

# **UNIVERSITY OF NAIROBI**

## Faculty of Engineering Department of Civil and Construction Engineering

## Pozzolanic Potentials of Fresh Cow Dung and Cow Dung Ash for Gravel Roads Construction

BY

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A Thesis Submitted in Partial Fulfilment of the Requirements for the Award of the Degree of Master of Science in Civil Engineering (Transportation Engineering) in the Department of Civil & Construction Engineering, University of Nairobi

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## DECLARATION

I, Anthony Mugendi Nyagah, hereby declare that this thesis is my original work. To the best of my knowledge, the work presented here has not been presented for a thesis in any other university.

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## CERTIFICATION

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## **DEDICATION**

I dedicate this work to my parents and friends who have taught me persistence, determination and work smart. Who has loved and cherished me all through my life, taught me to embrace passion, humility, patience and above all to fear the Lord in everything that I do

Also, I would like to dedicate this report to my young brother Late Police Constable (L/PC) Kelvin M. Njoka who passed away in the line of duty on 06/12/2019 following an Al-Shabaab attack at Wajir on his way back to work.

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### ABSTRACT

Among third-world countries, gravel and earth roads form an excessively large portion of the road network when compared to paved roads. In Kenya, earth roads comprise about 47% of the road network, gravel roads 38% and surface-dressed and premixed asphalt roads 11 and 4% respectively (KENHA, 2019). It is important to note that paving roads is an expensive exercise, though pertinent, that competes for the deficient resources in the usually strained economies resulting in their easy neglect.

Over the years, there has been an overreliance on cement as the primary chemical stabilizer, which has contributed to the low development of gravel and earth s due to cost reasons. In addition, the manufacture of cement is an environment-polluting activity that adds to the carbon footprint due to the gaseous pollutants released during the cement production process. This research investigated FCD and CDA as alternative stabilizers as they are readily available and eco-friendly. The effects of FCD and CDA were determined at various percentages for FCD (0%, 3%, 6%, 9%, and 12%) and CDA (0%, 3%, 6%, 9%, 12%, and 15%) both by weight was used. The index properties, compaction properties, plasticity requirements and bearing strength CBR and UCS were determined.

The results show that for the mechanical stabilization with FCD, the MDD decreases with an increase in the percentage of FCD stabilizer, while OMC increased with the increase in dosages of FCD. The CBR test results showed an increase with the increase in FCD dosages where a maximum result of 54% was attained with 6% FCD replacement, further increase in FCD dosages lowered the CBR value while the UCS test results showed a maximum value was attained with 6% FCD replacement and with further increase in FCD decreased the UCS values. The chemical stabilization with CDA, the MDD showed a decrease with an increase in dosages of CDA while OMC increased with the increase in amounts of CDA. The test results for CBR showed an increase with the increase of CDA dosages and attained a maximum with 6% CDA dosage and a further increase in CDA dosages showed a decrease in UCS results.

Both FCD and CDA are inexpensive, readily obtainable, sustainable and eco-friendly. This will help low and middle-income countries in paving their gravel roads.

## TABLE OF CONTENTS

DECLARATIONi
CERTIFICATIONi
DEDICATION ii
ACKNOWLEDGEMENT iii
ABSTRACTiv
TABLE OF CONTENTSv
LIST OF TABLESx
LIST OF FIGURESxi
LIST OF PLATES xii
LIST OF ABBREVIATIONSxiv
CHAPTER 1: INTRODUCTION1
1.0 Background1
1.1 Problem Statement4
1.2 Research Objective5
1.2.1 The specific objectives of this research are:
1.3 Research Questions
1.4 The Scope of Study6
1.5 The Justification for the Study6
1.6 The Limitations of the Study6
CHAPTER 2: LITERATURE REVIEW
2.0 Introduction7
2.1 Soil Stabilization
2.2 Conventional Soil Stabilizers

2.2.1 Lime Stabilization	7
2.2.2 Portland Cement	8
2.2.3 Fly-ash	9
2.3 Non-traditional stabilizers	9
2.3.1 Salts	9
2.3.2 Polymers	
2.3.3 Molasses	
2.3.4 Bio-enzymes	
2.3.5 Ashes of Agro-byproducts	
2.3.6 Groundnut Shell Ash	
2.3.7 Bagasse Ash	
2.4 Applications of Fresh Cow Dung	
2.5 Applications of Cow Dung Ash	
2.6 Optimization of Gravel soils Engineering Properties	
2.7 Critique of the Existing Literature	
2.7.1 Mechanical Stabilization using Fresh Cow Dung	
2.7.2 Chemical stabilization using Cow Dung Ash (CDA)	
2.8 Summary and Conceptual Framework	
2.8.1 Mechanical Stabilization	
2.8.2 Chemical Stabilization	
CHAPTER 3: MATERIALS AND METHODS	
3.0 Introduction	
3.1 Materials Collection and Preparation	
3.1.1 Lateritic Gravel Soil	

3.1.2 Fresh Cow Dung (FCD)	
3.1.3 Cow Dung Ash (CDA)	
3.2 Materials Index Properties and Characterization	
3.3 Method of Testing	
3.4 Determination of Compaction Properties (MDD & OMC)	
3.4.1 Mechanical Stabilization using FCD	
3.4.2 Chemical Stabilization using CDA	
3.5 Determination of Strength Properties (CBR & UCS)	
3.5.1 California Bearing Ratio	34
3.5.2 Unconfined Compressive Strength (UCS)	35
3.6 Determination of Grading and Atterberg limits	
3.6.1 Particle Size Distribution	
3.6.2 Atterberg Limits	
3.6.2.1 Apparatus	
3.6.2.2 Liquid Limit	
3.6.2.3 Plastic Limit	40
3.6.2.4 Plasticity Index	40
3.6.2.5 Linear Shrinkage	40
3.6.2.6 Plasticity Modulus	40
CHAPTER 4: RESULTS AND DISCUSSIONS	41
4.0 Introduction	41
4.1 Index Properties and the characterization of the materials	41
4.1.1 Index Properties of Lateritic Gravel	41
4.1.2 Characterization of the FCD sample	42
4.1.3 Characterization of CDA sample	42

4.2 Effects of FCD and CDA Stabilizer on Compaction43
4.3 Effects of FCD and CDA Stabilizer on Lateritic Gravel Strength Properties.
4.4 Effects of FCD and CDA Stabilizer on Lateritic Gravel Atterberg limits48
4.5 Effects of FCD and CDA Stabilizer on Grading of the Lateritic Gravel50
4.6 Suitability of FCD as a Stabilizer
4.7 Suitability of CDA as a Stabilizer
CHAPTER 5: CONCLUSIONS AND RECOMMENDATIONS53
5.1 Conclusions
5.2 Recommendations
REFERENCES
APPENDICES
Appendix A Chemical Characterization for the Samples
Appendix A1 Chemical Composition of FCD Sample59
Appendix B Chemical Composition of CDA Sample60
Appendix B Specific Gravity for the Samples61
Appendix B1 Specific Gravity for FCD Sample61
Appendix B2 Specific Gravity for CDA Sample62
Appendix C NEAT Sample63
Appendix C1 Compaction Properties (MDD & OMC)63
Appendix C2 Strength Properties (UCS & CBR)64
Appendix C3 Atterberg Limits65
Appendix C4 Grading66
Appendix D FCD Stabilized Samples
Appendix D1 Compaction Properties (MDD & OMC)68 viii

Appendix D2 Strength Properties (UCS)	69
Appendix D3 Strength Properties (CBR)	70
Appendix D4 Atterberg Limits	71
Appendix D5 Grading	72
Appendix E CDA Stabilized Samples	74
Appendix E1 Compaction Properties (MDD & OMC)	74
Appendix E2 Strength Properties (UCS)	75
Appendix E3 Strength Properties (CBR)	76
Appendix E4 Atterberg Limits	77
Appendix E5 Grading	78

## LIST OF TABLES

Table 1-1: Road Classifications in Kenya	3
Table 2-1: Chemical composition of Bagasse Ash	15
Table 2-2: Chemical composition of manures and urines of different farmed animals	19
Table 2-3: Cube strength of cubes for each curing period	20
Table 2-4: Workability results	20
Table 2-5: Chemical composition	21
Table 2-6: Chemical Composition of CDA from several sources and OPC	22
Table 2-7: Compressive strength	23
Table 2-8: Chemical properties of CDA	23
Table 2-9: Good Gravel Material for Surface Gravel roads	26
Table 4-1: Index properties of Lateritic Gravel	41
Table 4-2: Chemical composition of FCD sample	42
Table 4-3: Chemical composition of CDA sample.	43
Table 4-4: FCD Stabilized Material Atterberg Limits	49
Table 4-5: CDA Stabilized Material Atterberg Limits	50

## LIST OF FIGURES

Figure 2-1: Cement Stabilized Material	8
Figure 2-2: Compressive Strength vs % Replacement of CDA	24
Figure 2-3 Gravel Wearing Course Specifications	25
Figure 2-4: Conceptual framework for mechanical stabilization	28
Figure 2-5: Conceptual framework for chemical stabilization	29
Figure 3-1: Sampling Location in Membley	31
Figure 3-2: Methodology Flow Chart	33
Figure 4-1: Maximum dry density (MDD) values for FCD stabilized material.	44
Figure 4-2: Optimum moisture content values for FCD stabilized material	44
Figure 4-3: Optimum moisture content values for CDA stabilized material.	45
Figure 4-4: Optimum moisture content for CDA stabilized material.	45
Figure 4-5: Unconfined compressive strength values for FCD stabilized material	46
Figure 4-6: California bearing ratio values for FCD stabilized material.	46
Figure 4-7: California bearing ratio values for CDA stabilized material	47
Figure 4-8: Unconfined compressive strength values for CDA stabilized material.	48
Figure 4-9: Grading values for FCD stabilized material	51
Figure 4-10: Grading values for CDA stabilized material.	52

## LIST OF PLATES

Plate 1-1: Dust on gravel roads
Plate 2-1: Step 1 -Materials17
Plate 2-2: Step 2 -Mixing the material
Plate 2-3: Step 3 -Mixing the materials slowly with water
Plate 2-4: Step 4 -Smearing the dung evenly
Plate 2-5: Step 5 -Drying
Plate 3-1: Removing of foreign materials
Plate 3-2: Sieving using 20mm sieve
Plate 3-3: Burning in Kiln
Plate 3-4: Cooling after Burning in kiln
Plate 3-5: Final product after sieving
Plate 3-6: FCD stabilizer
Plate 3-7: Mixing FCD with soil
Plate 3-8: Water mesurement
Plate 3-9: Moulding
Plate 3-10: Water draining
Plate 3-11: CBR Testing
Plate 3-12: Moulds after Testing
Plate 3-13: CDA stabilizer
Plate 3-14: Mixing CDA with soil
Plate 3-15: Final mixture ready for moulding
Plate 3-16: UCS sample preparation
Plate 3-17: UCS Testing

Plate 3-18: UCS Failed samples after Testing	37
Plate 3-19: Sieved Sample	
Plate 3-20: Atterberg Limits apparatus	
Plate 3-21: Penetrometer apparatus	
Plate 3-22: Mixing	
Plate 3-23: Cup filled with sample	
Plate 3-24: Testing for Liquid Limit	
Plate 3-25: Rolling the samples	
Plate 3-26: Sample for plastic limit	

## LIST OF ABBREVIATIONS

AASHTO	American Association of State Highway and Transportation Officials	
ASTM	American Society for Testing and Materials	
CBR	California Bearing Ratio	
CDA	Cow Dung Ash	
FCD	Fresh Cow Dung	
KENHA	<b>KENHA</b> Kenya National Highways Authority	
MDD	Maximum Dry Density	
OMC	Optimum Moisture Content	
UCS	<b>CS</b> Unconfined Compressive Strength	
XRF	XRFX-ray Fluorescence	
SG	Specific Gravity	

### **CHAPTER 1: INTRODUCTION**

#### **1.0 Background**

The main reason why some roads remain surfaced but not paved is primarily due to the economics of scale. This is because, it is less expensive to build roadways out of compacted earth or gravel rather than concrete, which would satisfy the need to carry vehicles over without the ramping costs of pavement which are often not justifiable in areas receiving very little heavy vehicular traffic. However, the challenge associated with this is dirt and gravel roads are not as resilient as a paved surfaces. The loose aggregate nature of their surfaces makes them vulnerable to gradual erosion by the wind. Sudden torrential rains can rapidly accelerate the erosion of the road's surface, making the roadway difficult or impossible to traverse. Because of this, roads made from gravel and dirt are rarely a smooth ride, and gradual erosion is often enough to create a bumpy surface. This is usually worsened in the wake of a downpour, which would develop potholes and unpassable areas of mud (Burchcom, 2021).

A study carried out by the Korea Institute of Civil Engineering and Building Technology, on the use of soil-stabilized roads as a cost-effective alternative to traditional paving (Technology, 2018). The study was carried out in urban and rural areas in Southeast Asian countries, including Thailand and Malaysia, and they found that rural areas suffered from poor road infrastructure. They also found out that the soil in countryside areas was alike, weathered and was simply washed away by a slight quantity of rainfall that causes settlement and slurry, rendering the farm roads impassable. The cost to cover the road with tarmac or concrete was high and the government could not afford it hence the need to find other cost-effective methods to stabilize the roads (Technology, 2018). The service life of concrete paved farm roads was estimated to be two years due to the soft roadbed and the maintenance expenses for such roads were high every year. The alternative to asphalt or concrete roads were surface stabilized soil with a mixture of cement, pozzolan, lime and inorganic salt in an absolute ratio, which coagulates when it reacts with cement and additives. The result is, it forms long-term, strong stable ground in a short time on any type of soft base (Technology, 2018).

The majority of rural roads in Sub-Saharan Africa are unpaved (gravel & earth) roads (Ngezahayo, 2019). These roads act as links on day-to-day activities and benefits to the rural communities, they ack as links to farms, and access to social amenities like hospitals, and trade centres and they are used in transporting farm produce to the market. The key challenges faced by the rural roads in Sub-Saharan Africa during construction and maintenance activities are Lack of funding and engineering technology. Following these challenges, these roads are generally in a destitute condition. During the rainy season, they become nearly impassable, this is due to erosion processes that severely damage them. As a result, the communities using these roads suffer due to the poor transport of both goods and services. The overall result is that the country's development is hindered due to the inaccessibility of the farms to transport farm produce and people to market on time (Ngezahayo, 2019).

Mwaipungu and Allopi (2014) surveyed the quality control of the gravel materials used in the maintenance of gravel roads. they aimed to find out if the approvals and environmental impact assessment were sought by the organizations tasked with the maintenance of the gravel roads laid down by the Ministry responsible for mining before opening new borrow pits to harvest gravel soil. The results showed 70% of the respondents said that they do not look for approval and do not conduct environmental impact assessments, while 9.5% do environmental impact assessments through contractors who have been awarded construction or maintenance works. Another 40% of the respondents said they do not determine the geological nature of these borrow pits due to the scarcity of materials laboratories with such capacity. The active laboratories for conducting such tests are in Dodoma and Dar es Salaam regions (Mwaipungu, 2014).

According to Kenya National Highways Authority (KENHA), Kenya has about 63,575 km out of 177,800km of the classified road network. Table 1-1 gives a summary of the classified road network in Kenya as of 2019 from 41,800km at independence in 1963 (KENHA, 2019).

Gravel and earth roads form the major category of roads in Kenya. About 85% of the total road network is gravel and earth roads (KENHA, 2019). In Kenya, lateritic gravel

is used to build gravel and earth roads.

No	Road Class	Class Surface Type and Length (km) Tot			Total	
		Premix	Surface dressing	Gravel	Earth	
1.	International	1,245	1,564	715	95	3,619
	Trunk Roads (A)					
2.	National Roads (B)	350	1,166	819	346	2,681
3.	Primary Roads I	643	2,198	3,602	1,553	7,996
4.	Secondary Roads (D)	77	1,183	5,702	4,088	11,050
5.	Minor Roads I	166	542	8,216	17,983	26,907
6.	Special Purpose Roads	25	115	4,930	6,254	11,324
	All classes	2,506	6,768	23,984	30,319	63,577

Table 1-1: Road Classifications in Kenya (KENHA, 2019)

Gravels roads require frequent periodic maintenance as compared to paved roads. The effects of rain are more on gravel roads, especially when poorly drained. The major challenges associated with gravel roads are poor drainage and lack of proper compaction which results in rutting. Good drainage and proper compaction of the gravel roads can help to withstand the traffic loads.

