ASSESSING THE USE OF ACTIVATED WASTE GLASS POWDER FOR STABILISATION OF LATERITE SOILS FOR THE SUBBASE LAYER

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A FINAL YEAR RESEARCH AND DESIGN PROJECT REPORT SUBMITTED TO THE FACULTY OF ENGINEERING, DESIGN AND TECHNOLOGY, IN PARTIAL FULFILLMENT OF THE REQUIREMENTS FOR THE AWARD OF A DEGREE OF BACHELOR OF SCIENCE IN CIVIL AND ENVIRONMENTAL ENGINEERING OF UGANDA CHRISTIAN UNIVERSITY

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ABSTRACT

The aim of this research was to stabilize laterite soils using activated waste glass powder. This was driven by the challenges associated with using laterite soils in the subbase layer for road construction. They soils are greatly affected by climatic weather changes especially rain as they are susceptible to erosion. Laterite soils also have a low bearing capacity and high plasticity which could lead to deformation over traffic load. Waste glass powder contains silica and calcium oxide making it pozzolanic. Previous research showed that it can reduce soil plasticity and improve the strength and durability of the soil by binding the soil particles. Therefore, this research aimed at stabilizing the laterite soils with activated waste glass powder to improve the soils' geotechnical properties, improving their load-bearing capacity and reducing their plasticity. The waste glass was activated with sodium hydroxide to enhance the pozzolanic reaction and then blended with laterite soils in increasing percentages from 0% to 8% so as to determine the suitable mix design for stabilization. The optimum was selected as 6% activated waste glass powder since it gave the most effective results for the strength properties that is 99.6% for California Bearing Ratio. The Plasticity Index, California Bearing Ratio swell and linear shrinkage were also greatly reduced and in range following the Ministry of Works and Transport general specifications for road and bridge works 2005.

DECLARATION

I Tibyaze Vanessa Elizabeth hereby declare that the work in this report is genuine based on research and also confirm that it has been submitted on this date.

Date: …………………………….

Signed: ………………………………

APPROVAL

I certify that this report is for TIBYAZE VANESSA ELIZABETH. I fully accept that she has been under supervision and the report is ready to be submitted to the faculty of Engineering, Design and Technology in fulfilment of the requirements for the program.

Mr. Sejjemba Henry

Academic supervisor

Signature: ……………………….

Date: ………………………

DEDICATION

I dedicate this research to my parents Mr. & Mrs. Byabali who have been my greatest support throughout my academic journey. I also dedicate to my friends who have been a great support system in completing this journey.

ACKNOWLEDGEMENTS

I want to thank the Lord for His protection and carrying me through this academic journey.

I would also like to thank my parents for their continued support financially and emotionally allowing me to focus on this research. I would like to extend my gratitude to Mr. Sejjemba Henry for his guidance and advice during the course of this research project.

Contents

List of figures

List of tables

List of abbreviations

AASHTO - American Association of State Highway and Transportation Officials

BS - British Standards

CBR - California Bearing Ratio

MDD - Maximum Dry Density

C-S-H - Calcium Silicate hydrates

LL - Liquid limit

MoWT - Ministry of Works and Transport

OMC - Optimum Moisture Content

PL - Plastic limit

PI - Plasticity Index

UCS - Unconfined Compressive Strength

NaOH - Sodium hydroxide

WGP - Waste Glass Powder

CHAPTER ONE: INTRODUCTION

1.1 Background

Laterite soils are highly weathered soils with varying proportions of particle sizes ranging from clay to gravel (Oyelami, 2016). They are commonly found in tropical regions. Laterite soils form when silicate minerals decompose due to chemical weathering, forming iron and Aluminium oxides that give the soil a reddish-brown colour. In Uganda, laterite soils are widespread and commonly used in road construction, especially in the subbase layer and buildings.

The performance of laterite soils is greatly influenced by climate, drainage and compaction density (Lees, 2024). They are characterized by low bearing capacity, high moisture content and low densities which makes them unsuitable for construction. they have a high plasticity which can result in deformation under traffic load (Yamusa, 2019). They also contain clay minerals which make them susceptible to volumetric change and erosion leading to road deterioration over time.

Various techniques have been adopted to improve the properties of these soils such as the use of cement and lime. However, the use of these materials has increased the carbon footprint on the environment hence the need to look into eco-friendly materials that can be used to stabilize the soils and improve the geotechnical properties.

Uganda doesn’t have a proper glass recycling plant and most of the glass waste ends up in landfills. Glass doesn’t easily decompose hence need to come up with different ways to recycle it. Glass contains a big percentage of silica making it a portable stabilizer for soils. The silica will react with the constituents in the soil forming cementitious compounds that will bind the soil particles together. This will enhance the load-bearing capacity of the soil and reduce plasticity index.

1.2 Problem statement

Road failure is increasingly terrible in Uganda today due to several reasons such as rapidly increasing traffic volume, poor quality of materials used and also the presence of weak soils beneath the pavement. (Nansereko F,2019). Lateritic soils are reddish-brown soils due to the presence of clay minerals such as Iron and Aluminium oxide. They are found mostly in the tropical regions of Uganda.

These soils have a low bearing capacity and high plasticity of about 11.2%- 20.7% which makes them unsuitable when compacted back to their natural density because they are unable to offer relatively enough resistance to traffic loads (Tugume, 2019). The lateritic soils are greatly affected by the changing climatic conditions such as rains due to the presence of the clay mineral composition in the soils which may lead to road deterioration over time. A study carried out on soils to be used on Seeta-Bajjo road showed that the soils are unsuitable to be used as a subbase material as the CBR value was below the required standards.

Cement has been commonly used to stabilize the soils before the construction of the road but it adds to the carbon footprint on the environment hence need to research other materials that could be used to stabilize the soils. This research was aimed at using waste glass powder due to the pozzolanic properties to improve the geotechnical properties of lateritic soils thus reducing the plasticity index of the soils and enhancing the compressive strength and durability of the soils.

1.3 Objectives of study

1.3.1 Main objective

- To assess the use of activated waste glass powder for stabilisation of lateritic soils for the subbase layer.

1.3.2 Specific objectives

1. To determine the engineering properties of the neat soil samples.
2. To determine the chemical properties of waste glass powder
3. To determine the engineering properties of the laterite soils stabilized with varying percentages of activated waste glass powder.

1.4 Research questions

1. What are the engineering properties of laterite soils used for road construction?
2. What are the properties of waste glass powder?
3. What are the engineering properties of the laterite soil stabilized with activated waste glass powder?

1.5 Justification

Lateritic soils are soils with high moisture content, low bearing capacity and high plasticity. The addition of waste glass powder to the soils plays an effective role in the improvement of mechanical properties such as compressive strength and durability (Luizaga, 2020). Waste glass powder contains a high percentage of silica (SiO_2), which makes it a pozzolanic material that is; Silica with a percentage of 71.09, Calcium Oxide with a percentage of 10.59 and Sodium oxide with a percentage of 10.46, which form compounds that enhance strength and stability of lateritic soils. When combined with water, it forms cementitious compounds such as calcium silicate hydrate (C-S-H) improving the strength and durability of the soil. This reaction enhances the soil's load-bearing capacity reducing the likelihood of failure under heavy loads.

Adding waste glass powder to lateritic soils improves their geotechnical properties (Oliveira, 2018) such as; Increased Unconfined Compressive Strength (UCS) as the pozzolanic reaction leads to increased binding between soil particles enhancing the soil's strength. The Plasticity Index (PI) will also be reduced. The addition of glass powder lowers the plasticity index of soils making them less susceptible to shrinkage and swelling (Adedokun, 2019). This is critical in lateritic soils, which tend to have high plasticity. The permeability will also be reduced making the soil more resistant to erosion. The glass powder-soil mixture has also shown increased resistance to weathering conditions, such as moisture variation and temperature changes. This is particularly useful in tropical regions like Uganda where lateritic soils are common and experience high rainfall which could otherwise degrade untreated soils.

1.6 Scope

1.6.1 Geographical scope

The laterite soils were obtained from Nsambwe borrow pit in Mukono District at coordinates 0.40281°N, 32.75144°E. The waste glass was obtained from a glass collection company known as Yo Waste in Namanve and crushed into powder.

1.6.2 Content scope

The scope of the research was aimed at improving the engineering properties of laterite soils that will be used on Seeta-Bajjo road using waste glass powder.

1.6.3Time scope

The research was carried out from August 2024 to March 2025.

CHAPTER TWO: LITERATURE REVIEW

2.0 Introduction

The stabilization of laterite soils for road construction in tropical regions has been a research topic due to the challenges posed by the soils' natural properties. In Uganda, laterite soils are commonly used for low-volume roads but durability and longevity should be ensured. The purpose of this literature review was to examine the current research on the engineering properties of laterite soils and the different stabilization techniques.

2.1 Laterite soils

Laterite soils are reddish-brown soils that are formed as a result of weathering in areas with tropical climate. They are rich in oxides of Aluminium and Iron. According to research done by Mahalinga, the chemical analysis showed that the soil is comprised of kaolinite, quartz, gibbsite and haematite (Williams, 1991). According to geomorphology, laterization involves the concentration of hydrated iron and aluminium oxides also known as "sesquioxide" as well as the leaching out or removal of silica, alkali, and alkaline earth (Prasad, 2018). It is either hard or capable of hardening on exposure (Quadri, 2012). The reddish-brown colour is due to the presence of these secondary oxides of iron and aluminium (Tiboti, 2021).

The properties of these soils depend on several environmental factors (Swapna, 2020). Different factors influence the formation of these soils and they include;

- Properties of the parent rock: the characteristics of the soils will depend on the chemical composition of the rock from which the soils are formed (Oyelami, 2016).

- Climate and rainfall: a tropical region having alternately hot climate has a high rate of chemical weathering hence the formation of the soil. The higher the rainfall, the greater the leaching effect which increases the degree of laterization (Oyelami, 2016).
- Degree of weathering: when weathering occurs for a long time, the silica in the soil will be almost leached out leaving only iron and Aluminium oxides present in the soil (Santha, 2022).

Laterite soils may be cohesive or non-cohesive depending on the size of the particles. While the sand-based laterite soil displays non-cohesive behaviour, the silt and clay-based laterite soil displays cohesive behaviour (Roshan et al., 2022).

Uganda is one of the countries in the tropics hence it has an abundance of laterite soils. As such, these soils are readily available to be used in the construction industry because they are very economical. However, these soils often do not offer enough resistance to traffic loading and therefore will crush easily under traffic loading when used in road construction projects.

2.2 Soil stabilization

This is the alteration of soils to reinforce their physical properties. Stabilization can increase the shear strength of the soil and control the shrink-swell properties of soil thus improving the load-bearing capacity of the subgrade to support pavements and foundations (Abdullah, 2020). The process involves adding and combining different elements with the soil to enhance the engineering properties of the soil. It involves different techniques which can be categorized into two that is:

1. Mechanical stabilization
2. Chemical stabilization

2.2.1 Mechanical stabilization

This involves the densification of the soil which can be achieved through compaction to increase the load-bearing capacity. Two or more types of natural soils can be mixed in an attempt to change the gradation hence improving the properties of the soil (Archibong, 2020). This is aimed at reducing the void ratio in the soils. The soils added can either be aggregates or binders depending on the particle size. Below are some of the factors that affect mechanical stabilization;

- Strength of aggregate used: the stability of the soil increases with increasing strength of the aggregates
- Mineral composition: this contributes to the stability of the mixture. Weather-resistant minerals yield mixtures with greater mechanical stability (Archibong, 2020).
- Gradation of mixture: the pore spaces of the coarser grains should be effectively filled with the finer particles for effective mechanical stability.
- Adequate compaction of soil moisture: mechanical stability depends on the extent of compaction attained in the field.

2.2.2 Chemical stabilization

In chemical stabilization, the impact is based on the chemical reactions between the soil minerals and the added material (Makusa, 2013).

Chemical stabilization is done by mixing materials such as cement, lime, fly ash, rice husk ash and any other pozzolanic material with the soil. The reactions that occur between the soil components and the material lead to improved engineering properties of the soil (Patel, 2020).

Advantages of chemical stabilization

- According to (Abid, 2016), chemical stabilization gives more strength to the soils and increases permeability.
- The setting time and curing time can easily be controlled.
- The compaction density of the soil is increased.

Limitations of chemical stabilization

- The environments to which they are exposed may be affected by some of these chemical stabilizers. Many people are also unaware of this toxicity because there has been little research on the topic (Chijioke, 2019).
- It takes energy to produce some of these chemical stabilizers, like cement, and that energy often comes from non-renewable resources like coal, among others (Ohunakin, 2013). The manufacturing of these stabilizers frequently results in the emission of particles that contribute to global warming.

2.2.2.1 Selecting a suitable stabilizer for a type of soil

Although there may be many stabilizer options available for a particular type of soil, there are some general guidelines that increase the desirability of particular stabilizers depending on the soil's granularity, fluidity, or texture (Guyer, 2011). Traditionally, cement and lime have been the two most commonly employed chemical stabilizers.

According to the MoWT General Requirements for Road and Bridge Works 2005, the following criteria can be used to decide which of the two is best for stabilizing a particular soil:

Table 1: Requirements for cement stabilization

%passing the 0.075mm screen	Plasticity index %	Best suited stabilizer
Less than 25%	PI less than 6 or PI × % passing 0.075mm is less than 60	Cement only
	6-10	Cement is preferred
	More than 10	Cement and/ or lime
More than 25%	Less than 10	Cement is preferred
	10-20	Cement and/ or lime
	More than 20	Lime is preferred

From the table, it is concluded that cement is generally suitable for soils with a PI of less

than 20. For a PI above 20, then lime is more suitable.

Additionally, both cement and lime can be utilized when the soil's PI is between 10 and 20.

Lime is applied to soil material with a relatively high PI because it needs fine-sized soil particles to react to be effective. A high PI suggests that the soil can swell to a significant extent. This demonstrates that the soil contains clayey particles. Although lime is typically preferred in these situations, cement can be used to stabilize soils with a high PI. However, the MoWT General Standards for Road and Bridge Works 2005 recommend that the material be pre-treated with an addition of 2% lime before cement stabilization if cement must be used.

2.3 Waste glass powder

The use of waste materials in construction has gained a lot of interest, especially in sustainable development. Waste glass powder has pozzolanic properties which make it a potential stabilizer. It can react with calcium hydroxide to form compounds that contribute to soil stabilization just like cement and lime. The reaction produces calcium silicate hydrates (C-S-H) which enhances the strength and durability of the soil.

2.3.1 Effectiveness of waste glass powder

A study done by (Rashid, 2017) showed that the use of waste glass powder reduced the plasticity index of the soil making it less prone to deformation under load. There were also improvements in the unconfined compressive strength and California bearing ratio values.

Another study done by (Asiagwu, 2016) showed using 10-20% of waste glass powder on laterite soils increased the bearing capacity of the soil making it suitable for road construction. The soils stabilized with waste glass powder also performed well under varying weather conditions making them suitable for road construction (Ibrahim, 2020).

2.3.2 Chemical reactions and pozzolanic activity

Different scholars report different compositions of the oxides present in waste glass powder which can be seen in the table below

Table 2: chemical composition of waste glass powder

Oxides	(Meechoowas et el, 2011)	(Arcaro et el, 2018)	(Tihomirous et el, 2023)
SiO2	74.67	68.30	71.92
Al2O3	0.27	2.07	2.43
Fe2O3	0.04	0.41	0.07
K2O	0.05	0.44	0.82
MgO	0.09	1.80	3.83
Na2O	15.63	17.95	13.87
TiO2	0.07	0.06	-
ZrO2	0.01	-	-
CaO	9.16	8.94	6.77
P2O5	-	0.01	-

The reaction depends on the chemical composition of the glass and its fineness. Glass powder contains high levels of silica as seen from the table which reacts with calcium hydroxide to form C-S-H hence improving the binding properties of the soil. (Bhosale, 2021) performed an X-ray diffraction analysis that showed that the pozzolanic reaction resulted in the formation of C-S-H gels that fill the voids in the soil and enhance the soil's strength. He also highlighted that the optimum particle size of the powder should be 75 microns.

2.3.3 Factors considered in ensuring effectiveness of waste glass powder

When stabilizing laterite soils with waste glass powder, some factors need to be considered so as to ensure effective stabilization, durability and field performance. These may include;

- Soil properties; some characteristics of the laterite soils need to be considered for example grain size distribution, plasticity index and clay and silt content. Well-graded soils with a mix of fine and coarse particles are stabilized better. Soils with higher clay content may require addition of a more reactive stabilizer to the waste glass powder.
- Waste glass properties; the fineness of the waste glass powder should be considered as finer particles (<75µm) improve the pozzolanic activity. High composition of silica and alumina also enhance the pozzolanic reactions during stabilization. The waste glass powder should also be free from plastics, metals, and organic impurities that may hinder stabilization.
- Moisture content and curing conditions; the optimum moisture content should ensure proper compaction and reaction efficiency. Strength increases over time therefore curing time needs to be considered.
- Compaction and field implementation; higher compaction leads to better strength that is 95% MDD. The layer thickness should be between 150-300mm for road subbase applications depending on the other road properties. Ensure uniform mixing of the waste glass powder in the soil to avoid weak zones.
- Combination with other stabilizers; some soils may require combination with other stabilizers especially if the clay content is very high. Stabilizers that can be added include lime and cement. These enhance reactivity and long-term strength. However, instead of combining with other stabilizers, the waste glass powder can be activated.

2.3.4 Activation of waste glass powder

Activation refers to enhancing the pozzolanic reaction of the waste glass powder and it can be done in the following ways:

- Increase the fineness of the waste glass powder; the smaller the particle size, the higher its reactivity due to the increased surface area. This can accelerate the pozzolanic reactions improving strength and durability.
- Use of alkali activators; the most common activators used include sodium hydroxide, sodium silicate and potassium hydroxide. Sodium hydroxide enhances silica dissolution from the waste glass powder forming geopolymeric bonds (Sakhare & Bhangale, 2017).
- Increase curing temperature and time; heat curing can be done at 40-60°C for 24 hours. This accelerates the pozzolanic reaction especially when using alkali activators. Longer curing periods allow for more extensive strength development.
- Optimize soil pH; laterite soils usually have a low pH due to the iron oxides which can slow down pozzolanic reactions. Adding a small amount of soda ash or sodium bicarbonate can rise the pH and enhance silica dissolution (Zhang et el, 2023).
- Use of fine pozzolanic additives alongside waste glass powder; other pozzolanic materials can be used to enhance the reactivity for example rice husk ash, metakaolin and silica fume. Rice husk ash is high in amorphous silica which improves pozzolanic reaction (Sabbagh et el, 2018).

2.3.5 Activation of waste glass powder using sodium hydroxide and mode of action

Sodium hydroxide significantly enhances the pozzolanic reaction of waste glass powder. Alkali activation converts silica-rich materials into cementitious compounds without the use of lime or cement (Sakhare and Bhangale, 2017).

Waste glass powder contains amorphous silica which is not reactive in its raw state. When sodium hydroxide is added, it increases the pH of the soil breaking down the

Si-O-Si bonds in the waste glass powder. This releases soluble silicate ions into the soil which are necessary for pozzolanic reactions.

$SiO_2 + 2NaOH \rightarrow Na_2SiO_3 + H_2O$

In the presence of calcium from the soil, the dissolved silica reacts to form calcium silicate hydrates and calcium aluminate hydrates when it reacts with alumina. These gels form geopolymeric structures that improve long -term strength (Sakhare and Bhangale,2017).

2.3.6 Environmental and economic benefits

The main advantage of using waste glass powder in soil stabilization is the reduction of waste sent to landfills. It also reduces the need for stabilizers like cement and lime which are associated with high carbon emissions (Mohammed, 2019). This will also lower the construction cost.

2.3.7 Limitations of using waste glass powder

- The variability in the chemical composition of the waste glass may affect the consistency of the stabilization process. Glasses from different sources may have different pozzolanic properties (Kumar, 2020).
- Highly organic or highly plastic soils may not be effectively stabilized without the addition of other stabilizers like cement or lime (Sharma, 2019).

These challenges need to be addressed for its widespread application otherwise, waste glass powder has shown significant potential as an effective soil stabilizer.

2.4 Sub-base

This is the layer beneath the road base and above the subgrade. It can be made of crushed aggregate or recycled materials. the sub-base performs the following functions;

- It prevents capillary attraction effect.
- It distributes stresses to the subgrade layer
- It acts as a drainage layer in case the subgrade is poor.

According to the general specifications from the Ministry of Works and Transport, the subbase layer should be made of a G30 or G45 material as specified by the engineer.

CHAPTER THREE: METHODOLOGY

3.0 Introduction

This chapter discusses the procedure, methods and materials which were used to meet the specific objectives of the study.

3.1 Materials and methods

3.1.1 Materials

Laterite soil

The soil was sampled from Nsambwe borrow pit in Mukono District from two different locations. It was obtained at a depth of 1.5m in disturbed form. A total weight of about 400kg was collected, placed in airtight sacks and transported to Stirling laboratory in Mbalala for testing. The soil was then airdried for about 48 hours to attain a consistent moisture content before carrying out different tests.

Waste glass

Waste glass bottles were collected from Namanve and transported to the laboratory. The bottles were broken into smaller pieces using a hammer and then placed in a ball mill that is rotated at a high speed to crush the glass pieces into powder. The sample was them sieved through a 75µm sieve to obtain fine particles. The sample was then taken to the government analytical laboratory so that an x-ray fluorescence test could be carried out to determine the chemical composition of the powder.

3.1.2 Methods

Determining the engineering properties of neat laterite soils.

Different laboratory tests were carried out to determine which parameters needed to be improved. The tests include:

3.1.2.1 Particle distribution test

This was in reference to BS1377: Part 2: 1990.

This test was done to determine the different particle sizes present in the soil sample.

After preparing the sample, it was passed through different sieve sizes and the weight attained on each sieve was noted. The percentage passing was then calculated. The soil was then classified using AASHTO and the grading modulus was obtained.

Calculations

Percentage retained = [(mass retained)/ (initial mass of sample)] ×100

Percentage passing = 100 – percentage remained

Grading modulus = {3-[(%pass2mm + %pass0.425mm + %pass0.075mm)/ 100]}

3.1.2.2 Atterberg limits

This was in reference to BS1377: Part 2: 1990.

This was composed of three different tests that is; plastic limit, liquid limit and linear shrinkage. These are used to determine the plasticity index of the soil.

Equipment used

- 0.045mm sieve
- Oven
- Cone penetrometer

Liquid limit

This is the water content at which the soil changes from plastic to liquid.

About 200g of the air-dried sample was passed through the 0.0425mm sieve and prepared according to the standard. A graph of penetration against moisture content was plotted and the liquid limit was obtained at a penetration of 20mm.

Plastic limit

This is the water content at which the soil begins to get plastic.

Water was added to the material and it was moulded with hands until it started to crack. The rolled samples were weighed and then oven dried for 24 hours. The final weight was measured and the plastic limit was calculated.

Plasticity index

This was determined by obtaining the difference between the liquid limit and the plastic limit.

3.1.2.3 Proctor compaction test

This was in reference to BS1377: Part 4: 1990.

This test is done to obtain the optimum moisture content and maximum dry density that can be attained after compaction of the soil.

Equipment used

- Proctor mould
- Oven
- Weighing scale
- 4.5 kg rammer

The soil sample was compacted in five layers, each layer compacted with 27 blows with a 4.5 kg rammer. The sample was then oven dried for 24 hours and the new weight recorded. The dry density was computed and graph of dry unit weight against water content was plotted to determine the optimum moisture content. This is the moisture content at maximum dry density.

3.1.2.4 California Bearing Ratio

This was in reference to BS1377: Part 4: 1990.

It was done to determine the strength of the soil as it informs the soil's capacity to resist penetration.

Equipment used

- CBR mould
- Rammer
- CBR penetration machine
- Soaking pit

The optimum moisture content obtained from the proctor test was used to prepare the sample according to the standards. The sample was then compacted and soaked in water for 4 days. The surface was dried and prepared for penetration done by a CBR machine. The CBR value and the swell of the soil was then determined.

Determining the engineering properties of waste glass powder.

3.1.2.5 X-ray fluorescence test

This was carried out to determine the chemical composition of the powder. This provided the different components present in the material which were used to assess the suitability and effectiveness of waste glass powder as a stabilizer.

The sample was subjected to x-rays using an x-ray spectrometer. The X-rays interact with the atoms of the sample causing them to emit fluorescence x-rays. The rays are detected and recorded. Analysis was done to identify the elements present in the sample.

Determining the engineering properties of laterite soils stabilized with varying percentages of waste glass powder.

For glass powder to effectively work, it needed to be activated using sodium hydroxide. According to previous research, 2-3% NaOH of the glass weight was needed to effectively activate the powder (Hong,2024).

This was done to determine the optimum amount of waste glass powder needed to effectively stabilize the soils. The optimum waste glass powder should ensure;

1. Cost-effectiveness; using optimum waste glass powder should ensure that the soils have the necessary strength and durability while minimizing the amount of the powder used to reduce the cost of construction.
2. Performance; the optimum waste glass powder is determined by evaluating the mix properties and performance using various laboratory tests. This can be used to predict the performance of the road under traffic loads. This is used to ensure that the subbase meets the required specifications and standards for durability and safety.
3. Environmental impact; The use of waste glass powder should be able to minimize the amount of material used and energy required for production.
4. Safety and reliability: the optimum waste glass powder should ensure that the subbase has the necessary strength and durability to withstand traffic loads and environmental conditions.

3.1.2.6 Mix design

The glass powder was mixed with 3% NaOH. It was left to soak for 24 hours at room temperature in order to neutralize the unstable silicates so as to reduce alkali-silica related expansion problems. The mixture was then thoroughly rinsed with distilled water to remove excess alkali and then oven-dried for 24 hours at 105°C. This temperature is sufficient to remove moisture without altering the chemical structure of the activated glass. This temperature also ensures that the waste glass powder remains in a reactive state promoting dissolution of silica.

From previous research, the optimum percentage of waste glass powder used for stabilization was about 6% (Kumar, 2020). Using this, a mix design was developed increasing the activated glass powder.

Table 3: mix design

Soil (%)	Activated Glass powder (%)
100	0
98	2
96	4
94	6
92	8

3.1.2.7 Unconfined compressive strength test

This was done to determine the compressive strength of the soil.

Plates were placed on the sample to be tested and subjected to a uniform load of 0.5MPa/s till the sample is seen to fail. The values of the normal force and resultant shear stress were noted.

CHAPTER FOUR: RESULTS AND DISCUSSION

4.0 Introduction

This chapter contains the results obtained from the different tests carried out the materials. The tests were done in order to meet the specific objectives of the study using the methods described in chapter 3.

