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Geotechnical Characterization of Lateritic Soils at Federal University Oye-Ekiti, Ikole Campus: Implications for Foundation Design

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ABSTRACT: *Frequent structural collapses in Nigeria underscore the need for adequate geotechnical investigations to support safe and economical foundation design. This study assesses the geotechnical properties of lateritic soils from the Faculty of Engineering, Federal University Oye-Ekiti (FUOYE), Ikole Campus, to provide site-specific data for construction. Soil samples were collected from five trial pits at 1.0 m depth and analysed for particle size distribution, natural moisture content, Atterberg limits, specific gravity, compaction, and consolidation in accordance with BS 1377:1990. The soils collected were primarily silty and sandy clay, with fine soil and silt ranging from 42.68% to 73.44% passing the 0.075 mm sieve, and were classified as A-4 to A-7 according to the AASHTO classification system. Natural moisture content ranged from 8.78% to 17.55%, specific gravity ranged from 2.23 to 2.75, and plasticity index ranged from 18.45% to 25.45%, corresponding to medium to high plasticity. The optimum moisture content range for the compaction tests was 12.24%- 18.14%, and the maximum dry density was 1.775-1.834 g/cm³. Consolidation test results revealed a compression index of 0.081 - 0.138, a coefficient of consolidation of 36.212 - 56.460 m²/yr, and a coefficient of volume compressibility between 1.430 × 10^{-4} and 3.226 × 10^{-4} m²/kN. These results indicate slow consolidation, meaning the soils will require time to settle and may undergo long-term deformation under load. While suitable for limited uses such as earth dams, the soils' high plasticity and moisture sensitivity suggest that most civil engineering works on them will require stabilisation to achieve adequate performance.*

KEYWORDS: *Lateritic soil, Geotechnical properties, Soil classification, Consolidation, Compaction, Foundation design, Ekiti State*

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I. INTRODUCTION

In civil engineering, the most essential construction material is soil (Roy & Bhalla, 2017). The ultimate stability of buildings, bridges, highways, and dams depends entirely on the foundation soil's capacity to safely carry imposed loads (Ashioba & Udom, 2023; Roy, 2024). Thorough subsurface investigations of soil geotechnical properties are often necessary to ensure both safety and economic viability in construction (Das, 2019; Vincent & Mallo, 2023). Geotechnical properties, including particle size distribution, plasticity characteristics, compaction behaviour, and compressibility, significantly influence infrastructure design and construction (Roy & Bhalla, 2017). Understanding these properties helps engineers forecast soil behavior under varying load conditions, thereby ensuring structural integrity (Roy, 2024). Insufficient knowledge of these fundamental properties often leads to inefficient, sometimes very costly solutions that may compromise the structure's safety (Babalola et al., 2017).

Lateritic soils are an important part of the geological profile in the humid tropics of Nigeria, as in Ekiti State. They form as a product of extreme weathering under high temperatures and rainfall (Oyelami & Van Rooy, 2016). Several distinctive features characterise them: elevated iron and aluminium oxide levels give them a reddish-brown appearance; substantial kaolinite and clay mineral content confer high plasticity; minimal organic matter enhances their engineering stability; and permeability fluctuates with cementation and particle arrangement (Ayoola & Philip, 2023; Ebunoluwa et al., 2022). Although there are previous studies of the lateritic soils in Ekiti State [6,10], there is little to no documented geotechnical information or data regarding the lateritic soils of the Federal University Oye-Ekiti with respect to the Ikole campus, Faculty of Engineering, which leaves uncertainty, often resulting in conservative designs or constructions that may not succeed.

The Federal University Oye-Ekiti (FUOYE), situated at the Ikole Campus, lies between 7.8077°N and 7.8089°N and 5.4924°E and 5.4956°E, presenting unique geotechnical challenges. Site-specific geotechnical data is still lacking, despite ongoing or planned construction of residential, laboratory, and academic structures. This study seeks to fill this void by examining the geotechnical properties and design parameters of the soil on the Faculty of Engineering campus. Specifically, this study's objectives are to: (i) classify soil samples from five strategic locations using both the Unified Soil Classification System (USCS) and American Association of State Highway and Transportation Officials (AASHTO) classification system; (ii) examining physical and mechanical properties through standard laboratory testing; and (iii) investigate important soil parameters to assess construction applications. The findings will provide essential baseline data for informed decision-making in future construction projects, contribute to the regional database of lateritic soil properties in Ekiti State, and serve as a reference for similar geological settings in the Southwestern part of Nigeria.