Heavy amounts of rainfall on unpaved roads, can result in an uncomfortable drive. According to the report by the Federal Highway Administration (FHWA) the formation of periodic, transverse ripples in the surface of gravel also known as washboarding, is caused by; driving behaviours, dryness, inferior quality of gravel and lack of cover on the road surface. There is a need for correct classification of the gravel soil in terms of quality and strength of the gravel soil, as this will help to eliminate the corrugations and rebuild with a precise choice of sound quality gravel material to inhibit their restructuring.

In addition, dust on gravel roads is very common as shown in Plate 1-1. Dust control remains the biggest challenge facing most of the unpaved roads in rural areas, thus if these roads are well paved this will result in;

- 1. Decrease frequent periodic maintenance,
- 2. Alleviate well-being concerns, and
- 3. To avoid dust-related damage to wayside flora.



Plate 1-1: Dust on gravel roads (Google)

As days go by, there is a high demand for durable gravel roads, for this to happen there is a need to stabilize the gravel soil to be used. There exist two types of stabilization of the material conventional stabilizers like cement and lime and non-conventional stabilizers like, fly ash. Conventional stabilizers have been studied and well-documented in their application. However, for non-conventional stabilizers there exists less research on their application. More stabilizers are under research. Therefore, this research Investigates the pozzolanic ability of both FCD CDA aimed at stabilizing the gravel soil to be used on gravel pavement construction.

FCD possesses binding properties and controls dust as used in rural homes. Based on the chemical composition, Duna & Omoniyi, (2014) classified CDA as a class N pozzolan. Hence, this study seeks to investigate the pozzolanic ability of FCD as well as CDA for gravel pavement construction.

## **1.1 Problem Statement**

Lack of funding is the greatest challenge facing rural roads in Sub-Saharan Africa are (Ngezahayo, 2019). The reliability of conventional stabilizers like cement and lime has led to the low development of rural roads. This is because they are expensive and hence they are not affordable to the majority of the local (county) governments. There have been numerous technological advancements in the stabilization of soils to date. Many stabilizers like polymers, resins, fibers, chlorides, geosynthetics, cement, lime, fly ash,

and bitumen are being used in soil stabilization no matter how costly and "non-green" they are. Their production releases greenhouse gases that lead to climate change and the raw materials like limestone and iron ore being natural resources their continuous mining diminishes over time.

However, little is known about the use of non-traditional green sustainable stabilizers such as FCD and CDA. Further research needs to be carried out to govern the adequacy of non-traditional soil stabilizers and their effectiveness in the modification of engineering properties of soil. Some research has shown that CDA can be used in concrete. Fewer studies have been done on soil stabilization with CDA. No research exists to document the performance of FCD on soil stabilization. The use of FCD and CDA are less expensive, naturally occurring, and low energy consumption in their production and transportation hence sustainable materials. They can be produced annually and their contribution towards climate change is minimal.

Hence, this study is aimed at stabilizing lateritic soil with FCD and CDA to improve its engineering properties in the construction of gravel and earth roads.

## **1.2 Research Objective**

The research objective of this research is to evaluate and optimize the pozzolanic potentials of fresh cow dung and cow dung ash for gravel road construction.

### **1.2.1** The specific objectives of this research are:

- 1. To determine the effects of FCD and CDA on the grading of lateritic gravel as a soil stabilizer.
- 2. To determine the effects of FCD and CDA on compaction properties maximum dry densities (MDD), and optimum moisture content (OMC) of lateritic gravel as a soil stabilizer.
- 3. To determine the effects of FCD and CDA on bearing strengths CBR, and UCS of lateritic gravel as a stabilizer.
- 4. To determine the effects of FCD and CDA on the plasticity requirements of lateritic gravel as a soil stabilizer.

## **1.3 Research Questions**

- 1. Does the use of FCD and CDA as a stabilizer improve the grading of the lateritic gravel?
- 2. Does the use of FCD and CDA as a stabilizer improve the compaction properties of the lateritic gravel?
- 3. Does the use of FCD and CDA as a stabilizer improve the bearing strengths, CBR, and UCS of the lateritic gravel?
- 4. Does the use of FCD and CDA as a stabilizer improve the plasticity requirements of the lateritic gravel?

## **1.4 The Scope of Study**

The scope of this study is to investigate the index properties of the lateritic gravel, chemical and physical characterization of FCD & CDA, Compaction tests, CBR, UCS, and grading which were done on neat and stabilized lateritic gravel soil.

## **1.5 The Justification for the Study**

This research aims to solve the problems associated with duts on unpaved roads in rural areas like respiratory and cardiovascular health problems, irritation to eyes, skin and throat to the road users and the effects on the plants planted on the way side which leads to low harvest when the dust is so much. The above causes losses to both economic and social activities.

## 1.6 The Limitations of the Study

At the time of writing this thesis, there was no material available on the ways the preparation for the FCD as a stabilizer on lateritic gravel roads. Also, the preparation of CDA was done in two stages, the FCD cakes were first burnt in the open air, then the ash was collected and taken to the kiln and burnt at 500<sup>o</sup>c for 8 hours then cooled overnight. The main reason for first burning the FCD cakes in the open air was the smoke, this was because the kiln is located at the main campus of the University of Nairobi this meant the mechanical laboratory and the offices around the laboratory would have out-of-bounce for the entire period. The other point was I was allowed to use the kiln during the day only this was because the kiln required close supervision.

#### **CHAPTER 2: LITERATURE REVIEW**

#### **2.0 Introduction**

Cement and lime are the conventional whose properties are well documented and their efficiency has been verified through research and practical application. This literature evaluation aims to explore the works of other researchers in investigating the stabilization of soils using non-traditional stabilizers on engineering properties of soil, this research aims to review the stabilization of soils using non-traditional stabilizers.

#### 2.1 Soil Stabilization

Soil stabilization is a chemical or physical treatment of soil to improve its properties modifying its natural characteristics. Soil stabilization can be achieved in two ways, mechanical or chemical methods.

Mechanical stabilization is the physical process by which the physical properties of the soil structure are altered. Chemical stabilization is attained through chemical reactions between chemical addition (cementitious matter) plus soil limestones (pozzolanic materials) towards the required result. Soil stabilization is done for strength (load-bearing capacity) improvement, dust control, and soil waterproofing (Mwanga, 2015).

## 2.2 Conventional Soil Stabilizers

## 2.2.1 Lime Stabilization

Soil-lime stabilization is mixing soil with lime (calcium oxide-CaO) in the correct proportion. The lime reacts well with clay soils, particularly with a modest to high plasticity index (PI>15). Lime can modify almost all fine-grained soils however the best modification is in clay soils relative to extreme plasticity. Alteration occurs when calcium cations from hydrated lime (calcium hydroxide-Ca(OH)<sub>2</sub>) replace the cations present in the clay minerals, this reaction is enabled by the alkaline condition of the lime-water system. This reaction yields the following aids; Plasticity decrease, decrease in moisture-holding capacity (aeration), a bulge lessening, Enhanced stability and the capacity to build a dense working platform (Mwanga, 2015).

Soils stabilized with lime are supposed to be tested for: California bearing ratio (CBR), unconfined compressive strength (UCS), atterberg limits and particle size distribution.

The addition of 4 to 6% of lime is usually required to reduce the Plasticity index to less than 20, increase the shrinkage limit, reduction in the swell, increase CBR (10 for 7 days cure and 15 for 28 days cure) and modification of particle size distribution to similar to that of silt. Soil-lime stabilization is comparatively expensive in treating bulk clay soils, consequently, there are problems in acquiring a uniform and intimate mix (Ministry of Transport and Communications, 1987).

## 2.2.2 Portland Cement

Soil-cement stabilization is mixing soil and cement in correct proportions with water, compressing towards the required density and then curing. When a well-graded aggregate with adequate fines fills the voids if the coarse aggregates are stabilized with cement, the binder will improve the following properties: strength, compressibility, penetrability, swelling ability, ice vulnerability and responsiveness to changes in moisture content. Cement-stabilized materials are rigid or semi-rigid hence CBR is meaningless. The requirements for cement-stabilized soils are shown in Figure 2-1.

FOR BASE			
MATERIAL REQUIREMENTS			
Materials Before Treatment	Cement		
Experience has shown that materials which	Ordinary Portland Cement(KS		
Comply with the following requirement are	02-21) without any addition.		
generally suitable for improvement.			
Grading	Amounts usually required:		
Maximum size 2 - 40mm	Plastic Gravel 5 – 8%		
Passing 0.075 mm sieve Max. 35%	Clayey sands $5 - 7\%$		
Uniformly coefficient Min. 10			
Plasticity Index: Max. 25	· · · · · · · · · · · · · · · · · · ·		
Plasticity Modulus:			
Mix in place Min. 1,500			
Mix in plant Max. 700			
Soaked CBR Min 30			
Organic matter: Max. 0.5%			
Treated Material			
UCS of laboratory mix at 95% MDD (Modified AASHTO) and 7 days cure + 7 days			
soak: min. 1,800 kN/m <sup>2</sup>	incu mistri () and / days cure + / days		
,	lus May 250 (Calculated)		
Plasticity Index: Max. 6%, Plasticity Modu	ius max. 200 (Calculated)		
TDAFEIC I IMITATIONS none			

TRAFFIC LIMITATIONS none

Figure 2-1: Cement Stabilized Material (Ministry of Transport and Communications, 1987)

The UCS is the most convenient test for soil-cement mixtures. A minimum of UCS 1,800kN/m<sup>2</sup> is required on the laboratory mix, compacted at 95% MDD (modified AASHTO) after 7 days cure and 7 days soak (Ministry of Transport and Communications, 1987).

## 2.2.3 Fly-ash

Fly-ash is a by-product of burning coal. it contains amorphous oxide (mainly  $SiO_2$ ,  $Al_2O_3$ ), and metal oxides i.e.  $TiO_2$ ,  $Fe_2O_3$ , MnO, MgO, CaO, Na<sub>2</sub>O, K<sub>2</sub>O, P<sub>2</sub>O<sub>5</sub>, SO<sub>3</sub> and organic carbons hence, it has pozzolanic properties (Andavan & Pagadala, 2020).

Type "C" and type "F" are the two types of fly ash. This categorization is founded on chemical composition. Fly ash type "C" contains more than 20% of lime but has high silicate content, and does not require an activator while Class F fly ash has less than 7% lime (CaO) but has low silicate content. The standard adopted in choosing fly ash as a soil stabilizing agent is well described in (ASTM C593-19, 2019).

#### 2.3 Non-traditional stabilizers

An evaluation of the results of a few types of research conducted on non-traditional stabilizers namely salt, polymers, molasses, bio-enzymes, and ashes of agro-by-products. to examine the performance of soil stabilization.

## 2.3.1 Salts

Abood, *et al.* (2007) investigated the effect of stabilizing silty clay using salts as a stabilizer in the ratios of 2, 4, and 8% by dry weight of NaCl, MgCl<sub>2</sub> & CaCl<sub>2</sub>. The silty clay soil sample (from the south of Iraq) was taken one metre deep below the ground surface. The compaction properties were conducted according to ASTM (D 1557), and consistency limits and compressive strength were examined. MDD improved from 17.5 kN/m<sup>3</sup> to 19.0 kN/m<sup>3</sup> and OMC reduced from 15% to 13%. The Atterberg Limits were carried out using the Cassagrande apparatus according to ASTM (D423-66). decreased with the increase in salt content. The UCS conducted according to ASTM (D2166-65) increased as the salt content increased (Abood, et al., 2007).

Jaffer, (2013) also investigated the results of adding chloride salts (NaCl, MgCl<sub>2</sub> and CaCl<sub>2</sub>) to a sample of silty clay soil (from the south of Iraq). Where the percentage (2%, 4%, and 8%) of salt were added to the soil then the following studies were carried out, the effect of salts on the compaction characteristics carried out conferring to ASTM (D 1557), atterberg limits were carried out using the Cassagrande apparatus according to ASTM (D423-66), and unconfined compressive strength (UCS) conducted according to ASTM (D2166-65). The results showed the compaction properties showed there was an increase in MDD and a decrease in OMC as the salt content was increased. The liquid limit, plastic limit, and plasticity index decreased with increasing salt content. The unconfined compressive strength (UCS) increased with the increase in salt content (Jafer, 2013).

### 2.3.2 Polymers

Guo Liuhui (2014) evaluated the effects of biopolymer, the results were the sand stabilized with Polymer the shear strength increased compared to that of 8% cement-stabilized sand, and a healing potential was evident. The study also showed that the biopolymer being more eco-friendly, may provide a more sustainable alternative to traditional stabilization methods like cement and lime and still offer both environmental and economic benefits (Guo, 2014).

Naseer *et al.* (2018) investigated the use of acrylic polymer for the stabilization of clayey soil, six different formulations were studied containing different percentages ranging from 0%, 2%, 4%, 6% 8% & 10% of acrylic polymer and cured for 3, 7 & 14 days. The maximum dry density (MDD) was attained with a 6% concentration of acrylic polymer. It was noted that the liquid limit (LL) decreases as the amount of the acrylic polymer increases. Whereas, the plastic limit (PL) increases with increasing the acrylic concentration. The maximum unconfined compressive strength (UCS) was attained with 6% replacement with acrylic polymer, whereas the California bearing ratio (CBR) attained a maximum increment at 6% addition of stabilizer compared to the untreated soil. After 14 days of curing and testing, the above results were attained (Naseer, et al., 2018).

Torio-Kaimo et al. (2020) studied the effects of UCS on clay strengthened with

kerosene-treated coir fiber. The results were, Coir fiber had the highest tensile strength but it also had a very slow rate of biodegradation among natural fibers. The preliminary soil test performed classified the material as high-plasticity clay (CH), and kerosene reduced the moisture intake of coir by 170%. The samples with fiber concentrations ranging from 0% to 2% by dry weight of soil were tested for UCS in optimum moisture and dry states. At 1.5% fibre content, the coir enhanced the strength and stress-strain response of high-plasticity clay by 52% as compared to unreinforced samples, the ductility in the coir-reinforced samples tested at optimum moisture conditions. There was an increase in the elastic modulus, by 78%. (Torio-Kaimo, et al., 2020).

#### 2.3.3 Molasses

M'Ndegwa, (2011) investigated the improvement of expansive clay soil using cane molasses as a stabilizer material. The molasses content in the soil ranging from 4 to 14 % by weight of air-dried soil. The specific gravity (SG) of the molasses was 1.46. The optimum cane molasses used in stabilizing the expansive clay soil was 8%. This gave the highest value of CBR. It was also found that when expansive clay soils were mixed with molasses, the swelling of the expansive clay soil was reduced (M'Ndegwa, 2011).

Ravi *et al.* (2015) studied the effect of molasses on strength of soil both compressible Clay (CI) and Highly Compressible Clay (CH). The results showed that with 6% of molasses, the UCS of both CI and CH increased by 94%. CBR also increased by 6.37% when 6% of molasses was added. With the increased values of both UCS and CBR, showed that molasses took part in the enhancement of soil cohesion. (Ravi, et al., 2015).

Mwanga, (2015), investigated the molasses as a stabilizer in the stabilization of silt clay to be used as the inner zone for small dam embankment construction, the soil was improved by adding 5.0%, 5.5%, 6.0% 6.5%, 7.0% and 7.5% of molasses. The silt clay stabilized by adding 6.5% molasses showed an improvement of MDD from 18.5 kN/m<sup>3</sup> to 19.40 kN/m<sup>3</sup>, and the bulk density increased from 21.0 kN/m<sup>3</sup> to 21.34 kN/m<sup>3</sup>. The improvement in MDD and bulk density of the soil could be attributed to an increase in cohesion and a fill of voids in the soil. The OMC of the soil dropped from 12.0% to 10.0% with the increase in molasses. The recommended percentage of

molasses to be used in stabilizing the silt clay to be used for a dam embarkment construction ranges between 6% - 6.5%. (Mwanga, 2015).

