GEOTECHNICAL PROPERTIES OF A CLAY SAMPLE FROM IDOGBO COMMUNITY, IKPOBA OKHA LOCAL GOVERNMENT AREA, EDO STATE, SOUTH WESTERN NIGERIA.

BY

NJOKU TOCHI

Psc2011162

DEPARTMENT OF GEOLOGY

FACULTY OF PHYSICAL SCIENCE

UNIVERSITY OF BENIN,

BENIN CITY, EDO STATE

APRIL 2024

GEOTECHNICAL PROPERTIES OF A CLAY SAMPLE FROM IDOGBO COMMUNITY, IKPOBA OKHA LOCAL GOVERNMENT AREA, EDO STATE, SOUTH WESTERN NIGERIA.

BY

NJOKU TOCHI

PSC2011162

IN PARTIAL FULFILMENT OF THE REQUIREMENTS FOR THE AWARD OF BACHELOR OF SCIENCE DEGREE.

(B. Sc. HONS) IN GEOLOGY

APRIL 2024

CERTIFICATION

This is to certify that this project was carried out by **NJOKU TOCHI** with matriculation number **Psc2011162,** of the Department of Geology, University of Benin, Benin City

NJOKU TOCHI Date

(Project Student)

Dr. D. I. Omoruyi Date

(Project Supervisor)

DR. S. A SALAMI. Date

(Head of Department)

DEDICATION

This work is dedicated to my parents Mr. and Mrs. NJOKU for their unwavering support, encouragement and prayers, to God almighty and everyone who supported me in one way or another,

ACKNOWLEDGEMENT

My special thanks goes to God almighty for giving me strength and grace to finish this work. I also want to use this oppurtinity to acknowledge and thank my project supervisor, **Dr. D. I. Omoruyi** for his acceptance encouragement, patience and also for providing me with the necessary information and advice required for providing me with the necessary, information and advice required for making this project a success.

My acknowledgement also goes to the Head of the Geology Department, university of **Dr. S. A. SALAMI,** for his fatherly role in the department**,** and to the other lectures for their teachings, corrections and advice to ensure my academic success - PROFESSOR, O. I. IMASUEN, DR. A. OGBAMIKHUMI, DR. (MRS) ODOKUMA ALONGE, DR NOSA IGBINIGIE, DR. (MRS) OYOVWHIKOWHE-MAJU. I also appreciate myself, my colleagues REGINAL, CHI CHI, JESSICA, ANTHONY, DAFE, NKEM, PATRICIA, WASHINGTONG, GREG, for their support all throughout my acedemic session. also to the support of the non academic staff of the department.

Finally, I want to appreciate my lovely parents, and siblings for their immense contribution, support and unending prayers and encouragement.

ABSTRACT

Samples of three wetland soils were collected from the Idobgo Area of Benin City, Edo State and were subjected to engineering property tests with the principal objective of predicting their engineering behaviour. These samples were subjected to four basic engineering property tests. The tests are; specific gravity, compaction test, Atterberg limit tests, and particle size analysis. Results from the specific gravity tests show 2.34 Atterberg limits results is: Liquid limit 90.61%, plastic limits: 44.74%, and 45.87%. plasticity index. With a particle size distribution of 99.2% clay, and 0.8%.all these results show that the clay soils around the Idobgo, Benin area will need a lot of stabilization to be suitable for construction

Table of Contents

LIST OF FIGURES

LIST OF TABLES

CHAPTER ONE

1.0 GENERAL INTRODUCTION

1.1 Background of Study

Geotechnical analysis is the process of evaluating the physical properties and behavior of soil and rock formations to determine their suitability for construction projects. It involves a series of investigations and tests to determine the subsurface conditions, soil properties, and potential risks associated with a site. Geotechnical analysis is crucial for the design and construction of various structures, from single houses to large infrastructure projects like bridges, high-speed rail, and metros.

Geotechnical investigations typically involve surface exploration and subsurface exploration. Surface exploration can include geologic mapping, geophysical methods, and photogrammetry, while subsurface exploration usually involves soil sampling and laboratory tests of the soil samples retrieved. Soil sampling borings come in two main varieties: large diameter and small diameter. Large-diameter borings are rarely used due to safety concerns and expense but are sometimes used to allow a geologist or engineer to examine soil or rock cuttings or to retrieve and perform in-place soil tests. Small-diameter borings are frequently used to allow a geologist or engineer to examine soil or rock cuttings or to retrieve and perform in-place soil tests.

Geotechnical investigations are also used to measure the thermal resistance of soils or backfill materials required for oil and gas pipelines, radioactive waste disposal, and solar thermal storage facilities. In addition to soil sampling, geotechnical investigations may include geophysical exploration to evaluate a site's behavior in a seismic event, such as measuring a soil's shear wave velocity to estimate the dynamic response of that soil.

The results of geotechnical investigations are used to inform the design and construction process, ensuring that structures are built on suitable ground conditions and that potential risks are minimized. Geotechnical engineers and engineering geologists are responsible for conducting these investigations and interpreting the data to inform design decisions.

Subsequently this study seeks to interpret the geotechnical properties of a clay sample.

1.2 Aim and Objectives

The aim of this project work is to determine the geotechnical properties of a Clay soil sample taken from the idogbo community in Ikpoba okha local government area, Edo state with a view of evaluating their suitability for use as materials in construction.

Objectives include:

- To collect reasonable quantity of samples from the selected location that would serve as representative of the soils
- Subject samples to laboratory tests including moisture content, test particle size distribution, determination of specific gravity, Atterberg limits, triaxial texts
- To discuss the results in correlation with standards set by various international bodies
- To analyse the results considering specifications set by international bodies

1.3 Scope of the Exercise

This exercise involves employing laboratory analysis to analyse the geotechnical properties of a clay soil at the Idogbo area of Benin city in order to determine its sutability as a construction material

1.4 Location and Size of Study Areas

The soil samples were obtained from the Idogbo area of Ikpoba okha LGA, Benin city, Edo state in the south western part if Nigeria.

