values below 1.70 g/cm³ often exhibit reduced load-bearing capacity. Similarly, Samples B1, B2, and B3 achieved MDD values of 1.75 g/cm³ (B1 at 12.7%), 1.46 g/cm³ (B2 at 12.8%), and 1.78 g/cm³ (B3 at 12.1%). B1 and B3 satisfied subbase criteria and demonstrate excellent engineering properties, while B2, with its lower MDD, is more suitable for subgrade applications. Gidigasu (1976) noted similar behaviour in soils with moderate fines content, where higher compaction efficiency is observed at lower moisture levels.

For Samples C1, C2, and C3, the peak MDD values were 1.63 g/cm³ (C1 at 13.5%), 1.62 g/cm³ (C2 at 14.5%), and 1.59 g/cm³ (C3 at 13.3%). These values are below the 1.70 g/cm³ threshold, indicating marginal suitability for subgrade layers. Stabilisation techniques such as lime or cement treatment are recommended to enhance their structural performance, as corroborated by Adunoye *et al*. (2018).

Samples D1, D2, and D3 recorded MDD values of 1.76 g/cm³ (D1 at 12.1%), 1.68 g/cm³ (D2 at 13.7%), and 1.62 g/cm³ (D3 at 13.5%). D1 qualifies for subbase applications, while D2 and D3 are better suited for subgrade use. The results are consistent with Salifu *et al*. (2021), who highlighted the role of moisture-density relationships in determining soil suitability for road construction.

Lastly, Samples E1, E2, and E3 exhibited MDD values of 1.73 g/cm³ (E1 at 13.5%), 1.68 g/cm³ (E2 at 12.8%), and 1.59 g/cm³ (E3 at 13.3%), while Samples F1, F2, and F3 showed 1.78 g/cm³ (F1 at 11.8%), 1.79 g/cm³ (F2 at 11.5%), and 1.67 g/cm³ (F3 at 12.5%). E1, F1, and F2 meet the subbase criteria, demonstrating high compaction potential and strength, while the remaining samples require stabilisation for effective subgrade use.

The analysis underscores the variability in soil performance and highlights the need for targeted stabilisation to ensure long-term durability in construction projects. By adopting standards and empirical evidence, such as those by Adejumo *et al*. (2020) and Salifu *et al*. (2021), engineers can optimise soil compaction and enhance its performance.

b. **Unconfined compressive strength (UCS)**test results were analysed, comparing them to established thresholds for engineering applications. The Unconfined Compressive Strength (UCS) results provide valuable insights into the soil's ability to withstand axial loads without lateral confinement. The UCS values across all samples ranged from 107 kPa (D2) to 188 kPa (B2), indicating significant variability influenced by particle size distribution, fines content, and compaction characteristics. These variations directly impact the soil's suitability for subgrade and subbase applications in road construction. The UCS tests were conducted in accordance with BS 1377-7:1990, which ensures reliability and consistency in results. However, this standard primarily provides testing methodology rather than prescriptive UCS thresholds for engineering applications. To complement the UCS findings, cohesion (C), which represents the soil's resistance to shear stress, was estimated using the empirical relation C = UCS/2.