Prudhvi & Kameswar rao. (2017) investigated the stabilization of gravel soil by using molasses-lime with different amounts of molasses-lime 0%, 5%, 10%, 15%, 20% and 25%. An optimum of 10% of molasses was found to increase the MDD of soil from 1,890 Kg/m<sup>3</sup> to 1,933 Kg/m<sup>3</sup>. The OMC of soil increased from 10.0% to 12.0% with the increase in molasses-lime percentage. The above results have shown that the stabilization of soil with molasses and lime increased the strength properties of soil by using 7% to 10% of molasses and lime (Prudhvi & Kameswar rao, 2017).

Amunga (2020) investigated the stabilization of lateritic gravel using molasses as a stabilizer for unpaved rural roads, the roads studied were in Butere and Mumias both in Kakamega County. 1%, 2%, 3% and 4% were the mix ratios of the molasses by dry weight of the laterite gravel. The lateritic gravel mixed with 2% of the molasses by dry weight the results showed the MDD increased from 1712 to 2100 Kg/m<sup>3</sup>, the strength properties improved both UCS increased from 154 to 272 kN/m<sup>3</sup> and the CBR improved from 19 to 62 %. The plasticity index dropped from 20 to 13. This improvement was attributed to the increase in density of the stabilized laterite gravel soil, which was brought about by the improved binding capacity ad this increased the strength of the soil mass. (Amunga, 2020).

#### 2.3.4 Bio-enzymes

Agarwal *et al.* (2014) investigated the stabilization of black cotton soil using the Terrazyme bio-enzyme. The UCS was determined by adding the Terrazyme bio-enzyme to the black cotton soil at various dosages as (0.0, 0.25ml, 0.5ml, 0.75ml, 1.0ml, 2.0ml, 3.0ml, and 4.0ml/per 5kg of soil) then the stabilized soil was allowed one and seven days of curing. The results showed that a sample stabilized with 1ml/per 5kg of bio-enzyme, and cured for 7 days, gave higher strength values of the treated soil samples. Therefore the optimum dosage of Terrazyme bio-enzyme was 1ml/per 5kg of soil (Agarwal, et al., 2014).

Panchal *et al.* (2017) studied the effect of ground improvement using Terrazyme a bioenzyme used for improving the CBR value in road construction. Terrazyme is made from the fermentation of plants, vegetable extract and fruit extract which makes it a natural, non-toxic and liquid enzyme. Terrazyme was used as a soil stabilizer to improve the CBR value in road construction materials. The Terrazyme dosages were taken as 500ml/m<sup>3</sup>, 700ml/m<sup>3</sup>, 900ml/m<sup>3</sup> and 1000ml/m<sup>3</sup> per m<sup>3</sup> of the soil sample. After stabilization, the samples were cured for 7, 14 and 28 days respectively, after which the results were analyzed. The highest CBR value was observed with the third dosage (900ml/m<sup>3</sup>) with two weeks (14 days) curing periods and percentage increment as compared to the untreated soil sample (Panchal, et al., 2017).

Mugada & Nagaraj. (2019) studied the effect of Terrazyme bio-enzyme on plasticity and UCS characteristics of earthen construction material. The dosages of the enzymes used were 0.025, 0.039, 0.050, and 0.065ml/kg of soil. The stabilized samples were cured for 7, 14, 30 and 60 days. The results showed that the plastic and shrinkage limits increased with the increase in enzyme dosage and the curing period. Whereas the liquid limit decreased with an increase in dosage of enzyme and curing period, the UCS increased with the increase of Terrazyme bio-enzyme and the prolonged curing time, another observation made was that the sealed curing condition of the soil was found to be more effective than wet curing method (Muguda & Nagaraj, 2019).

#### 2.3.5 Ashes of Agro-byproducts

Soil stabilization by use of different stabilizers namely; rice husk ash (RHA), sugarcane bagasse ash (SCBA), and CDA was studied. RHA, SCBA and CDA were blended with untreated soil in the ratios of 0%, 2.5%, 5%, 7.5%, 10%, and 12.5% by weight. After testing the MDD of the soil reduces while the OMC increases following stabilization. This can be attributed to the increase in mix proportion and reduction in the amount of free silt, the clay portion and coarser materials with a large establishment of surface area, while the decrease in MDD can be attributed to the addition of ash which had a lower specific gravity to that of the soil. The unsoaked and soaked CBR and UCS achieved an optimum at 7.5% of ash. The unsoaked CBR improvement may have been brought about by the creation of calcium silicates after the reaction of silica from ash from the mixed stabilizers and calcium from the alluvial soil. whereas the soaked CBR and UCS were accredited to the gradual formation of cementitious compounds between the ashes of the mixed stabilizers and calcium hydroxide contained in the alluvial soil.

The decrease in the soaked CBR after 7.5% ash content could be attributed to the excess ash that was not used in the reaction, which therefore inhabits spaces within the sample and therefore reduces bonds in the soil–ash mixtures. (Yadav, et al., 2017).

#### 2.3.6 Groundnut Shell Ash

A study was carried out on the stabilization of black cotton soil using groundnut shell ash (GSA) as a stabilizer. The classification of regur soil using the AASHTO soil classification system was classified as A-7-6. The study was carried out in Nigeria to advance the engineering properties of black cotton soil. The results showed that as the OMC increased with the increase of GSA as a stabilizer, on the other hand, the MDD was decreasing with the increase in GSA as a stabilizer at the standard Proctor compaction energy. The peak CBR obtained was 6% at 8% GSA which was lower than the 80% CBR standard recommended for untreated base course materials. Hence the above value failed the recommended criterion for subgrade materials. The UCS at 7 days was lower than the 1034kN/m<sup>2</sup> evaluation standard recommended by TRRL (1977) for adequate stabilization. It was therefore recommended that groundnut shell ash could be used as an admixture with a more potent stabilizer compacted at standard Proctor compaction to reduce the cost of stabilization (Ijimdiya, et al., 2012).

The results of the atterberg limits presented showed the liquid limit increased from 83 % natural black cotton soil to 103 % stabilized black cotton soil with 10% GSA stabilizer. The improvement in liquid limit could be attributed to the flocculation and aggregation of the clay particles and the additional reduction in surface area and increase in strength. The plastic limits of GSA-treated black cotton soil decreased from 44% to 23% for soil stabilized with 2% GSA increased gradually with an increase in dosages of GSA and this could be attributed to the increase in the amount of fines content. This alteration of soil character occurred due to bi-valent calcium ions supplied by the GSA replacing less firmly attached monovalent ions in the double layer surrounding the clay particles. This according to O'Flaherty (1974) tends to decrease the thickness of the double layer and to depress the zeta potential (that is, a measure of the effectiveness of the particle's negative charges in repelling a second particle) thereby causing flocculation and agglomeration. (Ijimdiya, et al., 2012).

#### 2.3.7 Bagasse Ash

Amit *et al.* (2014) investigated the low bearing capacity, low permeability, and high compressibility of black cotton soil. The chemical characterization of the bagasse ash was as shown in Table 2-2. According to ASTM C618 (2001), for any material to be considered to have pozzolanic properties, the combination of Al<sub>2</sub>O<sub>3</sub>, SiO<sub>2</sub> and Fe<sub>2</sub>O<sub>3</sub> should be above 70% as a minimum. For the bagasse ash, it was found that the combination was 80.61% which was greater than the 70% minimum recommended as recommended in ASTM C618 (2001). The percentage composition of MgO was 0.85% which was less than the 5% stated in the standard and Na<sub>2</sub>O was spotted at 1.05% a value below 1.5% and this showed a pozzolanic action according to ASTM C618 (2001).

 Chemical composition of Bagasse Ash (Suryavanshi, et al., 2014)

 Chemical composition Bagasse Ash Oxide (%)

SiO <sub>2</sub>	Al <sub>2</sub> O <sub>3</sub>	Fe <sub>2</sub> O <sub>3</sub>	CaO	MgO	K <sub>2</sub> O	Na <sub>2</sub> O
64.38	11.67	4.56	10.26	0.85	3.57	1.05

The specific gravity (SG) of bagasse ash was found to be 1.306, and the stabilization of black cotton soil with bagasse ash was carried out by blending the soil with different percentages of bagasse ash (3%, 6%, 9% and 12%). The effective percentage replacement of bagasse ash was found to be 6%. The MDD increased by 6 %, CBR increased by 42 % and compressive strength increased by 44 %. The blend suggested by this research is black cotton soil + 6% replacement by bagasse ash, without any addition of bonding or chemical material, this would be an economic approach (Suryavanshi, et al., 2014).

### 2.4 Applications of Fresh Cow Dung

Yalley and Manu (2013) investigated the strength and durability properties of earth brick stabilized with cow dung. Where the local soil (from the Sunyani Polytechnic area of Ghana) was used. The compressive strength of the earth bricks improved with 20% cow dung by dry weight as a stabilizer. The bricks also had a dry and wet compressive strength of 6.64 and 2.27 MPa respectively. The compressive strength increased by 25% in the dry compressive strength of bricks stabilized with 20% cow dung content as compared to the unstabilized earth brick. The 20% cow dung content resulted in lower permeability of water into the brick. And the abrasive resistance increased with 20% cow dung content.

After immersion in water for 10 minutes, the compressive strength of the stabilized bricks decreased, despite the optimum Cow dung content, this showed the design of the stabilized earth bricks not come into direct conduct with rainwater if they were to last in any construction (Yalley & Manu, 2013).

Millogo, *et al.* (2016) investigated the effects of cow dung on micro-structural changes in earth blocks (adobes) X-ray diffraction (XRD) was used among other methods. They aimed to evaluate the effects of these changes on the physical properties (water absorption and linear shrinkage) and mechanical properties (flexural and compressive strengths) of adobe blocks. The results showed that cow dung reacted with kaolinite and fine quartz to produce insoluble silicate amine, which joined the isolated soil particles together. Moreover, the significant presence of fibres in cow dung prevents the propagation of cracks in the adobes and thus reinforces the material. The above phenomena make the adobe microstructure homogeneous with an apparent reduction of the porosity. The major effect of cow-dung additions is a significant improvement in the water-resistance of adobe, which led to the conclusion that adobes stabilized by cow-dung were suitable as building materials in wet environments (Millogo, et al., 2016).

Mbereyaho, *et al.* (2020) investigated the cohesive soil mixed with cow dung as a replacement for cement to be used for simple plastering works, the cohesive soil was extracted from one of the local sites (in Rwanda) mixed with various percentages of cow dung 10%, 20%, 30% & 40%. The cohesive soil was sieved to extract organic matter, and then the Atterberg limits test was conducted to establish the cohesive status of the soils. The cow dung was mixed with the cohesive and the respective cubes of 100mmx100mmx100mm 12 cubes in total, 3 cubes for each sample were moulded. The cohesive soil average specific gravity was 2.603 and this value was in line with standards as it should range between 2.6 - 2.8 following (ASTM D 854-92).

The mixture was then compacted manually using a metallic tamping rod severally over one layer and they were kept for 3 days in water for the water absorption test. Later they were dried for 28 days in an open-air space before they were tested accordingly. The liquid limit  $(W_L)$  was 40.785%, the plastic liquid  $(W_P)$  was 23.0% and the plasticity index  $(I_P)$  was 17.785%. The best water absorption for all cubes was found to be 19.82 on average which

corresponded to 20% of cow dung content.

In the cohesive soil mortar mixed with cow dung from 10% to 20%, the shrinkage increased from 24.6 to 25.3%, and then it decreased to 24 and 23% respectively at 30% and 40% of the cow dung content. The durability test was conducted visually and it showed that no cracks in the plastered mortar were well attached to the wall. The content of 20% of cow dung could be considered a low-cost alternative construction material to cement mortar for some structural members under normal conditions this is because it showed better properties and higher durability. To avoid earlier shrinkage and cracks in mortar due to spontaneous drying by the sun, this mortar should not be left in an open area for at least an earlier stage of seven days (Mbereyaho, et al., 2020).

Most rural homes in Kenya use cow dung smear coating, bi-monthly in keeping their homes clean and dust-free as shown; Plates 2-1 show the mixing of the materials required which are water, dudu dust (to prevent insects and worms invasion into the house) and the cow dung. Plates 2-2 & 2-3 show the mixing of the materials before smearing them on the mud house. Plate 2-4 shows the actual smearing of the mixed material in the house and finally Plate 2-5 shows after smearing the mixed material it is left for a while to dry before stepping on it.



Plate 2-1: Step 1 -Materials (Sand, FCD, Water & Dudu Dust) (Google)



Plate 2-2: Step 2 -Mixing the material (Google)



Plate 2-3: Step 3 -Mixing the materials slowly with water (Google)



Plate 2-4: Step 4 -Smearing the dung evenly (Google)



Plate 2-5: Step 5 -Drying (Google)

Miner and Smith (1975), and NACA (1989) carried out a chemical composition of both manure and urine for different farmed animals namely; cows, oxen, pigs, chickens and horses as shown in Table 2-2. From the results, the percentage of organic material for all the animals was the highest and this is an indication that the binding properties in the respective manure and urine could be a result of the organic material which are act as a binder.

	Dairy	Beef	Ox	Pig	Chicken	Chicken	Horse	Milk cow	Cow	Pig	Cow	Pig
	cattle	cattle			layers	broiler		dung	dung	manure	urine	urine
Dry as % of fresh manure	12.7	11.6	25	9.2	25.2	25.2	20.9	15	10-15	15	5-7	7
Dry matter (%)	100	100	100	100	100	100	100	15	10-15	15	5-7	7
Organic material (%)	82.5	85	85	80	70	70	80	11.4	14.6	15	2.3	2.5
Total nitrogen (%)	3.9	4.9	4.5	7.5	5.4	6.8	2.9	0.36	0.30- 0.45	0.50-0.60	0.60- 1.20	0.30- 0.50
Total phosphorous (%)	0.7	1.6	0.7	2.5	2.1	1.5	0.5	0.32	0.15- 0.25	0.45-0.60	trace	0.07- 0.15
Total potassium (%)	2.6	3.6	3.2	4.9	2.3	2.1	1.8	0.2	0.32	0.35-0.50	1.30- 1.40	0.20- 0.70
Biological oxygen demand <sup>5 days</sup>	16.5	23	9	33	27	-	-	-	-	-	-	-
Chemical oxygen demand	88	95	11.8	95	90	-	-	-	-	-	-	-
Source <sup>1</sup>	1	1	1	1	1	1	1	2	2	2	2	2

Table 2-2: Chemical composition of manures and urines of different farmed animals

Source: (1) Miner and Smith (1975); (2) NACA (1989).

## 2.5 Applications of Cow Dung Ash

Ojedokun *et al.* (2014) studied the outcomes of adding CDA as a partial replacement of cement in several ratios by weight (0%, 10%, 20% and 30%) of cement a total of 16 cubes were cast whose sizes were 150mmx150mmx150mm. The cubes were cured for a period of 7, 14, 21 and 28 days respectively before compressive strengths testing. CDA concrete was recommended for use only when 10% of CDA with a strength of 21.11N/mm<sup>2</sup> at 28 days of curing as shown in Table 2-3, and the workability as shown in Table 2-4. The initial and final setting time increased with an increase in the dosages of CDA and workability decreased with an increase in the dosages of CDA. The bulk density decreased with an increase in the dosages of CDA.