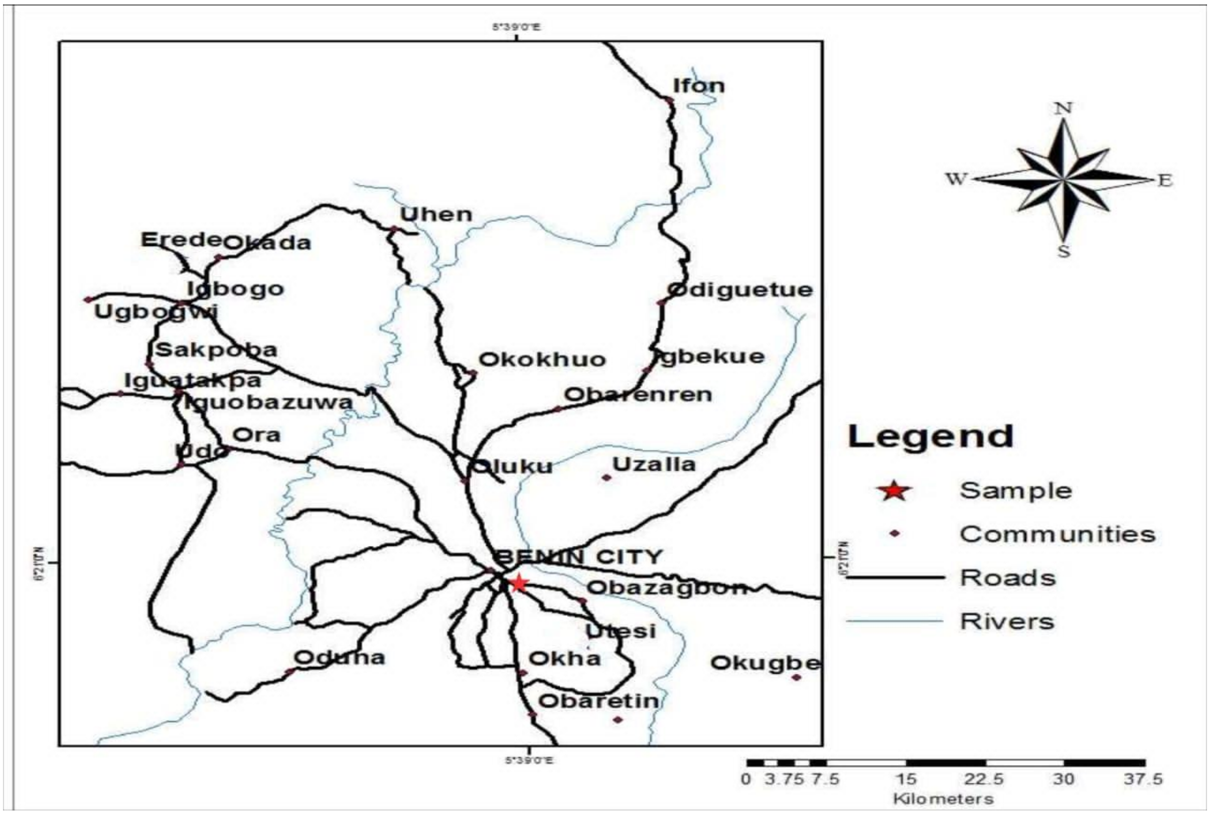

Figure 9: Map of Idogbo And Environs

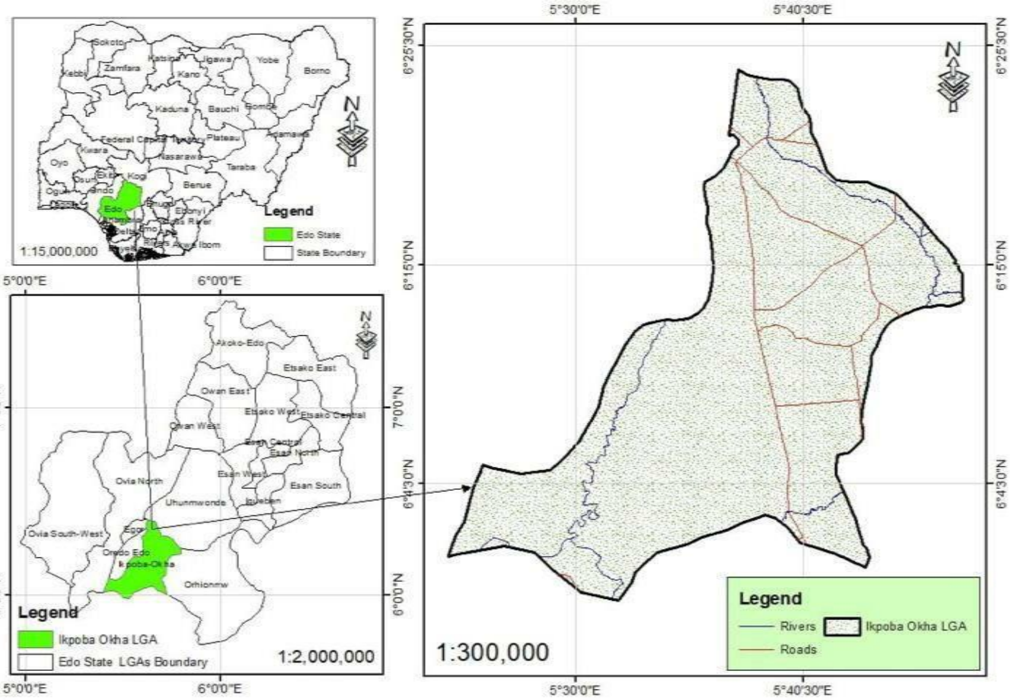

FIGURE 10: Map Of Edo State Showing Ikpoba Okha Local Government Area

CHAPTER TWO

2.0 LITERATURE REVIEW AND GEOLOGICAL SETTING

2.1 Literature Review

Based on the work of Orakwe et al (2018), The subsoil stratification can be classified as intercalation of sand and clayey sand. The upper sand is fined grained with thicknesses ranging from 4.5 m to 6 m and above 10 m at the northern and southern end of the study area respectively. The clayey sand is predominantly sand with tiny balls of low plastic clay that occur to a maximum depth of 10 m. The basal sand is fine to medium grained sand observed at depth ranging between 10 m and 17.5 m. The Natural Moisture Content (NMC) ranged from 5.0% at 0 m and 1 m depth in BH1 to a peak value of 66.05% at depth of 1 m in BH4.The samples collected had higher NMC values with increasing depth, suggesting that the soils have a higher water retention capacity. The high NMC also substantiates low density characteristics recorded. In line with the trend recorded in density values, natural moisture content of soil samples analyzed were observed to increase with depth in all boreholes sampled. Porosity ranged from 28.7% to 47.2% in soil samples, he also characterised the soil samples as being poorly graded -4 sand (SP) with soil permeability that can be classified as moderately permeable. In conclusion they observed that the study area is underlain by a thick column of poorly sorted unconsolidated sandy formation within the upper 10 m. This sandy layer is characterized by low bulk and dry density; moderate porosity;

low moisture content; and substantial hydraulic conductivity. Relatively low resistivity values.

From the work of Faseki (2016) the lithology is made up of soft silty sandy clay (0.0 – 5.0m), firm to stiff silty sandy clay/peat (5.0 – 17.0m) and medium dense silty sand (17.0 – 30.0m) which exemplify alluvial sediments of creek environments. which is considered the most competent foundation layers. His assessment was that , the upper and middle silty sandy clay layers with poor geotechnical properties have the potential to settle appreciably under foundation loads and are therefore considered inappropriate for support of the proposed structure.

2.2 Geology of the Sampled Area

The Benin Region is underlain by sedimentary formation of the South Sedimentary Basin. The geology is generally marked by top reddish earth, composed of ferruginized or literalized clay sand. (Parkinson, 1907) first used the term Benin sand to describe the reddish earth underlain by sands, sandy clays and ferruginized sandstone that mark the Paleo-Coastal Environment of Paleocene-Pleistocene Age. These sediments spread across the southern fringes of the Anambra Basin and marking the upper fancies off-flaps of the Niger Delta. Tattam (1943) used the name Coastal plain sands to describe the formation of red earth underlain by sands and clays that mark an ancient coastal plain environment now exposed in Calabar, Owerri, Onitsha and the Benin Region with the age Oligocene-Pleisto- cene.

However Rayment (1965) reinstated the name Benin formation to identify the reddish-brown-yellow generally white sands often with clayey and pebbly horizons with type-locality around Benin. This is also referenced at Calabar and other parts of South Eastern Nigeria. The formation was further established by well logging of Etete 1, well drilled on-shore east of River Niger by Shell Nigeria. Petroleum Development Company (SPDC) and described by (short & Stauble, 1967) . The formation is about 1830 m thick at the seashore but thins landwards. The sedimentary suits of the Benin Formation dip 2˚ - 8˚ south (Figure) . Geologically, the Benin Region comprises of 1) the Benin formation; 2) alluvium; 3) drift/top soil and 4) Azagba-Ogwashi (Asuba-Ogwashi) formation.