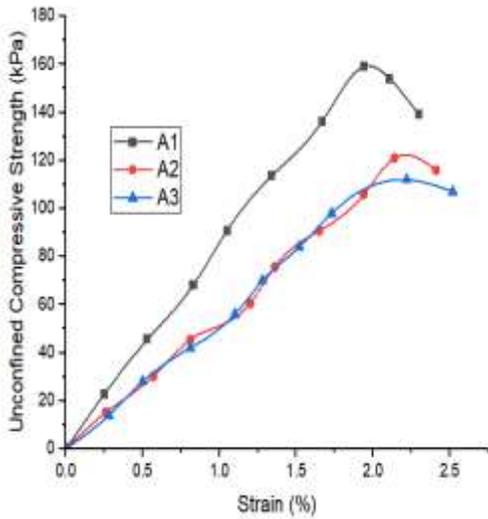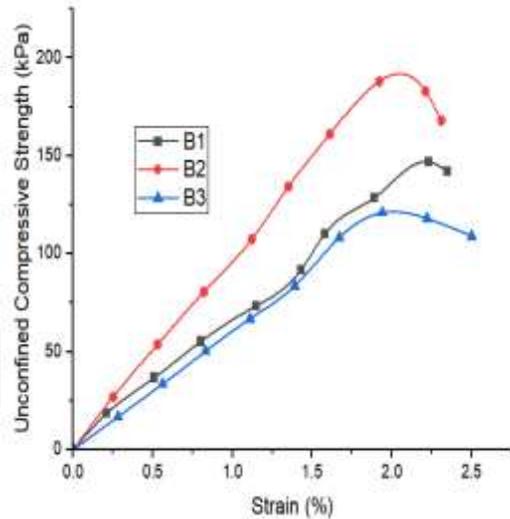**Fig. 17: UCS results of Samples A1-A3**

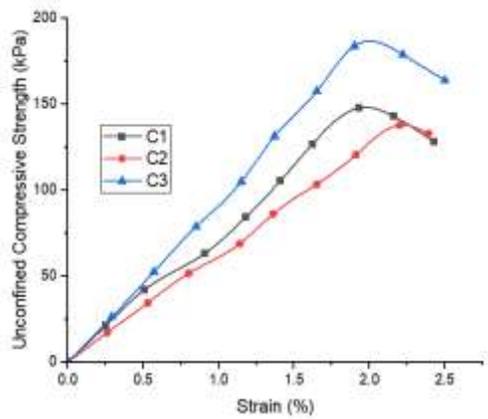**Fig. 18: UCS results of Samples B1-B3**

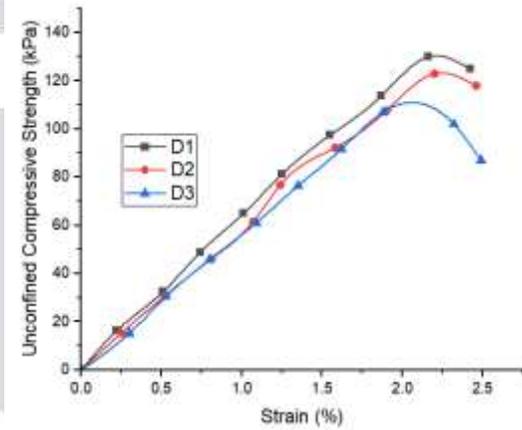**Fig. 19 : UCS results of Samples C1-C3**

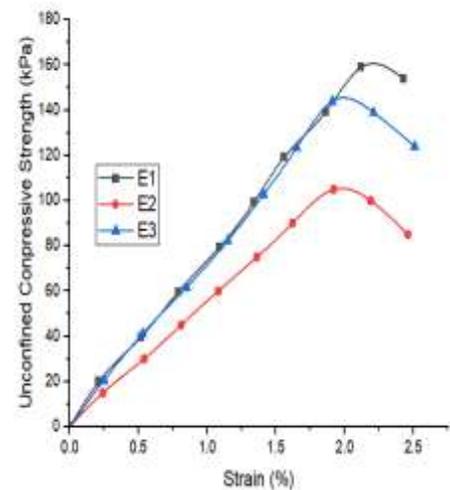**Fig. 20: UCS results of Samples D1-D3**

