

**THE SUITABILITY OF LATERITE SOILS AS SUBGRADE MATERIAL
IN THE CONSTRUCTION OF FLEXIBLE PAVEMENTS, OGHEGHE
COMMUNITY, OVIA NORTH EAST, SOUTHERN NIGERIA**

By

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FACULTY OF PHYSICAL SCIENCES
UNIVERSITY OF BENIN
BENIN CITY**

MAY, 2024

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**A PROJECT SUBMITTED TO THE DEPARTMENT OF GEOLOGY IN
PARTIAL FULFILLMENT OF THE REQUIREMENTS FOR THE AWARD
OF BACHELOR OF SCIENCE (BSc) DEGREE IN GEOLOGY, FACULTY
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STATE, NIGERIA.**

MAY, 2024

CERTIFICATION

This is to certify that this project titled “The suitability of laterite soils as subgrade material in the construction of flexible pavements, Ogheghe community, Ovia North East, Southern Nigeria” was carried out by Ezra CHIGBU, with Matriculation number PSC1908970, of the Department of Geology, University of Benin, Benin City, Nigeria.

Dr. Mrs. ANDRE-OBAYANJU
(Project Supervisor)

DATE

Dr. S.A. SALAMI
(Head of Department)

DATE

DEDICATION

The entirety of this project is dedicated first to God almighty for his never-ending grace, favor, mercy and guidance during the course of my study and my project. To my parents, Mr. and Mrs. CHIGBU, for their undying support and encouragement, my siblings, and my ever-supporting friends.

ACKNOWLEDGEMENT

I am indeed very grateful to God almighty for his never-ending love and grace upon my life and for the strength to complete my university education.

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Maju, Dr N.S Igbini, Dr. (Mrs.) Odokuma-Alonge, Dr. Edegbai my course advisor for his great teachings and support, and all others. It is my sincere prayer that the good Lord reward you all richly.

Special thanks to my parents Mr. and Mrs. CHIGBU for their constant love, support, encouragement, guidance, and care. Mr. and Mrs. Afolayan for their love, support, and advice. I appreciate my siblings Samuel Chigbu and Daniella Chigbu's love, support, and prayers.

In addition, I want to especially appreciate the family I made here, my friends; they play a big role in my success, and my graduating set, thank you for all the good times, and I wish you the best life has to offer.

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ABSTRACT

Three soil tests were gathered from the Ogheghe people group, Benin City, Edo state. The examples were exposed to a few research facility tests which included; Dampness content assurance, Atterberg limit (fluid breaking point and plastic cutoff), Molecule size examination, Explicit gravity, Compaction test, and California bearing proportion tests. As far as possible pliancy records are 53.87%, 32.59%, 35.13%, 14.81%, and 36.86%, 15.92% separately. The most extreme dry thickness and ideal dampness content qualities are 1.60g/cm³, 1.65g/cm³, 1.74g/cm³ and 14.2%, 11.4%, and 13.4% separately. Results acquired were contrasted and the writing and the Government Service of Works and Lodging (FMWH) necessities, demonstrating these dirt are really great for filling and subgrade in street development. In any case, I recommend that more examination ought to be directed to decide their appropriateness for use in other design developments.

CHAPTER ONE

GENERAL INTRODUCTION

1.1. BACKGROUND OF THE STUDY

Geology is the investigation of the earth, the materials of which it is made, the construction of those materials, and the cycles following up on them. It coordinates other logical disciplines in the investigation of nature and the development of physical, synthetic, and organic cycles working on the earth. The comprehension of soil conduct in the development of adaptable asphalt is very significant as the disappointment or opposition of these designs relies to a great extent upon it.

Designing geography is the utilization of geologic science in designing practice to guarantee that the geographical variables influencing the area, plan, and development activity like street development, building, development, dam, and extension development, and its upkeep are perceived and are enough accommodated is a part of human information that utilizes land data joined with training and experience to help the structural specialist in taking care of issues in which such information might be pertinent.

The designing way to deal with this examination venture will zero in on the attributes of soils as development materials and their appropriateness to endure loads applied by designs of different sorts. Soil can be characterized as the upper layer of ground comprised of unconsolidated material created because of

organizations that followed up on rocks. It can likewise be referred to as "TERRAFIRMA" meaning strong ground great base for streets, structures, and a wide range of construction projects (Gidigasu, 1972).

1.2 AIM AND OBJECTIVES

The premise of this undertaking lies in the attributes of soils as appropriate development materials and their capacity to endure loads applied by designs of different kinds. A significant comprehension of the designing geologist to discover with a fair level of conviction, the most reasonable development materials. This undertaking plans to determine the geotechnical attributes of three soil tests taken from the OGHEGHE People group in OVIA NORTH EAST, EDO STATE as development materials for adaptable and unbending asphalts.

Goals incorporate;

1. Assortment of sensible amounts of soil tests from chosen areas.
- 2: Exposing the gathered examples to a few research facility tests including; Dampness content assurance, Atterberg limit (fluid breaking point and plastic cutoff), Molecule size examination, Explicit gravity, Compaction test, and California bearing proportion tests.
3. Examination of results obtained from these tests, bringing into thought previously set guidelines.
4. Conversation of results in relationship with currently set guidelines or

determinations by public and worldwide bodies.

1.3 LOCATION AND SIZE OF STUDY AREA

Ogheghe people group is situated in Ovia North East Edo state which is inside the Niger Delta bowl. The tested region falls inside the southern district of Nigeria.

The general guide of the review region is displayed below. The examples gathered in this area were viewed as incomplete delegates of the mass soils inside the area.

OGHEGHE People Group

Ogheghe People group is in the Ikpoba-Okha Nearby Government region in Edo State, Southern Nigeria. It is along Benin Sapele Rd, Oka, Benin City, it is situated at scope 6.2174° N and longitude 5.6286° E and it is arranged at a rise 117m above ocean level.

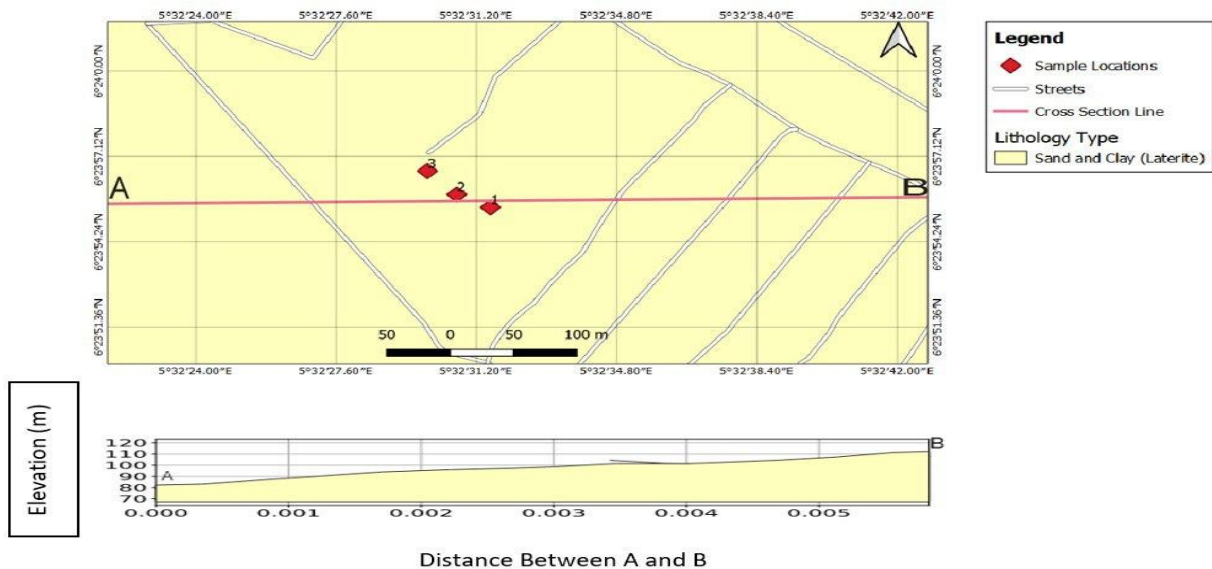


Figure 1: Geological map of Ogheghe community and environs showing the sampled location.

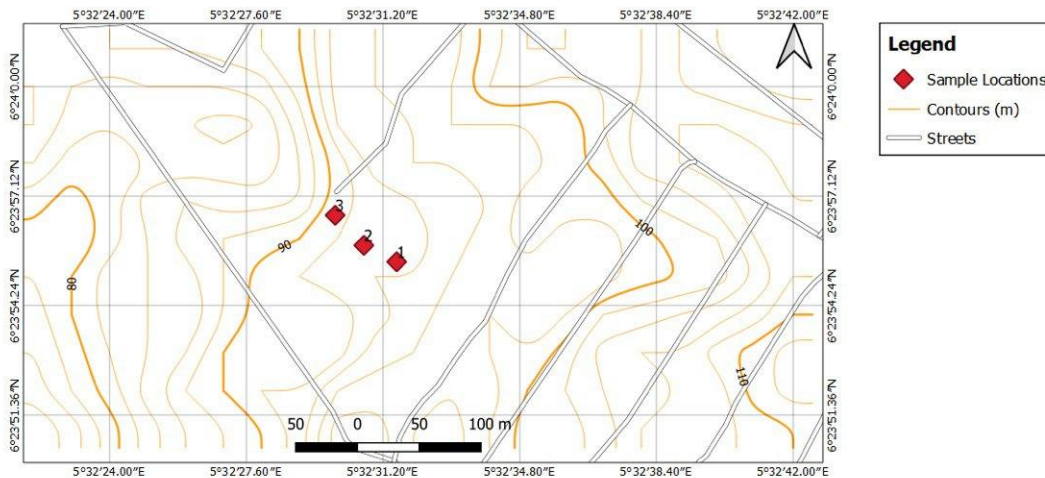


Figure 2: Map of Ogheghe community and environs showing the sampled locations.

1.4 GEOMORPHOLOGY AND GEOGRAPHY

1.4.1 CLIMATE

The climatic states of the Ogheghe people group and its environs fall inside the warm-appalling heat and humidity district where the wet and dry seasons are seen noticeably. The dry season is between November and February while the blustery seasons are generally between April and October. Normal precipitation is

somewhere in the range of 1000mm and 1500 mm with temperatures as high as 36.7° C.

1.4.2 VEGETATION

Ogheghe community has fertile soil and light forest vegetation, and crops such as Maize, Cocoyam, Yam, Cassava, and Plantain were planted.

1.4.3 ACCESSIBILITY

Accessibility of the area of sample collection was made possible by a motor vehicle.

CHAPTER TWO

2.1 GEOLOGY OF OGHEGHE COMMUNITY

The area of study exists in the Niger Delta Bowl. The Benin Locale is underlain by the sedimentary arrangement of the South Sedimentary Bowl. It is important for the Benin Arrangement, which includes more than 90% monstrous, permeable, coarse sand with thick mud/shale interbeds with a high groundwater maintenance limit. The geography is by and large set apart by top rosy earth, made out of ferruginized or literalized dirt sand, a few pieces of the district are encircled by the Benin verifiable canals. The district has been portrayed as a plowed plain in the southwestern heading. Soil profile uncovers that the district is made for the most part out of rosy-colored sandy laterite, Akujieze (2004). The area

is for the most part set apart by top Red Tropical soils made out of low silica sesquioxide proportion earth and sand which is delicate when wet and significantly hard when dry, Alayaki et al (2015). The term Benin sand was first utilized by Parkinson (1907). To depict the Red Tropical soils underlain by sands, sandy dirt, and ferruginous sandstone that mark the Paleo-Beach front Climate of the Palaeocene-Pleistocene Age.