2.2.1 The Benin Formation

It is assigned to the Oligocene-Pleistocene period in the continent of Africa and to the Oligocene-Pleistocene recent at the sub-oceanic (Whiteman, 1982) . The formation is characterized by top reddish to reddish brown lateritic massive fairly indurate clay and sand. This is often marked with reticulate muderacks. This caps the underlying more friable pinkish-yellowish white often gravelly-pebble sands clayey soils, sands and clay ((Akujieze, 2004) . The sedimentary sequences are poorly bedded with discontinuous clay horizons at various depths. It is estimated to be about 800m thick under Benin City and about 1,830m near the sea shore sections of the formation. They are exposed at various erosion sites, sand quarry sites, and road cuttings. The Benin formation covers 95% of the region.

2.2.2. Alluvium

These are found along Ikpoba and Ovia flood plains. They are made up of grayish-dirty white-yellowish-white sands, silts, clayey sands, gravels and even wood-plant materials. These have been washed down the river valley and deposited at the river banks. They are recent deposits.

2.2.3. Drift/Top Soil

Drifts are sediments still in the process of transportation or movement. They are made up of light brown-yellow- wish silt, mudflows and sands derived from the weathering of the parental Benin Formation. Drifts are washed down by fluvial agents especially the storms and floods dominating the wet season of the region. The drifts are not part of the solid geology. But they are mainly derived and reworked materials and loads dropped by moving floods. Drifts cover roadsides; fill up areas, concealing the underlying geology. Drifts vary from very thin veneers to up to 0.55 m. The drifts cover about 2% of the urban area. Where the drifts are stabilized soil profile formation is developed.

2.2.4. Azagba-Ogwashi (ASABA-OGWASHI) Formation

The Azagba-Ogwashi formation has been missing spelt as Ogwashi-Asaba formation (Rayment, 1964) . It consists of clays, sands and grits and seams of lignite alternating with gritty clays. It grades upwards into the Benin Formation.

The Ogwashi-Asaba formation is exposed in stream channels at the northern parts of the Benin Region, west of Ekiadolor-Iwu and 4 km east of Utekon and north of Azalla,

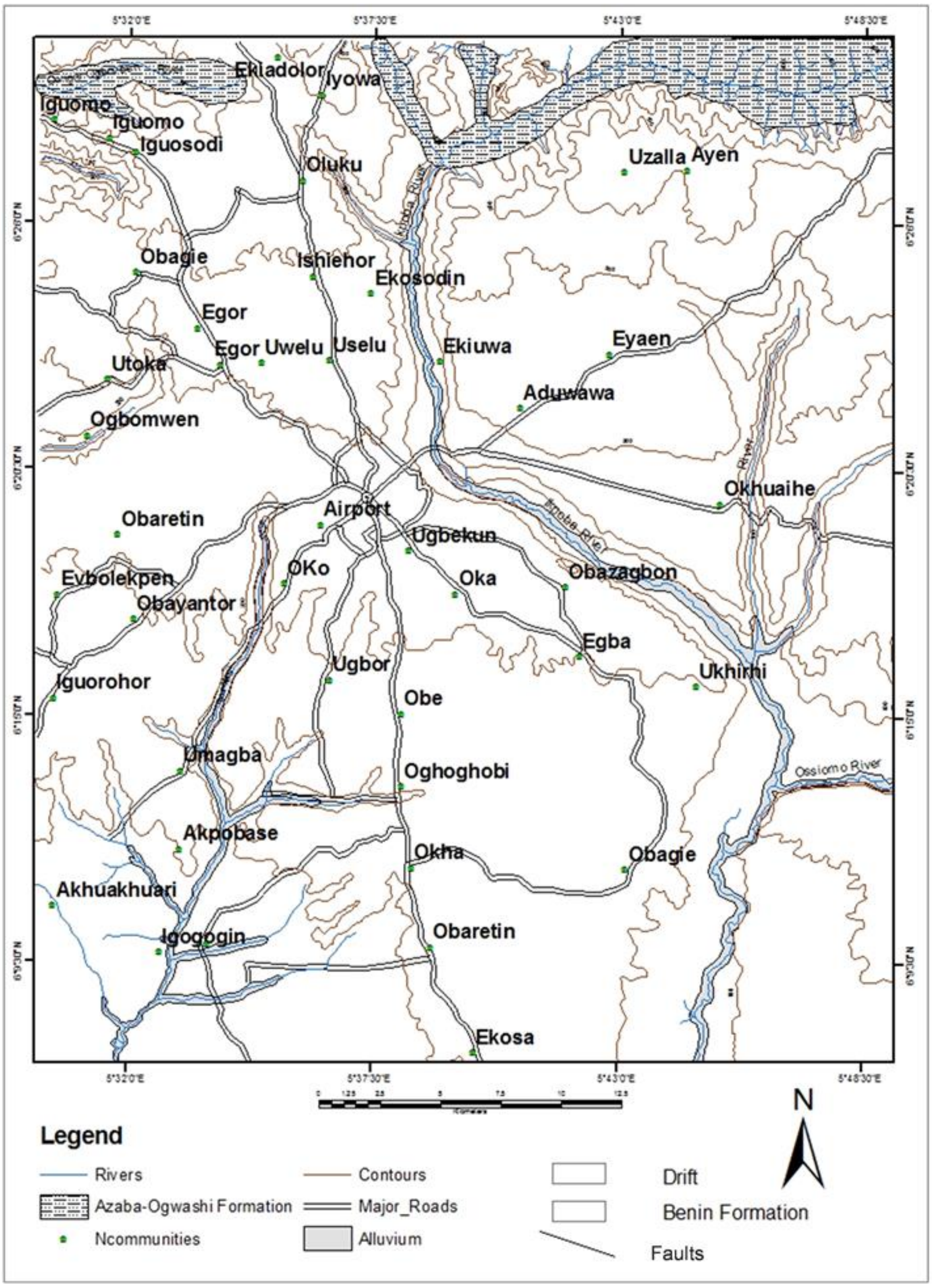

Figure 11: Benin Region Geological Formation (Source: Akujieze, 2004).

