ASSESSING THE USE OF POLYETHYLENE TEREPHTHALATE FIBRE IN THE REINFORCEMENT OF LIME-STABILISED EXPANSIVE SOILS

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ABSTRACT

Expansive soils are soils associated with constant volumetric change due to alternations in the moisture present in such soils, and such volume variations can lead to the expansive soils being unsuitable for use as subgrade material. The research was focused on the use of Polyethylene Terephthalate fibre in the reinforcement of hydrated lime-stabilised expansive soils to improve the properties of these soils. The research had specific objectives which were achieved by following a methodology that had implemented laboratory tests such as Sieve analysis, Atterberg Limits, California Bearing Ratio, Unconfined Compressive Strength, Free Swell Index, and Proctor Compaction on the neat soil along with other samples with a constant 6% content of Lime and varying percentages of fibre from 0 % to 2 %. There was a Tensile strength test done on the fibre. The tests were done following a given set of standards, after which the results on the neat sample found the soil to be expansive clayey soils and the fibre-reinforced soil that was lime stabilised had the optimum mix ratio of 6% lime and 1.5 % fibre. The optimum mix ratio had a California Bearing Ratio of 54 % and an Unconfined Compressive Strength of 0.59 MPa. The results of the soil mixed with 1.5 % fibre and 6 % lime all matched the standards of subgrade material according to the Ministry of Works and Transport, General Specifications for Road and Bridge Works, 2005 manual. This implied that hydrated lime and Polyethylene Terephthalate fibre can be implemented in the improvement of properties of expansive soils to acceptable standards for subgrade material. There is a need for more research into the use of other fibres in the reinforcement of lime-stabilised soils.

DECLARATION

I, MANANA MARK, declare that this Research and Design Project Report is my original work and has never been submitted to any institution of higher learning for an award of academic qualification.

Signature:………………………. Date:…………………………………

MANANA MARK S20B32/220

APPROVAL

This is to endorse that MANANA MARK has finalised his final year research and design project under the supervision of the project supervisor and that the report has been submitted with the approval of the academic supervisor.

Signature:…………………………….   Date:…………………………………

MR. KENNETH ECONI

DEDICATION

I dedicate this report to my lovely parents, project supervisor and colleagues along with other people who constantly showered me with endless motivation and support. The continuous love and care bestowed ensured that I remained focused and persistent to allow for the successful completion of the research. I shall forever remain grateful for the support showcased to me, and I pray that God continues to bless and watch over your lives.

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TABLE OF CONTENTS

ABSTRACT i

DECLARATION ii

APPROVAL iii

DEDICATION iv

ACKNOWLEDGEMENTS v

LIST OF FIGURES x

LIST OF TABLES xi

LIST OF ABBREVIATIONS xii

CHAPTER ONE: INTRODUCTION 1

1.1 Background 1

1.2 Problem Statement 2

1.3 Objectives and Research Questions 3

1.3.1 Main Objective 3

1.3.2 Specific Objectives 3

1.3.3 Research Questions 3

1.4 Scope of Work 4

1.4.1 Geographical scope 4

1.4.2 Time Scope 4

1.4.3 Content Scope 4

1.5 Justification 4

1.6 Significance 5

CHAPTER TWO: LITERATURE REVIEW 6

2.1 Expansive Soils 6

2.2 Soil Stabilisation 6

2.2.1 Selection of a suitable Soil chemical stabiliser 7

2.2.2 Hydrated Lime 9

2.2.3 Lime in Soil Stabilisation 10

2.3 Soil reinforcement 11

2.3.1 Fibre-reinforced soil 12

2.3.2 PET fibre reinforcement in soil 14

CHAPTER THREE: METHODOLOGY 16

3.0 Introduction 16

3.1 Summary of the Methodology 16

3.1.1 Physical properties of the neat soil sample 16

3.1.2 Mechanical properties of the Polyethylene Terephthalate fibre and chemical properties of hydrated lime 17

3.1.3 Mix ratios of Polyethylene Terephthalate fibre, hydrated lime, and expansive soils to achieve the desired strength properties 17

3.1.4 Strength properties of the soil stabilised with hydrated lime while reinforced with varying Polyethylene Terephthalate fibre in the appropriate mix ratios. 18

3.2 Materials and Methods 18

3.2.1 Materials 18

3.2.2 Methods 20

CHAPTER FOUR: RESULTS AND DISCUSSION 22

4.0 Introduction 22

4.1 Physical Properties of the Neat Soil Sample 22

4.1.1 Particle Size Distribution 22

4.1.2 Atterberg Limits 23

4.1.3 Proctor 27

4.1.4 California Bearing Ratio 28

4.2 Tensile Strength Test of the Polyethylene Terephthalate Fibre 29

4.3 Effect of PET fibre Reinforcement and Lime stabilisation on the soil properties 31

4.3.1 Particle Size Distribution 31

4.3.2 MDD and OMC 32

4.3.3 Atterberg Limits 35

4.3.4 California Bearing Ratio 36

4.3.5 Unconfined Compressive Strength 38

4.3.6 Free Swell Index 40

4.4 Project Design 42

CHAPTER FIVE: FINDINGS, CONCLUSION AND RECOMMENDATIONS 44

5.1 Findings 44

5.2 Conclusions and Recommendations 45

5.2.1 Conclusions 45

5.2.2 Recommendations 46

REFERENCES 47

APPENDIX 53

LIST OF FIGURES

Figure 1:Classification and illustration of Fibre reinforcement mechanism of soil.Source (Gowthaman, et al., 2018). 12

Figure 2: Schematic representation of a randomly distributed fibre unit at (a) initial stage and (b) deformation stage due to loading, where the effect of interlocking, friction and interface bonding induces mobilisation of the tensile stress on the fibre unit. Source (Gowthaman, et al., 2018). 14

Figure 3: Mixing of 6% hydrated lime and 94% dry weight of expansive soil. Source (Manana, 2024). 19

Figure 4: Particle Size Distribution graph of the neat soil sample 23

Figure 5: Liquid Limit graph for the neat soil sample 24

Figure 6:Plasticity chart for classification of fine-grained soils. Source (Mishra, n.d.). 26

Figure 7: MDD and OMC chart of the neat soil sample 27

Figure 8: CBR graph of the neat soil sample 28

Figure 9: Percentage passing against sieve size 31

Figure 10: MDD against Composition 32

Figure 11: Moisture Content against Composition 33

Figure 12: Plasticity Index against Composition 35

Figure 13: CBR against Composition 36

Figure 14: UCS against Composition 38

Figure 15: Swell against Composition 40

LIST OF TABLES

Table 1: Guide to the selection of stabiliser. Source (SERIES 3000- EARTHWORKS AND PAVEMENT LAYERS OF GRAVEL OR CR)..8

Table 2: Chemical properties of the hydrated lime. Source (Calik & Sadoglu, 2014)....9

Table 3:Summary of the Atterberg Limits results of the neat soil sample............... 25

Table 4: Tensile strength results of the PET Fibre 29

Table 5: Project Design 42

LIST OF ABBREVIATIONS

AASHTO	-	American Association of State Highway and Transportation Officials
CBR	-	California Bearing Ratio
LL	-	Liquid Limit
MDD	-	Maximum Dry Density
MoWT	-	Ministry of Works and Transport
ODFS	-	Oriented Distributed Fibre-reinforced Soil
OMC	-	Optimum Moisture Content
PET	-	Polyethylene Terephthalate
PI	-	Plasticity Index
PL	-	Plastic Limit
RDFS	-	Randomly Distributed Fibre-reinforced Soil
UCS	-	Unconfined Compressive Strength
UNRA	-	Uganda National Roads Authority
USCS	-	Unified Soil Classification System

CHAPTER ONE: INTRODUCTION

1.1 Background

Expansive soils, prone to large volume changes with moisture fluctuations, pose major engineering challenges globally. These "swell-shrink" soils, as they're sometimes called, cause billions in damage annually to pavements and structures. Expansive soils undergo notable volume alterations due to fluctuations in moisture levels. These changes can result in either swelling or shrinkage, which is why they are also referred to as swell/shrink soils (Jones & Jefferson, 2012). The shrink-swell phenomenon in soils is attributed to their mineral composition. Clay soils containing specific mineral types like montmorillonite, smectite, or vermiculite are especially susceptible to this shrink-swell behaviour (Lees, 2021). The expansive soils are found particularly in the Eastern and Northern parts of Uganda in districts such as Nakapiripirit and, such areas require suitable subgrade material for road construction.

Lime-stabilised soil exhibits superior strength enhancement properties. However, it suffers from low tensile strength and tends to develop significant cracking because the lime-stabilised soil becomes brittle. To address this limitation and further enhance the mechanical properties of the stabilised soil, there is a need to use PET fibres to reinforce such soil. This reinforcement aims to minimise both vertical and lateral deformation within the lime-stabilised soil (Wei, et al., 2018).

1.2 Problem Statement

Engineers come across a range of problematic soils, such as expansive soils, during road construction projects that pose significant obstacles. Because highly flexible clay minerals like aluminium and iron, which alternately expand and contract with variable moisture concentrations, are present in expansive soils, the roadways get cracked and collapse (Jones & Jefferson, 2012) . Expansive soils along the chainages of 47+800 km of the Muyembe-Nakapiripirit road were found to have expansive soils which have issues of experiencing constant volumetric changes due to moisture content variations in the subgrade resulting in pavement damage, and this has led to disruption of normal traffic flow on the road according to UNRA.

The issue of heaving was found to disrupt the normal movement of vehicles along the road section with the expansive soils. Lime stabilisation is a technique that has been applied in the controlling of the swell-shrink characteristics of the expansive soil. However, the sulphate present in the expansive soils leads to the lime stabilisation being ineffective. The experimental research showed that sulphate contamination had a substantial outcome on the soil profile, and the index properties of lime-stabilised soil which led to brittle failure of soil and a reduction in strength properties (Raja & Thyagaraj, 2021).

The response to the problem is to use the Polyethylene Terephthalate fibre to reinforce the lime-stabilised soils to improve the strength properties of such soils.

1.3 Objectives and Research Questions

1.3.1 Main Objective

To assess the use of Polyethylene Terephthalate fibre in the reinforcement of lime-stabilised expansive soils.

1.3.2 Specific Objectives

1. To ascertain the physical properties of the neat soil sample.
2. To determine the mechanical properties of the Polyethylene Terephthalate fibre and chemical properties of hydrated lime.
3. To ascertain the mix ratios of Polyethylene Terephthalate fibre, hydrated lime, and expansive soils to achieve the desired strength properties.
4. To determine the strength properties of the soil stabilised with hydrated lime while reinforced with varying Polyethylene Terephthalate fibre in the appropriate mix ratios.

1.3.3 Research Questions

1. What are the physical properties of the neat soil sample?
2. What are the mechanical properties of the Polyethylene Terephthalate fibre and the chemical properties of hydrated lime?
3. What are the mix ratios of Polyethylene Terephthalate fibre, hydrated lime, and expansive soils to achieve the desired strength properties?
4. What are the strength properties of the soil stabilised with hydrated lime while reinforced with varying Polyethylene Terephthalate fibre in the appropriate mix ratios?

1.4 Scope of Work

1.4.1 Geographical scope

The study was to be carried out along the Muyembe-Nakapiripirit road section along the chainages of 47+800 km, and this was where the expansive soils were obtained.

1.4.2 Time Scope

The study was conducted from September 2023 to April 2024.

1.4.3 Content Scope

The study scope focused on assessing the application of Polyethylene Terephthalate fibre in the reinforcement of lime-stabilised expansive soils.

1.5 Justification

The use of Polyethylene Terephthalate fibre and lime in the stabilisation of expansive soils aims to improve soil strength. Lime has been widely used in stabilisation, despite being associated with cases of low strength properties, failing to carry the loading of the structure in some cases influenced by different factors such as sulphate attack, carbonation, and so on. Normally 2 to 8 % of lime may be required for coarse-grained soils and 5 to 8 % of lime may be required for plastic soils. (Lone & Sachar, 2022).

Combining PET fibre with lime affirms that lime stabilisation has a more pronounced positive impact on strength. Additionally, the optimal strength for clayey soil reinforcement occurs with a 1.5 % fibre. Typically, reinforcement with strips results in higher strength, as indicated by the point load strength index, and greater flexibility under applied impact loads. (Koohmishi & Palassi, 2022).

Plastic pollution is a massive problem. Every year, hundreds of millions of tons of plastic trash are produced, and a huge portion ends up in our environment where it can last for many years. Millions of tons also wind up in our oceans each year. If no action is taken, this plastic pollution will keep growing at an alarming rate. Thus there is the need to find ways to either get rid of plastic waste entirely or develop environmentally friendly methods to reuse it (Urian, et al., 2023). The Polyethylene Terephthalate waste can be used to get the fibre to be used in the reinforcement of the expansive soils stabilised with lime.

1.6 Significance

The project will advance the knowledge of soil stabilisation and develop a method for implementing the Polyethylene Terephthalate fibre in the reinforcement of lime-stabilised expansive soils. This is significant because there will be no need for merely excavating and dumping such soils, resulting in cost savings as well as time saved in procuring labour and machinery to remove the given expansive soils. Furthermore, the project will provide the opportunity to use the good strength properties of Polyethylene Terephthalate fibre in improving the strength properties of lime-stabilised expansive soils.

CHAPTER TWO: LITERATURE REVIEW

2.1 Expansive Soils

Expansive soils pose significant challenges due to their tendency to undergo substantial volumetric changes with seasonal moisture fluctuations, particularly in arid and semi-arid regions. These fluctuations, characterized by drying and wetting cycles, lead to shrinkage and swelling, causing considerable differential movements in building foundations and highway pavements. Such movements, influenced by changes in water content and tension, are most severe in fine-grained soils with high plasticity. Expansive soils are responsible for common types of cracks and distress observed in pavement infrastructure, with longitudinal cracking indicative of volumetric changes in the pavement subgrade. These differential movements significantly impact pavement performance, reducing its service life. Engineering practitioners are currently seeking feasible and implementable solutions to mitigate the effects of seasonal pavement surface movements on both the functional and structural aspects of pavement structures (Sarker & Wang, 2022).

Furthermore, the shrinking and swelling are seen to be partly irreversible processes, and this implies that the damage to structures particularly road pavements and buildings can be a continuous occurrence (King, n.d.).

2.2 Soil Stabilisation

Soil stabilisation is the use of biological, chemical, or mechanical methods to improve the engineering properties of soil to increase its workability. Such properties include shear strength, permeability, compressibility, durability, and plasticity. The procedure of improving the grading of the particle size can be accomplished through binder addition to the weak soils. Soil stabilisation can be accomplished by several methods. All these methods fall into two broad categories namely;

1. Mechanical stabilisation

Under this category, soil stabilisation can be achieved through a physical process by altering the physical nature of native soil particles by either induced vibration or compaction or by incorporating other physical properties.

2. Chemical stabilisation

Soil stabilisation depends mainly on chemical reactions between the stabiliser (cementitious material) and soil minerals to achieve the desired results. By adding these stabilisers, loose soil particles become bound together, creating a stronger and more stable material. Compared to natural soil, stabilised soil is less likely to absorb water (lower permeability), resists compression better, and is generally stronger. The specific type of stabiliser used depends on which weaknesses of the natural soil need to be addressed. In the world of engineering, the key soil properties of concern are how much the soil shrinks or swells (volume stability), its strength, how much it compresses under pressure, and how easily water can pass through it (THE CONSTRUCTOR, n.d.).

2.2.1 Selection of a suitable Soil chemical stabiliser

There are predominantly two common chemicals used as soil stabilisers, and these are lime and cement in particular. However, the decision on what chemical stabiliser to use came from the guidance of the Ministry of Works and Transport General specifications for Roads and Bridges 2010 manual (SERIES 3000) as illustrated below.

% passing the 0.075 mm sieve BS 1377-2	Plasticity Index (%) BS 1377: Part 2	Best suited stabiliser
Less than 25%	PI is less than 6 or PI x (% passing 0.075 mm) is less than 60	Cement only 1)
	6 – 10	Cement preferred
	More than 10	Cement and/or lime
More than 25%	Less than 10	Cement preferred
	10 – 20	Cement and/or lime
	More than 20	Lime preferred 2)

Table 1: Guide to the selection of stabiliser. Source (SERIES 3000- EARTHWORKS AND PAVEMENT LAYERS OF GRAVEL OR CR)

The above table guided the selection of the chemical stabiliser to use based on the percentage passing of soil through the 0.075 mm sieve along with the obtained Plasticity Index. The two parameters were utilised in unison, and this was in that the given Plasticity Index obtained had to correlate with the percentage passing to communicate the chemical stabiliser to be used on the expansive soils.

2.2.2 Hydrated Lime

Hydrated lime is also known as calcium hydroxide. Hydrated lime can either be a white powder or a white putty-like material. It can be used in various applications, including construction, and chemical manufacturing. It is commonly used as a building material, particularly as a mortar for bricklaying and plastering. Hydrated lime has several advantages over other types of lime. It is easy to handle and store as a wet putty or dry powder. It is also less caustic than Quicklime, making it safer to handle. Additionally, it has a longer shelf life than quicklime, as it does not react with air as quickly (LimePlanet, 2023). The chemical properties of the hydrated lime tend to vary though based on what specific application of such lime. The hydrated lime has the following composition as stated below (Calik & Sadoglu, 2014).

Parameter	**Value (%)**
$Ca(OH)_2$	85.80
CaO	65%
MgO	1.40
SiO	0.23

Table 2: Chemical properties of the hydrated lime. Source (Calik & Sadoglu, 2014).

Hydrated lime can be applied to enhance soil stability and compaction on construction sites, thereby improving the long-term strength of the soil. Lime with a high composition of Calcium Hydroxide is taken to be of high purity (MINTEK RESOURCES, n.d.).

2.2.3 Lime in Soil Stabilisation

Lime soil stabilisation involves enhancing soil properties such as density and bearing capacity by adding lime. The factors influencing this process include soil and lime types, lime content, compaction, and curing duration. When lime is introduced to the soil, a pozzolanic reaction occurs, where pozzolana materials react with lime in the presence of water to generate cementitious compounds. The fundamental mechanism behind lime-soil stabilisation is the ion exchange between lime and soil. Treating clayey soil with lime facilitates cation exchange, leading to increased plastic limit and reduced plasticity index, thereby enhancing soil stability. Lime also acts as a binding agent for clayey gravel when clay contains gravel within it. The addition of lime to pozzolanic soil in water results in a reaction where calcium hydroxide from the lime reacts with siliceous and aluminous materials in the soil, creating a mixture with cementitious properties, known as the pozzolanic reaction. This reaction boosts the strength of the lime-soil mixture, with strength gradually increasing over time as the pozzolanic reaction continues for extended periods (THE CONSTRUCTOR, n.d.).

Normally 2 to 8 % of lime may be required for coarse-grained soils and 5 to 8 % of lime may be required for plastic soils. (Lone & Sachar, 2022).However, the reaction between sulphate and alumina in soils and the calcium of excess lime can lead to soil swelling that may contribute to expansion by hydration, and this swelling can lead to the weakening of the soil strength of the expansive soils (Wang, et al., 2019).

2.3 Soil reinforcement

Soil reinforcement is a method employed to enhance the strength and rigidity of soil. Various engineering methods, such as geogrid and geotextile, are utilized to bolster soil strength. This involves integrating earth fill with reinforcing strips, capable of withstanding significant tensile forces. Soil reinforcement represents a contemporary approach utilized across diverse projects to avert soil slope failures and enhance soil-bearing capacity (Civil Wale, n.d.).

Fibre-reinforced soil is characterized as a soil mixture containing randomly dispersed discrete elements, namely fibres, which enhance the mechanical properties of the soil composite. This type of soil acts as a composite material, with high-tensile-strength fibres embedded within a soil matrix. When subjected to shear stresses, the soil activates tensile resistance within the fibres, thereby augmenting the overall strength of the soil (Hejazi, et al., 2012).

Soil reinforcement stands out as a dependable and practical approach for enhancing the properties of fine-grained soil. Various technologies such as metallic strips, bars, geogrids, geotextiles, and fibres are widely recognized for this purpose. Utilizing metallic strips, geogrids, or geotextiles reinforces soil by enhancing its tensile strength in a specific direction. Despite the significance of tensile stresses, there's a possibility of weak planes existing at the interface between soil and reinforcement. Alternatively, the random integration of fibres into the soil is considered an efficient method akin to stabilising with additives. Fibres are simply blended into the soil, similar to other agents like lime or cement. This approach mimics the activity of plant roots, maintaining strength isotropy and minimizing the formation of weak planes in the reinforcement direction. Moreover, these fibre additives solely modify the physical properties of the soil without any adverse environmental impact. Compared to untreated soils, those reinforced with fibres demonstrate enhanced ductility and no decrease in post-peak strength. Synthetic fibres, owing to their consistent material properties and repeatability, are deemed suitable for reinforcement purposes (Zafar, et al., 2023).

2.3.1 Fibre-reinforced soil

Fibres rooted in the soil can vary in form, texture, stiffness, content, length or aspect ratio, orientation and so on among which content, length and orientation of fibres are the most practical concerns in geotechnical applications. Fibre-reinforced soil can be grouped into two categories according to their method of application: Oriented Distributed Fibre-reinforced Soil and Randomly Distributed Fibre-reinforced Soil.

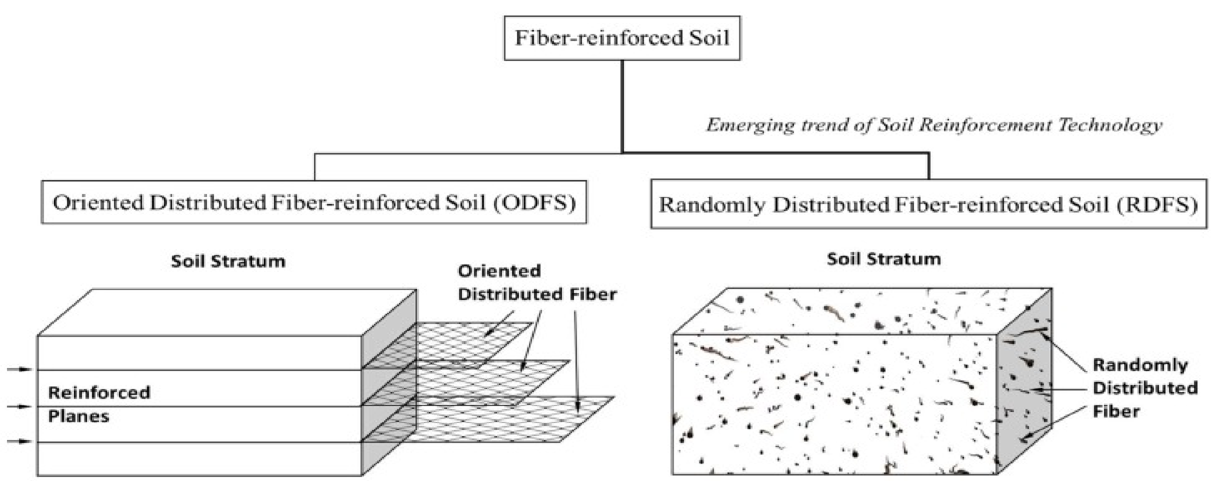

Figure 1:Classification and illustration of Fibre reinforcement mechanism of soil.Source (Gowthaman, et al., 2018).

ODFS is a commonly acknowledged method of soil reinforcement, involving the integration of natural fibres into planner systems in vertical, horizontal, or combined orientations. Its operational principle mirrors the geosynthetic methods, wherein materials such as geo-grids, geo-mats, and geo-textiles are utilized to reinforce weaker soil layers. By introducing fibres, ODFS boosts the frictional strength along the reinforced planes, while the un-reinforced sections depend solely on their inherent strength. This approach may result in the formation of potential failure planes in weaker, unreinforced zones. Alternatively, RDFS is a widely accepted method for enhancing soil quality, where fibres with desired characteristics and quantities are randomly mixed and compacted in situ. The adoption of RDFS has gained traction recently due to its simplicity: short discrete fibres can be easily blended with soil, akin to adding cement, lime, or other additives. This approach offers a uniform increase in the strength of the soil composite without introducing continuous weak planes. The RDFS technique capitalizes on the natural behaviour of plant roots, which reinforce soil by adding friction and interlocking. Initially, when the soil particles undergo stress, they compact and cause fibre deformation. Subsequently, as soil particles rotate and directly impact the fibres, they generate direct forces during the fibre-soil interlocking phase. At the same time, soil particles in contact with the fibres induce frictional forces in addition to interlocking forces. Eventually, these interlocking and frictional forces work together to activate tensile stress on the fibre material. Additionally, the random arrangement of fibres promotes adhesive bonding between the fibres and soil, enhancing composite strength. The interaction of the flexible fibres acts as a structural mesh, effectively binding the soil together and improving its structural integrity. The

RDFS mechanism was found to be the more applicable method when doing fibre reinforcement within soils (Gowthaman, et al., 2018).

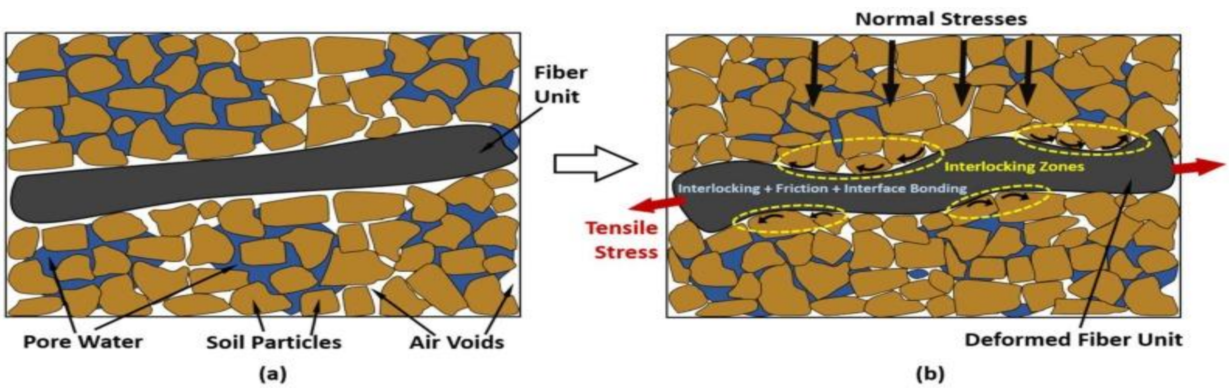

Figure 2: Schematic representation of a randomly distributed fibre unit at (a) initial stage and (b) deformation stage due to loading, where the effect of interlocking, friction and interface bonding induces mobilisation of the tensile stress on the fibre unit. Source (Gowthaman, et al., 2018).

2.3.2 PET fibre reinforcement in soil

Geosynthetics, composed of synthetic or natural polymers, are materials utilized in conjunction with soil, rock, or other geotechnical substances. They encompass a range of products like geotextiles, geogrids, geocells, geomembranes, erosion control mats, and geo-composites. Geotextiles, the most prevalent among these, trace their earliest known application back to sand-filled nylon bags used in the Dutch Delta Works in 1956. Over the past six decades, geotextiles have become integral to geotechnical engineering, serving purposes such as filtration, drainage, reinforcement, and erosion protection (Wu, et al., 2020).

Geosynthetics, specifically geotextiles crafted from synthetic polymers like PP and PET, are produced abundantly due to cost-effectiveness and the ease of obtaining fibres through melt-spinning technology. Their impressive mechanical strength, durability, and hydrophobicity make them ideal for various geotechnical engineering tasks, such as enhancing the load-bearing capacity of soil for construction site preparation such as road works (Tanasă, et al., 2022).

In recent years, the utilization of randomly dispersed fibres in clayey soil for soil improvement applications has gained considerable attention in geotechnical engineering research. Incorporating these fibres into the soil has been observed to enhance shear strength, soil soil-bearing capacity, diminish settlements, and restrict lateral deformations. Both natural and synthetic fibres offer significant advantages, including cost-effectiveness and the potential for synthetic fibre production through plastic waste recycling. Recycling polyethene terephthalate (PET) presents two main approaches: mechanical and chemical methods. Mechanical recycling involves techniques such as PET shredding using specialized machinery, which alters the physical form of PET without changing its chemical composition. (Kalkan, et al., 2020). Furthermore, the fibres enhance shear strength by establishing an interlocking matrix between the fibres and the soil. Fibres play a role in restraining soil movement under external stresses. Moreover, the formation of a gel within the stabilised soil matrix binds soil particles together, augmenting the strength of lime-stabilised soil with fibre reinforcements as compared to untreated soil (Tamassoki, et al., 2022).

CHAPTER THREE: METHODOLOGY

3.0 Introduction

This chapter encompasses the content of the materials used during the conduction of the research, and the methods implemented to achieve the objectives of the given research when incorporating the given materials in the project design. The section on materials looked at how the various components of the project design such as the fibre, lime and the expansive soils were obtained and managed till transportation to the testing laboratory then part of the methods looked at the various tests carried out using the obtained materials along with how they were applied in the mix ratio design.

3.1 Summary of the Methodology

The methodology looked at the various tests carried out to achieve the specific objectives of the research. The following specific objectives were meant to be achieved through the conduction of the given tests according to the standards.

3.1.1 Physical properties of the neat soil sample

The neat soil sample had the following tests carried out on it as stated below.

1. Particle size distribution with reference to BS 1377: Part 2 1990.
2. Atterberg Limit tests with respect to BS 1377: Part 2 1990.
3. Proctor test with respect to BS 1377: Part 1990.
4. CBR with respect to BS 1377: Part 4 1990.
5. Free Swell Index with reference to IS:2720 (Part 40) 1997.

3.1.2 Mechanical properties of the Polyethylene Terephthalate fibre and chemical properties of hydrated lime

The mechanical properties of the PET fibre in particular the tensile strength were obtained through carrying out a tensile strength test with reference to ASTM D638-14. The hydrated lime meant to be used for the research was purchased from the market hence it was found to have standard chemical properties.

3.1.3 Mix ratios of Polyethylene Terephthalate fibre, hydrated lime, and expansive soils to achieve the desired strength properties

The mix ratios of the project design were to incorporate varying portions of the expansive soils while maintaining a standard hydrated lime composition of 6 %, meant for soil stabilisation, which was identified to correspond to the optimum lime content range according to previous scholars. The PET fibre composition for reinforcement was to be added from 0 % to 2 % in intervals of 0.5% based on the literature. The total percentage for each mix ratio was to be 100 %, and the tests for each mix ratio were as stated below.

1. Particle size distribution with reference to BS 1377: Part 2 1990.
2. Atterberg limit tests with respect to BS 1377: Part 2 1990.
3. Proctor test with respect to BS 1377: Part 1990.
4. CBR with respect to BS 1377: Part 4 1990.
5. Free Swell Index with reference to IS:2720 (Part 40) 1997.
6. UCS with reference to BS 1924: Part 2: 1990.

3.1.4 Strength properties of the soil stabilised with hydrated lime while reinforced with varying Polyethylene Terephthalate fibre in the appropriate mix ratios.

The fourth specific objective was done in correlation with the third specific objective hence it was found that the tests conducted while using the suitable mix ratios were as stated below.

1. Proctor test with respect to BS 1377: Part 1990.
2. CBR with respect to BS 1377: Part 4 1990.
3. UCS with reference to BS 1924: Part 2: 1990.

3.2 Materials and Methods

3.2.1 Materials

a) Expansive soil

The soil samples of the expansive soil were obtained along the Muyembe-Nakapiripirit road stretch along the chainage of 47+800 km. There were two trial pits dug to an average depth of 0.5m along one pathway which was offset from the road stretch. The digging was done using a pickaxe and spades, and the dug soil samples were placed in eight tightly closed sacks with each sack carrying fifty kilograms of soil. Some soil samples were packed in two airtight bags each with a capacity of one kilogram. The packed soil samples were then all loaded onto a vehicle to be transported to the laboratory where the soil tests were to be conducted. The soil was air-dried for two days.

b) Hydrated Lime

The hydrated lime was purchased from a hardware store in Mukono District in Uganda.

c) **Polyethylene Terephthalate Fibre**

The PET material makes a variety of plastic bottles used by beverage companies for drinks like water and soda in particular. Hence the first step was to acquire an amount of around five kilograms of PET plastic waste bottles. The bottles were then washed with water and soap to remove any dirt. The clean plastic waste bottles were taken for cutting using a pair of scissors to remove the top part of the bottle and the lower part to allow for the acquisition of a sheet of plastic to be cut. The plastic sheets were then selectively chopped to a given size of 2mm in diameter and length of 20 mm. There was the application of the fibres in compositions of 0.5 %,1.0 %, 1.5 % and 2.0 % in the project mix design.

Figure 3: Mixing of 6% hydrated lime and 94% dry weight of expansive soil. Source (Manana, 2024).

3.2.2 Methods

The tests carried out were done in reference to set standards to achieve the set objectives of the research project. The tests were conducted in relation to the chronological order of the specific objectives of the research.

3.2.2.1 Particle Size Distribution

Particle size distribution was a critical factor in soil classification. Soil texture, which was determined by the proportion of sand, silt, and clay particles, was a fundamental property used to classify soils. The size ranges are likely to control the engineering properties of the soil. The test was done with reference to BS1377: part 2:1990.

3.2.2.2 Atterberg Limit tests

The tests were done to determine the Plastic Limit, Liquid Limit, and Plasticity Index. The tests were done with reference to the BS 1377: Part 2 1990. The Liquid Limit was the water content for which the soil altered from a liquid to a plastic state, and the Plastic Limit referred to the moisture concentration at which the soil can no longer change shape without cracking. The Plasticity Index is the difference between the Liquid Limit and Plastic Limit, PI= LL-PL.

3.2.2.3 Proctor Test

The test was used to determine the Maximum Dry Density and Optimum Moisture Content of the soil. The test was performed with reference to BS 1377: Part 4: 1990. The desired OMC was obtained at the highest point along the curve of Dry Density values against moisture content.

3.2.2.4 California Bearing Ratio

The Objective of the test was to measure the potential load-bearing capacity of soil and its resistance to deformation under load. The test was done with reference to BS 1377: Part 4 1990. The One-point method was deployed when carrying out the test.

3.2.2.5 Tensile Strength

The main objective of carrying out this test was to determine the mechanical properties of the Polyethylene Terephthalate fibres. The property in particular was the tensile strength of the PET fibre. The test was done in reference to ASTM D638-14.

3.2.2.6 Unconfined Compressive Strength

The main objective of this test was to determine the Unconfined Compressive Strength (UCS) of the stabilised soil sample. This test was done with reference to BS 1924: Part 2: 1990.

3.2.2.7 Free Swell Index Test

Free swell or differential free swell, also termed as “free swell index”, is the increase in the volume of soil without any external constraint when subjected to submergence in water. The objective of the test was to get the percentage change of volume of soil with no external loading subjected to the soil once submerged in water. The test was done with reference to IS:2720 (Part 40) 1997.

CHAPTER FOUR: RESULTS AND DISCUSSION

4.0 Introduction

This chapter involved the critical analysis of the results from the soil tests done with regards to Chapter Three, and some of the tests done included the Atterberg Limits, Proctor, Sieve Analysis, Unconfined Compressive Strength, Tensile Strength and California Bearing Ratio and so on. The chapter further dealt with the breakdown of the results and graphical representation of the data of the tests on the soil along with the PET fibre. There was further interpretation and analysis of the test conducted on the material in particular the Polyethylene Terephthalate fibre along with the tests done on the soil stabilised with the hydrated lime and varying percentages of the Polyethylene Terephthalate fibre.