Fig. 21:UCS results of Samples E1-E3

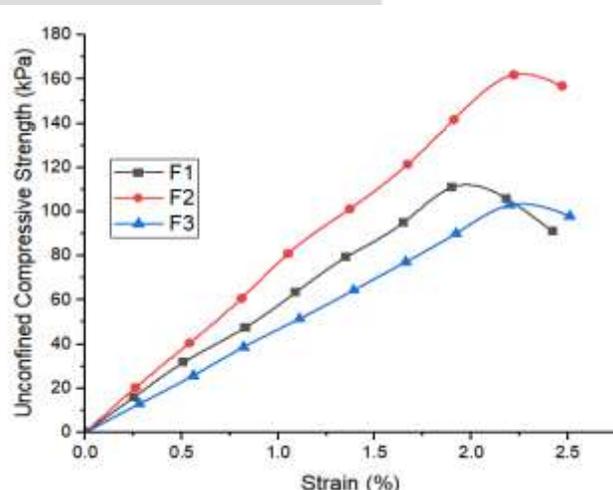**Fig. 22: UCS results of Samples F1-F3**

Among the samples, the results revealed distinct strength characteristics. Samples A1, A2, and A3 recorded UCS values of 159 kPa, 121 kPa, and 112 kPa with corresponding cohesion values of 79.5 kPa, 60.5 kPa, and 56.0 kPa, respectively. These values suggested moderate strength, typical of lateritic soils. Osuji et al. (2019) found UCS values between 120

and 160 kPa in stabilised tropical soils, indicating suitability for light to medium traffic loads. However, additional stabilisation may be required to enhance durability for higher load applications.

Samples B1, B2, and B3 exhibited UCS peaks of 128 kPa, 188 kPa, and 121 kPa, translating to cohesion values of 64.0 kPa, 94.0 kPa, and 60.5 kPa, respectively. B2, with the highest UCS (188 kPa) and cohesion (94.0 kPa), suggested a well-compacted soil matrix with minimal fines, making it particularly well-suited for subbase applications with minimal stabilisation. Amadi et al. (2018) noted that UCS values nearing 200 kPa indicate strong subgrades or subbases capable of supporting moderate to heavy traffic loads without excessive deformation.

A similar trend was observed in Samples C1, C2, and C3, which exhibited UCS values of 148 kPa, 120 kPa, and 128 kPa, corresponding to cohesion values of 74.0 kPa, 60.0 kPa, and 64.0 kPa, respectively. C3's lower UCS and cohesion values suggest a higher fines content, which reduces overall shear resistance. Salifu et al. (2021) highlighted that soils with UCS values below 130 kPa, such as C3 (128 kPa, C = 64.0 kPa) and D2 (107 kPa, C = 53.5 kPa), often require lime or cement treatment to enhance their structural integrity. Their study demonstrated that lime stabilisation could increase UCS by 20–50%, depending on the initial fines content and compaction effort, underscoring the need for targeted soil improvement strategies.

Samples D1, D2, and D3 recorded UCS values of 113 kPa, 107 kPa, and 139 kPa, with corresponding cohesion values of 56.5 kPa, 53.5 kPa, and 69.5 kPa, respectively. D2, with the lowest UCS and cohesion values (107 kPa, 53.5 kPa), highlights a weak soil matrix that would require stabilisation for improved engineering performance. Mirzababaei et al. (2020) suggested that UCS in weak soils can be increased by up to 50% through stabilisation techniques, making such approaches essential for soils with marginal strength.

The results for Samples E1, E2, and E3, with UCS values of 159 kPa, 138 kPa, and 124 kPa (cohesion values: 79.5 kPa, 69.0 kPa, and 62.0 kPa), and Samples F1, F2, and F3, with UCS values of 141 kPa, 162 kPa, and 157 kPa (cohesion values: 70.5 kPa, 81.0 kPa, and 78.5 kPa), indicate moderate to high strength. O'Brien et al. (2022) observed that UCS values nearing 200 kPa are associated with improved subbase performance.