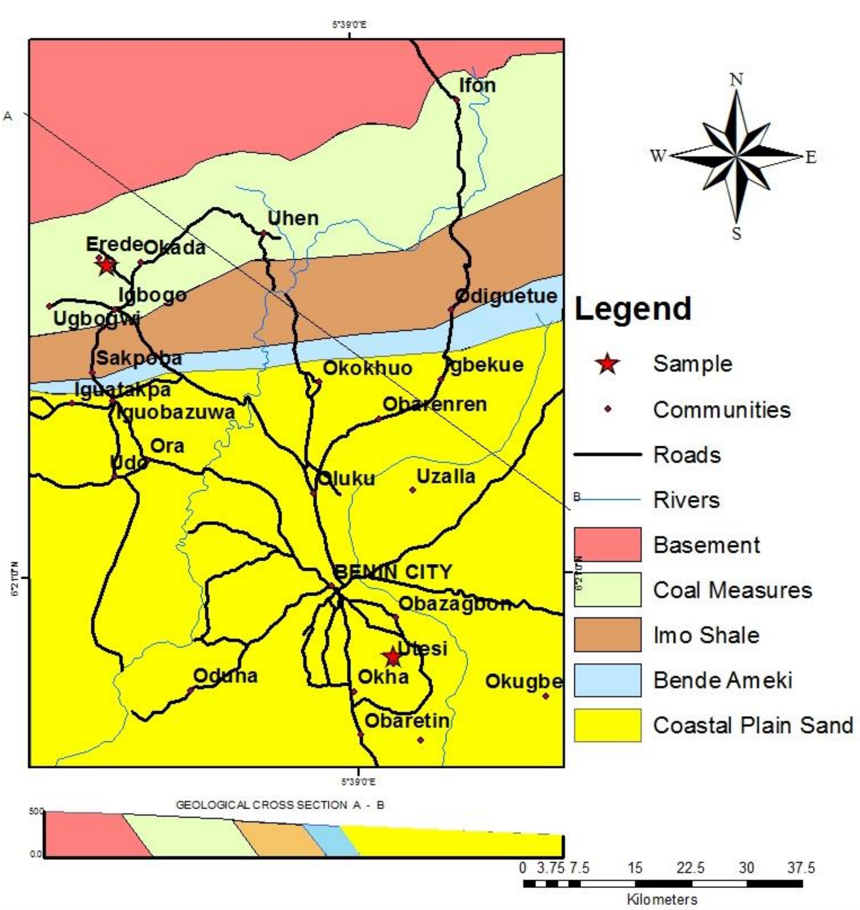

Figure 12: Geologic Map of Idogbo and its environs

Figure 13: Photograghs Of The Study Area

CHAPTER THREE

3.0 MATERIALS AND METHODS

3.1 Materials

In order to achieve the aforementioned objectives, an experimental approach had to be adopted. This involved the collection of soil samples from three locations in the study area. The following materials were used to obtain the samples;

- Global positioning system (GPS): this was used to obtain coordinates of the locations where the samples where the samples were obtained
- Sample bags: this was used to carry the soil samples obtained
- Shovels: this was used to put the soil samples into their respective sample bags
- Marker pen: this was used to label the samples
- Measured staff: this was used to measure the depth of collection.

3.2 Methods

3.2.1 Desk Study

This is the first stage that involves collection, collation and investigation of useful site information about the areas of study, this information is obtained from maps, published reports and personal study of the sample area.

3.2.2 Sample Collection

Sample collection is done in the field and involves the physical collection of samples during a field survey of the area, the samples were collected at a depth of 0.5 m to minimize the influence of organic and biogenic matter on the engineering soil properties

3.2.3 Laboratory Analysis

The samples after collection were then taken to the laboratory for analysis. The tests carried out include, particle size analysis, specific gravity test, natural moisture content test, Atterberg limit tests (plastic limit, liquid limit and plasticity index) and triaxial texts

3.2.3.1 Natural Moisture Content

a) Purpose: This test was performed to determine the natural moisture content of the soil samples. The water content is the ratio, expressed as a percentage, of "pore" or "free" water in a given mass of soil to the dry mass of soil solids.

b) Standard reference: ASTM D 2216 - Standard Test Method for Laboratory Determination of Moisture Content of Soil, Rock, and Soil- Aggregate Mixtures

c) Significance: Fore many soils, the water content may be a significant index used for establishing the relationship between the way a soil behaves and its properties. The consistency of a fine-grained soil largely depends on its water content. The water content is also used in expressing the phase relationships of air, water, and solids in a given volume of soil

d) Equipment: Drying oven, weight balance, moisture can, gloves, spatula.

e) Procedure: About 50grams of each sample was weighed in a container of known weight and then the sample was oven dried to a constant weight of approximately 105°C-110°C for a specified period of 24 hours. It was then allowed to cool in a desiccator and then weighed. The weight of water was recorded as the loss in weight of the sample and expressed as a percentage of the dry sample to obtain the natural moisture content.

Moisture content = $\frac{w1-w2}{w2-w3} \times \frac{100}{1}$ --i

Where: W_1 = weight of wet soil

W_2 = weight of dry soil

W_3 = weight of moisture lost

3.2.3.2 Particle Size Analysis

a) Purpose: This test was performed to determine the percentage of different grain sizes contained within the soil samples. The mechanical or sieve analysis is performed to determine the distribution of the coarser, larger sized particles, and the hydrometer method is used to determine the distribution of the finer particles.

b) Standard Reference: ASTM D 422 - Standard Test Method for Particle-Size Analysis of Soils.

c) Significance: The distribution of different grain sizes affects the engineering properties of soil. Grain size analysis provides the grain size distribution, and it is required in classifying the soil.

d) Equipment: Weight Balance, set of sieves, cleaning brush, sieve shaker, mixer (blender), 152H Hydrometer, sedimentation cylinder, control cylinder, thermometer, beaker, timing device.

e) Procedure:

a) Sieve Analysis (wet sieving): The weight of each sieve as well as the bottom pan to be used was recorded. 100 grams of the sample was weighed and soaked in water. These soaked samples were washed through the 425- and 75-microns sieve and they were dried for 24 hours. The weight of the given dry soil sample was taken and recorded. The sieves were assembled in the ascending order of sieve numbers (#4 sieve at top and #200 sieve at the bottom). The pan was placed below the #200 sieve. The soil sample was carefully poured into the top sieve and the cap was placed over it. The stack of sieves was then placed in the mechanical shaker and shaken for 10 minutes. The stack was removed from the shaker and each sieve was carefully weighed and the weight of each sieve with its retained soil, recorded. In addition, the weight of the bottom pan was also recorded with its retained fine soil.

b) Hydrometer Analysis: the fine soil from the bottom of the sieve set was placed in a beaker and 125ml of the dispersing agent (sodium hexametaphosphate(40g/L)) solution was added. The mixture was stirred until the soil was thoroughly wet and then allowed to soak for ten minutes. While the soil was soaking, 125mL of the dispersing agent was poured into the control cylinder and tilled with distilled water to the mark. The soil slurry was then transferred into a mixer by adding more distilled water, until the mixing cup was at least half full. The solution was then mixed for a period of two minutes. Immediately after that the soil slurry was transferred into the empty sedimentation cylinder. Distilled water was added up to the mark. The open end of the cylinder was covered with a stopper and secured with the palm of hand.

The cylinder was then turned upside down and back upright for one minute (the cylinder ought to be inverted approximately 30 times during a minute). The cylinder was set down and the time recorded. After an elapsed time of one minute and forty seconds the hydrometer very slowly and carefully inserted for the first reading (NOTE: it should take about 10 seconds to insert or remove the hydrometer to minimize and disturbance and the release of the hydrometer should be as close to the reading depth as possible to avoid excessive bobbing). The reading was taken by observing the top of the meniscus formed by the suspensions and the hydrometer stem. The hydrometer was then removed slowly and placed back into the control cylinder. It was very gently spun in the control to remove any particles that may have adhered. The hydrometer readings were taken after elapsed time of 2,5,8,15,31 and 60 mins.

3.2.3.3 Specific Gravity Determination

a) Purpose: This test was performed to determine the specific gravity of the soil samples using a pycnometer. Specific gravity is the ratio of the mass of unit volume of soil at a stated temperature to the mass of the same volume of gas-free distilled water at a stated temperature. Soil contains particle of different minerals with consequently different specific gravities. Hence, the specific gravity represents the average value of the specific gravities of the constituent particles that make up the sample.

b) Standard Reference: ASTM D 854-00 - Standard Test for Specific Gravity of Soil Solids by Water Pycnometer.

c) Significance: The specific gravity of a soil is used in the phase relationship of air, water, and solids in a given volume of the soil.

d) Equipment: Pycnometer, balance, vacuum pump, funnel, spoon.

e) Procedure:

There are two major methods of determining specific gravity, but the procedures are similar.