Table 2-3: Cube strength of cubes for each curing period (Ojedokun, et al., 2014) **Curing Period** 0% 10% 20% 30% 14.44 N/mm<sup>3</sup> 13.56 N/mm<sup>3</sup> 6.67 N/mm<sup>3</sup> 5.11 N/mm<sup>3</sup> 7 days 14 days  $15.56 \text{ N/mm}^3$  $15.20 \text{ N/mm}^3$  $9.24 \text{ N/mm}^{3}$  $5.42 \text{ N/mm}^3$ 5.78 N/mm<sup>3</sup> 21 days  $17.42 \text{ N/mm}^3$ 17.11 N/mm<sup>3</sup>  $10.13 \text{ N/mm}^3$ 21.33 N/mm<sup>3</sup> 21.11 N/mm<sup>3</sup> 11.11 N/mm<sup>3</sup>  $6.00 \text{ N/mm}^3$ 28 days

Table 2-4: Workability results (Ojedokun, et al., 2014)					
% of CDA	Slump (mm)				
0%	40				
10%	48				
20%	80				
30%	100				

Omoniyi, *et al.* (2014) investigated the use of CDA as an additional cementitious material in concrete. The cement was replaced at 5%, 10, 15%, 20%, 25% and 30% of CDA. The physical properties like specific gravity (SG) for CDA was 2.55 while that for OPC (Ashaka cement) was 3.15. The chemical properties of the CDA and OPC were as shown in Table 2-5 which showed that, The index properties of CDA were found to be 76.91%. This value is greater than the 75% minimum specified by STM C 618-12 class N pozzolana. The combined percentage of alkali (Na<sub>2</sub>O+K<sub>2</sub>O) was 3.5% this being a low percentage value, it reduced the possibility of the destruction of the aggregate alkali reaction as this would have caused the disintegration of concrete. The strength gain and the setting time of concrete were observed to be affected by the high alkalis percentage. It was also observed that the present Sulphur trioxide (SO<sub>3</sub>) of 1.4% was less than the 4% specified by ASTM C618-12 this showed the durability was improved and the expansion of the paste was prevented. This showed that CDA reacted with ordinary Portland cement, which made the concrete compressive strength acceptable.

Oxide	Weight (%)				
Composition	CDA	Ashaka Cement			
$S_iO_2$	69.65	20.26			
$Al_2O_3$	4.27	6.30			
$Fe_2O_3$	2.99	3.26			
CaO	12.55	65.51			
MgO	2.12	0.96			
$SO_3$	1.36	0.69			
$K_2O$	2.94	0.88			
Na <sub>2</sub> O	0.57	0.89			
$P_2O_5$	1.48	0.25			
$Mn_2O_3$	0.63	0.21			
TiO <sub>2</sub>	0.33	0.24			
SiO <sub>2</sub> +AlO <sub>3</sub> +Fe <sub>2</sub> O <sub>3</sub>	76.91	29.82			

Table 2-5: Chemical composition (Omonivi et al. 2014)

A total number of 105 cubes were prepared of size 150mmx150mmx150mm, among the tests carried out were; the initial and final setting time and slump test carried out on the fresh cement / CDA blended paste and concrete. The cubes were then cured for 7, 14, 28, 60 and 90 days and thereafter the compressive strength was tested for each cube. The results showed that as the percentage of CDA dosage was increased, both the initial and final setting times also increased from 12.2% - 59.3% and 2.74% - 43.90% respectively. This illustrated that CDA acted as a retarder. As the CDA content was increased, the workability of concrete also decreased. This was because additional water was required to maintain the steadiness of the concrete as the CDA dosage was increased.

The compressive strength results showed a decrease in crushing strength as the dosages of CDA increased regardless of the curing age. The results also showed there was no significant difference in crushing strength between the control concrete and those containing up to 15% CDA at a 5% level of significance.

Samson & Tope, (2014) also investigated the pozzolanic potentials of CDA. The summation of SiO<sub>2</sub>, Al<sub>2</sub>O<sub>3</sub> and Fe<sub>2</sub>O<sub>3</sub> in CDA exceeded the 70% minimum specified by ASTMC 618-12 as shown in Table 2-6 below. The test results indicated that CDA prolongs the setting time and reduces the compressive strength with the increase in dosages of CDA. Both the physical properties and the SG of CDA obtained was 2.55 a value lower than that of OPC (Ashaka cement) of 3.15 but it was above the required values which lie between 2.0 - 2.40 as specified in ASTM C618 (1978) for pozzolanic material. Due to the difference in specific gravity, it implied that more quantity of CDA was needed to replace an equal weight of Ashaka cement. CDA was seen to be finer than OPC and certainly increased the surface area of cementitious materials available for hydration (Samson & Tope, 2014).

Tope, 2014)						
Oxide Percentage Composition						
Composition (%)	Source 1	Source 2	Source 3	Source 4	Average	OPC
$S_iO_2$	69.76	69.65	61.786	61.866	65.7655	20.26
$Al_2O_3$	4.74	4.27	5.206	3.614	4.4575	6.30
$Fe_2O_3$	3.18	2.99	3.978	2.502	3.1625	3.26
CaO	13.25	12.55	13.307	12.852	12.98975	65.51
MgO	2.12	2.22	1.779	1.952	2.01775	0.96
$SO_3$	0.89	1.36	0.705	0.807	0.9405	0.69
$K_2O$	2.71	2.94	2.674	3.011	2.83375	0.88
Na <sub>2</sub> O	0.611	0.56	0.388	0.485	0.511	0.89
$P_2O_5$	1.37	1.48	1.215	1.466	1.38275	0.25
$Mn_2O_3$	0.62	0.63	0.565	0.582	0.59925	0.21
$TiO_2$	0.38	0.34	0.443	0.312	0.36875	0.24
CaCO <sub>3</sub>	23.64	22.40	23.751	22.938	23.18225	-
SiO <sub>2</sub> +AlO <sub>3</sub> +Fe <sub>2</sub> O <sub>3</sub>	77.68	76.91	70.97	67.982	73.3855	-

Table 2-6: Chemical Composition of CDA from several sources and OPC (Samson &

Gurjar & Bhadouriya, (2015) did a study on the production of concrete with CDA and rice husks ash (RHA) as a partial replacement of ordinary portland cement (OPC) in an M:15 mix proportional ratio of 1:2:4 was used. The consistency limit, setting time, and workability of CDA and RHA with ordinary portland cement were tested. Cement was replaced with CDA and RHA by weight in portions of 5%, 10%, 15%, 20% & 25% of respectively The cubes standard in concrete. concrete were size 150mmx150mmx150mm and a Compressive strength test was done after curing for 7, 14, and 28 days. The results showed that the maximum compressive strength was achieved with optimum content of CDA and RHA at 5% replacement as shown in Table 2-7. The workability decreased with an increase in dosages of both the CDA and RHA as a binder in concrete. The setting time increased with increasing replacement in cement (Gurjar & Bhadouriya, 2015)

	rubie 2 7. Compressive siteligin (Guijar & Dhadourija, 2013)						
CDA+RHA	COMPRESSIVE STRENGTH (N/mm <sup>2</sup> )						
<b>REPLACEMENT%</b>							
	7 Days	14 Days	28 Days				
0%	16.4	23.0	29.1				
5%	27.2	32.2	36.7				
10%	26.2	31.6	35.7				
15%	25.7	30.4	34.5				
20%	24.5	29.9	32.1				
25%	22.8	28.2	30.9				

 Table 2-7: Compressive strength (Gurjar & Bhadouriya, 2015)

Fredrick et al. (2018) characterized the chemical properties of CDA as shown in Table 2-8 and found out that the combination of Al<sub>2</sub>O<sub>3</sub>, SiO<sub>2</sub> and Fe<sub>2</sub>O<sub>3</sub> was 78% which was more than than the 70% specified in ASTM C618 (2001), calcium trioxocarbonate of 24% was detected and this contributed to the strength of the concrete. The percentage sulphur as MgO was 2.1 % which was less than the 5% specified in the standard and Na<sub>2</sub>O was detected at 0.6% less than 1.5% which conforms to ASTM C618 (2001) and showed high pozzolanic action.

Table 2-8: Chemical properties of CDA (Fredrick, et al., 2018) Chemical composition Elemental Oxide (%) SiO<sub>2</sub> Fe<sub>2</sub>O<sub>3</sub> MgO K<sub>2</sub>O TiO<sub>2</sub> Al<sub>2</sub>O<sub>3</sub> CaO  $SO_3$ Na<sub>2</sub>O  $P_2O_5$  $Mn_2O_5$ CaCO<sub>3</sub> 69.75 4.74 3.17 13.25 2.11 0.89 2.70 0.61 1.37 0.62 0.38 0.19

Another research was done to determine the permeability properties of cylindrical concrete samples with a diameter of 75mm and 100mm long, made with CDA as a binder. The specimens were tested after 28, 56, and 90 days of curing. Another set of cylindrical having a diameter of 100mm and 50mm height were prepared for a sorptivity test, they were tested at 28 and 56 days of curing. Concrete cube samples of class 25 N/mm<sup>2</sup> design strength with a water-to-cement ratio of 0.6 were prepared with ordinary Portland cement (OPC) and the OPC was partially replaced with CDA at 0%, 10%, 20% and 30% by weight. The results showed early strength for the control samples as compared with that of the CDA-stabilized as shown in Figure 2-2. Crushing strength test carried out samples on 100mmx100mmx100mm after 7, 28, 56 and 90 days of curing.

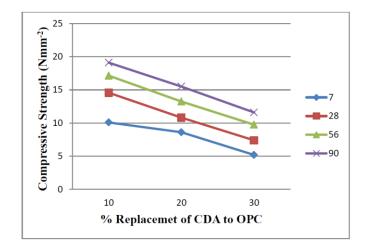


Figure 2-2: Compressive Strength vs % Replacement of CDA (Fredrick, et al., 2018).

The presence of CDA as a filler showed low early strength development compared to the control samples, this was because the CDA as a filler is a pozzolan that is known to reduce the early strength of concrete due to its slow rate of hydration. When CDA and OPC were mixed, the crushing strength increased after a long period of curing. From the results, the bending strength decreased with an increase in CDA dosages. CDA increased the capillary suction of concrete hence, the absorption of water into the cube increased this intern affected the durability of the concrete negatively. Permeability decreased with a longer period of curing then it increased as the dosages of CDA were increased. The high results for flexural strength, compressive strength, sorptivity, and water permeability were obtained with an optimal replacement for CDA as 10%. In conclusion, CDA is a good pozzolanic material, that can achieve up to 94% design strength within 28 days of curing, but with 10% of CDA partially replaced with the OPC the water absorption of moisture into concrete would be negligible. On the physical properties, the SG of CDA was determined as 2.28. This conforms to the requirements in ASTM C618 (1978) for pozzolanic materials. Though less than that of OPC which was 3.15. This implied that the concrete produced with a partial replacement using CDA had less weight as compared to that of 100 % OPC (Fredrick, et al., 2018).Kumar & Dr A. Anbuchezian, (2018) did a research project for use of CDA, alumina and lime as a full replacement for cement in concrete production. It was found out CDA can only be replaced at 10%-20% of cement since the further replacement of CDA, will require more water (Kumar & Anbuchezian, 2018)

Sruthy et al. (2017) studied the crushing strength of concrete made with CDA and glass

fibre as a binder. This was to minimize greenhouse gas emissions to the atmosphere. The CDA was added at various percentages (6%, 8%, 10%, 12% and 14%) by weight of cement. 0.5% glass fibre being an economically strong material, was added this was to strengthen the CDA concrete and make it more durable in addition, glass fibre has excellent bending strength, and resists cracks. With these properties, glass fibre can be used as an alternative material for producing concrete to be used in construction. The concrete class 25 was done and the results showed with an 8% replacement of cement with cow dung ash, increased the compressive strength (Sruthy, et al., 2017).

# 2.6 Optimization of Gravel soils Engineering Properties

The material requirements, traffic limitations and construction procedures for gravel roads are summarized in Figure 2-3 as defined by the Ministry of Transport and Communications.

Chart GWC		GRAVEL WE	ARING COURSE Chart GWC
Grading afte	r compactio	n	Plasticity requirements
Sieve (mm)	% by weig	ght passing	Plasticity modulus: min. 200 max 1,200 Plasticity index:
	Class 1	Class 2	-Wet areas Min. 5 Max. 20 -Dry areas min. 20 max. 30
37.5	-	100	
28	100	95-100	Bearing strength requirement
20	95-100	85-100	CBR at 95% MDD (Modified AASHTO) and 4 days
14	80-100	65-100	soak: Min. 20
10	65-100	55-100	
5	45-85	35-92	MECHANICAL STABILIZATION
2	30-68	23-77	These requirements also apply to mixture of the
1	25-56	18-62	natural gravel and sand or up to 30% of stone
0.425	18-44	14-50	(crushed or not)
0.075	12-32	10-40	

Figure 2-3 Gravel Wearing Course Specifications (Ministry of Transport and Communications, 1987)

According to the research done by the U.S Department of Transportation made by South Dakota Local Transport Assistance on the design and maintenance of manual for gravel roads. Table 2-9 below shows that a good gravel material to be used on gravel roads the percentage of fines passing the 200 No. sieve should range between (4-15%) and the plasticity index should also range between (4-12%) (Program, 2000).

Ciava No.	Demoente de magging
Sieve No.	Percentage passing
20mm	100
14mm	
4.75mm	50-78
2.36mm	37-67
0.425mm	13-35
0.075mm	4-15
Plasticity Index	4-12

 Table 2-9: Good Gravel Material for Surface Gravel roads (Program, 2000)

#### 2.7 Critique of the Existing Literature

From the literature review, we get valuable information where the use of different natural materials has been studied on how to use them as a soil stabilizer and the results have given positive results. Among the materials studied are salts (NaCl, CaCl<sub>2</sub> and MgCl<sub>2</sub>) molasses, and bio-enzymes, among other materials, studied.

## 2.7.1 Mechanical Stabilization using Fresh Cow Dung

On the study of stabilization using cow dung various studies have been done; Peter and Dorothy (2013) carried out a study in Ghana on the Strength and Durability Properties of cow dung Stabilized Earth Bricks by burning the bricks in the kiln the cow dung being a combustible material it was burnt in the process leaving pores in the bricks that's why after water immersion, the voids in the bricks left after burning were filled with water this made the strength of the bricks to drop. Hence it was found that the bricks stabilized with cow dung were not suitable in wet areas. Younoussa et al., (2016) did research titled; Earth blocks stabilized by cow dung' the study was done in Burkina Faso (Ouagadougou area) on lateritic clay, Leopold et al., (2020) did research where he replaced cement with cow dung in producing mortar for simple plastering works on cohesive soils in Rwanda. The above studies concentrated on stabilizing cohesive soils to make bricks for building construction whereas, In my study, cow dung is used to stabilize lateritic gravel soil on unpaved roads where I will carry out the following tests; Compaction Properties (MDD & OMC), strength

properties (CBR & UCS), grading and atterberg limits. The stabilization of lateritic gravel using cow dung to be used on gravel and earth roads was an area not exhaustively covered in the reports studied at the time of writing this thesis. These led to research on the possibilities of stabilizing the lateritic gravel using cow dung to be used on earth and gravel roads in rural areas.

#### 2.7.2 Chemical stabilization using Cow Dung Ash (CDA)

Ojedokun *et al.* (2014) studied CDA as a partial replacement of cement in the concretemaking process, Omoniyi *et al.* (2014) in their study titled, 'Compressive strength characteristic of cow dung ash (CDA) blended cement concrete, Duna & Omoniyi (2014) in their report titled; 'Investigating the pozzolanic potentials of CDA in cement paste mortars', Inderveer & Gautam (2015) Performed a Research on Study on the use of CDA and RHA as partial replacement of ordinary cement (OPC) in concrete production, Sruthy *et al.* (2017) carried out a research on the compressive strength of concrete made with CDA and glass fibre as a binder. The above studies showed that the CDA was used alone or mixed with other materials in the production of concrete, BUT in my study, CDA is used without blending it with any other material to stabilize the lateritic gravel to be used on gravel and earth roads mostly found in rural areas. The stabilization of lateritic gravel using CDA was an area not well covered in the literature review material found at the time of compiling this report, this study intends to study the possibility of stabilizing the lateritic gravel using CDA as a chemical stabilizer.

Ijimdiya *et al.* (2012) Investigated the stabilization of black cotton soil using groundnut shell ash (GSA), Amit *et al.* (2014) did a study titled; 'Stabilization of expansive soils with bagasse ash' for a material to be used as a base course in road construction. In my study, I am stabilizing the lateritic gravel soil with CDA and I will carry out the following tests; Compaction Properties (MDD & OMC), Strength Properties (CBR & UCS), grading and atterberg limits. Where the stabilized material is to be used as a gravel-wearing course (GWC) on unpaved rural roads in Kenya.