2.2. RED TROPICAL SOILS

Red tropical soils are by and large alluded to as laterite in the logical writing. The dirt named "laterites" was begotten by Buchanan (1807) in India from the Latin

word 'Later' significance block. Lacroix (1913) isolated laterites into genuine laterite, silicate laterite, and lateritic dirt, and this was grown further by (Martin and Doyne, 1930) with the utilization of a silica-alumina proportion. Alexander and Candy (1962) once again introduced the idea of solidifying and its relationship to the crystallization of iron oxides and lack of hydration. In this manner, a silica sesquioxide proportion ($\text{SiO}_2 (\text{Al}_2\text{O}_3 + \text{Fe}_2\text{O}_3)$) with a proportion somewhere in the range of 1.33 and 2 was proposed for lateritic soils. Values more prominent than 2 showed non-lateritic, hot, and humidly endured soil (Chime, 1993). A writing survey has uncovered that the geotechnical qualities and designing a way of behaving of red tropical soils rely predominantly upon the beginning and level of enduring (for example deterioration, lateralization, parching, and solidifying). Morphological qualities as well as the kind and content of optional minerals are other hereditary attributes (Agbede, 1992). A significant comprehension of the cellar soil on which roadways and other transportation offices are built is vital. Salter (1988) said the presentation of a high-way asphalt is impacted to a truly impressive degree by the sub-grade material. Balogun (1984) revealed that the expansion of lime to the dirt builds its ideal dampness content, fluid cutoff, and California Bearing Proportion. Jegede (1998) explored disappointment over the Powder Tremolite-schist territory of the Ife-Ilesha freeway in Osun state and presumed that since the subgrade and the tunneled materials are schist determined

they contain powder and Hydromica, which makes it unthinkable "for field compaction.

The designing land properties of sub-grade soil of the proposed law-Ekiti high way Southwestern Nigeria was done by Jegede (1998), the outcome showed that the regular dampness content went from 2.0% to

2.8%. As far as possible ranges from 36.0 to 43.0% direct shrinkage goes from 2.1% to 2.60% explicit gravity goes from 2.66 to 2.74. The compaction of the dirt demonstrates dry densities from 1910kg/m^3 to $2,050\text{kg/m}^3$ at an ideal dampness content of 15% to 18.2%. This information shows that the dirt is really great for street development function as sub-level and sub-base material in examination with currently set guidelines.

The designing geographical appraisal of soil from southwestern Nigeria as a seal in clean land fill completed by 0.01GE. The outcome showed that the particular gravity goes from 2.50 to 2.77 while the level of the fines goes from 23 to 75% fluid cutoff values range from 27.7 to 62.5% and pliancy files values go from 20.8 to 41.2%. The most noteworthy porousness worth $1.4 \times 10^{-8}\text{m/s}$ is likewise acquired from all dirt researched. Jegede (1994) dealt with the asphalt disappointment at a part along Ikere-Igbara-Odo street in Ekiti territory of Nigeria. He figured out that the California Bearing Proportion of the dirt reaches around half which showed unfortunate soil actual properties absence of seepage offices

joins with the overabundance fine soil grade running between 20-40% was liable for the disappointment along the area.

2.3 PAVEMENTS

Street or Asphalt is the genuine travel surface exceptionally made sturdy and useful to endure the traffic load driving upon it. Asphalt awards rubbing for the vehicles subsequently giving solace to the driver and moving the traffic load from the upper surface to the regular soil. Storm, water, waste, and natural circumstances are a main issue in the planning of an asphalt. A street or asphalt is an open, by and large open way for the entry of vehicles, individuals, and creatures. Asphalt is done with a hard smooth surface which assists with making it tough. The reason for asphalt is essentially for load support. The plan of these designs depends on the rule that for a heap of any size, the power of that heap reduces descending from the surface. Two sorts of asphalts vary in their appropriateness in various conditions.

Kinds OF Asphalts

In building or planning runways, thruways, and comparable designs, there are two of asphalt (as portrayed in the Plan of Manual for Streets and Scaffolds, 1991):

I. Adaptable asphalt

ii. Inflexible asphalts

The thing that matters depends on how the heaps are conveyed to the subgrade (existing soil).

2.5 FLEXIBLE PAVEMENT

Adaptable asphalts are built of a few thicknesses of black-top or bituminous substantial layers overlying a base of granular material on an arranged subgrade. Adaptable asphalts are viewed as 'adaptable' since the complete asphalt structure 'twists' or 'diverts' because of traffic loads. An adaptable asphalts structure is for the most part made out of a few layers of materials to oblige this 'adaptable' impact, adaptable asphalts by and large require support or recovery each 10 to 15 years. A regular adaptable asphalt structure comprises of the following;

1. Surface course
2. Base course
3. Sub base course
4. Subgrade

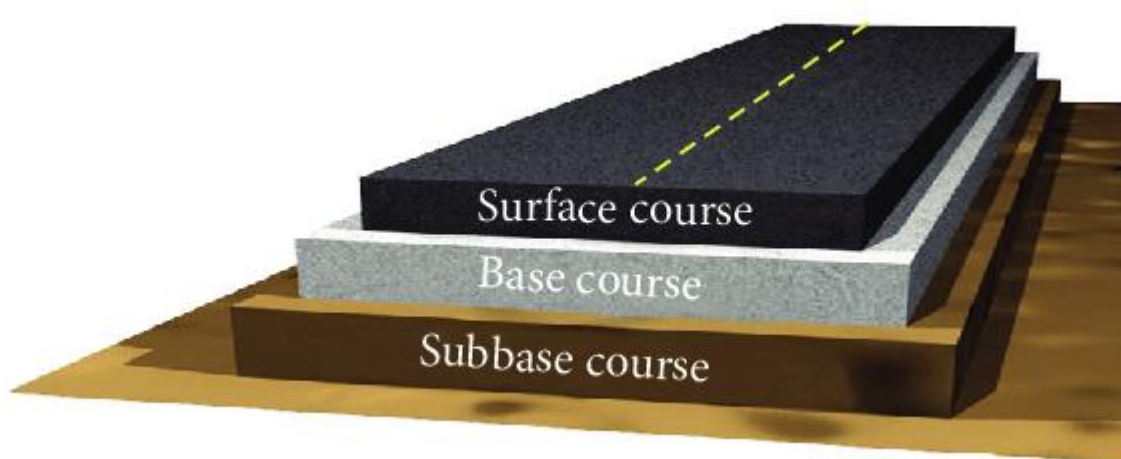


Figure 3: layers of flexible pavements

2.6 RIGID PAVEMENT

Rigid pavement is the technical name for any road surface made of concrete. The basic design is very simple. A surface layer. a typical rigid pavement structure consists of the following;

1. Concrete pavement
2. Base course
3. sub-base course
4. subgrade

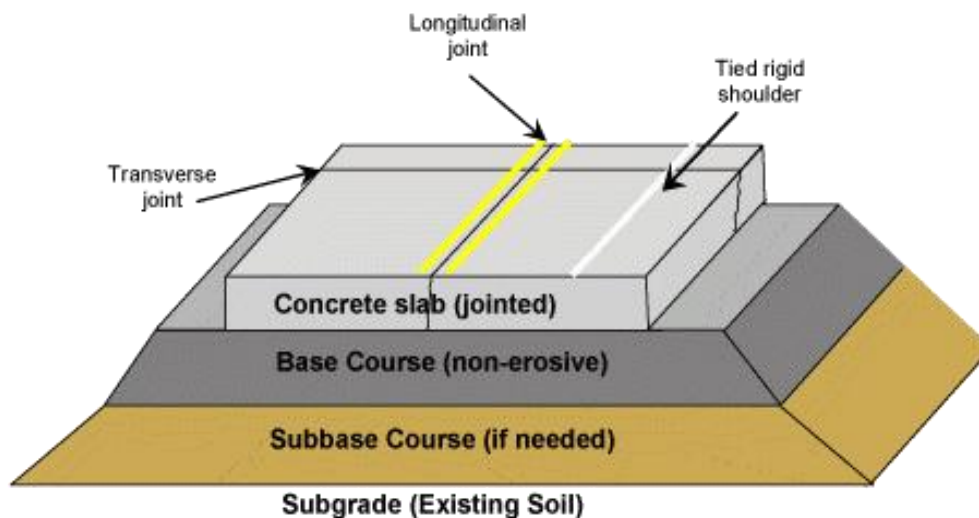


Figure 4: layers of rigid pavements

2.7 SURFACE COURSE

The layer is in touch with traffic loads. It gives attributes, for example, contact, perfection, commotion control, trench obstruction, and waste. Furthermore, it forestalls the entry of surface water into the hidden base, subbase, and subgrade.

This is the top layer presented to traffic loads. It very well might be made out of

one or a few different HMA sub-layers. The top underlying layer of material is at times partitioned into two layers:

- Wearing course: This is the top layer in an asphalt structure that is in direct contact with traffic loads. An appropriately planned (and financed) safeguarding system ought to have the option to distinguish asphalt surface pain while it is as yet restricted to the wearing course.
- Cover course: The motivation behind this layer is to convey the heap from the wearing course. This layer gives the majority of the HMA structure.

2.8 BASE COURSE

The layer is promptly underneath the surface course. It Gives extra burden appropriation and adds to seepage and ice obstruction. This is the layer straightforwardly beneath the hot blend black-top (HMA) layer and by and large, comprises of total (either settled or unstabilized). Base courses are normally built out of:

- Total is the most ordinarily developed. Solid totals won't be harmed by dampness or ice activity. Totals can be either balanced out or unstabilized.
- HMA, is utilized where high base firmness is wanted. In surface course HMA blends, ordinarily contain a bigger most extreme total size (0) reviewed) and exposed to additional permissive determinations.

2.9 SUB-BASE COURSE

This is the layer (or layers) under the base layer. The layer between the base course and subgrade. The sub-base generally consists of quality materials than the base course but better than the subgrade soils. A sub-base course is not usually needed or used. The sub-base consists of granular materials - gravel, crushed stone, reclaimed materials, or a combination of these materials. The sub-base is a layer of specified material and design thickness that supports the base. This generally is limited to use with composite base:

For a pavement constructed over a high quality, stiff subgrade may not need the additional features offered by the sub-base course. However, a pavement constructed over low-quality soil such as swelling clay may require the additional load distribution characteristics that require a subbase course to replace and support the poor-quality subgrade. It functions primarily as structural support but it can also:

- Minimize the intrusion of fines from the subgrade into the pavement structure.
- Minimize frost action damage.
- Provide a working platform for construction.

2.9.1 SUBGRADE

This is usually the existing soil. It is pertinent to test for the strength of the subgrade soil to ascertain the bearing capacity of the soil. Sandy soils usually make good subgrade soils, unlike clayey soils.

As noted by Gidigas (1974), highway failure is a common phenomenon in the tropics, mostly occurring in the form of rutting, pitting, and waviness. However, studies by Gidigas (1972), have identified geotechnical factors as the cause of most road failures in the country. In most cases, subgrade, and sub-base materials on which the pavements are placed rarely meet the highway sub-grade/sub-base specifications. These situations are due largely to the fact that most times, roads and highways are constructed without little or no geotechnical considerations and or study of soil along the highways

2.9.2 PAST WORK DONE

1. According to Gidigas (1991), experiences in road construction in the tropics within the past 50 years or so have established that local materials specifications and pavement construction technologies have to be developed in relation to climatic conditions. This has involved the knowledge of the processes of formation as well as the genetic characteristics of the local materials. These genetic characteristics exert considerable influence on the geotechnical properties and engineering behavior of local material under the pavement. It is noted that the

stability of pavements in tropical environments depends not so much on the geotechnical properties of the available materials, designers, and construction engineers, or the pavement construction technology but on the climatic and drainage conditions.