4.1 Physical Properties of the Neat Soil Sample

The aspect of the physical properties of the neat soil sample dealt with the first specific objective of the project. The physical properties of the soil were obtained through the various tests associated with specific objective one, and the various tests done to get such physical properties of the neat soil sample were as mentioned below

4.1.1 Particle Size Distribution

Particle Size Distribution involved the use of Sieve analysis with reference to BS 1377 Part 2:1990. Sieve analysis was done to determine the grading of a given soil sample. The result was a particle size distribution curve which represents the grading of the soil sample. It was done for coarse soils as the particles can be differentiated by passing through different sieve sizes. This gave the relative portions of various particle sizes that are contained in the soil sample which are gravel, silt, sand, or clay, and which one was predominant and hence capable of controlling the engineering properties of the soil.

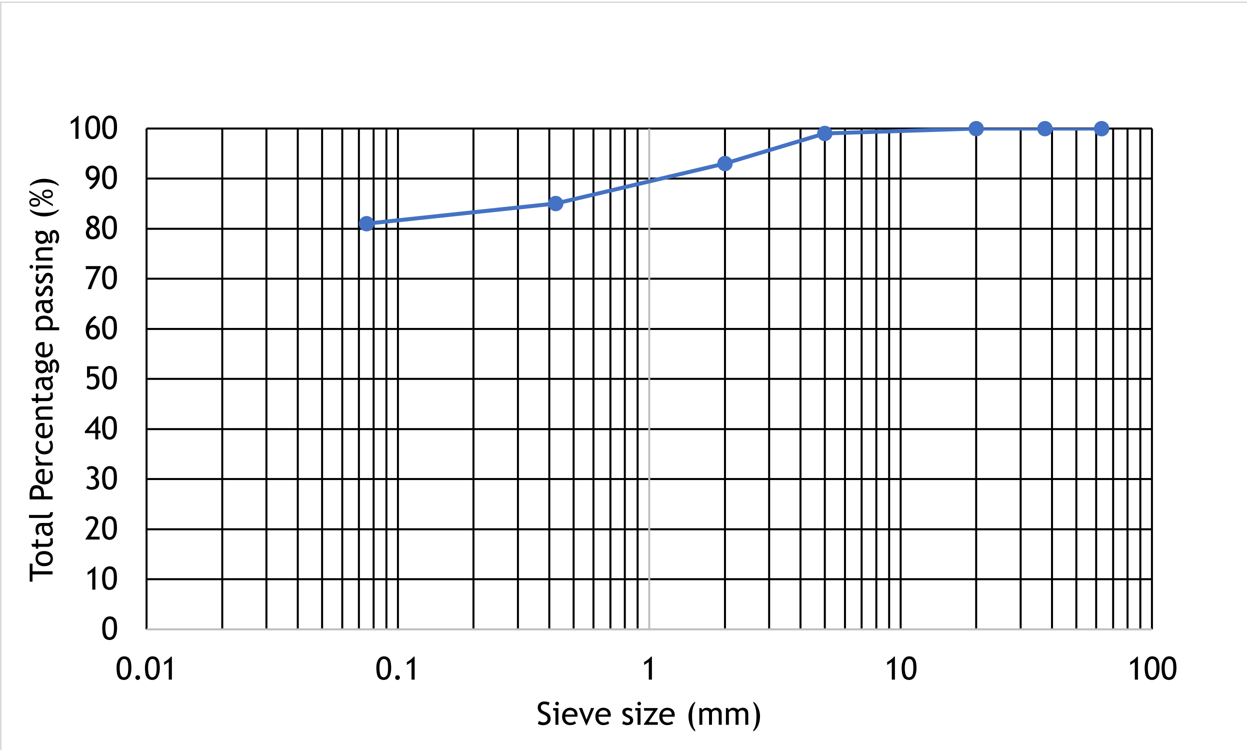

Figure 4: Particle Size Distribution graph of the neat soil sample

The Particle size distribution graph indicated that the percentage passing through the 0.075 mm sieve was 81 % which was greater than 50 %, which implied that the given soils were poorly graded along with the fact that most of the soil particles were lying within the fine grain range. The indication of poorly graded soils likely to be clayey implied that there was a need for stabilisation.

4.1.2 Atterberg Limits

The Atterberg limits were needed to classify soils for engineering purposes. Two samples were taken to determine the Atterberg Limits.

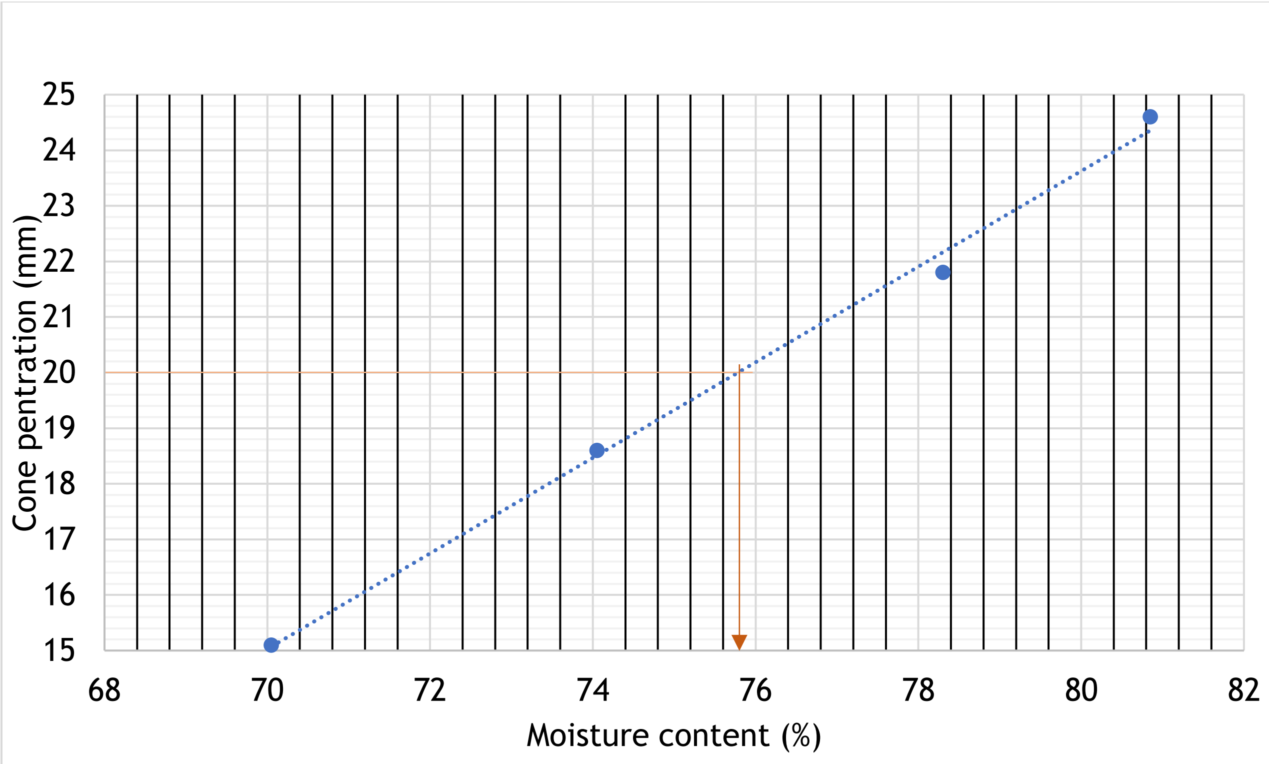

Figure 5: Liquid Limit graph for the neat soil sample

4.1.2.1 Liquid Limit

The maximum value of the Liquid Limit for neat sample-1 was 81.2 % while the minimum value was 69.4 %. The average value for the liquid limit for neat sample-1 was 75.6 %. The maximum value for the LL for neat sample-2 was 80.5 % at a depth of 0.5m and the minimum value was 70.7 % at 0.5m. The average value for the Liquid Limit for neat sample-2 was 76.0 %. The average value for the LL for all samples was taken as 75.8 %.

4.1.2.2 Plastic Limit

The average value for the Plastic Limit of neat sample 1 was 37.5 % at depths of 0.5m. The average value for the Plastic Limit for neat sample-2 was taken as 37.6 %. The average value for Plastic Limits for all samples was 37.6 %.

4.1.2.3 Plasticity Index

The Plasticity Index for neat sample-1 was 38.1 % and neat sample-2 was 38.4 %. The average was 38.2 %. The PI of 38.2 % was found to be high and this implied that the given soil could easily have discrepancies in volume when the soil moisture content is varied.

4.1.2.4 Linear Shrinkage

The linear shrinkage limit for neat sample-1 was 20% for neat sample-2 was 20% at a depth of 0.5m. The average value for all the samples was 20%. Linear Shrinkage is the phenomenon that refers to the transition of soil from a partial to a full solid state, during which no additional volume change takes place. It's important to highlight that soil shrinkage during this process leads to the formation of cracks within the soil mass. These cracks not only increase the soil's permeability to water but also pose potential risks of damage to geotechnical structures (Pratama, et al., 2021).

	Liquid Limit (%)	Plastic Limit (%)	Plasticity Index (%)
Neat Sample 1	75.6	37.5	38.1
Neat Sample 2	76.0	37.6	38.4
Average	75.8	37.6	38.2

Table 3:Summary of the Atterberg Limits results of the neat soil sample

Applying the use of the Plasticity chart based on the Unified Soil Classification System found the soils to be classified as inorganic clays of high plasticity, CH. The soils were fine-grained high plasticity inorganic clay soils *(Mishra, n.d.)*.

The AASHTO soil classification system found the soils to be Clayey soils of Group classification A-7, A-7-5, and A-7-6 *(Jamal, 2019)*. The given soil classification meant that such soils are poor subgrade materials having a high plasticity and likely low bearing capacity hence implying that to make such soils viable for subgrade use in road construction, there shall be an aim to use hydrated lime and PET fibre to improve the strength properties and plasticity of such soils to the allowed standards of subgrade materials.

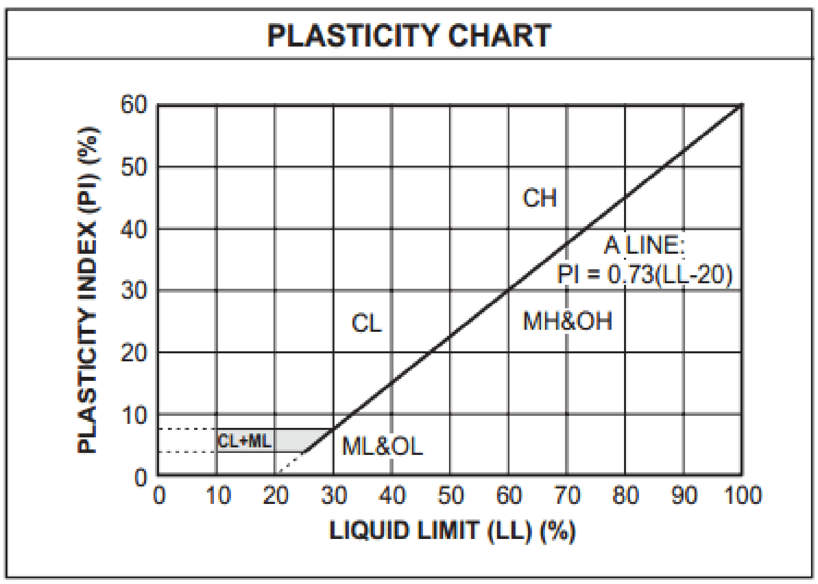

Figure 6:Plasticity chart for classification of fine-grained soils. Source *(Mishra, n.d.)*.

- Highly plastic soils clay soils tend to shrink with a loss of moisture and swell with the increase of moisture content. The swelling and shrinking cause volumetric changes and cracking that affect the structures (buildings and roads) that may be constructed on such soils. The research was targeted to reduce the plasticity of the soils and increase the soil strength to avoid the effects that are associated with clay soils of high plasticity.

4.1.3 Proctor

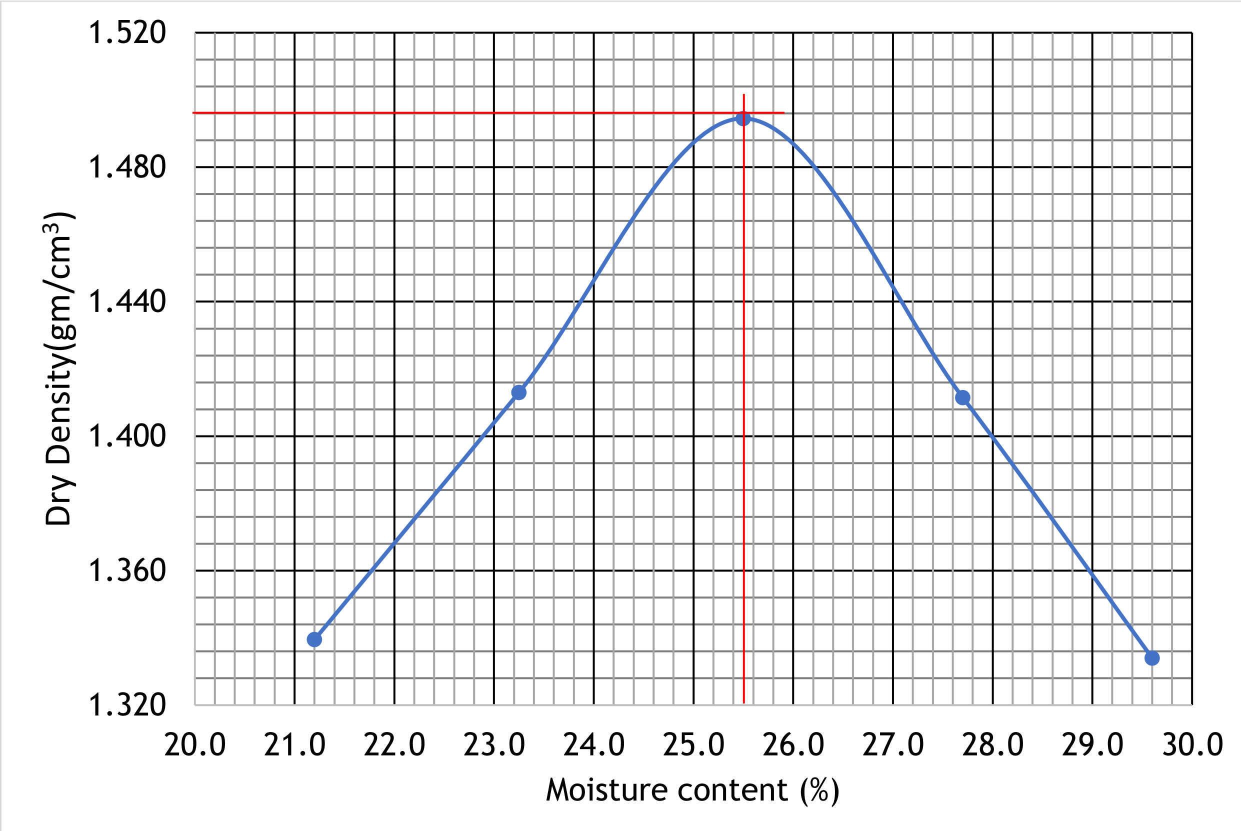

Figure 7: MDD and OMC chart of the neat soil sample

The MDD of the neat soil sample was discovered to be 1.495 gm/ cm^3 when the OMC of the given soil was 25.5 %. MDD was interconnected to OMC as it was found that this was the highest value of dry density of soil obtained when the ideal moisture content is added to such soil and then compacted with the utmost ease. Soil compaction performance is essential for evaluating its suitability in construction projects like roads, bridges, and buildings, ensuring stability and durability (Li , et al., 2024).

4.1.4 California Bearing Ratio

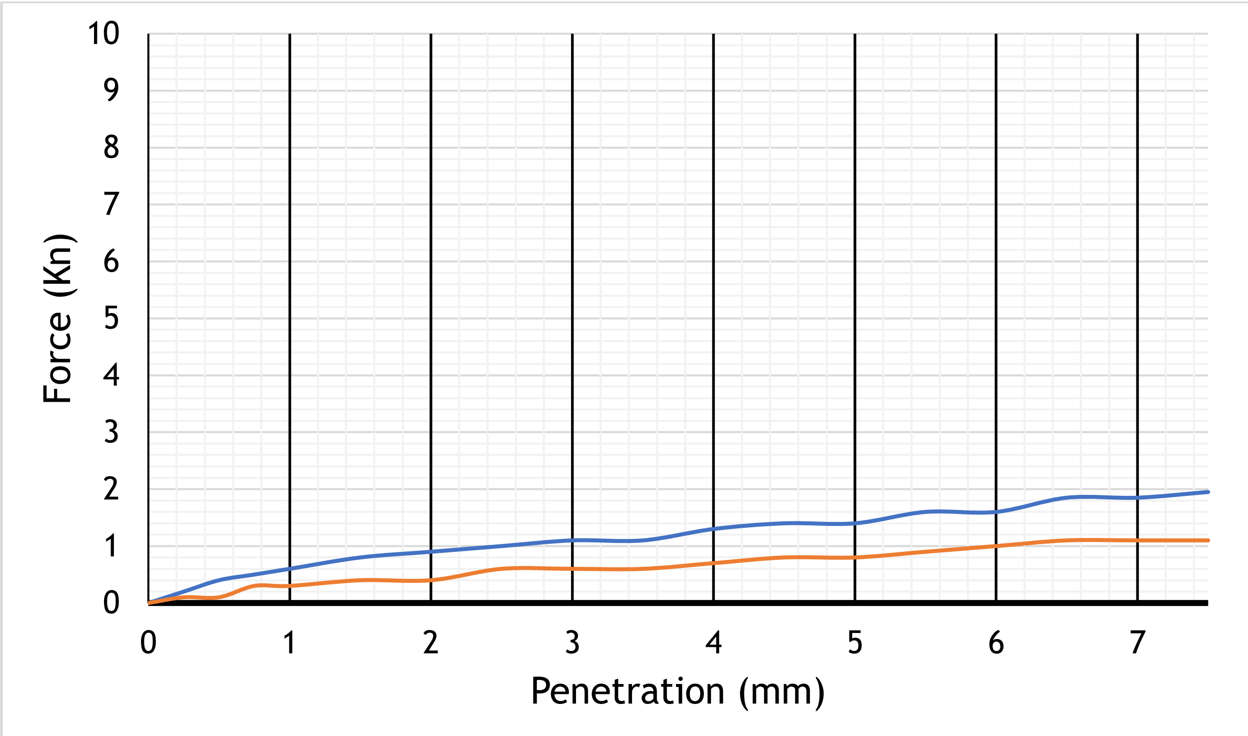

Figure 8: CBR graph of the neat soil sample

The results from the tests carried out on the sample gave the CBR value of 8.0% and 7.0% for neat samples 1 and 2 respectively, the average CBR was 7.5 %. A CBR of 7.5% in the soil analysis of a subgrade suggested that the soil has relatively low strength and may be considered weak for load-bearing purposes. Furthermore, there was the aim to achieve a CBR value that corresponds to the minimum UCS value of 0.50MPa lime-stabilised subgrade material, CM according to the SERIES 3000 manual. As the CBR of 7.5% was below the minimum value of 30% required to meet the standards of lime-stabilised material, CM, there was the need to stabilise the expansive soils using lime while also applying fibre reinforcement.

4.2 Tensile Strength Test of the Polyethylene Terephthalate Fibre

Sample Ref.		PET 1	PET 2	PET 3	PET 4	PET 5
Strip size	Width (mm)	11.5	8.4	11.1	11.5	7.1
	Thickness (mm)	0.3	0.3	0.3	0.3	0.3
Cross-Sectional Area (mm^2)		3.45	2.52	3.33	3.45	2.13
Force at Breaking (kN)		0.750	0.500	0.800	0.800	0.500
Tensile Strength (MPa)		217	198	241	232	235
Average Strength (MPa)		224.6				
Elongation (%)		64	59	62	68	65
Average Elongation (%)		63.6				

Table 4: Tensile strength results of the PET Fibre

Tensile strength and elongation are key properties of fibres that affect their reinforcement capability. Elongation is believed to be connected to the tensile strength of a fibre (Aishwarya & Rachel, 2023). The degree to which the tensile strength of the fibre is utilised was thought to depend on the extent of fibre elongation during shearing, hence the substantial elongation value of 63.6 % led to a high tensile strength value of 224.6 MPa. Additionally, it was essential to have assumed a particular distribution of tensile stress along the fibre length. The elongation and tensile strength were noted to vary depending on the cross-sectional area of the fibre (Shukla, 2017). With a tensile strength of 224.6 MPa, the PET fibre was able to resist the minimal tensile stresses dispersed within the fibre-reinforcement structure without jeopardising the integrity of the PET fibre (PolyGlobal, 2018).

Elongation has been noted to have had a strong correlation with the strength of individual fibres. Additionally, the influence of artificial weak-link effects introduced during testing also affected the breaking elongation (Bunsell, 2018). The distributed tension caused by fibres depended on both the content and the ultimate tensile strength of each fibre when the major mode of failure was fibre breakage (Palmeira, et al., 2008). The elongation of the PET fibre was found to be 63.6 %. The 63.6 % quantified the extent to which the fibre could stretch, represented as a percentage of its original size, before reaching the point of rupture. It reflected the capacity of the fibre to undergo substantial deformation before failure. Fibres exhibiting a greater percentage of elongation at break demonstrated increased ductility. This high ductility suggested that the fibres are inclined to deform rather than fracture, particularly when employed to reinforce lime-stabilised soil (PolyGlobal, 2018).

4.3 Effect of PET fibre Reinforcement and Lime stabilisation on the soil properties

4.3.1 Particle Size Distribution

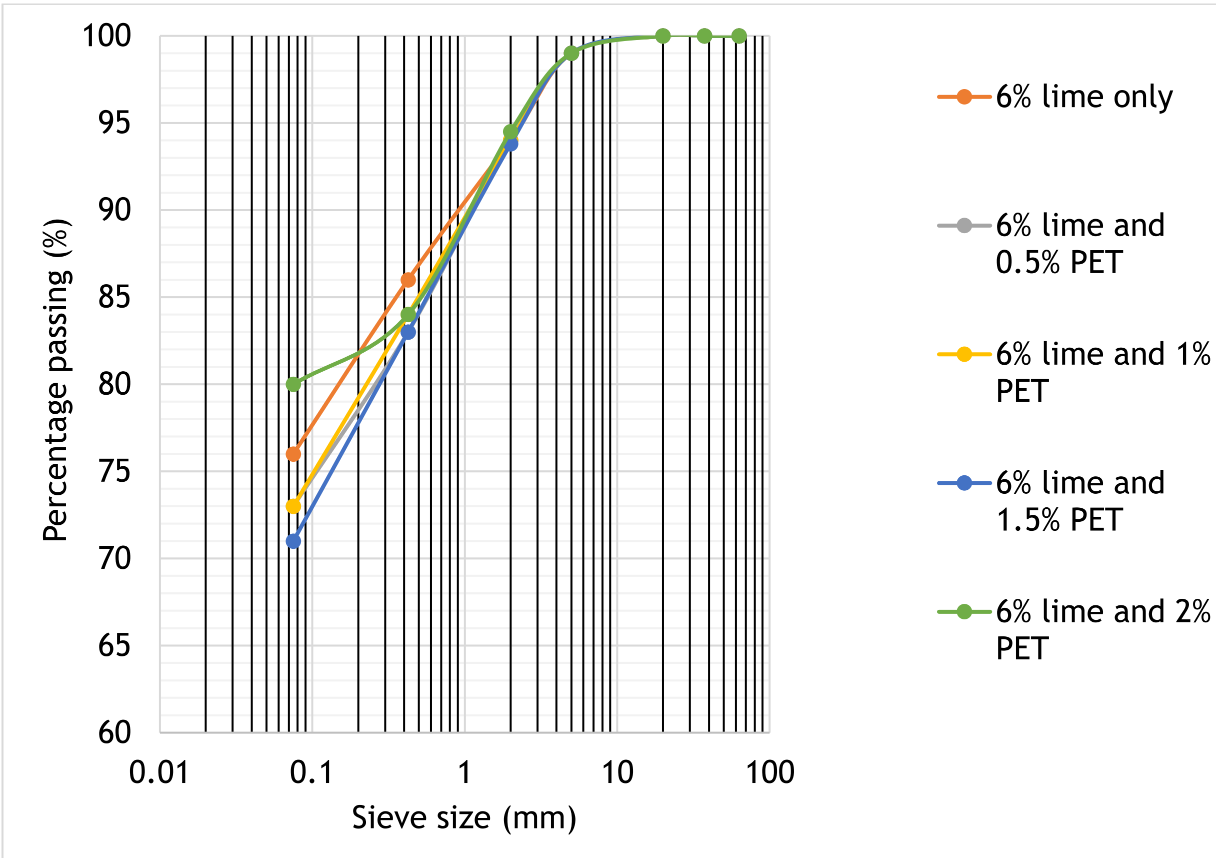

Figure 9: Percentage passing against sieve size

The addition of the constant 6 % lime and PET fibre affected the amount of the soil passing through the 75 µm sieve from 82% to an average of 75 %. This was due to the increased amount of solid PET fibres which bound the soil particles (Tamassoki, et al., 2022). The cohesion effect of the 6 % hydrated lime on the soil led to the formation of bigger particles (Firoozi, et al., 2017). The result was a decrease in the percentage of fines with the addition of the fibres and lime making the soil a better distribution of the various soil particles.

4.3.2 MDD and OMC

4.3.2.1 MDD

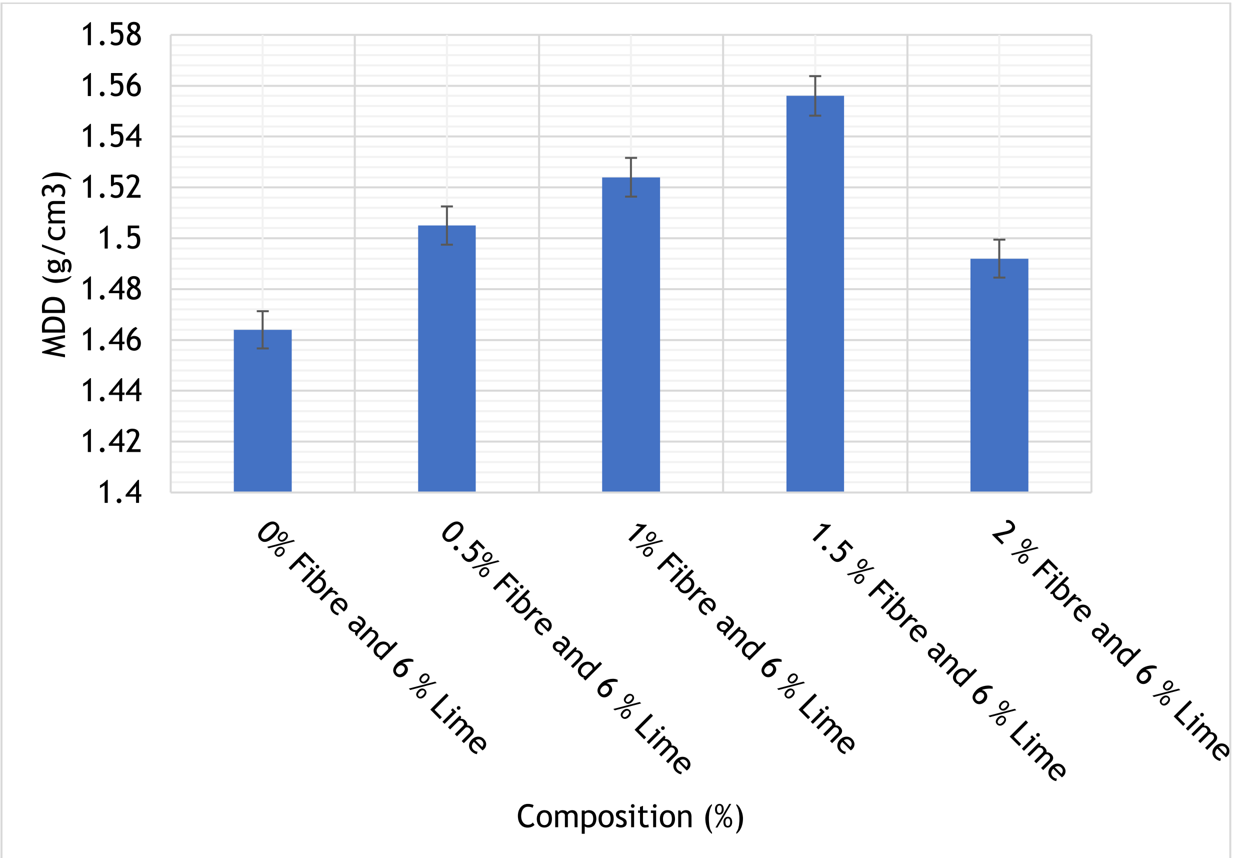

Figure 10: MDD against Composition

The pozzolanic reactions between the 6% lime and the expansive soils resulted in the reduction of MDD and the increase in OMC of the mixtures investigated. The decrease in MDD was attributed to the immediate formation of cementitious reaction products at particle contact points, which increased the porosity and thus reduced the MDD of the mixture (Abdi , et al., 2021). The addition of plastic fibres of 0.5 %, 1.0 % and 1.5 % into the soil decreased the number of voids thus improving effective compaction and cohesion hence leading to an increase in the MDD of the plastic-soil mixture (Kalliyath, et al., 2016).

However, with the addition of 2 % of PET fibre to the lime-stabilised, it was seen that the MDD of the soil decreased. An excessive amount of fibres acted like a lubricant, reducing the friction between soil particles and hindering the interlocking mechanisms, and that compromised the soil strength. This drop in the MDD was attributed to the properties of the fibre-reinforced soil due to a weaker soil structure with voids to allow for greater water movement and retention (Aishwarya & Rachel, 2023).

4.3.2.2 OMC

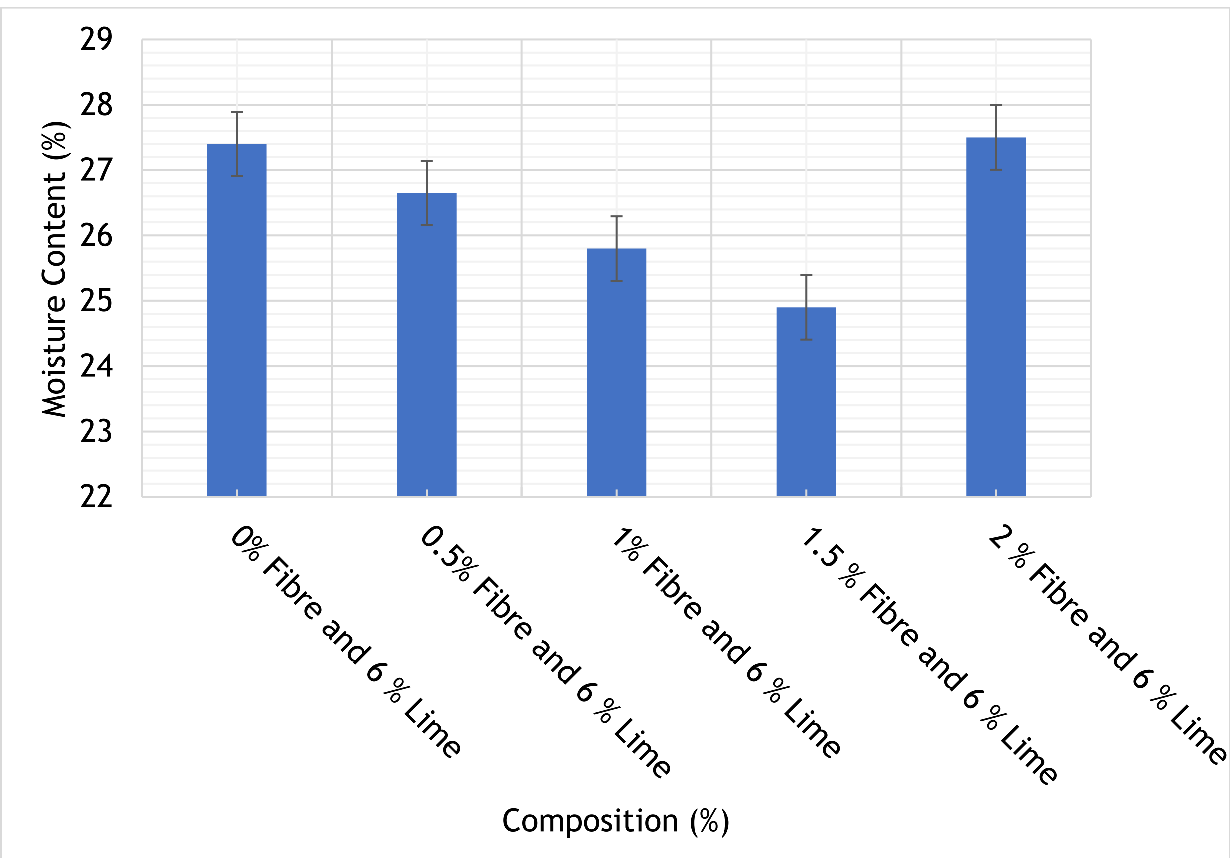

Figure 11: Moisture Content against Composition

Initially, the Optimum Moisture Content rose following the introduction of 6 % hydrated Lime, attributed to the reaction between lime and expansive soils, prompting a higher moisture requirement for soil compaction. Following the addition of 6 % hydrated Lime, the cation exchange and flocculation process ensued, causing an increase in grain size, subsequent expansion of void ratio, and consequently, a decrease in maximum dry density accompanied by an elevation in optimum moisture content. The compaction curve flattening post-lime treatment allows for achieving the prescribed density across a broader moisture content range. Jan and Mir associated these alterations with the reduction in diffuse double-layer thickness due to heightened cation concentration (Manzoor & Yousuf, 2020).

Generally, the OMC values for fibre contents of 0.5 %, 1.0 %, and 1.5 % indicated that adding plastic waste materials to soil reduced the OMC. This occurred because the plastics lack absorbent properties compared to clay soil replaced by plastic fibres, which have a strong attraction to water due to their surface tension (Hassan, et al., 2021).

When 2 % PET fibre was added, the OMC of the soil increased, but it led to failure in the reinforced samples due to cracking. The cracks initiated diagonally from the top and bottom of the sample, extending gradually towards the middle. This caused some surface blocks of the reinforced soil to detach. Eventually, these cracks merged to form a predominant shear plane at failure. As the fibre content increased, the failure pattern shifted from ductile to brittle in the reinforced soil. The cracks meant that paths were created which allowed for the movement of water within the soil matrix hence increasing the moisture content within this soil (Lawer, et al., 2021).