4.1 Neat soil sample

4.1.1 Particle size distribution

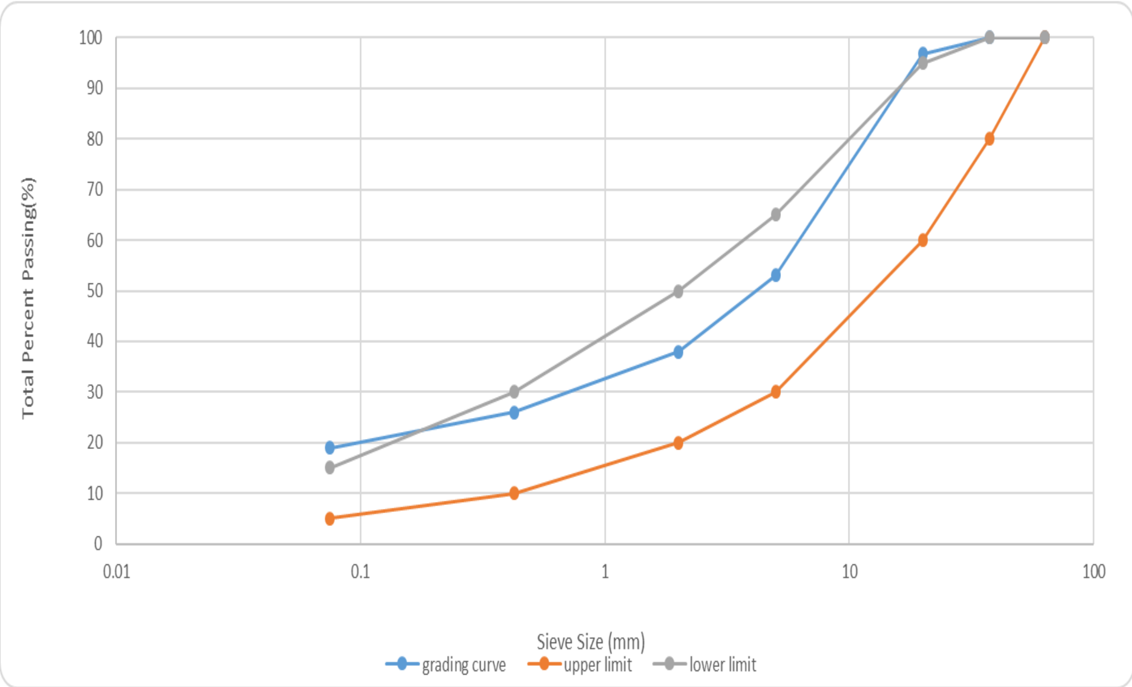


Figure 1: the grading curve for neat soil sample

The grading curve for the neat soil sample was obtained as shown in figure 1.

As seen from the graph, it doesn't lie fully within the grading envelope hence need to modify the soil.

A grading modulus of 2.17 was obtained which is above the minimum of 1.5 as per the standards as per MoWT general specifications for road and bridge works 2005. A grading modulus is used to assess the fineness or coarseness of the material. The obtained grading modulus shows that the material is relatively fine therefore it can be used as a subbase material.

Using AASHTO, the sample was classified as an A-2-6 soil. This indicates that the soil contains silty or clayey gravel and sand making it a good material to be used as a subbase. The fines contribute to the relatively high PI of the sample hence lowering the CBR of the soil sample. This indicates that the soil has a low bearing capacity and may fail under loading.

4.1.2 Atterberg limits

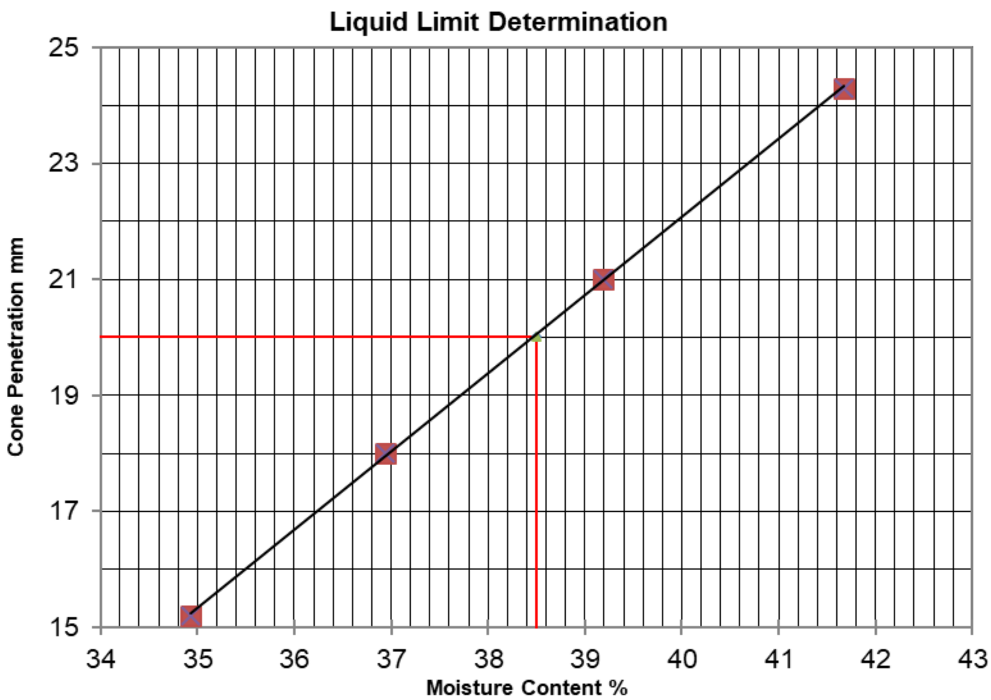


Figure 2: graph determining the liquid limit

The liquid limit from the sample was found to be 38.5%. This shows that the soil contains fine particles that are able to absorb more water. The plastic limit obtained was 20.7%. The plasticity index was calculated and found to be 17.7%. According to the specified standards, it is above the minimum PI of 14 for a G45 material. This can be due to the fines in the sample indicating that the soil contains a percentage of clay and silt increasing the soil's PI. This can lead to low strength and stability making the material prone to deformation.

Therefore, there is need to stabilize the soil so as to reduce its PI and make it a suitable material.

The linear shrinkage was obtained as 8.6 which is above the maximum of 7 as per the requirements. The linear shrinkage indicates the degree of volume reduction the soil undergoes when drying from a saturated state. The value obtained shows that the soil contains a significant amount of clay and silt which shrink when they are dry. This makes the soil prone to cracking and volume changes under varying moisture content hence the need to stabilize so as to reduce the shrinkage and improve performance.

4.1.3 Proctor test

This was done to determine the maximum dry density and optimum moisture content of the sample.

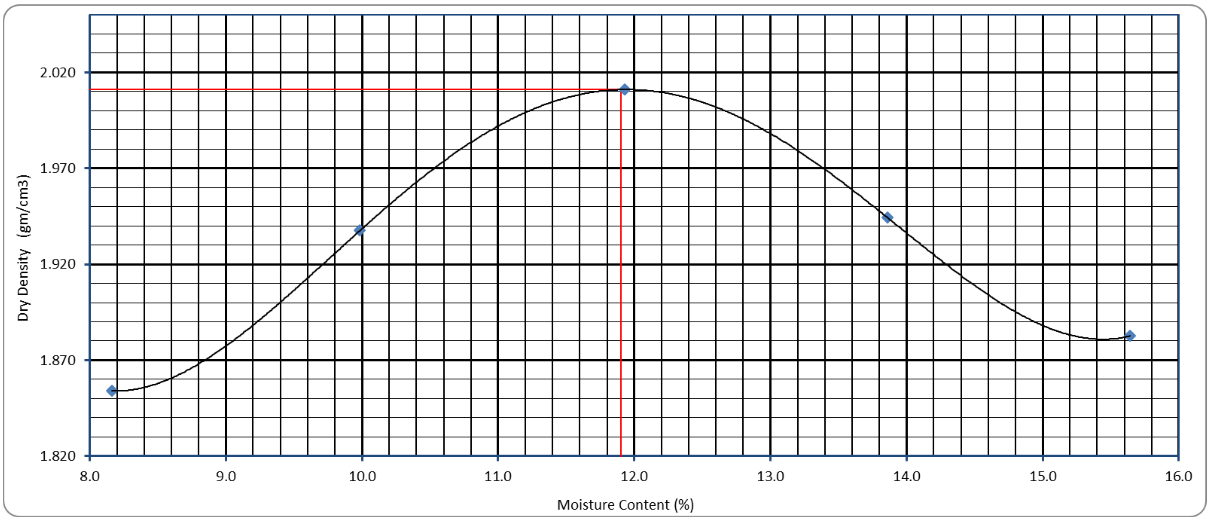


Figure 3: MDD curve for the neat sample

The optimum moisture content was obtained at 11.9% and a maximum dry density of 2.011g/cm^3. This shows that the best compaction is attained at 11.9% moisture content.

The soil has a moderate density which could be able to resist deformation under loading. This makes the soil a stable material for use as a subbase. The optimum moisture content shows that the soils needs moderate amount of water for compaction making it practical in field conditions.

4.1.4 California bearing ratio

This was done to determine the strength and stability of the soil.

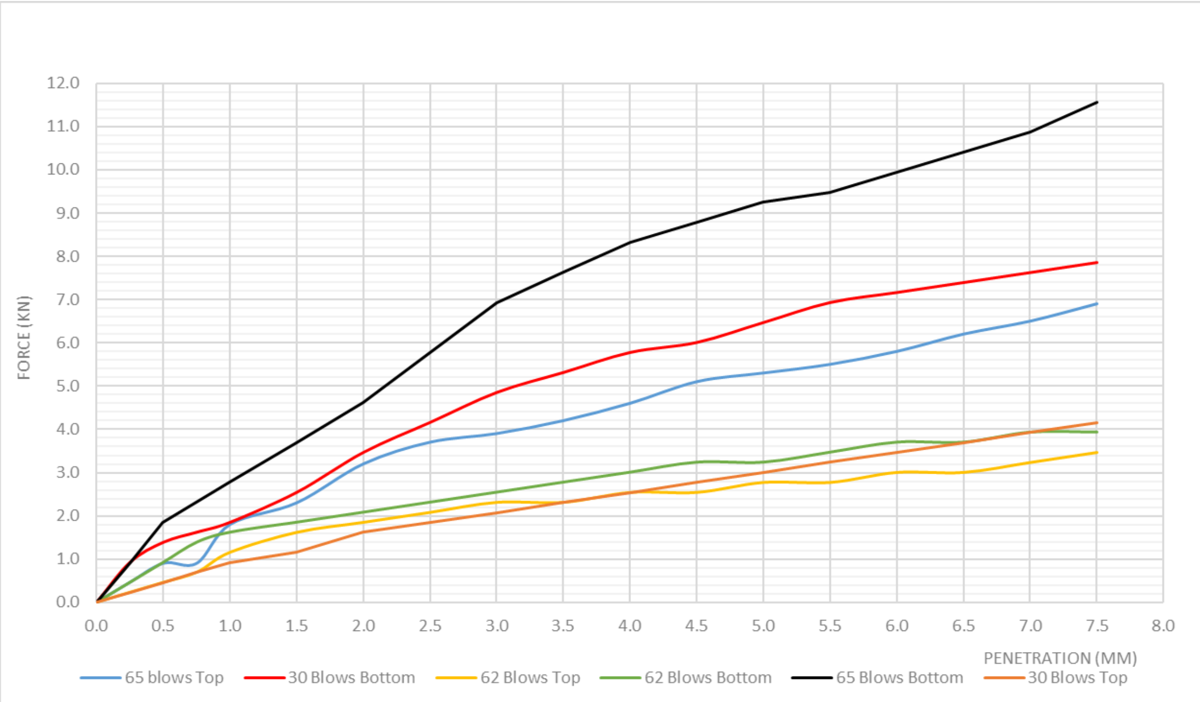


Figure 4: penetration Vs force curve

The sample didn't meet the required specifications for a G45 material. A minimum CBR of 45% required yet the sample had a CBR of 28%. Hence, the soil needs to be stabilized so as to enhance its strength. The swell was found to 0.81 which is above the maximum which is 0.5. This indicates that there is expansion when exposed to moisture which can cause uneven settlement in the layers.

The reason why the CBR is relatively low maybe due to the fines present in the soils which cause volumetric changes with change in the moisture content making the soils weak.

Table 4: summary of results of the neat soil sample

Parameter	Soil sample	MoWT general specifications for road and bridge works 2005
Grading modulus	2.17	Minimum 1.5
Liquid limit	38.5	Maximum 40
Plastic limit	20.7	-
Plasticity index	17.7	Maximum 14
Linear shrinkage	8.6	Maximum 7
MDD	2.011	-
OMC	11.9	-
CBR	28	Minimum 45
CBR swell	0.81	Maximum 0.5

The neat soil sample is not suitable to be used as a G45 material for the subbase as it doesn't meet all the required standards as per the MoWT general specifications for road and bridge works 2005. Therefore, there is need for stabilization in order to enhance the properties of the soil so that it is suitable for the subbase.

4.2 Chemical composition of waste glass powder

X-ray fluorescence test was carried out on the waste glass powder and composition of the sample is shown in the table below;

Table 5: chemical composition of waste glass powder

Compound	Composition (%)
Silicon dioxide	73.67
Sodium oxide	15.63
Calcium oxide	9.16
Aluminium oxide	0.47
Manganese (ii) oxide	0.19
Titanium dioxide	0.17
Potassium oxide	0.06
Iron (iii) oxide	0.05
Europium (iii) oxide	0.03
Phosphorus pentoxide	0.03

As shown in table 5, the dominant oxides are silicon dioxide, sodium oxide and calcium oxide. The waste glass powder can be classified as a class N Pozzolan according to the ASTM standards (Khmiri, 2012). The glass powder was activated using sodium hydroxide so as to enhance the pozzolanic reactivity. In raw form, the silica has a low reactivity limiting pozzolanic potential. The sodium hydroxide dissolves the amorphous silica to enhance the reaction with the soil minerals. When mixed, silica dissolves forming sodium silicate and hydroxyl ions.

$SiO_2 + 2NaOH \rightarrow Na_2SiO_3 + H_2O$

The released silicate ions react with sodium hydroxide forming sodium silicate gel which reacts with the soil particles enhancing binding and strength. This also reduces the plasticity of the soils (Sohail, 2018).

4.3 Stabilized laterite soil

After mixing the soil with different percentages of the activated waste glass powder, different tests were carried out and the following results were obtained.

4.3.1 Effect of activated waste glass powder on particle size distribution

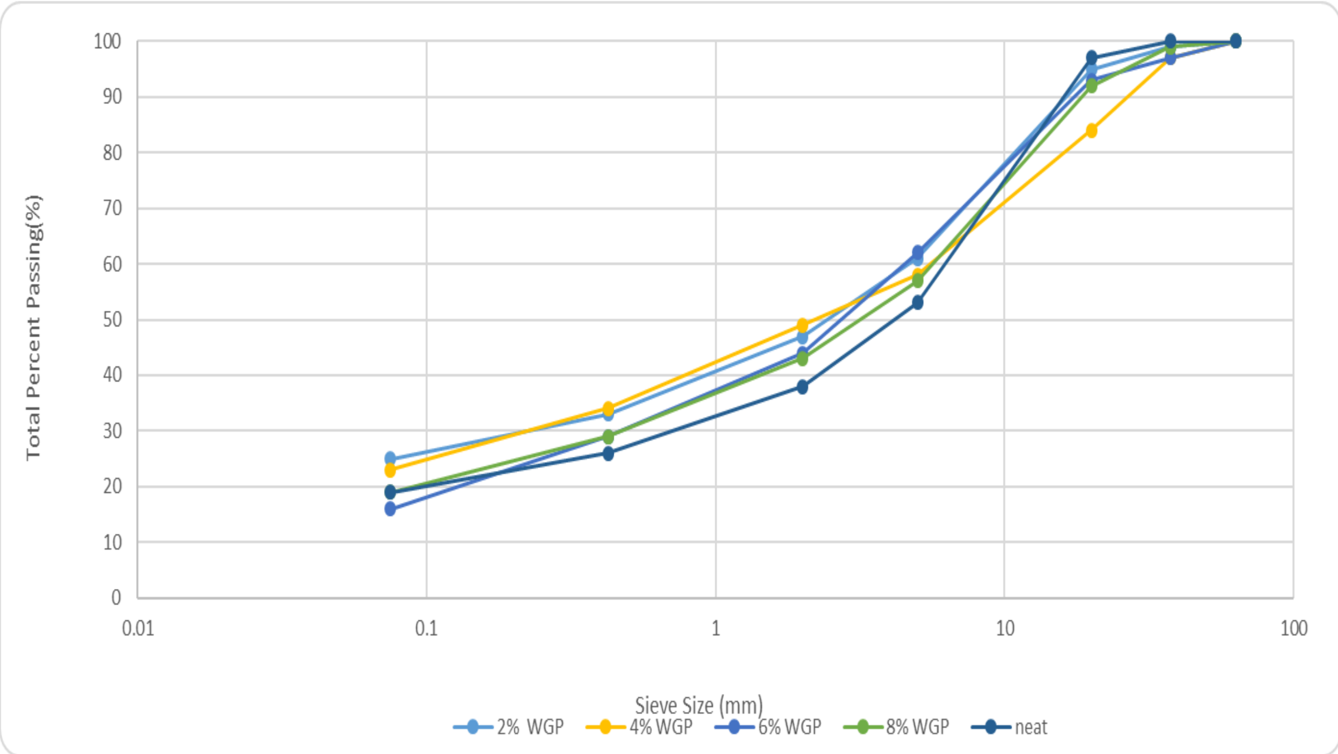


Figure 5: grading curves of the different % of WGP

Addition of activated waste glass powder reduced the fines present in the soil. The GM obtained is between 1.9 and 2.2 which shows that the soil is suitable for road subbase construction. This ensures good compaction, strength and resistance to water infiltration. At higher percentages, the soil transitions towards a more uniform gradation enhancing binding and reducing permeability (Marto et el, 2013).

4.3.2 Effect of activated waste glass powder on Atterberg limits

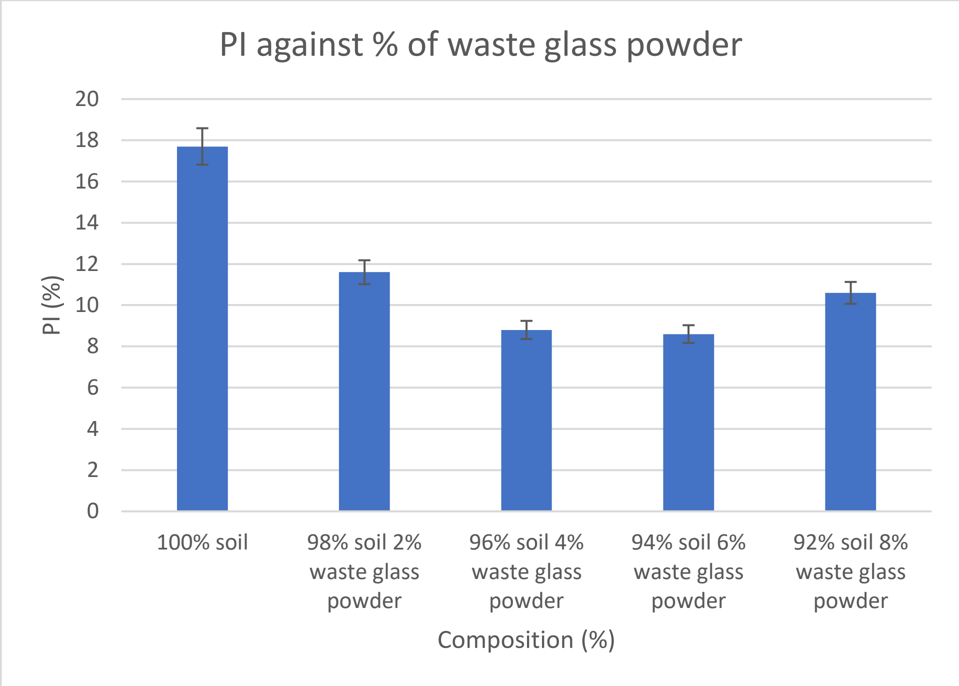


Figure 6: A graph showing variation of PI with % WGP

The PI of the neat sample was 17.7%. When 2% activated waste glass powder was added, it reduced to 11.6%. This is due to the pozzolanic reaction between the soil particles and the waste glass powder. The reaction forms sodium silicate gel which binds the soil particles together ensuring stability thus reducing the fines in the soil (Bilgen, 2020). The PI reduces from 0% to 6% and then increases beyond 8% due to excess waste glass powder. The lowest PI is obtained at 6% waste glass powder.

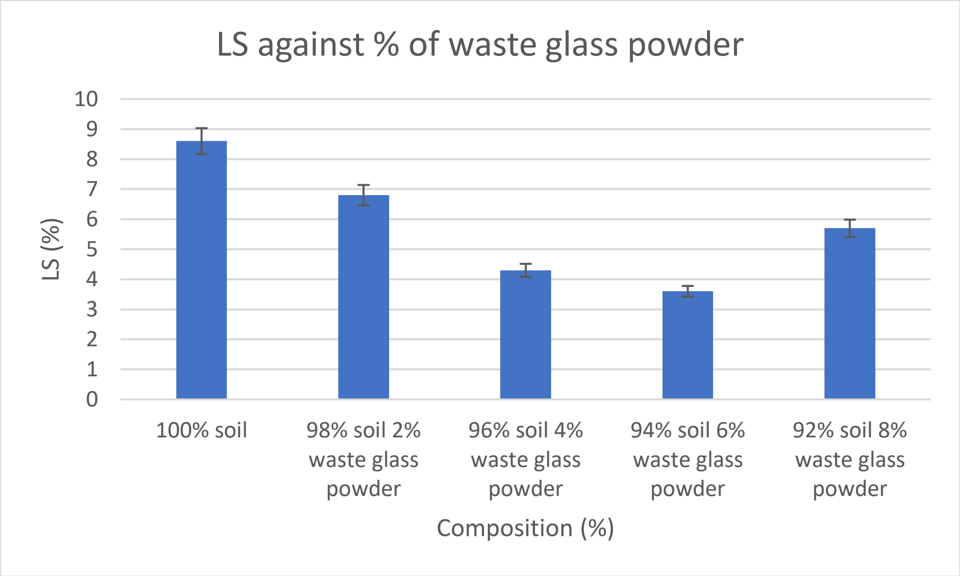


Figure 7: A graph showing variation of linear shrinkage with % WGP

The linear shrinkage also reduced from 0% to 6% and then increased beyond 6%. The pozzolanic reaction forms sodium silicate hydrate that binds the particles together filling the voids in the soil. This reduces water intake and retention hence reducing the linear shrinkage since there are less fines holding the water. The minimum value was obtained as 3.6 at 6% waste glass powder.

4.3.3 Effect of activated waste glass powder on MDD and OMC

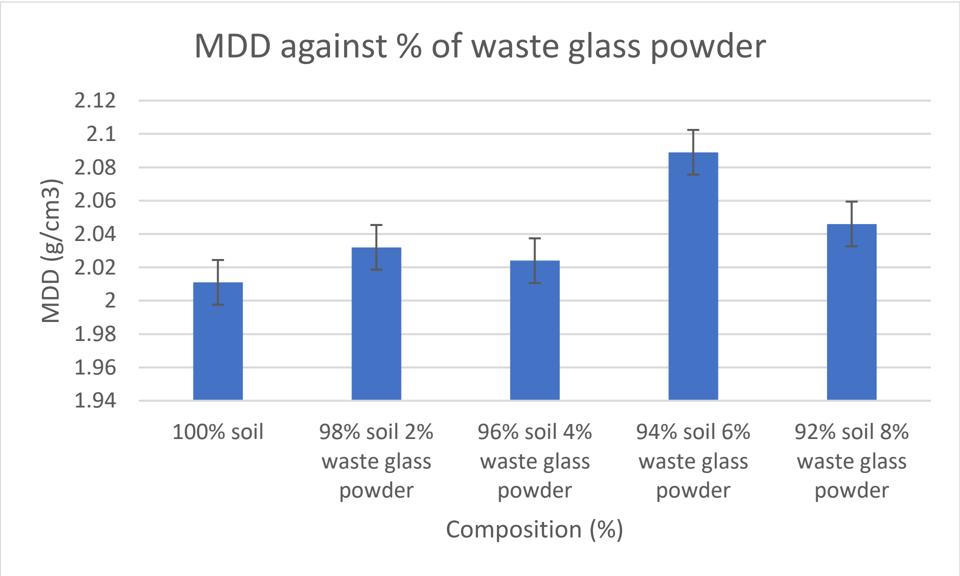


Figure 8: A graph showing variation of MDD with % OF WGP

The MDD decreases slightly from 2% to 4% due to particle replacement and flocculation effects. As the lighter glass particles replace the heavier ones, there is reduction in overall density. At 6%, it increases due to the cementation effects (Rasool, 2021). The pozzolanic reaction forms silicate hydrates that improve the bonding between the soil particles increasing the density. Beyond 6%, it decreases again due to excessive fines which increase the water demand hence reducing compactability. The increased fines lead to increased voids making it difficult to achieve proper compaction.

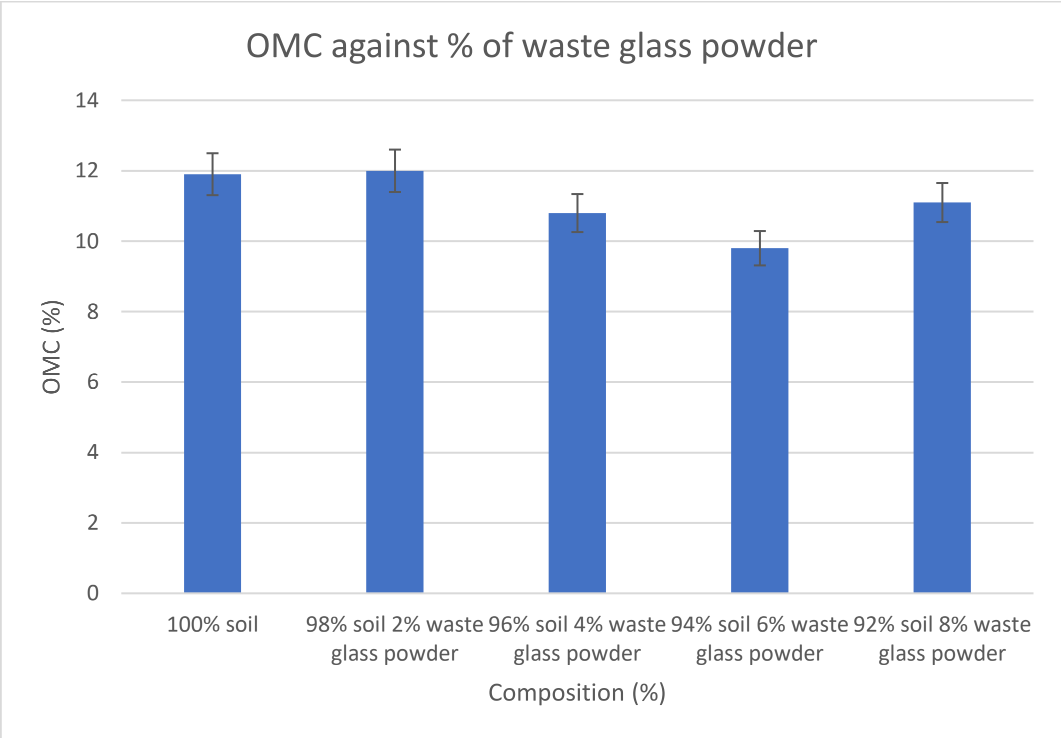


Figure 9: A graph showing variation of OMC with % of WGP

The optimum moisture content decreased from 11.9% to 9.8%. This is because activated waste glass powder has a relatively lower water absorption capacity. The waste glass powder fills the voids leading to a denser arrangement with less need for water (Rasool, 2021).