2. Andre-Obayanju et al, (2017) mentioned earlier in their research that most soils in parts of Edo State precisely in Akoko-Edo and Benin City contain fines (silt and clay) of less than 35% implying that they have low plasticity and good engineering characteristic. Hence, concluding that they are all good as subgrade material but depending on the type of road to be constructed they needed to be stabilized either mechanically by compaction or chemically by using chemical stabilizers such as lime, cement, fly ash marble dust, etc. to meet the requirement for use as sub-base and base material in flexible pavement structures.

3. Okagbue and Onyeobi (1999) evaluated the potential use of marble dust as a stabilizing agent for some red tropical soils. They concluded that adding the marble dust improved the soil by reducing its plasticity thereby increasing the strength and California Bearing Ratio values. However, with improvement, the strength can be successful as a base material for constructing light-trafficked roads and a sub-base for heavy-trafficked roads.

4. Andre-Obayanju, (2022) this work investigated the cause of road failure using geotechnical analysis along 20th Street, BDPA, Benin-city, Nigeria. Soil samples

from the failed section of the road were analyzed to ascertain their particle size distribution, limit liquid, plastic limit, maximum dry density, optimum moisture content, and California bearing ratio using the British Standard Institution (BS 1377 1990). It was found that there is a significant difference between the geotechnical characteristics of the soil and the standard for geotechnical characteristics set by the Federal Ministry of Works. This led to the conclusion that the soil geotechnical characteristics are a causative factor of road failure as well as the geology. Hence, it was recommended that the geotechnical and geological characteristics of sub-grades and fill materials be taken into consideration during road construction.

5. Andre-Obayanju and Otoakhia (2023) Bearing capacity is the maximum load applied on a foundation which should not cause shear failure to occur beneath a foundation. This depends primarily on the soil type, shear strength, and its density. This study looks into the Bearing Capacity of soils along Sapele Road Benin City, Edo state, a Metropolitan City in the south-south part of Nigeria. A total of six (6) Samples at various depths were collected and tested using geotechnical analysis to determine the following: soil moisture, particle size analysis, consistency limit, Bulk density determination test, and Triaxial shear test. The Terzaghi Bearing Capacity using the British standard units for footing for Strip, Square, and Circular footings was calculated for both Ultimate and Safe bearings capacities. Ultimate

Bearing Capacity is 131.03 to 784.05 / and Safe Bearing capacity is 43.67 to 261.35 / 2. These soils also indicate that they are clays with fine sands from the sieve analysis. It was found from the study that the soils in this area are good soil for the erection of buildings using shallow foundations or footing.

6. Adeyemi and Arogunyo (2023) Stabilization of lateritic soil developed over pegmatite by compacting it with soil developed over granite around Ikire and its environs was executed to determine the optimum combination of percentage by volume of the soil and the energy of compaction that will give adequate strength for construction purpose. Preliminary tests were carried out to determine the better set of soil before stabilization. Laboratory tests included petrographic study, grain size distribution analyses, consistency limits tests, and specific gravity determination, before stabilization with 15% and 30% respectively by volume of stabilizer and varying compaction energy before being subjected to an unconfined compression test. The major minerals in the pegmatite were quartz and feldspars with 25% and 51% respectively while the amounts in granite were 46% and 25% respectively. The pegmatite-derived soil possessed a higher amount of fines than the soil developed over granite with average values of 42% and 25% respectively, due to the amounts of feldspars. Stabilization of pegmatite-derived soil with granite-derived soil using 30% by volume of stabilizer at higher compaction energy was quite effective and it generated MDD and UCS which make it suitable

for use as bungalow bricks and good sub-base material for building and road construction respectively. Jegede (1998) investigated failure over the Talc-Tremolite-schist terrain of the Ife-Ilesha expressway in Osun state and concluded that since the subgrade and the burrowed materials are schist derived they contain talc and Hydromica, which makes it impossible "for field compaction. The engineering geological properties of sub-grade soil of the proposed law-Ekiti high way Southwestern Nigeria was carried out by Jegede (1998), the result obtained showed that the natural moisture content ranged from 2.0% to 2.8%. The liquid limit ranges from 36.0 to 43.0% linear shrinkage ranges from 2.1% to 2.60% specific gravity ranges from 2.66 to 2.74. The compaction of the soil indicates dry densities from 1910kg/m^3 to $2,050\text{kg/m}^3$ at an optimum moisture content of 15% to 18.2%. The data obtained show that the soil is good for road construction work as sub-grade and sub-base material in comparison with already set standards. The engineering geological assessment of soil from southwestern Nigeria as a seal in a sanitary landfill was carried out by 0.01GE. The result showed that the specific gravity ranges from 2.50 to 2.77 while the percentage of the fines ranges from 23 to 75% liquid limit values range from 27.7 to 62.5% and plasticity indices values ranges from 20.8 to 41.2%. The highest permeability value of $1.4 \times 10^{-8}\text{m/s}$ is also obtained for all soil investigated. Jegede (1994) worked on the pavement failure at a section along the

Ikere-Igbara-Odo road in Ekiti state of Nigeria. He found out that the California Bearing Ratio of the soil ranges around 50% which showed poor soil physical properties and lack of drainage facilities combined with the excess fine soil grade ranging between 20-40% was responsible for the failure along the area.

CHAPTER THREE

MATERIALS AND METHODS

3.1. MATERIALS

To accomplish the previously mentioned goals, a trial approach must be taken. This elaborates the assortment of soil tests from three (3) focuses in the area of the review region. The accompanying materials were utilized to accomplish this.

1. Worldwide Situating Framework (GPS): This was utilized to get directions to the places where tests were acquired.
2. Test sacks: This was utilized to convey the dirt examples acquired from a few areas in the field.
3. Scoop: this was utilized to put the dirt examples in their separate example packs.
4. Marker pen: this was utilized to name the examples.

3.2. METHODS

The examples were exposed to a few research facility tests in a bid to find out their reasonableness as development materials for an adaptable asphalt structure. To examine any development of designing designs, guidelines set by administrative organizations act as a background for obliging the reasonableness of the site for the development of each construction. In this examination, the examples gathered were tried in the research facility by the laid out guidelines of BS 1377 (1990). The tests completed incorporate molecule size examination, explicit gravity test, regular

dampness content test, Atterberg limit tests (plastic cutoff, fluid breaking point, and pliancy record), compaction test, and California bearing proportion (CBR) test.

3.3 NATURAL MOISTURE CONTENT

a) Reason: This test was performed to decide the regular dampness Content of the dirt examples. The water content is the proportion, communicated as Rate, of the mass of "pore" or "free" water in a given mass of soil to the mass of the dry soil solids.

b) Standard Reference: ASTM D 2216 - Standard Test Technique part

Research facility Assurance of Dampness Content of Soil, Rock, and Soil-
Total Blends.

c) Importance: For some dirt, the water content might be a critical list utilized for laying out the connection between the manner in which dirt acts and its properties. The consistency of fine-grained soil to a great extent relies upon its water content. The water content is likewise utilized in communicating the stage connections of air, water, and solids in a given volume of soil.

d) Gear. Drying stove, weight balance, dampness can, gloves, and spatula.

e) Technique: Around 50grams of every one of the examples was shown up a compartment of known weight and the example was then stove dried to a steady weight at roughly 105°C-110°C for a predetermined time of 24 hours. It was then permitted to cool in a desiccator and afterward gauged.

The heaviness of water was recorded as the misfortune in weight of the example and communicated as a level of the dry example to get the normal dampness content.

$$\text{Moisture content} = \frac{w_1 - w_2}{w_2 - w_3} \times \frac{100}{1} \text{ ----- Eqn(1)}$$

Where:

W_1 = weight of wet soil

W_2 = weight of dry soil

W_3 = weight of moisture lost

3.4 PARTICLE SIZE ANALYSIS

(a) Reason: This test was performed to decide the level of various grain sizes held inside soil tests. The mechanical or strainer examination is performed to decide the dispersion of the coarser, bigger measured particles, and the hydrometer strategy is utilized to decide the appropriation of the better particles.

(b) Standard Reference: The conveyance of various grain sizes influences the designing properties of the dirt. Grain size examination gives the grain size dispersion, and it is expected to order the dirt.

(c) Equipment: Weight Equilibrium, set of sifters, cleaning brush, strainer shaker, mixer(blender), 152H Hydrometer, sedimentation chamber, control chamber, thermometer, container, timing gadget.

(d) Strategy: Strainer investigation (wet sieving): The heaviness of each sifter as well as the base skillet to be utilized was recorded. 100 grams of the example was gauged and absorbed water. These drenched examples were washed through the 425 and 75 microns strainer and they were dried for 24 hours. The heaviness of the given dry soil test was taken and recorded. The strainers were collected in the climbing request of sifter numbers (#4 strainer at the top and #200 at the base). The skillet was set shaker for 10 minutes. The stack was taken out from the shaker and each sifter was painstakingly gauged and the heaviness of each strainer with its held soil was recorded. Furthermore, the heaviness of the base skillet was likewise recorded with its held fine soil.

3.5 SPECIFIC GRAVITY DETERMINATION

I) Reason: Utilizing a pycnometer, the test was performed to decide the particular gravity of the dirt examples. Explicit gravity is the proportion of the mass of a unit volume of soil at an expressed temperature to the mass of a similar volume of without gas refined water at an expressed temperature. Soil contains particles of various minerals with various explicit gravities of the constituent particles that include the example.

ii) Standard Reference: ASTM D 850-00-Standard Test for explicit Gravity of soil solids by water pycnometer.

iii) Importance: The particular gravity of dirt is utilized in the stage relationship of

air, water, and solids in a given volume of dirt.

iv) Hardware: pycnometer, balance, vacuum siphon, pipe, spoon.

v) Methodology: There are two significant strategies for deciding explicit gravity, however the systems are comparative.

I. Thickness bottle technique

ii. 1-liter gas container technique

The thickness bottle technique was utilized for this venture work. The thickness bottle was dried and gauged. It was then loaded up with refined water and its new weight was recorded. Around 1/3rd of the dirt, for example, was then filled into the dried thickness bottle and gauged, the dirt-filled thickness bottle was then loaded up with refined water and not entirely set in stone following 24 hours. The heaviness of the dirt example and that of an equivalent volume of water were then obtained by Numerical computations and the proportion is taken as the particular gravity of the dirt.

The mathematical calculation involved is given below:

$$S.G = \frac{w_2 - w_1}{w} \quad \text{----- Eqn (ii)}$$

Where $W = (W_4 - W_1) - (W_3 - W_2)$

W_1 = Weight of bottle

W_2 = weight of bottle + soil

3.6 COMPACTION TEST

(a) Reason: This research center test was performed to decide the connection between the dampness content and the dry thickness of the dirt examples for a predefined compaction exertion. The compaction exertion is how much mechanical Energy that is applied to the dirt mass. A few strategies are utilized to minimize soil in the field, including packing, massaging, vibration, and static burden compaction. This work utilized the effect compaction technique utilizing the sort of gear and strategy created by R.R Delegate in 1993, hence, the test is otherwise called the delegate test.

(b) Standard Reference: ASTM D 698 - Standard Test Strategies for Research Facility Compaction. Attributes of soil utilizing Standard Exertion (12,400 ft-Ibs/ft³ (600KN-m/m³)).