- Density bottle method
- 1 litre gas jar method

The density bottle method was used for this project work. The density bottle was dried and weighed. It was then filled with distilled water and its new weight was recorded. About 1/3rd of the soil sample was then filled into the dried density bottle and weighed, the soil filled density bottle was then filled with distilled water and the weight determined after 24 hours. The weight of the soil sample and that of an equal volume of water were then obtained by mathematical calculations and the ratio taken as the specific gravity of the soil. The mathematical calculation involved is given below:

S.G = W2-W1

Where W = (W4 - W1) - (W3 - W2) ---ii

W1 = weight of bottle

W2 = weight of bottle + soil

3.2.3.4. Compaction Test

a) Purpose: This laboratory test was performed to determine the relationship between the moisture content and the dry density of the soil samples for a specified compactive effort. The compactive effort is the amount of mechanical energy that is applied to the soil mass. Several different methods are used to compact soil in the field, and some examples include tamping, kneading, vibration, and static load compaction. This work employed the impact compaction method using the type of equipment and methodology developed by R. R. Proctor in 1933, therefore, the test is also known as the Proctor test.

b) Standard Reference: ASTM D 698 - Standard Test Methods for Laboratory Compaction.

c) Significance: Mechanical compaction is one of the most common and cost-effective means of stabilizing soils. An extremely important task of geotechnical engineers is the performance and analysis of field control tests to assure that compacted fills are meeting the prescribed design specifications. Design specifications usually state the required density (as a percentage of the maximum density measured in a standard laboratory), and the water content. In general, most engineering properties, such as the strength, stiffness, resistance to shrinkage, and imperviousness of the soil, will improve by increasing the soil density. The optimum water content is the water content that results in the greatest density for a specified compactive effort. Compacting at water contents higher than the optimum water content results in a relatively dispersed soil structure (parallel particle orientations), that is weaker, more ductile, less pervious, softer, more susceptible to shrinking, and less susceptible to swelling than soil compacted dry of optimum water content to the same density. The soil compacted lower than (dry of) the optimum water content typically results in a flocculated soil structure (random particle orientations) that has the opposite characteristics of the soil compacted wet of the optimum water content to the same density.

d) Equipment: Mould, manual rammer, extruder, balance, drying oven, mixing pan, trowel, #4 sieve, moisture cans, graduated cylinder, straight edge.

e) Procedure: The air-dried sample was sieved through a 4.75mm sieve and 3kg of the sample was collected. The soil was mixed with about 6% of distilled water and put immediately into a cylindrical compaction mould and an extension (collar) was added. The mould has a diameter of 105mm. A rammer which falls freely from a height of 50cm was used to compact the soil in the mould in 3 layers with each layer given 25 blows to achieve the proctor density. A calculated attempt was made to ensure that the last compacted layer was not below the collar joint and not more than 1cm above the collar joint. Thereafter the mould extension was then removed and the soil trimmed level with the mould and weighed. A suitable increment of 2% of water was now added and the test repeated 5 times with a significant drop in weight in the 4th and 5th time. The results of the tests were represented by a moisture-density curve in which the dried density for each determination was taken as the ordinate and plotted against the corresponding value of the moisture content which was taken as the abscissa.

3.2.3.5 Atterberg Limits Test

a) Purpose: This test was performed to determine the plastic and liquid limits of a fine-grained soil. The liquid limit (LL) is arbitrarily defined as the water content, in percent, at which a part of soil in a standard cup and cut by a groove of standard dimensions will flow together at the base of the groove for a distance of 13 mm (1/2 in.) when subjected to 25 shocks from the cup being dropped 10 mm in a standard liquid limit apparatus operated at a rate of two shocks per second. The plastic limit (PL) on the other hand, is the water content, in percent, at which a soil can no longer be deformed by rolling into 3.2 mm (1/8 in.) diameter threads without crumbling.

b) Standard Reference: ASTM D 4318 - Standard Test Method for Liquid Limit, Plastic Limit, and Plasticity Index of Soils.

c) Significance: The Swedish soil scientist, Albert Atterberg originally defined seven "limits of consistency" to classify fine-grained soils, but in current engineering practice only two of the limits, the liquid and plastic limits, are commonly used. (A third limit, called the shrinkage limit, is used occasionally). The Atterberg limits are based on the moisture content of the soil. The plastic limit is the moisture content that defines where the soil changes from a semi-solid to a plastic (flexible) state. The liquid limit is the moisture content that defines where the soil changes from a plastic to a viscous fluid state. The shrinkage limit is the moisture content that defines where the soil volume will not reduce further if the moisture content is reduced. The Engineering Properties of Soils Based on Laboratory Testing Prof. Krishna Reddy, UIC 61 wide variety of soil engineering properties have been correlated to the liquid and plastic limits, and these Atterberg limits are also used to classify a fine-grained soil according to the Unified Soil Classification system or AASHTO system.

d) Equipment: Liquid limit device, porcelain (evaporating) dish, flat grooving tool with gage, eight moisture cans, balance, glass plate, spatula, wash bottle filled with distilled water, drying oven set at 105°C. The Atterberg limits are a basic measure of the critical water contents of a fine-grained soil: its shrinkage limit, plastic limit and liquid limit, from which the, plasticity index is derived and it is the difference between the liquid limit and plastic limit.

e) Procedure:

3.2.3.5a Liquid Limit:

There are two specified methods for the determination of the liquid limit of a soil;

- **The cone penetrometer method**
- **The Casagrande method**

The method used for this work is the Casagrande method.

200grams of each air-dried soil sample was sieved though a 425um sieve. The soil was then placed on a glass sheet and mixed with a little distilled water to form a thick paste and then left overnight. Thereafter the cup of the apparatus was half filled with the wet soil and the top levelled off. A 2mm groove was then made at the middle of the soil by the means of a grooving tool. The handle of the apparatus was rotated at 2 revolutions per second and this caused the cup to lift 10mm and then to fall on to the rubber base continuously. The number of blows required to close the gap over 13mm was recorded and a position of the soil just tested was removed for moisture content determination. The test was repeated five more times applying a little more water for each test. The liquid limit was obtained by plotting the variations of moisture content against the corresponding number of blows. The best fit curve was drawn across points and the moisture content corresponding to 25 blows was taken as the liquid limit.

3.2.3.5b Plastic Limit:

About 20grams of each soil prepared during the liquid limit test was used. The soil was mixed on a glass plate with just enough water to make it sufficiently plastic for rolling into a ball, which was then rolled out between the hand and the glass to form a thread. The soil is said to be at its plastic limit when it just begins to crumble at a thread diameter of 3mm. At this stage a section of the thread was removed for moisture content determination. The test was repeated three more times and the average of the moisture content was taken as its plastic limit.

3.2.3.5c Plasticity Index:

The plasticity index is a measure of the plasticity of a soil. The plasticity index is the size of the range of water contents where the soil exhibits plastic properties.

The PI is the difference between the liquid limit and the plastic limit (PI = LL - PL).