4.3.4 Effect of activated waste glass powder on CBR

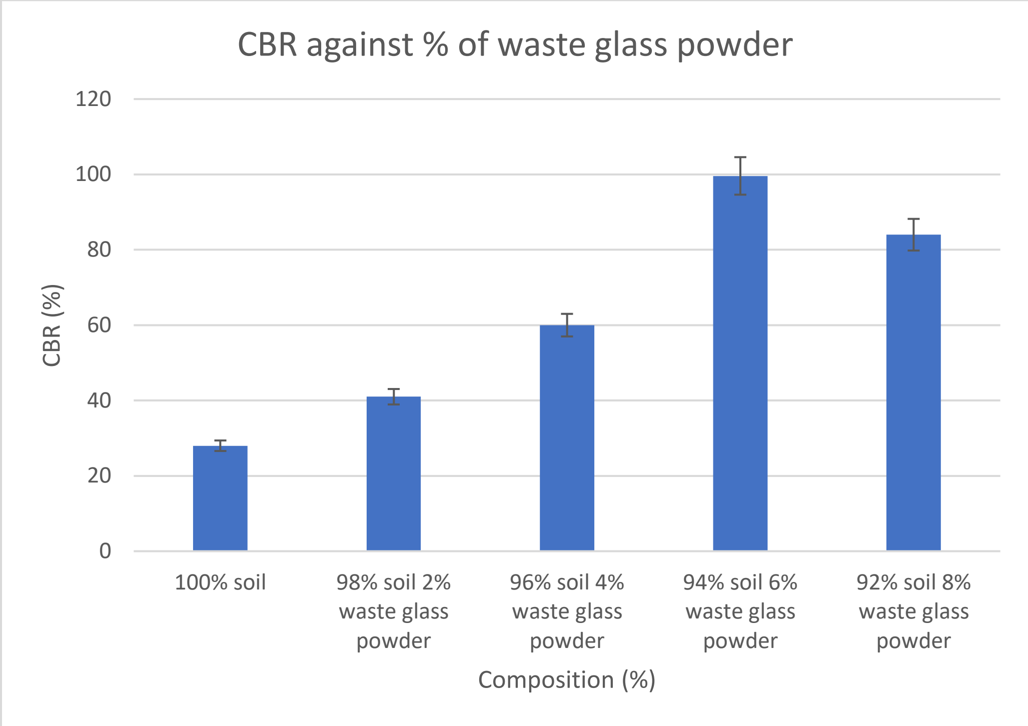


Figure 10: A graph showing variation of CBR with % of GWP

The CBR increased with addition of 0-6% of activated waste glass powder. the maximum value obtained is 99.6% at 6% activated waste glass. The glass particles improve the distribution enhancing compaction and load-bearing capacity. This is due to the pozzolanic reaction between silica, alumina and calcium which forms calcium silicate hydrates and calcium aluminate hydrates (Surabhi & Singh, 2021). These gels enhance soil bonding and strength. The activated waste glass powder fills the voids reducing permeability and enhancing interparticle friction and cohesion hence increasing the CBR (Marto, 2013). Beyond 6%, the CBR value decreases due to the excess waste glass powder. This leads to imbalance in silica-calcium ratios hence some of the particles will not react (Yadav & Tiwari, 2022). The excess fine glass particles also reduce interlocking between soil grains decreasing the load-bearing capacity (Obetoh, 2023).

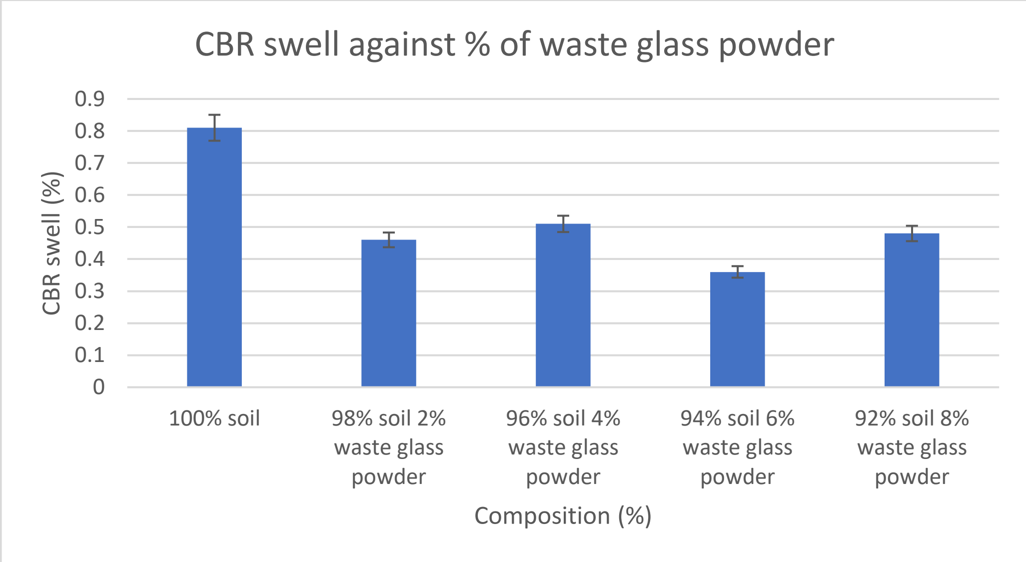


Figure 11: A graph showing variation of CBR swell with % of WGP

The CBR swell reduced with increase of activated waste glass powder from 0-6% and the minimum was obtained as 0.36% at 6%. This is due to the enhanced soil compaction which lowers the permeability hence reducing swell (Marto,2013). Beyond 6%, the swell increased due to excess fines that disrupt the soil structure and increase the water absorption capacity (Kumar & Dutta, 2020).

4.3.5 Effect of activated waste glass powder on UCS

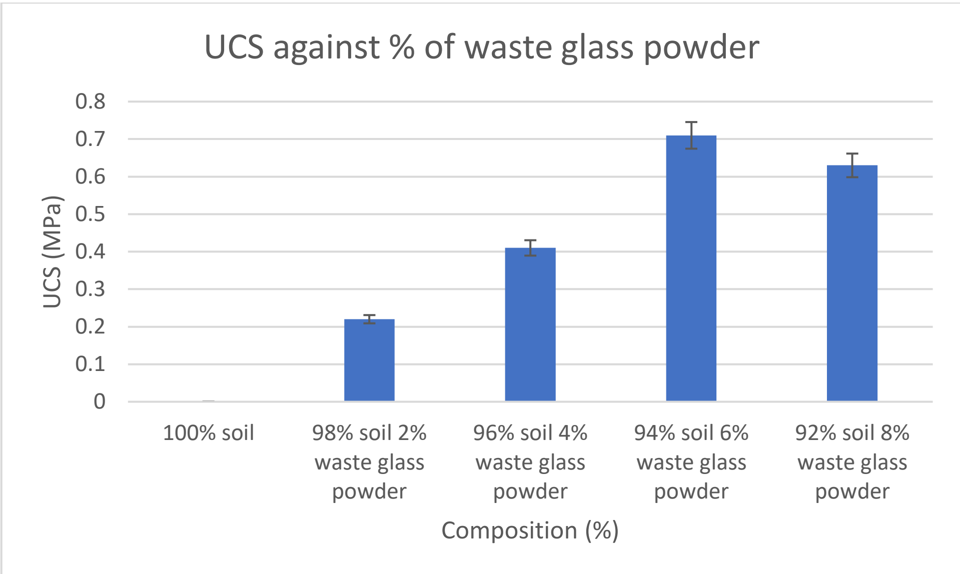


Figure 12: A graph showing variation of UCS with % of WGP

The UCS of the soil increased from 0-6% to a maximum of 0.71 at 6% activated waste glass powder. This is due to the pozzolanic reaction improving interparticle bonding hence increasing the soil strength (Surabhi & Singh, 2021). Beyond 6%, the UCS decreases due to excess fines that will not react. This reduces cohesion and bonding between the soil grains hence weakening the soil matrix (Rahman et el, 2018).

Research design

Table 6: Summary of results for stabilized soil

Soil (%)	WGP (%)	GM	PI (%)	LS	MDD (g/cm^3)	OMC (%)	CBR (%)	CBR swell	UCS (MPa)
100	0	2.17	17.7	8.6	2.011	11.9	28	0.81	-
98	2	1.95	11.6	6.8	2.032	12	41	0.46	0.22
96	4	2.09	8.8	4.3	2.024	10.8	60	0.51	0.41
<u>94</u>	<u>6</u>	<u>1.95</u>	<u>8.6</u>	<u>3.6</u>	<u>2.089</u>	<u>9.8</u>	<u>100</u>	<u>0.36</u>	<u>0.71</u>
92	8	2.12	10.6	5.7	2.046	11.1	84	0.48	0.63

The optimum mix ratio is 94% laterite soil and 6% activated waste glass powder as seen from table 6 above.

The PI of the ratio is 8.6% which is below the maximum of 14% for a G45 subbase material according to the MoWT General Specifications for road and bridge works 2005. The linear shrinkage also lowered to 3.6 which is below the maximum of 8.

The CBR of the mix ratio is 100% which is above the minimum of 45% showing that the soil ratio has a good load-bearing capacity. The CBR swell also reduced to 0.36 which is below the maximum of 0.5. The UCS value is 0.71MPa which is slightly above 0.7MPa minimum for a G45 material.

Using the optimum activated waste glass content of 6%, the amount needed to stabilize the subbase layer for a 1km stretch can be obtained from:

Considering a stretch of a road of 1km with a width of 6.5m and a subbase layer thickness of 150mm, then;

Volume of the soil and activated WGP = L × W × H

$$= 1000 \times 6.5 \times 0.15$$

$$= 975 m^3$$

Volume of the activated WGP = 6% of total volume

$$= 6\% \times 975$$

$$= 58.5 m^3$$

Weight of the activated WGP = $58.5 m^3$ × density of the glass

$$= 58.5 \times 975 kg/m^3$$

$$\underline{\underline{= 57{,}037.5 kg \rightarrow 57 \text{ tonnes}}}$$

Therefore, 57 tonnes of activated waste glass powder will be needed to stabilize the subbase layer for a 1km stretch of a road.

4.4 Design of the pavement layer

Seeta-Bajjo road is considered a low-volume road as it will be diverging traffic from the major road. Using the AASHTO method, consider the road to have low traffic of about 1×10^6 esa and subgrade CBR of about 8%.

The level of reliability of the road is 80% since it is an urban collector that is, it collects traffic from the major road.

The initial serviceability is 4.0 with a terminal serviceability of 4.0. Calculating the serviceability index as 4.0 – 2.0 = 2.0

Calculating the resilient modulus of the subgrade as;

MR = 1500 × 8

= 12000 psi

From the necessary graphs, the SN min is obtained as 2.7

In order to determine the layer thicknesses, the equation below is used;

SN actual $\leq a_1d_1 + a_2d_2m_1 + a_3d_3m_2$

Consider the drainage coefficients that is m_1 and m_2 as 0.8 and the layer coefficients as; $a_1 = 0.41$, $a_2 = 0.14$ and $a_3 = 0.14$

Considering the layer thicknesses as d_1 = 4", d_2 = 6" and d_3 = 6", then;

SN actual = (0.41×4) + (0.14×6×0.8) + (0.14×6×0.8)

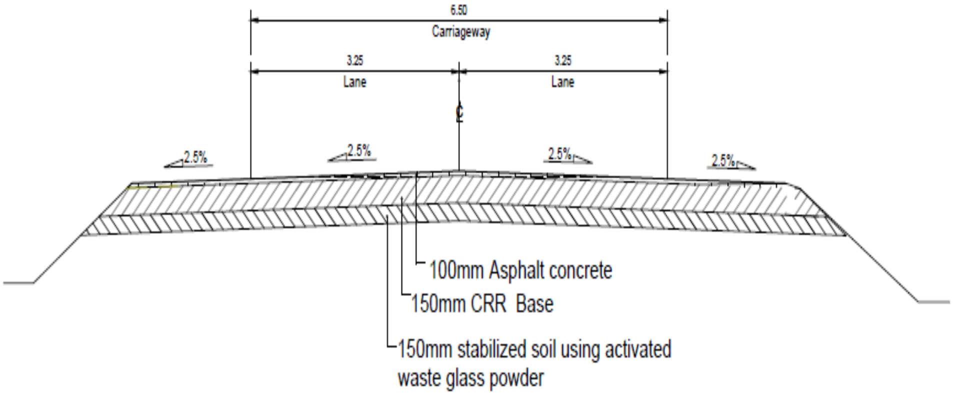
SN actual = 2.9

Since SN actual is greater than SN min, the layer thicknesses of the pavement will be;

Table 7: table showing the layer thicknesses

Layer	Thickness
Asphalt concrete	4" = 100mm
Road base	6" = 150mm
Subbase	6" = 150mm
Subgrade	Existing soil

The stabilized subbase can be used as the base layer since the geotechnical properties meet and exceed the minimum strength requirements for the base materials according to AASHTO. Conventionally, base layer requires 80-100% CBR and a UCS of atleast 0.7MPa for chemically stabilized materials. The CBR achieved was 100% which indicates a high load bearing capacity and a UCS value of 0.71MPa which indicates sufficient stiffness under traffic-induced stress. Those shows that the stabilized layer can effectively perform the functional role of the base course which is to distribute loads to the subgrade and enhance overall pavement performance. This also offers economical and environmental advantages by minimizing the need for granular aggregates. Therefore, stabilizing with activated waste glass powder reduces the number of the layers in the pavement since it greatly improves the strength properties of the subbase layer. So, the road can have an asphalt layer of 100mm thickness and subbase layer which will also perform as the base layer of 150mm thickness. The subgrade will be the existing soil.



Typical Cross Section

Pavement Layers Details		
Pavement Layer Type	Thickness	
Surfacing	100mm	Asphalt concrete
Base	150mm	CRR base min 98% of BS heavy Compaction according to BS 1377: Part 4
Sub-base	150mm	Stabilized soil using 6% activated waste glass powder to form a new subbase-G45, min 98% of BS Heavy compaction according to BS 1377:Part 4

TYPICAL CROSS SECTION	
PROJECT TITLE	ASSESSING THE USE OF ACTIVATED WASTE GLASS POWDER TO STABILIZE LATERITE SOILS FOR THE SUBBASE LAYER
AUTHOR	TIBYAZE VANESSA ELIZABETH
REG NUMBER	S21B32 / 019
SCALE	1:50 A3

Figure 13: typical road cross section

CHAPTER FIVE: CONCLUSION AND RECOMMENDATION

5.1 Conclusion

This research was aimed at the use of activated waste glass powder to stabilize laterite soils for the subbase layer and the following conclusions were drawn;

The sample was collected from Nsambwe borrow pit and it was classified as an A-2-6 soil containing clayey gravel and sand. The PI was found to be 17.7% which is above the maximum of 14% for a G45 material as per the MoWT general specifications for road and bridge works, 2005. This is due to the fines present in the soil. The CBR was also below the standards that is 28% which was below the minimum of 45% showing that the soil has a poor load-bearing capacity. The CBR swell was 0.81 with a linear shrinkage of 8.6 which were all above the maximum of 0.5 and 7 respectively. According to the MoWT general specifications for road and bridge works 2005, the soil did not meet the required standards for a G45 material making it unsuitable for use in the subbase. Therefore, it needed to be stabilized so as to improve its geotechnical properties to meet the specific requirements.

Waste glass powder contained a high percentage of silica, sodium oxide and calcium oxide at 73.67%, 15.63% and 9.16% respectively with 0.47% aluminium oxide. These are the dominant oxides that take part in the pozzolanic reaction. According to the ATSM standard, waste glass powder is classified as a class N pozzolan because the summation of the dominant oxides is greater than 70%. The waste glass powder was activated using sodium hydroxide to enhance the pozzolanic reaction. The silicate ions released react with calcium to form C-S-H gels that bind the soil particles improving the strength and reducing the plasticity index.

The soil was stabilized with varying percentages of activated waste glass powder that is 0%, 2%, 4%, 6% and 8%. The strength properties were seen to increase from

0% to 6% with maximum values of 100% and 0.71MPa for the CBR and UCS respectively at 6% activated waste glass powder. Beyond 6%, there was a decrease in these parameters due to the excess fines that didn't react. The PI also reduced to 8.6% at 6% activated waste glass powder with a linear shrinkage of 3.6. The optimum mix ratio is 94% laterite soil and 6% activated waste glass powder as it is the ratio that gave the most effective results. Since the soil met all the required standards for a G45 material after stabilization, it can be used as a subbase material and waste glass powder can be used as a potential stabilizer.

5.2 Recommendations

The UCS value of 0.71MPa obtained after stabilization with 6% activated waste glass powder was slightly above the minimum of 0.7MPa for G45 material hence further research should be done to ensure optimization so that the layer doesn't fail under traffic loading. Also, further observation of the UCS values should be done after longer curing days beyond 14 days.

Further research should be done into other materials that exhibit pozzolanic properties to enhance the workability of waste glass powder in stabilization of soils to add onto the existing knowledge.

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APPENDICES

APPENDIX A: PICTORAL

Figure 14: waste glass powder

Figure 15: activating the waste glass powder with NaOH

Figure 16: preparation for Atterberg limits

Figure 17: soaking for CBR

APPENDIX B: LABORATORY RESULTS

INSTITUTION	STUDENTS NAMES	Testing Lab
UGANDA CHRISTIAN UNIVERSITY	TIBYAZE VANESSA ELIZABETH & WANYENYA DINAH MARTHA	Stirling
PROJECT:	ASSESSING THE USE OF ACTIVATED GLASS POWDER FOR THE STABILISATION OF LATERITE SOILS FOR THE SUBBASE LAYER	

SUMMARY OF TEST RESULTS FOR NSAMBWE BORROWPIT

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	93%	95%	98%	65	30	62	AVERAGE
LIMITS																							
NSAMBWE BORROWPIT	NEAT	01/02/2025	100	100	100	51	35	24	17	2.24	38.4	20.6	17.8	8.6	2.011	11.9	22	28	36	0.60	0.71	1.13	0.81
			100	100	95	55	40	28	21	2.11	38.5	20.9	17.6	8.6	-	-							
	AVERAGE		100	100	97	53	38	26	19	2.17	38.5	20.7	17.7	8.6	2.011	11.9		28		0.60	0.71	1.13	0.81

Testing lab

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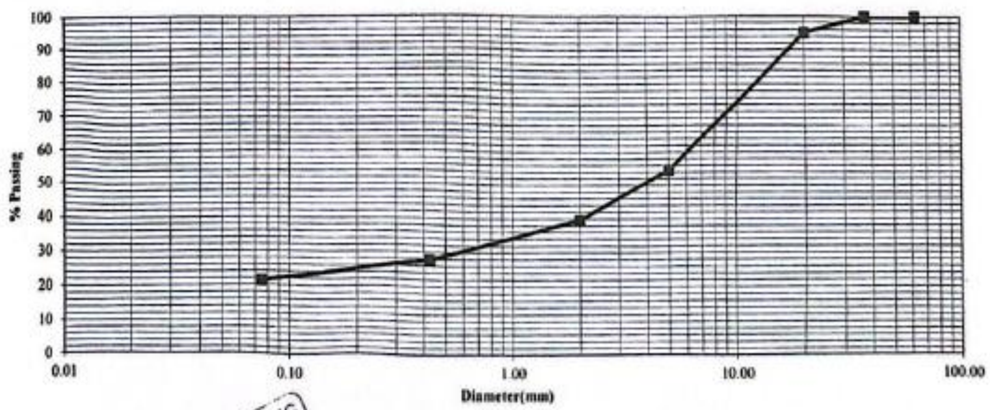
INSTITUTION	STUDENTS NAMES	TESTING LAB
UGANDA CHRISTIAN UNIVERSITY	TIBYAZE VANESSA ELIZABETH & WANYENYA DINAH MARTHA	Stirling

PROJECT : ASSESSING THE USE OF GLASS POWDER FOR THE STABILISATION OF LATERITE SOILS FOR THE SUBBASE LAYER

PARTICLE SIZE DISTRIBUTION (BS 1377 - 2 - 90)

Test Reference No.:		Lab. Refernece No.:		
Location :(km)	NSAMBWE BORROWPIT	Dry wt. of sample before washing: (g)		5521.4
Depth: (m)		Dry wt. of sample after washing: (g)		4351.1
Material description:	NEAT	Date Sampled:	Date Tested:	Technician
		1/Feb/2025	3/Feb/2025	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	278.8	5.0	95	60	95
5.0	2230.5	40.4	55	30	65
2.00	825.6	15.0	40	20	50
0.425	651.5	11.8	28	10	30
0.075	355.3	6.4	21	5	15
Total fines	1179.7	21.4			
Bottom Pan	9.4				
Extracted fines	1170.3				
Total sample	5521.4				
Grading Modulus		2.11			



TESTING LAB

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INSTITUTION	STUDENTS NAMES	TESTING LAB
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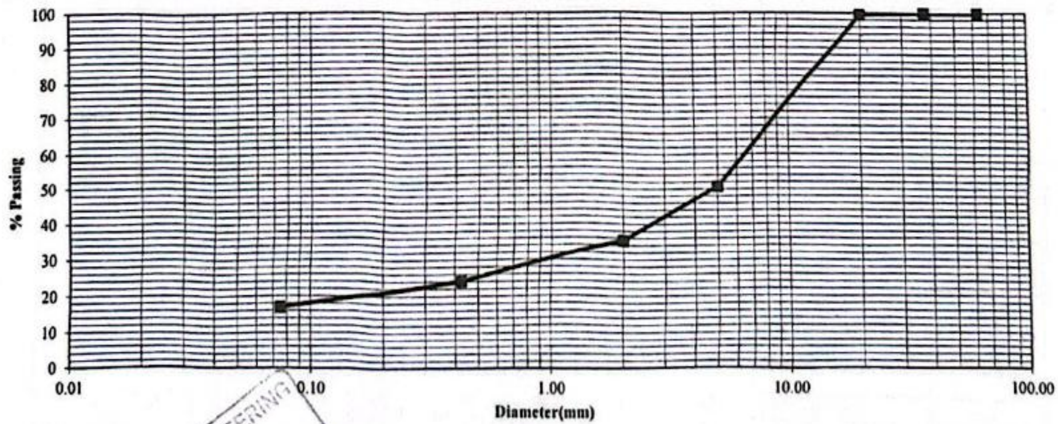
PROJECT : "ASSESSING THE USE OF GLASS POWDER FOR THE STABILISATION OF LATERITE SOILS FOR THE SUBBASE LAYER

PARTICLE SIZE DISTRIBUTION (BS 1377 - 2 - 90)

Test Reference No.:		Lab. Refernece No.:		
Location :(km)	NSAMBWE BORROWPIT	Dry wt. of sample before washing: (g)		5232.4
Depth: (m)		Dry wt. of sample after washing: (g)		4355.8
Material description:	NEAT	Date Sampled:	Date Tested:	Technician
		1/Feb/2025	3/Feb/2025	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	25.0	0.5	100	60	95
5.0	2552.5	48.8	51	30	65
2.00	801.2	15.3	35	20	50
0.425	593.3	11.3	24	10	30
0.075	374.3	7.2	17	5	15
Total fines	886.1	16.9			
Bottom Pan	9.5				
Extracted fines	876.6				
Total sample	5232.4				
Grading Modulus		2.24			



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STUDENTS NAMES | TESTING LAB

UGANDA CHRISTIAN UNIVERSITY

TIBYAZE VANESSA ELIZABETH & WANYENYA DINAH MARTHA

Stirling

PROJECT: **ASSESSING THE USE OF GLASS POWDER FOR THE STABILISATION OF LATERITE SOILS FOR THE SUBBASE LAYER**

ATTERBERG LIMITS

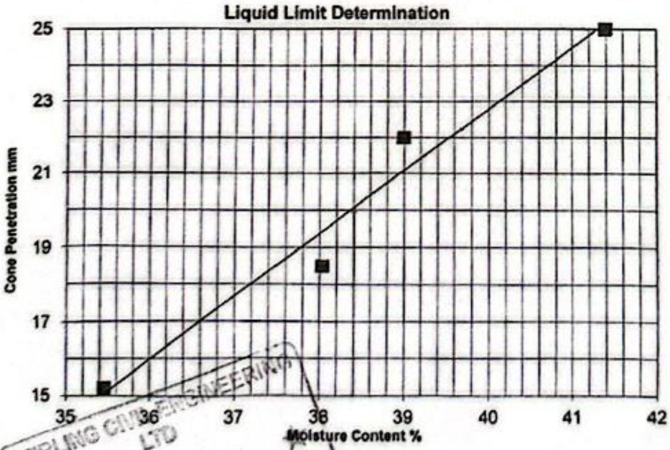
Liquid limit (cone penotrometer) and plastic limit

Test Reference No.:	Lab. Reference No.:	Technician:	Lab Team
Location	NSAMBWE BORROWPIT	Sample Date	1/Feb/2025
Test method	BS 1377: Part 2, 1990:4.3/4.4	Test Date	3/Feb/2025
LAYER	NEAT		

PLASTIC LIMIT	Test No.	KK	HR		Average
Mass of wet soil + container (g)		33.7	39.9		36.8
Mass of dry soil + container (g)		31.83	36.77		34.3
Mass of container (g)		22.78	21.53		22.155
Mass of moisture (g)		1.87	3.1		2.5
Mass of dry soil (g)		9.05	15.24		12.145
Moisture content %		20.7	20.5		20.6
AVERAGE					

LIQUID LIMIT	Test No	1	2	3	4
Initial gauge reading (mm)		0 0	0	0	0
Final gauge reading (mm)		15.2	18.5	22	25.0
penetration (mm)		15.2	18.5	22.0	25.0
AVERAGE		15.2	18.5	22.0	25.0
Container No.		OO	AX	PIB6	PII2
Mass of wet soil + container (g)		57.98	67.68	55.96	66.50
Mass of dry soil + container (g)		44.61	50.99	42.23	49.05
Mass of container (g)		6.90	7.10	7.02	6.89
Mass of moisture (g)		13.37	16.69	13.73	17.45
Mass of dry soil (g)		37.71	43.89	35.21	42.16
Moisture content (%)		35.5	38.0	39.0	41.4
AVERAGE		35.5	38.0	39.0	41.4