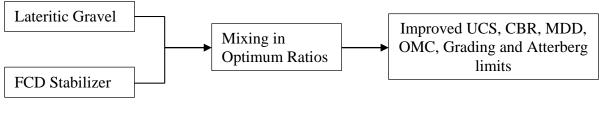
## 2.8 Summary and Conceptual Framework

# 2.8.1 Mechanical Stabilization

From the studies highlighted above, the information we get is that FCD is mixed with different types of cohesive soils, and stabilization of the said soils occurs this is evident by the improvement in the strength properties of the stabilized soils. At the time of writing this thesis, there was no material found on lateritic soils stabilized with fresh cow dung to be used on unpaved roads in rural areas.

#### 2.8.2 Chemical Stabilization

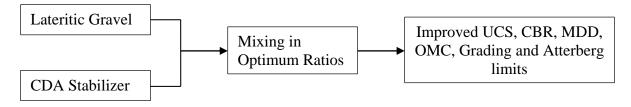
From the studies above CDA on full or partial replacement of ordinary portland cement (OPC) in the production of concrete showed there was an increase in strength properties like compressive strength after a prolonged period of curing time. Other materials studied were groundnut shell ash (GSA) as a stabilizer of expansive soils to be used as a road base and found that this stabilization decreased the maximum dry density (MDD), California Bearing Ratio strength(CBR) and unconfined compressive strength (UCS). Stabilization of expansive soils (black cotton soil) using bagasse ash found that this increased both CBR and the weight-bearing ability of the soil. The MDD and UCS of the stabilized expansive soil were also increased after stabilization. This study aims to find out the ability of both FCD and CDA in stabilizing the lateritic gravel soils on earth and gravel roads without the addition of any other additive. Figure 2-4 & Figure 2-5, illustrates the procedure to adopt in stabilizing the gravel soils for unpaved roads in rural areas.



Independent variables

**Dependent Variables** 





Independent variables

**Dependent Variables** 

Figure 2-5: Conceptual framework for chemical stabilization

The use of both FCD and CDA as a stabilization material for the lateritic gravel soils as a road construction material is more economical and environmentally friendly in comparison with other conventional methods of soil stabilization. At the time of writing this thesis, the majority of the studies have laid more emphasis on improved pavement layers for paved roads by the use of conventional stabilizers like lime and cement. This research aims to find out how to improve the gravel course material by mixing the optimal ratios of FCD and CDA to the lateritic gravel to improve the earth and gravel roads in rural areas to serve the community for a much longer time without reservicing.

# **CHAPTER 3: MATERIALS AND METHODS**

## **3.0 Introduction**

This chapter explains the collection, preparation and analysis of the materials to be used for the entire laboratory tests. The aim is to determine the strength of the lateritic gravel sample when stabilized with different amounts of both fresh cow dung (FCD) and cow dung ash (CDA). It describes the materials that will be used and methods adopted to get the samples from the field, and the tests to be carried out in the laboratory on the materials. This chapter explains the methodology and sampling approach to be used for the lateritic gravel.

## **3.1 Materials Collection and Preparation**

# **3.1.1 Lateritic Gravel Soil**

The lateritic clay sample used for this investigation was collected from a quarry at Kamiti, Kiambu County (37M 268108.00 m E 9871211.00 m S) as shown in Figure 3-1 at a depth of 1.2m using the method of disturbed sampling. The sample collected was packed in sampling bags and transported to the University of Nairobi (Transportation and soil Mechanics laboratory) where upon arrival the lateritic gravel sample is homogenously mixed and air-dried for 24 hours. After drying the soil, clods are crushed gently and grounded with the help of a wooden pestle and mortar then the sample is passed through 20mm sieve No. and the retained material on the sieve was discarded. The sufficient quantity is safely stored in plastic bags for use during the entire laboratory testing work.

# 3.1.2 Fresh Cow Dung (FCD)

The dried cow dung is collected from the Upper Kabete Campus (College of Agriculture and Veterinary Sciences) at the dairy farm. The caked samples were collected from the grazing fields. The cakes are pounded lightly using a pestle and mortar. Foreign materials like natural vegetable matter, sticks and stones are removed through sieving (sieve number 20mm) as shown in plates 3-1 and 3-2, Part of this prepared material is used directly as FCD.



Figure 3-1: Sampling Location in Membley (Google)



Plate 3-1: Removing of foreign materials Plate 3-2: Sieving using a 20mm sieve

# 3.1.3 Cow Dung Ash (CDA)

Cow dung ash part of the prepared dried cakes used for the FCD is calcined at  $500^{\circ}$ C (Kiln at Mechanical laboratory, UON main campus) as shown in Plate 3-3, after removing from the kiln, it is allowed to cool overnight as shown in Plate 3-4. Then that sample is taken to the Ministry of Petroleum and Mining situated in an Industrial area on Machakos road, for grinding (using the pulverization machine) and then sieved through B.S. sieve No. 200 (75µm) before usage as shown in Plate 3-5.



Plate 3-3: Burning in Kiln







Plate 3-5: Final product after sieving

# 3.2 Materials Index Properties and Characterization

The index properties on laterite gravel are done to classify the lateritic gravel in accordance to AASHTO, while the FCD material is taken to the College of Agriculture & Veterinary Sciences (CAVS) Upper Kabete Campus laboratory to analyse its chemical composition like organic matter, organic carbon, among other chemical elements present in the FCD. The cow dung ash (CDA) is done by both Physical and Chemical Methods. Chemical analysis of the ash was done using the X-ray Fluorescence (XRF) machine. While the specific gravity of CDA is determined following ASTM C188-1995.

# 3.3 Method of Testing

Figure 3-2 shows the flow chart to be used in conducting the tests. The research laboratory investigations will be done on the natural soil and the stabilized material (both Mechanical and Chemical) stabilization involve the following;

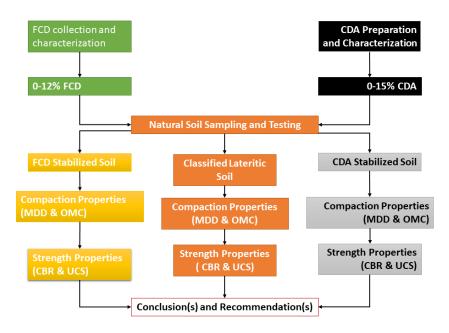


Figure 3-2: Methodology Flow Chart

## **3.4 Determination of Compaction Properties (MDD & OMC)**

The standard compaction test was done using a 4.5kg rammer following AASHTO T180. Mould size 101.6mm diameterx116.4mm (volume 950mm<sup>3</sup>) was used. A sample passing the 20 mm test sieve was roughly 20kg then the sieved sample was divided into five samples each weighing 4kg. each sample was entirely mixed with different amounts of water to get the right mixture of moisture contents, after mixing with water they were closed in an airtight container and let to cure for 4 hours before working on them. Moulds were filled in five layers by applying 25 blows for each layer using the 4.5 kg compaction rammer. This was to determine the MDD and OMC of the laterite gravel.

## 3.4.1 Mechanical Stabilization using FCD

The lateritic gravel soils were mixed with FCD stabilizer at various percentages of (0%, 3%, 6%, 9% and 12%) by weight. The test aimed to determine the MDD and OMC of the laterite gravel. The air-dried sample was subdivided to get the representative sample of 6 kg by the quartering method (BS 1377-4, 1990).

## 3.4.2 Chemical Stabilization using CDA

The effects of CDA at (0%, 3%, 6%, 9%, 12% and 15%) by weight. The test aimed to determine both the MDD and OMC of the stabilized lateritic gravel. The air-dried sample

was subdivided to get the representative sample of 6 kg by the quartering method (BS 1377-4, 1990).

# **3.5 Determination of Strength Properties (CBR & UCS)**

# 3.5.1 California Bearing Ratio

The effects of FCD stabilizer on lateritic gravel were determined at various percentages (0%, 3%, 6%, 9% and 12%) and CDA stabilizer at (0%, 3%, 6%, 9%, 12% and 15%) both by weight. The CBR test was performed in the laboratory following AASHTO T193:1990 the aim was to determine the index strength and bearing capacity of the material. The material passing the 20 mm sieve was prepared for the test, and then the sample was stored for 24 hours in a secured place before compaction into the moulds. The moisture content of the material sample was determined using the heavy compaction test. and. The material was compacted statically in CBR mould at 95% MDD and OMC. The material was soaked for 4 days in perforated moulds with surcharge this was to determine the rate of water absorption and the degree of swell for the neat and FCD stabilized sample, while the CDA stabilized samples were cured for seven days and soaked for seven days. The samples were removed from the water, surcharge weights removed and samples were drained for 15 minutes before CBR penetration.



Plate 3-6: FCD stabilizer

Plate 3-7: Mixing FCD with soil

Plate 3-8: Water mesurement

Plate 3-9: Moulding



Plate 3-10: Water draining

Plate 3-12: Moulds after Testing

As shown in Plates 3-6 to 3-9 show the measuring, mixing and moulding for the CBR test. Plates 3-10 show the draining of water for the soaked CBR samples for about 15 minutes before testing as shown in Plate 3-11. The applied force to the plunger from each dial gauge reading at each penetration at intervals of 2.5 mm was recorded. The ring factor was used to convert the gauge readings into force (kN). A graph of force on the plunger against penetration was plotted and a smooth curve was drawn through the points. The forces corresponding to 2.5mm and 5.0mm were calculated from the shown equations. The higher value of the two was taken as the CBR of the material.

• CBR value at 2.5mm: = 
$$\frac{Force \ at \ 2.5mm \ x \ 100}{13.2 \ (KN)}$$
 (3.1)

• CBR value at 5.0mm: = 
$$\frac{Force \ at \ 5.0mm \ x \ 100}{20.0 \ (KN)}$$
 (3.2)

# 3.5.2 Unconfined Compressive Strength (UCS)

The effects of FCD (mechanical stabilization) at (0%, 3%, 6%, 9% and 12%) and CDA at (0%, 3%, 6%, 9%, 12% and 15%) both by weight on lateritic gravel was determined. The UCS tests were carried out per BS 1924:1990. To determine the optimum amount of the stabilizer, seven specimens (for mechanical stabilization) and Three specimens (for chemical stabilization) were used for each stabilizer content. Plate 3-13 shows the CDA stabilizer, Plate 3-14 shows the mixing of the lateritic gravel with the CDA stabilizer and Plate 3-15 shows the final mix of the lateritic gravel and CDA awaiting water and then moulding.



soil for moulding

Plate 3-16 shows the final sample this is after compaction and now the sample is being removed from the mould. Plate 3-17 shows the UCS testing and Plate 3-18 shows the failed samples after UCS testing.

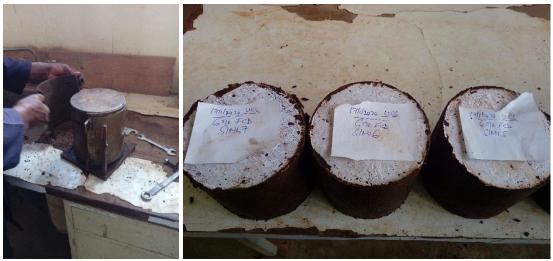


Plate 3-16: UCS sample preparation



Plate 3-17: UCS Testing

Plate 3-18: UCS Failed samples after Testing

The dial readings were converted to the appropriate load and length units, and these values were recorded on the datasheet in the deformation and total load columns. The sample cross-sectional area and strain were computed. The corrected area (for both neat and FCD stabilized samples) was determined using the formula:

$$A = A_0 (1 - e)$$
 (3.3)

for CDA stabilized sample the original area (A<sub>o</sub>) was used to calculate the UCS.

# 3.6 Determination of Grading and Atterberg limits

## **3.6.1 Particle Size Distribution**

The sieve analysis of the lateritic gravel soil was carried out as per BS 1377, Part 2; 1990. A representative sample weighing 2.5 kg was obtained by riffling, this sample was airdried for twelve hours. Wet sieving was carried out to remove the silt and clay-sized particles, and then dry sieving was done to remove the remaining course materials. down to the fine sand size. The sieve sizes used ranged between sizes 0.075 mm to 10 mm. they were arranged from the smallest to the largest size in ascending order from the receiver pan. The sample was poured on the top sieve and hand shaken. The cumulative percentage retained on each sieve was determined using the following equation;

$$\% retained = \frac{m_2 \times 100}{m_1} \tag{3.4}$$

Where  $m_1 = \text{mass of the test sample after cooling}$ 

 $m_2 = mass$  of the retained sample on each sieve

The data obtained were presented in the form of a graph plotted on a grading chart.

# **3.6.2** Atterberg Limits

These tests were done in the laboratory according to BS 1377; Part 2; 1990. The samples were prepared to determine the plastic limits and liquid limits, from which the plasticity index was determined.

The cone penetrometer method (definitive method) was used and the test samples weighing about 400g as shown on Plate 3-19 which pass the 425  $\mu$ m sieve were used and the material retained on the mentioned sieve was discarded (BS 1377-2, 1990). Both the liquid limit and plastic limit for neat lateritic gravel and the stabilized material at various percentages were determined.

# 3.6.2.1 Apparatus

A Penetrometer complying with BS 1377-2:1990, a cone of stainless steel approximately 35 mm long, with a smooth, polished surface and an angle of  $30 \pm 1^{\circ}$ ., A metal cup  $55 \pm 2$ ) mm in diameter and  $(40 \pm 2)$  mm deep with the rim parallel to the flat base, A flat glass plate 10 mm thick and 500 mm square, Two spatulas, An evaporating dish, of about 150 mm diameter as shown on Plate 3-20 and Plate 3-21, Apparatus for moisture content determination, A wash bottle containing distilled water, a straight-bladed spatula and a stopwatch.



Plate 3-19: Sieved Sample

Plate 3-20: Atterberg Limits apparatus



Plate 3-21: Penetrometer apparatus



Plate 3-22: Mixing



Plate 3-23: Cup filled with sample



Plate 3-24: Testing for Liquid Limit

Plate 3-25: Rolling the samples

Plate 3-26: Sample for plastic limit

# 3.6.2.2 Liquid Limit

After recording the cone penetration four times to determine the liquid limits, the moisture content of each sample was recorded after oven drying for 12 hours. The cone penetration on the (y-axis) and moisture content on the (x-axis) was plotted on a linear scale. From the linear graph, the moisture content corresponding to a penetration of 20 mm was interpolated. This value was recorded as the liquid limit ( $w_L$ ) of the soil sample (BS 1377-2, 1990) Repeat the above procedure for both Neat and stabilized material.

## 3.6.2.3 Plastic Limit

The plastic limit of the soil sample is the lowest moisture content at which the soil is plastic. The sample was from the soil in its natural state and passed the 425  $\mu$ m test sieve. The moisture content of each sample was recorded. The plastic limit computed was the average of the water contents ( $w_p$ ) (BS 1377-2, 1990)

# **3.6.2.4 Plasticity Index**

The Plasticity Index  $(I_P)$  is the difference between the Liquid Limit  $(w_L)$  and the Plastic Limit

(*w*<sub>P</sub>) and is calculated from the equation:  $I_P = w_L - w_P$  (BS 1377-2, 1990) (3.5)

# 3.6.2.5 Linear Shrinkage

The linear shrinkage is the decrease in length of a soil sample when oven-dried, starting with the moisture content of the sample at the liquid limit.

Percentage of linear shrinkage  $(w_s) = \left(1 - \frac{L_D}{L_0}\right) 100$  (3.6)

Where; *L*<sub>o</sub> is the Original length (in mm)

 $L_D$  is the length of the oven-dried specimen (in mm)

## **3.6.2.6 Plasticity Modulus**

Is defined as the product of linear shrinkage (LS) and percentage passing BS No 40 sieve (i.e.,  $\% < 425 \mu m$ ):

 $SM = LS (\% < 425 \mu m)$  (3.7)

# **CHAPTER 4: RESULTS AND DISCUSSIONS**

## 4.0 Introduction

This chapter presents the results and the discussions of the test results obtained on both the neat lateritic gravel material and the stabilized laterite gravel mixed with FCD and CDA stabilizers in varying percentages. These results were presented in either tabular or graphical presentations. The obtained results were then compared with the specific standard values as recommended in the Gravel Wearing Course chart by the Ministry of Transport and Infrastructure Road Design Manual Part III (1987) and the South Dakota Standard Specifications a good gravel material to be used on gravel roads.