II. THOERY/CALCULATION/ METHODS

2.1 STUDY AREA

This research was carried out within the Faculty of Engineering of the Federal University of Oye-Ekiti (FUOYE), located at Ikole-Ekiti in the Ikole Local Government Area of Ekiti State, in the South-West Zone of Nigeria. The campus is in Ikole-Ekiti, and its latitude lies between 7.8077°N and 7.8089°N, while its longitude lies between 5.4924°E and 5.4956°E, and the elevation ranges from 532.70 m to 546.82 m above sea level. The area's tropical environment is characterised by distinct rainy and dry seasons. The geology mainly consists of Precambrian basement complex rocks that have undergone extensive weathering, resulting in characteristic lateritic soils (Oyelami & Van Rooy, 2016).

2.2 SOIL SAMPLING

To document the geographical diversity of soil parameters, a soil investigation was conducted at five key locations across the Faculty of Engineering campus. At each site, trial pits were dug by hand to a depth of 1.0 m. The selection of locations was based on the representation of various topographic conditions and potential building sites. Table 1 shows the coordinates, elevations, and locations for each trial pit. Both undisturbed and disturbed soil samples were collected from each trial pit. Hand tools were used to extract the disturbed samples and seal them in polythene bags for classification testing, while core cutters were used to extract the undisturbed samples to preserve their natural soil structure. The samples were wrapped in aluminium foil, sealed with wax, and transported to the lab for testing. The investigation collected 10 samples in total (5 undisturbed and 5 disturbed) for comprehensive analysis.

Table 1: Location and Coordinates of Trial Pits

Trial Pit	Location	Northing (°)	Easting (°)	Elevation (m)
TP1	Back of Central Workshop	7.8080727	5.4956467	546.82
TP2	Back of Professorial Building	7.8085882	5.4923269	532.70
TP3	Back of Design Studio	7.8088846	5.4940772	542.62
TP4	Back of Civil Engineering Block	7.8076624	5.4929885	542.19
TP5	Back of Central Laboratory	7.8088259	5.4950472	544.51

2.3 LABORATORY TESTING

All laboratory tests were carried out in compliance with British Standards BS 1377:1990 (Methods of Test for Soils for Civil Engineering Purposes). The testing includes both the classification tests and engineering property tests.

I. **Classification Tests:**

a. ***Determination of moisture content***

Natural moisture content of the soil samples was determined using the oven-drying method (oven-drying representative soil samples at 105°C for 24 hours) and calculated using Equation 1:

$$w(\%) = \frac{M_w}{M_s} \times 100 \ldots\ldots\ldots\ldots (1)$$

Where: $\mathbf{M_w}$ = Mass of water; and

$\mathbf{M_s}$ = Mass of dry soil.

b. ***Particle size distribution test***

The particle size distribution test was performed using British Standard sieves ranging from 9.5mm to 0.075mm (No. 200 sieve). 500g of oven-dried soil samples were passed through the sieve stack with the mechanical sieve shaker. The mass of soil retained on each sieve was recorded, and the percentage passing each sieve size was calculated to plot the grain-size distribution curves.

c. ***Atterberg limits tests***

The liquid limit (LL) of the soil samples was determined using the Casagrande cup apparatus with soil samples prepared at varying moisture contents. The liquid limit was calculated as the moisture content corresponding to 25 blows, after the number of blows required to close a standard groove was noted. Similarly, soil samples were repeatedly rolled into three mm-diameter threads until they crumbled to measure the plastic limit (PL). Therefore, Equation 2 was used to calculate the plasticity index (PI):

$$PI = LL - PL \ldots\ldots\ldots\ldots (2)$$

Where: **LL** = liquid limit; and

PL = plastic limit.

Linear shrinkage was determined using a shrinkage mould, measuring length reduction after oven-drying.

d. ***Specific Gravity test***

The specific gravity of soil solids was measured using the density bottle method. Distilled water was put to a 50ml density bottle containing about 50g of oven-dried soil. After removing air bubbles, distilled water was poured into the bottle until it was full, then weighed. Equation 3 was then used to determine the specific gravity from the recorded masses:

$$G_s = \frac{M_s}{[(M_2 - M_1) - (M_3 - M_4)]} \ldots\ldots\ldots\ldots (3)$$

Where: $\mathbf{G_s}$ is the specific gravity of soil solids, $\mathbf{M_s}$ is the mass of oven-dried soil, $\mathbf{M_1}$ is the mass of the empty density bottle, $\mathbf{M_2}$ is the mass of the density bottle plus soil, $\mathbf{M_3}$ is the mass of the density bottle plus soil plus water, and $\mathbf{M_4}$ is the mass of the density bottle plus water only.