Liquid Limit Determination



Liquid limit (%)	38.4
Plastic limit (%)	20.6
Plasticity Index (%)	17.8
Linear shrinkage	
Trough No.	4
Trough length (cm)	14.0
Specimen length (cm)	12.8
L.shringage =	1.2
% L.shrinkage =	8.6

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Remarks:

TESTING LAB

INSTITUTION	STUDENTS NAMES	TESTING LAB
UGANDA CHRISTIAN UNIVERSITY	TIBYAZE VANESSA ELIZABETH & WANYENYA DINAH MARTHA	Stirling

PROJECT:	ASSESSING THE USE OF GLASS POWDER FOR THE STABILISATION OF LATERITE SOILS FOR THE SUBBASE LAYER

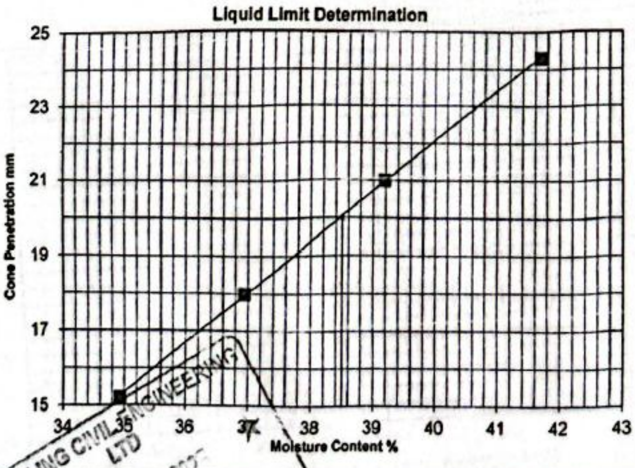
ATTERBERG LIMITS

Liquid limit (cone penotrometer) and plastic limit

Test Reference No.:	Lab. Reference No.:		Technician:	Lab Team
Location	NSAMBWE BORROWPIT		Sample Date	1/Feb/2025
Test method	BS 1377: Part 2, 1990:4.3/4.4		Test Date	3/Feb/2025
LAYER	NEAT			

PLASTIC LIMIT	Test No.	P4	41		Average
Mass of wet soil + container (g)		33.29	42.29		37.79
Mass of dry soil + container (g)		31.45	38.85		35.15
Mass of container (g)		22.64	22.33		22.485
Mass of moisture (g)		1.84	3.4		2.64
Mass of dry soil (g)		8.81	16.52		12.665
Moisture content %		20.9	20.6		20.9
AVERAGE					

LIQUID LIMIT	Test No	1	2	3	4
Initial gauge reading (mm)		0	0	0	0
Final gauge reading (mm)		15.2	18	21	24.3
penetration (mm)		15.2	18.0	21.0	24.3
AVERAGE		15.2	18.0	21.0	24.3
Container No.		A6	PI26	AO	PI82
Mass of wet soil + container (g)		66.33	70.67	59.02	70.57
Mass of dry soil + container (g)		50.93	53.50	44.38	51.87
Mass of container (g)		6.84	7.02	7.02	7.00
Mass of moisture (g)		15.4	17.17	14.64	18.7
Mass of dry soil (g)		44.09	46.48	37.36	44.87
Moisture content (%)		34.9	36.9	39.2	41.7
AVERAGE		34.9	36.9	39.2	41.7



Liquid limit (%)	38.5
Plastic limit (%)	20.9
Plasticity Index (%)	17.6
Linear shrinkage	
Trough No.	4
Trough length (cm)	14.0
Specimen length (cm)	12.8
L.shringage =	1.2
% L.shrinkage =	8.6

Remarks:

TESTING LAB

STIRLING CIVIL ENGINEERING LTD ... KAMPALA (U)

INSTITUTION	STUDENTS NAMES	TESTING LAB
UGANDA CHRISTIAN UNIVERSITY	TIBYAZE VANESSA ELIZABETH & WANYENYA DINAH MARTHA	Stirling

PROJECT:	ASSESSING THE USE OF ACTIVATED GLASS POWDER FOR THE STABILISATION OF LATERITE SOILS FOR THE SUBBASE LAYER			
Test Reference No.	Lab. Reference No.	Date Sampled	Date Tested	Technician
Location:	NSAMBWE BORROWPIT	1/Feb/25	3/Feb/25	Lab team
Material description:	NEAT	Natural moisture (%) :	7.3	

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	62	5	457	152	2,260

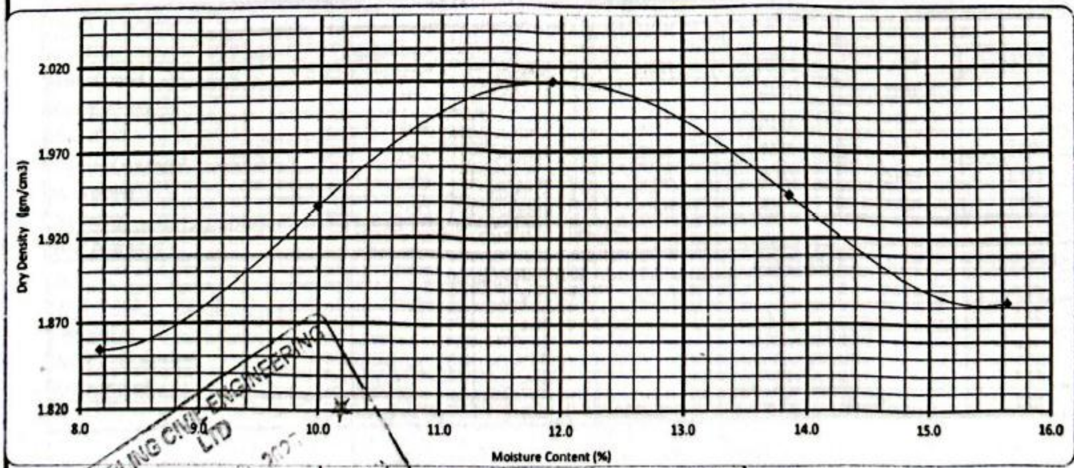
MOISTURE CONTENT DATA

Test No.		1	2	3	4	5
Tin No.		A	A	A	A	A
Water Added	cm^3	30	150	270	390	510
Mass of Compacted soil + mould	gm	9,405	9,689	9,960	9,876	9,793
Mass of Mould	gm	4,873	4,873	4,873	4,873	4,873
Mass of Compacted soil	gm	4532	4816	5087	5003	4920
Volume of mould	cm^3	2,260	2,260	2,260	2,260	2,260
Wet density of soil	g/cm^3	2.005	2.131	2.251	2.214	2.177

DATA FOR PROCTOR CURVE

Container No.		UPC	KAU	RWE	Z6T	ACB
Mass of wet soil + Container	gm	2,712.0	2,674.0	3,173.0	2,892.0	2,897.0
Mass of dry soil + container	gm	2,568.3	2,503.7	2,921.7	2,638.3	2,610.7
Mass of container	gm	808.0	798.0	815.0	808.0	780.0
Mass of water added	gm	143.7	170.3	251.3	253.7	286.3
Mass of dry soil	gm	1760.3	1705.7	2106.7	1830.3	1830.7
Moisture content	%	8.2	10.0	11.9	13.9	15.6
Dry density	g/cm^3	1.854	1.938	2.011	1.944	1.883

Maximum dry density (gm/cm^3) 2.011 Optimum moisture content (%) 11.9



TESTING LAB

STIRLING CIVIL ENGINEERING LTD KAMPALA (U)

Institution	Students Names	Testing Lab
UGANDA CHRISTIAN UNIVERSITY A Centre of Excellence in the Heart of Africa	TIBYAZE VANESSA ELIZABETH & WANYENYA DINAH MARTHA	Stirling

ASSESSING THE USE OF ACTIVATED GLASS POWDER FOR THE STABILISATION OF LATERITE SOILS FOR THE SUBBASE LAYER

CALIFORNIA BEARING RATIO TEST (BS 1377 Part 4)

Test sample reference :	Laboratory Reference No.:	Sampling Date :	1/Feb/25
Location:	NSAMBWE BORROWPIT	Casting date :	4/Feb/25
		Testing Date :	8/Feb/25
		Technician :	Lab team
Sample Description:	NEAT	**Volume of Mould used (m^3)**	2305

Natural moisture of air dried sample			**Volume of water added**	
Tin No.	GMM		Mass of air dried soil (g)	18000
Tin + air dried soil sample (g)	2992		MDD (Mg/m^3)	2.011
Tin + oven dry soil sample (g)	2839.9		N.M.C (%)	7.3
Tin (g)	757		OMC (%)	11.9
Dry soil sample	2082.9		Added OMC (%)	4.6
Water (g)	152.1		Calculated dry wt of soil (g)	16685.6
N.M.C (%)	7.3		Water added (g)	771
Average (%)	7.3		**Water added (mL)**	771

Number of blows		65				30				62 blows of 2.5 kg			
Number of layer		5				5				3			
Water Content Determination		Before Soaking		After Soaking		Before Soaking		After Soaking		Before Soaking		After Soaking	
Tare No		ACB	-	BAR	-	ACB	-	AT	-	ACB	-	OU	-
Mass of wet sample + Tare	g	2574	-	2855	-	2574	-	1252	-	2574	-	1380	-
Mass of dry sample + Tare	g	2381	-	2600	-	2381	-	1102	-	2381	-	1208	-
Mass of Tare	g	780	-	800	-	780	-	120	-	780	-	120	-
Mass of water	g	193	-	255	-	193	-	150	-	193	-	172	-
Mass of dry sample	g	1601	-	1800	-	1601	-	982	-	1601	-	1088	-
Water content	%	12.1	-	14.2	-	12.1	-	15.3	-	12.1	-	15.8	-
Average water Content	%	12.1		14.2		12.1		15.3		12.1		15.8	
Density determination													
Mould No		21				OK				NK			
Mass of mould + soil	g	12789		12940		11821		12480		12004		13115	
Mass of mould	g	7507		7507		6831		6831		7290		7290	
Mass of soil	g	5282		5394		4990		5151		4714		4891	
Volume of the mould	cm3	2305		2305		2305		2305		2305		2305	
Moist density	g/cm3	2.292		2.340		2.165		2.235		2.045		2.122	
Dry density	g/cm3	2.045		2.050		1.932		1.938		1.825		1.832	
Swell Determination													
Date		Hour		D.Gauge Reding		Hour		D.Gauge Reding		Hour		D.Gauge Reding	
Initial reading		96 hrs		2.09		96 hrs		1.12		96 hrs		5.16	
Final reading				2.85				2.02				6.59	
Height of the specimen				127				127				127	
Height of swell				0.76				0.9				1.43	
		Swelling(%)		0.60		Swelling(%)		0.71		Swelling(%)		1.13	

Observations:

Testing Lab

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Institution	Students Names	Testing Lab
UGANDA CHRISTIAN UNIVERSITY A Centre of Excellence in the Heart of Africa	TIBYAZE VANESSA ELIZABETH & WANYENYA DINAH MARTHA	**Stirling**

ASSESSING THE USE OF ACTIVATED GLASS POWDER FOR THE STABILISATION OF LATERITE SOILS FOR THE SUBBASE LAYER

CALIFORNIA BEARING RATIO TEST (BS1377 Part 4)

Test sample reference :	Laboratory Reference No.:	Sampling Date	1/Feb/25
Location:	NSAMBWE BORROWPIT	Penetration Date	8/Feb/25
Depth :		Technician	:: Lab team
Sample Description :	: NEAT		

Number of blows per layer		65	30	62 blows of 2.5 kg
Number of layers		5	5	3
Mould No		21	OK	NK
Capacity of the Proving Ring (KN)		50	50	50
Proving Ring Constant (KN/div.)		0.2312	0.2312	0.2312

Speed : ... ...mm/min.		Top		Bottom		Top		Bottom		Top		Bottom	
Penetration of the plunger (mm)	Time (s)	Reading *10³mm	Force (KN)	Reading *10³mm	Force (KN)	Reading *10³mm	Force (KN)	Reading *10³mm	Force (KN)	Reading *10³mm	Force (KN)	Reading *10³mm	Force (KN)
0	0	0	0.0	0	0.0	0	0.0	0	0.0	0	0.0	0	0.0
0.25	12	2	0.5	4	0.9	1	0.2	4	0.9	1	0.2	2	0.5
0.5	24	4	0.9	8	1.8	2	0.5	6	1.4	2	0.5	4	0.9
0.75	35	8	1.8	10	2.3	3	0.7	7	1.6	3	0.7	6	1.4
1	47	10	2.3	12	2.8	4	0.9	8	1.8	5	1.2	7	1.6
1.5	71	12	2.8	16	3.7	5	1.2	11	2.5	7	1.6	8	1.8
2	94	14	3.2	20	4.6	7	1.6	15	3.5	8	1.8	9	2.1
2.5	118	16	3.7	25	5.8	8	1.8	18	4.2	9	2.1	10	2.3
3	142	17	3.9	30	6.9	9	2.1	21	4.9	10	2.3	11	2.5
3.5	165	18	4.2	33	7.6	10	2.3	23	5.3	10	2.3	12	2.8
4	189	20	4.6	36	8.3	11	2.5	25	5.8	11	2.5	13	3.0
4.5	213	22	5.1	38	8.8	12	2.8	26	6.0	11	2.5	14	3.2
5	236	23	5.3	40	9.2	13	3.0	28	6.5	12	2.8	14	3.2
5.5	260	24	5.5	41	9.5	14	3.2	30	6.9	12	2.8	15	3.5
6	283	25	5.8	43	9.9	15	3.5	31	7.2	13	3.0	16	3.7
6.5	307	27	6.2	45	10.4	16	3.7	32	7.4	13	3.0	16	3.7
7	331	28	6.5	47	10.9	17	3.9	33	7.6	14	3.2	17	3.9
7.5	354	30	6.9	50	11.6	18	4.2	34	7.9	15	3.5	17	3.9

Observations

Testing Lab

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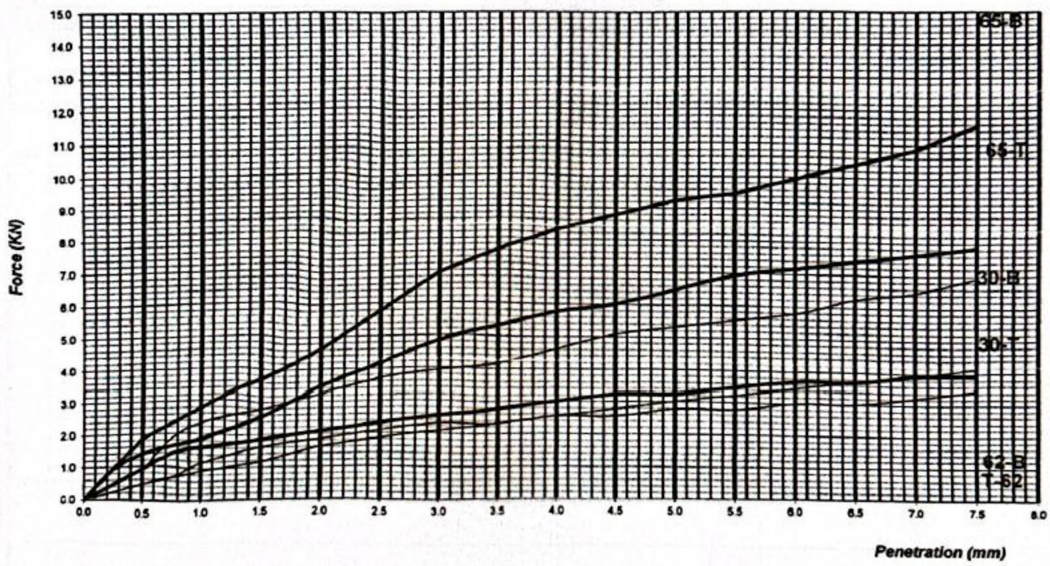
Institution	Students Names	Testing Lab
UGANDA CHRISTIAN UNIVERSITY	TIBYAZE VANESSA ELIZABETH & WANYENYA DINAH MARTHA	Stirling

ASSESSING THE USE OF ACTIVATED GLASS POWDER FOR THE STABILISATION OF LATERITE SOILS FOR THE SUBBASE LAYER

CALIFORNIA BEARING RATIO TEST (BS1377 Part 4)

Test sample reference :	Laboratory Reference No :	Sampling Date :	1/Feb/25
Location:	NSAMBWE BORROWPIT	Testing Date :	8/Feb/25
Depth:	0.15m	Technician	: Lab team
Sample Description:	NEAT		

PENETRATION vs FORCE CURVE



	65 blows				30 blows				62 blows of 2.5 kg			
	Force		CBR		Force		CBR		Force		CBR	
	Bottom	Top	Bottom	Top	Bottom	Top	Bottom	Top	Bottom	Top	Bottom	Top
2.5 mm Penetration	5.8	3.7	44	28	4.2	1.8	31	14	2.3	2.1	17	16
5.0 mm Penetration	9.2	5.3	46	27	6.5	3.0	32	15	3.2	2.8	16	14
Average	7.5	4.5	45.0	27.3	5.3	2.4	31.9	14.5	2.8	2.4	16.8	14.8
Retained CBR	45.0				31.9				16.8			
Observations												

Testing Lab

....

....

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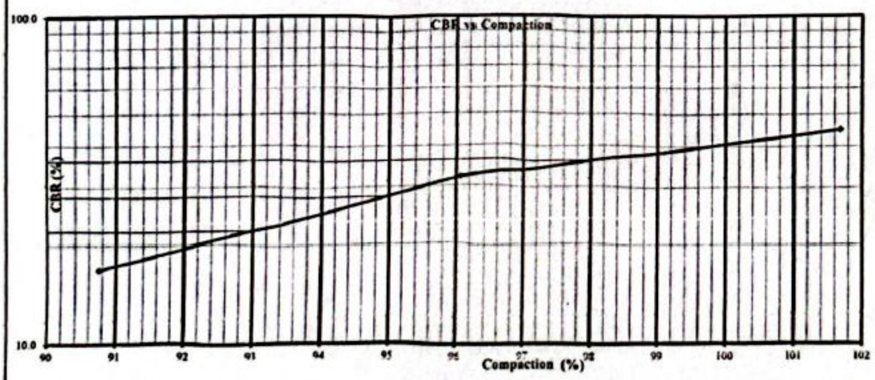
ASSESSING THE USE OF ACTIVATED GLASS POWDER FOR THE STABILISATION OF LATERITE SOILS FOR THE SUBBASE LAYER

CALIFORNIA BEARING RATIO TEST (BS 1377 Part 4)

Test sample reference :	Laboratory Reference No.:	Sampling Date :	1/Feb/25
Location:	NSAMBWE BORROWPIT	Testing Date :	8/Feb/25
Depth :		Technician :	: Lab team
Sample Description :	NEAT		

Number of blows per layer		65	30	62 blows of 2.5 kg
Density	Mg/m3	2.045	1.932	1.825
CBR	%	45.0	31.9	16.8
Relative compaction	(%)	101.7	96.1	90.8



Maximum Dry Density (Mg/m³)	2.011	CBR at 98% MDD	36
		CBR at 95% MDD	28
Optimum Moisture Content(%)	11.9	CBR at 93% MDD	22
Observations			
Testing Lab			

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FOR GOD AND MY COUNTRY

THE REPUBLIC OF UGANDA

MINISTRY OF INTERNAL AFFAIRS
DIRECTORATE OF GOVERNMENT ANALYTICAL LABORATORY
Plot No. 2 Lourdel Road
Wandegeya,
P.O. Box 105639
Kampala - Uganda

DFD 022/2025
04th February 2025

MS. TIBYAZE VANESSA ELIZABETH AND MS. WANYENYA DINAH MARTHA
REG NO. S21B32/019 AND S21B32/104
UGANDA CHRISTIAN UNIVERSITY
P.O BOX 4,
MUKONO-UGANDA
Tel: 256-706-4276008

REPORT OF ANALYSIS

Description of the Samples

One sample in black polythene bag containing white powder sample was submitted by Ms. Tibyaze Vanessa, on 22nd January 2025, and analysed on 27th January 2025. A summary of the sample received is shown in table below

S/N	Description	Quantity	Assigned Lab ID
1	White powdered substances packed in a black polythene bag.	01	Sample "A" DFD 022/2025

Analysis Requested

Elemental analysis

Method of Analysis

Elemental analysis was done using the XRF Method

Results of Analysis

The above sample has been analyzed with the following results as below,

Parameter	Units	Results for DFD 022/2025 White powder sample
Silicon dioxide	% m/m	73.67
Sodium Oxide	% m/m	15.63
Calcium Oxide	% m/m	9.16
Aluminium Oxide	% m/m	0.47
Manganese (II)Oxide	% m/m	0.19
Titanium di oxide	% m/m	0.17
Potassium Oxide	% m/m	0.06
Iron (III) Oxide	% m/m	0.05
Europium (III) oxide	% m/m	0.03
Phosphorous pentaoxide	% m/m	0.03

Remarks

1. Results relate to sample analyzed and are reported as on received basis.

04/02/25
Semalago Fredrick
Government Analyst

"Go Scientific for a Safe and Just Society"

INSTITUTION	STUDENTS	TESTING LAB
UGANDA CHRISTIAN UNIVERSITY A Centre of Excellence in the Heart of Africa	TIBYAZE VANESSA ELIZABETH & WANYENYA DINAH MARTHA	Stirling

PROJECT: ASSESSING THE USE OF ACTIVATED GLASS POWDER FOR THE STABILISATION OF LATERITE SOILS FOR THE SUBBASE LAYER

SUMMARY OF TEST RESULTS FOR GRAVEL MIXED WITH 2% ACTIVATED GLASS

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	62 BLOWS OF COMPACTION	62	AVERAGE
GRAVEL MIXED WITH 2% ACTIVATED GLASS	GRAVEL MIXED WITH 2% ACTIVATED GLASS	20/01/2025	100	97	94	60	45	32	23	2.00	29.8	18.2	11.6	6.8	2.032	12.0	41	0.46	0.46
			100	100	95	63	49	35	26	1.90	29.7	18.2	11.5	6.8	-	-	- - -	-	
			100	98.66	94.55	61.46	46.76	33.35	24.65	1.95	29.8	18.2	11.6	6.8	2.032	12.0	41	0.46	0.46
	AVERAGE		100	99	95	61	47	33	25	1.952	29.8	18.2	11.6	6.8	2.032	12.0	41	0.46	0.46

FOR LAB
STIRLING CIVIL ENGINEERING LTD
Lab Technician
14 MAR 2025
P. O. BOX 796, KAMPALA (U)

Materials Engineer

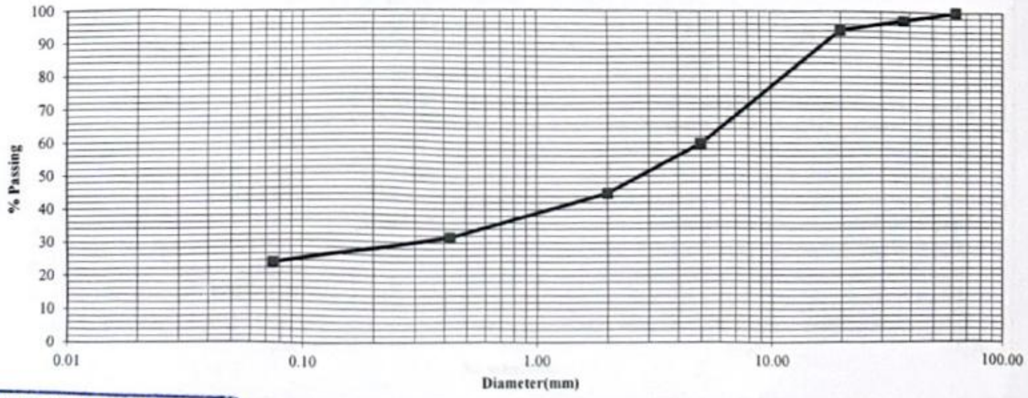
INSTITUTION	STUDENTS NAMES	CONTRACTOR
UGANDA CHRISTIAN UNIVERSITY A Centre of Excellence in the Heart of Africa	TIBYAZE VANESSA ELIZABETH & WANYENYA DINAH MARTHA	Stirling

PROJECT : ASSESSING THE USE OF ACTIVATED GLASS POWDER FOR THE STABILISATION OF LATERITE SOILS FOR THE SUBBASE LAYER

PARTICLE SIZE DISTRIBUTION (BS 1377 - 2 - 90)

Test Reference No.:		Lab. Refernece No.:		
Location :(km)	NSAMBWE BORROWPIT	Dry wt. of sample before washing: (g)		2879.2
Depth: (m)		Dry wt. of sample after washing: (g)		2207.1
Material description:	GRAVEL MIXED WITH 2% GLASS	Date Sampled:	Date Tested:	Technician
		24/Feb/2025	25/Feb/2025	Lab team

Sieve Size (mm)	Weight Retained (g)	Retained (%)	Passing (%)	Grading Limits (G60 & 80)	
63.0	0.0	0	100	100	100
37.5	77.0	2.7	97	80	100
20.0	90.7	3.2	94	60	95
5.0	991.3	34.4	60	30	65
2.00	427.9	14.9	45	20	50
0.425	383.8	13.3	32	10	30
0.075	233.9	8.1	23	5	15
Total fines	674.6	23.4			
Bottom Pan	2.5				
Extracted fines	672.1				
Total sample	2879.2				
Grading Modulus		2.00			



STIRLING CIVIL ENGINEERING LTD
FOR TESTING LAB
14 MAR 2025
P. O. BOX 795, KAMPALA (U)

Lab Technician | Materials Engineer

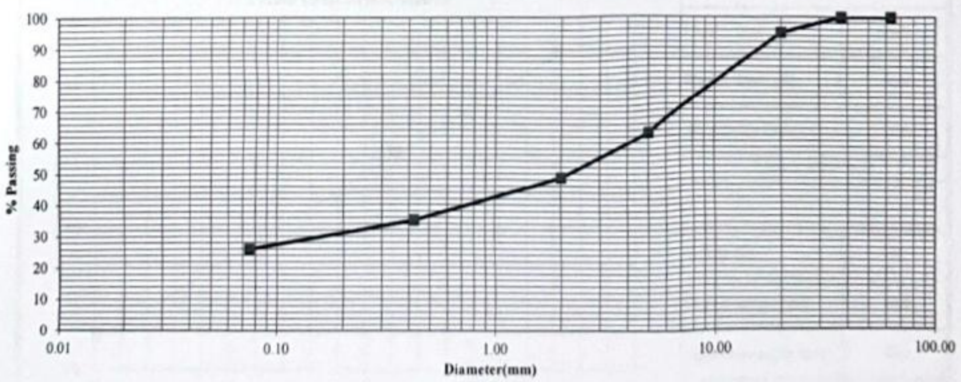
INSTITUTION	STUDENTS NAMES	CONTRACTOR
UGANDA CHRISTIAN UNIVERSITY A Centre of Excellence in the Heart of Africa	TIBYAZE VANESSA ELIZABETH & WANYENYA DINAH MARTHA	Stirling