# 4.1 Index Properties and the characterization of the materials

# 4.1.1 Index Properties of Lateritic Gravel

The engineering and the geotechnical properties were carried out on the laterite gravel using the standard methods where a series of standardized tests were carried out in the laboratory using the laboratory equipment and the results are shown in Table 4-1. The aim was to assist in the classification of the lateritic gravel as per the AASHTO Classification.

Table 4-1: Index properties of Lateritic Gravel					
Test Description	Results	Method			
Soil sample collected from (Name and	Kamiti (37M 268108.00	BS 1377-1, 1990			
coordinates)	m E 9871211.00 mS)				
Sieve analysis:	Figure 2	BS 1377-2, 1990			
Natural moisture content (%)	9.2	BS 1377-2, 1990			
Percentage passing B.S Sieve No. 200	39.3	BS 1377-2, 1990			
Liquid Limit (%)	69	BS 1377-2, 1990			
Plastic Limit (%)	35	BS 1377-2, 1990			
Plasticity Index (%)	34	BS 1377-2, 1990			
Shrinkage Index %	15	BS 1377-2, 1990			
Free Swell %	0.18	BS 1377: 1990			
Group Index	29.15(29)	BS 1377: 1990			
AASHTO Classification	A-7-6	AASHTO			
Unified system of classification (USC)	СН	ASTM D2487-11			
Maximum Dry Density (kg/m <sup>3</sup> )	1674	BS 1377-4, 1990			
Optimum Moisture Content %	24.74	BS 1377-4, 1990			
Unconfined Compressive Strength (kN/m <sup>2</sup> )	257	ASTM D2166			
California Bearing Ratio (%)		BS 1377-5: 1990			
Unsoaked	99	BS 1377-5: 1990			
Soaked	39	BS 1377-5: 1990			
Specific Gravity	1.82	BS 1377-2: 1990			
Colour	Brown	BS 1377-2: 1990			

 Table 4-1: Index properties of Lateritic Gravel

# **4.1.2** Characterization of the FCD sample

Following the analysis of the FCD material, the results showed that it contained, organic matter 31.80%, organic carbon 18.50% and Nitrogen 1.35%. The other minor elements of the FCD material are shown in Table 4-2. This was to establish the chemical composition of the FCD and the binding components present in FCD that will be responsible for binding the lateritic gravel during the stabilization (mechanical stabilization)

Table 4-2: Chemical composition of FCD sample						
Parameters	Units	Values	Method			
pН	-	10.20	1.2.5 (water)			
Ec	dS/m	2.5	1.2.5 (water)			
Nitrogen	%	1.35	Kjedhal			
Organic Carbon	%	18.50	Walkley black			
Organic matter	%	31.80	Calculated			
Potassium	ppm	3250	Flame photometer			
Phosphorous	ppm	720.2	Calorimetric			
Sodium	ppm	600	Atomic absorption			
Calcium	ppm	2350	Atomic absorption			
Magnesium	ppm	938	Atomic absorption			
Copper	ppm	90	Atomic absorption			
Manganese	ppm	194	Atomic absorption			
Zinc	ppm	108	Atomic absorption			
Iron	ppm	620	Atomic absorption			
Aluminium	ppm	Trace	Atomic absorption			
Sulphate - S	ppm	0.20	Atomic absorption			
Specific gravity		1.48	-			

Table 4-2: Chemical composition of FCD sample

Key: pH- Hydrogen potential, Ec- Electro conductivity, ppm- parts per million

## **4.1.3** Characterization of CDA sample

Table 4-3 shows the results from the material characterization of the CDA sample done using X-ray Fluorescence (XRF) for CDA. The CDA material sample is composed of the following; silicon oxide 46.96%, aluminium oxide 8.53% and iron oxide 5.52% among other oxides as shown in Table 4-3 below.

Duna & Omoniyi (2014), Omoniyi, et al., (2014) and Fredrick et al., (2018), in their research, found that the combination of Al<sub>2</sub>O<sub>3</sub>, SiO<sub>2</sub> and Fe<sub>2</sub>O<sub>3</sub> was 73.39%, 76.91% & 77.66% respectively which was higher than the recommended 70% as per the ASTM C618 (2001)

Oxide	Nyagah	Duna &	Omoniyi et	Fredrick, et
Composition (%)		Omoniyi(2014)	al.,(2014)	al.,(2018)
SiO <sub>2</sub>	45.96	65.7655	69.65	69.75
Al <sub>2</sub> O <sub>3</sub>	8.53	4.4575	4.27	4.74
Fe <sub>2</sub> O <sub>3</sub>	5.52	3.1625	2.99	3.17
CaO	11.85	12.98975	12.55	13.25
MgO	5.17	2.01775	2.12	2.11
SO <sub>3</sub>	1.02	0.9405	1.36	0.89
K <sub>2</sub> O	11.79	2.83375	2.94	2.70
Na <sub>2</sub> O	-	0.511	0.57	0.61
$P_2O_5$	6.66	1.38275	1.48	1.37
Mn <sub>2</sub> O <sub>3</sub>	0.45	0.59925	0.63	0.62
TiO <sub>2</sub>	0.55	0.36875	0.33	0.38
CaCO <sub>3</sub>	-	23.18225	-	0.19
CaSO <sub>4</sub>	-	-	-	-
SiO <sub>2</sub> +AlO <sub>3</sub> +Fe <sub>2</sub> O <sub>3</sub>	60.01	73.3855	76.91	77.66
Characterization method	XRF,	XRF	XRF	-

Table 4-3: Chemical composition of CDA sample.

## **4.2 Effects of FCD and CDA Stabilizer on Compaction**

Figures 4-1and 4-2 below show the results from the compaction for the stabilized gravel soil (mechanical stabilization) using FCD. The OMC and MDD at different dosages of FCD indicate that OMC increases with an increase of FCD stabilizer from 24.47% at 0% (NEAT) FCD stabilizer to 29.5% with 12% FCD. This can be attributed to the FCD stabilizer being increased which is a fine material more water content is required for compaction. Fines have a high surface area to volume ratio which absorbs more water.

The MDD decreases from 1666 kg/m<sup>3</sup> of the untreated gravel soil (NEAT) to 1474 kg/m<sup>3</sup> at 12% FCD. This can be explained by the fact that we are replacing natural gravel with a lighter material where FCD is (1420 kg/m<sup>3</sup>) compared to natural gravel which is (1820 kg/m<sup>3</sup>) thus the low densities of the stabilized material.

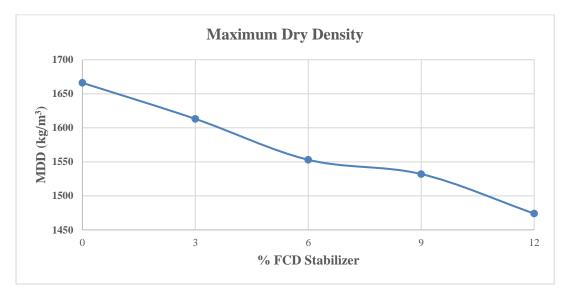


Figure 4-1: Maximum dry density (MDD) values for FCD stabilized material.

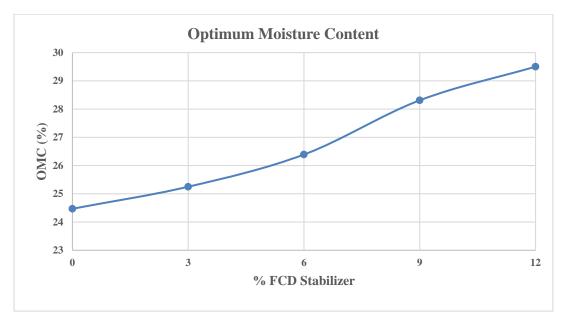


Figure 4-2: Optimum moisture content values for FCD stabilized material.

Figures 4-3 and 4-4 show the results from the compaction for the stabilized gravel soil (chemical stabilization) using the CDA. The OMC and MDD at different dosages of CDA indicate that OMC increases with an increase of CDA stabilizer from 24.47% at 0% % CDA stabilizer to 27.80% with 15% CDA. This can be attributed to the CDA stabilizer is increased which is a fine material more water content is required for compaction. Fines have a high surface area to volume ratio which absorbs more water.

The MDD decreases from 1666 kg/m<sup>3</sup> of the untreated gravel soil (NEAT) to 1560 kg/m<sup>3</sup> at 15% CDA. This can be explained by the fact that we are replacing natural gravel with a

lighter material where CDA is  $(2164 \text{ kg/m}^3)$  compared to natural gravel which is  $(1820 \text{ kg/m}^3)$  thus the low densities of the stabilized material. Figures 4-1and 4-2 below show the results from the compaction for the stabilized gravel soil (chemical stabilization) using CDA.

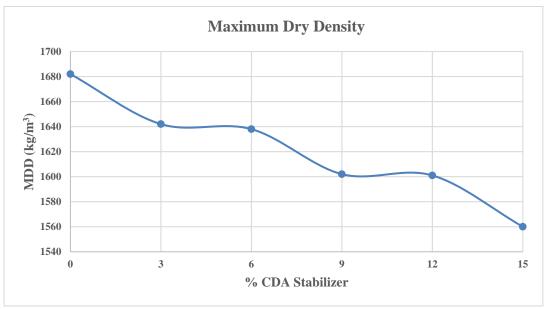


Figure 4-3: Optimum moisture content values for CDA stabilized material.

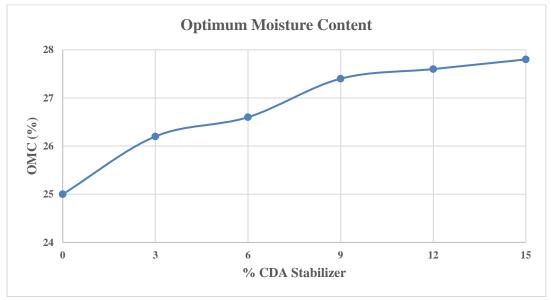


Figure 4-4: Optimum moisture content for CDA stabilized material.

# 4.3 Effects of FCD and CDA Stabilizer on Lateritic Gravel Strength Properties.

Figures 4-5 and 4-6 below show the lateritic gravel soil strength results after mechanical stabilization using FCD. The results show that UCS and values increase with an increase in FCD content up to a maximum of  $300 \text{ kN/m}^2$  for UCS and 54% for CBR at 6% FCD. This can be attributed to the fibres in FCD which binds the gravel hence increasing in strength and a further increase in FCD dosages leads to a decrease in UCS. This is due to the increase in the fines from FCD.

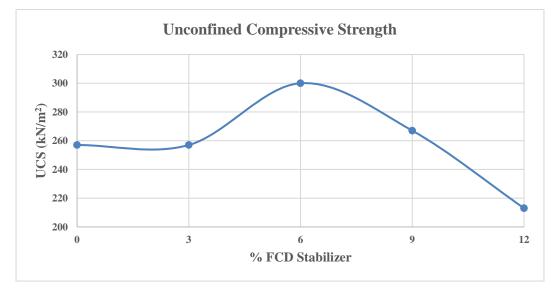


Figure 4-5: Unconfined compressive strength values for FCD stabilized material.

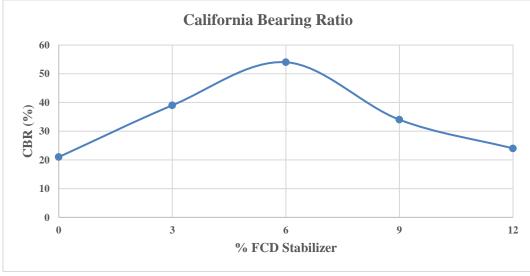


Figure 4-6: California bearing ratio values for FCD stabilized material.

Figure 4-7 shows the lateritic gravel soil strength CBR results after the chemical

stabilization using the CDA. The results show that the CBR values increase with the increase in CDA dosages, this can be accredited to the more the CDA stabilizer (being a chemical stabilizer) is added the more the particles of the lateritic gravel will be bonded together since this is a chemical reaction.

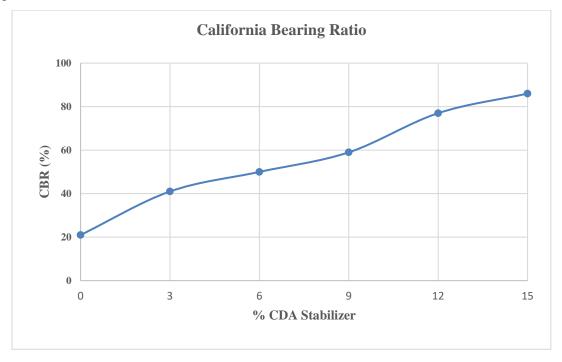


Figure 4-7: California bearing ratio values for CDA stabilized material.

Figure 4-8 shows the lateritic gravel soil strength UCS results after the chemical stabilization using the CDA. The results show that UCS increases with the increase in CDA dosages up to 9% CDA where we attain a maximum value of 496 kN/m<sup>2</sup>. Further increase in CDA leads to lower values of UCS. This can be attributed to the more the CDA the more the fines which require more water.

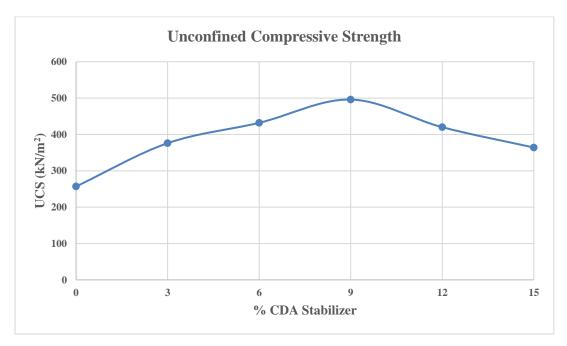


Figure 4-8: Unconfined compressive strength values for CDA stabilized material.

## 4.4 Effects of FCD and CDA Stabilizer on Lateritic Gravel Atterberg limits.

Table 4-4 shows the atterberg limits results after mechanical stabilization using FCD. For FCD stabilized material the liquid limit increases from 69% NEAT to 73% with 3% FCD stabilizer. This can be attributed to as the FCD stabilizer is added more water is required this explains why the liquid limit values rise, and then the values drop from 73% with 3% FCD to 70% with both 9% & 12% FCD. This can be attributed to as the FCD stabilizer material is added, the voids are replaced by the fibres in the FCD stabilizer which could not hold much water hence the decrease in liquid limit values. The values then increase from 70% with both 6% & 12% FCD to 74% with 12% FCD, this can be attributed to the FCD stabilizer added more water was required since the voids are filled with the fibres meaning the excess FCD material required more water.

The plastic limit increases from 35% NEAT to 37% with both 6% and 9% FCD to 40% with both 9% & 12% FCD. This can be attributed to as the FCD material is added more water was required to change the material from a solid state to a plastic state. The reason for the values in both 9% and 12% FCD to remain the same can be explained as at 6% FCD the material was enough to bond more fines together and to fill the voids. This meant that the material could not hold water hence the reason for the constant values of plastic

limit.

The plasticity index is dependent on the liquid limit and plastic limit, therefore the higher the values of the liquid limit and the lower the values of the plastic limit, the higher the values of the plasticity index and vice versa.

Linear shrinkage is the decrease in length of a wet soil sample after drying, therefore from our results Table 4-4 below shows the linear shrinkage increases from the NEAT sample to 3% FCD stabilized sample, then it is maintained at 6% FCD stabilized sample. This is attributed to the FCD material added to it and the water used during the moulding, even after drying, the FCD material filled in the voids left after drying.

After the 6%, FCD stabilized material the linear shrinkage then further reduced up to 13 with the 12% FCD stabilized material after drying, this can be attributed to as the material dried, part of the excess FCD material also dried up thus leaving behind more voids.