4.3.3 Atterberg Limits

4.3.3.1 Plasticity Index

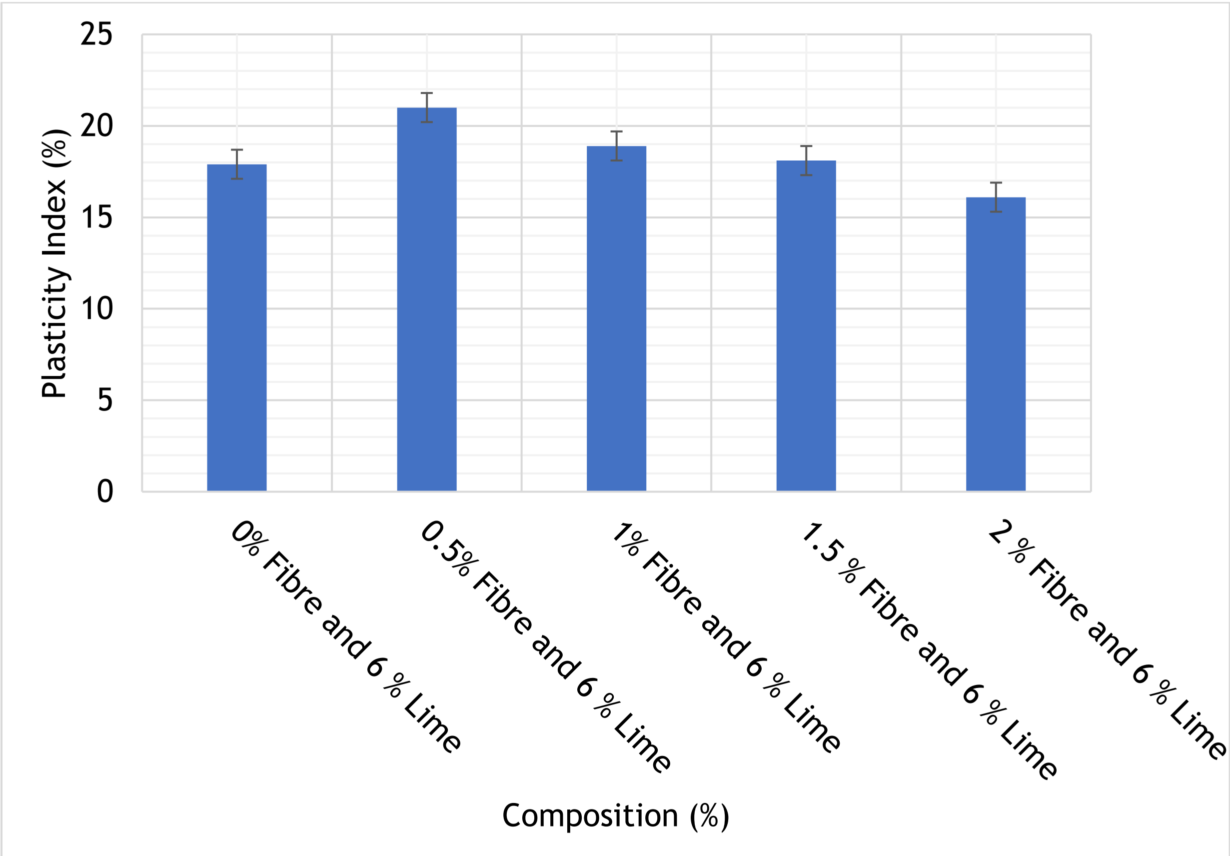

Figure 12: Plasticity Index against Composition

The inclusion of 6 % hydrated lime caused drying primarily through chemical alterations in the soil, reducing its water retention capacity and enhancing stability. Upon initial mixing, Calcium ions (Ca2+) from the hydrated lime migrated to the surface of clay particles, displacing water and other ions. Consequently, the soil became more crumbly and granular, facilitating easier manipulation and compaction. This led to a further decrease in the Plasticity Index and reduced the tendency of the soil to undergo swelling and shrinkage. This process, known as "flocculation and agglomeration," typically occured within a few hours (Firoozi, et al., 2017).

The PI values increased when compared to the PI initially got for the soil stabilised with 6% lime only. The given trend for the PI illustrated a reduction of the soil reinforced with fibre contents ranging from 0.5 % to 2 %. This occurred because the fibres lack absorbent properties compared to clay soil replaced by plastic fibres, which have a strong attraction to water due to their surface tension (Hassan, et al., 2021).

4.3.4 California Bearing Ratio

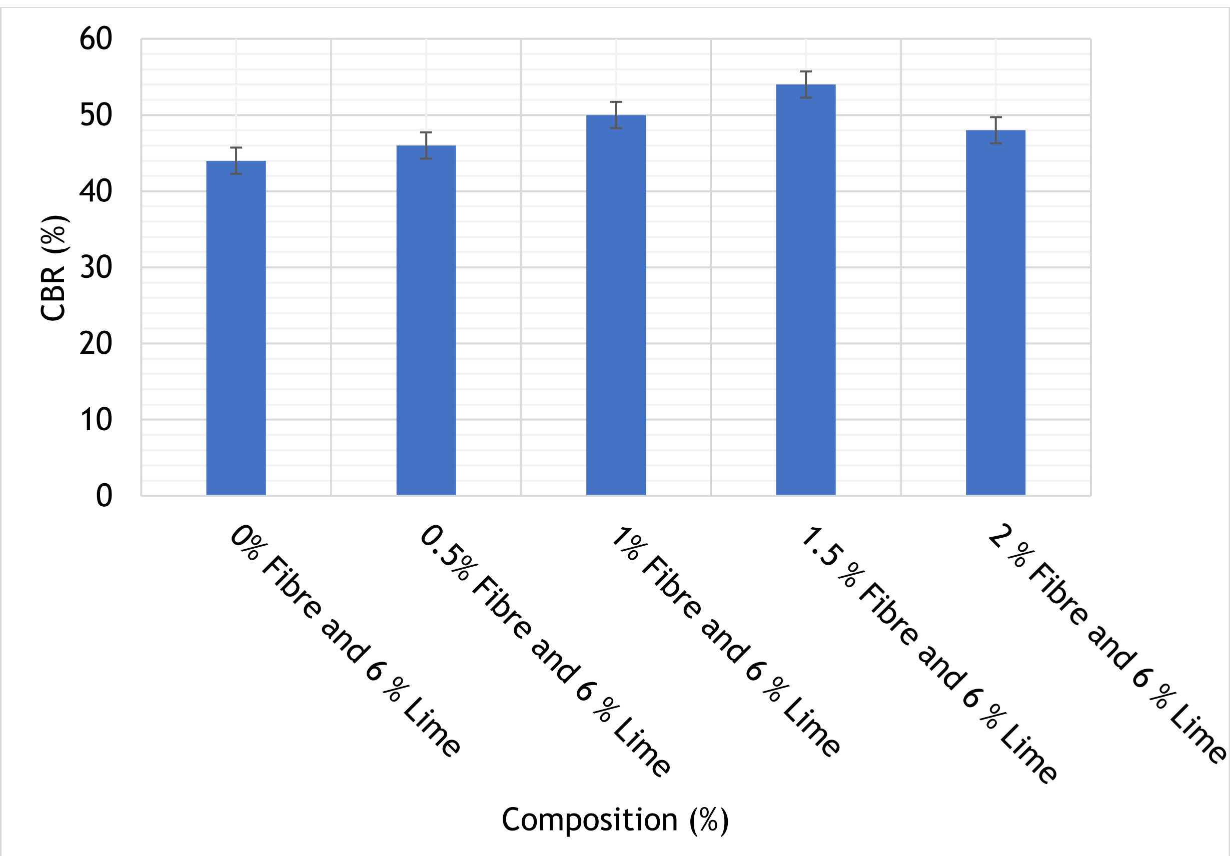

Figure 13: CBR against Composition

The CBR of the soil stabilised with 6 % hydrated lime was observed to have increased to 44% from the initial CBR value of 7.5 % of the neat soil sample. When water and lime are added to clayey soil, lime breaks down into Ca^{2+} and OH^{-} ions. The Ca2+ ions then replace monovalent ions such as Na^{+} and Li^{+} that are adsorbed to the surface of clay minerals. This binding of $Ca2^{+}$ ions to the clay mineral surface led to a reduction in repulsive forces and a decrease in the thickness of the diffuse water layer. As a result, soil particles drew closer together, a process commonly referred to as flocculation, and the process of flocculation allowed for the formation of large soil particles that are interlocked and able to withstand greater loadings applied to them *(Manzoor & Yousuf, 2020)*.

A noticeable stiffer response with increasing penetration was observed with the addition of fibre content from 0.5 to 1.5 % in intervals of 0.5 %. This improvement in soil properties was due to the fibre addition. The fibre addition meant that the randomly distributed discrete fibres reinforced the soft soil subgrade under heavy loads leading to improved strength for the soil which may suffer excessive deformation when left unreinforced (Hasrajani, et al., 2015). The rise in CBR of lime-stabilised fibre-reinforced soil was credited to the considerable improvement in the bearing capacity facilitated by the addition of discrete fibres. With an increase in the plastic content within the soil bed, the load-bearing capacity of the footing escalated up to a certain threshold, beyond which it diminished (Iravanian & Haider, 2020).

A decrease was noted after reinforcing the soil with 2 % PET fibre. The decrease of the CBR due to the further addition of plastic to the soil was because more plastic fibres into the soil sample led to the segregation of the soil-plastic matrix during compaction hence causing poor bonding between the materials (Raghu, 2018). An excessive amount of fibres acted like a lubricant, reducing the friction between soil particles and hindering the interlocking mechanisms, and that led to a weaker overall soil structure. This decline might have been due to the abundance of waste plastics, which could have compromised the strength of the soil. Consequently, this resulted in reduced strength and a less robust soil structure overall (Niyomukiza, et al., 2021).

4.3.5 Unconfined Compressive Strength

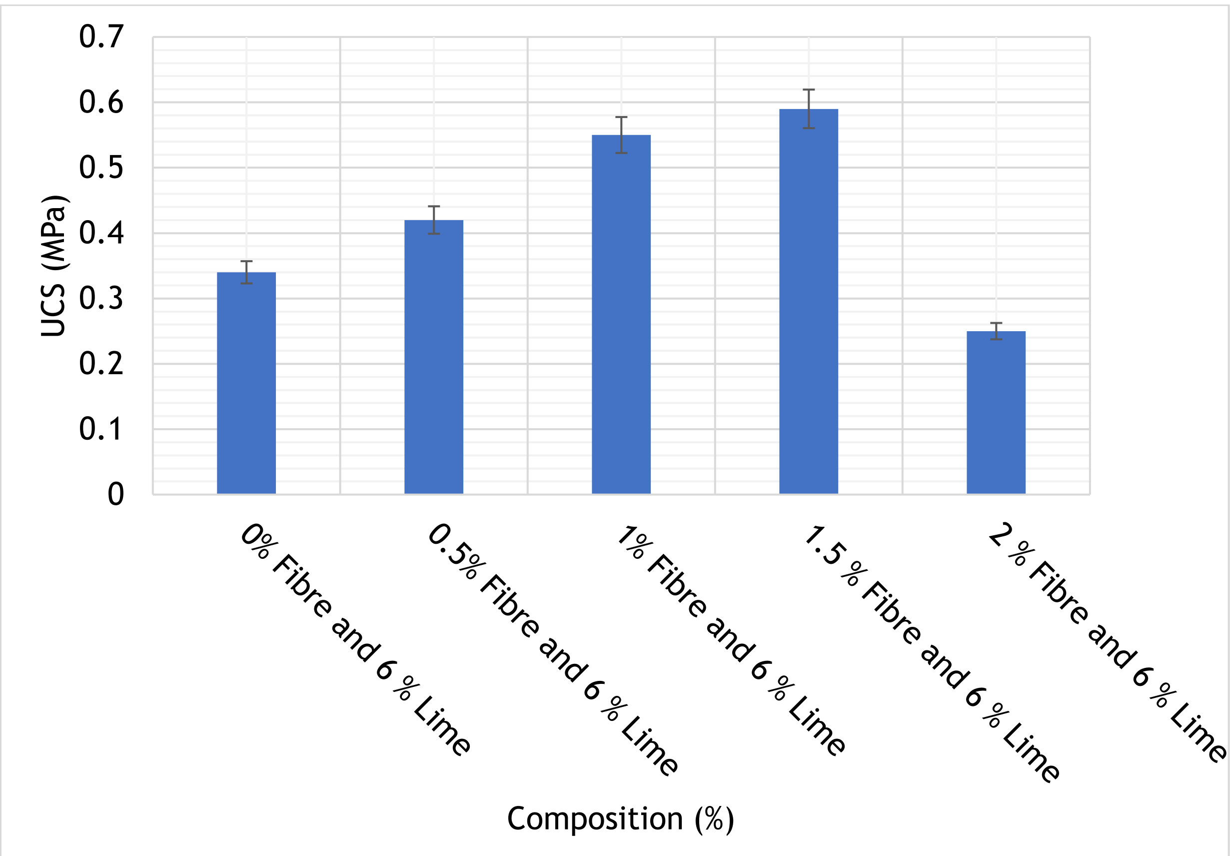

Figure 14: UCS against Composition

The trend of the results of the UCS was that there was a continuous increment from the point where there was a composition of 0 % fibre to 1.5 % fibre with a constant mix of

6% hydrated lime. At the 2 % fibre content, it was illustrated that the UCS reduced greatly. The variation of the UCS values with fibre incorporation was ideally attributed to the fibre interaction mechanisms with the expansive soils.

When adequate quantities of lime and water were added, the pH of the soil quickly increased to above 10.5, which enabled the clay particles to break down. Silica and alumina were released and reacted with Calcium ions from the lime to form Calcium-silicate-hydrates and Calcium-aluminate-hydrates. The Calcium hydrates were cementitious products similar to those formed in Portland cement. They formed the matrix that contributed to the strength of lime-stabilised soil layers. As this matrix formed, the soil was transformed from a sandy, granular material to a hard, relatively impermeable layer with significant load-bearing capacity. The matrix formed was permanent, durable, and significantly impermeable, producing a structural layer that was both strong and flexible (Firoozi, et al., 2017).

Fibre reinforcements contained the tensile stresses, which arose from the friction between the reinforcements and the soil. The transfer of these tensile stresses within the reinforcements typically resulted in an enhancement of the shear strength of the soil. This improvement was achieved by redistributing shear stresses within the soil through the tensile strength of the reinforcements. Introducing randomly distributed polymeric additives, such as polypropylene and Polyethylene Terephthalate, into soils enhanced their mechanical properties (Marçal, et al., 2020). Furthermore, the fibres enhanced shear strength by establishing an interlocking matrix between the fibres and the soil. Moreover, the formation of a gel within the stabilised soil matrix bound the soil particles together, augmenting the strength of lime-stabilised soil with fibre reinforcements as compared to untreated soil (Tamassoki, et al., 2022).

UCS samples reinforced with a 2 % fibre content experienced failure through cracking. These cracks initiated diagonally from both the top and bottom of the sample, gradually extending towards the middle. As a consequence, some surface blocks of the reinforced soil detached. The cracks eventually merged to form a predominant shear plane at failure. As the fibre content increased, the failure pattern of the reinforced soil transitioned from ductile to brittle (Lawer, et al., 2021).

4.3.6 Free Swell Index

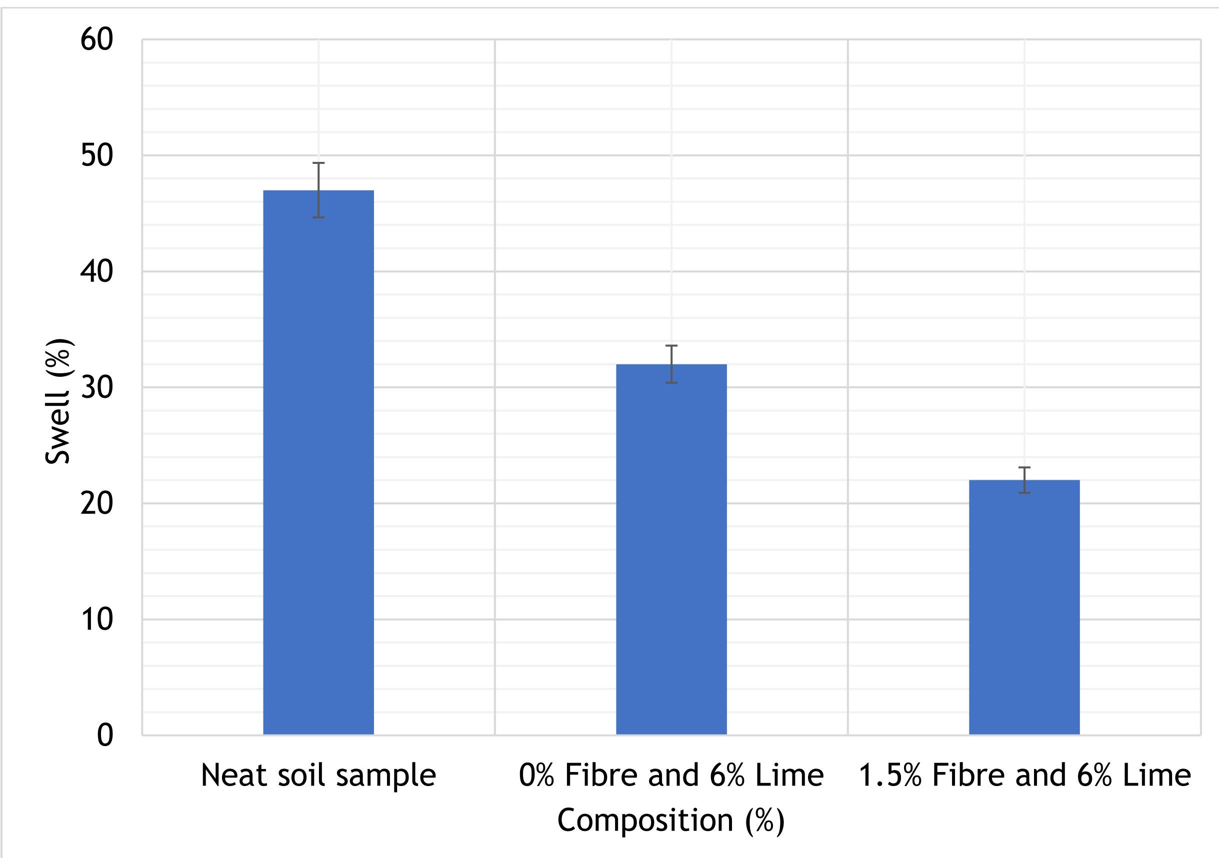

Figure 15: Swell against Composition

The trend of the Free Swell Index tests was shown to continuously decrease with regards to the neat soil, the soil reinforced with 0 % and 1.5 % PET fibre, and 6 % hydrated lime. According to Holtz and Gibbs, the Free Swell Index classification found that swell results within the range of 35-50 % were considered to be high while those found fall within the range of 20-35 %, were taken to be medium (Pardoyo, et al., 2020).

The neat soil sample was observed to have a swell value of 47 %. The Free Swell Index result of the neat soil sample implied that the given soil was unsuitable for use as a subgrade material. The swell value of 47 % is attributed to the fact that expansive clay soils containing minerals such as montmorillonite, smectite, or vermiculite are especially susceptible to this swell behaviour once exposed to water (Lees, 2021).

The soil sample stabilised with only 6 % of hydrated Lime obtained a swell value of 32%, and this value was lower compared to the value initially obtained for the neat soil sample. This is because when lime reacted with clay minerals, it underwent a pozzolanic reaction. This reaction formed cementing materials like calcite and calcium-silicate-hydrate. These acted like glue, binding the clay particles together. This tightened the soil structure, leaving less space for water to be absorbed by the clay (THE CONSTRUCTOR, n.d.).

The soil sample with a mix ratio of 6 % Lime and 1.5 % PET fibre had a swell value of 22%, and this was due to the fibre addition limiting the swell of soil by forming a coherent fibre-soil matrix with higher strength that restricts soil movement resulting in swell behaviour of the soil is reduced even when such soil was already stabilised using lime (Rabab'ah, et al., 2021).

4.4 Project Design

PERCENTAGES BY MASS OF MATERIALS (%)				TEST RESULTS				
Expansive soils	Polyethylene Terephthalate fibre	Hydrated Lime	Total	CBR (%)	MDD (g/cm^3)	UCS (MPa)	OMC (%)	PI (%)
94.0	0	6	100	44	1.464	0.34	27.4	17.9
93.5	0.5	6	100	46	1.505	0.42	26.7	21.0
93.0	1.0	6	100	50	1.524	0.55	25.8	18.9
92.5	1.5	6	100	54	1.556	0.59	24.9	18.1
92.0	2	6	100	48	1.492	0.23	27.5	16.1

Table 5: Project Design

The project design table shows that the optimum mix ratio of Polyethylene Terephthalate Fibre and hydrated Lime was found to be at 1.5 % and 6 % respectively. This optimum mix ratio was found to have CBR and UCS values of 54 % and 0.59 MPa respectively, which met the minimum CBR and UCS standards of 30 % and 0.50 MPa for the lime-stabilised material, CM according to the MoWT General Specifications for Road and Bridge Works, 2005 manual.

The soil samples with the mix ratios of a consistent percentage of 6 % of hydrated Lime and fibre contents of 0 %, 1.0 % and 0.5 % had UCS values that did not meet the minimum UCS value of 0.5MPa required for cemented layer subgrade material of CM according to the SERIES 3000 Manual.

The soil sample that was reinforced with 2 % PET fibre and stabilised with 6 % hydrated lime obtained a UCS value of 0.23 MPa and a CBR of 48 %. However, the UCS value did not meet the standards of a lime-stabilised material, CM according to SERIES 3000 - EARTHWORKS AND PAVEMENT LAYERS OF GRAVEL OR CR.

CHAPTER FIVE: FINDINGS, CONCLUSION AND RECOMMENDATIONS

5.1 Findings

a) The neat soil was found to have poorly graded soils along with Atterberg limits of a high Plasticity Index and Liquid Limit of 38.2 % and 75.8 %. The soil also had a low CBR value of 7.5 % for a subgrade material plus a high swell value of 47 %.

b) The high tensile strength value of 224.6 MPa along with the elongation of the PET fibre further gave the justification for the use of such fibres in the reinforcement of soils stabilised with lime. The hydrated lime was found to have a Calcium hydroxide composition of around 85.80 %.

c) The various PET fibre contents of 0 %, 0.5 %, 1.0 %, 1.5 % and 2.0 % while using a constant amount of 6 % of hydrated lime once mixed were found to have CBR and UCS values of 44 %, 46 %, 50 %, 54 % and 4 8%, and 0.34 MPa, 0.42 MPa, 0.55 MPa, 0.59 MPa and 0.23 MPa respectively. However, the values of the CBR, MDD and UCS decreased for the 2 % PET fibre and 6 % Hydrated lime mix ratio. The optimum mix ratio of 1.5 % PET fibre and 6 % hydrated Lime was found to have a CBR and UCS value of 54 % and 0.59 Ma respectively.

d) The PET fibre composition of 1.5 % PET fibre and 6 % hydrated lime resulted in the acquisition of parameters of a suitable chemically stabilised subgrade material, CM that has a CBR and UCS value of 54 % and 0.59 MPa respectively.

5.2 Conclusions and Recommendations

5.2.1 Conclusions

a) Observations of the neat soil sample indicated highly plastic clay, necessitating soil property modification. This was due to the soil having a high Plasticity Index value of 38.2 % and Liquid Limit of 75.6 % which resulted in the soil being classified as a highly plastic clayey soil. Furthermore, the swell value of 47 % indicated that the soil was prone to high volumetric changes.

b) The tensile strength and elongation of the PET fibre influenced the confirmed suitability to transfer tensile stresses within the soil matrix without the fibres undergoing failure. Furthermore, the hydrated lime was found to have a composition of Calcium Hydroxide of around 85.80 % which was sufficient to ensure pozzolanic reactions between the lime and expansive soils.

c) The 6 % hydrated lime stabilised soil samples reinforced with 0 %, 0.5 %, 1.0% and 1.5 % PET fibre were observed to have increased strength parameters of the CBR and UCS. The mix ratio of 1.5 % PET fibre and 6 % hydrated lime was found to be the optimum mix ratio as this ratio had the CBR and UCS values of 54 % and 0.59 MPa respectively which met the minimum standards of a lime-stabilised soil material, CM. The mix ratio of 6 % lime and 2 % PET fibre was found to have a decrease in the strength parameter of UCS of 0.23 MPa which did not meet the MoWT General Specifications for Road and Bridge Works,2005 for minimum standard UCS of 0.50 MPa. Furthermore, it was ascertained that PET fibre had improved the strength parameters of the lime-stabilised soil up to the optimum PET fibre content of 1.5 % used for reinforcement.

d) The soil stabilised with 6% hydrated Lime and reinforced with 1.5 % PET fibre mix ratio was found to obtain the required parameters of 0.59 MPa and 54 % of UCS and CBR respectively required for a chemically stabilised subgrade material, CM of minimum CBR of 30 % and UCS of 0.5 MPa according to the MoWT General Specifications for Road and Bridge Works,2005. Hence the mix ratio of 6 % hydrated lime and 1.5% PET fibre was found to be the optimum mix ratio along with the PET fibre being found to be suitable for application in the reinforcement of lime-stabilised soils.

5.2.2 Recommendations

a) There is the consideration of conducting durability tests such as wetting and drying to ascertain the endurance of the PET fibre to reinforce the subgrade soils over long periods.

b) Further research is needed into the application of other fibres such as natural fibres in the reinforcement of lime-stabilised expansive soils.

c) There is a need to conduct the UCS tests over long curing periods beyond 14 days to ascertain whether higher UCS values of fibre-reinforced lime-stabilised soil can be obtained.

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APPENDIX

INSTITUTION	STUDENTS	TESTING LAB
UGANDA CHRISTIAN UNIVERSITY	ASIIMWE CALEB & MANANA MARK	Stirling

PROJECT: ASSESSING THE USE OF POLYETHYLINE TEREPHTHALATE FIBRE AND LIME FOR STABILISATION OF EXPANSIVE SOILS

SUMMARY OF ALL THE TEST RESULTS FOR EXPANSIVE SOIL STABILISED WITH LIME & FIBRE

LOCATION	BLENDED %	SAMPLING DATE	GRADING								ATTERBERG LIMITS				MDD		CBR	CBR SWELL
			63	37.5	20	5	2	0.425	0.075	GM	LL	PL	PI	LS	MDD	OMC	62Blows	62
	NEAT LATERATIC GRAVEL		100	100	100	99	93	85	81	0.41	75.6	37.5	38.1	20.0	1.498	25.5	8.0	1.13
			100	100	100	99	93	84	80	0.43	76.0	37.6	38.4	20.0	1.492	25.4	7.0	1.01
	EXPANSIVE SOIL STABILISED WITH 6% LIME & 0% FIBRE		100	100	100	98	94	86	76	0.451	65.1	47.2	17.9	10.5	1.464	27.4	44	0.50
			100	100	100	99	94	86	71	0.490	65.2	47.3	17.9	10.5				
	EXPANSIVE SOIL STABILISED WITH 6% LIME & 0.5% FIBRE		100	100	100	99	95	83	73	0.486	67.2	46.4	20.8	20.0	1.505	26.7	46	0.46
			100	100	100	99	92	84	78	0.452	67.3	46.2	21.1	20.0				
0	EXPANSIVE SOIL STABILISED WITH 6% LIME & 1% FIBRE	12/9/2023	100	100	100	99	94	85	73	0.480	66.0	47.0	19.0	20.0	1.524	25.8	50	0.5
			100	100	100	99	94	85	74	0.476	65.6	46.8	18.8	20.0				
	EXPANSIVE SOIL STABILISED WITH 6% LIME & 1.5% FIBRE		100.0	100.0	100.0	99.0	94.1	84.4	70.7	0.508	67.4	49.3	18.1	9.4	1.556	24.9	54	0.31
			100.0	100.0	100.0	99.0	93.2	82.8	75.4	0.486	67.4	49.3	18.1	9.4				
	EXPANSIVE SOIL STABILISED WITH 6% LIME & 2% FIBRE		100.0	100.0	100.0	98.9	94.4	84.9	80.1	0.406	65.5	49.4	16.0	9.0	1.492	27.5	48	0.43
			100.0	100.0	100.0	99.1	94.5	83.8	77.6	0.441	65.5	49.3	16.2	9.0				

FOR LAB

Lab Technician

Materials Engineer

STIRLING CIVIL ENGINEERING LTD P. O. BOX KAMPALA (U)

INSTITUTION	STUDENTS	TESTING LAB
UGANDA CHRISTIAN UNIVERSITY	ASIIMWE CALEB & MANANA MARK	Stirling

PROJECT: ASSESSING THE USE OF POLYETHYLINE TEREPHTHALATE FIBRE AND LIME FOR STABILISATION OF EXPANSIVE SOILS

SUMMARY OF TEST RESULTS FOR EXPANSIVE SOIL STABILISED WITH 6% LIME & 0% FIBRE

LOCATION: MUYEMBE-NAKAPIRIPIRIT ROAD Depth: 0.5m

LOCATION	BLENDED %		GRADING								ATTERBERG LIMITS				MDD		CBR	CBR SWELL	NATURAL MOISTURE CONTENT
		SAMPLING DATE	63	37.5	20	5	2	0.425	0.075	GM	LL	PL	PI	LS	MDD	OMC		62	AVERAGE
MUYEMBE-NAKAPIRIPIRIT ROAD	EXPANSIVE SOIL STABILISED WITH 6% LIME & 0% FIBRE	Sample 01	100	100	100	98	94	86	76	0.45	65.1	47.2	17.9	10.5	1.464	27.4	43.8	0.50	37.75
		Sample 02	100	100	100	99	94	86	71	0.49	65.2	47.3	17.9	10.5					
			100	100	100	98.59	93.75	85.78	73.44	0.47	65.2	47.2	17.9	10.5	1.464	27.4	43.8	0.50	37.7
		1/8/2024																	
	AVERAGE		100	100	100	99	94	86	73	0.470	65.2	47.3	17.9	10.5	1.464	27.4	43.8	0.50	37.75

FOR LAB

Lab Technician

Materials Engineer

STUDENTS

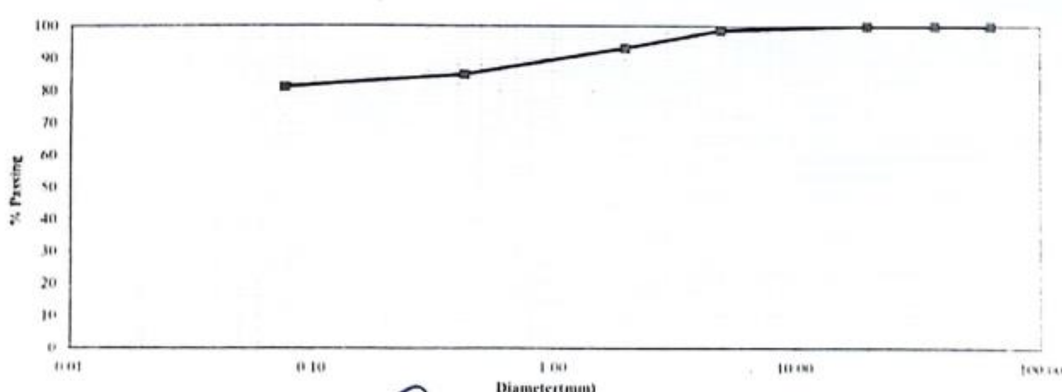
INSTITUTION	STUDENTS NAMES	TESTING LAB
UGANDA CHRISTIAN UNIVERSITY	ASIIMWE CALEB & MANANA MARK	Stirling

PROJECT : ASSESSING THE USE OF POLYETHYLINE TEREPHTHALATE FIBRE AND LIME FOR STABILISATION OF EXPANSIVE SOILS

PARTICLE SIZE DISTRIBUTION (BS 1377 - 2 - 90)

Location :	MUYEMBE-NAKAPIRIPIRIT ROAD	Lab. Refernece No.:		
Location :(km)	NEAT SAMPLE TP 01	Dry wt. of sample before washing: (g)		4296.2
Depth: (m)	0.5m	Dry wt. of sample after washing: (g)		826.9
Material description:	MUYEMBE-NAKAPIRIPIRIT ROAD	Date Sampled:	Date Tested:	Technician
		8/Jan/2024	13/Jan/2024	Lab team

Sieve Size (mm)	Weight Retained (g)	Retained (%)	Passing (%)	Grading Limits (G60 & 80)	
63.0	0.0	0	100	100	100
37.5	0.0	0.0	100	80	100
20.0	0.0	0.0	100	60	95
5.0	52.9	1.2	99	30	65
2.00	237.5	5.5	93	20	50
0.425	353.1	8.2	85	10	30
0.075	172.1	4.0	81	5	15
Total fines	3480.6	81.0			
Bottom Pan	11.3				
Extracted fines	3469.3				
Total sample	4296.2				
Grading Modulus		0.41			



Testing Lab

Lab Technician

STIRLING CIVIL ENGINEERING LTD

P. O. BOX 796, KAMPALA (U)

STUDENTS

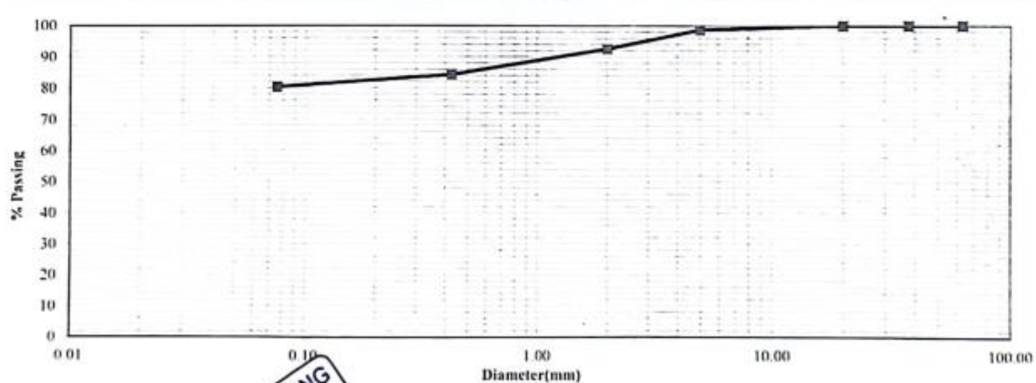
INSTITUTION	STUDENTS NAMES	TESTING LAB
UGANDA CHRISTIAN UNIVERSITY	ASIIMWE CALEB & MANANA MARK	Stirling

PROJECT : ASSESSING THE USE OF POLYETHYLINE TEREPHTHALATE FIBRE AND LIME FOR STABILISATION OF EXPANSIVE SOILS

PARTICLE SIZE DISTRIBUTION (BS 1377 - 2 - 90)

Location :	MUYEMBE-NAKAPIRIPIRIT ROAD	Lab. Refernece No.:		
Location :(km)	NEAT SAMPLE TP 02	Dry wt. of sample before washing: (g)		4130.9
Depth: (m)	0.5m	Dry wt. of sample after washing: (g)		818.6
Material description:	MUYEMBE-NAKAPIRIPIRIT ROAD	Date Sampled:	Date Tested:	Technician
		8/Jan/2024	13/Jan/2024	Lab team

Sieve Size (mm)	Weight Retained (g)	Retained (%)	Passing (%)	Grading Limits (G60 & 80)	
63.0	0.0	0	**100**	100	100
37.5	0.0	0.0	**100**	80	100
20.0	0.0	0.0	**100**	60	95
5.0	54.6	1.3	**99**	30	65
2.00	249.7	6.0	**93**	20	50
0.425	345.9	8.4	**84**	10	30
0.075	166.9	4.0	**80**	5	15
Total fines	3313.8	80.2			
Bottom Pan	1.5				
Extracted fines	3312.3				
Total sample	4130.9				
Grading Modulus		**0.43**			



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Lab Technician

Materials Engineer

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PROJECT:	ASSESSING THE USE OF POLYETHYLINE TEREPHTHALATE FIBRE AND LIME FOR STABILISATION OF EXPANSIVE SOILS

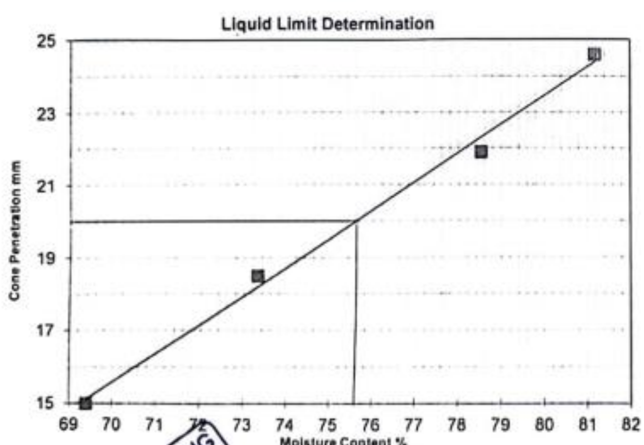
ATTERBERG LIMITS

Liquid limit (cone penotrometer) and plastic limit

SOURCE :	MUYEMBE-NAKAPIRIPIRIT ROAD	Technician:	Lab Team
mix	NEAT SAMPLE TP 01	Sample Date	8/Jan/2024
Test method	BS 1377: Part 2, 1990:4.3/4.4	Test Date	11/Jan/2024
LAYER	EXPANSIVE SOILS		
Depth:	0.5m		