Overall, laterietic soils with UCS values nearing 200 kPa, such as B2 (188 kPa, C = 94.0 kPa) and F2 (162 kPa, C = 81.0 kPa), are suitable for heavy traffic applications with minimal treatment. In contrast, soils like D2 (107 kPa, C = 53.5 kPa) and C3 (128 kPa, C = 64.0 kPa) exhibit lower cohesion and require chemical stabilisation to enhance load-bearing capacity. These findings underscore the relevance of UCS and cohesion in evaluating soil performance, to determine appropriate stabilisation strategies for improved road construction applications.

c.   **California bearing ratio (CBR)** which of Soaked and unsoaked CBR values were presented and discussed in the context of Nigerian standards for road construction. The California Bearing Ratio (CBR) results is a significant parameter use in road construction and pavement design to evaluate the strength and load bearing capacity of lateriatic soil. The tests were conducted in accordance with the Nigerian General Specification (1997) for Roads and Bridges, which establishes thresholds for subbase and subgrade layers. Specifically, the standard requires soaked CBR values of at least 30% for subbase materials and 15% for subgrade applications, ensuring the reliability and consistency of the results when applied to local construction conditions. The unsoaked CBR values ranged from 18.5% (C3) to 39.2% (B3), while the soaked CBR values varied between 13.3% (C3) and 29.2% (F1). These variations provide insights into the soils' performance under dry and saturated conditions, which are critical for infrastructure durability.
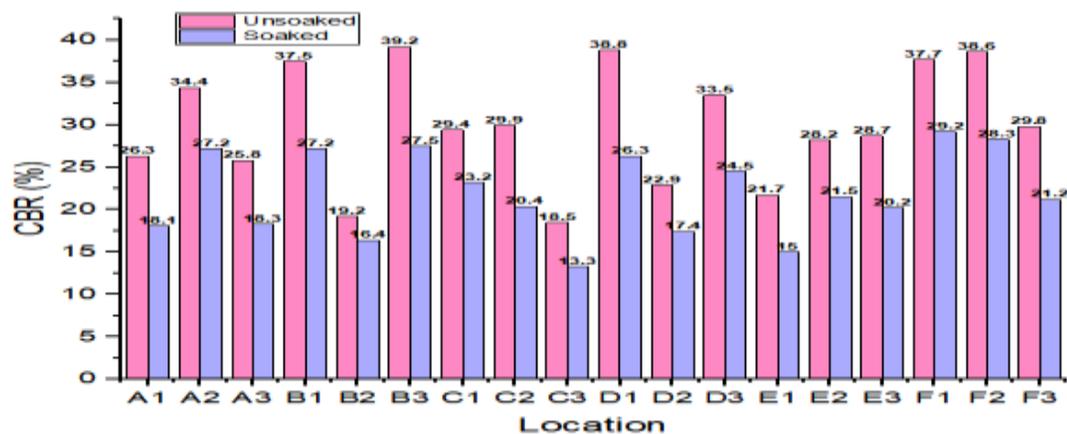
Fig. 23: California bearing ratio (CBR) results

Samples A1, A2, and A3 exhibited unsoaked CBR values of 26.3%, 34.4%, and 25.8%, respectively, and soaked values of 18.1%, 27.2%, and 18.3%. These values indicated moderate strength, with A2 demonstrating the highest potential for load-bearing among this group. Osuji and Akinwamide (2017) found similar trends in lateritic soils, where unsoaked CBR values between 30% and 35% indicated suitability for subbase layers with minimal treatment.

Samples B1, B2, and B3 recorded unsoaked CBR values of 37.5%, 19.2%, and 39.2%, and soaked values of 27.2%, 16.4%, and 27.5%, respectively. B3's high unsoaked CBR suggested excellent dry condition strength, aligning with findings by Amadi *et al*. (2018) who reported that unsoaked CBR values above 35% are ideal for high-traffic subbase applications. However, the relatively low soaked values for B2 highlight the need for stabilisation to improve moisture resistance.

Samples C1, C2, and C3 demonstrated unsoaked CBR values of 29.4%, 29.9%, and 18.5%, with soaked values of 23.2%, 20.4%, and 13.3%, respectively. C3's low values under both conditions indicate poor load-bearing performance and high moisture sensitivity. Salifu *et al*. (2021) observed that soils with soaked CBR values below 15% often require lime or cement stabilisation to enhance strength and durability.