(C) Importance: Mechanical compaction is the most well-known and practical method for balancing out soils. A critical undertaking of geotechnical engineers is the presentation and examination of field control tests to guarantee that compacted fills meet the recommended plan determinations. Plan details as a rule express the necessary thickness (as a level of the greatest thickness in a standard research facility), and the water content. As a general rule, most designing properties, like the strength, firmness, protection from shrinkage, and impenetrability of the dirt, will further develop by expanding the dirt thickness. The ideal water content is the

water content that outcomes in the best thickness for a predefined compaction exertion. Compacting at water contents higher than the ideal water content outcomes in a moderately scattered soil structure (equal molecule directions), that is more fragile, more malleable, less pervious, milder, more defenseless to contracting, and less helpless to expanding than soil compacted dry of ideal water content to a similar thickness. The dirt compacted lower than (dry of) the ideal water content regularly brings about a flocculated soil structure (irregular molecule directions) that has the contrary qualities of the dirt compacted wet of the ideal water content to a similar thickness.

d) Gear: Form, manual rammer, extruder, balance, drying broiler, blending skillet, scoop, #4 strainer, dampness jars, graduated chamber, straight edge.

e) Methodology: The air-dried example was sieved through a 4.75mm sifter and 3kg of the example was gathered. The dirt was blended in with around 6% of refined water and put promptly into a round and hollow compaction form and an expansion (collar) was added. The shape has a width of 105mm. A rammer which falls unreservedly from a level of 50cm was utilized to smaller the dirt in the form in 3 layers with each layer given 25 disasters to accomplish the delegate thickness. A determined endeavor was made to guarantee that the last compacted layer was not underneath the collar joint and not more than 1cm over the collar joint. From there on the shape augmentation was then eliminated and the dirt was managed

level with the form and gauged. A reasonable augmentation of 2% of water was currently added and the test was rehashed multiple times with a huge drop in weight in the 4' and 5' time. The consequences of the tests were addressed by a dampness thickness bend in which the dried thickness for every assurance was taken as the ordinate and plotted against the related worth of the dampness content which was taken as the abscissa. The pinnacle of the bend is assigned as the most extreme dried thickness (MDD estimated in g/cm³) and its related worth of dampness content is assigned as the ideal dampness content OMC measure (in %). The zero air voids for every compaction were resolved utilizing the equation:

$$p_d = \frac{G_s}{(1+wG_s)} p_w \quad \text{--- Eqn(iii)}$$

Where, p_d = maximum dry density

G_s = specific gravity of the soil sample

p_w = density of water.

3.7 ATTERBERG LIMITS TEST

I) Reason: The test was performed to decide the plastic and fluid restrictions of fine-grained soil. As far as possible (LL) is with no obvious end goal in mind characterized as the water content, in percent, at which a piece of the dirt in a standard cup and cut by a furrow of standard aspects will stream together at the foundation of the section for a distance of 13 mm (1/2 in.) when exposed to 25 shocks from the cup being dropped 10 mm in a standard fluid breaking point

device worked at a pace of two shocks each second. As far as possible (PL) is water content, in percent, at which dirt can at this point not be disfigured by moving into 3.2 mm (1/8 in.) measurement strings without disintegrating

ii) Standard Reference: STM D 4318 - Standard Test Technique for Fluid Cutoff, Plastic Breaking point, and Versatility List of soils

iii) Importance: The Swedish soil researcher, Albert Atterberg initially characterized seven "restrictions of consistency" to order fine-grained soils, however in momentum designing practice just two of the limits, the Fluid and plastic cutoff points, are normally utilized (shrinkage limit, third breaking point. As far as possible depends on the dampness content of the dirt. As far as possible is the dampness that characterizes where the dirt changes from a semi-strong to a plastic (adaptable) state. As far as possible is the dampness content that characterizes where the dirt changes from a plastic to a gooey liquid state. As far as possible is the dampness content that characterizes where the dirt volume won't diminish further on the off chance that the dampness content is decreased. Designing properties of strong in light of lab testing Prof. Krishna Reddy, UIC 61 wide assortment of soil designing properties have been connected to the fluid and plastic cutoff points, and these A cutoff points are likewise used to characterize a fine-grained soil as indicated by the Bound together Soil Grouping framework or AASHTO framework.

D) Hardware: as far as possible is significant in deciding the water levels of fine-grained soil. These cutoff points, which incorporate as far as possible, plastic cutoff, and fluid cutoff, are utilized to compute the plasticity file. This file estimates the distinction between the dirt's fluid breaking point and plastic cutoff. To gauge these cutoff points, you will require a fluid cutoff gadget, a porcelain dish for vanishing, a level scoring instrument with a gage, eight dampness jars, an equilibrium, a glass plate, a spatula, a wash bottle loaded up with refined water, and a drying stove set at 1050C.

E) Methodology: Fluid Breaking point: There are two indicated strategies for the assurance of the fluid furthest reaches of soil;

Cone Penetrometer Technique (CPT)

The cone penetrometer test (CPT) is a famous in-situ testing strategy utilized in geotechnical designing to survey the properties of soils. It's an immediate and proficient method for:

- a. Deciding soil stratigraphy: Distinguishing different soil layers in light of their protection from entrance.
- b. Assessing soil strength and firmness: Estimating the power expected to drive a cone-formed tip into the ground.
- c. Assessing soil conduct: Giving information to ascertain soil properties like shear strength, compressibility, and liquefaction potential.

Reason:

The CPT offers a few benefits over customary soil testing techniques:

- a. Ceaseless profiling: Gives a constant profile of soil properties with profundity, dissimilar to discrete pieces of information from boreholes.
- b. Fast testing: Generally speedy and productive contrasted with boring and research facility testing.
- c. Insignificant aggravation: Negligibly obtrusive, making less interruption of the dirt contrasted with penetrating.
- d. Extensive variety of uses: Appropriate for different soil types, from delicate dirt to thick sands.

Technique: Gear Arrangement: A CPT rig, ordinarily mounted on a truck, houses the penetrometer test and information-obtaining framework.

Test Progression: The test, containing a cone tip and contact sleeve along its shaft, uses pressurized water driven into the ground at a consistent rate (ordinarily 2 cm/s).

Information Securing: Sensors inside the test measure the obstruction at the cone tip (cone opposition) and grinding along the sleeve (sleeve erosion) as it infiltrates.

Information Recording: The information-obtaining framework consistently records the cone opposition, sleeve grinding, and different boundaries (like profundity) at close spans.

Information Translation: After the test, the gathered information is deciphered utilizing specific programming and connections with soil mechanics standards. This permits architects to gauge different soil properties pertinent to establishment configuration, slant solidness examination, and other geotechnical applications.

The Casagrande strategy, otherwise called the Casagrande fluid breaking point test, is a standard research facility test utilized in soil mechanics to decide the fluid's furthest reaches of fine-grained soil. As far as possible is a pivotal boundary that shows the water content at which the dirt conduct changes from a fluid state to a plastic state.

a. Reason: The Casagrande technique fills a few needs in geotechnical designing:

I. Soil Grouping: as far as possible worth characterizes fine-grained soils in light of their pliancy. This characterization is fundamental for grasping their design way of behaving, like the potential for shrinkage, enlarging, and compressibility.

ii. Establishment Configuration: Realizing as far as possible permits specialists to evaluate the likely settlement and bearing limit of soil for the establishment plan. Soils with high fluid cutoff points might be more powerless to unreasonable settlement under load.

iii. Asphalt Plan: In asphalt designing, as far as possible is utilized to assess the potential for subgrade soils to lose strength and become temperamental when immersed in water.

b. Strategy: The Casagrande technique includes a particular contraption and a progression of steps:

I. Test Planning: A sodden soil test is ready by going it through a sifter to eliminate particles bigger than 2mm and afterward blending it in with a controlled measure of water to accomplish a functional consistency.

Scoring the Example: A metal cup containing the pre-arranged soil is evened out, and a furrow is sliced through the focal point of the example utilizing a normalized cutting instrument.

ii. Dropping the Notched Example: The cup is raised and dropped more than once at a particular rate onto a hard elastic base.

iii. Checking the Furrow Conclusion: The section in the dirt example closes dynamically with each drop. The quantity of drops expected for the depression to tight to a particular width (regularly 1.25 cm) is counted.

iv. Water Content Assurance: In the wake of arriving at the predefined groove conclusion, the water content of the dirt example is resolved utilizing a gravimetric technique (drying and gauging).

v. Information Plotting and Understanding: Various tests are directed at various beginning water contents, and the quantity of drops is plotted against the comparing water content. As far as not entirely set in stone the dampness content is worth comparing to a particular number of drops (commonly 25).

The strategy utilized for this work is the Casagrande technique.

200 grams of each air-dried soil test was sieved through a 425um sifter. The dirt was then put on a glass sheet and blended in with a little refined water to shape a thick glue and afterward left for the time being. From that point, the cup of the mechanical assembly was half loaded up with the red soil and high level off.

A 2mm furrow was made in the focal point of the dirt utilizing a cutting device. The handle of the contraption was turned at a pace of 2 cycles each second, making the cup rise 10mm before constantly falling onto the elastic base. The number of effects expected to close the hole by 13mm was noted, and an example of the dirt in that area was taken for dampness content investigation. This technique was rehashed five additional times, with gradual options of water for each test. As far is not entirely set in stone by diagramming the dampness content against the comparing number of effects. A bend was fitted to the relevant pieces of information, and the dampness content at 25 effects was viewed as far as possible. For as far as possible test, around 20 grams of each dirt example arranged during as far as the test was utilized. The dirt was blended in with barely enough water on a glass plate to make it adequately moldable for forming into a ball. This ball was then carried out into a string between the hand and the glass surface. The dirt arrived at its plastic breaking point when the string started to disintegrate at a breadth of 3mm. As of now, a part of the string was eliminated for dampness

content assurance. This interaction was rehashed three additional times, and the typical dampness content was determined as far as possible.

Versatility list: The pliancy record is a proportion of the pliancy of soil. The versatility list is the size of the scope of water contents where the dirt displays plastic properties. The PI is the distinction between as far as possible and as far as possible (PI = LL-PL).

Mathematically, it can be represented as;

$$P.I = L.L - P.L \quad \dots\dots\dots Eqn(iv)$$

Where P.I = Plasticity index

L.L = liquid limit

P.L = plastic limit

3.8 CALIFORNIA BEARING RATIO (CBR) TEST

The California Bearing Proportion (CBR) test was directed on the compacted soils utilizing a CBR shape estimating 150mm in breadth and 175mm in level. The dirt example was compacted into three layers, with each layer exposed to 55 blows, and how much water was utilized was resolved in light of its ideal dampness content. The form highlighted a separable collar with a level of 50mm and a separable punctured base plate. To work with test readiness, a displacer plate 50mm profound was set in the shape, considering an example profundity of

125mm. During testing, a heap was applied to the entrance cylinder, bringing about an infiltration pace of roughly 1.25mm/min. Load readings were recorded at explicit infiltration profundities of 0, 0.5, 1.0, 1.5, 2.0, 2.5, 3.0, 4.0, 5.0, 7.5, 10.0, and 12.5mm. These heap values, duplicated by the ring consistent, were plotted on the y-pivot, while the related entrance profundities of the unclogger in millimeters were plotted on the x-hub. Tests were led on both the top and lower part of soil tests for both unsoaked and doused conditions and information focuses were plotted as needed.

CHAPTER FOUR

RESULT AND DISCUSSION OF RESULTS

The results obtained from the test of the three (3) soil samples are presented and interpreted in this chapter.

4.1 NATURAL MOISTURE CONTENT DETERMINATION

The results from the experiment are summarized below with the aid of tables.

Table 1: DETERMINATION OF MOISTURE CONTENT OF SOIL PARTICLES

(STANDARD LABORATORY METHOD)

S/N	BOREHOLE ID	DEPTH (M)	CN	WWS+WC	WDS+WC	WC	WDS	WM	MC	AMC
1	SAMPLE 1	1.0	AA	138.60	119.60	24.40	95.20	19.00	19.96	20.02
			FX	114.90	99.70	24.00	75.70	15.20	20.08	
2	SAMPLE 2	1.0	BA	120.30	101.90	16.90	85.00	18.40	21.65	21.91
			VB	131.40	110.60	16.80	93.80	20.80	22.17	
3	SAMPLE 3	1.0	WZ	167.70	143.20	29.40	113.40	24.50	21.53	21.64
			NO	162.20	138.60	30.10	108.50	23.60	21.75	

WC = weight of container

WWS = weight of wet soil

WDS = weight of dry soil

WM = weight of moisture (M2-M3)

MC = moisture content $((M2-M3)/ (M3-M1))*100$

AMC = average moisture content $(mc/2)$

The typical normal dampness content (AMC) of the three examples gathered is 20.02%, 21.91%, and 21.75% respectively.