Table 4-4: FCD Stabilized Material Atterberg Limits						
Stabilized material	Liquid limit	Plastic limit	Plasticity Index	Linear shrinkage		
NEAT	69	35	34	15		
3% FCD	73	37	36	17		
6% FCD	70	37	33	17		
9% FCD	70	40	30	14		
12% FCD	74	40	34	13		

Table 4-4: FCD Stabilized Material Atterberg Limits

Table 4-5 shows the results after the chemical stabilization using the CDA. The liquid limit for CDA stabilized material shows a decrease with the increase in dosages of the CDA stabilizer from 69% NEAT to 62% with 15% CDA stabilizer. This can be attributed to as the CDA stabilizer material was added, more fines were bonded together hence the sample could not have much water.

The plastic limit increases from 35% NEAT to 36% with both 3% and 6% CDA stabilizer. This can be attributed to more water being required as the dosages of CDA were added to the soil sample for both 3% and 6% CDA to have similar values, it meant that the additional 6% CDA was not sufficient to bond more particles and required a similar amount of water as 3% CDA. The plastic limit then dropped from 36% with 6% CDA to 31% with 15% CDA. This can be attributed to as the CDA material was increased, more

fines we bonded together hence a low surface area to volume ratio and less the sample could retain less water.

The plasticity index is dependent on the liquid limit and plastic limit, therefore the higher the values of the liquid limit and the lower the values of the plastic limit, the higher the values of the plasticity index and vice versa.

Linear shrinkage is the decrease in length of a wet soil sample after drying, therefore from our results Table 4-5 below shows the linear shrinkage increases from the NEAT sample to 3% CDA stabilized sample, then it is maintained at 6% CDA stabilized sample. This is attributed to as the CDA material is added more water is required after drying, as water evaporates more voids are left hence the increase in linear shrinkage.

After the 6% CDA stabilized material the linear shrinkage then further reduced up to 13 with both the 12% and 15% CDA stabilized material after drying, this can be attributed to the as the CDA material was added more fines were bonded together and after drying, the voids were already filled by the CDA hence the reason for reduction of the linear shrinkage.

Stabilized material	Liquid limit	Plastic limit	Plasticity Index	Linear shrinkage
NEAT	69	35	34	15
3% CDA	66	36	29	17
6% CDA	65	36	29	17
9% CDA	62	32	30	14
12% CDA	63	33	29	13
15% CDA	62	31	30	13

Table 4-5: CDA Stabilized Material Atterberg Limits

#### 4.5 Effects of FCD and CDA Stabilizer on Grading of the Lateritic Gravel

Figure 4-9 shows the % of fines increases with the increase in the dosages of the FCD material from 41.1% with 3% FCD material to 46.6% with 12% of FCD. This can be attributed to as the FCD was added, fewer particles of clay were bonded together hence which meant more fines were left unbonded together hence the reason for the increase in the % of fines.

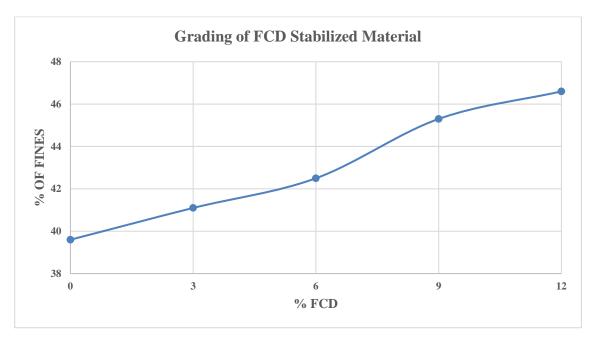


Figure 4-9: Grading values for FCD stabilized material.

Figure 4-10 shows the % of fines decreases with the increase in the dosages of the CDA material to 39.1% with 3% CDA material then the fines reduce up to 37.2% with 6% of CDA. This can be attributed to at 6% of CDA, there is enough material to bind the gravel particles together thus less % of fines. Then the % of fines increases from 39.1 with 6% of CDA to 44.5% with 15% of CDA material. This can be attributed to as the dosages of CDA are increased, the CDA does not have any clay particles to bind together since the majority of the clay bonding through the chemical reaction took place with 6% of CDA as a stabilizer. This meant the excess CDA material was left unused hence the reason for the increase in the percentage of fines.

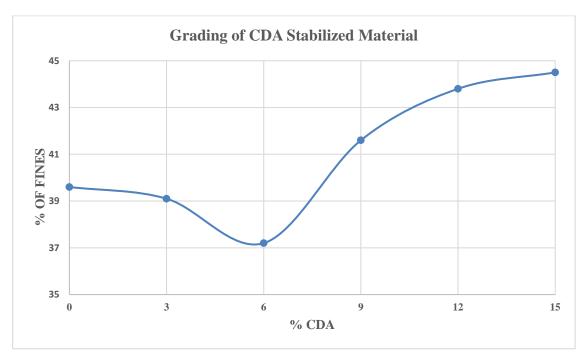


Figure 4-10: Grading values for CDA stabilized material.

## 4.6 Suitability of FCD as a Stabilizer

The results obtained from the chemical analysis of the FCD sample, the results obtained show that the percentage of organic matter is 31.8% among other elements found in the sample. These results were compared to the results that were obtained by Miner & Smith (1975) also NACA (1989) had done a similar test and found that the percentage of organic material was 82.5% for the dairy cattle, the key binding material is the organic matter as a by-product after the digestion. The FCD was considered a stabilizer after careful study of its use in plastering the mad houses back in the villages to prevent dust.

## 4.7 Suitability of CDA as a Stabilizer

The chemical characterization of the CDA material results shows that the combination of  $Al_2O_3$ ,  $SiO_2$  and  $Fe_2O_3$  was 60.01% which was less than 70% minimum according to ASTM C618 (2001) though the difference could have occurred during the material preparation as mentioned in the limitations of the study.

## **CHAPTER 5: CONCLUSIONS AND RECOMMENDATIONS**

## **5.1 Conclusions**

The optimum amount of both FCD and CDA to be adopted for the stabilization of lateritic soil was 6%.

The grading properties for the stabilized lateritic soil using the FCD was 42.5% (mechanical Stabilization) and for CDA-stabilized material was 37.2% (chemical stabilization). From the road design specification manual part III GWC chart the CDA stabilized material passed the grading test as class 2 material which requires the percentage (%) passing the 200mm sieve No. ranges between (10-40%). But the mechanically stabilized material failed the grading.

According to the South Dakota Standard Specifications a good gravel material to be used on gravel roads, the percentage of fines passing the 200 No. sieve should range from (4-15%). Our material both FCD and CDA stabilized material failed since the values obtained were out of the recommended range.

2. The MDD for both FCD and CDA stabilized material was 1553kg/m<sup>3</sup> and 1638kg/m<sup>3</sup> respectively theses values were lower compared to the NEAT sample.

The OMC for both FCD and CDA stabilized material was 26.4% and 26.6% respectively.

 The CBR for both FCD and CDA stabilized material passes the required minimum of 20% CBR (mechanical stabilized) and 30% CBR (chemical stabilized). This is according to the road's design manual part III Chart B3 GWC chart.

The UCS for mechanically stabilized material is not a requirement while for the CDA chemical stabilized the material has 432 kN/m<sup>2</sup> which fails the required minimum of 1,800 kN/m<sup>2</sup>. This is according to the roads design manual part III Chart B3 for cement stabilized material for the base.

4. The plasticity requirements were as follows;

For FCD-stabilized material plasticity index was 33% whereas for the CDAstabilized material was 29%. The CDA stabilized material passed the test according to the road design manual part III Chart GWC under dry areas which ranges between (min 20 & max 30). The mechanically stabilized did not meet the requirements as per the Chart GWC.

According to the South Dakota Standard Specifications a good gravel material to be used on gravel roads, the plasticity index should range from (4-12%). Our material failed since both FCD and CDA stabilized material was out of the recommended range.

# **5.2 Recommendations**

- 1. The cattle manure in most of our homes is mostly used as manure in the farms but from our research, we have found out that it can be used to improve the strength characteristics of the lateritic gravel soil used on unpaved and earth roads in most rural areas as the manure both as FCD or CDA promotes stabilization of the lateritic gravel soil.
- Scientific studies should be carried out to determine how long the FCD and CDA gravel soil would last since the FCD is an organic material and CDA is organic though undergone some chemical change, especially in adverse weather conditions i.e rainy season.
- 3. Pilot studies are required before the utilization of FCD and CDA stabilization on gravel road construction.

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# APPENDICES

Appendix A Chemical Characterization for the Samples

Appendix A1 Chemical Composition of FCD Sample



# **UNIVERSITY OF NAIROBI COLLEGE OF AGRICULTURE & VETERINARY SCIENCES**

**Department of Land Resource Management & Agricultural Technology** 

Telephone: 631225 (DL) 3592736-9 Ext.27021 Fax: 631225 Email: larmat@uonbi.ac.ke

P.O. BOX 29053-00625 Nairobi, Kenya

Certificate of Analysis

Sample name : Manure Sample A

Date received January 2020

Sample source

# **LABORATORY RESULTS**

**Manure Analytical Data** 

	Sample ID	-	Anthony
Parameters	Lab No	091	Method
pH		10.20	1.2.5 (water )
Ec	dS/m	2.50	1.2.5 (water )
Nitrogen	%	1.35	Kjedhal
Organic Carbon	%	18.5	Walkley black
Organic matter	%	31.80	Calculated
Potassium	ppm	3250	Flame photometer
Phosphorus	ppm	720.2	calorimetric
Sodium	Ppm	600.0	Flame photometer
Calcium	Ppm	2350.0	Atomic absorption
Magnesium	Ppm	938.0	Atomic absorption
copper	Ppm	90.0	Atomic absorption
Manganese	Ppm	194	Atomic absorption
Zinc	Ppm	108	Atomic absorption
Iron	Ppm	620	Atomic absorption
Aluminum	Ppm	Trace	Atomic absorption
Sulphate-S	ppm	0.20	colorimetric
Specific density	g/cm3	2.01	

J.Z. Date. 201 112020 NAME: J Kimothi Signature

SOIL /WATER LABORATORY Dept. of Land Res. Mgt. & Agric. Tech. (LARMAT) University of Nairobi P. O. Box 29053 - 00625, NAIROBI - KENYA.

Appendix B Chemical Composition of CDA Sample



# **REPUBLIC OF KENYA**

# **MINISTRY OF PETROLEUM AND MINING**

# STATE DEPARTMENT OF MINING

ASSAY CERTIFICATE

e-mail:cg@mining.go.ke When replying please quote ref No & date Ref. No.ORIGINAL CERT NO. 1851/20

# MADINI HOUSE MACHAKOS ROAD P.O. Box 30009-00100 GPO NAIROBI

Date...3rd August, 2020

SENDER'S NAME : ANTHONY MUGENDI NYAGAH DATE : 24.07.2020 SAMPLE TYPE : COWDUNG ASH SAMPLE NO : 1851/20

**SAMPLE A** 

:

# **RESULT**

The sample was analyzed by XRF and gave the following chemical composition.

# **CHEMICAL COMPOSITION:**

**SENDER'S REF** 

Silica as SiO <sub>2</sub>	45.96%
Potassium as K <sub>2</sub> O	11.79%
Calcium as CaO	11.85%
Aluminium as Al <sub>2</sub> O <sub>3</sub>	8.53%
Phosphorus as P <sub>2</sub> O <sub>5</sub>	6.66%
Iron as $Fe_2O_3$	5.52%
Magnesium as MgO	5.17%
Chlorine as Cl	1.97%
Sulphur as S	1.02%
Titanium as TiO	0.55%
Manganese as MnO	0.45%
Zinc as Zn	0.13%
Zirconium as Zr	0.12%
Copper as Cu	0.08%
Strontium as Sr	0.08%

EDWARD MWANGI FOR: DIRECTOR OF GEOLOGICAL SURVEYS.

The results are based on test sample only.

FOR DIRECTOR OF DECLODICAL SURVLY, 03 AUG 2021

P. O. Box 30009-00100 MAIRORI



# **REPUBLIC OF KENYA**

# MINISTRY OF PETROLEUM AND MINING

# STATE DEPARTMENT OF MINING

e-mail:cg@mining.go.ke When replying please quote ref No & date Ref. No.ORIGINAL CERT NO. 1852/20

## MADINI HOUSE MACHAKOS ROAD P.O. Box 30009-00100 GPO NAIROBI

Date...3rd August, 2020

# ASSAY CERTIFICATE

SENDER'S NAME	:	ANTHONY MUGENDI NYAGAH
DATE	:	24.07.2020
SAMPLE TYPE	:	COWDUNG ASH
SAMPLE NO	:	1852/20
SENDER'S REF	:	SAMPLE B
T TT		

# **RESULT**

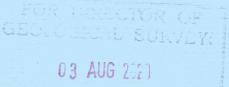
The sample was analyzed by XRF and gave the following chemical composition.

# **CHEMICAL COMPOSITION:**

Silica as SiO <sub>2</sub>	41.12%
Potassium as K <sub>2</sub> O	15.83%
Calcium as CaO	11.58%
Phosphorus as P <sub>2</sub> O <sub>5</sub>	8.36%
Aluminium as Al <sub>2</sub> O <sub>3</sub>	7.17%
Magnesium as MgO	5.19%
Iron as Fe <sub>2</sub> O <sub>3</sub>	3.80%
Chlorine as Cl	3.65%
Sulphur as S	2.10%
Titanium as TiO	0.36%
Manganese as MnO	0.33%
Zinc as Zn	0.19%
Copper as Cu	0.09%
Zirconium as Zr	0.08%
Strontium as Sr	0.07%
Gold as Au	0.004%

EDWARD MWANGI FOR: DIRECTOR OF GEOLOGICAL SURVEYS.

The results are based on test sample only.



P. O. Box 30009-00100

Appendix B Specific Gravity for the Samples

Appendix B1 Specific Gravity for FCD Sample



(Soil Mechanics Laboratory)

# **SPECIFIC GRAVITY**

Student	Anthony Mugendi N	Vyagah					
Project	Mechanical Stabiliz	ation of Lateritic G	Fravel Using FCD				
Depth (m)			Test pit ID:		Sample. No.		
Test date:	27-Jul-20		Sample Description				
Specification	According to BS 13	77:1990 Part			Location:		
Sample Number				Murram	FCD		
Bottle Number				Х	G		
Mass of empty bo	· · · ·			61.3	59.8		
Mass of bottle + S				72.2	69.4		
	Soil+ Water (W <sub>3)</sub>			179.7	168.6		
Mass of bottle ful				174.8	165.5		
Mass of Water us				107.5	99.2		
Mass of soil used				10.9	9.6		
Volume of Soil (V	$W_4 - W_1) - (W_3 - W_2)$			6	6.5		
Specific Gravity	of Soil	• •					
		(W2 - W1) · W1)- (W3 - W2)		1.817	1.477		
	05 (#1	• •• • • • • • • • • • • • • • • • • • •					
	Ave	rage Gs			<u> </u>	I	
TECHNOLOGIST		uru	Ve	rified : Elly O	yier		
Date	27-Jul-20						
Observations:							
	pecifications						

Appendix B2 Specific Gravity for CDA Sample





(Soil Mechanics Laboratory)

# **SPECIFIC GRAVITY**

STUDENT	Anthony Mugendi N	yagah				
PROJECT	Chemical Stabilizati	on of Lateritic Grav	vel using the CDA			
Depth (m)			Test pit ID:		Sample. No.	
Test date:	25-Sep-20		Sample Description	:		
Specification	According to BS 137	7:1990 Part			Location:	 
			<u> </u>		1	
Sample Number				CDA SAMPLE	A CDA SAMPLE B	
Bottle Number				С	В	
Mass of empty bot	tle (W <sub>1</sub> )			64.6	65.3	
Mass of bottle + S	oil (W <sub>2)</sub>			76.8	75.4	
Mass of bottle + Se	oil+ Water (W <sub>3)</sub>			184	184.5	
Mass of bottle full	of Water (W <sub>4)</sub>			177.4	179.1	
Mass of Water use	d (W <sub>3-W2)</sub>			107.2	109.1	
Mass of soil used	(W <sub>2-W1</sub> )			12.2	10.1	
Volume of Soil (W	<sup>7</sup> <sub>4</sub> - W <sub>1</sub> )- (W <sub>3</sub> - W <sub>2</sub> )			5.6	4.7	
Specific Gravity o	f Soil	I	III			
				2 1 5 0	2.140	
		W2 - W1)		2.179	2.149	
	<b>GS</b> = (W4 -	W1)- (W3 - W2)				
					<u> </u>	
	Aver	age Gs		2.164		
TECHNOLOGIST	Mathew Mbu	ru	Ve	rified : Elly C	Dyier	
Date	25-Sep-20					
Observations: Conform to the spe						

Appendix C NEAT Sample

Appendix C1 Compaction Properties (MDD & OMC)

No.