PLASTIC LIMIT	Test No.	TN	DT		Average
Mass of wet soil + container (g)		26.31	27.62		26.965
Mass of dry soil + container (g)		25.19	26.31		25.75
Mass of container (g)		22.25	22.76		22.505
Mass of moisture (g)		1.12	1.3		1.215
Mass of dry soil (g)		2.94	3.55		3.245
Moisture content %		38.1	36.9		37.5
AVERAGE					

LIQUID LIMIT	Test No	1	2	3	4
Initial gauge reading (mm)		0	0	0	0
Final gauge reading (mm)		15.0	18.5	21.9	24.6
penetration (mm)		15.0	18.5	21.9	24.6
AVERAGE		15.0	18.5	21.9	24.6
Container No.		PI66	A6	PI46	PP
Mass of wet soil + container (g)		45.02	53.52	47.54	46.51
Mass of dry soil + container (g)		29.46	33.75	29.81	28.74
Mass of container (g)		7.04	6.78	7.23	6.85
Mass of moisture (g)		15.56	19.77	17.73	17.77
Mass of dry soil (g)		22.42	26.97	22.58	21.89
Moisture content (%)		69.4	73.3	78.5	81.2
AVERAGE		69.4	73.3	78.5	81.2



Liquid limit (%)	75.6
Plastic limit (%)	37.5
Plasticity Index (%)	38.1
Linear shrinkage	
Trough No	4
Trough length (cm)	14.0
Specimen length (cm)	11.2
L.shringage =	2.8
% L.shrinkage =	20.0

Remarks:

TESTING LAB		STUDENTS
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Lab Technician		

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PROJECT:	ASSESSING THE USE OF POLYETHYLINE TEREPHTHALATE FIBRE AND LIME FOR STABILISATION OF EXPANSIVE SOILS

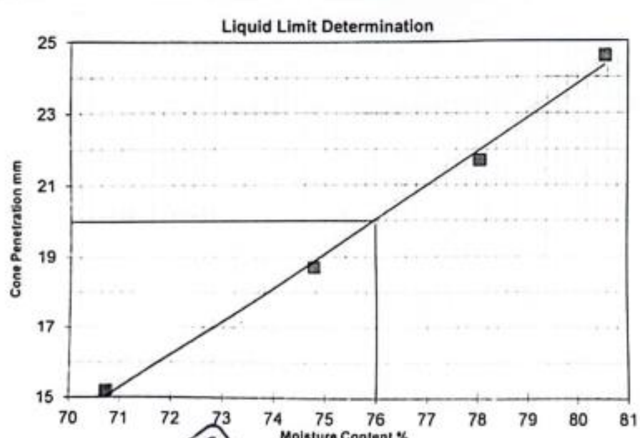
ATTERBERG LIMITS

Liquid limit (cone penotrometer) and plastic limit

SOURCE .	MUYEMBE-NAKAPIRIPIRIT ROAD	Technician:	Lab Team
mix	NEAT SAMPLE TP 02	Sample Date .	8/Jan/2024
Test method	BS 1377: Part 2, 1990:4.3/4.4	Test Date	11/Jan/2024
LAYER	EXPANSIVE SOILS		
Depth:	0.5m		

PLASTIC LIMIT	Test No.	SO	PL		Average
Mass of wet soil + container (g)		44.23	36.25		40.24
Mass of dry soil + container (g)		38.4	32.22		35.31
Mass of container (g)		22.9	21.5		22.2
Mass of moisture (g)		5.83	4.0		4.93
Mass of dry soil (g)		15.5	10.72		13.11
Moisture content %		37.6	37.6		37.6
AVERAGE					

LIQUID LIMIT	Test No	1	2	3	4
Initial gauge reading (mm)		0	0	0	0
Final gauge reading (mm)		15.2	18.7	21.7	24.6
penetration (mm)		15.2	18.7	21.7	24.6
AVERAGE		15.2	18.7	21.7	24.6
Container No.		PI28	PI33	PI33	AT
Mass of wet soil + container (g)		49.76	40.88	56.72	56.63
Mass of dry soil + container (g)		32.02	26.30	34.91	35.51
Mass of container (g)		6.94	6.80	6.97	9.29
Mass of moisture (g)		17.74	14.58	21.81	21.12
Mass of dry soil (g)		25.08	19.5	27.94	26.22
Moisture content (%)		70.7	74.8	78.1	80.5
AVERAGE		70.7	74.8	78.1	80.5



Liquid limit (%)	76.0
Plastic limit (%)	37.6
Plasticity Index (%)	38.4
Linear shrinkage	
Trough No	4
Trough length (cm)	14.0
Specimen length (cm)	11.2
L.shringage =	2.8
% L.shrinkage =	20.0

Remarks:

TESTING LAB

Materials Engineer

Lab Technician

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JAN 2024
P.O. BOX 796, KAMPALA (U)

STUDENTS

INSTITUTION	STUDENTS NAMES	TESTING LAB
UGANDA CHRISTIAN UNIVERSITY	ASIIMWE CALEB & MANANA MARK	Stirling

PROJECT:	ASSESSING THE USE OF POLYETHYLINE TEREPHTHALATE FIBRE AND LIME FOR STABILISATION OF EXPANSIVE SOILS				
Test Reference No.	Depth. 0.5m		Date Sampled	Date Tested	Technician
Mix	NEAT SAMPLE TP 01		8/Jan/24	13/Jan/24	Lab team
SOURCE	MUYEMBE-NAKAPIRIPIRIT ROAD				
Material description:	EXPANSIVE SOILS		Natural moisture (%) :	11.0	

TEST DATA

Weight of rammer (Kg)	No. of blows per layer	No of layers	Height of drop (mm)	Diameter of mould(mm)	Volume of mould (cm^3)
4.5	27	5	457	100	1,000

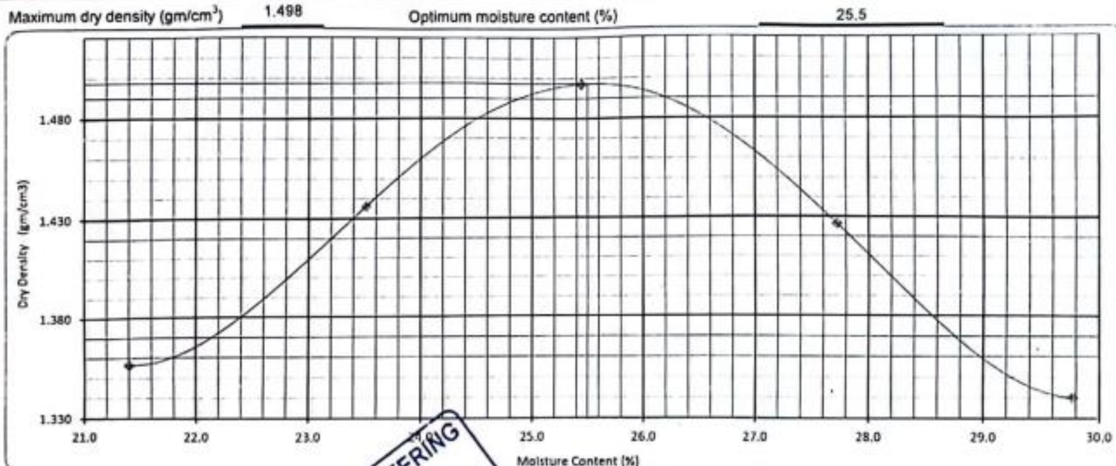
MOISTURE CONTENT DATA

Test No.		1	2	3	4	5
Tin No.		A	A	A	A	A
Water Added	cm^3	120	220	320	420	520
Mass of Compacted soil + mould	gm	5,929	6,056	6,160	6,104	6,021
Mass of Mould	gm	4,282	4,282	4,282	4,282	4,282
Mass of Compacted soil	gm	1647	1774	1878	1822	1739
Volume of mould	cm^3	1,000	1,000	1,000	1,000	1,000
Wet density of soil	g/cm^3	1.647	1.774	1.878	1.822	1.739

DATA FOR PROCTOR CURVE

Container No		2I	NMT	KT	CMI	MJR
Mass of wet soil + Container	gm	2,073.0	1,928.0	2,145.0	2,030.0	2,198.0
Mass of dry soil + container	gm	1,850.0	1,707.0	1,872.0	1,755.0	1,875.0
Mass of container	gm	808.0	767.0	799.0	763.0	790.0
Mass of water added	gm	223	221	273	275	323
Mass of dry soil	gm	1042	940	1073	992	1085
Moisture content	%	21.4	23.5	25.4	27.7	29.8
Dry density	g/cm^3	1.357	1.436	1.497	1.427	1.340

Maximum dry density (gm/cm^3) 1.498 Optimum moisture content (%) 25.5



Remarks:

FOR TESTING LAB		STUDENTS
Lab Technician	Materials Engineer	

STIRLING CIVIL ENGINEERING LTD P.O. BOX 796, KAMPALA (U)

INSTITUTION	STUDENTS NAMES	TESTING LAB
UGANDA CHRISTIAN UNIVERSITY	ASIIMWE CALEB & MANANA MARK	Stirling

PROJECT:	ASSESSING THE USE OF POLYETHYLINE TEREPHTHALATE FIBRE AND LIME FOR STABILISATION OF EXPANSIVE SOILS				
Test Reference No.	Depth.	0.5m	Date Sampled	Date Tested	Technician
Mix	NEAT SAMPLE TP 02		8/Jan/24	13/Jan/24	Lab team
SOURCE	*MUYEMBE-NAKAPIRIPIRIT ROAD*				
Material description:	EXPANSIVE SOILS		Natural moisture (%) :	11.0	

TEST DATA

Weight of rammer (Kg)	No. of blows per layer	No of layers	Height of drop (mm)	Diameter of mould(mm)	Volume of mould (cm^3)
4.5	27	5	457	100	1,000

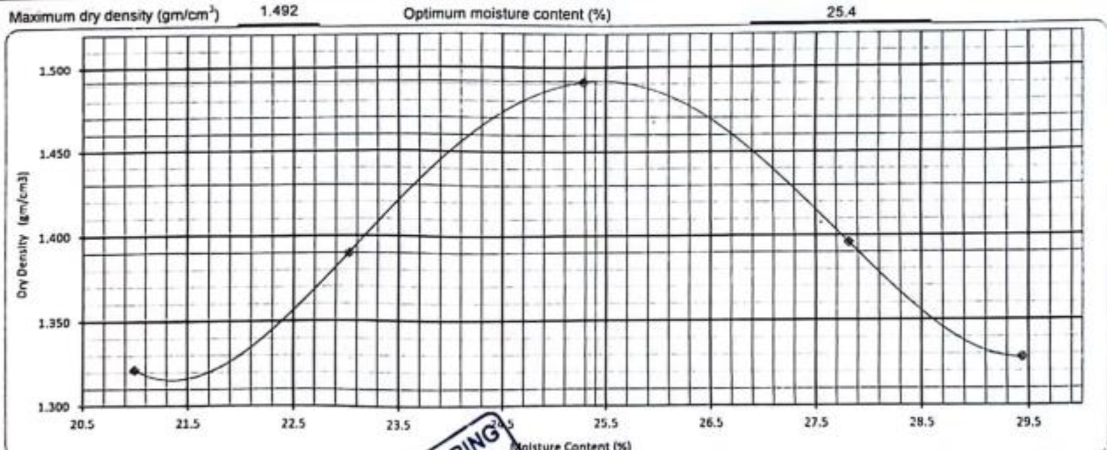
MOISTURE CONTENT DATA

Test No.		1	2	3	4	5
Tin No.		A	A	A	A	A
Water Added	cm^3	200	300	400	500	600
Mass of Compacted soil + mould	gm	4,815	4,926	5,084	5,000	4,935
Mass of Mould	gm	3,216	3,216	3,216	3,216	3,216
Mass of Compacted soil	gm	1599	1710	1868	1784	1719
Volume of mould	cm^3	1,000	1,000	1,000	1,000	1,000
Wet density of soil	g/cm^3	1.599	1.710	1.868	1.784	1.719

DATA FOR PROCTOR CURVE

Container No.		ACB	CB	NBM	NUK	UPC
Mass of wet soil + Container	gm	1,952.0	2,005.0	1,915.0	1,735.0	2,165.0
Mass of dry soil + container	gm	1,753.0	1,772.0	1,690.0	1,525.0	1,855.0
Mass of container	gm	805.0	760.0	800.0	770.0	802.0
Mass of water added	gm	199	233	225	210	310
Mass of dry soil	gm	948	1012	890	755	1053
Moisture content	%	21.0	23.0	25.3	27.8	29.4
Dry density	g/cm^3	1.322	1.390	1.491	1.396	1.328

Maximum dry density (gm/cm^3) 1.492 Optimum moisture content (%) 25.4



Remarks:

FOR TESTING LAB			STUDENTS
Lab Technician	Materials Engineer		

STIRLING CIVIL ENGINEERING LTD

P. O. BOX 796, KAMPALA (U)

Institution	Students Names	Testing Lab
UGANDA CHRISTIAN UNIVERSITY	ASHIMWE CALEB & MANANA MARK	Stirling

ASSESSING THE USE OF POLYETHYLINE TEREPHTHALATE FIBRE AND LIME FOR STABILISATION OF EXPANSIVE SOILS

CALIFORNIA BEARING RATIO TEST (BS 1377 Part 4)

Test sample reference :	Depth. 0.5m	Sampling Date :	8/Jan/24
mix:	NEAT SAMPLE TP 01	Casting date :	14/Jan/24
Source:	MUYEMBE-NAKAPIRIPIRIT ROAD	Testing Date :	18/Jan/24
		Technician :	Lab team
Sample Description:	EXPANSIVE SOILS	Volume of Mould used (m^3)	2305

Natural moisture of air dried sample			Volume of water added	
Tin No.	UCJ		Mass of air dried soil (g)	6000
Tin + air dried soil sample (g)	2025		MDD (Mg/m^3)	1.498
Tin + oven dry soil sample (g)	1845		N.M.C (%)	17.3
Tin (g)	807		OMC (%)	25.5
Dry soil sample	1038		Added OMC (%)	8.2
Water (g)	180		Calculated dry wt of soil (g)	4959.5
N.M.C (%)	17.3		Water added (g)	417
Average (%)	17.3		Water added (ml.)	417

Number of blows		62									
Number of layer		5									
Water Content Determination		Before Soaking		After Soaking							
Tare No		XZM	-	MU	-						
Mass of wet sample + Tare	g	2005	-	2460	-						
Mass of dry sample + Tare	g	1756	-	2096	-						
Mass of Tare	g	805	-	807	-						
Mass of water	g	249	-	364	-						
Mass of dry sample	g	951	-	1289	-						
Water content	%	26.2	-	28.2	-						
Average water Content	%	26.2		28.2							
Density determination											
Mould No		NO									
Mass of mould + soil	g	11625		11720							
Mass of mould	g	6999		6999							
Mass of soil	g	4626		4721							
Volume of the mould	cm3	2305		2305							
Moist density	g/cm3	2.007		2.048							
Dry density	g/cm3	1.591		1.597							
Swell Determination											
Date		Hour		D.Gauge Reding							
Initial reading		96 hrs		18.22							
Final reading				19.66							
Height of the specimen				127							
Height of swell				1.44							
		Swelling(%)		1.13							
Observations											

For the Lab	For Students
Lab. Technician	

STIRLING CIVIL ENGINEERING LTD
P.O. BOX 798, KAMPALA (U)

Institution	Students Names	Testing Lab
UGANDA CHRISTIAN UNIVERSITY	ASIIMWE CALEB & MANANA MARK	Stirling

ASSESSING THE USE OF POLYETHYLINE TEREPHTHALATE FIBRE AND LIME FOR STABILISATION OF EXPANSIVE SOILS

CALIFORNIA BEARING RATIO TEST (BS1377 Part 4)

Test sample reference :	Depth. 0.5m	Sampling Date	8/Jan/24
mix	NEAT SAMPLE TP 01	Penetration Date	18/Jan/24
Source.	MUYEMBE-NAKAPIRIPIRIT ROAD	Technician	:: Lab team
Sample Description :	**EXPANSIVE SOILS**		

Number of blows per layer	62			
Number of layers	5	5		5
Mould No	NO			
Capacity of the Proving Ring (KN)	50	50		50
Proving Ring Constant (KN/div.)	0.2052	0.2052		0.2052

Speed : ....mm min.		Top		Bottom					
Penetration of the plunger (mm)	Time (s)	Reading $*10^{3}$mm	Force (KN)	Reading $*10^{3}$mm	Force (KN)				
0	0	0	0.0	0	0.0				
0.25	12	1	0.2	1	0.2				
0.5	24	1	0.2	2	0.4				
0.75	35	2	0.4	2	0.4				
1	47	2	0.4	3	0.6				
1.5	71	3	0.6	4	0.8				
2	94	3	0.6	5	1.0				
2.5	118	4	0.8	5	1.0				
3	142	4	0.8	6	1.2				
3.5	165	4	0.8	6	1.2				
4	189	5	1.0	7	1.4				
4.5	213	5	1.0	8	1.6				
5	236	5	1.0	8	1.6				
5.5	260	6	1.2	9	1.8				
6	283	6	1.2	9	1.8				
6.5	307	7	1.4	10	2.1				
7	331	7	1.4	10	2.1				
7.5	354	7	1.4	11	2.3				

Observations

For the Contractor		For Students
Lab. Technician	Materials Engineer	

STIRLING CIVIL ENGINEERING LTD
P.O. BOX 796, KAMPALA (U)

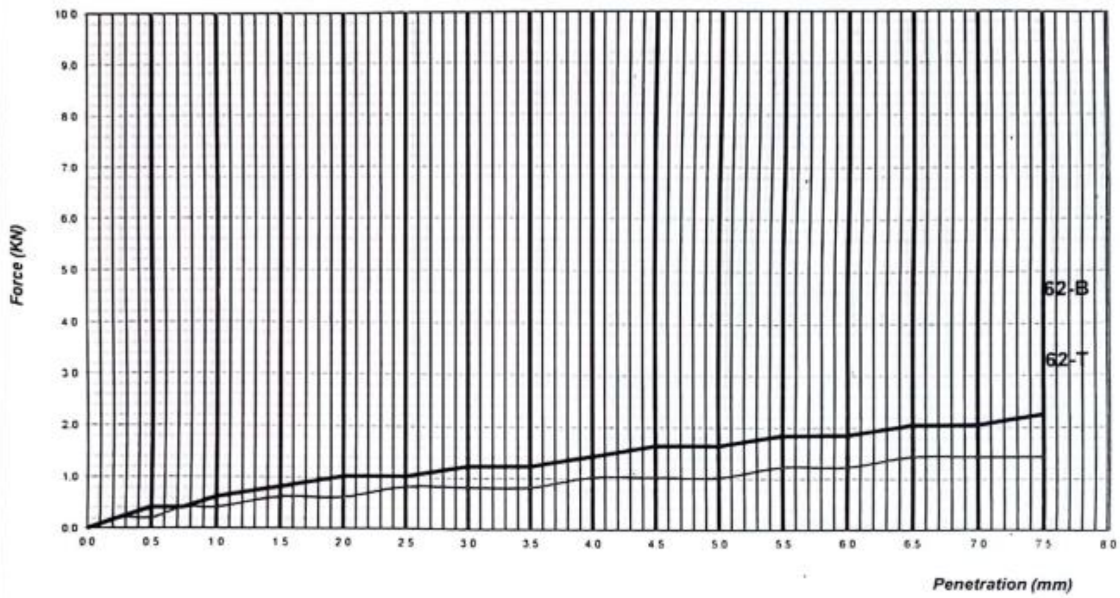
Institution	Students Names	Testing Lab
UGANDA CHRISTIAN UNIVERSITY	ASHMWE CALEB & MANANA MARK	Stirling

ASSESSING THE USE OF POLYETHYLINE TEREPHTHALATE FIBRE AND LIME FOR STABILISATION OF EXPANSIVE SOILS

CALIFORNIA BEARING RATIO TEST (BS1377 Part 4)

Test sample reference	Depth. 0.5m	Sampling Date	8/Jan/24
mix	NEAT SAMPLE TP 01	Testing Date	18/Jan/24
Source:	MUYEMBE-NAKAPIRIPIRIT ROAD	Technician	Lab team
Sample Description:	EXPANSIVE SOILS		

PENETRATION vs FORCE CURVE



	62 blows											
	Force		CBR									
	Bottom	Top	Bottom	Top								
2.5 mm Penetration	1.0	0.8	8	6								
5.0 mm Penetration	1.6	1.0	8	5								
Average	1.3	0.9	8.0	5.7								
Retained CBR												
Observations	CBR= 8.0											

For the Lab		For Students	
Lab. Technician	Materials Engineer		

STIRLING CIVIL ENGINEERING LTD
19 JAN 2024
P.O. BOX 796, KAMPALA (U)

Institution	Students Names	Testing Lab
UGANDA CHRISTIAN UNIVERSITY	ASIIMWE CALEB & MANANA MARK	Stirling

ASSESSING THE USE OF POLYETHYLINE TEREPHTHALATE FIBRE AND LIME FOR STABILISATION OF EXPANSIVE SOILS

CALIFORNIA BEARING RATIO TEST (BS 1377 Part 4)

Test sample reference	Depth. 0.5m	Sampling Date	8/Jan/24
mix	NEAT SAMPLE TP 02	Casting date	14/Jan/24
Source	MUYEMBE -NAKAPIRIPIRIT ROAD	Testing Date	18/Jan/24
		Technician	Lab team
Sample Description	EXPANSIVE SOILS	**Volume of Mould used (m^3)**	2305

Natural moisture of air dried sample			Volume of water added	
Tin No	NM1		Mass of air dried soil (g)	6000
Tin + air dried soil sample (g)	3280		MDD (Mg/m^3)	1.492
Tin + oven dry soil sample (g)	3093		N.M.C (%)	8.0
Tin (g)	765		OMC (%)	25.4
Dry soil sample	2328		Added OMC (%)	17.4
Water (g)	187		Calculated dry wt of soil (g)	5518.0
N.M.C (%)	8.0		Water added (g)	965
Average (%)	8.0		**Water added (mL)**	965

Number of blows		62					
Number of layer		5					
Water Content Determination		Before Soaking	After Soaking				
Tare No		BOJ	Z61				
Mass of wet sample + Tare	g	2260	2460				
Mass of dry sample + Tare	g	1963	2099				
Mass of Tare	g	804	815				
Mass of water	g	297	361				
Mass of dry sample	g	1159	1284				
Water content	%	25.6	28.1				
Average water Content	%	25.6	28.1				
Density determination							
Mould No		14					
Mass of mould + soil	g	10213	10331				
Mass of mould	g	5477	5477				
Mass of soil	g	4736	4854			-	
Volume of the mould	cm3	2305	2305				
Moist density	g/cm3	2.055	2.106				
Dry density	g/cm3	1.636	1.644				
Swell Determination							
Date		Hour	D Gauge Reding				
Initial reading		96 hrs	4.71				
Final reading			5.99				
Height of the specimen			127				
Height of swell							
		Swelling(%)	1.01				

Observations

For the		For Students
Lab Technician		

STIRLING CIVIL ENGINEERING LTD
P. O. BOX 796, KAMPALA (U)

Institution	Students Names	Testing Lab
UGANDA CHRISTIAN UNIVERSITY	ASHIMWE CALEB & MANANA MARK	Stirling

ASSESSING THE USE OF POLYETHYLINE TEREPHTHALATE FIBRE AND LIME FOR STABILISATION OF EXPANSIVE SOILS

CALIFORNIA BEARING RATIO TEST (BS1377 Part 4)

Test sample reference	Depth. 0.5m	Sampling Date	8/Jan/24
mix	NEAT SAMPLE TP 02	Penetration Date	18/Jan/24
Source.	MUYEMBE-NAKAPIRIPIRIT ROAD	Technician	Lab team
Sample Description	EXPANSIVE SOILS		

Number of blows per layer		62							
Number of layers		5				5		5	
Mould No		T4							
Capacity of the Proving Ring (KN)		50				50		50	
Proving Ring Constant (KN/div.)		0.2052				0.2052		0.2052	
Speed *mm/min*		Top		Bottom					
Penetration of the plunger (mm)	Time (s)	Reading $*10^3$mm	Force (KN)	Reading $*10^3$mm	Force (KN)				
0	0	0	0.0	0	0.0				
0.25	12	0	0.0	1	0.2				
0.5	24	0	0.0	2	0.4				
0.75	35	1	0.2	3	0.6				
1	47	1	0.2	3	0.6				
1.5	71	1	0.2	4	0.8				
2	94	1	0.2	4	0.8				
2.5	118	2	0.4	5	1.0				
3	142	2	0.4	5	1.0				
3.5	165	2	0.4	5	1.0				
4	189	2	0.4	6	1.2				
4.5	213	3	0.6	6	1.2				
5	236	3	0.6	6	1.2				
5.5	260	3	0.6	7	1.4				
6	283	4	0.8	7	1.4				
6.5	307	4	0.8	8	1.6				
7	331	4	0.8	8	1.6				
7.5	354	4	0.8	8	1.6				

Observations

For the Contractor		For Students
Lab. Technician	Materials Engineer	

STIRLING CIVIL ENGINEERING LTD
2024
P. O. BOX 796, KAMPALA (U)

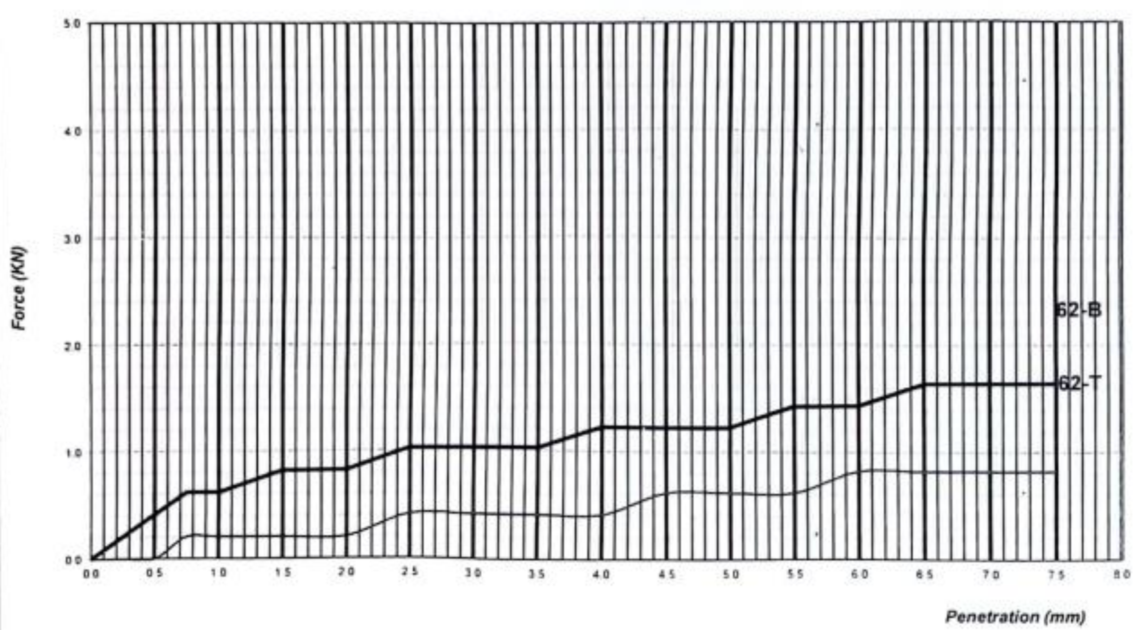
Institution	Students Names	Testing Lab
UGANDA CHRISTIAN UNIVERSITY	ASIIMWE CALEB & MANANA MARK	Stirling

ASSESSING THE USE OF POLYETHYLINE TEREPHTHALATE FIBRE AND LIME FOR STABILISATION OF EXPANSIVE SOILS

CALIFORNIA BEARING RATIO TEST (BS1377 Part 4)

Test sample reference	Depth. 0.5m	Sampling Date	8/Jan/24
mix	NEAT SAMPLE TP 02	Testing Date	18/Jan/24
Source	MUYEMBE-NAKAPIRIPIRIT ROAD	Technician	Lab team
Sample Description	EXPANSIVE SOILS		

PENETRATION vs FORCE CURVE



	62 blows			
	Force		CBR	
	Bottom	Top	Bottom	Top
2.5 mm Penetration	1.0	0.4	8	3
5.0 mm Penetration	1.2	0.6	6	3
Average	1.1	0.5	7.0	3.1
Retained CBR				
Observations	CBR= 7.0			

For Lab — Lab. Technician — Materials Engineer

For Students

STIRLING CIVIL ENGINEERING LTD
P. O. BOX 756, KAMPALA (U)

INSTITUTION	STUDENTS NAMES	TESTING LAB
UGANDA CHRISTIAN UNIVERSITY	ASIIMWE CALEB & MANANA MARK	Stirling

PROJECT:	ASSESSING THE USE OF POLYETHYLINE TEREPHTHALATE FIBRE AND LIME FOR STABILISATION OF EXPANSIVE SOILS					
Test Reference No.		Depth.	0.5	Date Sampled	Date Tested	Technician
Mix		NATURAL MOISTURE CONTENT		9/Jan/24	11/Jan/24	Lab team
SOURCE		MUYEMBE-NAKAPIRIPIRIT ROAD				
Material description:		EXPANSIVE SOILS				

DATA FOR FIELD MOISTURE CONTENT

Container No.		NMT	Y6Y	UCJ	CR7	
Mass of wet soil + Container	gm	2,409.0	2,295.0	2,125.0	2,152.0	
Mass of dry soil + container	gm	1,955.0	1,895.0	1,750.0	1,767.0	
Mass of container	gm	768.0	821.0	808.0	769.0	
Mass of water added	gm	454	400	375	385	
Mass of dry soil	gm	1187	1074	942	998	
Moisture content	%	38.2	37.2	39.8	38.6	
Average Moisture content				**38.5**		

FOR TESTING LAB		STUDENTS
Lab Technician	Materials Engineer	

STIRLING CIVIL ENGINEERING LTD
P. O. BOX 796, KAMPALA (U)

INSTITUTION	STUDENTS	TESTING LAB
UGANDA CHRISTIAN UNIVERSITY	ASIIMWE CALEB & MANANA MARK	Stirling

PROJECT: ASSESSING THE USE OF POLYETHYLINE TEREPHTHALATE FIBRE AND LIME FOR STABILISATION OF EXPANSIVE SOILS

SUMMARY OF TEST RESULTS FOR EXPANSIVE SOIL STABILISED WITH 6% LIME & 0% FIBRE

LOCATION: MUYEMBE-NAKAPIRIPIRIT ROAD Depth: 0.5m

LOCATION	BLENDED %		GRADING								ATTERBERG LIMITS				MDD		CBR	CBR SWELL	NATURAL MOISTURE CONTENT
		SAMPLING DATE	63	37.5	20	5	2	0.425	0.075	GM	LL	PL	PI	LS	MDD	OMC		62	AVERAGE
MUYEMBE-NAKAPIRIPIRIT ROAD	EXPANSIVE SOIL STABILISED WITH 6% LIME & 0% FIBRE	Sample 01	100	100	100	98	94	86	76	0.45	65.1	47.2	17.9	10.5	1.464	27.4	43.8	0.50	37.75
		Sample 02	100	100	100	99	94	86	71	0.49	65.2	47.3	17.9	10.5					
			100	**100**	**100**	**98.59**	**93.75**	**85.78**	**73.44**	**0.47**	**65.2**	**47.2**	**17.9**	**10.5**	**1.464**	**27.4**	**43.8**	**0.50**	**37.7**
		1/8/2024																	
	AVERAGE		**100**	**100**	**100**	**99**	**94**	**86**	**73**	**0.470**	**65.2**	**47.3**	**17.9**	**10.5**	**1.464**	**27.4**	**43.8**	**0.50**	**37.75**

FOR LAB

Lab Technician

Materials Engineer

STUDENTS

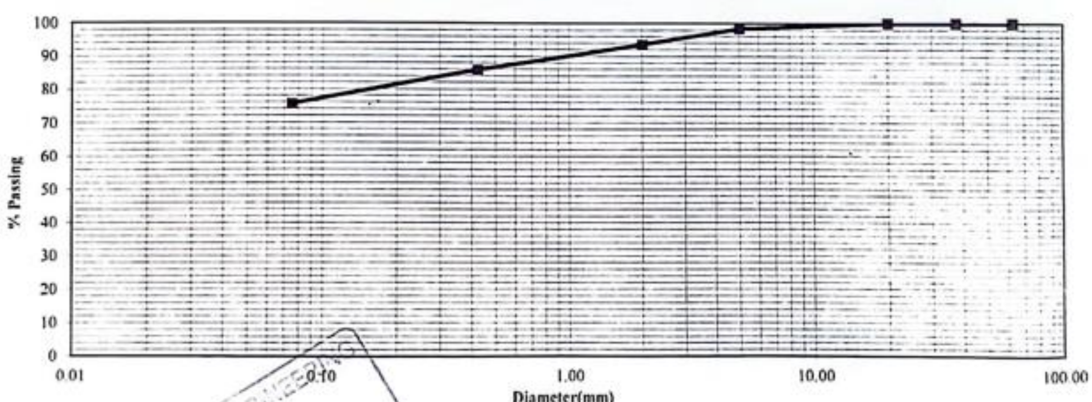
INSTITUTION	STUDENTS NAMES	TESTING LAB
UGANDA CHRISTIAN UNIVERSITY	ASIIMWE CALEB & MANANA MARK	Stirling

PROJECT : ASSESSING THE USE OF POLYETHYLINE TEREPHTHALATE FIBRE AND LIME FOR STABILISATION OF EXPANSIVE SOILS

PARTICLE SIZE DISTRIBUTION (BS 1377 - 2 - 90)

Location :	MUYEMBE-NAKAPIRIPIRIT ROAD	Lab. Refernece No.:		
Location :(km)	EXPANSIVE SOIL STABILISED WITH 6% LIME & 0% FIBRE	Dry wt. of sample before washing: (g)		2320.6
Depth: (m)	0.5m	Dry wt. of sample after washing: (g)		586.7
Material description:	MUYEMBE-NAKAPIRIPIRIT ROAD	Date Sampled:	Date Tested:	Technician
		8/Jan/2024	26/Feb/2024	Lab team

Sieve Size (mm)	Weight Retained (g)	Retained (%)	Passing (%)	Grading Limits (G60 & 80)	
63.0	0.0	0	100		
37.5	0.0	0.0	100		
20.0	0.0	0.0	100		
5.0	37.7	1.6	98		
2.00	111.7	4.8	94		
0.425	179.0	7.7	86		
0.075	239.5	10.3	76		
Total fines	1752.7	75.5			
Bottom Pan	18.8				
Extracted fines	1733.9				
Total sample	2320.6				
Grading Modulus		0.45			



Testing Lab

Lab Technician

Materials Engineer

STUDENTS

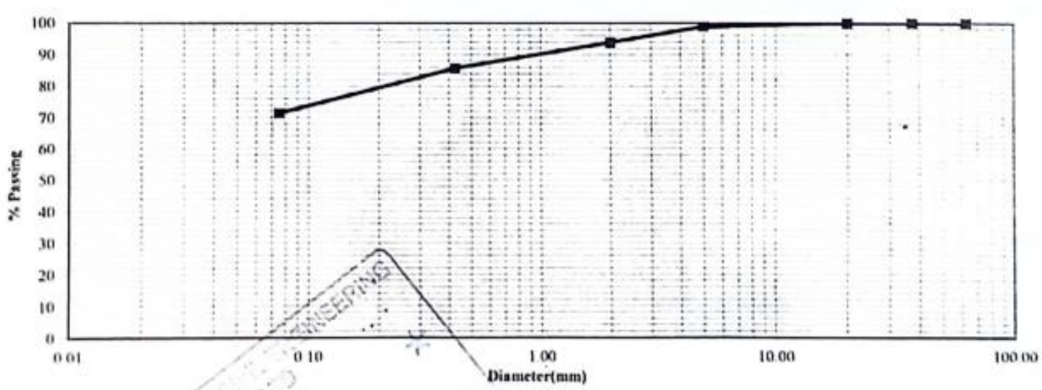
INSTITUTION	STUDENTS NAMES	TESTING LAB
UGANDA CHRISTIAN UNIVERSITY	ASIIMWE CALEB & MANANA MARK	Stirling