II. **Engineering Property Tests:**

a. ***Compaction test***

The soil samples' maximum dry density (MDD) and optimum moisture content (OMC) were determined using standard Proctor compaction tests. A 2.5 kg rammer dropped from a height of 300 mm was used to compact soil samples that were placed in a conventional mould with a volume of 1000 cm³. Three distinct levels of compaction were applied, each receiving 25 blows. The compaction curve was plotted after the experiments were conducted at five distinct moisture contents. For every moisture content, the dry density was computed. At the curve's peak, the OMC was determined to be the corresponding moisture content, and the MDD was also found at the peak.

b. ***Consolidation test***

One-dimensional consolidation tests were performed using the standard oedometer apparatus. Undisturbed soil samples were cut to the dimensions of the consolidation rings (20 mm high and 50 mm in diameter). Samples were loaded in increments of 50, 100, 200, 400, and 800 kN/m². Dial gauge readings were recorded at predetermined time intervals for each load increment to observe settlement. Upon completion of loading, the specimens were oven-dried to determine their final water content. Calculations were made to estimate representative consolidation parameters, including the compression index (Cc), coefficient of volume compressibility (Mv), void ratio (e), and coefficient of consolidation (Cv). Taylor's approach, which takes the square root of time, was used to calculate the coefficient of consolidation. The slope of the void ratio versus the logarithm of pressure (e-log P) curve was then used to compute the compression index.

III. RESULTS AND DISCUSSIONS

I. Index Properties and Soil Classification

The moisture content of natural soil samples ranged from 8.78% to 17.55% in the five Trial Pits (Table 2), with the minimum in TP4 and the maximum in TP2. These values fall within normal ranges for silty-clay materials (Chen et al., 2025) and, therefore, indicate a moisture state that lies between sandy and/or purely clayey materials. Specific gravity varied from 2.23 to 2.75, with maximum specific gravity in TP4 and minimum in TP5. These values fall within the accepted range for lateritic soils (Bowles, 2012) and thus may be considered typical of the mineralogy of soils in southwest Nigeria. The somewhat higher specific gravity in TP4 may indicate a compacted soil that is superior in compaction, and hence soil strength and stability.

Table 2: Summary of Index Properties

Trial Pit	Natural Moisture Content (%)	Specific Gravity	Liquid Limit (%)	Plastic Limit (%)	Plasticity Index (%)	Linear Shrinkage (%)
TP1	14.96	2.25	40.44	20.72	19.72	11.43
TP2	17.55	2.39	40.45	16.91	23.54	11.43
TP3	10.61	2.29	45.24	20.46	24.78	12.14
TP4	8.78	2.75	36.99	18.54	18.45	6.43
TP5	12.20	2.23	50.07	24.62	25.45	13.57

II. Atterberg Limits and Plasticity Characteristics

Atterberg limits showed significant variability in plasticity properties. Liquid limits ranged from 36.99% to 50.07%, while plastic limits varied between 16.91% and 24.62%, leading to plasticity indices of 18.45% to 25.45% (Table 2). The classification scheme according to Roy and Bhalla (2017) classifies soils as silty clay with medium plasticity if their plasticity index is between 7 and 17%, and as clay with high plasticity if their plasticity index is greater than 17%. The observed values suggest that all sampling locations contain soils with medium to high plasticity, predominantly clayey materials. The linear shrinkage values varied from 6.43% at TP4 to 13.57% at TP5. The lower linear shrinkage value at TP4 indicated there was lower clay content and less potential for volume change, which can affect foundation stability. The higher linear shrinkage values at other locations indicated greater shrink-swell potential when moisture content varies, a common characteristic of lateritic clay soils (Hobbs et al., 2018). The plasticity chart (Fig. 1), which represents plasticity index plotted against liquid limit, is another means to examine plasticity characteristics. All sample soils were located above the A-line, indicating their classification as clayey materials (CL to CH in the USCS). The high plasticity indicates that there are strong intermolecular attraction forces between soil particles that will affect engineering behavior (Roy & Bhalla, 2017). These soils will expand when wet and shrink when dry, which can create challenges during construction.