Mathematically, it can be represented as:

P.I = L.L - P.L

Where P.I = plasticity index

L.L = liquid limit

P. L= Plastic limit

CHAPTER FOUR

4.0 RESULTS AND DISSCUSSIONS

4.1 Results of Atterberg Limiit Tests

The results show the liquid and plastic limit and the linear shrinkage gotten from the analysis of samples A, B and C. the results are shown in the tables 2, 3, and 4 and represented in table 2 below;

LIQUID AND PLASTIC LIMITS, LINEAR SHRINKAGE

Liquid Limit: 90.61% Plastic Limit: 44.74% Plastic Index: 45.87%

Linear Shrinkage: 15.71% Date: 12/03/2024.

No. of blows refers to liquid limit determination. Shrinkage % refers to linear Shrinkage.

Table 5: Liquid and Plastic Limit, Linear Shrinkage of the Sample

Type of Test	**LL**	**LL**	**LL**	**LL**	**LL**
No. of Blows/shrinkage %	40.00	30.00	22.00	17.00	11.00
Container No.	ZH	PA	LO	MP	PL
Wt of wet soil & container (g)	27.70	33.00	34.30	34.70	35.00
Wt of dried soil & container (g)	23.00	25.70	26.65	26.60	26.40
Wt of container (g)	17.40	17.40	18.30	18.00	17.60
Wt of dry soil (Wd) (g)	5.60	8.30	8.35	8.60	8.80
Wt of moisture (Wm) (g)	4.70	7.30	7.65	8.10	8.60
Moisture contain 100 (Wm/Wd)	83.93	87.95	91.62	94.19	97.73

Type of Test	PLASTIC LIMIT				
No. of Blows/shrinkage %	**PL**	**PL**	**PL**		
Container No.	BO	TA	OB		
Wt of wet soil & container (g)	22.20	21.00	21.40		
Wt of dried soil & container (g)	20.90	19.80	20.30		
Wt of container (g)	17.80	17.10	18.00		
Wt of dry soil (Wd) (g)	3.10	2.70	2.30		
Wt of moisture (Wm) (g)	1.30	1.20	1.10		
Moisture contain 100 (Wm/Wd)	41.94	44.44	47.83		

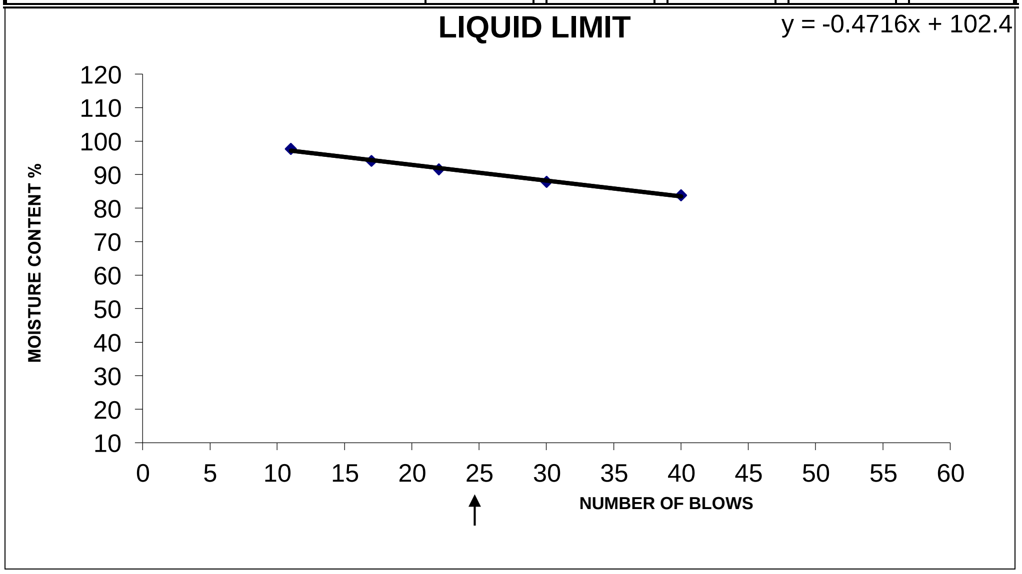

Figure 14: Graph Of Liquid Limits

4.1.1 Atterberg Limits

The liquid limit of sample is: 90.61%, plastic limits: 44.74%, soils with plastic limits greater than 50% are said to have high plasticity, those with a range of 30% to 50% are said to be medium plasticity, soils with less than 30% are said to have low plasticity. It can therefore be inferred that the plasticity of the soil is medium. Usually, the compressibility of a soil is said to be high if its plasticity index exceeds 30%, medium if it has between 10 – 29% and low if it is less than 9%. Plasticity index is the numerical difference of the liquid and plastic limit. The plasticity index of sample is; 45.87%. the sample can therefore be said to be highly compressible

UNIBEN GEOTECH RESEARCH

4.2 Grain Size Analysis by wet Seieving

Below is the particle size analysis for the sample

Table 6:Grain Size Analysis

SIEVE NO.				
APPROX IMPERIAL EQUIV (inches)	BRITISH STANDARD SIEVE SIZES (mm)	RETAINED IN gm	PASSING IN gm	PASSING IN (%)
3/16	5			
⅛	3.35		50	100
7	2.36	0	50	100
10	2	0	50	100
14	1.18	0	50	100
25	0.6	0	50	100
36	0.425	0	50	100
52	0.3	0	50	100
72	0.212	0	50	100
100	0.15	0	50	100
200	0.075	0.8	49.2	99.2
Hydrometer Results	0.068			12.22
	0.050			11.89
	0.033			11.63
	0.025			11.53

	0.019			11.23
	0.013			10.93
	0.009			10.24
	0.006			10.14
	0.004			8.19
	0.002			5.28
	0.000			0.00