PROJECT : ASSESSING THE USE OF POLYETHYLINE TEREPHTHALATE FIBRE AND LIME FOR STABILISATION OF EXPANSIVE SOILS

PARTICLE SIZE DISTRIBUTION (BS 1377 - 2 - 90)

Location	MUYEMBE-NAKAPIRIPIRIT ROAD	Lab. Refernece No.:		
Location :(km)	NEAT SAMPLE TP 02	Dry wt. of sample before washing: (g)		2733.9
Depth: (m)	0.5m	Dry wt. of sample after washing: (g)		811.0
Material description:	MUYEMBE-NAKAPIRIPIRIT ROAD	Date Sampled:	Date Tested:	Technician
		8/Jan/2024	26/Feb/2024	Lab team

Sieve Size (mm)	Weight Retained (g)	Retained (%)	Passing (%)	Grading Limits (G60 & 80)	
63.0	0.0	0	100		
37.5	0.0	0.0	100		
20.0	0.0	0.0	100		
5.0	32.6	1.2	99		
2.00	133.3	4.9	94		
0.425	224.7	8.2	86		
0.075	392.6	14.4	71		
Total fines	1950.7	71.4			
Bottom Pan	27.8				
Extracted fines	1922.9				
Total sample	2733.9				
Grading Modulus		0.49			



Testing Lab	STUDENTS
Lab Technician / Materials Engineer	

INSTITUTION	STUDENTS	TESTING LAB
UGANDA CHRISTIAN UNIVERSITY	ASIIMWE CALEB & MANANA MARK	Stirling

PROJECT:	ASSESSING THE USE OF POLYETHYLINE TEREPHTHALATE FIBRE AND LIME FOR STABILISATION OF EXPANSIVE SOILS

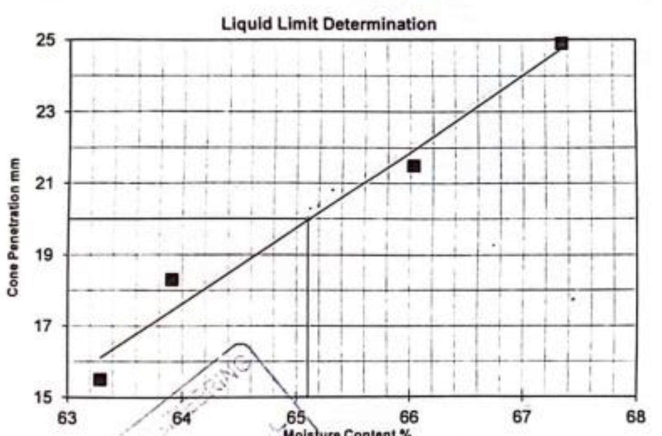
ATTERBERG LIMITS

Liquid limit (cone penotrometer) and plastic limit

SOURCE :	MUYEMBE-NAKAPIRIPIRIT ROAD	Technician:	Lab Team
mix	XPANSIVE SOIL STABILISED WITH 6% LIME & 0% FIBR	Sample Date	8/Jan/2024
Test method	BS 1377: Part 2, 1990:4.3/4.4	Test Date	11/Jan/2024
LAYER	EXPANSIVE SOILS		
Depth:	0.5m		

PLASTIC LIMIT	Test No.	VP	AB		Average
Mass of wet soil + container (g)		39.49	33.52		36.505
Mass of dry soil + container (g)		33.73	29.5		31.615
Mass of container (g)		21.53	20.99		21.26
Mass of moisture (g)		5.76	4.0		4.89
Mass of dry soil (g)		12.2	8.51		10.355
Moisture content %		47.2	47.2		47.2
AVERAGE					

LIQUID LIMIT	Test No	1	2	3	4
Initial gauge reading (mm)		0	0	0	0
Final gauge reading (mm)		15.5	18.3	21.5	24.9
penetration (mm)		15.5	18.3	21.5	24.9
AVERAGE		15.5	18.3	21.5	24.9
Container No.		BB	A7	BC	PI86
Mass of wet soil + container (g)		57.10	61.87	59.74	66.88
Mass of dry soil + container (g)		37.62	41.40	38.79	42.81
Mass of container (g)		6.84	9.37	7.06	7.07
Mass of moisture (g)		19.48	20.47	20.95	24.07
Mass of dry soil (g)		30.78	32.03	31.73	35.74
Moisture content (%)		63.3	63.9	66.0	67.3
AVERAGE		63.3	63.9	66.0	67.3



Liquid limit (%)	65.1
Plastic limit (%)	47.2
Plasticity Index (%)	17.9
Linear shrinkage	
Trough No.	4
Trough length (cm)	14.0
Specimen length (cm)	12.5
L.shringage =	1.5
% L.shrinkage =	10.5

Remarks:

TESTING LAB		STUDENTS
Materials Engineer		
Lab Technician		

INSTITUTION	STUDENTS	TESTING LAB
UGANDA CHRISTIAN UNIVERSITY	ASIIMWE CALEB & MANANA MARK	Stirling

PROJECT:	ASSESSING THE USE OF POLYETHYLINE TEREPHTHALATE FIBRE AND LIME FOR STABILISATION OF EXPANSIVE SOILS

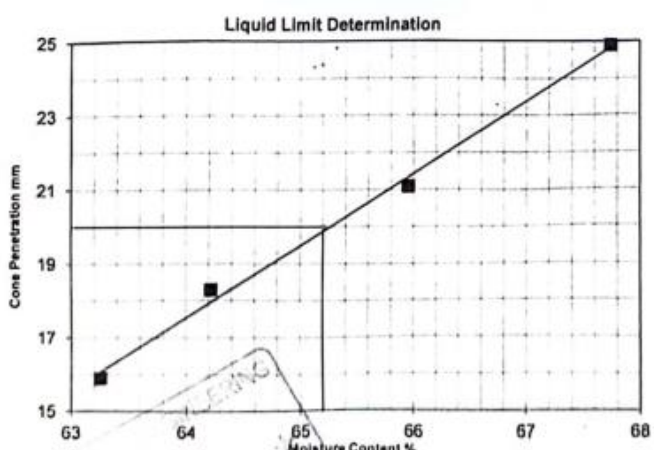
ATTERBERG LIMITS

Liquid limit (cone penetrometer) and plastic limit

SOURCE	MUYEMBE-NAKAPIRIPIRIT ROAD	Technician:	Lab Team
mix	NEAT SAMPLE TP 02	Sample Date	8/Jan/2024
Test method	BS 1377: Part 2, 1990:4.3/4.4	Test Date	11/Jan/2024
LAYER	EXPANSIVE SOILS		
Depth.	0.5m		

PLASTIC LIMIT	Test No.	RAD	Q		Average
Mass of wet soil + container (g)		48.2	45.71		46.955
Mass of dry soil + container (g)		39.78	38.01		38.895
Mass of container (g)		21.98	21.7		21.84
Mass of moisture (g)		8.42	7.7		8.06
Mass of dry soil (g)		17.8	16.31		17.055
Moisture content %		47.3	47.2		47.3
AVERAGE					

LIQUID LIMIT	Test No	1	2	3	4
Initial gauge reading (mm)		0	0	0	0
Final gauge reading (mm)		15.9	18.3	21.1	24.9
penetration (mm)		15.9	18.3	21.1	24.9
AVERAGE		15.9	18.3	21.1	24.9
Container No.		P114	P182	P153	PIM
Mass of wet soil + container (g)		89.07	67.55	68.78	91.61
Mass of dry soil + container (g)		57.29	43.75	44.88	57.49
Mass of container (g)		7.05	6.69	8.64	7.12
Mass of moisture (g)		31.78	23.8	23.9	34.12
Mass of dry soil (g)		50.24	37.06	36.24	50.37
Moisture content (%)		63.3	64.2	65.9	67.7
AVERAGE		63.3	64.2	65.9	67.7



Liquid limit (%)	65.2
Plastic limit (%)	47.3
Plasticity Index (%)	17.9
Linear shrinkage	
Trough No.	4
Trough length (cm)	14.0
Specimen length (cm)	12.5
L.shringage =	1.5
% L.shrinkage =	10.5

Remarks:

TESTING LAB

Materials Engineer

Lab Technician

STUDENTS

INSTITUTION	STUDENTS NAMES	TESTING LAB
UGANDA CHRISTIAN UNIVERSITY	ASIIMWE CALEB & MANANA MARK	Stirling

PROJECT:	ASSESSING THE USE OF POLYETHYLINE TEREPHTHALATE FIBRE AND LIME FOR STABILISATION OF EXPANSIVE SOILS				
Test Reference No.	Depth 0.5m		Date Sampled	Date Tested	Technician
Mix	EXPANSIVE SOIL STABILISED WITH 6% LIME & 0% FIBRE		8/Jan/24	26/Feb/24	Lab team
SOURCE	MUYEMBE-NAKAPIRIPIRIT ROAD				
Material description:	EXPANSIVE SOILS		Natural moisture (%)	11.0	

TEST DATA

Weight of rammer (Kg)	No. of blows per layer	No of layers	Height of drop (mm)	Diameter of mould(mm)	Volume of mould (cm^3)
4.5	27	5	457	100	1,000

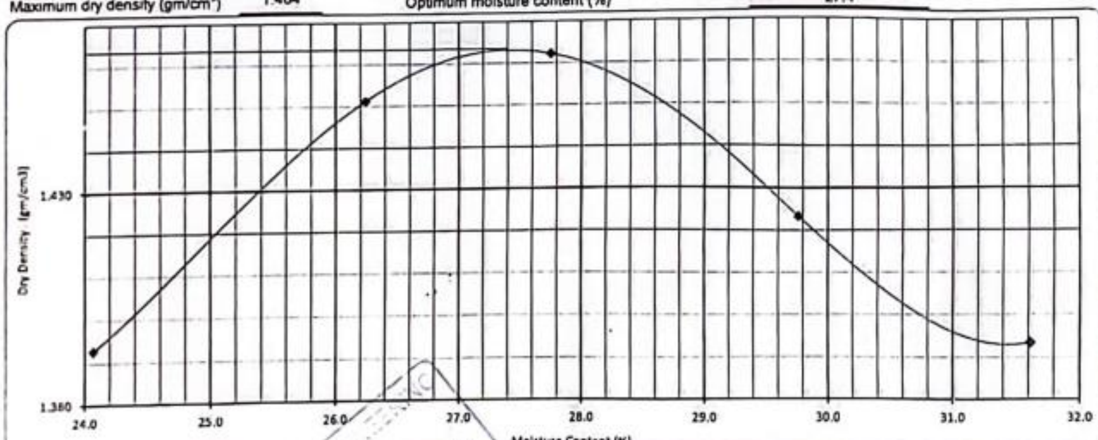
MOISTURE CONTENT DATA

Test No.		1	2	3	4	5
Tin No.		A	A	A	A	A
Water Added	cm^3	260	320	380	440	500
Mass of Compacted soil + mould	gm	4,946	5,050	5,086	5,065	5,052
Mass of Mould	gm	3,218	3,218	3,218	3,218	3,218
Mass of Compacted soil	gm	1728	1832	1868	1847	1834
Volume of mould	cm^3	1,000	1,000	1,000	1,000	1,000
Wet density of soil	g/cm^3	1.728	1.832	1.868	1.847	1.834

DATA FOR PROCTOR CURVE

Container No		KT	CMD	Y6Y	ACB	BAK
Mass of wet soil + Container	gm	2,130.0	2,009.0	2,301.0	2,089.0	2,158.0
Mass of dry soil + container	gm	1,872.0	1,750.0	1,981.0	1,789.0	1,833.0
Mass of container	gm	800.0	763.0	828.0	781.0	805.0
Mass of water added	gm	258	259	320	300	325
Mass of dry soil	gm	1072	987	1153	1008	1028
Moisture content	%	24.1	26.2	27.8	29.8	31.6
Dry density	g/cm^3	1.393	1.451	1.462	1.423	1.393

Maximum dry density (gm/cm^3) 1.464 Optimum moisture content (%) 27.4



Remarks:

FOR TESTING LAB		STUDENTS
Lab Technician	Materials Engineer	

Institution	Students Names	Testing Lab
UGANDA CHRISTIAN UNIVERSITY	ASIIMWE CALEB & MANANA MARK	Stirling

ASSESSING THE USE OF POLYETHYLINE TEREPHTHALATE FIBRE AND LIME FOR STABILISATION OF EXPANSIVE SOILS

CALIFORNIA BEARING RATIO TEST (BS1377 Part 4)

Test sample reference :	Depth 0.5m	Sampling Date	8/Jan/24
mix:	EXPANSIVE SOIL STABILISED WITH 6% LIME & 0% FIBRE	Penetration Date	12/Mar/24
Source:	MUYEMBE-NAKAPIRIPIRIT ROAD	Technician	Lab team
Sample Description :	EXPANSIVE SOILS		

Number of blows per layer	62		
Number of layers	5	5	5
Mould No	MM		
Capacity of the Proving Ring (KN)	50	50	50
Proving Ring Constant (KN/div.)	0.2052	0.2052	0.2052

Speed : ....mm min.		Top		Bottom					
Penetration of the plunger (mm)	Time (s)	Reading $*10^3$mm	Force (KN)	Reading $*10^3$mm	Force (KN)				
0	0	0	0.0	0	0.0				
0.25	12	1	0.2	2	0.4				
0.5	24	2	0.4	5	1.0				
0.75	35	2	0.4	8	1.6				
1	47	4	0.8	10	2.1				
1.5	71	10	2.1	13	2.7				
2	94	15	3.1	16	3.3				
2.5	118	21	4.3	22	4.5				
3	142	26	5.3	26	5.3				
3.5	165	32	6.6	32	6.6				
4	189	37	7.6	40	8.2				
4.5	213	44	9.0	49	10.1				
5	236	49	10.1	52	10.7				
5.5	260	52	10.7	57	11.7				
6	283	56	11.5	61	12.5				
6.5	307	58	11.9	65	13.3				
7	331	59	12.1	69	14.2				
7.5	354	62	12.7	72	14.8				

Observations

For the Contractor		For Students	
Lab. Technician	Materials Engineer		

Institution	Students Names	Testing Lab
UGANDA CHRISTIAN UNIVERSITY	ASHMWE CALEB & MANANA MARK	Stirling

ASSESSING THE USE OF POLYETHYLINE TEREPHTHALATE FIBRE AND LIME FOR STABILISATION OF EXPANSIVE SOILS

CALIFORNIA BEARING RATIO TEST (BS 1377 Part 4)

Test sample reference	Depth. 0.5m	Sampling Date	8/Jan/24
mix:	EXPANSIVE SOIL STABILISED WITH 6% LIME & 0% FIBRE	Casting date :	27/Feb/24
Source:	MUYEMBE-NAKAPIRIPIRIT ROAD	Testing Date :	12/Mar/24
		Technician :	Lab team
Sample Description	EXPANSIVE SOILS	**Volume of Mould used (m^3)**	2305

Natural moisture of air dried sample				Volume of water added	
Tin No.	Z6T			Mass of air dried soil (g)	6000
Tin + air dried soil sample (g)	2475			MDD (Mg/m^3)	1.464
Tin + oven dry soil sample (g)	2273			N.M.C (%)	13.8
Tin (g)	810			OMC (%)	27.4
Dry soil sample	1463			Added OMC (%)	13.6
Water (g)	202			Calculated dry wt of soil (g)	5171.6
N.M.C (%)	13.8			Water added (g)	717
Average (%)	13.8			**Water added (ml.)**	717

Number of blows		62								
Number of layer		5								
Water Content Determination		Before Soaking		After Soaking						
Tare No		Y6Y	-	Z6T	-					
Mass of wet sample + Tare	g	2228	-	1937	-					
Mass of dry sample + Tare	g	1915	-	1668	-					
Mass of Tare	g	820	-	810	-					
Mass of water	g	313	-	269	-					
Mass of dry sample	g	1095	-	858	-					
Water content	%	28.6	-	31.4	-					
Average water Content	%	28.6		31.4						
Density determination										
Mould No		MM								
Mass of mould + soil	g	10421		10542						
Mass of mould	g	6050		6050						
Mass of soil	g	4371		4492						
Volume of the mould	cm3	2305		2305						
Moist density	g/cm3	1.896		1.949						
Dry density	g/cm3	1.475		1.484						
Swell Determination										
Date		Hour		D.Gauge Reding						
Initial reading		96 hrs		9.36						
Final reading				10						
Height of the specimen				127						
Height of swell				0.64						
		Swelling(%)		**0.50**						
Observations										

For the Lab		For Students	
Lab Technician	Materials Engineer		

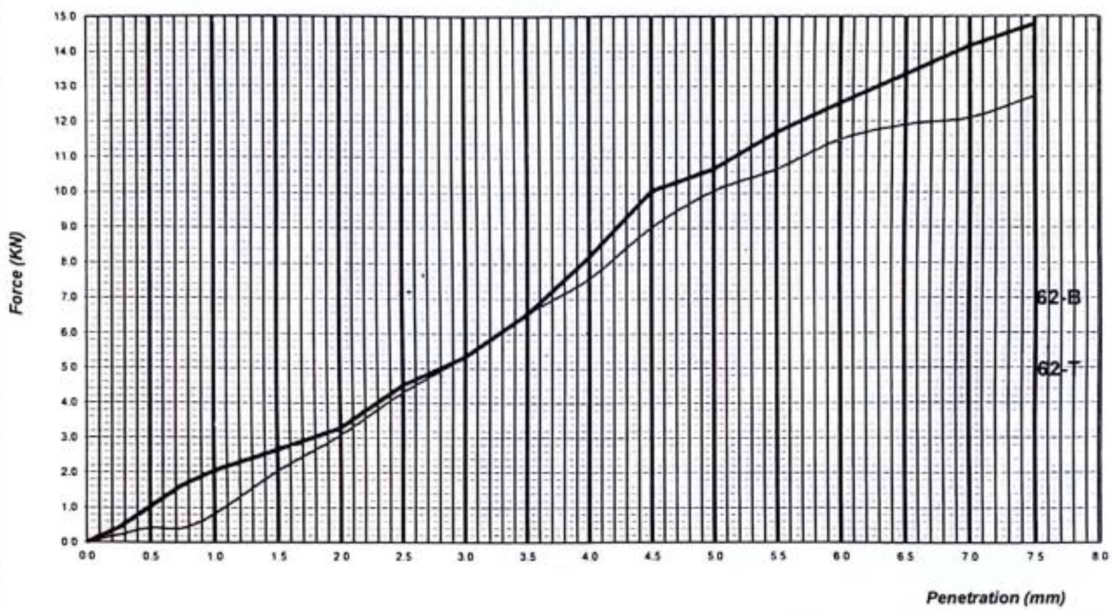
Institution	Students Names	Testing Lab
UGANDA CHRISTIAN UNIVERSITY	ASHMWE CALEB & MANANA MARK	Stirling

ASSESSING THE USE OF POLYETHYLINE TEREPHTHALATE FIBRE AND LIME FOR STABILISATION OF EXPANSIVE SOILS

CALIFORNIA BEARING RATIO TEST (BS1377 Part 4)

Test sample reference	Depth 0.5m	Sampling Date	8/Jan/24
mix	EXPANSIVE SOIL STABILISED WITH 6% LIME &	Testing Date	12/Mar/24
Source	MUYEMBE-NAKAPIRIPIRIT ROAD	Technician	Lab team
Sample Description	EXPANSIVE SOILS		

PENETRATION vs FORCE CURVE



	62 blows											
	Force		CBR									
	Bottom	Top	Bottom	Top								
2.5 mm Penetration	4.5	4.3	34	33								
5.0 mm Penetration	10.7	10.1	53	50								
Average	7.6	7.2	43.8	41.5								
Retained CBR	43.8											
Observations	CBR= 43.8											

For the Lab		For Students	
Lab. Technician	*Materials Engineer*		

INSTITUTION	STUDENTS	TESTING LAB
UGANDA CHRISTIAN UNIVERSITY	ASIIMWE CALEB & MANANA MARK	Stirling

PROJECT: ASSESSING THE USE OF POLYETHYLINE TEREPHTHALATE FIBRE AND LIME FOR STABILISATION OF EXPANSIVE SOILS

SUMMARY OF TEST RESULTS FOR EXPANSIVE MATERIAL OF EXPANSIVE SOIL STABILISED WITH 6% LIME & 0.5% FIBRE

LOCATION: MUYEMBE-NAKAPIRIPIRIT ROAD Depth: 0.5m

LOCATION	BLENDED %		GRADING								ATTERBERG LIMITS				MDD		CBR	CBR SWELL	NATURAL MOISTURE CONTENT
		SAMPLING DATE	63	37.5	20	5	2	0.425	0.075	GM	LL	PL	PI	LS	MDD	OMC		62	AVERAGE
MUYEMBE-NAKAPIRIPIRIT ROAD	EXPANSIVE SOIL STABILISED WITH 6% LIME & 0.5% FIBRE	Sample 01	100	100	100	99	95	83	73	0.49	67.2	46.4	20.8	20.0	1.505	26.7	45.8	0.46	
			100	100	100	99	92	84	78	0.45	67.3	46.2	21.1	20.0					
			100	**100**	**100**	**99.38**	**93.65**	**83.86**	**75.6**	**0.47**	**67.3**	**46.3**	**21.0**	**20.0**	**1.505**	**26.7**	**45.8**	**0.46**	
		1/8/2024																	
	AVERAGE		**100**	**100**	**100**	**99**	**94**	**84**	**76**	**0.469**	**67.3**	**46.2**	**21.0**	**20.0**	**1.505**	**26.7**	**45.8**	**0.46**	**#DIV/0!**

FOR LAB

Lab Technician

Materials Engineer

STUDENTS

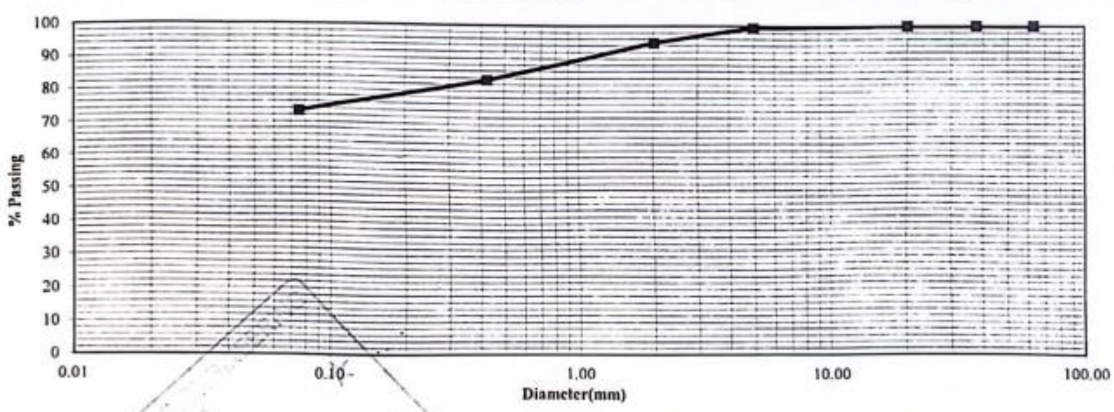
INSTITUTION	STUDENTS NAMES	TESTING LAB
UGANDA CHRISTIAN UNIVERSITY A Centre of Excellence in the Heart of Africa	ASIIMWE CALEB & MANANA MARK	Stirling

PROJECT : ASSESSING THE USE OF POLYETHYLINE TEREPHTHALATE FIBRE AND LIME FOR STABILISATION OF EXPANSIVE SOILS

PARTICLE SIZE DISTRIBUTION (BS 1377 - 2 - 90)

Location :	MUYEMBE-NAKAPIRIPIRIT ROAD	Lab. Refernece No.:		
Location :(km)	EXPANSIVE SOIL STABILISED WITH 6% LIME & 0.5% FIBRE	Dry wt. of sample before washing: (g)		2296.3
Depth: (m)	0.5m	Dry wt. of sample after washing: (g)		851.1
Material description:	MUYEMBE-NAKAPIRIPIRIT ROAD	Date Sampled:	Date Tested:	Technician
		8/Jan/2024	26/Feb/2024	Lab team

Sieve Size (mm)	Weight Retained (g)	Retained (%)	Passing (%)	Grading Limits (G60 & 80)	
63.0	0.0	0	**100**		
37.5	0.0	0.0	**100**		
20.0	0.0	0.0	**100**		
5.0	12.9	0.6	**99**		
2.00	105.8	4.6	**95**		
0.425	265.0	11.5	**83**		
0.075	230.5	10.0	**73**		
Total fines	1682.1	73.3			
Bottom Pan	236.9				
Extracted fines	1445.2				
Total sample	2296.3				
Grading Modulus		**0.49**			



Testing Lab	STUDENTS
Lab Technician *Materials Engineer*	

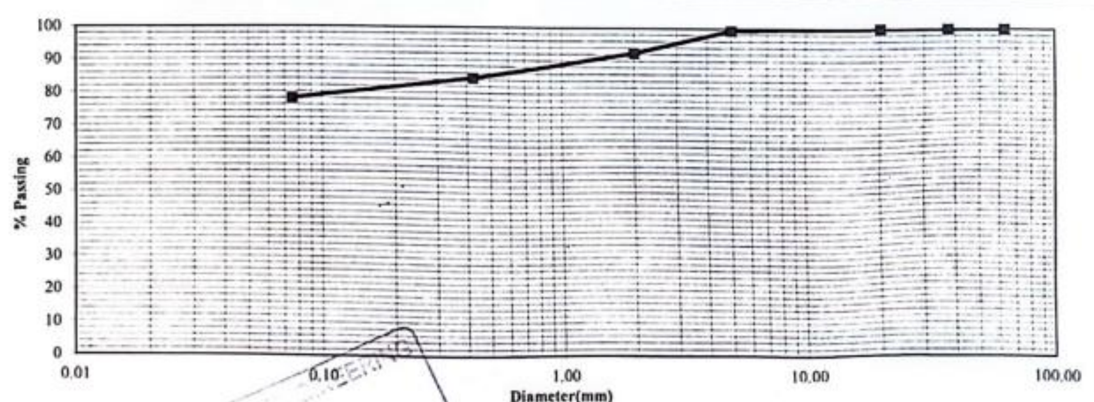
INSTITUTION	STUDENTS NAMES	TESTING LAB
UGANDA CHRISTIAN UNIVERSITY	ASIIMWE CALEB & MANANA MARK	Stirling

PROJECT : ASSESSING THE USE OF POLYETHYLINE TEREPHTHALATE FIBRE AND LIME FOR STABILISATION OF EXPANSIVE SOILS

PARTICLE SIZE DISTRIBUTION (BS 1377 - 2 - 90)

Location :	MUYEMBE-NAKAPIRIPIRIT ROAD	Lab. Refernece No.:		
Location :(km)	EXPANSIVE SOIL STABILISED WITH 6% LIME & 0.5% FIBRE	Dry wt. of sample before washing: (g)		2857.4
Depth: (m)	0.5m	Dry wt. of sample after washing: (g)		792.6
Material description:	MUYEMBE-NAKAPIRIPIRIT ROAD	Date Sampled:	Date Tested:	Technician
		8/Jan/2024	26/Feb/2024	Lab team

Sieve Size (mm)	Weight Retained (g)	Retained (%)	Passing (%)	Grading Limits (G60 & 80)	
63.0	0.0	0	100		
37.5	0.0	0.0	100		
20.0	0.0	0.0	100		
5.0	19.6	0.7	99		
2.00	195.6	6.8	92		
0.425	229.8	8.0	84		
0.075	185.1	6.5	78		
Total fines	2227.3	77.9			
Bottom Pan	162.5				
Extracted fines	2064.8				
Total sample	2857.4				
Grading Modulus		0.45			



Testing Lab	STUDENTS
Lab Technician	Materials Engineer

INSTITUTION	STUDENTS	TESTING LAB
UGANDA CHRISTIAN UNIVERSITY	ASIIMWE CALEB & MANANA MARK	Stirling

PROJECT:	ASSESSING THE USE OF POLYETHYLINE TEREPHTHALATE FIBRE AND LIME FOR STABILISATION OF EXPANSIVE SOILS

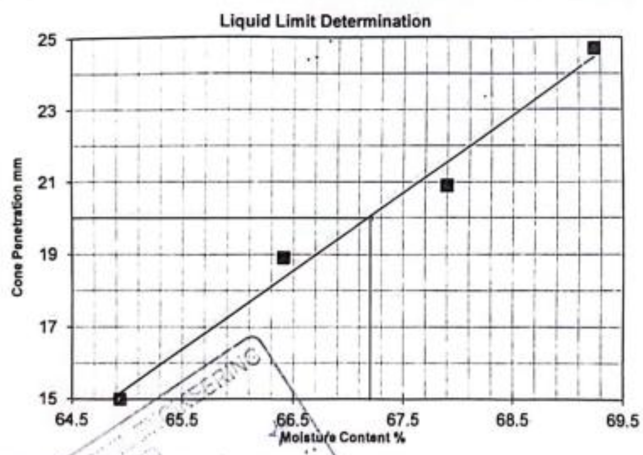
ATTERBERG LIMITS

Liquid limit (cone penotrometer) and plastic limit

SOURCE :	MUYEMBE-NAKAPIRIPIRIT ROAD	Technician:	Lab Team
mix	PANSIVE SOIL STABILISED WITH 6% LIME & 0.5% FIB	Sample Date	8/Jan/2024
Test method	BS 1377: Part 2, 1990:4.3/4.4	Test Date	11/Jan/2024
LAYER	EXPANSIVE SOILS		
Depth:	0.5m		

PLASTIC LIMIT	Test No.	2f	h		Average
Mass of wet soil + container (g)		32.17	41.22		36.695
Mass of dry soil + container (g)		29.05	34.79		31.92
Mass of container (g)		22.31	20.98		21.645
Mass of moisture (g)		3.12	6.4		4.775
Mass of dry soil (g)		6.74	13.81		10.275
Moisture content %		46.3	46.6		46.4
AVERAGE					

LIQUID LIMIT	Test No	1	2	3	4
Initial gauge reading (mm)		0	0	0	0
Final gauge reading (mm)		15.0	18.9	20.9	24.7
penetration (mm)		15.0	18.9	20.9	24.7
AVERAGE		15.0	18.9	20.9	24.7
Container No.		a5	P126	P153	TF
Mass of wet soil + container (g)		51.94	64.77	61.47	61.50
Mass of dry soil + container (g)		34.20	41.70	40.09	39.55
Mass of container (g)		6.88	6.96	8.60	7.85
Mass of moisture (g)		17.74	23.07	21.38	21.95
Mass of dry soil (g)		27.32	34.74	31.49	31.7
Moisture content (%)		64.9	66.4	67.9	69.2
AVERAGE		64.9	66.4	67.9	69.2



Liquid limit (%)	67.2
Plastic limit (%)	46.4
Plasticity Index (%)	20.8
Linear shrinkage	
Trough No.	4
Trough length (cm)	14.0
Specimen length (cm)	11.2
L.shringage =	2.8
% L.shrinkage =	20.0

Remarks:

TESTING LAB Materials Engineer Lab Technician		STUDENTS

INSTITUTION	STUDENTS	TESTING LAB
UGANDA CHRISTIAN UNIVERSITY	ASIIMWE CALEB & MANANA MARK	Stirling

PROJECT:	ASSESSING THE USE OF POLYETHYLINE TEREPHTHALATE FIBRE AND LIME FOR STABILISATION OF EXPANSIVE SOILS

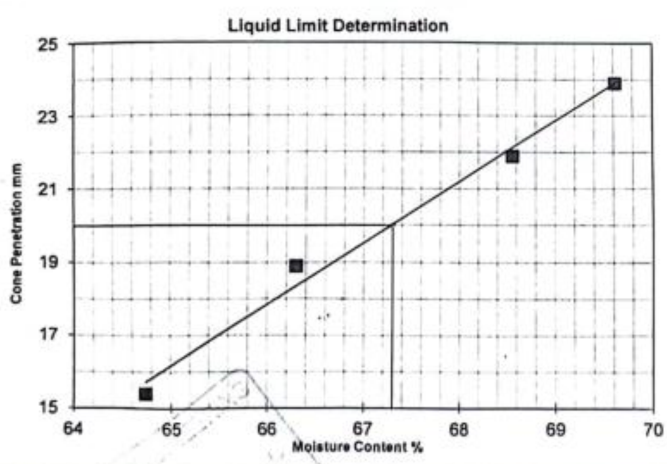
ATTERBERG LIMITS

Liquid limit (cone penotrometer) and plastic limit

SOURCE :	MUYEMBE-NAKAPIRIPIRIT ROAD		Technician:	Lab Team
mix	PANSIVE SOIL STABILISED WITH 6% LIME & 0.5% FIB		Sample Date	8/Jan/2024
Test method	BS 1377: Part 2, 1990:4.3/4.4		Test Date	11/Jan/2024
LAYER	EXPANSIVE SOILS			
Depth:	0.5m			

PLASTIC LIMIT	Test No.	QO	PNU		Average
Mass of wet soil + container (g)		35.76	36.89		36.325
Mass of dry soil + container (g)		31.34	32.46		31.9
Mass of container (g)		21.74	22.89		22.315
Mass of moisture (g)		4.42	4.4		4.425
Mass of dry soil (g)		9.6	9.57		9.585
Moisture content %		46.0	46.3		46.2
AVERAGE					

LIQUID LIMIT	Test No	1	2	3	4
Initial gauge reading (mm)		0	0	0	0
Final gauge reading (mm)		15.4	18.9	21.9	23.9
penetration (mm)		15.4	18.9	21.9	23.9
AVERAGE		15.4	18.9	21.9	23.9
Container No.		P135	P154	AB	PIPI
Mass of wet soil + container (g)		77.67	73.37	78.69	63.35
Mass of dry soil + container (g)		50.94	46.99	49.56	40.30
Mass of container (g)		9.65	7.20	7.07	7.19
Mass of moisture (g)		26.73	26.38	29.13	23.05
Mass of dry soil (g)		41.29	39.79	42.49	33.11
Moisture content (%)		64.7	66.3	68.6	69.6
AVERAGE		64.7	66.3	68.6	69.6



Liquid limit (%)	67.3
Plastic limit (%)	46.2
Plasticity Index (%)	21.1
Linear shrinkage	
Trough No.	4
Trough length (cm)	14.0
Specimen length (cm)	11.2
L.shringage =	2.8
% L.shrinkage =	20.0

Remarks:

TESTING LAB

Materials Engineer.