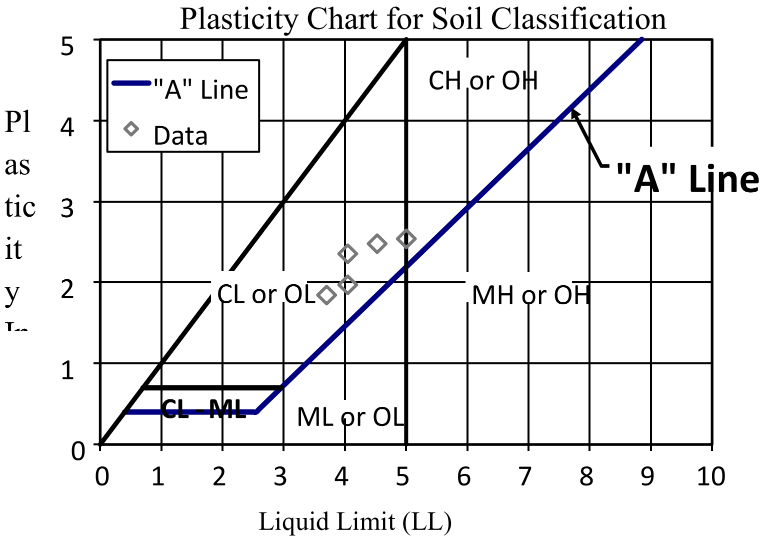

Fig.1: Plasticity Chart for Soil Classification

III. Particle Size Distribution and Soil Classification

An examination of the particle-size distribution of soil samples showed that all samples contained sizable fine-grained fractions (Table 3). The percentage of soil samples that passed the 0.075mm (No. 200) sieve ranged from 42.68% to 73.44%, which is significantly greater than the 35% threshold that the USCS and AASHTO soil classification systems employ to distinguish between fine- and coarse-grained soils. Grain size distribution curves (Fig. 2) indicate that TP1, TP2, and TP5 have higher amounts of fine particles than TP3 and TP4. The relatively high percentage of fine particles in TP2 (73.44% passing the 0.075 mm sieve) results in lower permeability and a higher moisture-holding capacity than soils with lower percentages of fine particles (Lipiński et al., 2017; Osinubi et al., 2012). This is beneficial for certain applications that require clay-like materials, such as clay liners, but it can be problematic for structures that are designed to allow drainage of water. TP4 had the lowest fine content (42.68%), therefore TP4 may have relatively higher permeability and drainage potential.

Table 3: Particle Size Distribution Results

Sieve Size (mm)	TP1 (% Passing)	TP2 (% Passing)	TP3 (% Passing)	TP4 (% Passing)	TP5 (% Passing)
9.5	100.00	99.36	99.37	92.44	99.06
4.75	99.68	99.24	98.01	86.60	97.48
2.36	98.64	98.56	94.37	79.88	94.41
1.18	95.88	96.36	89.84	75.36	90.17
0.6	86.88	96.32	82.24	66.92	78.42
0.3	71.00	83.56	73.41	53.56	61.62
0.15	57.80	73.72	67.12	43.72	51.06
0.075	54.76	73.44	66.98	42.68	50.78

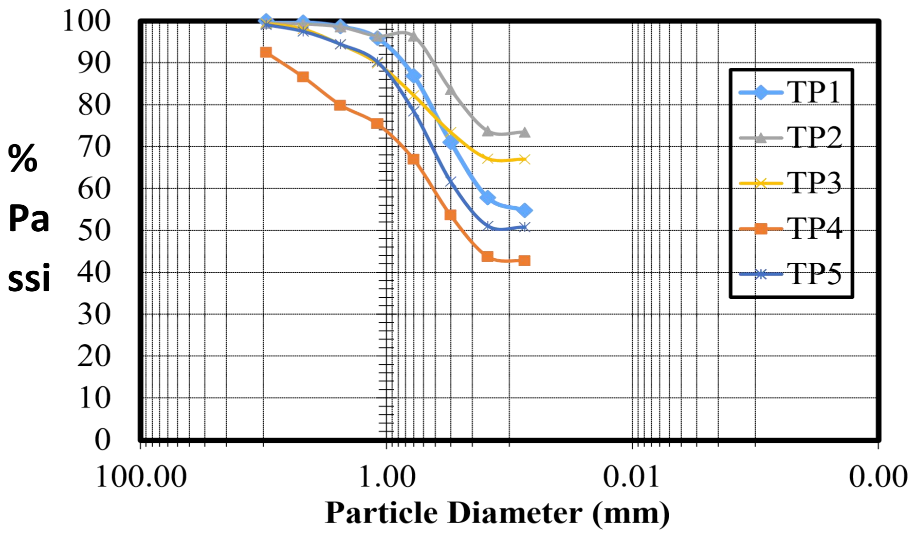

Fig. 2: Particle size distribution of soil samples

Grain size distribution indicates whether soils can be used for more specific construction applications, such as roads, airfields, levees, dams and embankments (Bowles, 2012). Because there was an abundance of fine-grain materials in each of the soil samples, the soils may require specific drainage design, and each site has the ability to settle under loading conditions due to consolidation. Overall, the use of the AASHTO soil classification system (AASHTO, 2003) shows all soil samples belong to A-4, A-6, or A-7; hence they are considered silty-clay materials (Table 4). All soil samples were classified as highway subgrade materials that were fair to poor quality.

Table 4: AASHTO Soil Classification

Trial Pit	% Passing 0.075mm	Liquid Limit (%)	Plasticity Index (%)	AASHTO Group	General Rating
TP1	54.76	40.44	19.72	A-6 or A-7	Fair to Poor
TP2	73.44	40.45	23.54	A-7	Fair to Poor
TP3	66.98	45.24	24.78	A-7	Fair to Poor
TP4	42.68	36.99	18.45	A-4 or A-6	Fair to Poor
TP5	50.78	50.07	25.45	A-7	Fair to Poor

The AASHTO classification shows that these soils are normally unacceptable for direct application as highway subgrade material, unless they are stabilized. However, due to their cohesiveness, they are also considered for certain applications, e.g., earth dam construction requiring impervious materials (Bolarinwa et al., 2017).