Samples D1, D2, and D3 showed unsoaked CBR values of 38.8%, 22.9%, and 33.5%, and soaked values of 26.3%, 17.4%, and 24.5%, respectively. The relatively high unsoaked values for D1 and D3 indicated good performance under dry conditions, whereas D2's lower values suggest the need for moisture-resistance improvements.

Samples E1, E2, and E3, with unsoaked CBR values of 21.7%, 28.2%, and 28.7%, and soaked values of 15%, 21.5%, and 20.2%, showed moderate strength, suitable for low to medium traffic subgrades.

Similarly, Samples F1, F2, and F3 recorded unsoaked CBR values of 37.7%, 38.6%, and 29.8%, and soaked values of 29.2%, 28.3%, and 21.2%, highlighting their potential for use in subbase applications with minimal stabilisation. The results revealed that soils with unsoaked CBR values exceeding 30%, such as B3, F1, and F2, exhibit excellent dry condition strength and are suitable for high-traffic applications. Conversely, soils with soaked CBR values below 30%, such as C3 and E1, fall short of the Nigerian General Specification for subbase applications and require stabilisation to enhance their moisture resistance and load-bearing capacity. Stabilisation techniques, including lime and cement treatment can improve soaked CBR values by 20-40%, ensuring their reliability for long-term use in road construction (Mirzababaei *et al*. 2019).

2.3 EVALUATION OF THE DIFFERENT SOIL SAMPLE IN EACH LOCAL COMMUNITY DEVELOPMENT AREA LCDA AND WITHIN THE VARIOUS LCDA.

This subsection evaluated and classified the soils across the six different local community development area and within the various LCDAs in Alimosholocal government area of lagos state using established classification systems.

Table 11 : Summary of soil classification and recommendations

Sample ID	USCS Classification	AASHTO Classification	Key Characteristics	Applications	Recommended Stabilisation Techniques	References
A1 (Command area)	SC (Clayey Sand)	A-2-6 (Clayey Gravel/Sand)	Moderate permeability; increased fines.	Subgrade layers only.	Proper compaction; lime stabilisation recommended.	Gidigasu (1976), Adejumo et al. (2020)
A2 (Ekoro)	SC (Clayey Sand)	A-2-6 (Clayey Gravel/Sand)	Moderate fines; increased water sensitivity.	Subgrade layers.	Lime or cement stabilisation to reduce plasticity.	Oyeniyi and Oloruntola (2020)
A3 (Aboru)	SC (Clayey Sand)	A-2-6 (Clayey Gravel/Sand)	High fines; poor drainage and moisture retention.	Subgrade layers.	Lime stabilisation to improve performance.	Sadeeq et al. (2015)
B1 (Akowonjo)	SC (Clayey Sand)	A-2-6 (Clayey Gravel/Sand)	Moderate fines; good compaction.	Subgrade applications.	Lime stabilisation recommended; proper drainage needed.	Ola (1983)
B2 (Shasha)	CL (Low Plasticity Clay)	A-7-6 (Clayey Soil)	High fines; poor drainage and moisture retention; low strength.	Limited to subgrade use in low-loading areas.	Lime stabilisation to improve compressive strength; geotextiles for load distribution.	
B3 (Ijegun)	SC (Clayey Sand)	A-2-6 (Clayey Gravel/Sand)	Moderate permeability; increased water sensitivity.	Subgrade layers.	Proper compaction and lime stabilisation to reduce plasticity.	
C1 (Ayobo-Agbado road (exhusted)	CL (Low Plasticity Clay)	A-6 (Clayey Soil)	High fines; poor drainage and moisture retention; low strength.	Subgrade layers.	Lime stabilisation to reduce plasticity; cement for enhanced compressive strength.	
C2 (Kande-ijon area)	SM (Silty Sand)	A-2-4 (Silty Gravel/Sand)	Well-graded silty sand with good compaction.	Subgrade layers.	Mechanical stabilisation; ensure proper compaction.	
C3 (Megida)	CL (Low Plasticity Clay)	A-6 (Clayey Soil)	Moderate fines with good compaction properties.	Subgrade layers for light-duty traffic.	Lime or cement stabilisation; proper drainage	