Lab Technician

STUDENTS

INSTITUTION	STUDENTS NAMES	TESTING LAB
UGANDA CHRISTIAN UNIVERSITY	ASIIMWE CALEB & MANANA MARK	Stirling

PROJECT:	ASSESSING THE USE OF POLYETHYLINE TEREPHTHALATE FIBRE AND LIME FOR STABILISATION OF EXPANSIVE SOILS				
Test Reference No.	Depth 0.5m	Date Sampled	Date Tested	Technician	
Mix	EXPANSIVE SOIL STABILISED WITH 6% LIME & 0.5% FIBRE	8/Jan/24	26/Feb/24	Lab team	
SOURCE	MUYEMBE-NAKAPIRIPIRIT ROAD				
Material description:	EXPANSIVE SOILS	Natural moisture (%) :	11.0		

TEST DATA

Weight of rammer (Kg)	No. of blows per layer	No of layers	Height of drop (mm)	Diameter of mould(mm)	Volume of mould (cm^3)
4.5	27	5	457	100	1,000

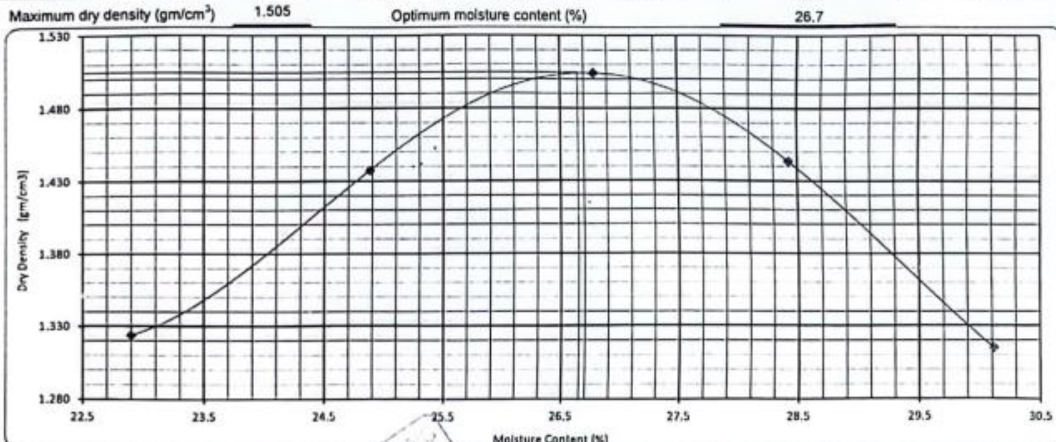
MOISTURE CONTENT DATA

Test No.		1	2	3	4	5
Tin No.		A	A	A	A	A
Water Added	cm^3	250	310	370	430	490
Mass of Compacted soil + mould	gm	4,912	5,080	5,192	5,139	4,996
Mass of Mould	gm	3,285	3,285	3,285	3,285	3,285
Mass of Compacted soil	gm	1627	1795	1907	1854	1711
Volume of mould	cm^3	1,000	1,000	1,000	1,000	1,000
Wet density of soil	g/cm^3	1.627	1.795	1.907	1.854	1.711

DATA FOR PROCTOR CURVE

Container No.		AT	UCJ	Y64	BBC	BA
Mass of wet soil + Container	gm	2,864.0	3,234.0	3,180.0	2,822.0	2,735.0
Mass of dry soil + container	gm	2,480.0	2,770.0	2,681.0	2,376.0	2,280.0
Mass of container	gm	803.0	905.0	818.0	807.0	769.0
Mass of water added	gm	384	464	499	446	455
Mass of dry soil	gm	1677	1865	1863	1569	1511
Moisture content	%	22.9	24.9	26.8	28.4	30.1
Dry density	g/cm^3	1.324	1.437	1.504	1.444	1.315

Maximum dry density (gm/cm^3) 1.505 Optimum moisture content (%) 26.7



Remarks:

FOR TESTING LAB		STUDENTS	
Lab Technician	Materials Engineer		

Institution	Students Names	Testing Lab
UGANDA CHRISTIAN UNIVERSITY	ASHMWE CALEB & MANANA MARK	Stirling

ASSESSING THE USE OF POLYETHYLINE TEREPHTHALATE FIBRE AND LIME FOR STABILISATION OF EXPANSIVE SOILS

CALIFORNIA BEARING RATIO TEST (BS 1377 Part 4)

Test sample reference :	Depth. 0.5m	Sampling Date :	8/Jan/24
mix:	EXPANSIVE SOIL STABILISED WITH 6% LIME & 0.5% FIBRE	Casting date :	27/Feb/24
Source:	MUYEMBE-NAKAPIRIPIRIT ROAD	Testing Date :	12/Mar/24
Sample Description:	EXPANSIVE SOILS	Technician :	Lab team
		Volume of Mould used (m^3)	2305

Natural moisture of air dried sample			**Volume of water added**	
Tin No.	Y6Y5		Mass of air dried soil (g)	6000
Tin + air dried soil sample (g)	2566		MDD (Mg/m^3)	1.505
Tin + oven dry soil sample (g)	2415		N.M.C (%)	9.4
Tin (g)	802		OMC (%)	26.65
Dry soil sample	1613		Added OMC (%)	17.3
Water (g)	151		Calculated dry wt of soil (g)	5438.3
N.M.C (%)	9.4		Water added (g)	949
Average (%)	9.4		**Water added (mL)**	949

Number of blows		62						
Number of layer		5						
Water Content Determination		Before Soaking	After Soaking					
Tare No		DR	PU					
Mass of wet sample + Tare	g	1456	1968					
Mass of dry sample + Tare	g	1255	1700					
Mass of Tare	g	505	756					
Mass of water	g	201	268					
Mass of dry sample	g	750	944					
Water content	%	26.8	28.4					
Average water Content	%	26.8	28.4					
Density determination								
Mould No			L					
Mass of mould + soil	g	11580	11650					
Mass of mould	g	7155	7155					
Mass of soil	g	4425	4495					
Volume of the mould	cm3	2305	2305					
Moist density	g/cm3	1.920	1.950					
Dry density	g/cm3	1.514	1.519					
Swell Determination								
Date		Hour	D.Gauge Reding					
Initial reading		96 hrs	12					
Final reading			12.58					
Height of the specimen			127					
Height of swell			0.58					
		Swelling(%)	0.46					
Observations								

For the Lab		For Students	
Lab. Technician	*Materials Engineer*		

Institution	Students Names	Testing Lab
UGANDA CHRISTIAN UNIVERSITY	ASHIMWE CALEB & MANANA MARK	Stirling

ASSESSING THE USE OF POLYETHYLINE TEREPHTHALATE FIBRE AND LIME FOR STABILISATION OF EXPANSIVE SOILS

CALIFORNIA BEARING RATIO TEST (BS1377 Part 4)

Test sample reference :	Depth 0.5m	Sampling Date	8/Jan/24
mix:	EXPANSIVE SOIL STABILISED WITH 6% LIME & 0.5% FIBRE	Penetration Date	12/Mar/24
Source:	MUYEMBE-NAKAPIRIPIRIT ROAD	Technician	: Lab team
Sample Description :	EXPANSIVE SOILS		

Number of blows per layer	62				
Number of layers	5		5		5
Mould No	L				
Capacity of the Proving Ring (KN)	50		50		50
Proving Ring Constant (KN/div.)	0.2052		0.2052		0.2052

Speed : ... mm min		Top		Bottom									
Penetration of the plunger (mm)	Time (s)	Reading $*10^3$mm	Force (KN)	Reading $*10^3$mm	Force (KN)								
0	0	0	0.0	0	0.0								
0.25	12	1	0.2	2	0.4								
0.5	24	2	0.4	5	1.0								
0.75	35	2	0.4	10	2.1								
1	47	3	0.6	14	2.9								
1.5	71	6	1.2	19	3.9								
2	94	7	1.4	21	4.3								
2.5	118	9	1.8	26	5.3								
3	142	11	2.3	30	6.2								
3.5	165	12	2.5	35	7.2								
4	189	14	2.9	39	8.0								
4.5	213	16	3.3	45	9.2								
5	236	17	3.5	50	10.3								
5.5	260	18	3.7	54	11.1								
6	283	19	3.9	58	11.9								
6.5	307	20	4.1	62	12.7								
7	331	22	4.5	66	13.5								
7.5	354	23	4.7	67	13.7								

Observations

For the Contractor		For Students
Lab. Technician	Material Engineer	

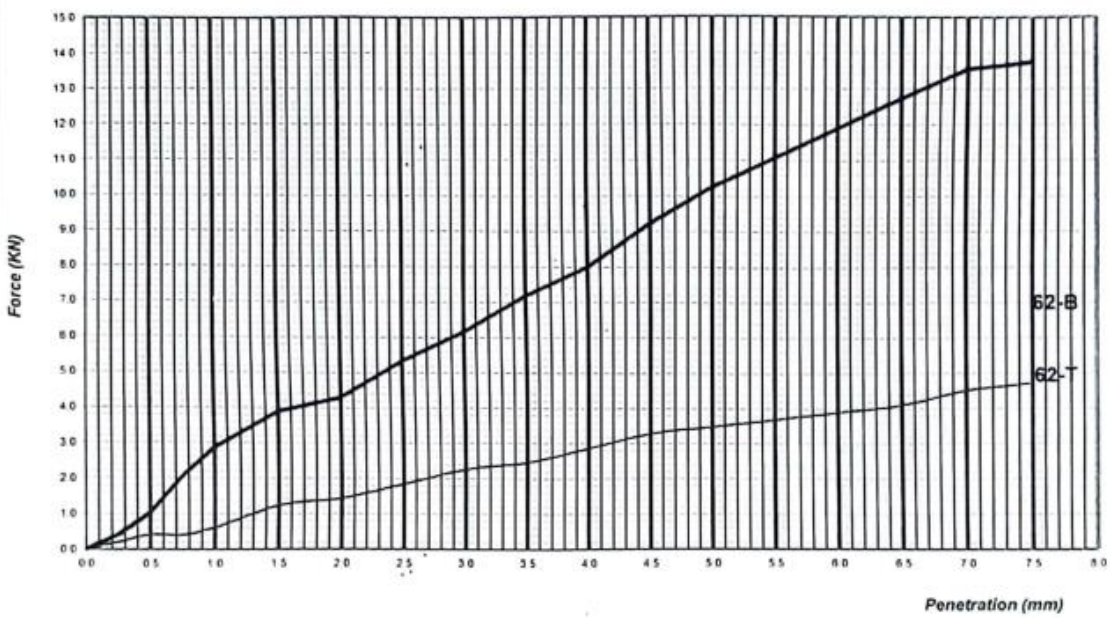
Institution	Students Names	Testing Lab
UGANDA CHRISTIAN UNIVERSITY	ASHMWE CALEB & MANANA MARK	Stirling

ASSESSING THE USE OF POLYETHYLINE TEREPHTHALATE FIBRE AND LIME FOR STABILISATION OF EXPANSIVE SOILS

CALIFORNIA BEARING RATIO TEST (BS1377 Part 4)

Test sample reference	Depth 0.5m	Sampling Date	8/Jan/24
mix	EXPANSIVE SOIL STABILISED WITH 6% LIME &	Testing Date	12/Mar/24
Source	MUYEMBE-NAKAPIRIPIRIT ROAD	Technician	Lab team
Sample Description	EXPANSIVE SOILS		

PENETRATION vs FORCE CURVE



	62 blows			
	Force		CBR	
	Bottom	Top	Bottom	Top
2.5 mm Penetration	5.3	1.8	40	14
5.0 mm Penetration	10.3	3.5	51	17
Average	7.8	2.7	45.8	15.7
Retained CBR	45.8			
Observations	CBR= 45.8			

For the Lab		For Students	
Lab. Technician	Materials Engineer		

INSTITUTION	STUDENTS	TESTING LAB
UGANDA CHRISTIAN UNIVERSITY	ASIIMWE CALEB & MANANA MARK	Stirling

PROJECT: ASSESSING THE USE OF POLYETHYLINE TEREPHTHALATE FIBRE AND LIME FOR STABILISATION OF EXPANSIVE SOILS

SUMMARY OF TEST RESULTS FOR EXPANSIVE SOIL STABILISED WITH 6% LIME & 1% FIBRE

LOCATION: MUYEMBE-NAKAPIRIPIRIT ROAD **Depth:** 0.5m

LOCATION	BLENDED %		GRADING								ATTERBERG LIMITS				MDD		CBR	CBR SWELL	NATURAL MOISTURE CONTENT
		SAMPLING DATE	63	37.5	20	5	2	0.425	0.075	GM	LL	PL	PI	LS	MDD	OMC		62	AVERAGE
MUYEMBE-NAKAPIRIPIRIT ROAD	EXPANSIVE SOIL STABILISED WITH 6% LIME & 1% FIBRE	Sample 01	100	100	100	99	94	85	73	0.48	66	47.0	19.0	20.0	1.524	25.8	50.0	0.54	
		Sample 02	100	100	100	99	94	85	74	0.48	65.6	46.8	18.8	20.0					
			100	**100**	**100**	**98.74**	**93.82**	**85.07**	**73.34**	**0.48**	**65.8**	**46.9**	**18.9**	**20.0**	**1.524**	**25.8**	**50.0**	**0.54**	
		1/8/2024																	
	AVERAGE		**100**	**100**	**100**	**99**	**94**	**85**	**73**	**0.478**	**65.8**	**46.8**	**18.9**	**20.0**	**1.524**	**25.8**	**50.0**	**0.54**	**#DIV/0!**

FOR LAB

Lab Technician

Materials Engineer

STUDENTS

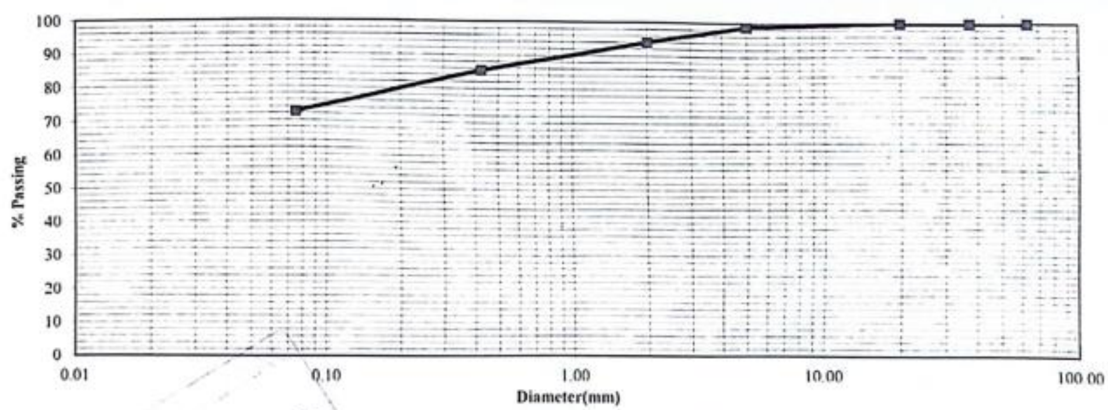
INSTITUTION	STUDENTS NAMES	TESTING LAB
UGANDA CHRISTIAN UNIVERSITY A Centre of Excellence in the Heart of Africa	ASIIMWE CALEB & MANANA MARK	Stirling

PROJECT : ASSESSING THE USE OF POLYETHYLINE TEREPHTHALATE FIBRE AND LIME FOR STABILISATION OF EXPANSIVE SOILS

PARTICLE SIZE DISTRIBUTION (BS 1377 - 2 - 90)

Location :	MUYEMBE-NAKAPIRIPIRIT ROAD	Lab. Refernece No.:		
Location :(km)	EXPANSIVE SOIL STABILISED WITH 6% LIME & 1% FIBRE	Dry wt. of sample before washing: (g)		3009.6
Depth: (m)	0.5m	Dry wt. of sample after washing: (g)		828.0
Material description:	MUYEMBE-NAKAPIRIPIRIT ROAD	Date Sampled:	Date Tested:	Technician
		8/Jan/2024	26/Feb/2024	Lab team

Sieve Size (mm)	Weight Retained (g)	Retained (%)	Passing (%)	Grading Limits (G60 & 80)	
63.0	0.0	0	100		
37.5	0.0	0.0	100		
20.0	0.0	0.0	100		
5.0	32.2	1.1	99		
2.00	148.3	4.9	94		
0.425	257.3	8.5	85		
0.075	388.1	12.9	73		
Total fines	2183.7	72.6			
Bottom Pan	2.1				
Extracted fines	2181.6				
Total sample	3009.6				
Grading Modulus		0.48			



Testing Lab

Lab Technician *Materials Engineer*

STUDENTS

P.O.

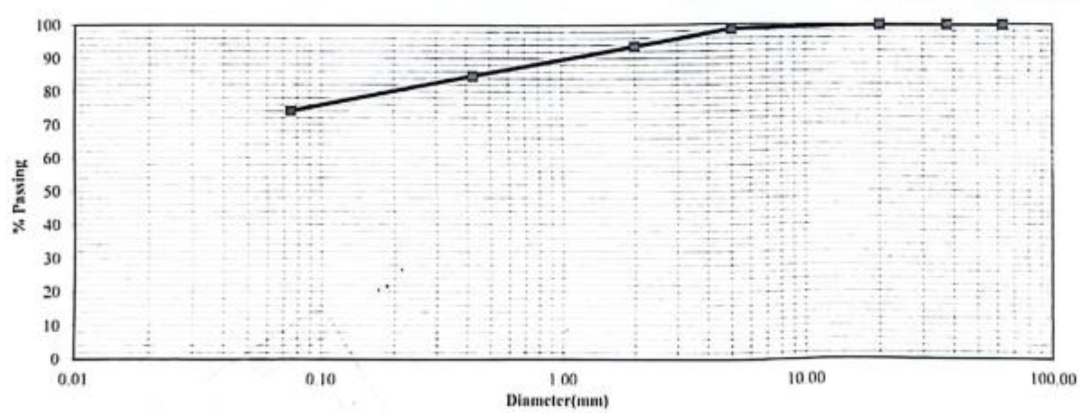
INSTITUTION	STUDENTS NAMES	TESTING LAB
UGANDA CHRISTIAN UNIVERSITY	ASIIMWE CALEB & MANANA MARK	Stirling

PROJECT : ASSESSING THE USE OF POLYETHYLINE TEREPHTHALATE FIBRE AND LIME FOR STABILISATION OF EXPANSIVE SOILS

PARTICLE SIZE DISTRIBUTION (BS 1377 - 2 - 90)

Location :	MUYEMBE-NAKAPIRIPIRIT ROAD	Lab. Refernece No.:		
Location :(km)	EXPANSIVE SOIL STABILISED WITH 6% LIME & 1% FIBRE	Dry wt. of sample before washing: (g)		2474.9
Depth: (m)	0.5m	Dry wt. of sample after washing: (g)		643.5
Material description:	MUYEMBE-NAKAPIRIPIRIT ROAD	Date Sampled:	Date Tested:	Technician
		8/Jan/2024	26/Feb/2024	Lab team

Sieve Size (mm)	Weight Retained (g)	Retained (%)	Passing (%)	Grading Limits (G60 & 80)	
63.0	0.0	0	100		
37.5	0.0	0.0	100		
20.0	0.0	0.0	100		
5.0	35.9	1.5	99		
2.00	121.6	4.9	94		
0.425	221.5	8.9	85		
0.075	261.5	10.6	74		
Total fines	1834.4	74.1			
Bottom Pan	3.0				
Extracted fines	1831.4				
Total sample	2474.9				
Grading Modulus		0.48			



Testing Lab | STUDENTS

Lab Technician , *Materials Engineer*

INSTITUTION	STUDENTS	TESTING LAB
UGANDA CHRISTIAN UNIVERSITY	ASIIMWE CALEB & MANANA MARK	Stirling

PROJECT:	ASSESSING THE USE OF POLYETHYLINE TEREPHTHALATE FIBRE AND LIME FOR STABILISATION OF EXPANSIVE SOILS

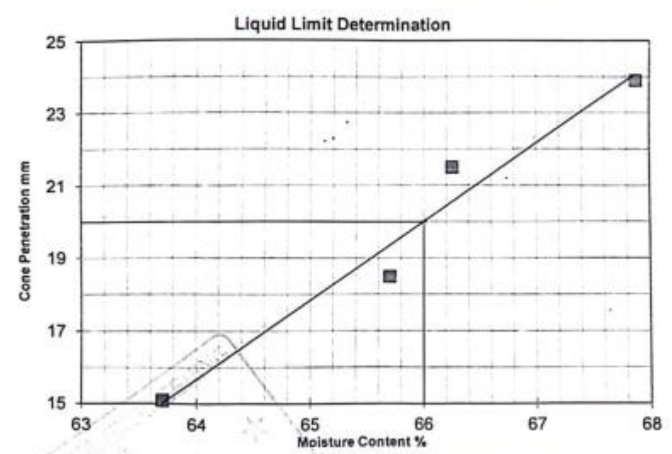
ATTERBERG LIMITS

Liquid limit (cone penotrometer) and plastic limit

SOURCE :	MUYEMBE-NAKAPIRIPIRIT ROAD	Technician:	Lab Team
mix	XPANSIVE SOIL STABILISED WITH 6% LIME & 1% FIBR	Sample Date	8/Jan/2024
Test method	BS 1377: Part 2, 1990:4.3/4.4	Test Date	11/Jan/2024
LAYER	EXPANSIVE SOILS		
Depth:	0.5m		

PLASTIC LIMIT	Test No.	TN	GT		Average
Mass of wet soil + container (g)		37.73	45.36		41.545
Mass of dry soil + container (g)		32.8	38.35		35.575
Mass of container (g)		22.26	23.5		22.88
Mass of moisture (g)		4.93	7.0		5.97
Mass of dry soil (g)		10.54	14.85		12.695
Moisture content %		46.8	47.2		47.0
AVERAGE					

LIQUID LIMIT	Test No	1	2	3	4
Initial gauge reading (mm)		0	0	0	0
Final gauge reading (mm)		15.1	18.5	21.5	23.9
penetration (mm)		15.1	18.5	21.5	23.9
AVERAGE		15.1	18.5	21.5	23.9
Container No.		AB	PIOE	PIA	BE
Mass of wet soil + container (g)		63.41	66.87	64.04	67.45
Mass of dry soil + container (g)		41.42	43.10	41.25	43.02
Mass of container (g)		6.90	6.92	6.85	7.03
Mass of moisture (g)		21.99	23.77	22.79	24.43
Mass of dry soil (g)		34.52	36.18	34.4	35.99
Moisture content (%)		63.7	65.7	66.3	67.9
AVERAGE		63.7	65.7	66.3	67.9



Liquid limit (%)	66.0
Plastic limit (%)	47.0
Plasticity Index (%)	19.0
Linear shrinkage	
Trough No.	4
Trough length (cm)	14.0
Specimen length (cm)	11.2
L.shringage =	2.8
% L.shrinkage =	20.0

Remarks:

TESTING LAB		STUDENTS
Materials Engineer.		
Lab Technician		

INSTITUTION	STUDENTS	TESTING LAB
UGANDA CHRISTIAN UNIVERSITY	ASIIMWE CALEB & MANANA MARK	Stirling

PROJECT:	ASSESSING THE USE OF POLYETHYLINE TEREPHTHALATE FIBRE AND LIME FOR STABILISATION OF EXPANSIVE SOILS

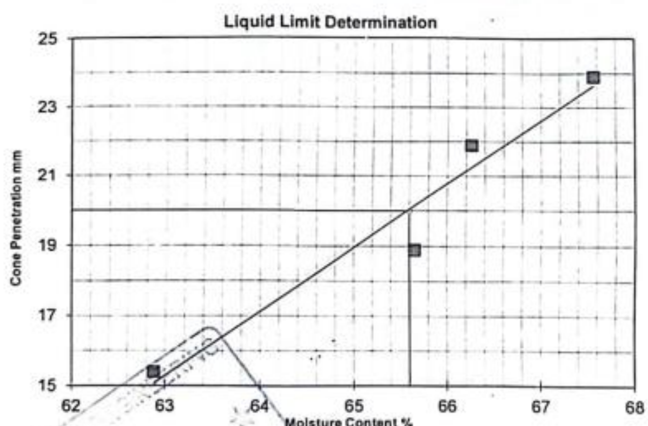
ATTERBERG LIMITS

Liquid limit (cone penotrometer) and plastic limit

SOURCE :	MUYEMBE-NAKAPIRIPIRIT ROAD	Technician:	Lab Team
mix	XPANSIVE SOIL STABILISED WITH 6% LIME & 1% FIBR	Sample Date	8/Jan/2024
Test method	BS 1377: Part 2, 1990:4.3/4.4	Test Date	11/Jan/2024
LAYER	EXPANSIVE SOILS		
Depth:	0.5m		

PLASTIC LIMIT	Test No.	44	2		Average
Mass of wet soil + container (g)		51.26	48.29		49.775
Mass of dry soil + container (g)		42.07	39.66		40.865
Mass of container (g)		21.23	22.24		21.735
Mass of moisture (g)		9.19	8.6		8.91
Mass of dry soil (g)		20.84	17.42		19.13
Moisture content %		44.1	49.5		46.8
AVERAGE					

LIQUID LIMIT	Test No	1	2	3	4
Initial gauge reading (mm)		0	0	0	0
Final gauge reading (mm)		15.4	18.9	21.9	23.9
penetration (mm)		15.4	18.9	21.9	23.9
AVERAGE		15.4	18.9	21.9	23.9
Container No.		P182	A4	A6	P133
Mass of wet soil + container (g)		96.05	81.45	79.01	83.24
Mass of dry soil + container (g)		61.56	51.88	50.25	52.52
Mass of container (g)		6.71	6.84	6.84	7.05
Mass of moisture (g)		34.49	29.57	28.76	30.72
Mass of dry soil (g)		54.85	45.04	43.41	45.47
Moisture content (%)		62.9	65.7	66.3	67.6
AVERAGE		62.9	65.7	66.3	67.6



Liquid limit (%)	65.6
Plastic limit (%)	46.8
Plasticity Index (%)	18.8
Linear shrinkage	
Trough No.	4
Trough length (cm)	14.0
Specimen length (cm)	11.2
L.shringage =	2.8
% L.shrinkage =	20.0

Remarks:

TESTING LAB		STUDENTS
Materials Engineer		
Lab Technician		

INSTITUTION	STUDENTS NAMES	TESTING LAB
UGANDA CHRISTIAN UNIVERSITY	ASIIMWE CALEB & MANANA MARK	Stirling

PROJECT:	ASSESSING THE USE OF POLYETHYLINE TEREPHTHALATE FIBRE AND LIME FOR STABILISATION OF EXPANSIVE SOILS				
Test Reference No.	Depth 0.5m		Date Sampled	Date Tested	Technician
Mix	EXPANSIVE SOIL STABILISED WITH 6% LIME & 1% FIBRE		8/Jan/24	26/Feb/24	Lab team
SOURCE	MUYEMBE-NAKAPIRIPIRIT ROAD				
Material description:	EXPANSIVE SOILS		Natural moisture (%) :	11.0	

TEST DATA

Weight of rammer (Kg)	No. of blows per layer	No of layers	Height of drop (mm)	Diameter of mould(mm)	Volume of mould (cm^3)
4.5	27	5	457	100	1,000

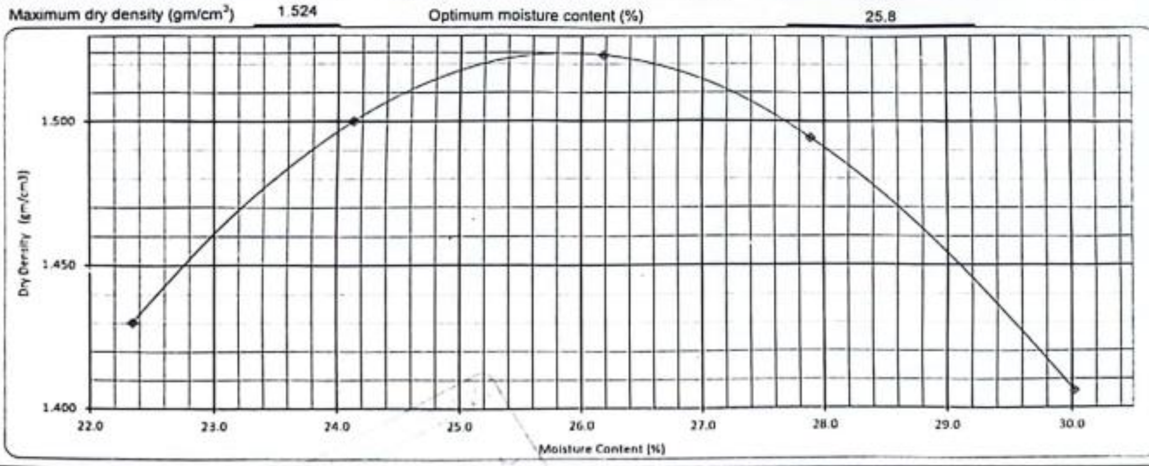
MOISTURE CONTENT DATA

Test No.		1	2	3	4	5
Tin No		A	A	A	A	A
Water Added	cm^3	360	420	480	540	600
Mass of Compacted soil + mould	gm	6,028	6,140	6,200	6,189	6,106
Mass of Mould	gm	4,278	4,278	4,278	4,278	4,278
Mass of Compacted soil	gm	1750	1862	1922	1911	1828
Volume of mould	cm^3	1,000	1,000	1,000	1,000	1,000
Wet density of soil	g/cm^3	1.750	1.862	1.922	1.911	1.828

DATA FOR PROCTOR CURVE

Container No.		BKN	CR7	YY	NBM	FDC
Mass of wet soil + Container	gm	2,263.0	2,191.0	2,230.0	2,214.0	2,321.0
Mass of dry soil + container	gm	1,996.0	1,915.0	1,930.0	1,905.0	1,971.0
Mass of container	gm	801.0	771.0	784.0	797.0	805.0
Mass of water added	gm	267	276	300	309	350
Mass of dry soil	gm	1195	1144	1146	1108	1166
Moisture content	%	22.3	24.1	26.2	27.9	30.0
Dry density	g/cm^3	1.430	1.500	1.523	1.494	1.406

Maximum dry density (gm/cm^3) 1.524 Optimum moisture content (%) 25.8



Remarks:

FOR TESTING LAB		STUDENTS	
Lab Technician	Materials Engineer		

Institution	Students Names	Testing Lab
UGANDA CHRISTIAN UNIVERSITY	ASHIMWE CALEB & MANANA MARK	Stirling

ASSESSING THE USE OF POLYETHYLINE TEREPHTHALATE FIBRE AND LIME FOR STABILISATION OF EXPANSIVE SOILS

CALIFORNIA BEARING RATIO TEST (BS1377 Part 4)

Test sample reference	Depth. 0.5m	Sampling Date	8/Jan/24
mix:	EXPANSIVE SOIL STABILISED WITH 6% LIME & 1% FIBRE	Penetration Date	12/Mar/24
Source:	MUYEMBE-NAKAPIRIPIRIT ROAD	Technician	: Lab team
Sample Description :	: EXPANSIVE SOILS		

Number of blows per layer		62								
Number of layers		5				5			5	
Mould No		WR								
Capacity of the Proving Ring (KN)		50				50			50	
Proving Ring Constant (KN/div.)		0.2052				0.2052			0.2052	
Speed : .... mm min.		Top		Bottom						
Penetration of the plunger (mm)	Time (s)	Reading $*10^3$mm	Force (KN)	Reading $*10^3$mm	Force (KN)					
0	0	0	0.0	0	0.0					
0.25	12	1	0.2	2	0.4					
0.5	24	2	0.4	3	0.6					
0.75	35	4	0.8	5	1.0					
1	47	5	1.0	8	1.6					
1.5	71	10	2.1	12	2.5					
2	94	16	3.3	18	3.7					
2.5	118	22	4.5	26	5.3					
3	142	29	6.0	33	6.8					
3.5	165	34	7.0	40	8.2					
4	189	40	8.2	48	9.8					
4.5	213	43	8.8	53	10.9					
5	236	46	9.4	58	11.9					
5.5	260	48	9.8	62	12.7					
6	283	49	10.1	64	13.1					
6.5	307	50	10.3	66	13.5					
7	331	51	10.5	69	14.2					
7.5	354	52	10.7	71	14.6					
Observations										

For the Contractor		For Students	
Lab. Technician	Materials Engineer		

Institution	Students Names	Testing Lab
UGANDA CHRISTIAN UNIVERSITY	ASIIMWE CALEB & MANANA MARK	Stirling

ASSESSING THE USE OF POLYETHYLINE TEREPHTHALATE FIBRE AND LIME FOR STABILISATION OF EXPANSIVE SOILS

CALIFORNIA BEARING RATIO TEST (BS 1377 Part 4)

Test sample reference :	Depth. 0.5m	Sampling Date :	8/Jan/24
mix:	EXPANSIVE SOIL STABILISED WITH 6% LIME & 1% FIBRE	Casting date :	27/Feb/24
Source:	MUYEMBE-NAKAPIRIPIRIT ROAD	Testing Date :	12/Mar/24
Sample Description:	EXPANSIVE SOILS	Technician :	Lab team
		Volume of Mould used (m^3)	2305

Natural moisture of air dried sample			Volume of water added	
Tin No.	UPC		Mass of air dried soil (g)	6000
Tin + air dried soil sample (g)	2393		MDD (Mg/m^3)	1.524
Tin + oven dry soil sample (g)	2191		N.M.C (%)	14.6
Tin (g)	807		OMC (%)	25.8
Dry soil sample	1384		Added OMC (%)	11.2
Water (g)	202		Calculated dry wt of soil (g)	5124.3
N.M.C (%)	14.6		Water added (g)	587
Average (%)	14.6		**Water added (mL)**	587

Number of blows		62							
Number of layer		5							
Water Content Determination		Before Soaking		After Soaking					
Tare No		ACB	-	KT	-				
Mass of wet sample + Tare	g	2078	-	2120	-				
Mass of dry sample + Tare	g	1778	-	1803	-				
Mass of Tare	g	781	-	800	-				
Mass of water	g	300	-	317	-				
Mass of dry sample	g	997	-	1003	-				
Water content	%	30.1	-	31.6	-				
Average water Content	%	30.1		31.6					
Density determination									
Mould No		WR							
Mass of mould + soil	g	10397		10463					
Mass of mould	g	6041		6041					
Mass of soil	g	4356		4422					
Volume of the mould	cm3	2305		2305					
Moist density	g/cm3	1.890		1.918					
Dry density	g/cm3	1.453		1.458					
Swell Determination									
Date		Hour		D.Gauge Reding					
Initial reading		96 hrs		9.86					
Final reading				10.55					
Height of the specimen				127					
Height of swell				0.69					
		Swelling(%)		0.54					
Observations									

For the Lab		For Students	
Lab. Technician	*Materials Engineer*		

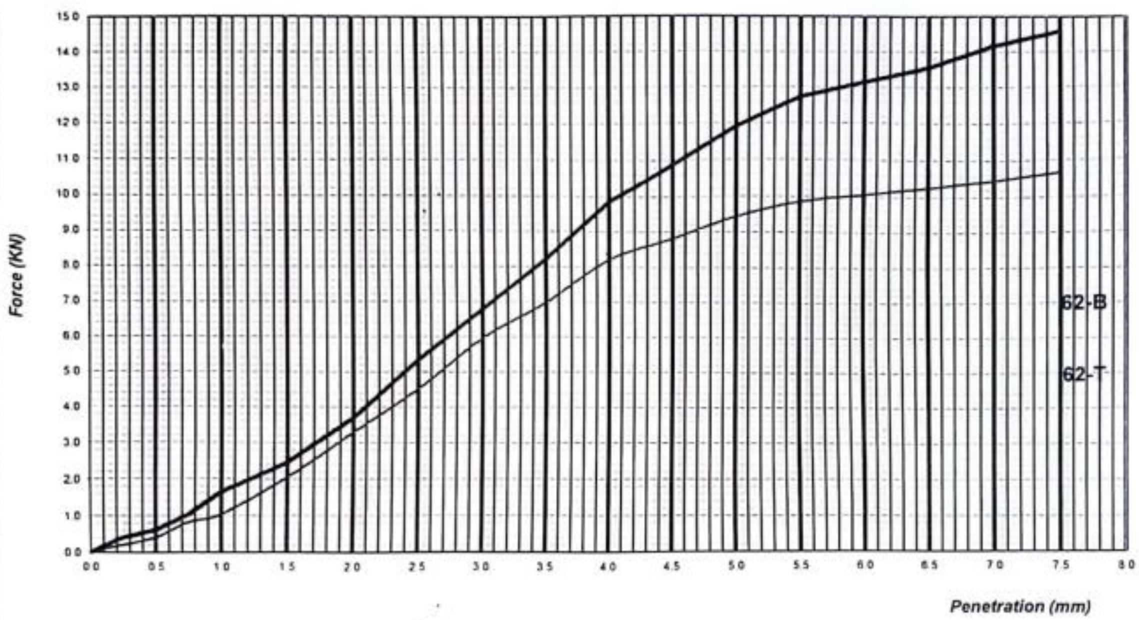
Institution	Students Names	Testing Lab
UGANDA CHRISTIAN UNIVERSITY	ASIIMWE CALEB & MANANA MARK	Stirling