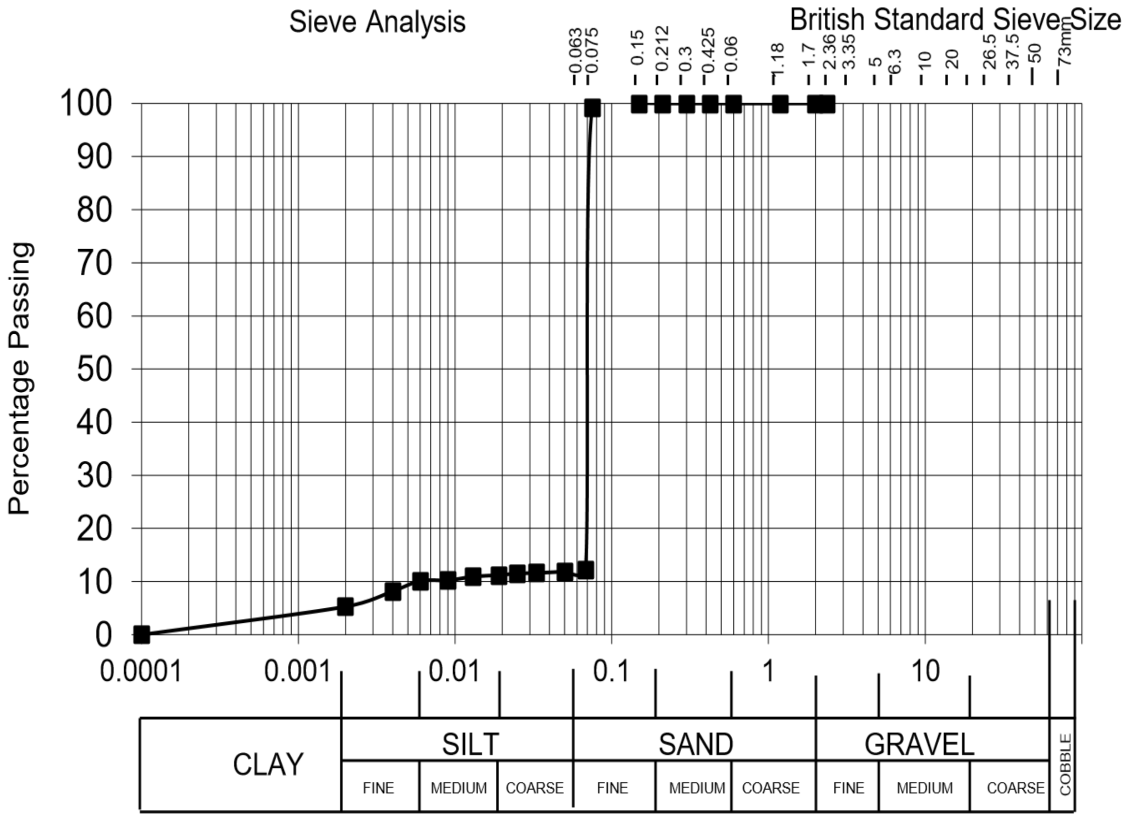

Figure 15: Graph Of The Particle Size Distribution

4.2.1 Particle Size Analysis

According to clause 6201 of federal ministry of works and housing specification, for a sample to be used as both or subgrade or fill or base, the percentage weight passing through the no 200 sieve (75µm) shall be less than but not greater than 35% and if the percentage passing the no 200 sieve is greater than 35% no need for further tests and material rejected. The sample under review have 99.2% passing the 200 sieves. Therefore, the samples are bad as they exceed the 35% requirement.

Based on the percentage passing it can be said that the soil samples are Fine grained. With a 99.2% clay. The particle size distribution was analysed and plotted to obtain a grain size curve

4.3 Specific Gravity Determination

Table 7: Summary of Specific Gravity

S/N	BN	B+W	B+S+W	B+S	B	Ad. W	WWAS	WS	WOWDS	Gs	AGs
1	UR	73.80	82.00	35.50	21.30	52.50	46.50	14.20	6.00	2.37	2.34
	AU	73.50	81.70	35.30	20.90	52.60	46.40	14.40	6.20	2.32	

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

4.3.1 Specific Gravity

The higher the specific gravity of a soil the more suitable it is for construction. The results of the specific gravity analysis (table 8) is 2.34. Gidigasu (1976) stated that a soil is good subgrade if its specific gravity (Gs) range between 2.50-4.60 and all the samples fell in the range of 2.4-2.67 which indicate that it is a fine-grained soil (good subgrade) with fairly high specific gravity mineral and also correlates with the mechanical strength of subgrade (Mesida, 1981). Also, because of narrow range of specific gravity, it’s not particularly useful for this evaluation. Sample B is the most suitable

4.4 Determination of the Moisture/Density Relation of Soil

USING STANDARD/HEAVY COMPACTION

DETERMINATION OF THE MOISTURE/DENSITY RELATION OF SOIL

USING STANDARD/HEAVY COMPACTION

Table 8: Moisture Content and Density Relation Test

Sample ID**:...SP.....**

Date**: 12/03/2024…** MDD: **1.25g/cm^3**

Total weight of Sample**:…3000g……** OPT.MC: **32.6%**

Wt. of mould & wet Soil (W2) g	4811.00	4930.00	5008.00	4986.00	4950.00		
Wt. of mould (W1) g	3353.00	3353.00	3353.00	3353.00	3353.00		
Wt. of wet soil (W2-W1) g	1458.00	1577.00	1655.00	1633.00	1597.00		
Bulk Density (Pb) (W2-W1)/x g/cm^3	1.46	1.58	1.66	1.64	1.60		

MOISTURE CONTENT DETERMINATIONS for B.S. Mould, X = 995.79cm^3

Container No.	OA	AE	ST	RT	BB	TA	VB	MA	VZ	TA				
Wt. of wet soil & container (g)	32.64	27.34	35.43	33.78	44.82	34.41	43.21	50.02	47.13	54.89				
Wt. of Dry soil & container (g)	29.45	25.10	31.20	30.06	38.13	30.40	36.40	41.96	39.27	45.01				
Wt. of Container (g)	18.40	17.43	17.54	17.82	17.47	18.07	16.72	18.48	16.90	17.45				

Wt. of dry soil (Wd) g	11.05	7.67	13.66	12.24	20.66	12.33	19.68	23.48	22.37	27.56
Wt. of Moisture (Wm) g	3.19	2.24	4.23	3.72	6.69	4.01	6.81	8.06	7.86	9.88
Moistur Content 100(Wm/Wd) %	28.87	29.20	30.97	30.39	32.38	32.52	34.60	34.33	35.14	35.85
Average Moisture Content (m) %	29.04		30.68		32.45		34.47		35.49	
Dry Density = Pb/1+ (m/100) (g/cm^3)	1.13		1.21		1.25		1.22		1.18	
C.B.R. (mseen of top & bottom) %										

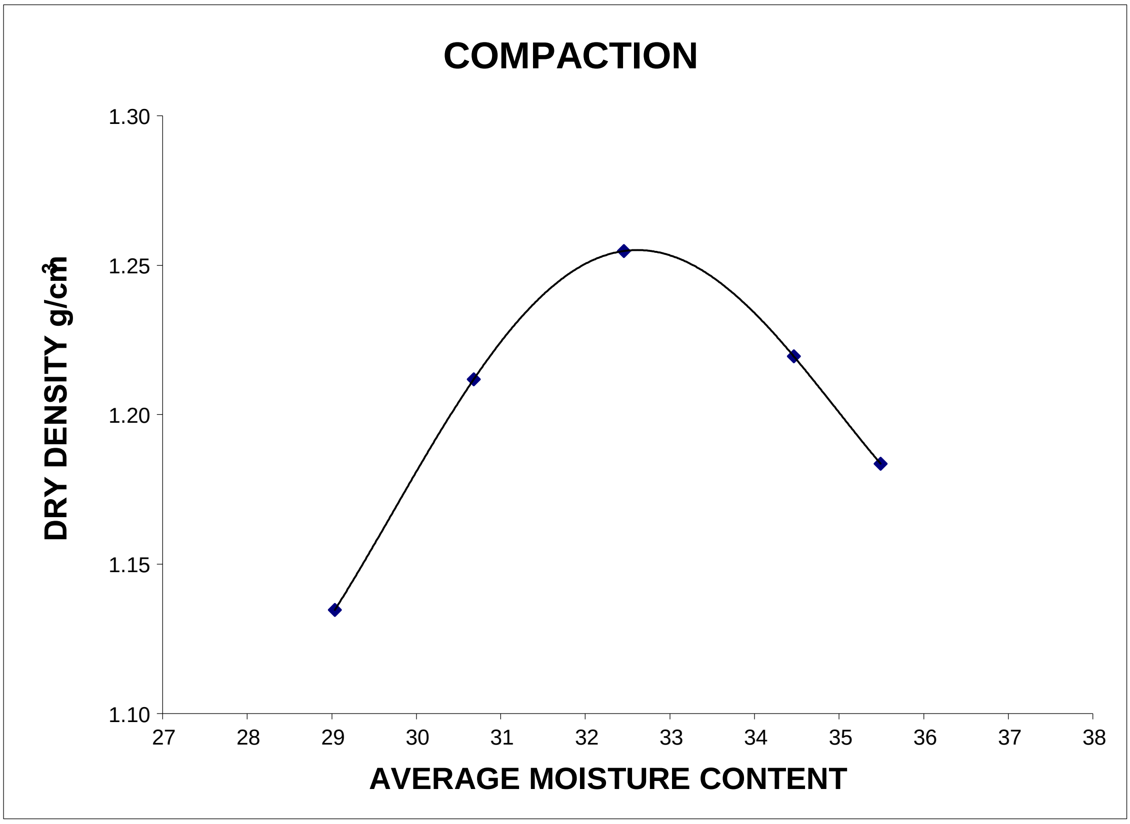

Figure 16: Graph Of Compaction Test

4.4.1 Compaction Test

From the results obtained, it can be seen that optimum moisture content (OMC) for the Sample is 32.6%.