PROJECT : ASSESSING THE USE OF ACTIVATED GLASS POWDER FOR THE STABILISATION OF LATERITE SOILS FOR THE SUBBASE LAYER

PARTICLE SIZE DISTRIBUTION (BS 1377 - 2 - 90)

Test Reference No.:		Lab. Refernece No.:			
Location :(km)	NSAMBWE BORROWPIT	Dry wt. of sample before washing: (g)			2973.7
Depth: (m)		Dry wt. of sample after washing: (g)			2207.2
Material description:	GRAVEL MIXED WITH 2% GLASS	Date Sampled:		Date Tested:	Technician
		24/Feb/2025		25/Feb/2025	Lab team

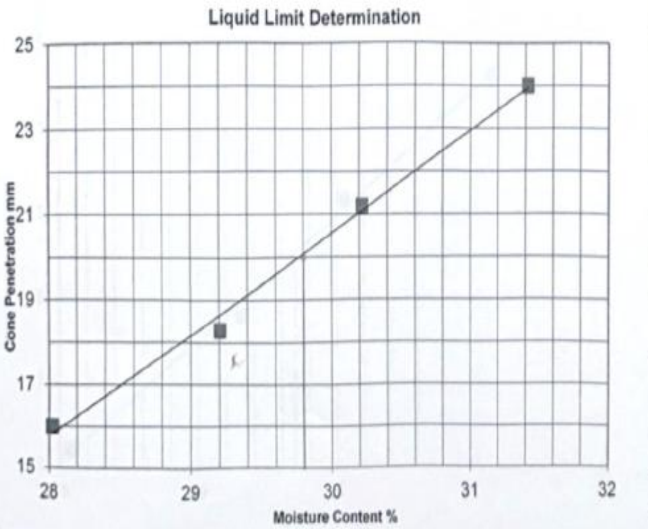
Sieve Size (mm)	Weight Retained (g)	Retained (%)	Passing (%)	Grading Limits (G60 & 80)	
63.0	0.0	0	**100**	100	100
37.5	0.0	0.0	**100**	80	100
20.0	151.0	5.1	**95**	60	95
5.0	944.1	31.7	**63**	30	65
2.00	432.5	14.5	**49**	20	50
0.425	401.0	13.5	**35**	10	30
0.075	275.8	9.3	**26**	5	15
Total fines	769.3	25.9			
Bottom Pan	2.8				
Extracted fines	766.5				
Total sample	2973.7				
Grading Modulus		**1.90**			



FOR TESTING LAB
STIRLING CIVIL ENGINEERING LTD
Lab Technician   Materials Engineer
P. O. BOX 796, KAMPALA (U)

Depth:					
PLASTIC LIMIT	Test No.	BA	4L		Average
Mass of wet soil + container (g)		41.67	46.39		44.03
Mass of dry soil + container (g)		38.81	42.69		40.75
Mass of container (g)		23.12	22.31		22.715
Mass of moisture (g)		2.86	3.7		3.28
Mass of dry soil (g)		15.69	20.38		18.035
Moisture content %		18.2	18.2		18.2
AVERAGE					

LIQUID LIMIT	Test No	1	2	3	4
Initial gauge reading (mm)		0	0	0	0
Final gauge reading (mm)		16.0	18.3	21.2	24.0
penetration (mm)		16.0	18.3	21.2	24.0
AVERAGE		16.0	18.3	21.2	24.0
Container No.		KF	PI26	PIV6	PI8
Mass of wet soil + container (g)		75.33	62.12	63.88	63.22
Mass of dry soil + container (g)		61.52	49.69	50.68	49.72
Mass of container (g)		12.24	7.13	7.00	6.75
Mass of moisture (g)		13.81	12.43	13.2	13.5
Mass of dry soil (g)		49.28	42.56	43.68	42.97
Moisture content (%)		28.0	29.2	30.2	31.4
AVERAGE		28.0	29.2	30.2	31.4



Liquid limit (%)	29.8
Plastic limit (%)	18.2
Plasticity Index (%)	11.6
Linear shrinkage	
Trough No.	R
Trough length (cm)	14.0
Specimen length (cm)	13.1
L.shringage =	0.9
% L.shrinkage =	6.8

Remarks:

STIRLING CIVIL ENGINEERING LTD
TESTING LAB
2025
Materials Engineer

STUDENTS

INSTITUTION	STUDENTS	TESTING LAB
UGANDA CHRISTIAN UNIVERSITY	VANESSA AND DINAH	Stirling

PROJECT:	ASSESSING THE USE OF ACTIVATED GLASS POWDER FOR THE STABILISATION OF LATERITE SOILS FOR THE SUBBASE LAYER

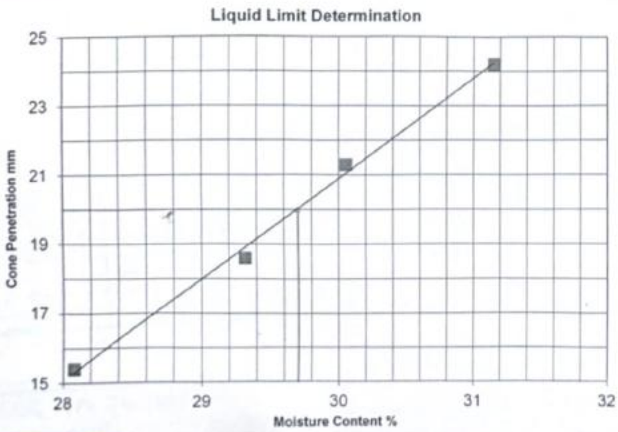
ATTERBERG LIMITS

Liquid limit (cone penotrometer) and plastic limit

Material description:	GRAVEL MIXED WITH 2% GLASS	Technician:	Lab Team
mix	NSAMBWE BORROWPIT	Sample Date	24/Feb/2025
Test method	BS 1377: Part 2, 1990:4.3/4.4	Test Date	28/Feb/2025
LAYER	GRAVEL MIXED WITH 2% GLASS		
Depth:	0		

PLASTIC LIMIT	Test No.	PL	OO		Average
Mass of wet soil + container (g)		42.02	45.41		43.715
Mass of dry soil + container (g)		39.04	41.75		40.395
Mass of container (g)		22.64	21.66		22.15
Mass of moisture (g)		2.98	3.7		3.32
Mass of dry soil (g)		16.4	20.09		18.245
Moisture content %		18.2	18.2		18.2
AVERAGE					

LIQUID LIMIT	Test No	1	2	3	4
Initial gauge reading (mm)		0	0	0	0
Final gauge reading (mm)		15.4	18.6	21.3	24.2
penetration (mm)		15.4	18.6	21.3	24.2
AVERAGE		15.4	18.6	21.3	24.2
Container No.		PI42	AX	PI33	PI45
Mass of wet soil + container (g)		63.78	51.06	44.34	56.96
Mass of dry soil + container (g)		51.41	41.11	35.76	45.12
Mass of container (g)		7.36	7.17	7.21	7.11
Mass of moisture (g)		12.37	9.95	8.58	11.84
Mass of dry soil (g)		44.05	33.94	28.55	38.01
Moisture content (%)		28.1	29.3	30.1	31.1
AVERAGE		28.1	29.3	30.1	31.1



Liquid limit (%)	29.7
Plastic limit (%)	18.2
Plasticity Index (%)	11.5
Linear shrinkage	
Trough No.	R
Trough length (cm)	14.0
Specimen length (cm)	13.1
L.shringage =	0.9
% L.shrinkage =	6.8

Remarks:

STIRLING CIVIL ENGINEERING LTD
TESTING LAB
1? ... 2025
Materials Engineer
P. O. BOX 796, KAMPALA (U)
Lab Technician

STUDENTS

INSTITUTION	STUDENTS NAMES	TESTING LAB
UGANDA CHRISTIAN UNIVERSITY	TIBYAZE VANESSA ELIZABETH & WANYENYA DINAH MARTHA	Stirling

PROJECT:	ASSESSING THE USE OF ACTIVATED GLASS POWDER FOR THE STABILISATION OF LATERITE SOILS FOR THE SUBBASE LAYER				
Test Reference No.	Lab. Reference No.		Date Sampled	Date Tested	Technician
LOCATION	NSAMBWE BORROWPIT		24/Feb/25	25/Feb/25	Lab team
Material description:	GRAVEL MIXED WITH 2% ACTIVATED GLASS		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	3	457	100	1,000

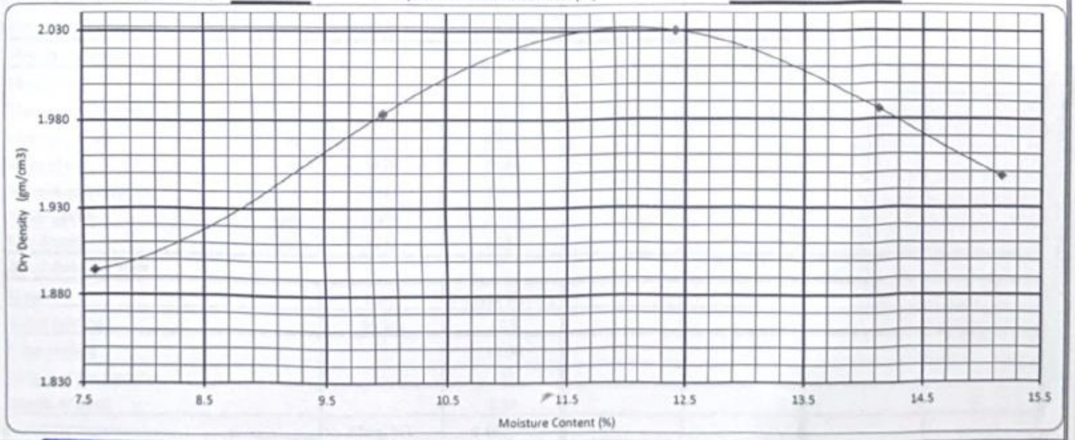
MOISTURE CONTENT DATA

Test No.		1	2	3	4	5
Tin No.		A	A	A	A	A
Water Added	cm^3	80	140	200	260	320
Mass of Compacted soil + mould	gm	5,251	5,394	5,495	5,479	5,456
Mass of Mould	gm	3,213	3,213	3,213	3,213	3,213
Mass of Compacted soil	gm	2038	2181	2282	2266	2243
Volume of mould	cm^3	1,000	1,000	1,000	1,000	1,000
Wet density of soil	g/cm^3	2.038	2.181	2.282	2.266	2.243

DATA FOR PROCTOR CURVE

Container No.		FDC	UCU	21	EVE	BA
Mass of wet soil + Container	gm	2,532.0	1,891.0	2,557.0	2,411.0	2,636.0
Mass of dry soil + container	gm	2,410.0	1,792.0	2,363.0	2,207.0	2,390.0
Mass of container	gm	804.0	800.0	800.0	763.0	768.0
Mass of water added	gm	122	99	194	204	246
Mass of dry soil	gm	1606	992	1563	1444	1622
Moisture content	%	7.6	10.0	12.4	14.1	15.2
Dry density	g/cm^3	1.894	1.983	2.030	1.986	1.948

Maximum dry density (gm/cm^3) 2.032 Optimum moisture content (%) 12.0



Remarks:

STIRLING CIVIL ENGINEERING LTD
FOR TESTING LAB
14 MAR 2025
P. O. BOX 738, KAMPALA (U)

Lab Technician

Materials Engineer

Institution	Students Names	Testing Lab
UGANDA CHRISTIAN UNIVERSITY	TIBYAZE VANESSA ELIZABETH & WANYENYA DINAH MARTHA	Stirling

ASSESSING THE USE OF ACTIVATED GLASS POWDER FOR THE STABILISATION OF LATERITE SOILS FOR THE SUBBASE LAYER

CALIFORNIA BEARING RATIO TEST (BS 1377 Part 4)

Test sample reference :	Laboratory Reference No.:	Sampling Date :	24/Feb/25
Location:	NSAMBWE BORROWPIT	Casting date :	6/Mar/25
		Testing Date :	13/Mar/25
		Technician :	Lab team
Sample Description:	GRAVEL MIXED WITH 2% GLASS	**Volume of Mould used (m^3)**	2305

Natural moisture of air dried sample			**Volume of water added**	
Tin No.	Y2Y		Mass of air dried soil (g)	6000
Tin + air dried soil sample (g)	2314		MDD (Mg/m^3)	2.032
Tin + oven dry soil sample (g)	2231		N.M.C (%)	5.9
Tin (g)	820		OMC (%)	12
Dry soil sample	1411		Added OMC (%)	6.1
Water (g)	83		Calculated dry wt of soil (g)	5647.1
N.M.C (%)	5.9		Water added (g)	347
Average (%)	5.9		**Water added (mL)**	347

Number of blows		62			
Number of layer		5			
Water Content Determination		Before Soaking		After Soaking	
Tare No		UMT	-	BA	-
Mass of wet sample + Tare	g	1630	-	1765	-
Mass of dry sample + Tare	g	1588	-	1689	-
Mass of Tare	g	800	-	768	-
Mass of water	g	42	-	76	-
Mass of dry sample	g	788	-	921	-
Water content	%	5.3	-	8.3	-
Average water Content	%	5.3		8.3	
Density determination					
Mould No		B			
Mass of mould + soil	g	12193		12353	
Mass of mould	g	6717		6717	
Mass of soil	g	5476		5636	
Volume of the mould	cm3	2305		2305	
Moist density	g/cm3	2.376		2.445	
Dry density	g/cm3	2.255		2.259	
Swell Determination					
Date		Hour		D.Gauge Reding	
Initial reading		96 hrs		10.5	
Final reading				11.08	
Height of the specimen				127	
Height of swell				0.58	
		Swelling(%)		**0.46**	

Observation

For the Lab

Lab Technician | Materials Engineer

STIRLING CIVIL ENGINEERING LTD
14 MAR 2025
P. O. BOX 796, KAMPALA (U)

Institution	Students Names	Testing Lab
UGANDA CHRISTIAN UNIVERSITY	TIBYAZE VANESSA ELIZABETH & WANYENYA DINAH MARTHA	Stirling

ASSESSING THE USE OF ACTIVATED GLASS POWDER FOR THE STABILISATION OF LATERITE SOILS FOR THE SUBBASE LAYER

CALIFORNIA BEARING RATIO TEST (BS1377 Part 4)

Test sample reference :	Laboratory Reference No.:	Sampling Date	24/Feb/25
Location:		Penetration Date	13/Mar/25
Depth :		Technician	: : Lab team
Sample Description :	GRAVEL MIXED WITH 2% GLASS		

Number of blows per layer	62		
Number of layers	5	5	5
Mould No	B		
Capacity of the Proving Ring (KN)	50	50	50
Proving Ring Constant (KN/div.)	0.2312	0.2312	0.2312

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	4	0.9	3	0.7
0.5	24	7	1.6	4	0.9
0.75	35	9	2.1	5	1.2
1	47	12	2.8	6	1.4
1.5	71	16	3.7	7	1.6
2	94	19	4.4	9	2.1
2.5	118	23	5.3	12	2.8
3	142	26	6.0	13	3.0
3.5	165	29	6.7	15	3.5
4	189	31	7.2	17	3.9
4.5	213	33	7.6	19	4.4
5	236	36	8.3	21	4.9
5.5	260	38	8.8	23	5.3
6	283	39	9.0	25	5.8
6.5	307	41	9.5	27	6.2
7	331	43	9.9	29	6.7
7.5	354	45	10.4	31	7.2

Observations

STIRLING CIVIL ENGINEERING LTD For the Contractor

14 MAR 2025

Lab Technician | Materials Engineer

P. O. BOX 796, KAMPALA (U)

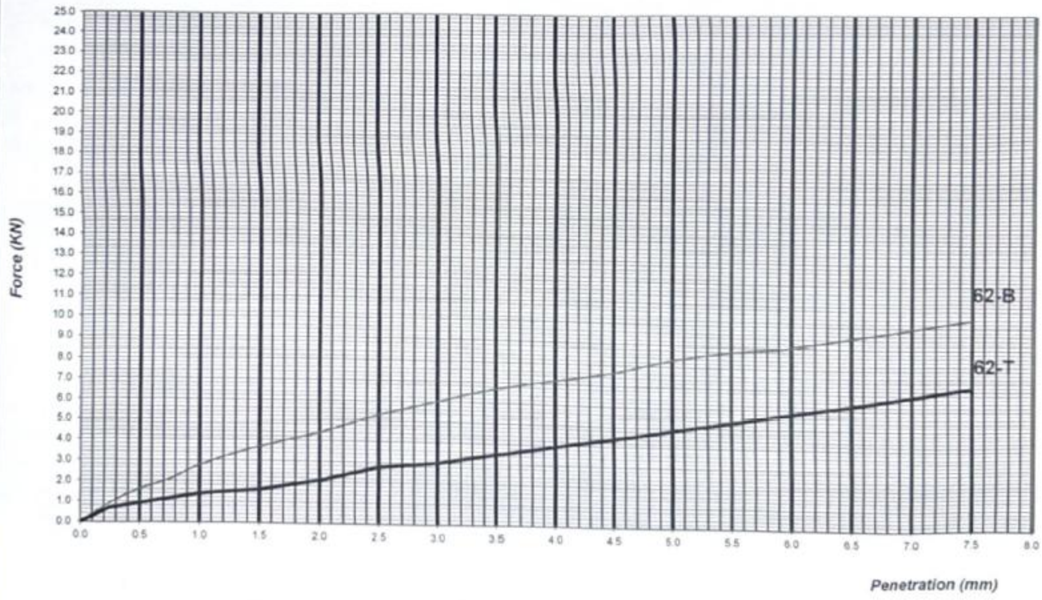
Institution	Students Names	Testing Lab
UGANDA CHRISTIAN UNIVERSITY	TIBYAZE VANESSA ELIZABETH & WANYENYA DINAH MARTHA	Stirling

ASSESSING THE USE OF ACTIVATED GLASS POWDER FOR THE STABILISATION OF LATERITE SOILS FOR THE SUBBASE LAYER

CALIFORNIA BEARING RATIO TEST (BS1377 Part 4)

Test sample reference :	Laboratory Reference No.:	Sampling Date :	24/Feb/25
Location:		Testing Date :	13/Mar/25
Depth:		Technician	: Lab team
Sample Description:	GRAVEL MIXED WITH 2% GLASS		

PENETRATION vs FORCE CURVE



	62 blows			
	Force		CBR	
	Bottom	Top	Bottom	Top
2.5 mm Penetration	2.8	5.3	21	40
5.0 mm Penetration	4.9	8.3	24	42
Average	3.8	6.8	22.6	40.9
Retained CBR	40.9			
Observations	CBR= 40.9			

STIRLING CIVIL ENGINEERING LTD

Lab Technician 4 MAR 2025 Materials Engineer

P. O. BOX 796, KAMPALA (U)

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INSTITUTION	STUDENTS NAMES	TESTING LAB
UGANDA CHRISTIAN UNIVERSITY	TIBYAZE VANESSA ELIZABETH & WANYENYA DINAH MARTHA	Stirling
PROJECT	ASSESSING THE USE OF ACTIVATED GLASS POWDER FOR THE STABILISATION OF LATERITE SOILS FOR THE SUBBASE LAYER	
STABLISED CBR (BS 1924 PART 2 1)		Load applied 140kpa/s

GRAVEL MIXED WITH 2% ACTIVATED GLASS

M/c of air dried sample			
Tin No.		Y2Y	
Tin + Wet soil	gm	2,314.0	
Tin + Dry Soil	gm	2,231.0	
Tin	gm	820.0	
Water	gm	83.0	
Dry Soil	gm	1,411.0	
M/c	%	5.9	
Av. M/c	%	5.9	

M/c After Mixing			
Stabliser	ACTIVATED GLASS		
Content	2.0		
Tin No.	ZION		
Tin + Wet Soil	1,305.0		
Tin + Dry Soil	1,232.0		
Tin	441.0		
Water	73.0		
Dry Soil	791.0		
M/c	9.2		

(a)MDD	2.032	kg/m3	(b)Air Dry M/c	5.9	%
(c)WD	2.438	kg/m3	(e)M/c to add	6.1	%
(d)OMC	12.0	%	(F) volume	2.305	

Date prepared 1/Mar/25 Date immerse 8/Mar/25 Date tested 15/Mar/25

Mould No.	A	B	C
Factor(f)	2.305	2.305	2.305
(h)Wet Soil to fill mould c x f x %comp	5,620.5	5,620.5	5,620.5
(j) Wt of air dried soil	6,000	6,000	6,000
Air dry M/c	5.9	0.0	0.0
(k) soil dry wt (100j/100+b)	5,666.7	6,000.0	6,000.0
Stabliser	ACTIVATED GLASS		
(m)Stablisers content %	2.0		
(n) Stabliser to add k x(m/100)	113.3		
Water Addition((j+n)x(d-b))/(100+b)	353.2		
Wt. per layer CBR Only h/3	1,873.5		

SPECIMEN WEIGHT CHECK				
No. of blows	62.0	62.0	AVERAGE	AVERAGE
Mould No.	7 DAYS AIR TIGHT, 7 DAYS SOAKED	7 DAYS AIR TIGHT, 7 DAYS SOAKED	7DAYS AIR TIGHT, 7 DAYS SOAKED	7DAYS AIR TIGHT, 7 DAYS SOAKED
Stabliser	ACTIVATED GLASS	ACTIVATED GLASS		
Content %	2.0	2.0	2.0	
Mould g	A	B	C	
Wet Soil g	5,315.0	5,510.0	5,485.0	
Compaction M/c %	9.2	9.2	9.2	
Dry density kg/m3	2.111	2.188	2.179	
%Compaction	103.9	107.7	107.2	
FORCE	3.9	3.9	4.2	
UCS	0.216	0.216	0.228	0.22

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

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INSTITUTION	STUDENTS	TESTING LAB
UGANDA CHRISTIAN UNIVERSITY A Centre of Excellence in the Heart of Africa	VANESSA AND DINAH	Stirling

PROJECT: ASSESSING THE USE OF ACTIVATED GLASS POWDER FOR THE STABILISATION OF LATERITE SOILS FOR THE SUBBASE LAYER

SUMMARY OF TEST RESULTS FOR GRAVEL MIXED WITH 4% GLASS ACTIVATED

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	62 BLOWS OF COMPACTION	62	AVERAGE
GRAVEL MIXED WITH 4% GLASS ACTIVATED	GRAVEL MIXED WITH 4% GLASS ACTIVATED	20/01/2025	100	100	90	59	45	32	23	2.00	27.7	19.0	8.7	4.3	2.024	10.8	59.5	0.51	0.51
			100	95	79	56	42	26	14	2.18	27.7	18.8	8.9	4.3	-	-	-	-	
			100	97.47	84.5	57.5	43.59	28.87	18.69	2.09	27.7	18.9	8.8	4.3	2.024	10.8	60	0.51	0.51
	AVERAGE		100	97	84	58	44	29	19	2.088	27.7	18.8	8.8	4.3	2.024	10.8	60	0.51	0.51

STIRLING CIVIL ENGINEERING LTD
Lab Technician 14 MAR 2025 Materials Engineer
P. O. BOX 796, KAMPALA (U)

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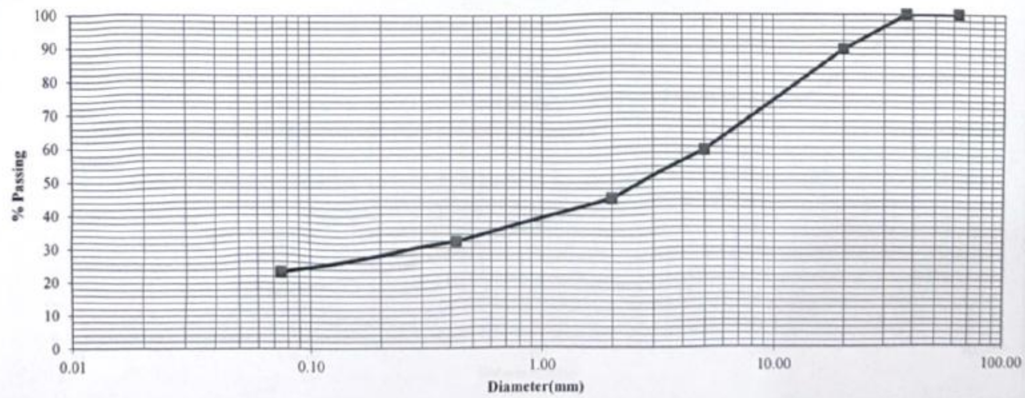
INSTITUTION	STUDENTS NAMES	CONTRACTOR
UGANDA CHRISTIAN UNIVERSITY A Centre of Excellence in the Heart of Africa	VANESSA AND DINAH	Stirling

PROJECT : ASSESSING THE USE OF ACTIVATED GLASS POWDER FOR THE STABILISATION OF LATERITE SOILS FOR THE SUBBASE LAYER

PARTICLE SIZE DISTRIBUTION (BS 1377 - 2 - 90)

Test Reference No.:		Lab. Refernece No.:		
Location :(km)	NSAMBWE BORROWPIT	Dry wt. of sample before washing: (g)		3118.1
Depth: (m)		Dry wt. of sample after washing: (g)		2396.6
Material description:	GRAVEL MIXED WITH 4% GLASS ACTIVATED	Date Sampled:	Date Tested:	Technician
		24/Feb/2025	25/Feb/2025	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	325.3	10.4	**90**	60	95
5.0	948.3	30.4	**59**	30	65
2.00	434.3	13.9	**45**	20	50
0.425	413.8	13.3	**32**	10	30
0.075	271.9	8.7	**23**	5	15
Total fines	724.5	23.2			
Bottom Pan	3.0				
Extracted fines	721.5				
Total sample	3118.1				
Grading Modulus		**2.00**			



FOR TESTING LAB
STIRLING CIVIL ENGINEERING LTD
Lab Technician Materials Engineer
14 MAR 2025
P. O. BOX 796, KAMPALA (U)