					needed.
D1 (Idimu-ikotun road)	ML (Silty Clay)	A-6 (Clayey Soil)	Silty clay with high water retention; low UCS.	Subgrade layers.	Lime stabilisation; geotextile reinforcement to improve load distribution.
D2 (idimu-ejigbo link road)	CL (Low Plasticity Clay)	A-7-6 (Clayey Soil)	Low plasticity clay with moderate strength.	Subgrade layers for light-duty roads.	Lime or cement to enhance strength; proper compaction at OMC.
D3 (Ogunrombi)	SC (Clayey Sand)	A-2-6 (Clayey Gravel/Sand)	Clayey sand with moderate permeability.	Subgrade layers.	Proper drainage and mechanical stabilisation recommended.
E1 (Akesan)	SM (Silty Sand)	A-2-4 (Silty Gravel/Sand)	Well-graded silty sand with good permeability.	Subgrade layers in low-traffic roads.	Minimal stabilisation needed; ensure proper compaction.
E2 (Oba Dore)	CL (Low Plasticity Clay)	A-7-6 (Clayey Soil)	Low plasticity clay with moderate water sensitivity.	Subgrade layers for low-load applications.	Lime stabilisation to reduce plasticity.
E3 (Igando-Isheri road (exhusted))	ML (Silty Clay)	A-6 (Clayey Soil)	Silty clay with low strength and high fines.	Limited to subgrade in low-loading areas.	Lime stabilisation to reduce plasticity; geotextile for load distribution.
F1 (Gowon Estate) (exhusted)	SC (Clayey Sand)	A-2-6 (Clayey Gravel/Sand)	Clayey sand with favourable geotechnical properties.	Subgrade layers.	Proper drainage; lime stabilisation recommended.
F2 (Abisi Village)	SC (Clayey Sand)	A-2-6 (Clayey Gravel/Sand)	Clayey sand with good load-bearing capacity.	Subgrade applications.	Proper compaction at OMC; minimal stabilisation needed.
F3 (Baruwa-ipaja boundary)	CL (Low Plasticity Clay)	A-6 (Clayey Soil)	Low plasticity clay with moderate UCS.	Subgrade layers for light traffic.	Lime or cement stabilisation to enhance compressive strength.

In a nutshell in evaluating the geotechnical properties of the lateritic soils from the six LCDAs in Alimosho LGA were done using USCS and AASHTO classification systems. Across all locations, Non of the 18 soil samples in their natural state are suitable as Subbase marterial due to their low soaked CBR values across all LCDAs but could be used as Subgrade.

Two (2) samples (C2 and E1) were catergorised under unified soil classification system as SM (silty sand) and classified under AASHTO as A-2-4 is silty or slightly clayey sand or gravel, commonly used in road construction has low plasticity, moderate strength, and moderate drainage. It performs well when properly compacted or stabilized and can be commonly used in subbase layer and base layer possible if well compacted or stabilized. Under USCS, eight (8) samples like A1, A2, A3, B1, B3, D3, F1& F2were

categorised as Clayey Sand (SC) and classified under AASHTO as A-2-6 (Clayey gravel sand) which makes them common & moderately strong, sensitive to water but fairly to be use as subgrade, also needs improvement as subbase material. 6 samples like B2, C1, C3, D2, E2, F3 were catergorised as Low Plasticity Clays (CL) and Silty Sands (SM) and classified under AASHTO as A-6 and A-7-6 which shows they are weaker or poorer drainage and have low strength, they require improvement with 2 of these samples D1, E3 are Silty Clay (ML) and in AASHTO falls under A-6 which are Silty clay with high water retention and low UCS.