IV. Compaction Characteristics

According to Table 5, the compaction tests revealed that the maximum dry density (MDD) ranged from 1.775 g/cm³ to 1.834 g/cm³, while the optimal moisture content (OMC) ranged from 12.24% to 18.14%. At an OMC of 14.50%, Sample TP1's maximum dry density was 1.834 g/cm³, indicating excellent compaction capacity and suitable for high load-bearing applications. On the other hand TP5 tested at the lowest density of 1.775 g/cm³ at OMC of 15.51%, indicating a low level of compaction. According to the compaction classification scheme (O'Flaherty, 2001) silty-clay soils compare with OMC of 15-25% and MDD between 1.60-1.845 g/cm³, while sandy-clay soils are normally classified with OMC of 8–15% and MDD of 1.75–2.165 g/cm³. The results from the testing are within the established range which indicates a silty-clay and sandy-clay material respectively.

Table 5: Compaction Test Results

Trial Pit	Optimum Moisture Content (%)	Maximum Dry Density (g/cm³)	Classification*
TP1	14.50	1.834	Sandy-Clay
TP2	18.14	1.778	Silty-Clay
TP3	14.53	1.790	Sandy-Clay
TP4	12.24	1.826	Sandy-Clay
TP5	15.51	1.775	Silty-Clay

**Based on O'Flaherty (2001) compaction classification*

The typical bell-shaped relationship between dry density and moisture content is depicted by compaction curves (Fig. 3). Every soil sample reached its maximum density at its corresponding optimal moisture content. The differences in compaction characteristics of the test pits are representative of the natural variability of lateritic soils at the study site. Compaction characteristics are of interest because they are indicative of the quality of compacted fills and the stability of earthen structures. Compaction increases shear strength, decreases compressibility, and reduces permeability - all properties that are desirable as a foundation material or in earth structures (Ratnam & Prasad, 2019).

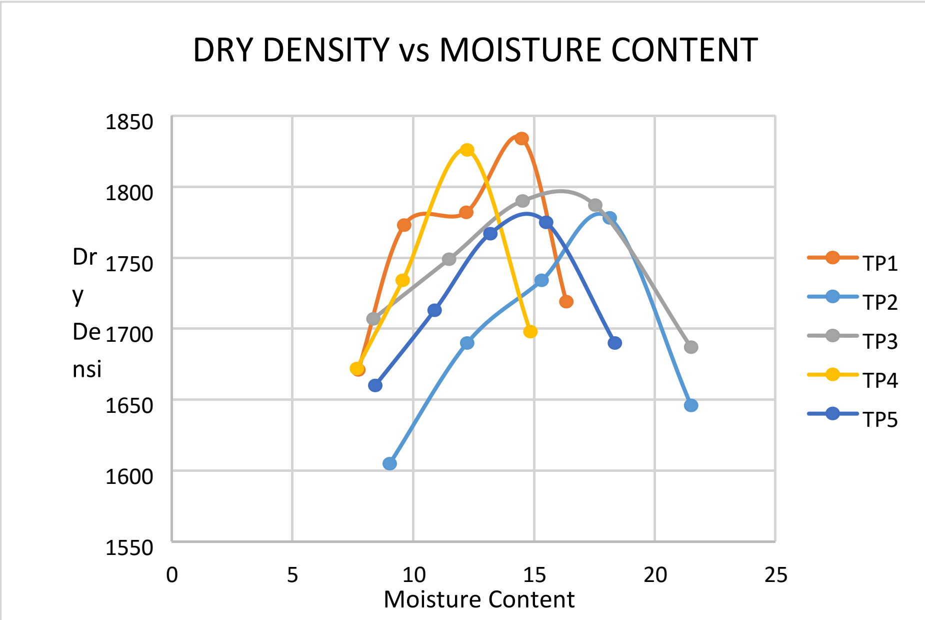

Fig. 3: Graph of Dry Density vs Moisture Content of Soil samples

The higher maximum dry densities (MDD) values (>1.775 g/cm³) would indicate that when compacted at the optimum moisture content these soils could provide sufficient support for a variety of light to moderate structural loads. The moderate optimum moisture content (OMC) values (between 12-18%) indicate that the soils are sensitive to moisture. This means the achieved density and subsequent engineering performance could significantly affected by not compacting the soil at the optimum moisture content during construction.

V. Consolidation Behavior and Settlement Characteristics

The results from consolidation tests provided insights regarding their compressibility and time-dependent deformation characteristics (Table 6). Index values for compression (Cc) fell in the range of 0.081 to 0.138, with TP2 with the highest value and TP5 with the lowest. According to Terzaghi's classification system for soil compressibility uses Cc index values between 0.01 and 0.20, soils would be classified as having low to medium compressibility. The Cc values for these soils indicate they have low to medium compressibility that is typically suitable for most foundation applications. The coefficients of consolidation (Cv) values ranged from 36.212 m²/yr to 56.460 m²/yr, with TP4 with the highest value. The coefficients of consolidation were relatively low and indicated that these soils would experience slow consolidation and that settlement would occur over time with sustained loading.