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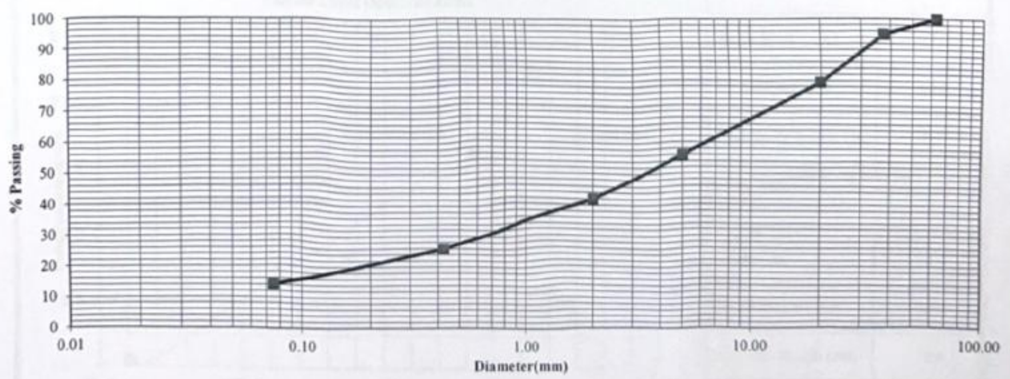
INSTITUTION	STUDENTS NAMES	CONTRACTOR
UGANDA CHRISTIAN UNIVERSITY A Centre of Excellence in the Heart of Africa	VANESSA AND DINAH	Stirling

PROJECT : ASSESSING THE USE OF ACTIVATED GLASS POWDER FOR THE STABILISATION OF LATERITE SOILS FOR THE SUBBASE LAYER

PARTICLE SIZE DISTRIBUTION (BS 1377 - 2 - 90)

Test Reference No.:		Lab. Refernece No.:		
Location :(km)	NSAMBWE BORROWPIT	Dry wt. of sample before washing: (g)		2854.8
Depth: (m)		Dry wt. of sample after washing: (g)		2455.3
Material description:	GRAVEL MIXED WITH 4% GLASS ACTIVATED	Date Sampled:	Date Tested:	Technician
		24/Feb/2025	25/Feb/2025	Lab team

Sieve Size (mm)	Weight Retained (g)	Retained (%)	Passing (%)	Grading Limits (G60 & 80)	
63.0	0.0	0	**100**	100	100
37.5	144.2	5.1	**95**	80	100
20.0	443.0	15.5	**79**	60	95
5.0	673.2	23.6	**56**	30	65
2.00	396.5	13.9	**42**	20	50
0.425	461.7	16.2	**26**	10	30
0.075	332.6	11.7	**14**	5	15
Total fines	403.6	14.1			
Bottom Pan	4.1				
Extracted fines	399.5				
Total sample	2854.8				
Grading Modulus		**2.18**			



FOR TESTING LAB

STIRLING CIVIL ENGINEERING LTD

Lab Technician Materials Engineer

14 MAR 2025

P. O. BOX 798, KAMPALA (U)

INSTITUTION	STUDENTS	TESTING LAB
UGANDA CHRISTIAN UNIVERSITY	VANESSA AND DINAH	Stirling

PROJECT:	ASSESSING THE USE OF ACTIVATED GLASS POWDER FOR THE STABILISATION OF LATERITE SOILS FOR THE SUBBASE LAYER

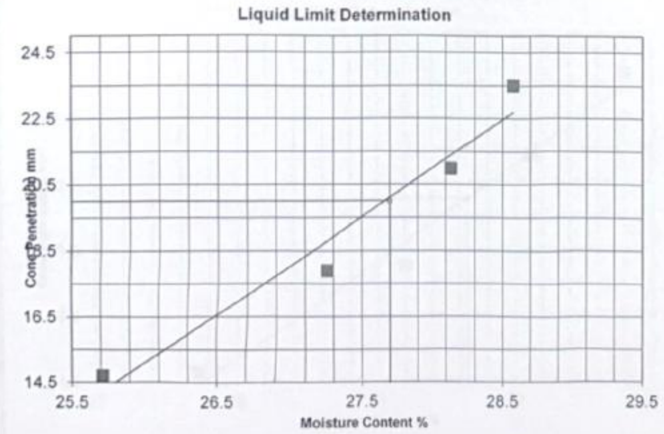
ATTERBERG LIMITS

Liquid limit (cone penotrometer) and plastic limit

Material description:		GRAVEL MIXED WITH 4% GLASS ACT	Technician:		Lab Team
mix		NSAMBWE BORROWPIT	Sample Date		12/Jan/2025
Test method	BS 1377: Part 2, 1990:4.3/4.4		Test Date		28/Jan/2025
LAYER	GRAVEL MIXED WITH 4% GLASS ACTIVATED				
Depth:					

PLASTIC LIMIT	Test No.	I3	44		Average
Mass of wet soil + container (g)		40.14	39.08		39.61
Mass of dry soil + container (g)		37.31	36.25		36.78
Mass of container (g)		22.48	21.28		21.88
Mass of moisture (g)		2.83	2.8		2.83
Mass of dry soil (g)		14.83	14.97		14.9
Moisture content %		19.1	18.9		19.0
AVERAGE					

LIQUID LIMIT	Test No	1	2	3	4
Initial gauge reading (mm)		0	0	0	0
Final gauge reading (mm)		14.7	17.9	21	23.5
penetration (mm)		14.7	17.9	21.0	23.5
AVERAGE		14.7	17.9	21.0	23.5
Container No.		FORD	A5	PII9	BE
Mass of wet soil + container (g)		64.83	41.79	51.38	52.58
Mass of dry soil + container (g)		53.01	34.33	41.65	42.45
Mass of container (g)		7.04	6.96	7.07	7.00
Mass of moisture (g)		11.82	7.46	9.73	10.13
Mass of dry soil (g)		45.97	27.37	34.58	35.45
Moisture content (%)		25.7	27.3	28.1	28.6
AVERAGE		25.7	27.3	28.1	28.6



Liquid limit (%)	27.7
Plastic limit (%)	19.0
Plasticity Index (%)	8.7
Linear shrinkage	
Trough No.	I
Trough length (cm)	14.0
Specimen length (cm)	13.4
L.shringage =	0.6
% L.shrinkage =	4.3

Remarks:

TESTING LAB	STUDENTS
STIRLING CIVIL ENGINEERING LTD Materials Engineer 14 MAR 2025 Lab Technician P. O. BOX 796, KAMPALA (U)	

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INSTITUTION	STUDENTS	TESTING LAB
UGANDA CHRISTIAN UNIVERSITY A Centre of Excellence in the Heart of Africa	VANESSA AND DINAH	Stirling

PROJECT:	ASSESSING THE USE OF ACTIVATED GLASS POWDER FOR THE STABILISATION OF LATERITE SOILS FOR THE SUBBASE LAYER

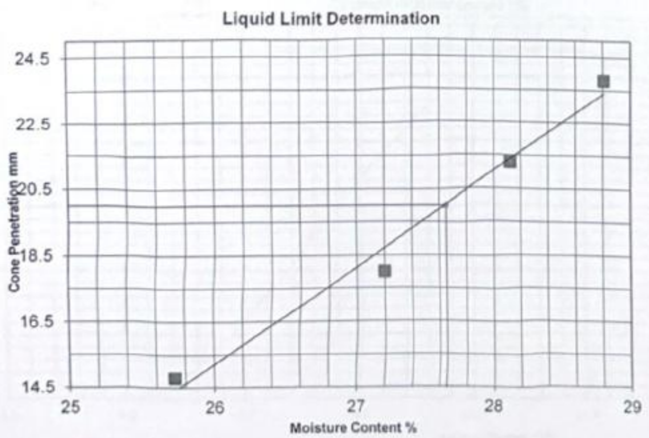
ATTERBERG LIMITS

Liquid limit (cone penotrometer) and plastic limit

Material description:	GRAVEL MIXED WITH 4% GLASS ACT	Technician:	Lab Team
mix	NSAMBWE BORROWPIT	Sample Date	12/Jan/2025
Test method	BS 1377: Part 2, 1990:4.3/4.4	Test Date	28/Jan/2025
LAYER	GRAVEL MIXED WITH 4% GLASS ACTIVATED		
Depth:	0		

PLASTIC LIMIT	Test No.	JL	RAD		Average
Mass of wet soil + container (g)		40.25	36.52		38.385
Mass of dry soil + container (g)		37.44	34.23		35.835
Mass of container (g)		22.55	21.95		22.25
Mass of moisture (g)		2.81	2.3		2.55
Mass of dry soil (g)		14.89	12.28		13.585
Moisture content %		18.9	18.6		18.8
AVERAGE					

LIQUID LIMIT	Test No	1	2	3	4
Initial gauge reading (mm)		0	0	0	0
Final gauge reading (mm)		14.8	18	21.3	23.8
penetration (mm)		14.8	18.0	21.3	23.8
AVERAGE		14.8	18.0	21.3	23.8
Container No.		PIBO	PI20	PI38	PA
Mass of wet soil + container (g)		57.06	50.23	53.48	56.36
Mass of dry soil + container (g)		46.86	41.98	43.32	45.29
Mass of container (g)		7.21	11.65	7.19	6.86
Mass of moisture (g)		10.2	8.25	10.16	11.07
Mass of dry soil (g)		39.65	30.33	36.13	38.43
Moisture content (%)		25.7	27.2	28.1	28.8
AVERAGE		25.7	27.2	28.1	28.8



Liquid limit (%)	27.7
Plastic limit (%)	18.8
Plasticity Index (%)	8.9
Linear shrinkage	
Trough No.	I
Trough length (cm)	14.0
Specimen length (cm)	13.4
L.shringage =	0.6
% L.shrinkage =	4.3

Remarks:

TESTING LAB	STUDENTS
Materials Engineer	
Lab Technician	

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INSTITUTION	STUDENTS NAMES	TESTING LAB
UGANDA CHRISTIAN UNIVERSITY	TIBYAZE VANESSA ELIZABETH & WANYENYA DINAH MARTHA	Stirling

PROJECT:	ASSESSING THE USE OF ACTIVATED GLASS POWDER FOR THE STABILISATION OF LATERITE SOILS FOR THE SUBBASE LAYER			
Test Reference No.	Lab. Reference No.	Date Sampled	Date Tested	Technician
LOCATION	NSAMBWE BORROWPIT	24/Feb/25	25/Feb/25	Lab team
Material description:	GRAVEL MIXED WITH 4% GLASS ACTIVATED	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 (cm³)
4.5	27	3	457	100	1,000

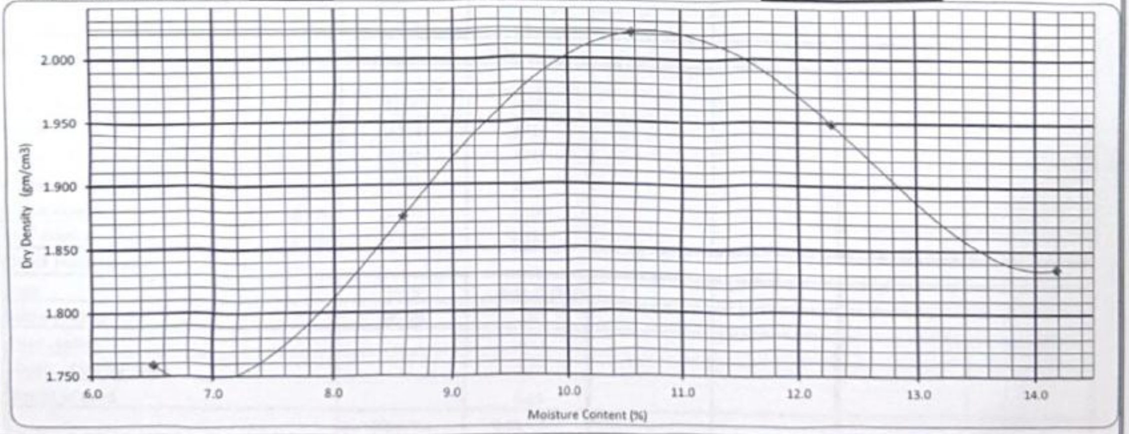
MOISTURE CONTENT DATA

Test No.		1	2	3	4	5
Tin No.		A	A	A	A	A
Water Added	cm³	50	110	170	230	290
Mass of Compacted soil + mould	gm	5,086	5,249	5,448	5,401	5,309
Mass of Mould	gm	3,213	3,213	3,213	3,213	3,213
Mass of Compacted soil	gm	1873	2036	2235	2188	2096
Volume of mould	cm³	1,000	1,000	1,000	1,000	1,000
Wet density of soil	g/cm³	1.873	2.036	2.235	2.188	2.096

DATA FOR PROCTOR CURVE

Container No.		KT	ACB	UMT	Z6T	BAR
Mass of wet soil + Container	gm	1,854.0	2,500.0	2,378.0	2,588.0	2,532.0
Mass of dry soil + container	gm	1,789.0	2,364.0	2,227.0	2,393.0	2,317.0
Mass of container	gm	791.0	779.0	798.0	806.0	801.0
Mass of water added	gm	65	136	151	195	215
Mass of dry soil	gm	998	1585	1429	1587	1516
Moisture content	%	6.5	8.6	10.6	12.3	14.2
Dry density	g/cm³	1.758	1.875	2.021	1.949	1.836

Maximum dry density (gm/cm³) 2.024 Optimum moisture content (%) 10.8



Remarks:

STIRLING CIVIL ENGINEERING LTD
FOR TESTING LAB
14 MAR 2025
Lab Technician
Materials Engineer
P. O. BOX 796, KAMPALA (U)

Institution	Students Names	Testing Lab
UGANDA CHRISTIAN UNIVERSITY	TIBYAZE VANESSA ELIZABETH & WANYENYA DINAH MARTHA	Stirling

ASSESSING THE USE OF ACTIVATED GLASS POWDER FOR THE STABILISATION OF LATERITE SOILS FOR THE SUBBASE LAYER

CALIFORNIA BEARING RATIO TEST (BS 1377 Part 4)

Test sample reference :	Laboratory Reference No.:	Sampling Date :	24/Feb/25
Location:	NSAMBWE BORROWPIT	Casting date :	6/Mar/25
		Testing Date :	13/Mar/25
Sample Description:	GRAVEL MIXED WITH 4% GLASS ACTIVATED	Technician :	Lab team
		Volume of Mould used (m^3)	**2305**

Natural moisture of air dried sample			Volume of water added	
Tin No.	BBC		Mass of air dried soil (g)	6000
Tin + air dried soil sample (g)	2668		MDD (Mg/m^3)	2.024
Tin + oven dry soil sample (g)	2575		N.M.C (%)	5.3
Tin (g)	812		OMC (%)	10.8
Dry soil sample	1763		Added OMC (%)	5.5
Water (g)	93		Calculated dry wt of soil (g)	5683.5
N.M.C (%)	5.3		Water added (g)	315
Average (%)	5.3		**Water added (mL)**	**315**

Number of blows		62			
Number of layer		5			
Water Content Determination		Before Soaking		After Soaking	
Tare No		KT	-	BAX	-
Mass of wet sample + Tare	g	1630	-	2158	-
Mass of dry sample + Tare	g	1550	-	2005	-
Mass of Tare	g	798	-	801	-
Mass of water	g	80	-	153	-
Mass of dry sample	g	752	-	1204	-
Water content	%	10.6	-	12.7	-
Average water Content	%	10.6		12.7	
Density determination					
Mould No		II			
Mass of mould + soil	g	12147		12259	
Mass of mould	g	6714		6714	
Mass of soil	g	5433		5545	
Volume of the mould	cm3	2305		2305	
Moist density	g/cm3	2.357		2.406	
Dry density	g/cm3	2.130		2.135	
Swell Determination					
Date		Hour		D.Gauge Reding	
Initial reading		96 hrs		10	
Final reading				10.65	
Height of the specimen				127	
Height of swell				0.65	
		Swelling(%)		**0.51**	

STIRLING CIVIL ENGINEERING LTD

For the Lab

14 MAR 2025

Lab Technician | Materials Engineer

P.O. BOX 790, KAMPALA (U)

Institution	Students Names	Testing Lab
UGANDA CHRISTIAN UNIVERSITY	TIBYAZE VANESSA ELIZABETH & WANYENYA DINAH MARTHA	Stirling

ASSESSING THE USE OF ACTIVATED GLASS POWDER FOR THE STABILISATION OF LATERITE SOILS FOR THE SUBBASE LAYER

CALIFORNIA BEARING RATIO TEST (BS1377 Part 4)

Test sample reference :	Laboratory Reference No.:	Sampling Date	24/Feb/25
Location:		Penetration Date	13/Mar/25
Depth :		Technician	Lab team
Sample Description :	GRAVEL MIXED WITH 4% GLASS ACTIVATED		

Number of blows per layer	62		
Number of layers	5	5	5
Mould No	II		
Capacity of the Proving Ring (KN)	50	50	50
Proving Ring Constant (KN/div.)	0.2312	0.2312	0.2312

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	3	0.7
0.5	24	4	0.9	7	1.6
0.75	35	7	1.6	10	2.3
1	47	9	2.1	13	3.0
1.5	71	11	2.5	19	4.4
2	94	13	3.0	30	6.9
2.5	118	16	3.7	35	8.1
3	142	18	4.2	39	9.0
3.5	165	21	4.9	42	9.7
4	189	23	5.3	45	10.4
4.5	213	25	5.8	48	11.1
5	236	27	6.2	50	11.6
5.5	260	28	6.5	52	12.0
6	283	29	6.7	54	12.5
6.5	307	31	7.2	56	12.9
7	331	33	7.6	58	13.4
7.5	354	35	8.1	60	13.9

Observations

Lab. Technician | *Material Engineer*

STIRLING CIVIL ENGINEERING LTD
14 MAR 2025
P. O. BOX 796, KAMPALA (U)

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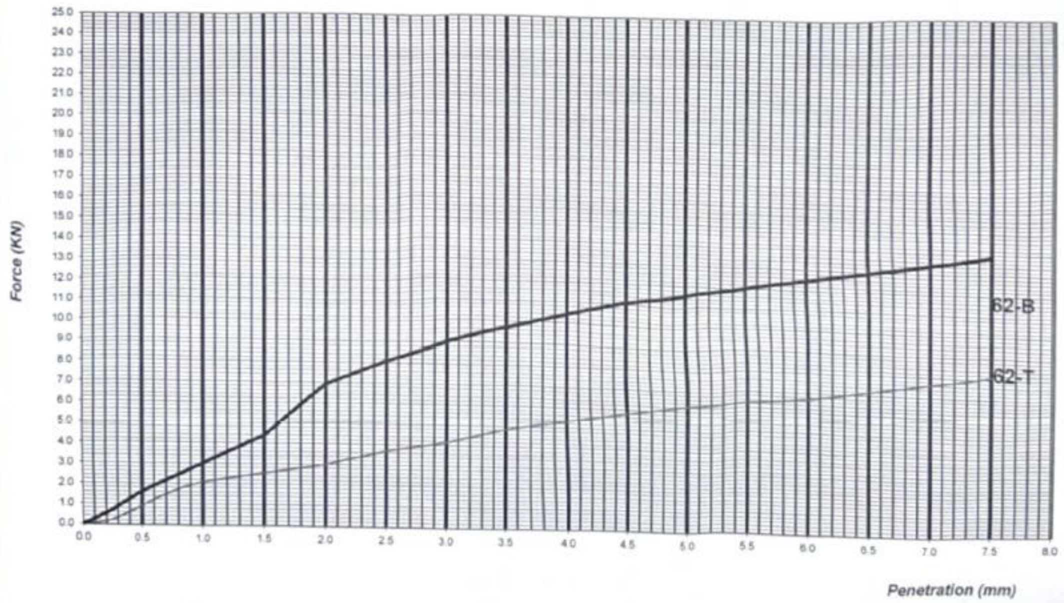
Institution	Students Names	Testing Lab
UGANDA CHRISTIAN UNIVERSITY A Centre of Excellence in the Heart of Africa	TIBYAZE VANESSA ELIZABETH & WANYENYA DINAH MARTHA	Stirling

ASSESSING THE USE OF ACTIVATED GLASS POWDER FOR THE STABILISATION OF LATERITE SOILS FOR THE SUBBASE LAYER

CALIFORNIA BEARING RATIO TEST (BS1377 Part 4)

Test sample reference :	Laboratory Reference No.:	Sampling Date :	24/Feb/25
Location:		Testing Date :	13/Mar/25
Depth:		Technician	: Lab team
Sample Description:	GRAVEL MIXED WITH 4% GLASS ACTIVATED		



	62 blows											
	Force		CBR									
	Bottom	Top	Bottom	Top								
2.5 mm Penetration	8.1	3.7	61	28								
5.0 mm Penetration	11.6	6.2	58	31								
Average	9.8	5.0	59.5	29.6								
Retained CBR	59.5											
Observations	CBR= 59.5											

For the Lab

Lab. Technician | Materials Engineer

STIRLING CIVIL ENGINEERING LTD
14 MAR 2025
P. O. BOX 796, KAMPALA (U)

INSTITUTION	STUDENTS NAMES	TESTING LAB
UGANDA CHRISTIAN UNIVERSITY	TIBYAZE VANESSA ELIZABETH & WANYENYA DINAH MARTHA	Stirling
PROJECT	ASSESSING THE USE OF ACTIVATED GLASS POWDER FOR THE STABILISATION OF LATERITE SOILS FOR THE SUBBASE LAYER	

STABLISED CBR (BS 1924 PART 2 1) — Load applied 140kpa/s

GRAVEL MIXED WITH 4% ACTIVATED GLASS

M/c of air dried sample			
Tin No.		BBC	
Tin + Wet soil	gm	2,668.0	
Tin + Dry Soil	gm	2,575.0	
Tin	gm	812.0	
Water	gm	93.0	
Dry Soil	gm	1,763.0	
M/c	%	5.3	
Av. M/c	%	5.3	

M/c After Mixing			
Stabliser	ACTIVATED GLASS		
Content	4.0		
Tin No.	ZION		
Tin + Wet Soil	1,305.0		
Tin + Dry Soil	1,232.0		
Tin	441.0		
Water	73.0		
Dry Soil	791.0		
M/c	9.2		

(a)MDD	2.024	kg/m3	(b)Air Dry M/c	5.3	%
(c)WD	2.185	kg/m3	(e)M/c to add	5.5	%
(d)OMC	10.8	%	(F) volume	2.305	

Date prepared 1/Mar/25 Date immerse 8/Mar/25 Date tested 15/Mar/25

Mould No.	A	B	C
Factor(f)	2.305	2.305	2.305
(h)Wet Soil to fill mould c x f x %comp	5,037.3	5,037.3	5,037.3
(j) Wt of air dried soil	6,000	6,000	6,000
Air dry M/c	5.3	0.0	0.0
(k) soil dry wt (100j/100+b)	5,699.4	6,000.0	6,000.0
Stabliser	ACTIVATED GLASS		
(m)Stablisers content %	4.0		
(n) Stabliser to add k x(m/100)	228.0		
Water Addition((j+n)x(d-b))/(100+b)	326.8		
Wt. per layer CBR Only h/3	1,679.1		

SPECIMEN WEIGHT CHECK				
No. of blows	62.0	62.0	AVERAGE	AVERAGE
Mould No.	7 DAYS AIR TIGHT, 7 DAYS SOAKED	7 DAYS AIR TIGHT, 7 DAYS SOAKED	7DAYS AIR TIGHT, 7 DAYS SOAKED	7DAYS AIR TIGHT, 7 DAYS SOAKED
Stabliser	ACTIVATED GLASS	ACTIVATED GLASS		
Content %	4.0	4.0	4.0	
Mould g	A	B	C	
Wet Soil g	5,530.0	5,525.0	5,795.0	
Compaction M/c %	9.2	9.2	9.2	
Dry density kg/m3	2.196	2.194	2.302	
%Compaction	108.5	108.4	113.7	
FORCE	7.9	7.4	7.2	
UCS	0.431	0.406	0.393	0.41

STIRLING CIVIL ENGINEERING LTD
P. O. BOX 736, KAMPALA (U)

INSTITUTION	STUDENTS	TESTING LAB
UGANDA CHRISTIAN UNIVERSITY A Centre of Excellence in the Heart of Africa	TIBYAZE VANESSA ELIZABETH & WANYENYA DINAH MARTHA	Stirling

PROJECT: ASSESSING THE USE OF ACTIVATED GLASS POWDER FOR THE STABILISATION OF LATERITE SOILS FOR THE SUBBASE LAYER

SUMMARY OF TEST RESULTS FOR GRAVEL MIXED WITH 6% GLASS ACTIVATED

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	62 BLOWS OF COMPACTION	62	AVERAGE
GRAVEL MIXED WITH 6% GLASS ACTIVATED	GRAVEL MIXED WITH 6% GLASS ACTIVATED	20/01/2025	100	95	87	55	42	30	20	2.08	29.85	21.1	8.7	4.6	2.089	9.8	99.6	0.36	0.36
			100	100	98	70	55	38	25	1.82	29.8	21.3	8.5	4.6	-	-	-	-	
			100	97.41	92.53	62.41	48.76	33.93	22.7	1.95	29.8	21.2	8.6	4.6	2.089	9.8	100	0.36	0.36
	AVERAGE		100	97	93	62	49	34	23	1.946	29.8	21.3	8.6	4.6	2.089	9.8	100	0.36	0.36

FOR LAB
STIRLING CIVIL ENGINEERING LTD
Lab Technician 14 Mar 2025 Materials Engineer
P. O. BOX 796, KAMPALA (U)

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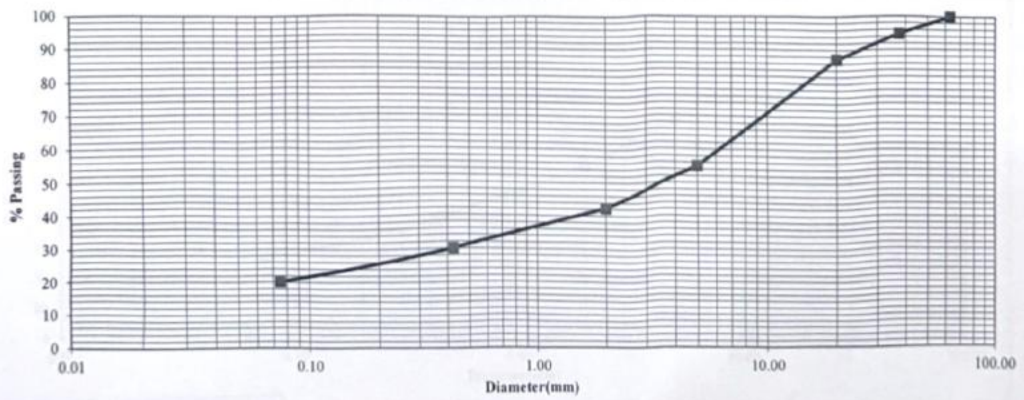
INSTITUTION	STUDENTS NAMES	CONTRACTOR
UGANDA CHRISTIAN UNIVERSITY A Centre of Excellence in the Heart of Africa	TIBYAZE VANESSA ELIZABETH & WANYENYA DINAH MARTHA	Stirling