The Unified Soil Classification System (USCS) and AASHTO classifications for the lateritic soils from the six Local Community Development Areas (LCDA) (Table 4) provide essential insights into their geotechnical properties, potential applications, and necessary stabilisation techniques for road construction. These evaluations highlight the influence of soil composition on performance under load, moisture retention, and strength. The following subsections discuss the geotechnical properties of these soils using both classification systems.

a.   **Agbado/Oke-odo LCDA (A)**

In Agbado/Oke-odo LCDA, the sampled locations included Command area (A1), Ekoro (A2), and Aboru(A3). Based on the soaked CBR values, none of the soils in this area met the requirements for subbase applications. A1, classified as SC (Clayey Sand) under USCS and A-2-6 under AASHTO, is suitable for subgrade layers, with good compaction properties and moderate permeability. A2, also SC (Clayey Sand) and A-2-6 under AASHTO, demonstrates increased water sensitivity, requiring lime or cement stabilisation to reduce plasticity. A3, classified as SC (Clayey Sand) under USCS and A-2-6 under AASHTO, has poor drainage and moisture retention, limiting its use to subgrade applications with appropriate stabilisation.

b.   **Alimosho LCDA (B)**

In Alimosho LCDA, the sampled locations include Akowonjo (B1), Shasha (B2), and Ijegun (B3). None of these soils qualify for subbase applications due to their soaked CBR values. B1, classified as SC (Clayey Sand) under USCS and A-2-6 under AASHTO, is suitable for subgrade applications, with moderate permeability and good compaction properties. B2, classified as CL (Low Plasticity Clay) under USCS and A-7-6 under AASHTO, requires extensive stabilisation with lime to improve its strength. B3, also SC (Clayey Sand) under USCS and A-2-6 under AASHTO, has moderate permeability but increased water sensitivity, necessitating proper drainage measures.

c.   **Ayobo/Ipaja LCDA (C)**

Ayobo/Ipaja LCDA includes Olorunishola(C1), Kande-ijon area (C2), and Megida (C3). All locations fail to met the subbase requirements due to their soaked CBR values. C1, classified as CL (Low Plasticity Clay) under USCS and A-6 under AASHTO, is best suited as a subgrade layers, with lime stabilisation recommended to reduce plasticity. C2, classified as SM (Silty Sand) under USCS and A-2-4 under AASHTO, has good compaction properties but is limited to subgrade applications due to water sensitivity. C3, classified as CL (Low Plasticity Clay) under USCS and A-6 under AASHTO, requires stabilisation for light-duty subgrade use.

d.   **Egbe/Idimu LCDA (D)**

Egbe/Idimu LCDA comprised (D1)Idimu-ikotun road, idimu-ejigbo link road (D2), and Ogunrombi (D3). None of these soils meet the subbase requirements. D1, classified as ML (Silty Clay) under USCS and A-6 under AASHTO, has low UCS and is limited to low-load subgrade areas. D2, classified as CL (Low Plasticity Clay) under USCS and A-7-6 under AASHTO, requires lime stabilisation for light-duty subgrade applications. D3, classified as SC (Clayey Sand) under USCS and A-2-6 under AASHTO, has moderate permeability, requiring stabilisation for subgrade use.

e.   **Igando/Ikotun LCDA (E)**

Igando/Ikotun LCDA includes Akesan (E1), Oba Dore (E2), and Igando-Isheri road (exhusted) (E3). The soaked CBR values indicated that these soils are not suitable for subbase applications. E1, classified as SM (Silty Sand) under USCS and A-2-4 under AASHTO, is limited to subgrade applications, with minimal stabilisation needed. E2, classified as CL (Low Plasticity Clay) under USCS and A-7-6 under AASHTO, requires lime stabilisation for improved performance. E3, classified as ML (Silty Clay) under USCS and A-6 under AASHTO, is suitable only for low-loading subgrade areas with proper stabilisation.