From the dampness content acquired from the three example areas, we can signify that the second example with 21.91% has the most elevated dampness content. This infers that it has the most elevated water maintenance limit contrasted with different examples, the high maintenance limit of soil shows the presence of granular materials (sands and rock). The maintenance limit hurts the value of soil as a base material for expressway development making the primary example less reasonable than the other two.

Table 3: summary of particle size distribution of the second sample site

**UNIBEN GEOTECH RESEARCH
GRAIN SIZE ANALYSIS BY DRY-SIEVING**

SITE: OGHEGHE COMMUNITY...

JOB: UNDERGRADUATE PROJECT..

LOCATION:Sample 2 MIDDLE

DATE: 02/02/2024.....

DEPTH: ...1m.....

TESTED BY: WET SIEVE.....

SIEVE NO.	BRITISH STANDARD SIEVE SIZES (mm)	RETAINED IN gm	PASSING IN gm	PASSING IN (%)
3	75			
2 ½				
2	50			
1 ½	37.5			
1	26.5			
¾	20			
½	14			
⅜	10			
¼	6.3			
3/16	5			
⅛	3.35		100.00	100.00
7	2.36	9.20	90.80	90.80
10	2	2.00	88.80	88.80
14	1.18	10.14	78.66	78.66
25	0.6	24.74	53.92	53.92
36	0.425	13.76	40.16	40.16
52	0.3	10.79	29.37	29.37
72	0.212	9.79	19.58	19.58
100	0.15	4.33	15.25	15.25
200	0.075	4.52	10.73	10.73

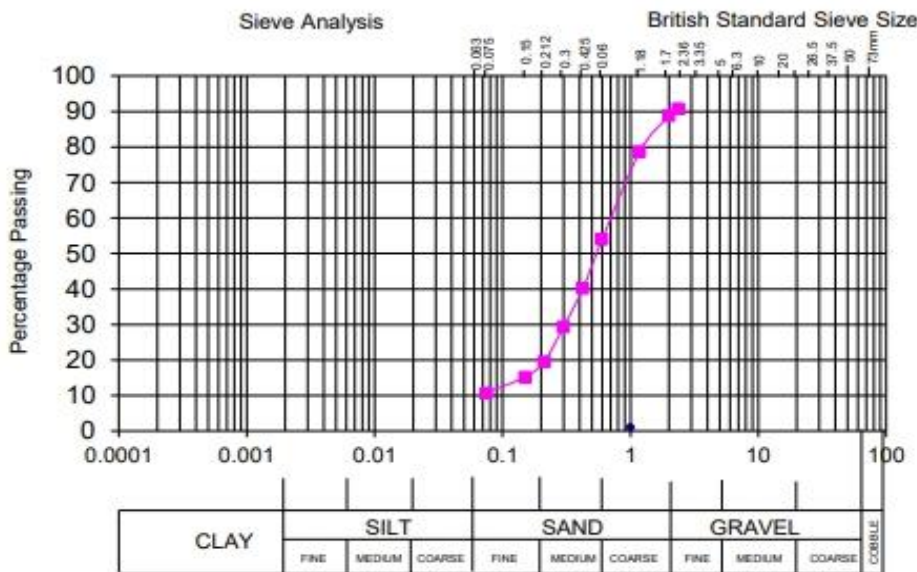


Figure 6: Graph of particle size distribution of the second location.

4.3 SPECIFIC GRAVITY DETERMINATION

Below is the summary of the result of the specific gravity determination

Table 5: summary of specific gravity test for all three samples collected in the location.

S/N	LOC	DEPT	BN	B+W	B+S+W	B+S	B	Ad. W	WWAS	WS	WOWDS	GS	AGs
1	1 RIGHT	1m	API	37.52	50.91	35.14	12.80	24.72	15.77	22.34	8.95	2.50	2.50
			IT	36.11	49.08	33.27	11.68	24.43	15.81	21.59	8.62	2.50	
2	2 MIDDLE	1m	UWI	68.66	90.75	56.01	19.27	49.39	34.74	36.74	14.65	2.51	2.51
			I	69.56	91.27	56.35	20.23	49.33	34.92	36.12	14.41	2.51	
3	3 LEFT	1m	ZOO	89.51	116.12	69.84	23.82	65.69	46.28	46.02	19.41	2.37	2.37
			AMED	72.10	93.27	52.85	16.19	55.91	40.42	36.66	15.49	2.37	

B+W = Wt. of Bottle + Water (full) W4

B+S+W = Wt. of Bottle + Soil+ Water W3

B+S = Wt. of Bottle + Soil W2

B = Wt. of Bottle W1

Ad. W = Wt. of Added Water (full) (W4-W1)

WWAS = Wt. of Water added to Soil (W3-W2)

WS = Wt. of Soil (W2-W1)

WOWDS = Wt. of Water Displaced by Soil (W4-W1)-(W3-W2) = W

GS = Specific Gravity (W2-W1) /W

The specific gravity of a given soil sample is dependent on the mineralogy or chemical composition. The higher the specific gravity of a soil the more suitable it is for road construction. The average specific gravity for the first, second, and third samples are 2.50%, 2.51%, and 2.37% respectively. Sample 2 has the highest specific gravity value which makes most suitable.

Table 7: summary of compaction test of the second sample.

**DETERMINATION OF THE MOISTURE/DENSITY RELATION OF SOIL
USING STANDARD/HEAVY COMPACTION**

PROJECT : UNDERGRADUATE Sample No....Sample 2 MIDDLE Operator...EZRA...
 Site...OGHEGHE COMMUNITY Date:.....02/02/2024 MDD: **1.78g/cm³**
 Amount retained on 20mm B.S. Sieve..... Total weight of Sample..... OPT.MC: **9.20%**
 B.S. / C.B.R. Mould.....**4653g**.....

Wt. of mould & wet Soil (W2) g	6334.00	6435.00	6497.00	6538.00	6592.00	6573.00	6550.00							
Wt. of mould (W1) g	4653.00	4653.00	4653.00	4653.00	4653.00	4653.00	4653.00							
Wt. of wet soil (W2-W1) g	1681.00	1782.00	1844.00	1885.00	1939.00	1920.00	1897.00							
Bulk Density (Pb) (W2-W1)/x g/cm ³	1.69	1.79	1.85	1.89	1.95	1.93	1.91							
MOISTURE CONTENT DETERMINATIONS for B.S. Mould, X = 995.79cm ³														
Container No.	B2	Y7	PATI	EE	MTI	B2	TZ	6PW	NOH	P23	GG	JEZ	IB	SPK
Wt. of wet soil & container (g)	49.80	39.42	39.56	48.18	49.59	50.85	49.21	46.88	47.20	42.01	42.80	46.79	46.59	46.44
Wt. of Dry soil & container (g)	48.04	38.09	38.16	46.29	47.39	41.39	46.67	44.52	44.42	39.18	39.97	43.38	42.91	42.81
Wt. of Container (g)	9.73	9.47	15.97	14.90	16.62	14.11	13.67	13.12	15.36	11.50	15.69	12.06	13.79	14.86
Wt. of dry soil (Wd) g	38.31	28.62	22.19	31.39	30.77	27.28	33.00	31.40	29.06	27.68	24.28	31.32	29.12	27.95
Wt. of Moisture (Wm) g	1.76	1.33	1.40	1.89	2.20	9.46	2.54	2.36	2.78	2.83	2.83	3.41	3.68	3.63
Moistur Content 100(Wm/Wd) %	4.59	4.65	6.31	6.02	7.15	34.68	7.70	7.52	9.57	10.22	11.66	10.89	12.64	12.99
Average Moisture Content (m) %	4.62	6.17	20.91	7.61	9.90	11.27	12.81							
Dry Density = Pb/1+ (m/100) (g/cm ³)	1.61	1.69	1.53	1.76	1.77	1.73	1.69							
C.B.R. (mseen of top & bottom) %														

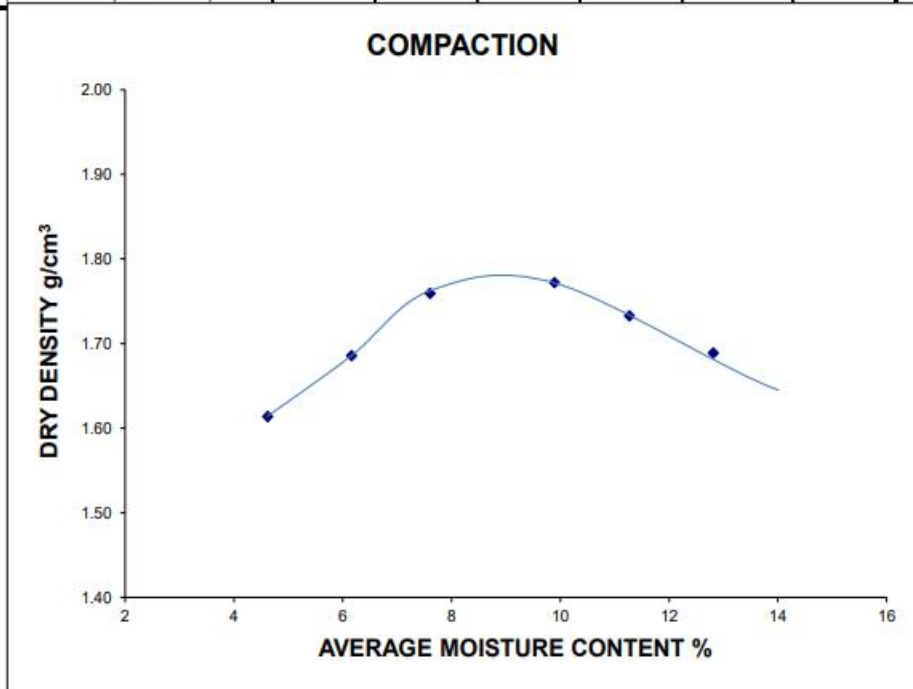


Figure 9: Graph of compaction Test of the second sample

Table 8: summary of compaction test of the third sample.

**DETERMINATION OF THE MOISTURE/DENSITY RELATION OF SOIL
USING STANDARD/HEAVY COMPACTION**

PROJECT: **UNDERGRADUATE** Sample No....Sample 3 RHS Operator.....EZRA.....
 Site...**OGHEGHE COMMUNITY** Date:.....**02/02/2024** MDD: **1.78g/cm³**
 Amount retained on 20mm B.S. Sieve..... Total weight of Sample..... OPT.MC:**11.1%**
 B.S. / C.B.R. Mould.....**4641g**.....