Table 6: Consolidation Test Results

Trial Pit	Compression Index, Cc	Average Cv (m²/yr)	Average Mv (m²/kN)	T_{90} (min)
TP1	0.095	37.042	2.880×10^{-4}	5.028
TP2	0.138	36.212	1.992×10^{-4}	5.034
TP3	0.110	38.602	3.226×10^{-4}	4.880
TP4	0.120	56.460	1.430×10^{-4}	3.268
TP5	0.081	49.008	2.612×10^{-4}	3.632

Coefficients of volume compressibility (M_v) ranged from 1.430×10^{-4} m²/kN (TP4) to 3.226×10^{-4} m²/kN (TP3). The M_v parameter indicates volume change per unit volume per unit increase in effective stress (Craig, 2004). The relatively small values of Mv suggest moderate resistance to volume change when loaded, which is beneficial for foundation performance and stability. Fig. 4 presents the e-logP curves showing the typical sigmoidal shape of normally consolidated or lightly overconsolidated clays. Virgin compression lines are all relatively steep, indicating that soils will undergo measurable consolidation settlement when preconsolidation pressure is exceeded.

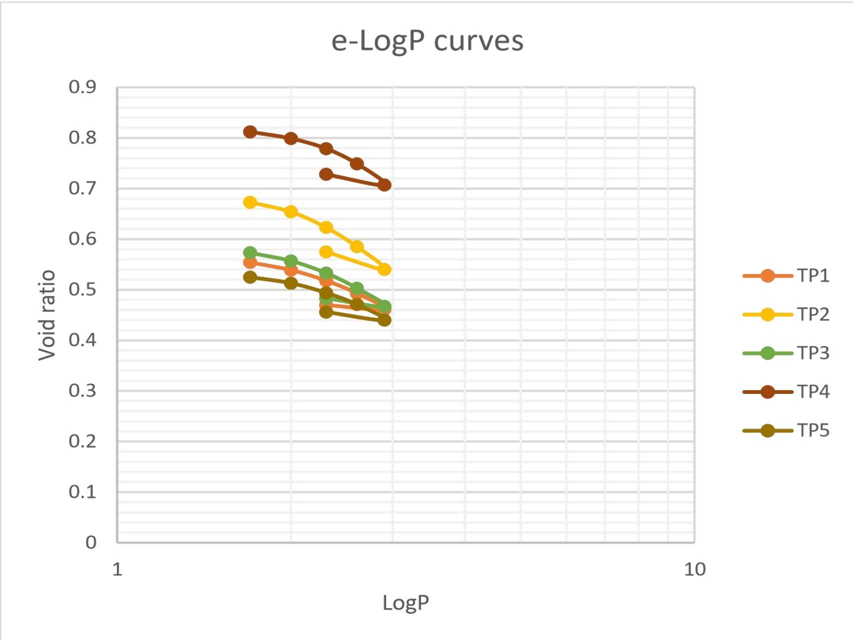

Fig.4: e-logP curve of soil samples

Time to 90% consolidation (T_{90}) in laboratory trials ranged from 3.268 min (TP4) to 5.034 min (TP2). When accounting for drainage path lengths for field conditions, these times suggest that consolidation, under normal loading for foundations, may take well into months or years depending on layer thickness and drainage conditions. Comparing laboratory results with previously published studies in the region, Bolarinwa *et al.* (2017) reported compression indices of 0.048-0.043 for lateritic soils in the Ootunja area of Ikole area. The Cc values noted in these tests are much greater, suggesting much greater compressibility, whereas the Mv values are considerably lower, indicating limited susceptibility to volume change.

VI. Spatial Variability and Engineering Implications

The investigation of the spatial distribution of soil properties among the five trial pits indicates substantial variation among soils on campus. TP4, located behind the Civil Engineering Block, has distinct properties: lowest moisture content (8.78%), highest specific gravity (2.75), lowest linear shrinkage (6.43%), lowest OMC (12.24%), high MDD (1.826 g/cm³), and highest Cv (56.460 m²/yr). Collectively, the highlighted properties suggest this location has optimum characteristics for construction from all sampling sites. TP2 and TP5 display properties that indicated higher plasticity and moisture sensitivity; thus, these sites may need further attention for foundation design.

Geotechnical characterization provides context for soil properties in terms of its suitability for various engineering applications. For foundation applications, the soils have consistent moderate bearing capacity potential. The soils had moderate MDD values (1.775-1.834 g/cm³), and were found to be low to moderate compressibility (Cc = 0.081-0.138), which suggests shallow foundations may be highest suited in low to moderate structural loads and proper design criteria. High plasticity percentage (PI = 18.45-25.45%), in addition to slow consolidation rates warrants due diligence to settlement predictions and moisture control concerns.