The maximum dry density (MDD) obtained from the test is; 1.25g/cm3.

The Nigeria specification for road and bridge materials (Nigeria federal ministry of works and housing, 1970) recommends that for a material to be used as fills it should possess maximum dry density (MDD) greater than 0.047 kg/m^3 and optimum moisture content (OMC) less than 18% therefore the moisture content is unsuitable.

CHAPTER FIVE

5.0 SUMMARY, CONCLUSION, AND SUGGESTION FOR FURTHER WORK

5.1 Summary

Soil is an important construction material in the subject of engineering geology, because it acts as the foundation as well as material during building construction. To determine the ability of a soil to withstand the load on an engineering structure, geotechnical analysis is done.

These geotechnical properties can be detected through parameters such as Atterberg limits (plastic limit, liquid limit, linear shrinkage and plasticity index), compaction test, triaxial, text, specific gravity, these parameters help to determine the strength and bearing capacity of the soil suitable for engineering purposes.

5.2 Conclusion

The results gotten from the analysis of the soil sample in the Idogbo area shows that the samples is a poor construction materials. Although, the samples will have to undergo chemical stabilization (preferable cement or lime) in order to be usable for construction purposes. Based on the collation and interpretation of the result obtained from these tests, it is shown that the soils are not suited for construction materials for engineering projects.

5.3 Suggestion for Further Studies

Based on the investigations of this study, the following recommendations can be proffered: the resident engineers and contractors conduct proper analysis and adhere to the code of ethics and ensure that the international set standards are adhered to. Also, suitable stabilization methods should be employed before construction can begin.

REFERENCES

Adegbola, R.B., Oyedele, K.F., Adeoti, L. and Adeloye, A.B. (2016). Multichannel analysis of the surface waves of earth materials in some parts of Lagos State, Nigeria. 82- 83

Adeyemi, (1972): Sedimentology of Lagos lagoon. Unpublished B.Sc. Thesis, Obafemi Awolowo University, Ife-Ife, Osun State, Nigeria.

Andre-obayanju, O.O. and ireaja, C.C. (2022). Geotechnical Evaluation of Road Failure along 20th Street BDPA, Benin City, Nigeria. TAL MANAGEMENT. J. Appl. Sci. Environ. Manage. Vol. 26 (5) 809-814

ASTM [C 136] (2012). Standard Test for Sieve Analysis of Fine and Coarse Aggregates by Sieving. Pages 15 – 17.

ASTM [D 1883] (2007). Standard Test Method for California Bearing Ratio of Pavement, Subgrade, Base – course and Sub – base materials. Pages 97– 110.

ASTM [D 421] (2007). Standard Test Method for Dry Preparation of Soil Samples for Particle Size Analysis. Page 2.

ASTM [D 698] (2007). Standard Test Method for Laboratory Compaction Characteristics. Pages 117 – 121.

Babalola TS, Oso T, Fasina A. S. and Godonu K. (2011). Land evaluation studies of two wetland soils in Nigeria. International Research Journal of Agricultural Science and Soil Science.1(6) pp. 193-204

Bankole, I.S., Schrank, E. and Erdtmann, B. (2007): Palynology of the Paleogene Oshosun formation in the Dahomey basin, Southwestern Nigeria. *Revista Espanola de Micropaleontologia*,39 (1-2) 29-44.

Billman, H. G. (1992). Ofshore stratigraphy and paleontology of the dahomey embayment, West African. Niger. Assoc. Pet. Explor. Bull. 7, 121–130

British Standard 1377 (1975). Methods of test for soils for Civil Engineering Purpose. British Standard Institution HMSO London.

Coker, S. J. L. (2002). Field excursion guide to tar sand outcrops.

D'Almeida, G. A. F., Kaki, C. and Adeoye, J. A. (2016). Benin and Western Nigeria Ofshore Basins: a stratigraphic nomenclature comparison. Int. J. Geosci. 07, 177–188

Fajemidagba, K. J. (2015). Hydrogeological Characteristics of Deep Wells In The Coastal Sands Of Alimosho Area, Lagos State

Fasina, A.S. (2005). Properties and classification of some selected Wetland soils in Ado Ekiti, Southwest Nigeria. Applied Tropical Agriculture, 10 (2): 76-82

Gidigasu, M.D. (1976). Laterite Soil Engineering. Elsevier Scientific Publishing Co., New York.

Ikhile, C. (2016) Geomorphology and Hydrology of the Benin Region, Edo State, Nigeria. International Journal of Geosciences, 7, 144-157.

Jones, H.A. and Hockey, R.D. (1964): The geology of part of South-Western Nigeria Geological Survey of Nigeria Bulletin No 31.

Longe, E.O., Malomo, S. and Olorunniwo, M. A. (1987): Hydrogeology of Lagos metropolis. J. Afr Earth Sci., 6(3) 163-174.

Mesida E.A. (1981). Laterites on the Highway - Understanding Soil Behaviour. West African Technical Review, November, 1981. Pp 112 - 118.

Mohammed S., Opuwari M. and Titinchi S. (2020). Source rock evaluation of Afowo clay type from the Eastern Dahomey Basin, Nigeria: insights from different measurements, 3-4

Nton, M. E., Ikhane, P. R. and Tijani, M. N. (2009). Aspect of rock-eval studies of the Maastrichtian-Eocene sediments from subsurface, in the eastern Dahomey basin southwestern Nigeria. Eur. J. Sci. Res. 25, 417–427

North Carolina Division of Water Resources

Faseki, O. E. (2016). Geotechnical Properties of Soil Sequence for Foundation Design at Addo, Lagos, Nigeria. MAYFEB Journal of Civil Engineering Vol 1 (2016) - Pages 12-25

Olaleye, AO (1998). Characterization, Evaluation, Nutrient dynamics and Rice Yields of Selected Wetland soils in Nigeria. PhD Tesis in the Department of Agronomy, University of Ibadan. 202 pp

Omatsola, M. E. and Adegoke, O. S. (1981). Tectonic evolution and cretaceous stratigraphy of the Dahomey Basin. Niger. J. Min. Geol. 18, 130–137

Orakwe L. O. Olorunfemi M. O. Ofoezie I. E. and Oni A. G. (2018). Integrated Geotechnical and Hydrogeophysical Investigation of the Epe Wetland Dumpsite in Lagos State, Nigeria**.** Ife Journal of Science vol. 20, no. 3 (2018)

Singh P. (2008). Engineering and general geology. Eighth Revised Edition. S.K. Kataria & Sons;

Vasilas, L.M., Hurt, G.W. and Berkowitz, J.F. (eds) (2016). Field indicators of hydric soils in the United States, Version 8.0. U.S. Department of Agriculture, Natural Resources Conservation Service, Washington, DC, 55 p