Wt. of mould & wet Soil (W2) g	6362.00	6534.00	6608.00	6614.00	6623.00	6583.00									
Wt. of mould (W1) g	4641.00	4641.00	4641.00	4641.00	4641.00	4641.00									
Wt. of wet soil (W2-W1) g	1721.00	1893.00	1967.00	1973.00	1982.00	1942.00									
Bulk Density (Pb) (W2-W1)/x g/cm ³	1.73	1.90	1.98	1.98	1.99	1.95									
MOISTURE CONTENT DETERMINATIONS for B.S. Mould, X = 995.79cm ³															
Container No.	SAN	CP	W20	E	RF	IM	IO	NNP	2S	AGN	440	JO2			
Wt. of wet soil & container (g)	37.78	36.65	42.72	38.43	48.78	48.53	44.69	47.07	33.88	32.83	45.23	32.28			
Wt. of Dry soil & container (g)	35.64	34.88	40.14	36.40	45.39	45.07	41.17	43.61	31.58	30.64	40.99	29.42			
Wt. of Container (g)	15.48	14.82	16.09	14.80	15.05	13.59	10.98	15.29	16.31	16.16	16.16	11.61			
Wt. of dry soil (Wd) g	20.16	20.06	24.05	21.60	30.34	31.48	30.19	28.32	15.27	14.48	24.83	17.81			
Wt. of Moisture (Wm) g	2.14	1.77	2.58	2.03	3.39	3.46	3.52	3.46	2.30	2.19	4.24	2.86			
Moistur Content 100(Wm/Wd) %	10.62	8.82	10.73	9.40	11.17	10.99	11.66	12.22	15.06	15.12	17.08	16.06			
Average Moisture Content (m) %	9.72		10.06			11.08			11.94			15.09		16.57	
Dry Density = Pb/1+ (m/100) (g/cm ³)	1.58		1.73			1.78			1.77			1.73		1.67	
C.B.R. (mseen of top & bottom) %															

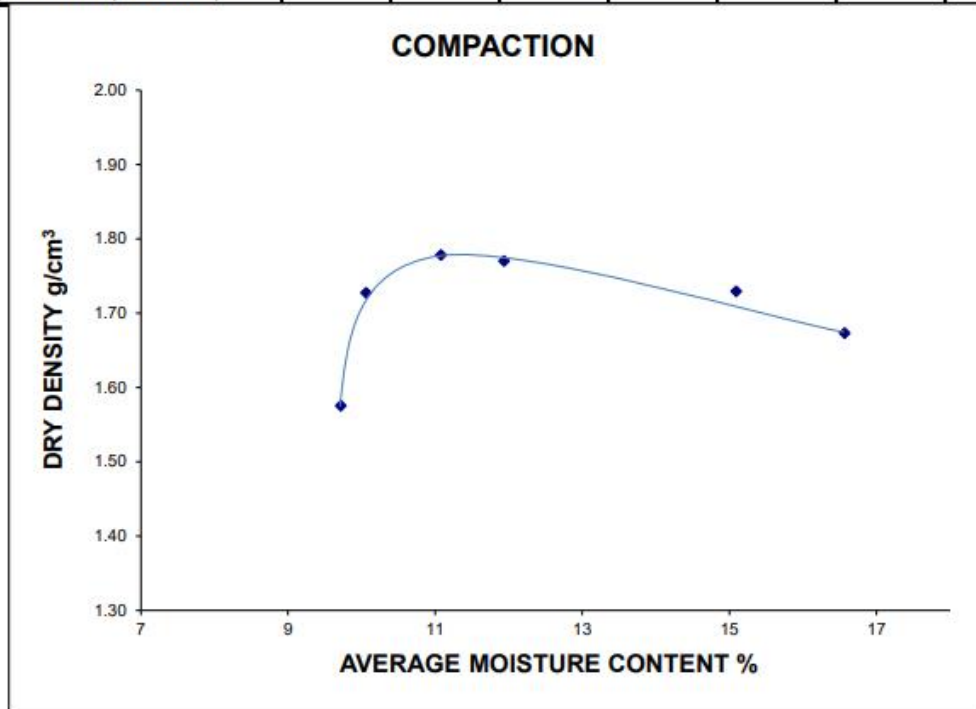


Figure 10: Graph of compaction Test of the third sample

The Nigerian determination for Street and Extension Materials (Nigeria Government Service of Works and Lodging, 1970) prescribes that for a material to be utilized by and large as fills, it ought to have the most extreme dry thickness (MDD) more noteworthy than 0.047 kg/cm^3 and ideal dampness content (OMC) under 18%. From the outcomes obtained, it very well may be seen that the ideal dampness content (OMC) for the first, second, and third examples is 12.4%, 9.20%, and 11.1% individually. The principal test has the most noteworthy worth. The most extreme dry thickness (MDD) obtained from the test for the first, second, and third examples separately are 1.62g/cm^3 , 1.78g/cm^3 , and 1.78g/cm^3 individually. Tests 2 and 3 have the most elevated worth of MDD, while test 1 has the least worth of MDD. Soil tests portrayed by a high worth of most extreme dry thickness and low ideal dampness content are best reasonable as subbase and subgrade material. Each of the three examples meets the prerequisite.

4.5 ATTERBERG LIMITS TEST

Below is the result of the Atterberg limits test carried out on sample 1

Table 9: Summary of Atterberg limits test of the first sample

LIQUID AND PLASTIC LIMITS, LINEAR SHRINKAGE

Sample No ..**Sample 1 LHS.** Liquid Limit...**54.98..** Plastic Limit.**16.99..g/cm³**
 Date.....**02/02/2024.....** Plastic Index.**37.99.....** Linear Shrinkage...%
 Job....**UNDERGRADUATE PROJECT.....** Description of Soil...
 Site...**OGHEGHE COMMUNITY.....**
 L.L. Machine No..... Operator.....**EZRA.....**
 Proportion of sample retained on No. 36 B.S. Sieve = Per cent
 No. of blows refers to liquid limit determination.
 Shrinkage % refers to linear Shrinkage.
 Liquid limit marked L.L. plastic limit marked P.L. Linear shrinkage marked L.S.

Type of Test	LL		LL		LL		LL		LL
No. of Blows/shrinkage %	43.00		33.00		24.00		17.00		13.00
Container No.	NOA		TXZ		GBS		NOH		HIP
Wt of wet soil & container (g)	32.99		32.44		42.40		53.10		54.40
Wt of dried soil & container (g)	27.68		26.14		31.83		39.38		39.35
Wt of container (g)	16.83		13.68		12.45		15.35		14.98
Wt of dry soil (Wd) (g)	10.85		12.46		19.38		24.03		24.37
Wt of moisture (Wm) (g)	5.31		6.30		10.57		13.72		15.05
Moisture contain 100 (Wm/Wd)	48.94		50.56		54.54		57.10		61.76
Type of Test		PL		PL		PL		PL	PL
No. of Blows/shrinkage %									
Container No.		CHI		CM		TZ			
Wt of wet soil & container (g)		19.41		20.65		18.83			
Wt of dried soil & container (g)		18.76		19.86		18.07			
Wt of container (g)		14.93		15.16		13.65			
Wt of dry soil (Wd) (g)		3.83		4.70		4.42			
Wt of moisture (Wm) (g)		0.65		0.79		0.76			
Moisture contain 100 (Wm/Wd)		16.97		16.81		17.19			

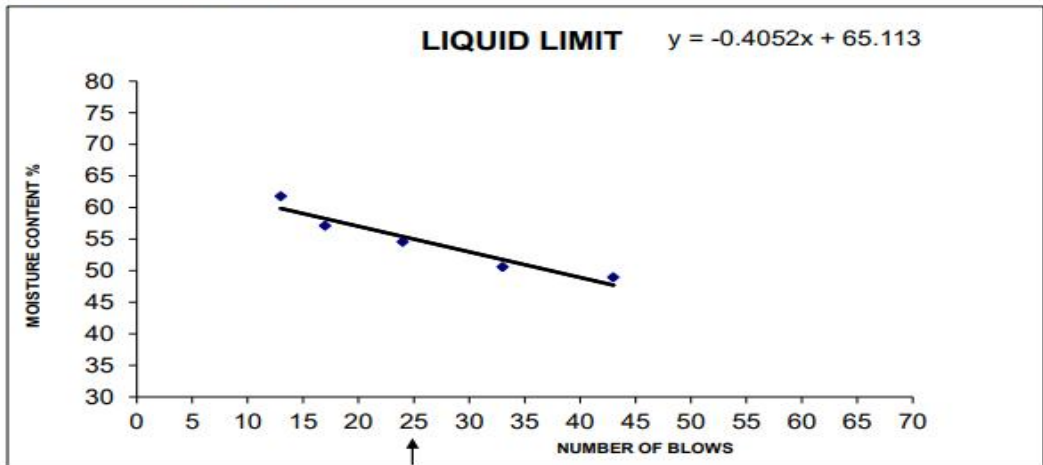


Figure 11: Graph of liquid limit test of sample 1.

Table 10: Summary of Atterberg limits test of sample 2

LIQUID AND PLASTIC LIMITS, LINEAR SHRINKAGE

Sample No ..**Sample 2 MIDDLE.** Liquid Limit...**30.88..** Plastic Limit.**14.37..g/cm³**
 Date.....**02/02/2024.....** Plastic Index....**16.51...** Linear Shrinkage...%
 Job....**UNDERGRADUATE PROJECT.....** Description of Soil...
 Site....**OGHEGHE COMMUNITY.....**
 L.L. Machine No..... Operator.....**EZRA.....**
 Proportion of sample retained on No. 36 B.S. Sieve = Per cent
 No. of blows refers to liquid limit determination.
 Shrinkage % refers to linear Shrinkage.
 Liquid limit marked L.L. plastic limit marked P.L. Linear shrinkage marked L.S.

Type of Test	LL		LL		LL		LL		LL
No. of Blows/shrinkage %	42.00		32.00		24.00		17.00		13.00
Container No.	AN		W46		SA		J6		W36
Wt of wet soil & container (g)	26.98		32.44		39.57		51.52		60.73
Wt of dried soil & container (g)	24.33		28.52		33.82		42.68		48.91
Wt of container (g)	14.78		15.19		14.86		14.46		15.12
Wt of dry soil (Wd) (g)	9.55		13.33		18.96		28.22		33.79
Wt of moisture (Wm) (g)	2.65		3.92		5.75		8.84		11.82
Moisture contain 100 (Wm/Wd)	27.75		29.41		30.33		31.33		34.98
Type of Test		PL		PL		PL		PL	PL
No. of Blows/shrinkage %									
Container No.		1B		AA		H1			
Wt of wet soil & container (g)		20.28		19.96		20.16			
Wt of dried soil & container (g)		19.46		19.44		19.45			
Wt of container (g)		13.79		15.75		14.57			
Wt of dry soil (Wd) (g)		5.67		3.69		4.88			
Wt of moisture (Wm) (g)		0.82		0.52		0.71			
Moisture contain 100 (Wm/Wd)		14.46		14.09		14.55			

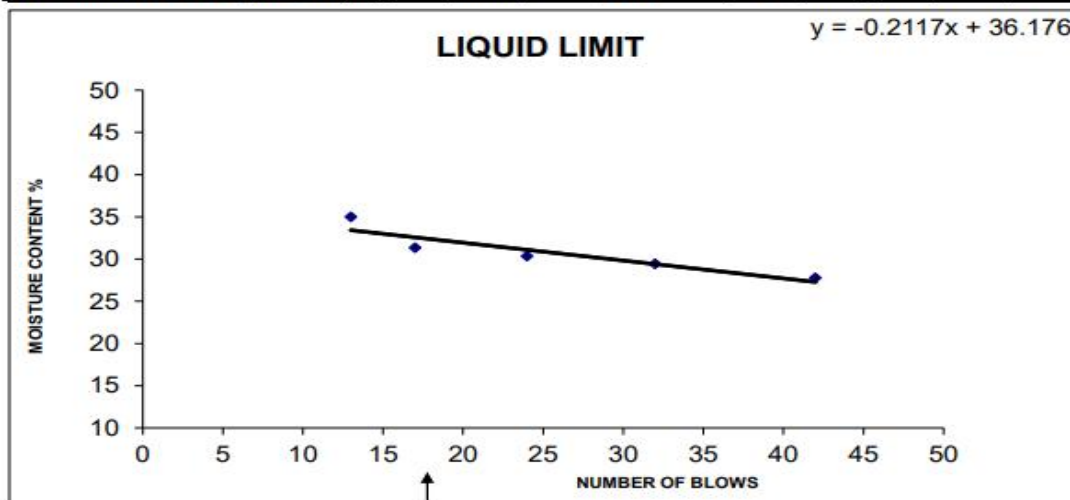


Figure 12: Graph of liquid limit test of sample 2.