AASHTO classification designates these soils as groups A-4 through A-7, for use in road construction as rated fair to poor subgrade materials. It is not advisable to use the soils directly as subgrade material in road construction without stabilization. However, the soils could be modified to meet subgrade specifications through appropriate chemical stabilization (lime or cement treatment), as was demonstrated with lateritic soils in Ekiti State [19]. Despite the lower hydraulic conductivity, the cohesive characteristics may allow for these soils to be suitable for earth dam construction material, specifically for the impervious core (Bolarinwa et al., 2017).

VII. Comparison with Regional Studies and Limitations

The findings from this study exhibit some consistencies and some discrepancies when compared with earlier studies on lateritic soils in Ekiti State. Babalola *et al.* (2017) suggested liquid limits of 44-58% and plastic limits of 18-26 % from soils located in the Ootunja axis of Ikole, which are again in the range observed in this study. There is a significant difference in terms of consolidation parameters; soils at FUOYE campus are more compressible. Specific gravity values (2.23-2.75) are similar to the regional average of 2.72, according to Adebisi *et al.* (2015) for southwestern Nigeria.

This study has certain limitations, it considered a depth of only 1.0m, which mainly provides information for the design of shallow foundations. The study does not account for the direct measurement of shear strength parameters due to testing limitations. The study did not consider the time aspect of soil's behaviors, particularly the seasonal variation on moisture content. Despite these limitations, the study brings an important baseline geotechnical information for the FUOYE Ikole campus.

IV. CONCLUSION AND RECOMMENDATION

From the analysis of the investigation conducted above, the following conclusions are drawn:

I. **Index Properties and Soil Classification**: The natural moisture content of the soil samples was between 8.78% and 17.55%, indicating moderate water retention in silty-clay materials. Specific gravity was in the range of 2.23 and 2.75 and is comparable to lateritic soils in southwestern Nigeria. TP4 had the highest specific gravity value, implying that it has the densest soil and the highest compaction potential of the soil samples.

II. **Atterberg Limits and Plasticity Properties**: All soil samples are medium to high plasticity material with plasticity index specific gravity ranging from 18.45% to 25.45%, making them solely clayey materials. The linear shrinkage values of each sample were between 6.43% and 13.57%. These range of values also indicate the capacity of significant volume change with changes in moisture. TP4 showed the best linear shrinkage value which suggests the best structural quality for foundation stability.

III. **Particle Size Distribution and Soil Classification**: All soil samples had significant amounts of fine-grained soil, ranging from 42.68% to 73.44% of the sample material passing through the 0.075mm sieve, exceeding the 35% threshold for finite-grained soil classification. Under the AASHTO classification system, all samples were class A-4 to A-7, corresponding to fair to poor quality as subgrade material for highways, unmodified. Homogeneous binding potential indicates a potential suitability for earth dam construction.

IV. **Compaction Characteristics**: The maximum dry density was between 1.775 g/cm³ and 1.834 g/cm³, and the optimum moisture content ranged between 12.24% and 18.14 percent, indicating that the soils as silty-clay and sandy-clay. The MDD values are relatively high and indicate a good ability to support light to moderate structural loads when compacted. However, moisture sensitivity will require rigorous field compaction control in order to achieve the density value specified.

V. **Consolidation Behavior and Settlement Characteristics**: The compression index values range from 0.081 to 0.138 which correspond to low to moderate compressibility and are suitable for foundation use. The coefficient of consolidation values range from 36.212 to 56.460 m^2/yr suggesting a slow consolidation with a time-dependent settlement under sustained loading. These parameters indicate that any structures built on these soils will experience some measurable but manageable settlement and all engineers, builders, etc. should consider appropriate foundation design and long-term monitoring.

VI. **Spatial Variability and Engineering Implications**: The campus exhibited large spatial variability in the soils, with the waterslide site (TP4) showing the most favorable properties, including the instance of the lowest moisture content, the highest specific gravity (density), and the most rapid consolidation rate, therefore making it the most suitable for construction. The soils could support shallow foundations for light to moderate loads and earthen dam construction, but additional chemical stabilization with lime or cement may be required for road building projects and ground improvement methods for heavy structures that are sensitive to differential settlement.

This comprehensive geotechnical investigation provides essential baseline data filling a critical knowledge gap for FUOYE Ikole campus, enabling informed decision-making for future construction projects while contributing to the regional database of lateritic soil properties in Ekiti State and southwestern Nigeria.

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CONFLICT OF INTEREST

There is no conflict of interest associated with this work.

REFERENCES

[1]. AASHTO. (2003). *Standard specifications for transportation materials and methods of sampling and testing* (23rd ed.). American Association of State Highway and Transportation Officials.