PROJECT : ASSESSING THE USE OF ACTIVATED GLASS POWDER FOR THE STABILISATION OF LATERITE SOILS FOR THE SUBBASE LAYER

PARTICLE SIZE DISTRIBUTION (BS 1377 - 2 - 90)

Test Reference No.:		Lab. Refernece No.:		
Location :(km)	NSAMBWE BORROWPIT	Dry wt. of sample before washing: (g)		3277.8
Depth: (m)		Dry wt. of sample after washing: (g)		2625.0
Material description:	GRAVEL MIXED WITH 6% GLASS ACTIVATED	Date Sampled:	Date Tested:	Technician
		24/Feb/2025	25/Feb/2025	Lab team

Sieve Size (mm)	Weight Retained (g)	Retained (%)	Passing (%)	Grading Limits (G60 & 80)	
63.0	0.0	0	**100**	100	100
37.5	169.6	5.2	**95**	80	100
20.0	247.8	7.6	**87**	60	95
5.0	1057.4	32.3	**55**	30	65
2.00	415.5	12.7	**42**	20	50
0.425	405.1	12.4	**30**	10	30
0.075	322.0	9.8	**20**	5	15
Total fines	660.4	20.1			
Bottom Pan	7.6				
Extracted fines	652.8				
Total sample	3277.8				
Grading Modulus		**2.08**			



EOT TESTING LAB / ... CIVIL ENGINEERING LTD

Lab Technician   Materials Engineer

P. O. BOX 798, KAMPALA (U)

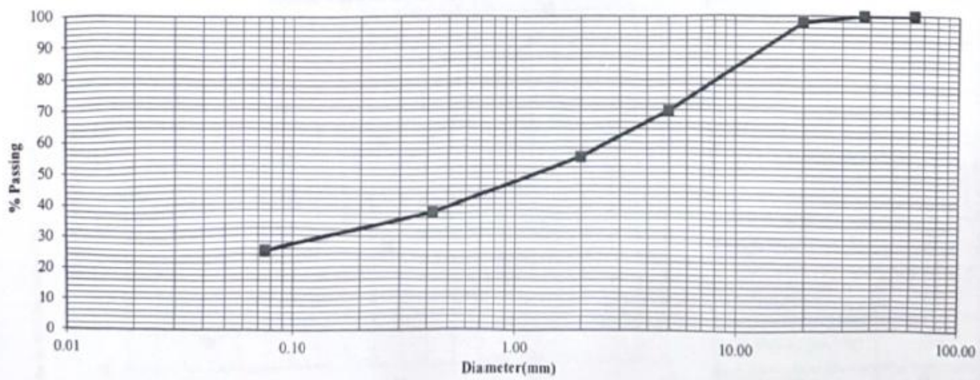
INSTITUTION	STUDENTS NAMES	CONTRACTOR
UGANDA CHRISTIAN UNIVERSITY A Centre of Excellence in the Heart of Africa	TIBYAZE VANESSA ELIZABETH & WANYENYA DINAH MARTHA	Stirling

PROJECT : ASSESSING THE USE OF ACTIVATED GLASS POWDER FOR THE STABILISATION OF LATERITE SOILS FOR THE SUBBASE LAYER

PARTICLE SIZE DISTRIBUTION (BS 1377 - 2 - 90)

Test Reference No.:		Lab. Refernece No.:		
Location :(km)	NSAMBWE BORROWPIT	Dry wt. of sample before washing: (g)		3199.5
Depth: (m)		Dry wt. of sample after washing: (g)		2395.8
Material description:	GRAVEL MIXED WITH 6% GLASS ACTIVATED	Date Sampled:	Date Tested:	Technician
		24/Feb/2025	25/Feb/2025	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	70.3	2.2	**98**	60	95
5.0	895.5	28.0	**70**	30	65
2.00	468.2	14.6	**55**	20	50
0.425	553.2	17.3	**38**	10	30
0.075	404.1	12.6	**25**	5	15
Total fines	808.3	25.3			
Bottom Pan	4.5				
Extracted fines	803.8				
Total sample	3199.5				
Grading Modulus		**1.82**			



STIRLING CIVIL ENGINEERING

FOR TESTING LAB

14 MAR 2025

Lab Technician

Materials Engineer

P. O. BOX 796, KAMPALA (U)

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INSTITUTION	STUDENTS	TESTING LAB
UGANDA CHRISTIAN UNIVERSITY	VANESSA AND DINAH	Stirling

PROJECT:	ASSESSING THE USE OF ACTIVATED GLASS POWDER FOR THE STABILISATION OF LATERITE SOILS FOR THE SUBBASE LAYER

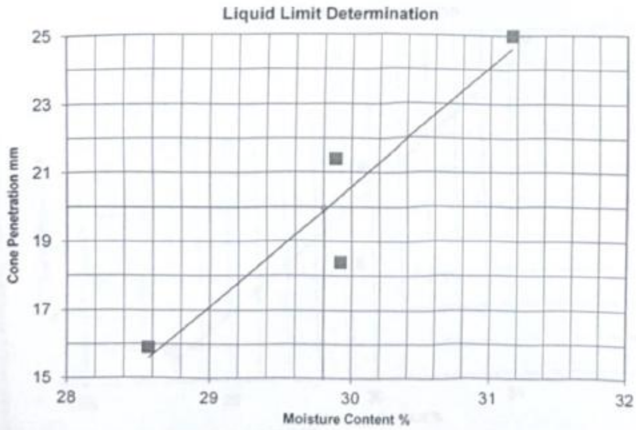
ATTERBERG LIMITS

Liquid limit (cone penotrometer) and plastic limit

Material description:	GRAVEL MIXED WITH 6% GLASS ACT	Technician:	Lab Team
mix	NSAMBWE BORROWPIT	Sample Date	24/Feb/2025
Test method	BS 1377: Part 2, 1990:4.3/4.4	Test Date	28/Feb/2025
LAYER	GRAVEL MIXED WITH 6% GLASS ACTIVATED		
Depth:	0		

PLASTIC LIMIT	Test No.	DJ	OG		Average
Mass of wet soil + container (g)		45.56	38.7		42.13
Mass of dry soil + container (g)		41.53	35.68		38.605
Mass of container (g)		22.76	21.39		22.075
Mass of moisture (g)		4.03	3.0		3.525
Mass of dry soil (g)		18.77	14.29		16.53
Moisture content %		21.5	21.1		21.3
AVERAGE					

LIQUID LIMIT	Test No	1	2	3	4
Initial gauge reading (mm)		0	0	0	0
Final gauge reading (mm)		15.9	18.4	21.4	25.0
penetration (mm)		15.9	18.4	21.4	25.0
AVERAGE		15.9	18.4	21.4	25.0
Container No.		A4	PI8II	FOO	A
Mass of wet soil + container (g)		54.51	49.52	51.57	57.04
Mass of dry soil + container (g)		43.95	39.79	41.31	45.22
Mass of container (g)		6.99	7.27	6.98	7.28
Mass of moisture (g)		10.56	9.73	10.26	11.82
Mass of dry soil (g)		36.96	32.52	34.33	37.94
Moisture content (%)		28.6	29.9	29.9	31.2
AVERAGE		28.6	29.9	29.9	31.2



Liquid limit (%)	29.8
Plastic limit (%)	21.3
Plasticity Index (%)	8.5
Linear shrinkage	
Trough No.	R
Trough length (cm)	14.0
Specimen length (cm)	13.4
L.shringage =	0.7
% L.shrinkage =	4.6

Remarks:

TESTING LAB	STUDENTS
Materials Engineer	
Lab Technician	

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INSTITUTION	STUDENTS	TESTING LAB
UGANDA CHRISTIAN UNIVERSITY A Centre of Excellence in the Heart of Africa	VANESSA AND DINAH	Stirling

PROJECT:	ASSESSING THE USE OF ACTIVATED GLASS POWDER FOR THE STABILISATION OF LATERITE SOILS FOR THE SUBBASE LAYER

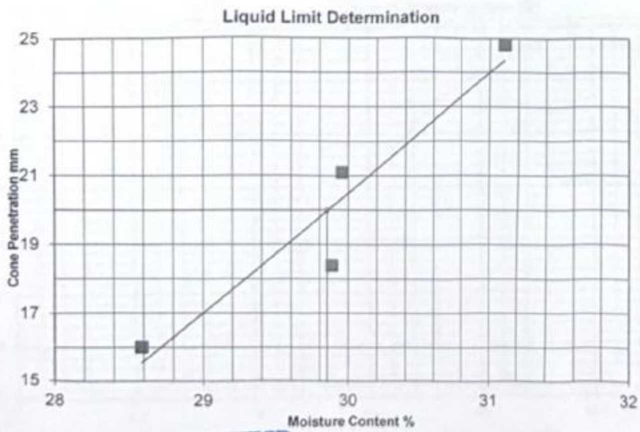
ATTERBERG LIMITS

Liquid limit (cone penotrometer) and plastic limit

Material description:	GRAVEL MIXED WITH 6% GLASS ACT	Technician:	Lab Team
mix	NSAMBWE BORROWPIT	Sample Date	24/Feb/2025
Test method	BS 1377: Part 2, 1990:4.3/4.4	Test Date	28/Feb/2025
LAYER	GRAVEL MIXED WITH 6% GLASS ACTIVATED		
Depth:			

PLASTIC LIMIT	Test No.	Q	SO		Average
Mass of wet soil + container (g)		37.45	43.84		40.645
Mass of dry soil + container (g)		34.69	40.21		37.45
Mass of container (g)		21.69	22.9		22.295
Mass of moisture (g)		2.76	3.6		3.195
Mass of dry soil (g)		13	17.31		15.155
Moisture content %		21.2	21.0		21.1
AVERAGE					

LIQUID LIMIT	Test No	1	2	3	4
Initial gauge reading (mm)		0	0	0	0
Final gauge reading (mm)		16.0	18.4	21.1	24.8
penetration (mm)		16.0	18.4	21.1	24.8
AVERAGE		16.0	18.4	21.1	24.8
Container No.		PIMO	PI57	PII2	PIVPN
Mass of wet soil + container (g)		47.42	51.41	57.19	49.89
Mass of dry soil + container (g)		38.45	41.16	45.61	39.72
Mass of container (g)		7.07	6.86	6.95	7.02
Mass of moisture (g)		8.97	10.25	11.58	10.17
Mass of dry soil (g)		31.38	34.3	38.66	32.7
Moisture content (%)		28.6	29.9	30.0	31.1
AVERAGE		28.6	29.9	30.0	31.1



Liquid limit (%)	29.9
Plastic limit (%)	21.1
Plasticity Index (%)	8.7
Linear shrinkage	
Trough No.	R
Trough length (cm)	14.0
Specimen length (cm)	13.4
L shringage =	0.7
% L shrinkage =	4.6

Remarks:

TESTING LAB	STUDENTS
STIRLING CIVIL ENGINEERING LTD 2025 Materials Engineer. P. O. BOX 798, KAMPALA (U) Lab Technician	

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INSTITUTION	STUDENTS NAMES	TESTING LAB
UGANDA CHRISTIAN UNIVERSITY	TIBYAZE VANESSA ELIZABETH & WANYENYA DINAH MARTHA	Stirling

PROJECT:	ASSESSING THE USE OF ACTIVATED GLASS POWDER FOR THE STABILISATION OF LATERITE SOILS FOR THE SUBBASE LAYER				
Test Reference No.	Lab. Reference No.		Date Sampled	Date Tested	Technician
LOCATION	NSAMBWE BORROWPIT		24/Feb/25	25/Feb/25	Lab team
Material description:	GRAVEL MIXED WITH 6% GLASS ACTIVATED		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 (cm³)
4.5	27	3	457	100	1,000

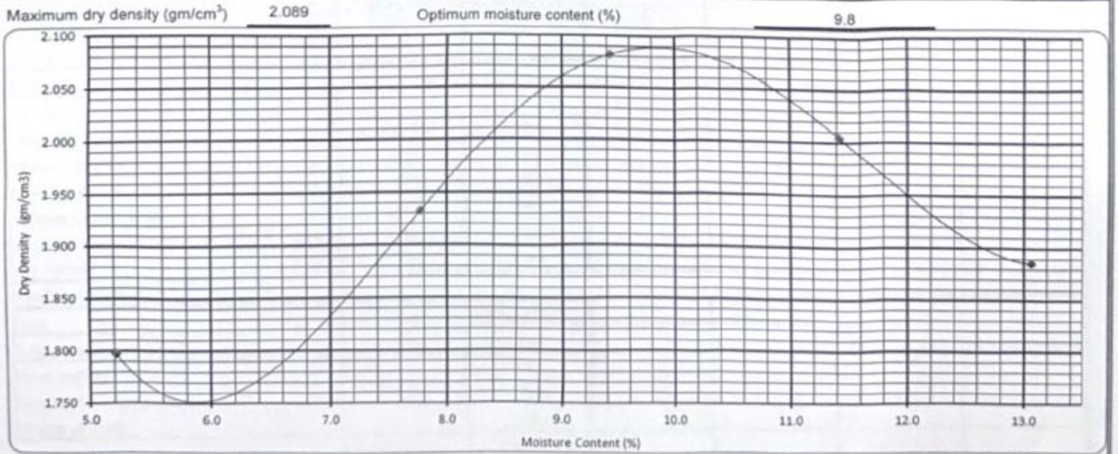
MOISTURE CONTENT DATA

Test No.		1	2	3	4	5
Tin No.		A	A	A	A	A
Water Added	cm³	80	140	200	260	320
Mass of Compacted soil + mould	gm	5,104	5,295	5,491	5,446	5,345
Mass of Mould	gm	3,213	3,213	3,213	3,213	3,213
Mass of Compacted soil	gm	1891	2082	2278	2233	2132
Volume of mould	cm³	1,000	1,000	1,000	1,000	1,000
Wet density of soil	g/cm³	1.891	2.082	2.278	2.233	2.132

DATA FOR PROCTOR CURVE

Container No.		AA	DEN	ZIK	BUS	MSJ
Mass of wet soil + Container	gm	2,356.0	1,046.0	951.0	1,012.0	1,121.0
Mass of dry soil + container	gm	2,260.0	976.0	875.0	915.0	1,000.0
Mass of container	gm	418.0	75.0	69.0	66.0	74.0
Mass of water added	gm	96	70	76	97	121
Mass of dry soil	gm	1842	901	806	849	926
Moisture content	%	5.2	7.8	9.4	11.4	13.1
Dry density	g/cm³	1.797	1.932	2.082	2.004	1.886

Maximum dry density (gm/cm³) 2.089 Optimum moisture content (%) 9.8



Remarks

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FOR TESTING LAB
14 Mar 2025
P. O. BOX 796, KAMPALA (U)

Lab Technician | Materials Engineer

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Institution	Students Names	Testing Lab
UGANDA CHRISTIAN UNIVERSITY	TIBYAZE VANESSA ELIZABETH & WANYENYA DINAH MARTHA	Stirling

ASSESSING THE USE OF ACTIVATED GLASS POWDER FOR THE STABILISATION OF LATERITE SOILS FOR THE SUBBASE LAYER

CALIFORNIA BEARING RATIO TEST (BS 1377 Part 4)

Test sample reference :	Laboratory Reference No.:	Sampling Date :	24/Feb/25
Location:	NSAMBWE BORROWPIT	Casting date :	5/Mar/25
		Testing Date :	12/Mar/25
Sample Description:	GRAVEL MIXED WITH 6% GLASS ACTIVATED	Technician :	: Lab team
		Volume of Mould used (m^3)	2305

Natural moisture of air dried sample			**Volume of water added**	
Tin No.	NBM		Mass of air dried soil (g)	6000
Tin + air dried soil sample (g)	2171		MDD (Mg/m^3)	2.089
Tin + oven dry soil sample (g)	2123		N.M.C (%)	3.6
Tin (g)	793		OMC (%)	9.8
Dry soil sample	1330		Added OMC (%)	6.2
Water (g)	48		Calculated dry wt of soil (g)	5783.5
N.M.C (%)	3.6		Water added (g)	359
Average (%)	3.6		**Water added (mL)**	359

Number of blows		62								
Number of layer		5								
Water Content Determination		Before Soaking		After Soaking						
Tare No		YY	-	MANU	-					
Mass of wet sample + Tare	g	1523	-	1091	-					
Mass of dry sample + Tare	g	1456	-	1032	-					
Mass of Tare	g	782	-	544	-					
Mass of water	g	67	-	59	-					
Mass of dry sample	g	674	-	488	-					
Water content	%	9.9	-	12.1	-					
Average water Content	%	9.9		12.1						
Density determination										
Mould No		7								
Mass of mould + soil	g	12590		12706						
Mass of mould	g	5313		5313						
Mass of soil	g	7237		7393						
Volume of the mould	cm3	2305		2305						
Moist density	g/cm3	3.140		3.207						
Dry density	g/cm3	2.856		2.861						
Swell Determination										
Date		Hour		D.Gauge Reding						
Initial reading		96 hrs		1.25						
Final reading				1.71						
Height of the specimen				127						
Height of swell				0.46						
		Swelling(%)		0.36						

Observations

For the Lab		
Lab. Technician	Materials Engineer	

STIRLING CIVIL ENGINEERING LTD
14 MAR 2025

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Institution	Students Names	Testing Lab
UGANDA CHRISTIAN UNIVERSITY	TIBYAZE VANESSA ELIZABETH & WANYENYA DINAH MARTHA	Stirling

ASSESSING THE USE OF ACTIVATED GLASS POWDER FOR THE STABILISATION OF LATERITE SOILS FOR THE SUBBASE LAYER

CALIFORNIA BEARING RATIO TEST (BS1377 Part 4)

Test sample reference :	Laboratory Reference No.:	Sampling Date	24/Feb/25
Location:		Penetration Date	12/Mar/25
Depth :		Technician	: : Lab team
Sample Description :	GRAVEL MIXED WITH 6% GLASS ACTIVATED		

Number of blows per layer	62		
Number of layers	5	5	5
Mould No	7		
Capacity of the Proving Ring (KN)	50	50	50
Proving Ring Constant (KN/div.)	0.2312	0.2312	0.2312

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	3	0.7	3	0.7						
0.5	24	6	1.4	6	1.4						
0.75	35	11	2.5	19	4.4						
1	47	14	3.2	27	6.2						
1.5	71	18	4.2	39	9.0						
2	94	25	5.8	46	10.6						
2.5	118	31	7.2	55	12.7						
3	142	37	8.6	63	14.6						
3.5	165	42	9.7	70	16.2						
4	189	46	10.6	76	17.6						
4.5	213	50	11.6	83	19.2						
5	236	53	12.3	89	20.6						
5.5	260	56	12.9	93	21.5						
6	283	59	13.6	97	22.4						
6.5	307	61	14.1	102	23.6						
7	331	63	14.6	105	24.3						
7.5	354	63	14.6	108	25.0						

Observations:

STIRLING CIVIL ENGINEERING LTD
For the Contractor
14 MAR 2025
P. O. BOX 796, KAMPALA (U)

Lab. Technician

Materials Engineer

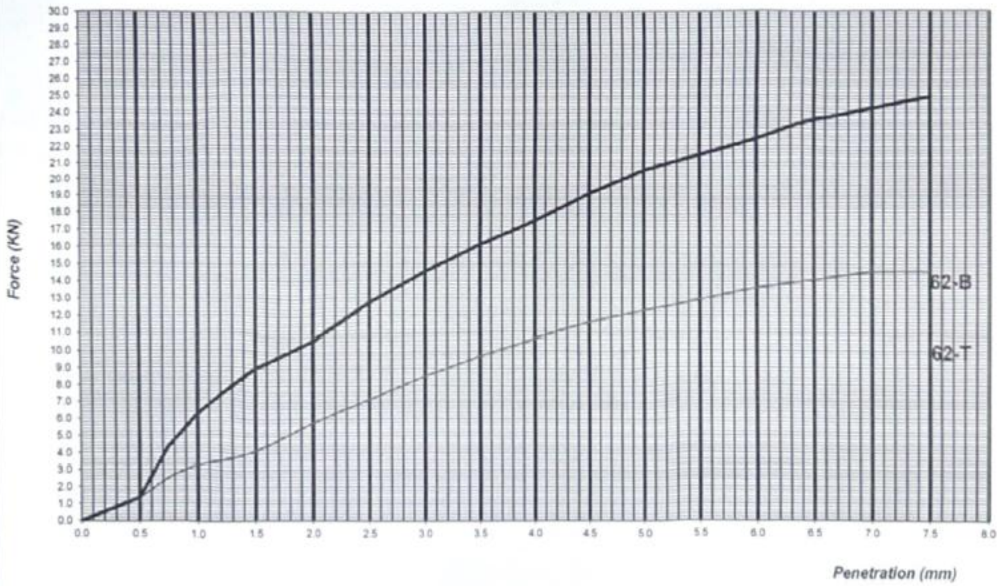
Institution	Students Names	Testing Lab
UGANDA CHRISTIAN UNIVERSITY	TIBYAZE VANESSA ELIZABETH & WANYENYA DINAH MARTHA	Stirling

ASSESSING THE USE OF ACTIVATED GLASS POWDER FOR THE STABILISATION OF LATERITE SOILS FOR THE SUBBASE LAYER

CALIFORNIA BEARING RATIO TEST (BS1377 Part 4)

Test sample reference :	Laboratory Reference No.:	Sampling Date : 24/Feb/25
Location:		Testing Date : 12/Mar/25
Depth:		Technician : Lab team
Sample Description: GRAVEL MIXED WITH 6% GLASS ACTIVATED		

PENETRATION vs FORCE CURVE



	62 blows			
	Force		CBR	
	Bottom	Top	Bottom	Top
2.5 mm Penetration	12.7	7.2	96	54
5.0 mm Penetration	20.6	12.3	103	61
Average	16.6	9.7	99.6	57.8
Retained CBR	99.6			
Observations	CBR= 99.6			

For the Lab

Lab. Technician — *Materials Engineer*

STIRLING CIVIL ENGINEERING LTD
14 MAR 2025
P. O. BOX 796, KAMPALA (U)

INSTITUTION	STUDENTS NAMES	TESTING LAB
UGANDA CHRISTIAN UNIVERSITY	TIBYAZE VANESSA ELIZABETH & WANYENYA DINAH MARTHA	Stirling
PROJECT	ASSESSING THE USE OF ACTIVATED GLASS POWDER FOR THE STABILISATION OF LATERITE SOILS FOR THE SUBBASE LAYER	

STABLISED CBR (BS 1924 PART 2 1) — Load applied 140kpa/s

GRAVEL MIXED WITH 6% ACTIVATED GLASS

M/c of air dried sample		
Tin No.	NBM	
Tin + Wet soil gm	2,171.0	
Tin + Dry Soil gm	2,123.0	
Tin gm	793.0	
Water gm	48.0	
Dry Soil gm	1,330.0	
M/c %	3.6	
Av. M/c %	3.6	

M/c After Mixing			
Stabliser	ACTIVATED GLASS		
Content	6.0		
Tin No.	ZION		
Tin + Wet Soil	1,305.0		
Tin + Dry Soil	1,229.0		
Tin	441.0		
Water	76.0		
Dry Soil	788.0		
M/c	9.6		

(a)MDD	2.089	kg/m3	(b)Air Dry M/c	3.6	%
(c)WD	2.047	kg/m3	(e)M/c to add	6.2	%
(d)OMC	9.8	%	(F) volume	2.305	

Date prepared 1/Mar/25 Date immerse 8/Mar/25 Date tested 15/Mar/25

Mould No.	A	B	C
Factor(f)	2.305	2.305	2.305
(h)Wet Soil to fill mould c x f x %comp	4,718.8	4,718.8	4,718.8
(j) Wt of air dried soil	6,000	6,000	6,000
Air dry M/c	3.6	0.0	0.0
(k) soil dry wt (100j/100+b)	5,791.0	6,000.0	6,000.0
Stabliser	ACTIVATED GLASS		
(m)Stablisers content %	6.0		
(n) Stabliser to add k x(m/100)	347.5		
Water Addition((j+n)x(d-b))/(100+b)	379.3		
Wt. per layer CBR Only h/3	1,572.9		

SPECIMEN WEIGHT CHECK

No. of blows	62.0	62.0	AVERAGE	AVERAGE
Mould No.	7 DAYS AIR TIGHT, 7 DAYS SOAKED	7 DAYS AIR TIGHT, 7 DAYS SOAKED	7DAYS AIR TIGHT, 7 DAYS SOAKED	7DAYS AIR TIGHT, 7 DAYS SOAKED
Stabliser	ACTIVATED GLASS	ACTIVATED GLASS		
Content %	6.0	6.0	6.0	
Mould g	A	B	C	
Wet Soil g	5,481.0	5,509.0	5,489.0	
Compaction M/c %	9.6	9.6	9.6	
Dry density kg/m3	2.169	2.180	2.172	
%Compaction	103.8	104.3	104.0	
FORCE	13.6	12.5	12.7	
UCS	0.748	0.685	0.697	0.71

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

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INSTITUTION	STUDENTS	TESTING LAB
UGANDA CHRISTIAN UNIVERSITY A Centre of Excellence in the Heart of Africa	TIBYAZE VANESSA ELIZABETH & WANYENYA DINAH MARTHA	Stirling

PROJECT: ASSESSING THE USE OF ACTIVATED GLASS POWDER FOR THE STABILISATION OF LATERITE SOILS FOR THE SUBBASE LAYER

SUMMARY OF TEST RESULTS FOR GRAVEL MIXED WITH 8% ACTIVATED GLASS

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	62 BLOWS OF COMPACTION	62	AVERAGE
GRAVEL MIXED WITH 8% ACTIVATED GLASS	GRAVEL MIXED WITH 8% ACTIVATED GLASS	20/01/2025	100	97	90	57	43	29	20	2.08	32.1	21.2	10.9	5.7	2.046	11.1	84.2	0.48	0.48
			100	100	94	56	42	29	13	2.16	31.8	21.4	10.4	5.7	-	-	-	-	
			100	98.52	91.61	56.72	42.74	28.91	16.2	2.12	32.0	21.3	10.6	5.7	2.046	11.1	84	0.48	0.48
	AVERAGE		100	99	92	57	43	29	16	2.121	32.0	21.4	10.6	5.7	2.046	11.1	84	0.48	0.48