Table 11: Summary of Atterberg limits test of sample 3.

LIQUID AND PLASTIC LIMITS, LINEAR SHRINKAGE

Sample No ..**Sample 3 RHS.** Liquid Limit...**51.89** Plastic Limit..**16.06.g/cm³**
 Date.....**02/02/2024**..... Plastic Index..**35.83**..... Linear Shrinkage...%
 Job....**UNDERGRADUATE PROJECT**..... Description of Soil...
 Site.....**OGHEGHE COMMUNITY**.....
 L.L. Machine No..... Operator.....**EZRA**.....

Proportion of sample retained on No. 36 B.S. Steve = Per cent
 No. of blows refers to liquid limit determination.
 Shrinkage % refers to linear Shrinkage.
 Liquid limit marked L.L. plastic limit marked P.L. Linear shrinkage marked L.S.

Type of Test	LL		LL		LL		LL		LL
No. of Blows/shrinkage %	43.00		33.00		24.00		17.00		13.00
Container No.	SA		D20		B2		IZH		A8
Wt of wet soil & container (g)	26.26		29.71		41.53		43.88		71.97
Wt of dried soil & container (g)	23.00		24.16		32.13		33.47		52.29
Wt of container (g)	16.16		12.80		13.68		13.76		18.19
Wt of dry soil (Wd) (g)	6.84		11.36		18.45		19.71		34.10
Wt of moisture (Wm) (g)	3.26		5.55		9.40		10.41		19.68
Moisture contain 100 (Wm/Wd)	47.66		48.86		50.95		52.82		57.71
Type of Test			PL		PL		PL		PL
No. of Blows/shrinkage %									
Container No.			X22		SPK		GG5		
Wt of wet soil & container (g)			20.70		18.66		20.89		
Wt of dried soil & container (g)			20.09		18.13		20.20		
Wt of container (g)			16.22		14.84		15.97		
Wt of dry soil (Wd) (g)			3.87		3.29		4.23		
Wt of moisture (Wm) (g)			0.61		0.53		0.69		
Moisture contain 100 (Wm/Wd)			15.76		16.11		16.31		

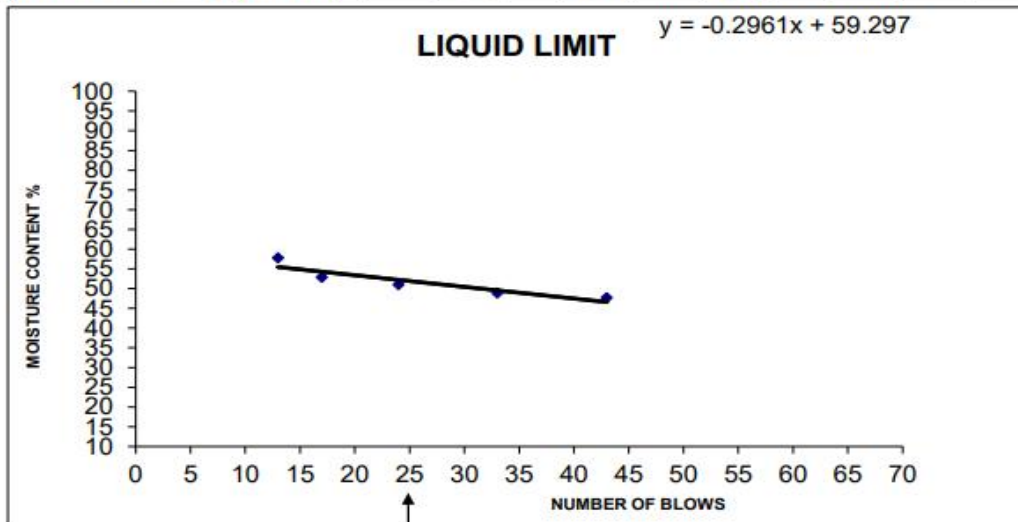


Figure 13: Graph of liquid limit test of sample 3.

The fluid furthest reaches of the three soil tests are 54.98%, 30.88%, and 51.89%, separately, while the comparing plastic cutoff points are: 16.99%, 14.37%, and 16.06%. Soils with fluid restrictions of under 30% are viewed as of low pliancy, those with fluid restricts that reach somewhere in the range of 30% and half are viewed as of medium versatility, while those with fluid cutoff points higher than half are said to have high versatility. Test 2 can be supposed to be of moderate versatility while Test 1 and Test 3 can be supposed to be of high pliancy and this could show the presence of clayey materials. Generally, the compressibility of soil is supposed to be high assuming that its versatility file surpasses 30%, medium in the event that it has between 10-29%, and low assuming it's lower than 9%. The pliancy record for the three examples is 37.99%, 16.51%, and 35.83% individually. Consequently, test 1 and test 3 can be said to have high compressibility while test 2 can be said to have moderate compressibility.

4.6 CALIFORNIA BEARING RATIO TEST

Table 12: Summary of CBR Test for soaked and unsoaked the first sample.

CALIFORNIA BEARING RATIO TEST												
SAMPLE NO	SAMPLE 1											
DESCRIPTION	DATE: 2/02/2024											
NOTES O SOIL												
TEST ON BOTTOM (UNSOAKED)						SURCHARGE						
Penetration (mm)	0.00	0.50	1.00	1.50	2.00	2.50	3.00	4.00	5.00	7.50	10.00	12.50
Load Indicator	0	68.00	101	130	152	176	196	223	246	305	363	415
Ditto corrected												
Load (KN)	0	0.74379	1.10475	1.42196	1.6626	1.92511	2.14388	2.43921	2.69078	3.33614	3.97055	4.53933
C. B. R. %												
TEST ON TOP (UNSOAKED)						SURCHARGE						
Penetration (mm)	0.00	0.50	1.00	1.50	2.00	2.50	3.00	4.00	5.00	7.50	10.00	12.50
Load Indicator	0	53.00	88	109	116	143	161	193	225	303	391	462
Ditto corrected												
Load (KN)	0	0.57972	0.96256	1.19226	1.26883	1.56416	1.76104	2.11106	2.46108	3.31426	4.27682	5.05343
C. B. R. %												
TEST ON BOTTOM (SOAKED)						SURCHARGE						
Penetration (mm)	0.00	0.50	1.00	1.50	2.00	2.50	3.00	4.00	5.00	7.50	10.00	12.50
Load Indicator	0	29.00	39	47	57	63	69	80	90	115	152	177
Ditto corrected												
Load (KN)	0	0.31721	0.42659	0.51409	0.62347	0.6891	0.75473	0.87505	0.98443	1.25789	1.6626	1.93605
C. B. R. %												
TEST ON TOP (SOAKED)						SURCHARGE						
Penetration (mm)	0.00	0.50	1.00	1.50	2.00	2.50	3.00	4.00	5.00	7.50	10.00	12.50
Load Indicator	0	50.00	70	92	108	120	128	142	153	169	184	197
Ditto corrected												
Load (KN)	0	0.54691	0.76567	1.00631	1.18132	1.31258	1.40008	1.55322	1.67354	1.84855	2.01262	2.15482
C. B. R. %												

	UNSOAKED		SOAKED	
	2.5mm	5.0mm	2.5mm	5.0mm
BOTTOM	14.53	13.4808	5.20273	4.93201
TOP	11.8094	12.33	9.90996	8.38442

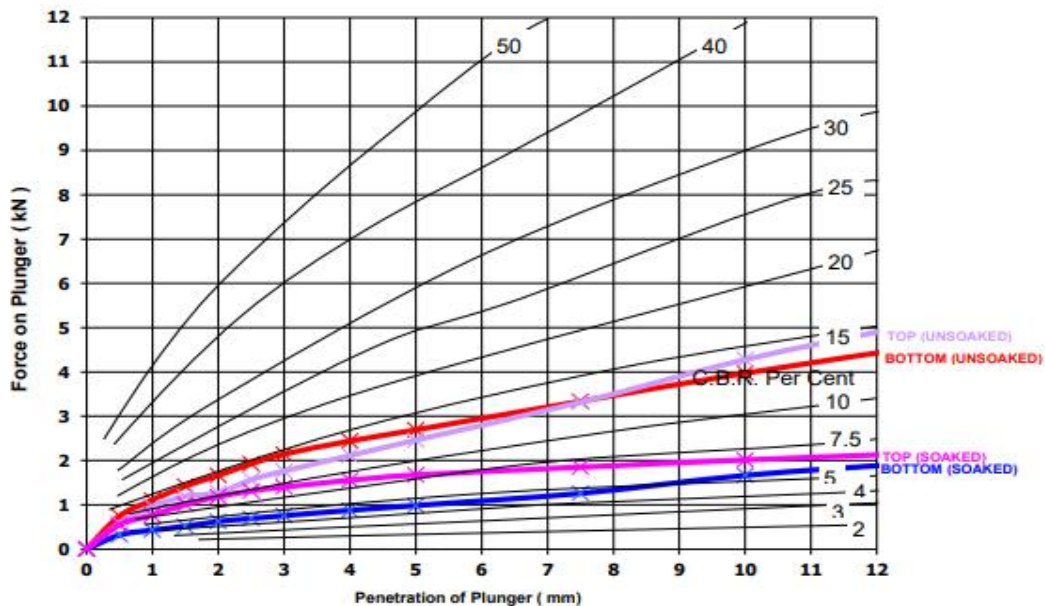


Figure 14: Graph of CBR Test for soaked and unsoaked samples of sample 1.

Table 13: Summary of CBR Test for soaked and unsoaked sample 2.

CALIFORNIA BEARING RATIO TEST

SAMPLE NO: **SAMPLE 2**
 DESCRIPTION: _____ DATE: 2/02/2024
 NOTES O SOIL: _____

TEST ON BOTTOM (UNSOAKED)						SURCHARGE						
Penetration (mm)	0.00	0.50	1.00	1.50	2.00	2.50	3.00	4.00	5.00	7.50	10.00	12.50
Load Indicator	0	14.00	36	53	73	88	101	118	129	145	161	178
Ditto corrected												
Load (KN)	0	0.15313	0.39377	0.57972	0.79848	0.96256	1.10475	1.2907	1.41102	1.58603	1.76104	1.94699
C. B. R. %												

TEST ON TOP (UNSOAKED)						SURCHARGE						
Penetration (mm)	0.00	0.50	1.00	1.50	2.00	2.50	3.00	4.00	5.00	7.50	10.00	12.50
Load Indicator	0	10.00	16	22	27	31	36	45	55	72	86	105
Ditto corrected												
Load (KN)	0	0.10938	0.17501	0.24064	0.29533	0.33908	0.39377	0.49222	0.6016	0.78755	0.94068	1.14851
C. B. R. %												

TEST ON BOTTOM (SOAKED)						SURCHARGE						
Penetration (mm)	0.00	0.50	1.00	1.50	2.00	2.50	3.00	4.00	5.00	7.50	10.00	12.50
Load Indicator	0	7.00	14	21	32	41	51	69	85	114	134	140
Ditto corrected												
Load (KN)	0	0.07657	0.15313	0.2297	0.35002	0.44846	0.55785	0.75473	0.92974	1.24695	1.46571	1.53134
C. B. R. %												

TEST ON TOP (SOAKED)						SURCHARGE						
Penetration (mm)	0.00	0.50	1.00	1.50	2.00	2.50	3.00	4.00	5.00	7.50	10.00	12.50
Load Indicator	0	9.00	17	22	25	28	31	39	46	70	85	102
Ditto corrected												
Load (KN)	0	0.09844	0.18595	0.24064	0.27345	0.30627	0.33908	0.42659	0.50315	0.76567	0.92974	1.11569
C. B. R. %												