f.   Mosan/Okunola LCDA (F)

Mosan/Okunola LCDA covers Gowon Estate (Exhusted)(F1), Abisi Village (F2), and Baruwa-ipaja boundary (F3). These soils also do not meet subbase requirements due to their soaked CBR values. F1, classified as SC (Clayey Sand) under USCS and A-2-6 under AASHTO, has favourable geotechnical properties for subgrade layers but requires proper drainage. F2, classified as SC (Clayey Sand) under USCS and A-2-6 under AASHTO, demonstrates good load-bearing capacity but is limited to subgrade use with compaction at OMC. F3, classified as CL (Low Plasticity Clay) under USCS and A-6 under AASHTO, requires stabilisation for light-traffic subgrade application.

In providing a holistic summary on the evaluation of the geotechnical properties of lateritic soils and its usages across the six LCDAs in Alimosho Local Government Area, The initial general belief that borrow pits material in Alimosho LGA are one of the best in lagos state for road fills material, at subgrades even at subbase level are partly not supported by some of the test results, The general performance and suitability showed that ten (10) different soil samples showed Moderate permeability, with granular soils and due to the sand content, has a good Compaction properties at Optimum Moisture Content (OMC) so were classified as A-2-4 (C2 and E1) and A-2-6 (A1, A2, A3, B1, B3,D3, F1,F2) from the six LCDAs can fairly be use as a subbase and subgrade (as flexible pavement for A-2-4) material in its natural state and in low to medium traffic roads, Also can used in rural, residential, and low-volume roads, but since they never met the soaked CBR requirements for subbase applications (typically ≥30% for soaked CBR) they still requires a very minimal stabilization to enhance its performance which can be extended to more demanding road types or to a more demanding conditions. Soils samples like C1, C3, D1 E3 and F3 where classified according to AASHTO as A-6 which are generally poor, have high plasticity, with poor strength, Moisture sensitivity, and after stabilization can be used as subgrade material (for foundation of a pavement layers) and fill material in a non-critical areas. Samples like B2, D2 and E2 which were classified in AASHTO soil system as A-7-6 refers to as a highly plastic clayey soils, have poor drainage, higher moisture retention, Harder to compact uniformly, require improved surface and subsurface drainage design. in their natural state are generally unsuitable for road construction due to its poor engineering properties, these can only be usable after significant improvement and as a Subgrade materials in very low-traffic roads environments where loading demands are minimal, as a road fill material in embankments (non-load-critical areas) and used in footpaths, pedestrian walkways, lightly trafficked rural access roads and as borrow material provided that adequate compaction is achieved. . Policy or construction planning in these area should also search for sourcing for granular material externally for higher-load applications that is needed.

3.0 Conclusions

In conclusion, the preliminary tests revealed significant variability on the NMC with higher values indicating increased water retention and reduced compaction efficiency. The Specific gravity values indicated variations in mineral composition and soil density, while the particle size distribution showed that some samples exhibited well-graded profiles conducive to good compaction and potential suitability for sub-base applications.The geotechnical properties demonstrated a mix of low to high plasticity soils with compaction tests showed that few samples met the threshold for sub-base applications, CBR tests revealed that no sample met the sub-base requirements emphasising the need for stabilisation. During the evaluation of the soil classification using AASHTO and USCS systems, it revealed that some soils were classified as A-2-4 and CL which showed moderate strength and plasticity, making them potentially suitable for sub-base applications also soils classified as A-7-6 and CH which showed high plasticity and poor strength, limiting their use to subgrade applications without significant stabilisation.

Recommendations

This paper recommended that Pre-treatment methods, such as blending with drier materials, should be considered for soils with high natural moisture content, such as C2 (14.3%) and D3 (13.9%), to improve their compaction potential. Stabilisation is necessary for soils with high plasticity or low strength. Lime and cement stabilisation are recommended for soils like C3 (soaked CBR:3.3%) to meet Nigerian specifications for subbase materials.

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