ASSESSING THE USE OF POLYETHYLINE TEREPHTHALATE FIBRE AND LIME FOR STABILISATION OF EXPANSIVE SOILS

CALIFORNIA BEARING RATIO TEST (BS1377 Part 4)

Test sample reference	Depth : 0.5m	Sampling Date	8/Jan/24
mix	EXPANSIVE SOIL STABILISED WITH 6% LIME &	Testing Date	12/Mar/24
Source	MUYEMBE-NAKAPIRIPIRIT ROAD	Technician	Lab team
Sample Description	EXPANSIVE SOILS		

PENETRATION vs FORCE CURVE



	62 blows											
	Force		CBR									
	Bottom	Top	Bottom	Top								
2.5 mm Penetration	5.3	4.5	40	34								
5.0 mm Penetration	11.9	9.4	60	47								
Average	8.6	7.0	50.0	40.7								
Retained CBR	50.0											
Observations	CBR= 50.0											

For the Lab		For Students	
Lab. Technician	Materials Engineer		

INSTITUTION	STUDENTS	TESTING LAB
UGANDA CHRISTIAN UNIVERSITY	ASIIMWE CALEB & MANANA MARK	Stirling

PROJECT: ASSESSING THE USE OF POLYETHYLINE TEREPHTHALATE FIBRE AND LIME FOR STABILISATION OF EXPANSIVE SOILS

SUMMARY OF TEST RESULTS FOR EXPANSIVE SOIL STABILISED WITH 6% LIME & 1.5% FIBRE

LOCATION: MUYEMBE-NAKAPIRIPIRIT ROAD   Depth: 0.5m

LOCATION	BLENDED %		GRADING								ATTERBERG LIMITS				MDD		CBR	CBR SWELL	
		SAMPLING DATE	63	37.5	20	5	2	0.425	0.075	GM	LL	PL	PI	LS	MDD	OMC		62	
MUYEMBE-NAKAPIRIPIRIT ROAD	EXPANSIVE SOIL STABILISED WITH 6% LIME & 1.5% FIBRE	Sample 01	100	100	100	99	94	84	71	0.51	67.4	49.3	18.1	9.4	1.556	24.9	53.6	0.31	
		Sample 02	100	100	100	99	93	83	75	0.49	67.4	49.3	18.1	9.4					
			100	**100**	**100**	**98.99**	**93.61**	**83.59**	**73.07**	**0.50**	**67.4**	**49.3**	**18.1**	**9.4**	**1.556**	**24.9**	**53.6**	**0.31**	
		1/8/2024																	
	AVERAGE		**100**	**100**	**100**	**99**	**94**	**84**	**73**	**0.497**	**67.4**	**49.3**	**18.1**	**9.4**	**1.556**	**24.9**	**53.6**	**0.31**	**#DIV/0!**

FOR LAB

Lab Technician   Materials Engineer

STUDENTS

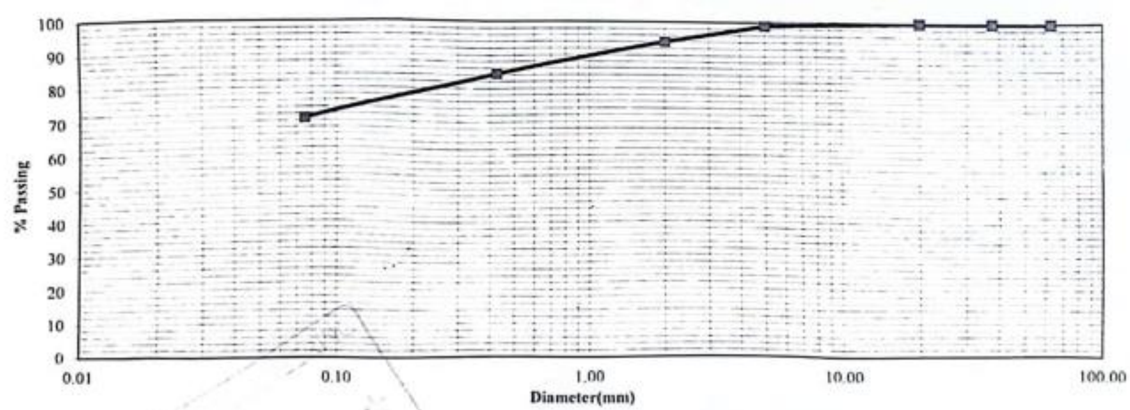
INSTITUTION	STUDENTS NAMES	TESTING LAB
UGANDA CHRISTIAN UNIVERSITY	ASIIMWE CALEB & MANANA MARK	Stirling

PROJECT : ASSESSING THE USE OF POLYETHYLINE TEREPHTHALATE FIBRE AND LIME FOR STABILISATION OF EXPANSIVE SOILS

PARTICLE SIZE DISTRIBUTION (BS 1377 - 2 - 90)

Location :	MUYEMBE-NAKAPIRIPIRIT ROAD	Lab. Refernece No.:		
Location :(km)	EXPANSIVE SOIL STABILISED WITH 6% LIME & 1.5% FIBRE	Dry wt. of sample before washing: (g)		2662.9
Depth: (m)	0.5m	Dry wt. of sample after washing: (g)		785.9
Material description:	MUYEMBE-NAKAPIRIPIRIT ROAD	Date Sampled:	Date Tested:	Technician
		8/Jan/2024	26/Feb/2024	Lab team

Sieve Size (mm)	Weight Retained (g)	Retained (%)	Passing (%)	Grading Limits (G60 & 80)	
63.0	0.0	0	100		
37.5	0.0	0.0	100		
20.0	0.0	0.0	100		
5.0	26.4	1.0	99		
2.00	131.7	4.9	94		
0.425	257.5	9.7	84		
0.075	364.4	13.7	71		
Total fines	1882.9	70.7			
Bottom Pan	5.9				
Extracted fines	1877.0				
Total sample	2662.9				
Grading Modulus		0.51			



Testing Lab		STUDENTS
Lab Technician	Materials Engineer	

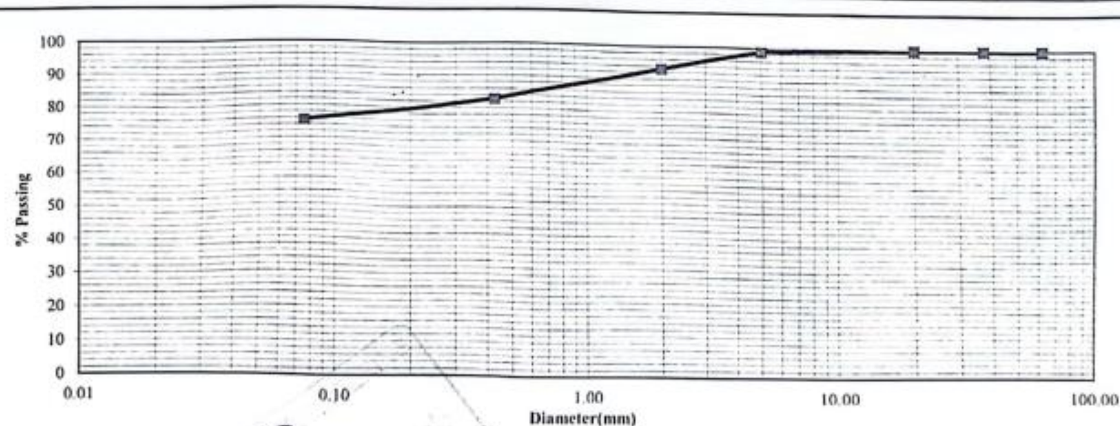
INSTITUTION	STUDENTS NAMES	TESTING LAB
UGANDA CHRISTIAN UNIVERSITY	ASIIMWE CALEB & MANANA MARK	Stirling

PROJECT : ASSESSING THE USE OF POLYETHYLINE TEREPHTHALATE FIBRE AND LIME FOR STABILISATION OF EXPANSIVE SOILS

PARTICLE SIZE DISTRIBUTION (BS 1377 - 2 - 90)

Location :	MUYEMBE-NAKAPIRIPIRIT ROAD	Lab. Refernece No.:		
Location :(km)	EXPANSIVE SOIL STABILISED WITH 6% LIME & 1.5% FIBRE	Dry wt. of sample before washing: (g)		2756.3
Depth: (m)	0.5m	Dry wt. of sample after washing: (g)		695.0
Material description:	MUYEMBE-NAKAPIRIPIRIT ROAD	Date Sampled:	Date Tested:	Technician
		8/Jan/2024	26/Feb/2024	Lab team

Sieve Size (mm)	Weight Retained (g)	Retained (%)	Passing (%)	Grading Limits (G60 & 80)	
63.0	0.0	0	**100**		
37.5	0.0	0.0	**100**		
20.0	0.0	0.0	**100**		
5.0	28.1	1.0	**99**		
2.00	160.5	5.8	**93**		
0.425	286.0	10.4	**83**		
0.075	202.7	7.4	**75**		
Total fines	2079.0	75.4			
Bottom Pan	17.7				
Extracted fines	2061.3				
Total sample	2756.3				
Grading Modulus		**0.49**			



Testing Lab

Lab Technician *Materials Engineer*

STUDENTS

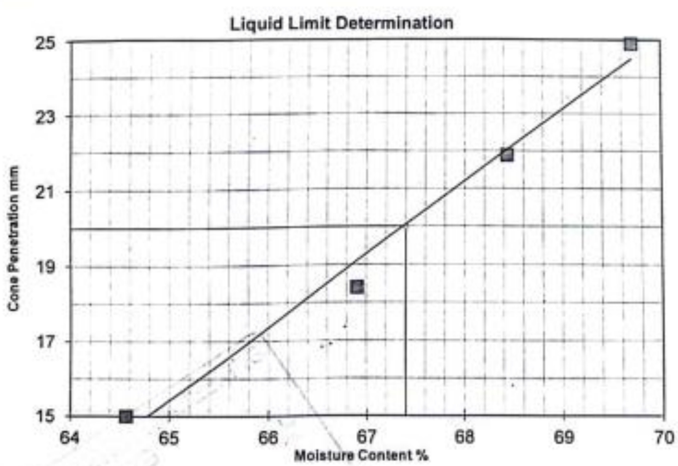
INSTITUTION	STUDENTS	TESTING LAB
UGANDA CHRISTIAN UNIVERSITY	ASIIMWE CALEB & MANANA MARK	Stirling

PROJECT:	ASSESSING THE USE OF POLYETHYLINE TEREPHTHALATE FIBRE AND LIME FOR STABILISATION OF EXPANSIVE SOILS

ATTERBERG LIMITS

Liquid limit (cone penotrometer) and plastic limit

SOURCE :	MUYEMBE-NAKAPIRIPIRIT ROAD			Technician:	Lab Team
mix	PANSIVE SOIL STABILISED WITH 6% LIME & 1.5% FIB			Sample Date	8/Jan/2024
Test method	BS 1377: Part 2, 1990:4.3/4.4			Test Date	11/Jan/2024
LAYER	EXPANSIVE SOILS				
Depth:	0.5m				
PLASTIC LIMIT	Test No.	SI	RAD		Average
Mass of wet soil + container (g)		41.01	40.7		40.855
Mass of dry soil + container (g)		35.05	34.5		34.775
Mass of container (g)		22.94	21.97		22.455
Mass of moisture (g)		5.96	6.2		6.08
Mass of dry soil (g)		12.11	12.53		12.32
Moisture content %		49.2	49.5		49.3
AVERAGE					
LIQUID LIMIT	Test No	1	2	3	4
Initial gauge reading (mm)		0	0	0	0
Final gauge reading (mm)		15.0	18.4	21.9	24.9
penetration (mm)		15.0	18.4	21.9	24.9
AVERAGE		15.0	18.4	21.9	24.9
Container No.		A2	PIOE	28PI	P153
Mass of wet soil + container (g)		64.29	79.00	71.70	75.70
Mass of dry soil + container (g)		42.06	50.25	45.60	48.32
Mass of container (g)		7.63	7.28	7.46	9.04
Mass of moisture (g)		22.23	28.75	26.1	27.38
Mass of dry soil (g)		34.43	42.97	38.14	39.28
Moisture content (%)		64.6	66.9	68.4	69.7
AVERAGE		64.6	66.9	68.4	69.7



Liquid limit (%)	67.4
Plastic limit (%)	49.3
Plasticity Index (%)	18.1
Linear shrinkage	
Trough No.	p
Trough length (cm)	14.0
Specimen length (cm)	12.7
L.shringage =	1.3
% L.shrinkage =	9.4

Remarks:

TESTING LAB		STUDENTS
Materials Engineer.		
Lab Technician		

INSTITUTION	STUDENTS	TESTING LAB
UGANDA CHRISTIAN UNIVERSITY	ASIIMWE CALEB & MANANA MARK	Stirling

PROJECT:	ASSESSING THE USE OF POLYETHYLINE TEREPHTHALATE FIBRE AND LIME FOR STABILISATION OF EXPANSIVE SOILS

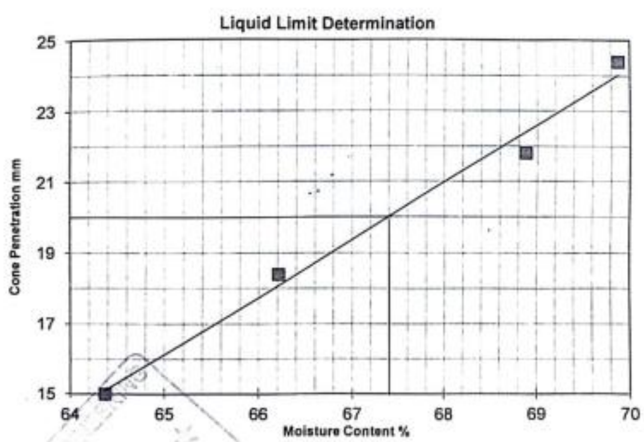
ATTERBERG LIMITS

Liquid limit (cone penotrometer) and plastic limit

SOURCE :	MUYEMBE-NAKAPIRIPIRIT ROAD	Technician:	Lab Team
mix	NEAT SAMPLE TP 02	Sample Date	8/Jan/2024
Test method	BS 1377: Part 2, 1990:4.3/4.4	Test Date	11/Jan/2024
LAYER	EXPANSIVE SOILS		
Depth:	0.5m		

PLASTIC LIMIT	Test No.	JL	2F		Average
Mass of wet soil + container (g)		38.74	41.22		39.98
Mass of dry soil + container (g)		33.35	35		34.175
Mass of container (g)		22.53	22.27		22.4
Mass of moisture (g)		5.39	6.2		5.805
Mass of dry soil (g)		10.82	12.73		11.775
Moisture content %		49.8	48.9		49.3
AVERAGE					

LIQUID LIMIT	Test No	1	2	3	4
Initial gauge reading (mm)		0	0	0	0
Final gauge reading (mm)		15.0	18.4	21.8	24.4
penetration (mm)		15.0	18.4	21.8	24.4
AVERAGE		15.0	18.4	21.8	24.4
Container No.		P160	AS	A3	PIBB
Mass of wet soil + container (g)		55.39	67.00	71.33	69.86
Mass of dry soil + container (g)		36.58	43.25	45.24	44.09
Mass of container (g)		7.36	7.38	7.36	7.21
Mass of moisture (g)		18.81	23.75	26.09	25.77
Mass of dry soil (g)		29.22	35.87	37.88	36.88
Moisture content (%)		64.4	66.2	68.9	69.9
AVERAGE		64.4	66.2	68.9	69.9



Liquid limit (%)	67.4
Plastic limit (%)	49.3
Plasticity Index (%)	18.1
Linear shrinkage	
Trough No.	p
Trough length (cm)	14.0
Specimen length (cm)	12.7
L.shringage =	1.3
% L.shrinkage =	9.4

Remarks:

TESTING LAB		STUDENTS
Materials Engineer		
Lab Technician		

INSTITUTION	STUDENTS NAMES	TESTING LAB
UGANDA CHRISTIAN UNIVERSITY	ASIIMWE CALEB & MANANA MARK	Stirling

PROJECT:	ASSESSING THE USE OF POLYETHYLINE TEREPHTHALATE FIBRE AND LIME FOR STABILISATION OF EXPANSIVE SOILS				
Test Reference No	Depth 0.5m		Date Sampled	Date Tested	Technician
Mix	EXPANSIVE SOIL STABILISED WITH 6% LIME & 1.5% FIBRE		8/Jan/24	26/Feb/24	Lab team
SOURCE	MUYEMBE-NAKAPIRIPIRIT ROAD				
Material description:	EXPANSIVE SOILS		Natural moisture (%)	11.0	

TEST DATA

Weight of rammer (Kg)	No. of blows per layer	No of layers	Height of drop (mm)	Diameter of mould(mm)	Volume of mould (cm^3)
4.5	27	5	457	100	1,000

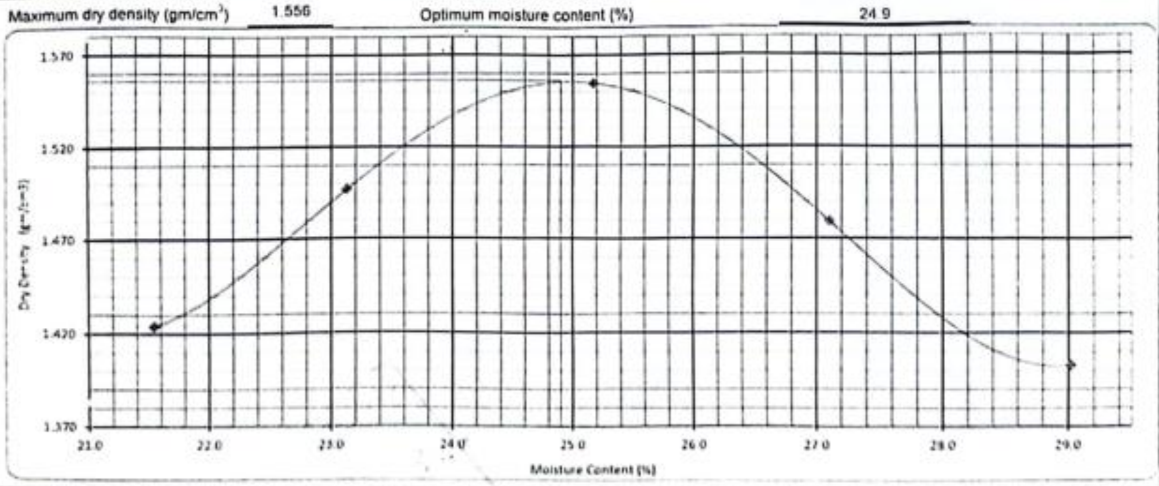
MOISTURE CONTENT DATA

Test No.		1	2	3	4	5
Tin No.		A	A	A	A	A
Water Added	cm^3	240	300	360	420	480
Mass of Compacted soil + mould	gm	4,949	5,061	5,164	5,098	5,028
Mass of Mould	gm	3,218	3,218	3,218	3,218	3,218
Mass of Compacted soil	gm	1731	1843	1946	1880	1810
Volume of mould	cm^3	1,000	1,000	1,000	1,000	1,000
Wet density of soil	g/cm^3	1.731	1.843	1.946	1.880	1.810

DATA FOR PROCTOR CURVE

Container No.		MANU	ZION	LDU	AA	NO
Mass of wet soil + Container	gm	1,461.0	1,755.0	1,878.0	1,502.0	924.0
Mass of dry soil + container	gm	1,299.0	1,508.0	1,584.0	1,270.0	729.0
Mass of container	gm	547.0	440.0	416.0	414.0	57.0
Mass of water added	gm	162	247	294	232	195
Mass of dry soil	gm	752	1068	1168	856	672
Moisture content	%	21.5	23.1	25.2	27.1	29.0
Dry density	g/cm^3	1.424	1.497	1.555	1.479	1.403

Maximum dry density (gm/cm^3) 1.556 Optimum moisture content (%) 24.9



Remarks:

FOR TESTING LAB		STUDENTS	
Lab Technician	Materials Engineer		

Institution	Students Names	Testing Lab
UGANDA CHRISTIAN UNIVERSITY	ASIIMWE CALEB & MANANA MARK	Stirling

ASSESSING THE USE OF POLYETHYLINE TEREPHTHALATE FIBRE AND LIME FOR STABILISATION OF EXPANSIVE SOILS

CALIFORNIA BEARING RATIO TEST (BS1377 Part 4)

Test sample reference	Depth 0.5m	Sampling Date	8/Jan/24
mix	EXPANSIVE SOIL STABILISED WITH 6% LIME & 1.5% FIBRE	Penetration Date	12/Mar/24
Source	MUYEMBE-NAKAPIRIPIRIT ROAD	Technician	Lab team
Sample Description	EXPANSIVE SOILS		

Number of blows per layer	62		
Number of layers	5	5	5
Mould No	XT		
Capacity of the Proving Ring (KN)	50	50	50
Proving Ring Constant (KN/div.)	0.2052	0.2052	0.2052

Speed: ...mm min.		Top		Bottom					
Penetration of the plunger (mm)	Time (s)	Reading $*10^{1}$mm	Force (KN)	Reading $*10^{1}$mm	Force (KN)				
0	0	0	0.0	0	0.0				
0.25	12	2	0.4	2	0.4				
0.5	24	5	1.0	7	1.4				
0.75	35	9	1.8	11	2.3				
1	47	11	2.3	15	3.1				
1.5	71	16	3.3	18	3.7				
2	94	20	4.1	25	5.1				
2.5	118	23	4.7	34	7.0				
3	142	28	5.7	38	7.8				
3.5	165	32	6.6	42	8.6				
4	189	36	7.4	45	9.2				
4.5	213	41	8.4	50	10.3				
5	236	45	9.2	53	10.9				
5.5	260	49	10.1	56	11.5				
6	283	53	10.9	62	12.7				
6.5	307	55	11.3	64	13.1				
7	331	57	11.7	65	13.3				
7.5	354	59	12.1	67	13.7				

Observations

For the Contractor		For Students	
Lab. Technician	*Materials Engineer*		

Institution	Students Names	Testing Lab
UGANDA CHRISTIAN UNIVERSITY	ASHMWE CALEB & MANANA MARK	Stirling

ASSESSING THE USE OF POLYETHYLINE TEREPHTHALATE FIBRE AND LIME FOR STABILISATION OF EXPANSIVE SOILS

CALIFORNIA BEARING RATIO TEST (BS 1377 Part 4)

Test sample reference :	Depth. 0.5m	Sampling Date :	8/Jan/24
mix:	EXPANSIVE SOIL STABILISED WITH 6% LIME & 1.5% FIBRE	Casting date :	27/Feb/24
Source:	MUYEMBE-NAKAPIRIPIRIT ROAD	Testing Date :	12/Mar/24
Sample Description:	EXPANSIVE SOILS	Technician :	Lab team
		Volume of Mould used (m^3)	2305

Natural moisture of air dried sample			Volume of water added	
Tin No.	21		Mass of air dried soil (g)	6000
Tin + air dried soil sample (g)	2118		MDD (Mg/m^3)	1.556
Tin + oven dry soil sample (g)	1953		N.M.C (%)	14.2
Tin (g)	790		OMC (%)	24.9
Dry soil sample	1163		Added OMC (%)	10.7
Water (g)	165		Calculated dry wt of soil (g)	5148.8
N.M.C (%)	14.2		Water added (g)	563
Average (%)	14.2		**Water added (ml.)**	563

Number of blows		62								
Number of layer		5								
Water Content Determination		Before Soaking		After Soaking						
Tare No		KAU	-	KT	-					
Mass of wet sample + Tare	g	2060	-	2069	-					
Mass of dry sample + Tare	g	1772	-	1743	-					
Mass of Tare	g	799	-	800	-					
Mass of water	g	288	-	326	-					
Mass of dry sample	g	973	-	943	-					
Water content	%	29.6	-	34.6	-					
Average water Content	%	29.6		34.6						
Density determination										
Mould No		XT								
Mass of mould + soil	g	10514		10732						
Mass of mould	g	6134		6134						
Mass of soil	g	4380		4598						
Volume of the mould	cm3	2305		2305						
Moist density	g/cm3	1.900		1.995						
Dry density	g/cm3	1.466		1.482						
Swell Determination										
Date		Hour		D.Gauge Reding						
Initial reading		96 hrs		9						
Final reading				9.39						
Height of the specimen				127						
Height of swell				0.39						
		Swelling(%)		**0.31**						
Observations										

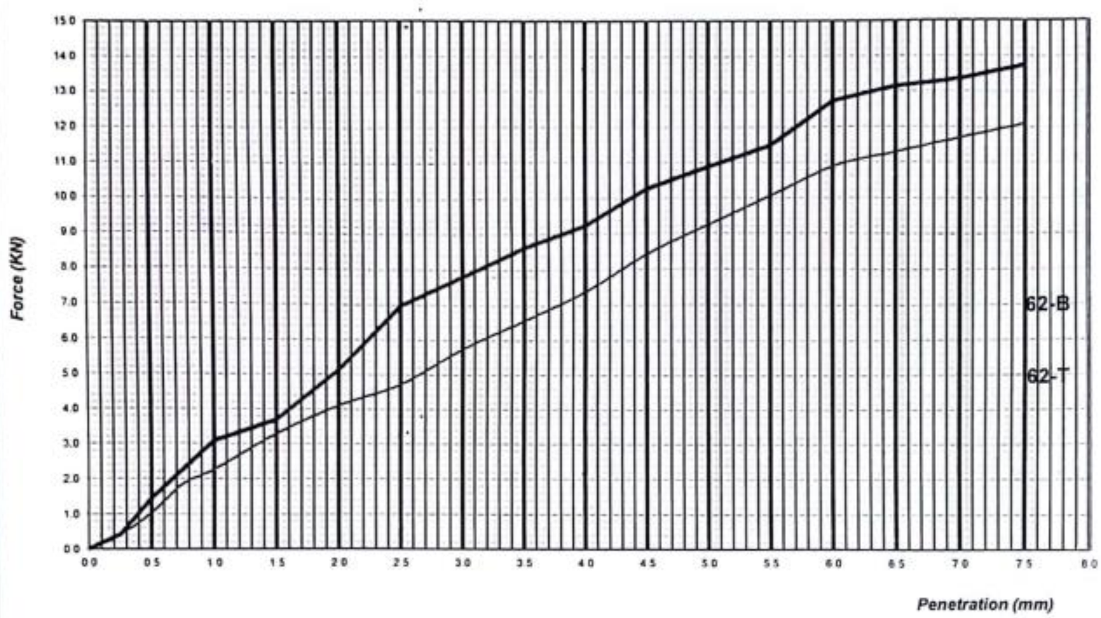
For the Lab		For Students	
Lab. Technician	*Materials Engineer*		

Institution	Students Names	Testing Lab
UGANDA CHRISTIAN UNIVERSITY	ASHMWE CALEB & MANANA MARK	Stirling

ASSESSING THE USE OF POLYETHYLINE TEREPHTHALATE FIBRE AND LIME FOR STABILISATION OF EXPANSIVE SOILS

CALIFORNIA BEARING RATIO TEST (BS1377 Part 4)

Test sample reference	Depth. 0.5m	Sampling Date	8/Jan/24
mix:	EXPANSIVE SOIL STABILISED WITH 6% LIME &	Testing Date	12/Mar/24
Source:	MUYEMBE-NAKAPIRIPIRIT ROAD	Technician	Lab team
Sample Description:	EXPANSIVE SOILS		



	62 blows			
	Force		CBR	
	Bottom	Top	Bottom	Top
2.5 mm Penetration	7.0	4.7	53	36
5.0 mm Penetration	10.9	9.2	54	46
Average	8.9	7.0	53.6	41.0
Retained CBR	53.6			
Observations	CBR= 53.6			

For the Lab		For Students	
Lab. Technician	Materials Engineer		

INSTITUTION	STUDENTS	TESTING LAB
UGANDA CHRISTIAN UNIVERSITY	ASIIMWE CALEB & MANANA MARK	Stirling

PROJECT: ASSESSING THE USE OF POLYETHYLINE TEREPHTHALATE FIBRE AND LIME FOR STABILISATION OF EXPANSIVE SOILS

SUMMARY OF TEST RESULTS FOR EXPANSIVE SOIL STABILISED WITH 6% LIME & 2% FIBRE

LOCATION: MUYEMBE-NAKAPIRIPIRIT ROAD Depth: 0.5m

LOCATION	BLENDED %		GRADING								ATTERBERG LIMITS				MDD		CBR	CBR SWELL	
		SAMPLING DATE	63	37.5	20	5	2	0.425	0.075	GM	LL	PL	PI	LS	MDD	OMC		62	
MUYEMBE-NAKAPIRIPIRIT ROAD	EXPANSIVE SOIL STABILISED WITH 6% LIME & 2% FIBRE	Sample 01	100	100	100	99	94	85	80	0.41	65.45	49.4	16.0	9.0	1.492	27.5	47.7	0.43	
		Sample 02	100	100	100	99	94	84	78	0.44	65.5	49.3	16.2	9.0					
			100	100	100	98.99	94.42	84.32	78.89	0.42	65.5	49.3	16.1	9.0	1.492	27.5	47.7	0.43	
		1/8/2024																	
	AVERAGE		100	100	100	99	94	84	79	0.424	65.5	49.3	16.1	9.0	1.492	27.5	47.7	0.43	#DIV/0!

FOR LAB

Lab Technician

Materials Engineer

STUDENTS

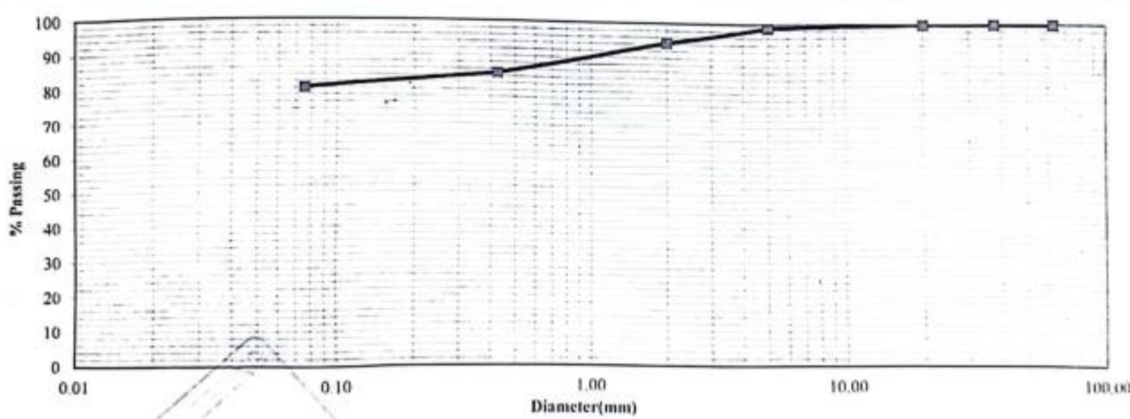
INSTITUTION	STUDENTS NAMES	TESTING LAB
UGANDA CHRISTIAN UNIVERSITY	ASIIMWE CALEB & MANANA MARK	Stirling

PROJECT : ASSESSING THE USE OF POLYETHYLINE TEREPHTHALATE FIBRE AND LIME FOR STABILISATION OF EXPANSIVE SOILS

PARTICLE SIZE DISTRIBUTION (BS 1377 - 2 - 90)

Location :	MUYEMBE-NAKAPIRIPIRIT ROAD	Lab. Refernece No.:		
Location :(km)	EXPANSIVE SOIL STABILISED WITH 6% LIME & 2% FIBRE	Dry wt. of sample before washing: (g)		3057.1
Depth: (m)	0.5m	Dry wt. of sample after washing: (g)		609.2
Material description:	MUYEMBE-NAKAPIRIPIRIT ROAD	Date Sampled:	Date Tested:	Technician
		8/Jan/2024	26/Feb/2024	Lab team

Sieve Size (mm)	Weight Retained (g)	Retained (%)	Passing (%)	Grading Limits (G60 & 80)	
63.0	0.0	0	**100**		
37.5	0.0	0.0	**100**		
20.0	0.0	0.0	**100**		
5.0	34.9	1.1	**99**		
2.00	136.9	4.5	**94**		
0.425	290.9	9.5	**85**		
0.075	144.2	4.7	**80**		
Total fines	2450.2	80.1			
Bottom Pan	2.3				
Extracted fines	2447.9				
Total sample	3057.1				
Grading Modulus		**0.41**			



Testing Lab		STUDENTS	
Lab Technician	*Materials Engineer*		

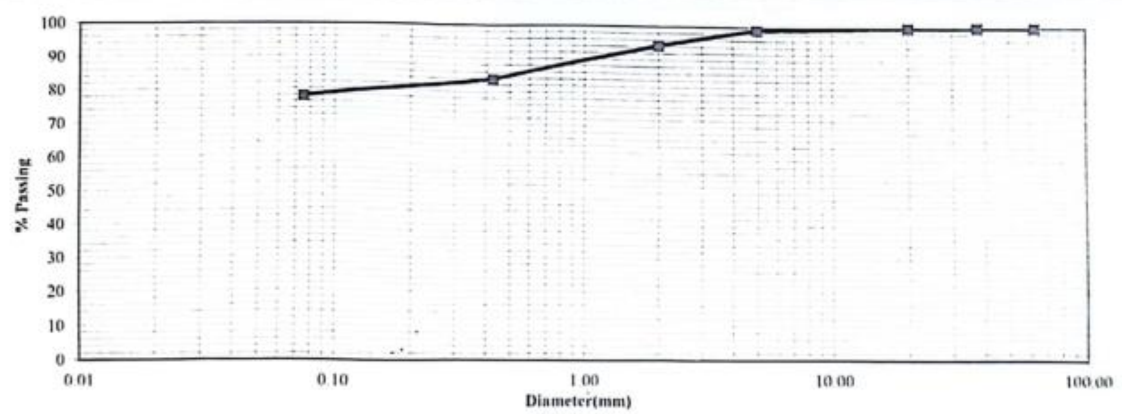
INSTITUTION	STUDENTS NAMES	TESTING LAB
UGANDA CHRISTIAN UNIVERSITY	ASIIMWE CALEB & MANANA MARK	Stirling

PROJECT : ASSESSING THE USE OF POLYETHYLINE TEREPHTHALATE FIBRE AND LIME FOR STABILISATION OF EXPANSIVE SOILS

PARTICLE SIZE DISTRIBUTION (BS 1377 - 2 - 90)

Location :	MUYEMBE-NAKAPIRIPIRIT ROAD	Lab. Refernece No.:		
Location :(km)	EXPANSIVE SOIL STABILISED WITH 6% LIME & 2% FIBRE	Dry wt. of sample before washing: (g)		2623.3
Depth: (m)	0.5m	Dry wt. of sample after washing: (g)		588.7
Material description:	MUYEMBE-NAKAPIRIPIRIT ROAD	Date Sampled:	Date Tested:	Technician
		8/Jan/2024	26/Feb/2024	Lab team

Sieve Size (mm)	Weight Retained (g)	Retained (%)	Passing (%)	Grading Limits (G60 & 80)	
63.0	0.0	0	100		
37.5	0.0	0.0	100		
20.0	0.0	0.0	100		
5.0	22.8	0.9	99		
2.00	122.6	4.7	94		
0.425	280.3	10.7	84		
0.075	160.9	6.1	78		
Total fines	2036.7	77.6			
Bottom Pan	2.1				
Extracted fines	2034.6				
Total sample	2623.3				
Grading Modulus		0.44			