	UNSOAKED		SOAKED	
	2.5mm	5.0mm	2.5mm	5.0mm
BOTTOM	7.27	7.06922	3.3859	4.65801
TOP	2.56007	3.01401	2.31232	2.52081

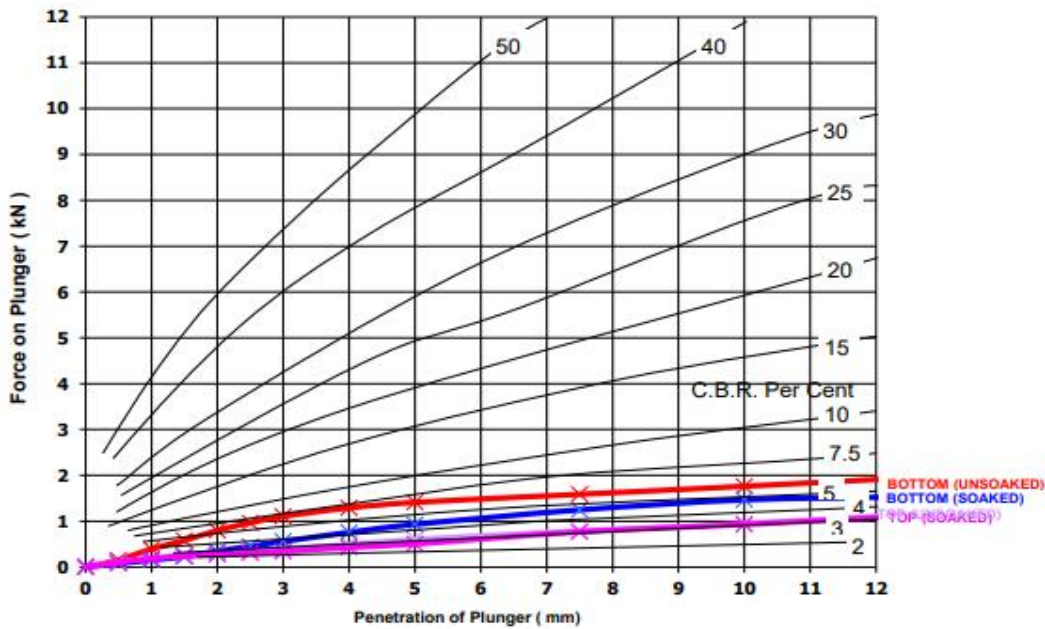


Figure 15: Graph of CBR Test for soaked and unsoaked samples of sample 2.

Table 14: Summary of CBR Test for soaked and unsoaked sample 3.

CALIFORNIA BEARING RATIO TEST

SAMPLE 3

SAMPLE NO
DESCRIPTION
NOTES O SOIL

DATE: 2/02/2024

TEST ON BOTTOM (UNSOAKED)											SURCHARGE	
Penetration (mm)	0.00	0.50	1.00	1.50	2.00	2.50	3.00	4.00	5.00	7.50	10.00	12.50
Load Indicator	0	72.00	105	127	140	162	179	207	238	313	380	445
Ditto corrected												
Load (KN)	0	0.78755	1.14851	1.38915	1.53134	1.77198	1.95793	2.2642	2.60328	3.42364	4.1565	4.86748
C. B. R. %												

TEST ON TOP (UNSOAKED)											SURCHARGE	
Penetration (mm)	0.00	0.50	1.00	1.50	2.00	2.50	3.00	4.00	5.00	7.50	10.00	12.50
Load Indicator	0	81.00	115	154	190	221	249	299	344	433	507	577
Ditto corrected												
Load (KN)	0	0.88599	1.25789	1.68448	2.07825	2.41733	2.7236	3.27051	3.76272	4.73622	5.54564	6.31131
C. B. R. %												

TEST ON BOTTOM (SOAKED)											SURCHARGE	
Penetration (mm)	0.00	0.50	1.00	1.50	2.00	2.50	3.00	4.00	5.00	7.50	10.00	12.50
Load Indicator	0	12.00	15	19	22	26	30	37	40	52	63	80
Ditto corrected												
Load (KN)	0	0.13126	0.16407	0.20782	0.24064	0.28439	0.32814	0.40471	0.43753	0.56878	0.6891	0.87505
C. B. R. %												

TEST ON TOP (SOAKED)											SURCHARGE	
Penetration (mm)	0.00	0.50	1.00	1.50	2.00	2.50	3.00	4.00	5.00	7.50	10.00	12.50
Load Indicator	0	40.00	62	78	90	100	105	112	118	133	149	161
Ditto corrected												
Load (KN)	0	0.43753	0.67817	0.85318	0.98443	1.09382	1.14851	1.22507	1.2907	1.45477	1.62978	1.76104
C. B. R. %												

	UNSOAKED		SOAKED	
	2.5mm	5.0mm	2.5mm	5.0mm
BOTTOM	13.38	13.0424	2.14716	2.19201
TOP	18.2509	18.8512	8.2583	6.46642

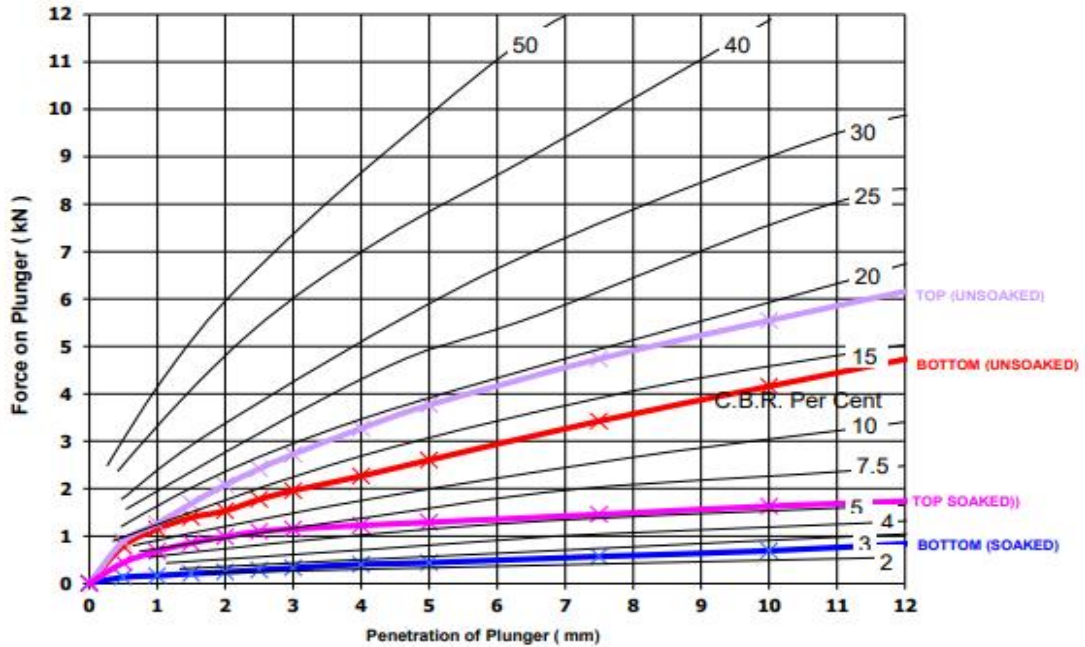


Figure 16: Graph of CBR Test for soaked and unsoaked samples of sample 3.

The CBR test may maybe the main in determining the nature of a material to be utilized as a subgrade in street development. The justification for the CBR test is to decide the opposition of the subgrade to twisting under the heap from vehicular traffic. The higher the qualities acquired for doused and unsoaked tests, the better the material for use as the base for expressway street developments. The Government Service of Works and Lodging (1972) suggested that for doused tests the upsides of CBR for subgrade, sub base, and street base ought not be under 10%, 30%, and 80% separately. BS 1377 (1975) indicates a CBR worth of something like 30% for base and sub-base material.

4.6.5 CALIFORNIA BEARING RATIO TEST

The CBR test may maybe the main in discovering the nature of a material to be utilized as a subgrade in street development. The justification behind the CBR test is to decide the opposition of the subgrade to twisting under the heap from vehicular traffic. The higher the qualities got for doused and unsoaked tests, the better the material for use as a base for parkway street developments. The Government Service of Works and Lodging (1972) suggested that for drenched examples the upsides of CBR for subgrade, subbase, and street base ought not be under 10%,30%, and 80% separately.

it is expressed that the norm for sub-base is 30%, however with what is seen from the outcome it falls below 29% for the examples and it tends not to be reasonable.

It doesn't meet the particulars so it is unacceptable then it should be balanced out in order for it to be ideal as a sub-base.

4.7 SUMMARY OF RESULTS

SAMPLE/PARAMETERS		1	2	3				
PERCENTAGE SANDS		28.36	10.73	6.56				
MOISTURE CONTENT		20.02	21.91	21.64				
SPECIFIC GRAVITY		2.50	2.51	2.37				
MAXIMUM DRY DENSITY(g/cm ³)		1.62	1.78	1.78				
OPTIMUM MOISTURE CONTENT (%)		12.4	9.20	11.1				
LIQUID LIMIT LL (%)		54.98	30.88	51.89				
PLASTIC LIMIT PL (%)		16.99	14.37	16.06				
CALIFORNIA BEARING RATIO (%)	SOAKED	BOTTOM	5.20	4.93	3.38	4.65	2.15	2.19
		TOP	9.90	8.38	2.31	2.52	8.26	6.47
	UNSOAKED	BOTTOM	14.53	13.48	7.27	7.07	13.38	13.04
		TOP	11.80	12.33	2.56	3.01	18.25	18.85

The laterite soils in this example region are appropriate for subgrade utilization yet not great for sub-base materials. From the table above we can see, the doused tests display a California Bearing Proportion (CBR) underneath the standard limit of 30% expected for street development. Whenever used, they might expect

adjustments to deliver them reasonably for use in sub-base and street-base development.

As far as possible demonstrated in the table recommends a high satisfaction of clayey materials, while the compressibility is likewise high, close by a high greatest dry thickness, meeting the standards for a powerful subgrade. In any case, the dampness content in the example demonstrates a critical water maintenance limit, possibly because of the presence of granular materials like sand and rock. While this maintenance limit is helpful for the dirt, it acts difficult for its ease of use as a base material in parkway development.

CHAPTER FIVE

SUMMARY AND SUGGESTION FOR FURTHER WORK

5.1 SUMMARY AND SUGGESTION FOR FURTHER WORK

The outcome from the evaluation of the geotechnical properties of soils at the review region (Ogheghe people group) shows that dirt examples acquired from the Ogheghe people group ended up being reasonable for earth-fill and subgrade in street development. Absolutely, the adequacy of materials can be upgraded to satisfy the guidelines for "sub-base sort 1" through different soil adjustment strategies. These may include consolidating added substances like concrete, lime, and flying debris, or changing molecule sizes to support the dirt's mechanical security. According to the Government Service of Works and Lodging FMWH (1997) rules, As far as possible (LL) shouldn't surpass half, As far as possible (PL) ought to be covered at 30%, and the Versatility File (PI) shouldn't outperform 20% for subgrade. All dirt examples tried to follow these particulars, demonstrating their reasonableness for use as subgrade materials.

As specified by the Government Service of Works and Lodging FMWH (1997), the California Bearing Proportion (CBR) prerequisites are 80% (unsoaked) for base, 30% (unsoaked) for subbase, and 10% (unsoaked) for subgrade, separately. In synopsis, the red tropical soils qualify as reasonable subgrade materials.

Nonetheless, their application as subbase and base materials in asphalt designs might require adjustment procedures like mechanical compaction or the utilization of compound stabilizers like lime, concrete, flying debris, or marble dust, contingent upon the particular street development needs.

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