[2]. Abe, E. O., & Adetoro, E. A. (2017). Assessment of performance properties of stabilized lateritic soil for road construction in Ekiti State. *International Journal of Advanced Engineering Research and Science, 4*(11), 33-39. https://doi.org/10.22161/ijaers.4.11.5

[3]. Adebisi, N., Kalumba, D., & Akintayo, F. (2015). Index and strength characteristics of residual lateritic soils from south-western Nigeria. *British Journal of Applied Science & Technology, 6*(3), 229-238. https://doi.org/10.9734/bjast/2015/7671

[4]. Ashioba, C., & Udom, G. J. (2023). Engineering geological properties of subsurface soils for foundation purposes in parts of Bayelsa State, Niger Delta. *British Journal of Earth Sciences Research, 11*(3), 1-12. https://doi.org/10.37745/bjesr.2013/vol11n3112

[5]. Ayoola, A., & Philip, A. (2023). Stabilization of lateritic soil for road application using lime and cow bone ash. *Journal of Engineering Research and Reports, 25*(6), 109-121. https://doi.org/10.9734/jerr/2023/v25i6927

[6]. Babalola, J., Bolarinwa, A., & Okeke, T. C. (2017). Geotechnical properties of soils in Ikole-Ekiti area, southwestern Nigeria. *Electronic Journal of Geotechnical Engineering, 22*(1), 21-32.

[7]. Bolarinwa, A., Adeyeri, J. B., & Okeke, T. C. (2017). Compaction and consolidation characteristics of lateritic soil of a selected site in Ikole Ekiti, southwest Nigeria. *Nigerian Journal of Technology, 36*(2), 339-345. https://doi.org/10.4314/njt.v36i2.3

[8]. Bowles, J. E. (2012). *Engineering properties of soils and their measurement* (4th ed.). McGraw-Hill.

[9]. Chen, G., Yang, W., Pan, Y., Zheng, Y., Zhang, H., Shao, S., Lu, F., Yang, C., & Guo, L. (2025). Study on accumulation deformation characteristics of silty clay based on dynamic triaxial tests. *Scientific Reports, 15*(11448), 1-

20. https://doi.org/10.1038/s41598-025-96348-1

[10]. Craig, R. F. (2004). *Craig's soil mechanics* (7th ed.). Spon Press.

[11]. Das, B. M. (2019). *Advanced soil mechanics* (5th ed.). CRC Press.

[12]. Ebunoluwa, M., Ogunsanwo, O., Ige, O. O., & Baiyegunhi, C. (2022). Geotechnical and mineralogical evaluation of lateritic soils to access their suitability for engineering construction works: A case study of some selected residual soils in parts of the southwestern Nigeria. *Petroleum and Coal, 64*(4), 908-916.

[13]. Hobbs, P. R. N., Jones, L. D., Kirkham, M. P., Gunn, D. A., & Entwisle, D. C. (2018). Shrinkage limit test results and interpretation for clay soils. *Quarterly Journal of Engineering Geology and Hydrogeology, 52*(2), 220-229. https://doi.org/10.1144/qjegh2018-100

[14]. Lipiński, M. J., Wdowska, M. K., & Jaroń, Ł. (2017). Influence of fines content on consolidation and compressibility characteristics of granular materials. *IOP Conference Series: Materials Science and Engineering, 245*, 032062. https://doi.org/10.1088/1757-899X/245/3/032062

[15]. O'Flaherty, C. A. (2001). *Highways: The location, design, construction and maintenance of road pavements* (4th ed.). Butterworth-Heinemann.

[16]. Osinubi, K. J., Eberemu, A. O., Bello, A. O., & Adzegah, A. (2012). Effect of fines content on the engineering properties of reconstituted lateritic soils in waste containment application. *Nigerian Journal of Technology (NIJOTECH), 31*(3), 277-287.

[17]. Oyelami, C. A., & Van Rooy, J. L. (2016). A review of the use of lateritic soils in the construction/development of sustainable housing in Africa: A geological perspective. *Journal of African Earth Sciences, 119*, 226-237. https://doi.org/10.1016/j.jafrearsci.2016.03.018

[18]. Ratnam, M., & Prasad, D. S. V. (2019). Effect of compaction on engineering properties of soils. *International Journal of Innovative Technology and Exploring Engineering, 8*(6), 1456-1460.

[19]. Roy, S. (2024). *Geotechnical and foundation engineering practice in industrial projects*. Springer Nature Singapore.

[20]. Roy, S., & Bhalla, S. K. (2017). Role of geotechnical properties of soil on civil engineering structures. *Resources and Environment, 7*(4), 103-109.

[21]. Vincent, A. S., & Mallo, S. J. (2023). Geotechnical investigation of soil properties for foundation design in Jos metropolis, Plateau State, Nigeria. *Journal of Applied Sciences and Environmental Management, 27*(3), 567-574.