Testing Lab	STUDENTS
Lab Technician / Materials Engineer	

INSTITUTION	STUDENTS	TESTING LAB
UGANDA CHRISTIAN UNIVERSITY	ASIIMWE CALEB & MANANA MARK	Stirling

PROJECT:	ASSESSING THE USE OF POLYETHYLINE TEREPHTHALATE FIBRE AND LIME FOR STABILISATION OF EXPANSIVE SOILS

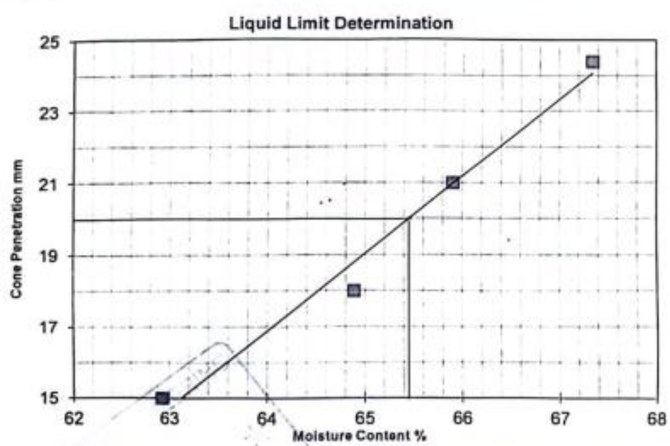
ATTERBERG LIMITS

Liquid limit (cone penotrometer) and plastic limit

SOURCE :	MUYEMBE-NAKAPIRIPIRIT ROAD	Technician:	Lab Team
mix	XPANSIVE SOIL STABILISED WITH 6% LIME & 2% FIBR	Sample Date	8/Jan/2024
Test method	BS 1377: Part 2, 1990:4.3/4.4	Test Date	11/Jan/2024
LAYER	EXPANSIVE SOILS		
Depth:	0.5m		

PLASTIC LIMIT	Test No.	BA	FT		Average
Mass of wet soil + container (g)		39.74	43.68		41.71
Mass of dry soil + container (g)		34.31	36.69		35.5
Mass of container (g)		23.29	22.58		22.935
Mass of moisture (g)		5.43	7.0		6.21
Mass of dry soil (g)		11.02	14.11		12.565
Moisture content %		49.3	49.5		49.4
AVERAGE					

LIQUID LIMIT	Test No	1	2	3	4
Initial gauge reading (mm)		0	0	0	0
Final gauge reading (mm)		15.0	18	21	24.4
penetration (mm)		15.0	18.0	21.0	24.4
AVERAGE		15.0	18.0	21.0	24.4
Container No.		MB	FORD	PI600	A3
Mass of wet soil + container (g)		69.12	55.52	70.70	75.37
Mass of dry soil + container (g)		45.14	36.36	45.38	47.86
Mass of container (g)		7.03	6.83	6.96	7.01
Mass of moisture (g)		23.98	19.16	25.32	27.51
Mass of dry soil (g)		38.11	29.53	38.42	40.85
Moisture content (%)		62.9	64.9	65.9	67.3
AVERAGE		62.9	64.9	65.9	67.3



Liquid limit (%)	65.5
Plastic limit (%)	49.4
Plasticity Index (%)	16.0
Linear shrinkage	
Trough No.	2
Trough length (cm)	14.0
Specimen length (cm)	12.7
L.shringage =	1.3
% L.shrinkage =	9.0

Remarks:

TESTING LAB		STUDENTS
Materials Engineer		
Lab Technician		

INSTITUTION	STUDENTS	TESTING LAB
UGANDA CHRISTIAN UNIVERSITY	ASIIMWE CALEB & MANANA MARK	Stirling

PROJECT:	ASSESSING THE USE OF POLYETHYLINE TEREPHTHALATE FIBRE AND LIME FOR STABILISATION OF EXPANSIVE SOILS

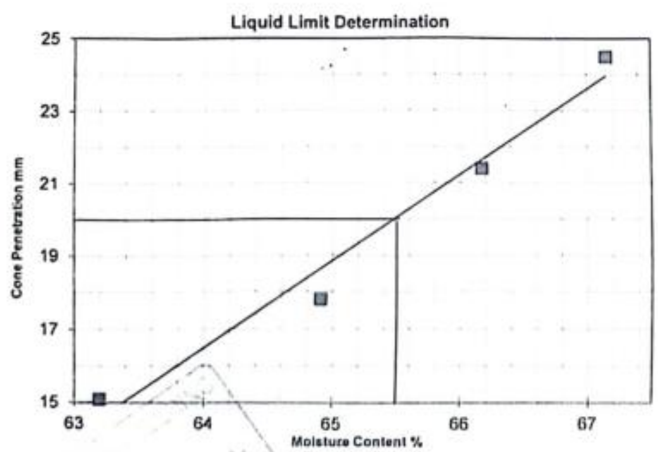
ATTERBERG LIMITS

Liquid limit (cone penetrometer) and plastic limit

SOURCE .	MUYEMBE-NAKAPIRIPIRIT ROAD	Technician:	Lab Team
mix	NEAT SAMPLE TP 02	Sample Date	8/Jan/2024
Test method	BS 1377: Part 2, 1990:4.3/4.4	Test Date	11/Jan/2024
LAYER	EXPANSIVE SOILS		
Depth:	0.5m		

PLASTIC LIMIT	Test No.	O	RAD		Average
Mass of wet soil + container (g)		35.78	30.56		33.17
Mass of dry soil + container (g)		31.05	27.71		29.38
Mass of container (g)		21.38	21.97		21.675
Mass of moisture (g)		4.73	2.9		3.79
Mass of dry soil (g)		9.67	5.74		7.705
Moisture content %		48.9	49.7		49.3
AVERAGE					

LIQUID LIMIT	Test No	1	2	3	4
Initial gauge reading (mm)		0	0	0	0
Final gauge reading (mm)		15.1	17.8	21.4	24.5
penetration (mm)		15.1	17.8	21.4	24.5
AVERAGE		15.1	17.8	21.4	24.5
Container No.		BE	P132	P152	P133
Mass of wet soil + container (g)		53.01	70.80	73.92	64.65
Mass of dry soil + container (g)		35.17	45.61	47.26	42.41
Mass of container (g)		6.94	6.80	6.97	9.29
Mass of moisture (g)		17.84	25.19	26.66	22.24
Mass of dry soil (g)		28.23	38.81	40.29	33.12
Moisture content (%)		63.2	64.9	66.2	67.1
AVERAGE		63.2	64.9	66.2	67.1



Liquid limit (%)	65.5
Plastic limit (%)	49.3
Plasticity Index (%)	16.2
Linear shrinkage	
Trough No.	2
Trough length (cm)	14.0
Specimen length (cm)	12.7
L.shringage =	1.3
% L.shrinkage =	9.0

Remarks:

TESTING LAB		STUDENTS
Materials Engineer		
Lab Technician		

INSTITUTION	STUDENTS NAMES	TESTING LAB
UGANDA CHRISTIAN UNIVERSITY	ASIIMWE CALEB & MANANA MARK	Stirling

PROJECT:	ASSESSING THE USE OF POLYETHYLINE TEREPHTHALATE FIBRE AND LIME FOR STABILISATION OF EXPANSIVE SOILS					
Test Reference No.	Depth.	0.5m	Date Sampled	Date Tested	Technician	
Mix	EXPANSIVE SOIL STABILISED WITH 6% LIME & 2% FIBRE		8/Jan/24	26/Feb/24	Lab team	
SOURCE	MUYEMBE-NAKAPIRIPIRIT ROAD					
Material description;	EXPANSIVE SOILS		Natural moisture (%) :	11.0		

TEST DATA

Weight of rammer (Kg)	No. of blows per layer	No of layers	Height of drop (mm)	Diameter of mould(mm)	Volume of mould (cm^3)
4.5	27	5	457	100	1,000

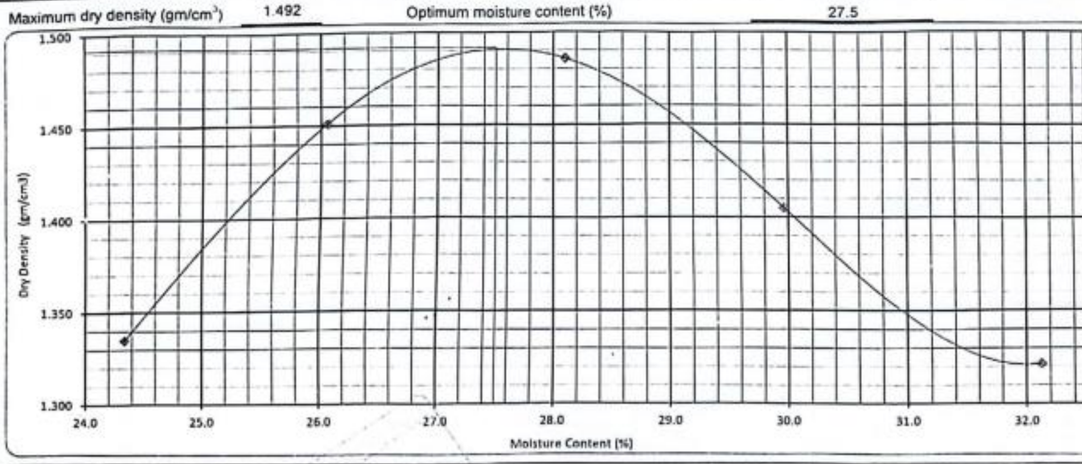
MOISTURE CONTENT DATA

Test No.		1	2	3	4	5
Tin No.		A	A	A	A	A
Water Added	cm^3	260	320	380	440	500
Mass of Compacted soil + mould	gm	5,938	6,107	6,181	6,104	6,024
Mass of Mould	gm	4,278	4,278	4,278	4,278	4,278
Mass of Compacted soil	gm	1660	1829	1903	1826	1746
Volume of mould	cm^3	1,000	1,000	1,000	1,000	1,000
Wet density of soil	g/cm^3	1.660	1.829	1.903	1.826	1.746

DATA FOR PROCTOR CURVE

Container No.		EX	DJ	KCR	YMC	NMT
Mass of wet soil + Container	gm	1,513.0	1,532.0	1,777.0	1,872.0	1,825.0
Mass of dry soil + container	gm	1,321.0	1,328.0	1,478.0	1,537.0	1,568.0
Mass of container	gm	532.0	545.0	414.0	419.0	768.0
Mass of water added	gm	192	204	299	335	257
Mass of dry soil	gm	789	783	1064	1118	800
Moisture content	%	24.3	26.1	28.1	30.0	32.1
Dry density	g/cm^3	1.335	1.451	1.486	1.405	1.321

Maximum dry density (gm/cm^3) 1.492 Optimum moisture content (%) 27.5



Remarks:

FOR TESTING LAB		STUDENTS	
Lab Technician	Materials Engineer		

Institution	Students Names	Testing Lab
UGANDA CHRISTIAN UNIVERSITY	ASHMWE CALEB & MANANA MARK	Stirling

ASSESSING THE USE OF POLYETHYLINE TEREPHTHALATE FIBRE AND LIME FOR STABILISATION OF EXPANSIVE SOILS

CALIFORNIA BEARING RATIO TEST (BS 1377 Part 4)

Test sample reference	Depth. 0.5m	Sampling Date :	8/Jan/24
mix:	EXPANSIVE SOIL STABILISED WITH 6% LIME & 2% FIBRE	Casting date :	27/Feb/24
Source:	MUYEMBE-NAKAPIRIPIRIT ROAD	Testing Date :	12/Mar/24
Sample Description:	EXPANSIVE SOILS	Technician :	Lab team
		Volume of Mould used (m^3)	**2305**

Natural moisture of air dried sample			Volume of water added	
Tin No.	MJR		Mass of air dried soil (g)	6000
Tin + air dried soil sample (g)	2118		MDD (Mg/m^3)	1.492
Tin + oven dry soil sample (g)	1958		N.M.C (%)	13.7
Tin (g)	790		OMC (%)	27.5
Dry soil sample	1168		Added OMC (%)	13.8
Water (g)	160		Calculated dry wt of soil (g)	5178.1
N.M.C (%)	13.7		Water added (g)	728
Average (%)	13.7		**Water added (ml.)**	**728**

Number of blows		62					
Number of layer		5					
Water Content Determination		Before Soaking	After Soaking				
Tare No		YY -	Y6Y -				
Mass of wet sample + Tare	g	1630 -	1956 -				
Mass of dry sample + Tare	g	1443 -	1654 -				
Mass of Tare	g	783 -	821 -				
Mass of water	g	187 -	302 -				
Mass of dry sample	g	660 -	833 -				
Water content	%	28.3 -	36.3 -				
Average water Content	%	28.3	36.3				
Density determination							
Mould No		N					
Mass of mould + soil	g	10442	10785				
Mass of mould	g	6118	6118				
Mass of soil	g	4324	4667				
Volume of the mould	cm3	2305	2305				
Moist density	g/cm3	1.876	2.025				
Dry density	g/cm3	1.462	1.486				
Swell Determination							
Date		Hour	D.Gauge Reding				
Initial reading		96 hrs	9.8				
Final reading			10.35				
Height of the specimen			127				
Height of swell			0.55				
		Swelling(%)	**0.43**				
Observations							

For the Lab		For Students	
Lab. Technician	*Materials Engineer*		

Institution	Students Names	Testing Lab
UGANDA CHRISTIAN UNIVERSITY	ASIIMWE CALEB & MANANA MARK	Stirling

ASSESSING THE USE OF POLYETHYLINE TEREPHTHALATE FIBRE AND LIME FOR STABILISATION OF EXPANSIVE SOILS

CALIFORNIA BEARING RATIO TEST (BS1377 Part 4)

Test sample reference	Depth 0.5m	Sampling Date	8/Jan/24
mix	EXPANSIVE SOIL STABILISED WITH 6% LIME & 2% FIBRE	Penetration Date	12/Mar/24
Source	MUYEMBE-NAKAPIRIPIRIT ROAD	Technician	Lab team
Sample Description	EXPANSIVE SOILS		

Number of blows per layer	62		
Number of layers	5	5	5
Mould No	N		
Capacity of the Proving Ring (KN)	50	50	50
Proving Ring Constant (KN/div.)	0.2052	0.2052	0.2052

Speed: ......mm min.		Top		Bottom					
Penetration of the plunger (mm)	Time (s)	Reading $*10^{3}$mm	Force (KN)	Reading $*10^{3}$mm	Force (KN)				
0	0	0	0.0	0	0.0				
0.25	12	1	0.2	2	0.4				
0.5	24	2	0.4	4	0.8				
0.75	35	3	0.6	5	1.0				
1	47	6	1.2	10	2.1				
1.5	71	9	1.8	16	3.3				
2	94	13	2.7	25	5.1				
2.5	118	16	3.3	29	6.0				
3	142	20	4.1	33	6.8				
3.5	165	23	4.7	38	7.8				
4	189	26	5.3	42	8.6				
4.5	213	29	6.0	46	9.4				
5	236	32	6.6	49	10.1				
5.5	260	34	7.0	51	10.5				
6	283	36	7.4	54	11.1				
6.5	307	38	7.8	55	11.3				
7	331	39	8.0	56	11.5				
7.5	354	40	8.2	57	11.7				

Observations

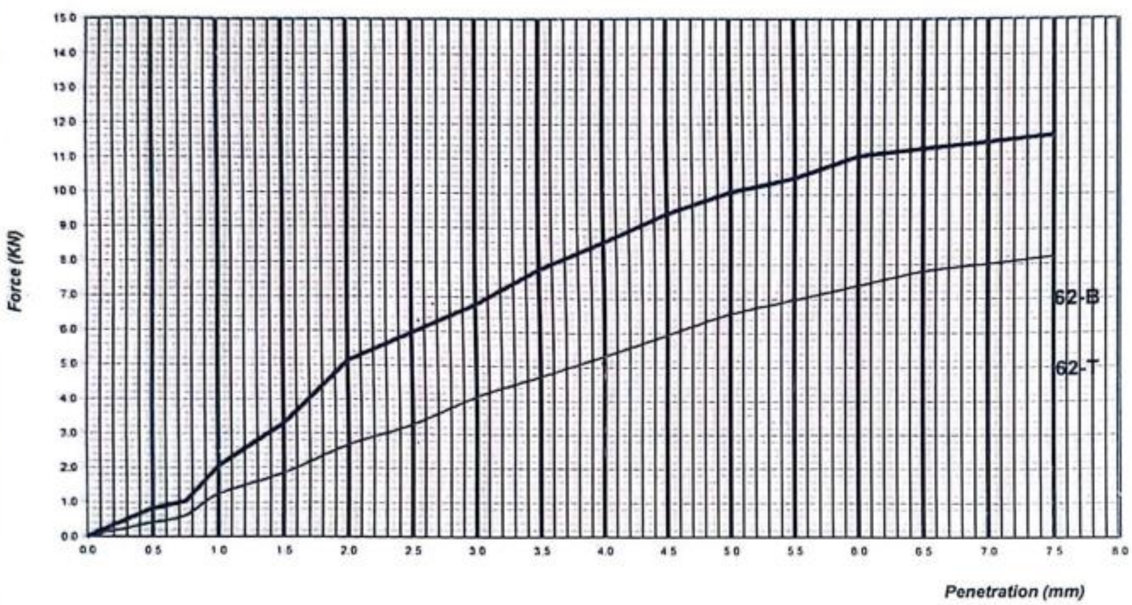
For the Contractor		For Students	
Lab. Technician	Materials Engineer		

Institution	Students Names	Testing Lab
UGANDA CHRISTIAN UNIVERSITY	ASIIMWE CALEB & MANANA MARK	Stirling

ASSESSING THE USE OF POLYETHYLINE TEREPHTHALATE FIBRE AND LIME FOR STABILISATION OF EXPANSIVE SOILS

CALIFORNIA BEARING RATIO TEST (BS1377 Part 4)

Test sample reference :	Depth. 0.5m	Sampling Date .	8/Jan/24
mix	EXPANSIVE SOIL STABILISED WITH 6% LIME &	Testing Date :	12/Mar/24
Source	MUYEMBE-NAKAPIRIPIRIT ROAD	Technician	Lab team
Sample Description:	EXPANSIVE SOILS		



	62 blows											
	Force		CBR									
	Bottom	Top	Bottom	Top								
2.5 mm Penetration	6.0	3.3	45	25								
5.0 mm Penetration	10.1	6.6	50	33								
Average	8.0	4.9	47.7	28.8								
Retained CBR	47.7											
Observations	CBR= 47.7											

For the Lab		For Students	
Lab. Technician	*Materials Engineer*		

INSTITUTION	STUDENTS NAMES	TESTING LAB
UGANDA CHRISTIAN UNIVERSITY	ASIIMWE CALEB & MANANA MARK	Stirling
PROJECT	ASSESSING THE USE OF POLYETHYLINE TEREPHTHALATE FIBRE AND LIME FOR STABILISATION OF EXPANSIVE SOILS	

STABLISED CBR

(BS 1924 PART 2 1)

EXPANSIVE SOIL STABILISED WITH 6% LIME & 0% FIBRE

	M/c of air dried sample				M/c After Mixing		
Tin No.	Z6T			Stabliser	6% LIME & 0% FIBRE		
Tin + Wet soil gm	2475			Content	6.0		
Tin + Dry Soil gm	2273			Tin No.	Y6Y		
Tin gm	810			Tin + Wet Soil	2228		
Water gm	202.0			Tin + Dry Soil	1915		
Dry Soil gm	1,463.0			Tin	820		
M/c %	13.8			Water	313.0		
Av. M/c %	13.8			Dry Soil	1,095.0		
				M/c	28.6		

(a)MDD	1.464	kg/m3	(b)Air Dry M/c	13.8	%
(c)WD	4,010	kg/m3	(e)M/c to add	13.6	%
(d)OMC	27.4	%	(F) volume	2.305	

Date prepared 1/Mar/24 Date immerse 8/Mar/24 Date tested 15/Mar/24

Mould No.			
Factor(f)	2.305		
(h)Wet Soil to fill mould c x f x %comp	9,243.0		
(j) Wt of air dried soil	6,000		
Air dry M/c	13.8		
(k) soil dry wt (100j/100+b)	5,272.1		
Stabliser	6% LIME & 0% FIBRE		
(m)Stablisers content %	6.0		
(n) Stabliser to add k x(m/100)	316.3		
Water Addition((j+n)x(d-b))/(100+b)	754.4		
Wt. per layer CBR Only h/3			

SPECIMEN WEIGHT CHECK

No. of blows	62.0	62.0	AVERAGE
Mould No.	7 DAYS AIR TIGHT, 7 DAYS SOAKED	7 DAYS AIR TIGHT, 7 DAYS SOAKED	
Stabliser	6% LIME & 0% FIBRE	6% LIME & 0% FIBRE	
Content %	6.0	6.0	
Mould g	A	B	
Wet Soil g	4,534.0	4,496.0	
Compaction M/c %	28.6	28.6	
Dry density kg/m3	1.530	1.517	
%Compaction	104.5	103.7	
FORCE	6.2	6.3	
UCS	0.338	0.343	0.34

STIRLING CIVIL ENGINEERING LTD P.O. BOX 703, KAMPALA (U)

INSTITUTION	STUDENTS NAMES	TESTING LAB
UGANDA CHRISTIAN UNIVERSITY	ASIIMWE CALEB & MANANA MARK	Stirling
PROJECT	ASSESSING THE USE OF POLYETHYLINE TEREPHTHALATE FIBRE AND LIME FOR STABILISATION OF EXPANSIVE SOILS	

STABLISED CBR

(BS 1924 PART 2 1)

EXPANSIVE SOIL STABILISED WITH 6% LIME & 0.5% FIBRE

M/c of air dried sample					M/c After Mixing		
Tin No.	Y6Y5			Stabliser	6% LIME & 0% FIBRE		
Tin + Wet soil gm	2566			Content	6.0		
Tin + Dry Soil gm	2415			Tin No.	DR		
Tin gm	802			Tin + Wet Soil	1456		
Water gm	151.0			Tin + Dry Soil	1255		
Dry Soil gm	1,613.0			Tin	505		
M/c %	9.4			Water	201.0		
Av. M/c %	9.4			Dry Soil	750.0		
				M/c	26.8		

(a)MDD	1.505	kg/m3	(b)Air Dry M/c	9.4	%
(c)WD	4,009	kg/m3	(e)M/c to add	17.3	%
(d)OMC	26.7	%	(F) volume	2.305	

Date prepared 1/Mar/24 Date immerse 8/Mar/24 Date tested 15/Mar/24

Mould No.			
Factor(f)	2.305		
(h)Wet Soil to fill mould c x f x %comp	9,241.9		
(j) Wt of air dried soil	6,000		
Air dry M/c	9.4		
(k) soil dry wt (100j/100+b)	5,486.4		
Stabliser	6% LIME & 0% FIBRE		
(m)Stablisers content %	6.0		
(n) Stabliser to add k x(m/100)	329.2		
Water Addition((j+n)x(d-b))/(100+b)	1,000.6		
Wt. per layer CBR Only h/3			

SPECIMEN WEIGHT CHECK

No. of blows	62.0	62.0	AVERAGE
Mould No.	7 DAYS AIR TIGHT, 7 DAYS SOAKED	7 DAYS AIR TIGHT, 7 DAYS SOAKED	
Stabliser	6% LIME & 0% FIBRE	6% LIME & 0% FIBRE	
Content %	6.0	6.0	
Mould g	A	B	
Wet Soil g	4,455.0	4,505.0	
Compaction M/c %	26.8	26.8	
Dry density kg/m3	1.524	1.541	
%Compaction	101.3	102.5	
FORCE	7.4	8.0	
UCS	0.405	0.439	0.42

STIRLING CIVIL ENGINEERING LTD P.O. BOX 793, KAMPALA (U)

INSTITUTION	STUDENTS NAMES	TESTING LAB
UGANDA CHRISTIAN UNIVERSITY	ASIIMWE CALEB & MANANA MARK	Stirling
PROJECT	ASSESSING THE USE OF POLYETHYLINE TEREPHTHALATE FIBRE AND LIME FOR STABILISATION OF EXPANSIVE SOILS	

STABLISED CBR

(BS 1924 PART 2 1)

EXPANSIVE SOIL STABILISED WITH 6% LIME & 1% FIBRE

	M/c of air dried sample				M/c After Mixing		
Tin No.	UPC			Stabliser	6% LIME & 1% FIBRE		
Tin + Wet soil gm	2393			Content	6.0		
Tin + Dry Soil gm	2191			Tin No.	ACB		
Tin gm	807			Tin + Wet Soil	2078		
Water gm	202.0			Tin + Dry Soil	1778		
Dry Soil gm	1,384.0			Tin	781		
M/c %	14.6			Water	300.0		
Av. M/c %	14.6			Dry Soil	997.0		
				M/c	30.1		

(a)MDD	1.519	kg/m3	(b)Air Dry M/c	14.6	%
(c)WD	4,419	kg/m3	(e)M/c to add	14.5	%
(d)OMC	29.1	%	(F) volume	2.305	

Date prepared	1/Mar/24 Date immerse	8/Mar/24 Date tested	15/Mar/24
Mould No.			
Factor(f)	2.305		
(h)Wet Soil to fill mould c x f x %comp	10,185.4		
(j) Wt of air dried soil	6,000		
Air dry M/c	14.6		
(k) soil dry wt (100j/100+b)	5,235.8		
Stabliser	6% LIME & 1% FIBRE		
(m)Stablisers content %	6.0		
(n) Stabliser to add k x(m/100)	314.1		
Water Addition((j+n)x(d-b))/(100+b)	799.2		
Wt. per layer CBR Only h/3			

SPECIMEN WEIGHT CHECK			
No. of blows	62.0	62.0	AVERAGE
Mould No.	7 DAYS AIR TIGHT, 7 DAYS SOAKED	7 DAYS AIR TIGHT, 7 DAYS SOAKED	
Stabliser	6% LIME & 1% FIBRE	6% LIME & 1% FIBRE	
Content %	6.0	6.0	
Mould g	A	B	
Wet Soil g	4,392.0	4,356.0	
Compaction M/c %	30.1	30.1	
Dry density kg/m3	1.465	1.453	
%Compaction	96.5	95.7	
FORCE	10.1	9.8	
UCS	0.551	0.540	0.55

STIRLING CIVIL ENGINEERING LTD P.O. BOX 703, KAMPALA (U)

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PROJECT	ASSESSING THE USE OF POLYETHYLINE TEREPHTHALATE FIBRE AND LIME FOR STABILISATION OF EXPANSIVE SOILS	

STABLISED CBR

(BS 1924 PART 2 1)

EXPANSIVE SOIL STABILISED WITH 6% LIME & 1.5% FIBRE

	M/c of air dried sample				M/c After Mixing		
Tin No.	21			Stabliser	6% LIME & 1.5% FIBRE		
Tin + Wet soil gm	2118			Content	6.0		
Tin + Dry Soil gm	1953			Tin No.	KAU		
Tin gm	790			Tin + Wet Soil	2060		
Water gm	165.0			Tin + Dry Soil	1772		
Dry Soil gm	1,163.0			Tin	799		
M/c %	14.2			Water	288.0		
Av. M/c %	14.2			Dry Soil	973.0		
				M/c	29.6		

(a)MDD	1.426	kg/m3	(b)Air Dry M/c	14.2	%
(c)WD	3.907	kg/m3	(e)M/c to add	13.2	%
(d)OMC	27.4	%	(F) volume	2.305	

Date prepared 1/Mar/24 Date immerse 8/Mar/24 Date tested 15/Mar/24

Mould No.			
Factor(f)	2.305		
(h)Wet Soil to fill mould c x f x %comp	9,006.2		
(j) Wt of air dried soil	6,000		
Air dry M/c	14.2		
(k) soil dry wt (100j/100+b)	5,254.5		
Stabliser	6% LIME & 1.5% FIBRE		
(m)Stablisers content %	6.0		
(n) Stabliser to add k x(m/100)	315.3		
Water Addition((j+n)x(d-b))/(100+b)	730.7		
Wt. per layer CBR Only h/3			

SPECIMEN WEIGHT CHECK			
No. of blows	62.0	62.0	AVERAGE
Mould No.	7 DAYS AIR TIGHT, 7 DAYS SOAKED	7 DAYS AIR TIGHT, 7 DAYS SOAKED	
Stabliser	6% LIME & 1.5% FIBRE	6% LIME & 1.5% FIBRE	
Content %	6.0	6.0	
Mould g	A	B	
Wet Soil g	4,513.0	4,596.0	
Compaction M/c %	29.6	29.6	
Dry density kg/m3	1.511	1.539	
%Compaction	105.9	107.9	
FORCE	10.9	10.5	
UCS	0.597	0.574	0.59

STIRLING CIVIL ENGINEERING LTD P.O. BOX 793, KAMPALA (U)

INSTITUTION	STUDENTS NAMES	TESTING LAB
UGANDA CHRISTIAN UNIVERSITY	ASIIMWE CALEB & MANANA MARK	Stirling
PROJECT	ASSESSING THE USE OF POLYETHYLINE TEREPHTHALATE FIBRE AND LIME FOR STABILISATION OF EXPANSIVE SOILS	

STABLISED CBR

(BS 1924 PART 2 1)

EXPANSIVE SOIL STABILISED WITH 6% LIME & 2.0% FIBRE

M/c of air dried sample				M/c After Mixing			
Tin No.	MJR			Stabliser	6% LIME & 2.0% FIBRE		
Tin + Wet soil gm	2118			Content	6.0		
Tin + Dry Soil gm	1958			Tin No.	YY		
Tin gm	790			Tin + Wet Soil	1630		
Water gm	160.0			Tin + Dry Soil	1443		
Dry Soil gm	1,168.0			Tin	783		
M/c %	13.7			Water	187.0		
Av. M/c %	13.7			Dry Soil	660.0		
				M/c	28.3		

(a)MDD	1.492	kg/m3	(b)Air Dry M/c	13.7	%
(c)WD	4.102	kg/m3	(e)M/c to add	13.8	%
(d)OMC	27.5	%	(F) volume	2.305	

Date prepared 1/Mar/24 Date immerse 8/Mar/24 Date tested 15/Mar/24

Mould No.			
Factor(f)	2.305		
(h)Wet Soil to fill mould c x f x %comp	9,454.2		
(j) Wt of air dried soil	6,000		
Air dry M/c	13.7		
(k) soil dry wt (100j/100+b)	5,277.1		
Stabliser	6% LIME & 2.0% FIBRE		
(m)Stablisers content %	6.0		
(n) Stabliser to add k x(m/100)	316.6		
Water Addition((j+n)x(d-b))/(100+b)	766.7		
Wt. per layer CBR Only h/3			

SPECIMEN WEIGHT CHECK			
No. of blows	62.0	62.0	AVERAGE
Mould No.	7 DAYS AIR TIGHT, 7 DAYS SOAKED	7 DAYS AIR TIGHT, 7 DAYS SOAKED	
Stabliser	6% LIME & 2.0% FIBRE	6% LIME & 2.0% FIBRE	
Content %	6.0	6.0	
Mould g	A	B	
Wet Soil g	4,462.0	4,502.0	
Compaction M/c %	28.3	28.3	
Dry density kg/m3	1.508	1.522	
%Compaction	101.1	102.0	
FORCE	4.5	4.5	
UCS	0.248	0.248	0.25

STIRLING CIVIL ENGINEERING P. O. BOX 79, KAMPALA (U)

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EXCELLENCE THROUGH PRECISION AND INTEGRITY

DETERMINATION OF FREE SWELL

Project:	**ASSESSING THE USE OF POLYETHYLENE TEREPHATHALATE FIBRE AND LIME IN THE STABILISATION OF EXPANSIVE SOILS**		
Client:	**MANANA MARK & ASIIMWE CALEB**		
Location:	**MUYEMBE-NAKAPIRIPIRIT ROAD**	**Sampling Date:**	**4-Apr-24**
Project ref:	**NEAT SOIL SAMPLE**	**Testing Date:**	**8-Apr-24**
Test standard:	**IS:2720 (Part 40) 1977**		

Sample Identification	Depth (m)	Measuring Cylinder No		Measuring Cylinder No (After 24Hrs)		Swell (%)
		Kerosene	Distilled Water	Kerosene	Distilled Water	
TBH1	0.5-0.9	100.0	10.0	10	14.4	**44**
TBH2	1.0-1.5	10.0	10.0	10	15	**50**
Average (%)						**47**

Technician *(Signature)*:	Computed by *(Signature)*:	Checked by *(Signature)*:

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EXCELLENCE THROUGH PRECISION AND INTEGRITY

DETERMINATION OF FREE SWELL

Project:	ASSESSING THE USE OF POLYETHYLENE TEREPHATHALATE FIBRE AND LIME IN THE STABILISATION OF EXPANSIVE SOILS
Client:	MANANA MARK & ASIIMWE CALEB
Location:	MUYEMBE-NAKAPIRIPIRIT ROAD — Sampling Date: 4-Apr-24
Project ref:	SOIL STABILISED WITH 6% LIME — Testing Date: 8-Apr-24
Test standard:	IS:2720 (Part 40) 1977

Sample Identification	Depth (m)	Measuring Cylinder No		Measuring Cylinder No (After 24Hrs)		Swell (%)
		Kerosene	Distilled Water	Kerosene	Distilled Water	
TBH1	0.5-0.9	100.0	10.0	10	13.0	**30**
TBH2	1.0-1.5	10.0	10.0	10	13.4	**34**
Average (%)						**32**

Technician*(Signature)*: | Computed by *(Signature)*: | Checked by *(Signature)*:

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DETERMINATION OF FREE SWELL

Project:	ASSESSING THE USE OF POLYETHYLENE TEREPHATHALATE FIBRE AND LIME IN THE STABILISATION OF EXPANSIVE SOILS				
Client:	MANANA MARK & ASIIMWE CALEB				
Location:	MUYEMBE-NAKAPIRIPIRIT ROAD			Sampling Date:	4-Apr-24
Project ref:	SOIL STABILISED WITH 6% LIME AND 1.5% PET FIBRE			Testing Date:	8-Apr-24
Test standard:	IS:2720 (Part 40) 1977				

Sample Identification	Depth (m)	Measuring Cylinder No		Measuring Cylinder No (After 24Hrs)		Swell (%)
		Kerosene	Distilled Water	Kerosene	Distilled Water	
TBH1	0.5-0.9	100.0	10.0	10	11.8	**18**
TBH2	0.5-1.0	10.0	10.0	10	12.5	**25**
Average (%)						**22**

Technician*(Signature)*:	Computed by *(Signature)*:	Checked by *(Signature)*:

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CENTRAL MATERIALS LABORATORY

CLIENT/ STUDENT NAMES:		M/S ASIIMWE CALEB AND MANANA MARK
UNIVERSITY	:	UGANDA CHRISTIAN UNIVERSITY – MUKONO
COURSE	:	BACHELOR OF SCIENCE IN CIVIL AND ENVIRONMENT ENGINEERING
RESEARCH PROJECT	:	ASSESSING THE USE OF POLYETHYLENE TEREPHTHALATE FIBER AND HYDRATED LIME FOR THE STABILISATION OF EXPANSIVE SOILS
DATE	:	12 APRIL 2024

TEST RESULTS FOR SAMPLES OF POLYETHYLENE TEREPHTHALATE (PET PLASTIC)

Test Standard/ Method: ASTM D638-14 "Standard Test Method for Tensile properties of plastics"

Sample Ref.	Strip Size		Cross-sectional Area (mm^2)	Force at Breaking (kN)	Tensile Strength (MPa)	Average Strength (MPa)	Elongation (%)	Average Elongation (%)
	Width (mm)	Thickness (mm)						
PET 1	11.5	0.3	3.45	0.750	217		64	
PET 2	8.4	0.3	2.52	0.500	198		59	
PET 3	11.1	0.3	3.33	0.800	241	224.6	62	63.6
PET 4	11.5	0.3	3.45	0.800	232		68	
PET 5	7.1	0.3	2.13	0.500	235		65	

Note: - Results relate to only the samples as delivered by the student

12.04.2024

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AND TRANSPORT
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