FOR LAB

STIRLING CIVIL ENGINEERING LTD

Lab Technician 14 MAR 2025 Materials Engineer

P. O. BOX 796, KAMPALA (U)

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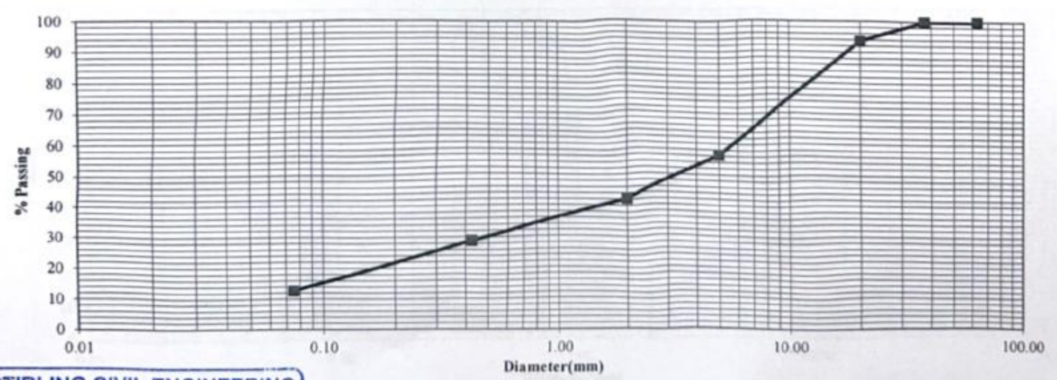
INSTITUTION	STUDENTS NAMES	CONTRACTOR
UGANDA CHRISTIAN UNIVERSITY A Centre of Excellence in the Heart of Africa	TIBYAZE VANESSA ELIZABETH & WANYENYA DINAH MARTHA	Stirling

PROJECT : ASSESSING THE USE OF ACTIVATED GLASS POWDER FOR THE STABILISATION OF LATERITE SOILS FOR THE SUBBASE LAYER

PARTICLE SIZE DISTRIBUTION (BS 1377 - 2 - 90)

Test Reference No.:		Lab. Refernece No.:		
Location :(km)	NSAMBWE BORROWPIT	Dry wt. of sample before washing: (g)		3699
Depth: (m)		Dry wt. of sample after washing: (g)		3235.5
Material description:	GRAVEL MIXED WITH 8% ACTIVATED GLASS	Date Sampled:	Date Tested:	Technician
		24/Feb/2025	25/Feb/2025	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	239.6	6.5	**94**	60	95
5.0	1373.6	37.1	**56**	30	65
2.00	524.0	14.2	**42**	20	50
0.425	495.8	13.4	**29**	10	30
0.075	596.0	16.1	**13**	5	15
Total fines	470.0	12.7			
Bottom Pan	6.5				
Extracted fines	463.5				
Total sample	3699.0				
Grading Modulus		2.16			



STIRLING CIVIL ENGINEERING LTD
FOR TESTING LAB
14 MAR 2025
P. O. BOX 796, KAMPALA (U)

Lab Technician | Materials Engineer

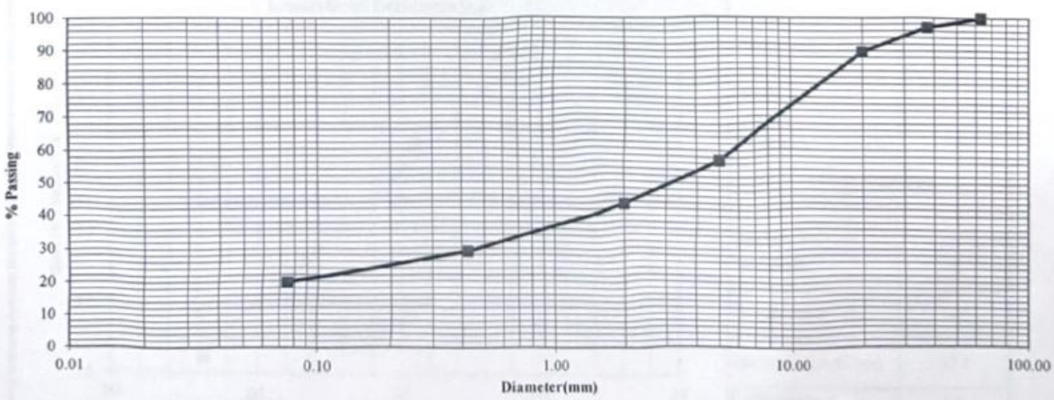
INSTITUTION	STUDENTS NAMES	CONTRACTOR
UGANDA CHRISTIAN UNIVERSITY A Centre of Excellence in the Heart of Africa	TIBYAZE VANESSA ELIZABETH & WANYENYA DINAH MARTHA	Stirling

PROJECT : ASSESSING THE USE OF ACTIVATED GLASS POWDER FOR THE STABILISATION OF LATERITE SOILS FOR THE SUBBASE LAYER

PARTICLE SIZE DISTRIBUTION (BS 1377 - 2 - 90)

Test Reference No.:		Lab. Refernece No.:		
Location :(km)	NSAMBWE BORROWPIT	Dry wt. of sample before washing: (g)		3898.2
Depth: (m)		Dry wt. of sample after washing: (g)		3138.1
Material description:	GRAVEL MIXED WITH 8% ACTIVATED GLASS	Date Sampled:	Date Tested:	Technician
		24/Feb/2025	25/Feb/2025	Lab team

Sieve Size (mm)	Weight Retained (g)	Retained (%)	Passing (%)	Grading Limits (G60 & 80)	
63.0	0.0	0	**100**	100	100
37.5	115.3	3.0	**97**	80	100
20.0	286.7	7.4	**90**	60	95
5.0	1272.5	32.6	**57**	30	65
2.00	537.3	13.8	**43**	20	50
0.425	555.8	14.3	**29**	10	30
0.075	362.9	9.3	**20**	5	15
Total fines	767.7	19.7			
Bottom Pan	7.6				
Extracted fines	760.1				
Total sample	3898.2				
Grading Modulus		**2.08**			



FOR TESTING LAB

Lab Technician   Materials Engineer

STIRLING CIVIL ENGINEERING LTD
14 MAR 2025
P. O. BOX 796, KAMPALA (U)

STUDENTS NAMES

INSTITUTION	STUDENTS	TESTING LAB
UGANDA CHRISTIAN UNIVERSITY A Centre of Excellence in the Heart of Africa	VANESSA AND DINAH	Stirling

PROJECT:	**ASSESSING THE USE OF ACTIVATED GLASS POWDER FOR THE STABILISATION OF LATERITE SOILS FOR THE SUBBASE LAYER**

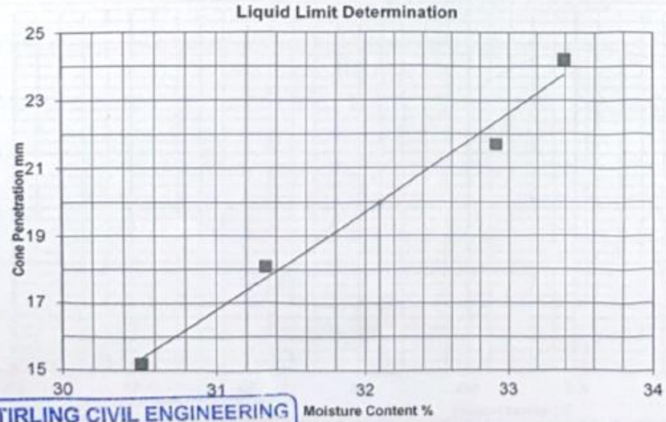
ATTERBERG LIMITS

Liquid limit (cone penotrometer) and plastic limit

Material description:	GRAVEL MIXED WITH 8% ACTIVATED GLASS	Technician:	Lab Team
mix	NSAMBWE BORROWPIT	Sample Date	24/Feb/2025
Test method	BS 1377: Part 2, 1990:4.3/4.4	Test Date	28/Feb/2025
LAYER	GRAVEL MIXED WITH 8% ACTIVATED GLASS		
Depth:			

PLASTIC LIMIT	Test No.	VP	LL		Average
Mass of wet soil + container (g)		38.12	35.95		37.035
Mass of dry soil + container (g)		35.19	33.59		34.39
Mass of container (g)		21.52	22.35		21.935
Mass of moisture (g)		2.93	2.4		2.645
Mass of dry soil (g)		13.67	11.24		12.455
Moisture content %		21.4	21.0		21.2
AVERAGE					

LIQUID LIMIT	Test No	1	2	3	4
Initial gauge reading (mm)		0	0	0	0
Final gauge reading (mm)		15.2	18.1	21.7	24.2
penetration (mm)		15.2	18.1	21.7	24.2
AVERAGE		15.2	18.1	21.7	24.2
Container No.		KO	A6	PI6OO	PI66
Mass of wet soil + container (g)		36.18	35.56	55.23	61.74
Mass of dry soil + container (g)		29.34	28.74	43.34	48.08
Mass of container (g)		6.92	6.97	7.21	7.17
Mass of moisture (g)		6.84	6.82	11.89	13.66
Mass of dry soil (g)		22.42	21.77	36.13	40.91
Moisture content (%)		30.5	31.3	32.9	33.4
AVERAGE		30.5	31.3	32.9	33.4



Liquid limit (%)	32.1
Plastic limit (%)	21.2
Plasticity Index (%)	10.9
Linear shrinkage	
Trough No.	I
Trough length (cm)	14.0
Specimen length (cm)	13.2
L.shringage =	0.8
% L.shrinkage =	5.7

STIRLING CIVIL ENGINEERING LTD

Remarks:

TESTING LAB

14 MAR 2025

Materials Engineer

P. O. BOX 759, KAMPALA (U)

Lab Technician

STUDENTS

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INSTITUTION	STUDENTS	TESTING LAB
UGANDA CHRISTIAN UNIVERSITY	VANESSA AND DINAH	Stirling

PROJECT:	ASSESSING THE USE OF ACTIVATED GLASS POWDER FOR THE STABILISATION OF LATERITE SOILS FOR THE SUBBASE LAYER

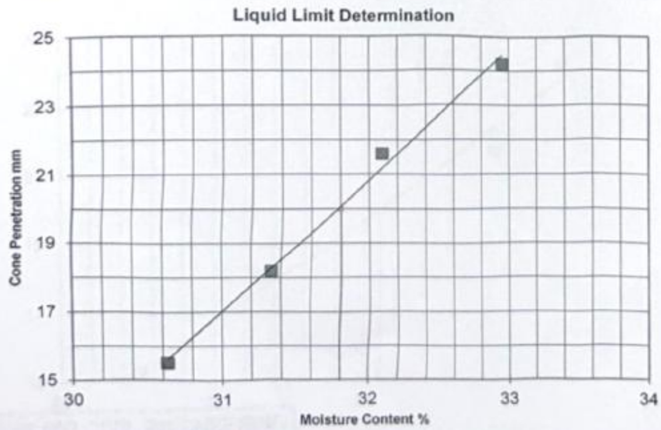
ATTERBERG LIMITS

Liquid limit (cone penotrometer) and plastic limit

Material description:	GRAVEL MIXED WITH 8% ACTIVATED	Technician:	Lab Team
mix	NSAMBWE BORROWPIT	Sample Date	24/Feb/2025
Test method	BS 1377: Part 2, 1990:4.3/4.4	Test Date	28/Feb/2025
LAYER	GRAVEL MIXED WITH 8% ACTIVATED GLASS		
Depth:	0		

PLASTIC LIMIT	Test No.	PNU	2F		Average
Mass of wet soil + container (g)		41.06	38.27		39.665
Mass of dry soil + container (g)		37.83	35.46		36.645
Mass of container (g)		22.86	22.25		22.555
Mass of moisture (g)		3.23	2.8		3.02
Mass of dry soil (g)		14.97	13.21		14.09
Moisture content %		21.6	21.3		21.4
AVERAGE					

LIQUID LIMIT	Test No	1	2	3	4
Initial gauge reading (mm)		0	0	0	0
Final gauge reading (mm)		15.5	18.2	21.6	24.2
penetration (mm)		15.5	18.2	21.6	24.2
AVERAGE		15.5	18.2	21.6	24.2
Container No.		A15	28PI	PIB6	PI53
Mass of wet soil + container (g)		43.60	44.90	56.10	61.03
Mass of dry soil + container (g)		35.06	35.91	44.22	48.02
Mass of container (g)		7.18	7.22	7.20	8.54
Mass of moisture (g)		8.54	8.99	11.88	13.01
Mass of dry soil (g)		27.88	28.69	37.02	39.48
Moisture content (%)		30.6	31.3	32.1	33.0
AVERAGE		30.6	31.3	32.1	33.0



Liquid limit (%)	31.8
Plastic limit (%)	21.4
Plasticity Index (%)	10.4
Linear shrinkage	
Trough No.	I
Trough length (cm)	14.0
Specimen length (cm)	13.2
L.shringage =	0.8
% L.shrinkage =	5.7

Remarks

STIRLING CIVIL ENGINEERING LTD

TESTING LAB

2025

Materials Engineer.

P. O. BOX ..., KAMPALA (U)

Lab Technician

STUDENTS

Scanned with CamScanner

INSTITUTION	STUDENTS NAMES	TESTING LAB
UGANDA CHRISTIAN UNIVERSITY	TIBYAZE VANESSA ELIZABETH & WANYENYA DINAH MARTHA	Stirling

PROJECT:	ASSESSING THE USE OF ACTIVATED GLASS POWDER FOR THE STABILISATION OF LATERITE SOILS FOR THE SUBBASE LAYER			
Test Reference No.	Lab. Reference No.	Date Sampled	Date Tested	Technician
LOCATION	NSAMBWE BORROWPIT	24/Feb/25	25/Feb/25	Lab team
Material description:	GRAVEL MIXED WITH 8% ACTIVATED GLASS	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	3	457	100	1,000

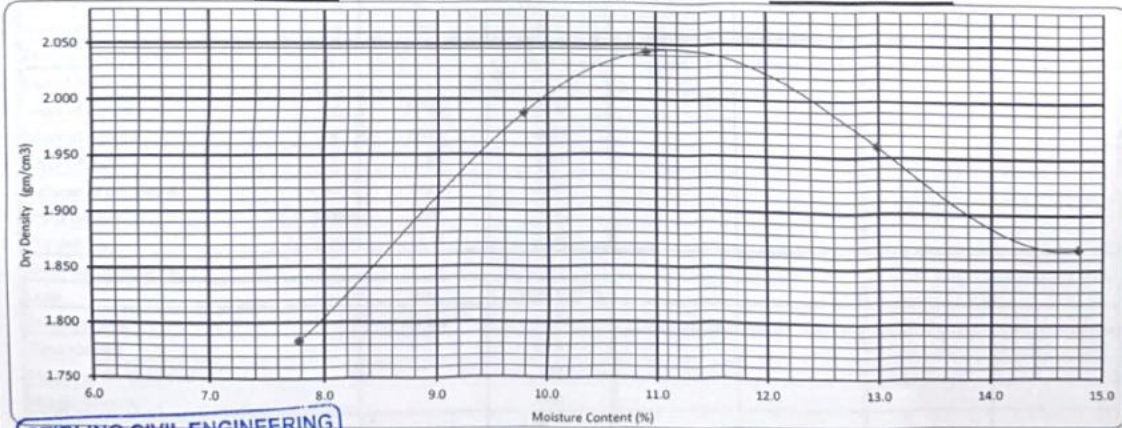
MOISTURE CONTENT DATA

Test No.		1	2	3	4	5
Tin No.		A	A	A	A	A
Water Added	cm^3	130	190	250	310	370
Mass of Compacted soil + mould	gm	5,135	5,395	5,479	5,427	5,358
Mass of Mould	gm	3,213	3,213	3,213	3,213	3,213
Mass of Compacted soil	gm	1922	2182	2266	2214	2145
Volume of mould	cm^3	1,000	1,000	1,000	1,000	1,000
Wet density of soil	g/cm^3	1.922	2.182	2.266	2.214	2.145

DATA FOR PROCTOR CURVE

Container No.		HM	DT	NMT	UPC	MANU
Mass of wet soil + Container	gm	2,205.0	1,802.0	2,290.0	2,850.0	1,762.0
Mass of dry soil + container	gm	2,085.0	1,690.0	2,140.0	2,615.0	1,605.0
Mass of container	gm	543.0	545.0	765.0	805.0	543.0
Mass of water added	gm	120	112	150	235	157
Mass of dry soil	gm	1542	1145	1375	1810	1062
Moisture content	%	7.8	9.8	10.9	13.0	14.8
Dry density	g/cm^3	1.783	1.988	2.043	1.960	1.869

Maximum dry density (gm/cm^3) 2.046 Optimum moisture content (%) 11.1



Remarks:

STIRLING CIVIL ENGINEERING LTD
14 MAR 2025
FOR TESTING LAB
P.O. BOX 796, KAMPALA (U)

Lab Technician Materials Engineer

Institution	Students Names	Testing Lab
UGANDA CHRISTIAN UNIVERSITY	TIBYAZE VANESSA ELIZABETH & WANYENYA DINAH MARTHA	Stirling

ASSESSING THE USE OF ACTIVATED GLASS POWDER FOR THE STABILISATION OF LATERITE SOILS FOR THE SUBBASE LAYER

CALIFORNIA BEARING RATIO TEST (BS 1377 Part 4)

Test sample reference :	Laboratory Reference No.:	Sampling Date :	24/Feb/25
Location:	NSAMBWE BORROWPIT	Casting date :	6/Mar/25
		Testing Date :	13/Mar/25
Sample Description:	GRAVEL MIXED WITH 8% ACTIVATED GLASS	Technician :	Lab team
		Volume of Mould used (m^3)	**2305**

Natural moisture of air dried sample			**Volume of water added**	
Tin No.	CR7		Mass of air dried soil (g)	6000
Tin + air dried soil sample (g)	2402		MDD (Mg/m^3)	2.046
Tin + oven dry soil sample (g)	2345		N.M.C (%)	3.6
Tin (g)	769		OMC (%)	11.1
Dry soil sample	1576		Added OMC (%)	7.5
Water (g)	57		Calculated dry wt of soil (g)	5783.0
N.M.C (%)	3.6		Water added (g)	**433**
Average (%)	3.6		**Water added (mL)**	**433**

Number of blows		62			
Number of layer		5			
Water Content Determination		Before Soaking		After Soaking	
Tare No		ZKT	-	YY	-
Mass of wet sample + Tare	g	1578	-	1692	-
Mass of dry sample + Tare	g	1505	-	1575	-
Mass of Tare	g	806	-	785	-
Mass of water	g	73	-	117	-
Mass of dry sample	g	699	-	790	-
Water content	%	10.4	-	14.8	-
Average water Content	%	10.4		14.8	
Density determination					
Mould No		NN			
Mass of mould + soil	g	11955		12186	
Mass of mould	g	6675		6675	
Mass of soil	g	5280		5511	
Volume of the mould	cm3	2305		2305	
Moist density	g/cm3	2.291		2.391	
Dry density	g/cm3	2.074		2.082	
Swell Determination					
Date		Hour		D.Gauge Reding	
Initial reading		96 hrs		12.74	
Final reading				13.35	
Height of the specimen				127	
Height of swell				0.61	
		Swelling(%)		0.48	

Observations

STIRLING CIVIL ENGINEERING LTD
14 MAR 2025
P. O. BOX 796, KAMPALA (U)

For the Lab		
Lab Technician	Materials Engineer	

Institution	Students Names	Testing Lab
UGANDA CHRISTIAN UNIVERSITY	TIBYAZE VANESSA ELIZABETH & WANYENYA DINAH MARTHA	Stirling

ASSESSING THE USE OF ACTIVATED GLASS POWDER FOR THE STABILISATION OF LATERITE SOILS FOR THE SUBBASE LAYER

CALIFORNIA BEARING RATIO TEST (BS1377 Part 4)

Test sample reference :	Laboratory Reference No.:	Sampling Date	24/Feb/25
Location:		Penetration Date	13/Mar/25
Depth :		Technician	: : Lab team
Sample Description :	GRAVEL MIXED WITH 8% ACTIVATED GLASS		

Number of blows per layer	62		
Number of layers	5	5	5
Mould No	NN		
Capacity of the Proving Ring (KN)	50	50	50
Proving Ring Constant (KN/div.)	0.2312	0.2312	0.2312

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**	2	0.5	2	0.5
0.5	**24**	4	0.9	6	1.4
0.75	**35**	6	1.4	15	3.5
1	**47**	8	1.8	30	6.9
1.5	**71**	11	2.5	40	9.2
2	**94**	14	3.2	46	10.6
2.5	**118**	17	3.9	52	12.0
3	**142**	22	5.1	58	13.4
3.5	**165**	27	6.2	62	14.3
4	**189**	30	6.9	64	14.8
4.5	**213**	33	7.6	66	15.3
5	**236**	35	8.1	67	15.5
5.5	**260**	37	8.6	70	16.2
6	**283**	40	9.2	73	16.9
6.5	**307**	42	9.7	77	17.8
7	**331**	44	10.2	80	18.5
7.5	**354**	46	10.6	82	19.0

Observations

STIRLING CIVIL ENGINEERING LTD
14 MAR 2025
P. O. BOX 790, KAMPALA (U)

For the Contractor

Lab Technician *Materials Engineer*

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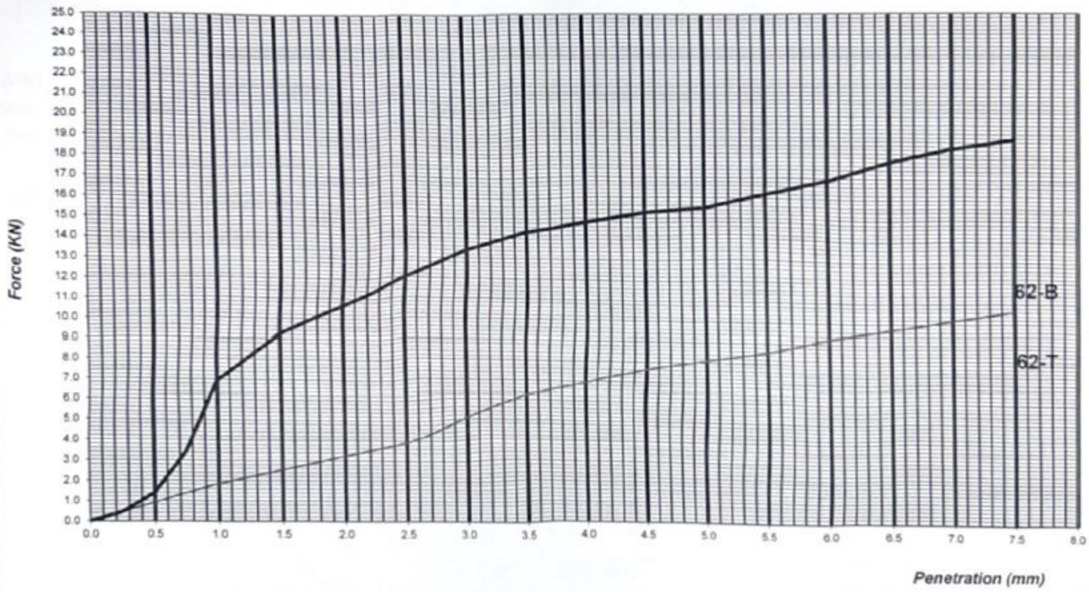
Institution	Students Names	Testing Lab
UGANDA CHRISTIAN UNIVERSITY	TIBYAZE VANESSA ELIZABETH & WANYENYA DINAH MARTHA	Stirling

ASSESSING THE USE OF ACTIVATED GLASS POWDER FOR THE STABILISATION OF LATERITE SOILS FOR THE SUBBASE LAYER

CALIFORNIA BEARING RATIO TEST (BS1377 Part 4)

Test sample reference :	Laboratory Reference No.:	Sampling Date : 24/Feb/25
Location:		Testing Date : 13/Mar/25
Depth:		Technician : Lab team
Sample Description: GRAVEL MIXED WITH 8% ACTIVATED GLASS		

PENETRATION vs FORCE CURVE



	62 blows			
	Force		CBR	
	Bottom	Top	Bottom	Top
2.5 mm Penetration	12.0	3.9	91	30
5.0 mm Penetration	15.5	8.1	78	41
Average	13.8	6.0	84.2	35.1
Retained CBR	84.2			

Observations CBR= 84.2

For the Lab

Lab. Technician Materials Engineer

STIRLING CIVIL ENGINEERING LTD 14 MAR 2025 P. O. BOX 796, KAMPALA (U)

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INSTITUTION	STUDENTS NAMES	TESTING LAB
UGANDA CHRISTIAN UNIVERSITY	TIBYAZE VANESSA ELIZABETH & WANYENYA DINAH MARTHA	Stirling
PROJECT	ASSESSING THE USE OF ACTIVATED GLASS POWDER FOR THE STABILISATION OF LATERITE SOILS FOR THE SUBBASE LAYER	

STABLISED CBR

(BS 1924 PART 2 1)

Load applied 140kpa/s

GRAVEL MIXED WITH 8% ACTIVATED GLASS

M/c of air dried sample			
Tin No.		CR7	
Tin + Wet soil	gm	2,402.0	
Tin + Dry Soil	gm	2,345.0	
Tin	gm	769.0	
Water	gm	57.0	
Dry Soil	gm	1,576.0	
M/c	%	3.6	
Av. M/c	%	3.6	

M/c After Mixing			
Stabliser	ACTIVATED GLASS		
Content	8.0		
Tin No.	ZION		
Tin + Wet Soil	1,305.0		
Tin + Dry Soil	1,232.0		
Tin	441.0		
Water	73.0		
Dry Soil	791.0		
M/c	9.2		

(a)MDD 2.046 kg/m3 — (b)Air Dry M/c 3.6 %

(c)WD 2.271 kg/m3 — (e)M/c to add 7.5 %

(d)OMC 11.1 % — (F) volume 2.305

Date prepared 1/Mar/25 Date immerse 8/Mar/25 Date tested 15/Mar/25

Mould No.	A	B	C
Factor(f)	2.305	2.305	2.305
(h)Wet Soil to fill mould c x f x %comp	5,233.5	5,233.5	5,233.5
(j) Wt of air dried soil	6,000	6,000	6,000
Air dry M/c	3.6	0.0	0.0
(k) soil dry wt (100j/100+b)	5,790.6	6,000.0	6,000.0
Stabliser	ACTIVATED GLASS		
(m)Stablisers content %	8.0		
(n) Stabliser to add k x(m/100)	463.2		
Water Addition((j+n)x(d-b))/(100+b)	466.8		
Wt. per layer CBR Only h/3	1,744.5		

SPECIMEN WEIGHT CHECK				
No. of blows	62.0	62.0	AVERAGE	AVERAGE
Mould No.	7 DAYS AIR TIGHT, 7 DAYS SOAKED	7 DAYS AIR TIGHT, 7 DAYS SOAKED	7DAYS AIR TIGHT, 7 DAYS SOAKED	7DAYS AIR TIGHT, 7 DAYS SOAKED
Stabliser	ACTIVATED GLASS	ACTIVATED GLASS		
Content %	8.0	8.0	8.0	
Mould g	A	B	C	
Wet Soil g	5,339.0	5,476.0	5,361.0	
Compaction M/c %	9.2	9.2	9.2	
Dry density kg/m3	2.121	2.175	2.129	
%Compaction	103.7	106.3	104.1	
FORCE	11.8	11.1	11.6	
UCS	0.647	0.609	0.634	0.63

STIRLING CIVIL ENGINEERING LTD BOX 796, KAMPALA (U)

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