UNIVERSITY OF NAIROBI DEPARTMENT OF CIVIL & CONSTRUCTION ENGINEERING

# Moisture - Density

	F										
Sample Type	Lateritic Gravel								1975		
Sample source	Membley Quarry, Kiambu County	Kiambu Count	₽							 	
Sample Date	28-Nov-19	Sample No		NEAT		Depth	ŧ	Ĭ	006T		
Test date	28-Nov-19	Sample Descriptio	scription	Lateriti	ateritic Gravel				1825 -		
Specification	In accordance with BS 1377: 1990	BS 1377: 195	0	-				_	1750		
									1675	ł	
Wt of Mould (g)	4700	Volume of Mould (	(I) pluok		0.956				1600		
Test No		NMC	-	2	m	4			(		

	1600		czci w/f	) (Ki	1375 MDI		0000	1225	1150	1025		15.0 19.0 23.0 27.0 31.0		Moisture Content (%)
	-	4	6590	1890	1977		140	335.30	104.10	283.80	179.70	51.50	28.66	1537
0 956	000.0	m	6682	1982	2073		145	329.25	106.00	283.60	177.60	45.65	25.70	1649
	_	2	6678	1978	2069	sture content	134	357.58	103.70	308.10	204.40	49.48	24.21	1666
	Volume of Mould (I)	1	6600	1900	1987	Moistu	213	349.10	92.60	302.00	209.40	47.10	22.49	1623
	Volume	NMC					62	290.30	94.60	256.50	161.90	33.80	20.88	
Wt of Mould (a) 4700		Test No	Wt of mould + wet material (g)	Wt wet material (g)	Wet density (kg/m <sup>3</sup> )		Container No	Wt of container + wet material (g)	Wt of container (g)	Wt of container + dry material (g)	Wt dry material (g)	Wt of moisture (g)	Moisture content (%)	Dry density (kg/m <sup>3</sup> )

24.47	1666
Optimum Moisture Content (%)	Maximum Dry Density (kg/m³)

echnician	Mathew Mburu	Verified :	Martin Mburu
ate	30-Nov-19		
bservations:		٦	

39

No.

UNIVERSITY OF NAIROBI DEPARTMENT OF CIVIL & CONSTRUCTION ENGINEERING

# Moisture - Density

Sample Type	Lateritic Gravel					
Sample source	Membley Quarry, Kiambu County	Kiambu County			110	
Sample Date	23-Sep-20	Sample No	Depth	Ţ		
Test date	23-Sep-20	Sample Description	NEAT			
Specification	In accordance with BS 1377: 1990	h BS 1377: 1990		-	1675	$\langle$
	-					
Wt of Mould (g)	4700	Volume of Mould (I)	0.956		1600	

Wt of Mould (g)	4700	Volum	Volume of Mould (I)		0.956		1600				
Test No		NMC	1	2	m	4	( <sub>8</sub>			_	
Wt of mould + wet material (g)	erial (g)		6645	6690	6710	6670	w/f		_		
Wt wet material (g)			1945	1990	2010	1970	) (K		-		
Wet density (kg/m <sup>3</sup> )			2035	2082	2103	2061	IDM				
			Moist	Moisture content			1100				
Container No		164	62	223	51	68	0041				
Wt of container + wet material (g)	naterial (g)	317.40	156.20	149.80	170.70	154.30					
Wt of container (g)		108.00	94.90	79.80	94.70	91.80	1375 -				-
Wt of container + dry material (g)	aterial (g)	299.70	144.50	136.10	155.20	141.10					
Wt dry material (g)		191.70	49.60	56.30	60.50	49.30					-
Wt of moisture (g)		17.70	11.70	13.70	15.50	13.20	1300	00 19.00	23.00	27.00	31.00
Moisture content (%)		9.23	23.59	24.33	25.62	26.77					
Dry density (kg/m <sup>3</sup> )			1646	1674	1674	1625			Moisture	Moisture Content (%)	

25.0	1682
Optimum Moisture Content (%)	Maximum Dry Density (kg/m <sup>3</sup> )

Technician	Mathew Mburu	Verified :	Martin Mburu
Date	24-Sep-20		
Observations:		1	
Conform to the specification	S		

Appendix C2 Strength Properties (UCS & CBR)

# **UNIVERSITY OF NAIROBI**

(HIGHWAYS LABORATORY)

# 

# WORKING SHEET

UCS TEST

	Chemical Sta						ic G	ravel			: 29-Sept	-2019		ays cured:			0
Student:	Anthony	Mu	<u> </u>		/aga	h				Mou	ld No.:			ays soaked	l:		0
			D	ATA								SAMF	LE DETAI			MDD	16
Do =152r	nm								10-	4	Type	<b> </b>	UNSTABI			OMC	
Lo 1.5. (152	-152-2 14)/4	1	mm	m <sup>2</sup>					127 0.0181	-	Stabilizer %		NEA 0	.1		NMC	
40 =(152 Volume =	<u>x152x3.14)/4</u> - AoL o	•		m m <sup>3</sup>					0.00275		70		U				
stabilizer =											Defl.		Deflec	tion			
			ST	<u>сет</u>								E=L/L0	1-E	A=(Ao)	/1-E		ress
		00	5 11	231												Load	Q
											mm					KN	KN/m
											0.00	0.0000	1	0.018		0	0
	340		Т				Π				0.32	0.0025	0.9975	0.018		0.42176	23 49
	320											0.0050	0.995			0.89624	
	300	$ \uparrow $	╈		$\square$		$\uparrow \uparrow$			<u> </u>	0.95	0.0075	0.9925	0.0182		1.4498	79
	280				$\square$					<u> </u>	1.27	0.0100	0.99	0.0182		2.1747	119
	260										1.59	0.0125	0.9875 0.9850	0.0183		2.92596 3.70358	160 202
	220										2.22	0.0150	0.9850	0.018		4.73162	202
<b>J</b> 2	200										2.54	0.0175	0.9825	0.0184		4.73102	
KN/I	180		$\perp$								2.34	0.0200	0.9800	0.010-	•/	4.52074	245
Stress KN/m <sup>2</sup>	160		+				$\left  \right $										
Str	140	$\vdash$	+	-	$\left  \right $	_	+										
	120 -	$\vdash$	-+	/	$\left  \right $	+	+										
	100	$\vdash$			$\square$	_	+										
	80	$\vdash$	≁			_	+										
	60				$\left  \right $	+	+										
	40		+			+	+										
	20		+			+	+							STUDE			
	0 🖊			0				, o		Tin I		NOULDI	NG MUI	STURE C	UNI	23A	
			000	012		0.021	024	30			Wet soil					196.4	
	Ū		-				, .	-			+ Dry soil					167.2	
											f Tin f Moistur	10				27.3 29.2	
				s	trair	1					f Moistur of dry soi					139.2	
											ture cont					20.9	
											ESULTS	-					
			ŀ	Resul	ts					Spe	cification				Result		
	Unconfined C	Comp	ressi	ve St	rengt	h								257	/ KN	$/m^2$	
	Estimated Ela	astic	Mod	ulus													

UNIV	ERSITY (	OF N	MAI	RC	)B]	I													
(	HIGHWAYS LA	BORA	TORY	)											WO	RKIN	NG S	HEE	Г
			T											(AAS]		TES T193:1			
		Deta!	34										NE.	AT (Unso	oaked)				
Project: Stabili	ization of Lat	eritic	Grav	el							Test	ted:	27/07/2	2020	Date s	oaked:			
Student.: An	thony Mugendi N	yagah									Mou	ıld	No.:		Date I	Moulde	d:	27/0	7/2020
		VELL I	DATA											SAMPLE	E DETAI	LS		MDD	16
Initial gauge R	eading		(div	)				0					Туре	- Sta	abilized/u	unstabiliz	ed	OMC	24.
Final gauge Re	ading		(div	<b>')</b>				18	3			S	tabilizer		Ν	lil		NMC	9
Difference		(	div)					18	3				%						
<b>Ring Factor</b>								0.0	1			S	Swell %			18			
	Gauge Fac	tor:0.0(	005 inc	hes/l	Div						Pene of th		tion unger	Bot (KN)	Top (KN)	Standa Load(l		CB	8R%
		CBR	TES	Г								(m	<b>m</b> )					Bott.	To
												0.	00	0	0				
												0.	64	2.25253					
	15.00	ПТ		П	Т		П	Τ	٦			1.	27	4.24006					
	14.00	$\left  \right $	+	++	_	++	++	+	_			1.		5.80359					
	13.00												54	7.08886			8.2	54	99
													18	8.10912					
	12.00			$\square$			++	1				3.		9.27514					
	11.00	H	++	++	*	++	++	+	-				45	10.2027					0.7
	10.00												08	11.1302			).0	56	87
													72	11.9914					
<b>X</b>	9.00			$\square$			$\square$					0	35	12.8527	17.769				
2.	8.00	$\vdash$		++	+	++	╉╋	╉											
Force in KN	7.00		4	++			++	_						M	louldin	σ Data			
Б	6.00	1									Wt.o	of M	[ould + ]	Wet soil		<u>g 20000</u>		1	
	0.00	1					Π						Iould		g	2			
	5.00	ř 🕂 🕇	++				++	+					e Conte	nt		, 0		1	
	4.00	+ + +	++	+	_	++	++	+	_		Wet	Der	nsity		Kg/m <sup>3</sup>				
	3.00			$\square$		$\square$	$\square$				Dry		ě.		Kg/m <sup>3</sup>				
											DIY	Den	isity		<u>Kg/m</u> % MI	מנ			
	2.00												MOL	LDING			CONT	ENT	
	1.00	$\left  \right $	++	++	+	++	++	+	-		Tin 1	No.	lifee	LDII(G	11010	<u>rent</u>		63	
	0.00			$\square$			$\downarrow$				_		et soil					167.8	
	0.00	->N лОл	ა. ე.თ	44 00	- 01 1 O	თი თი	6 - 5 -	ເ ວິເວ	0 10				ry soil				1	153.7	
	0000	οōŏ	οõ	οč	õ	οõ	οč	ó	ō		Wt o		v				1	92.8	
		Po-	etrati	on ir	۰ mr	n							loisture				1	14.1	
		ren	icu dil		1111	11					Wt.	of d	ry soil					75	
											Mois	stur	e conter	nt				18.80	
										RE	SULTS	5							
Penet	ration(mm)	S	Standa	rd Fo	orce(	KN)					Spe	ecifica	ation		CBR	%(top)		CBR%(bo	ott.)
	2.5			13.2	2										-	99		54	
	5			20			Γ									87		56	
								CB	R =	: <u>9</u> 9	%				Check	ked:	Marti	n Mburu	ı

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(HIGHWAYS	LABO	ORA	FORY	)												WO	RKIN	NG S	HEE	Г
2			A														TES			
	<u>.</u>	2	in the second			ŀ											T193:	1990)		
Project: Stabilization of I	otori	itio	Cros	ام								Too	to	ed: 03/12/2		(Soake	oaked:		20/1	1/2019
Student.: Anthony Mugen			Ulav	<sup>i</sup>										d No.:	017		Moulde			1/2019
	SWEI	-	ОАТА										Γ		SAMPLE				MDD	166
Initial gauge Reading			(div	<b>/</b> )						)			F	Туре	Sta	abilized/u	unstabiliz	ed	омс	24.4
Final gauge Reading			(div	v)					1	8			F	Stabilizer		Ν	lil		NMC	20
Difference		(	div)						1	8			F	%						
Ring Factor									0.	01				Swell %		0.	18			
Gauge	Factor	:0.00	005 inc	ches	/Div	7						Pene	et	ration	Bot	Тор	Standa	ard		
												of th	ne	plunger	(KN)	(KN)	Load(	KN)		BR%
	С	BR	TES	Т								_		(mm)					Bott.	Top
														0.00	0	0				
15.00														0.64	0.72876				_	
15.00		Π			Π									1.27	1.72253				-	
14.00		$\vdash$	++	-	+			+						1.91	2.91504				30	39
13.00		$\square$	++	_	$\left  \right $		_	_						2.54 3.18	3.93531	5.1676 5.5916		3.2	50	39
12.00 -		Ш												3.81	4.55157					
														4.45	4.94232					
11.00		H		╈	$\square$			┢						5.08	5.06158			).0	25	34
10.00 -	$\left  \right $	$\mathbb{H}$	++	_	+		+	╋	-	Н				5.72	5.16758					
9.00		$\square$	$\downarrow \downarrow$		$\square$									6.35	5.30008					
X 000																				
00.0		П			Π		T													
<b>Č</b> 7.00 -		$\vdash$	++	+		7		┢		Η						louldin	g Data			
<b>لت</b> 6.00 -		$\square$			4		_	_						Mould + V	Wet soil		<b>u</b>			
5.00 -			Π		$\Box$									f Mould		g				
				•-`	T I							Moi	st	ure Conte		%	0		_	
4.00 -		7			Ħ							Wet	t D	Density	]	Kg/m <sup>3</sup>				
3.00		Ĥ	++	+	+		+	+				Dry	D	Density		Kg/m <sup>3</sup>				
2.00		$\square$	++	_	$\square$			╞								% MI	DD			
1.00	*														LDING	MOIS	TURE	CONT		
												Tin							208	
0.00	→ <u>→                                  </u>	1   V N	ωω	4	 0 4	n Un	_ ი	 ი	↓ √	1 00 1 00				Wet soil					214	
.50	ດ ເຊຍ ເຊຍ	ດ 25	.00	88	50	3.22	8	.50 00	gi	<u>7</u> 8				Dry soil					187.2	
												Wto							78.7	
		Pen	etrati	on	in n	nm								Moisture					26.8 135.3	
														f dry soil are conten	<u>t</u>				135.3	
											ים	ESULTS		ure conten	ι			1	19.01	
Penetration(mm)		5	tanda	rd I	Tore	e(K	N				<u>N</u>			fication		CBD	%(top)		CBR%(b	off )
2.5		6	anua	13		vir	)		-			She		ncauvi			<u>39</u>	<u> </u>	<u>30</u>	
5				20													34	1	25	
					~						= 39					•		1	-0	1

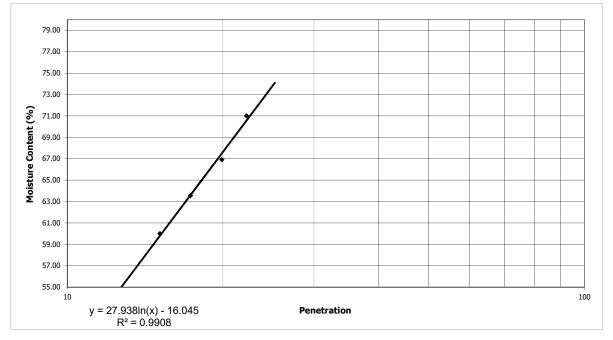
Appendix C3 Atterberg Limits

# **Plasticity Indices**

PROJECT		Later	itic Gravel	
STUDENT		Anthony	Mugendi Nyagah	
DEPTH		Sample No	NEAT	Sample time
Test date	28-Nov-19	Lab Ref No		
Specification		In accordance	e with BS 1377: 1990	

		Liquid Limit			Plasti	c Limit
Container No	32	8	10	17	К2	13
Penetration (mm)	15.1	17.3	19.9	22.2		
Wt of Container + Wet Soil (g)	54	63.2	76.1	87.3	16.9	16.9
Wt of Container + Dry Soil (g)	45	49.6	57.5	62.8	14.9	14.8
Wt of Container (g)	30	28.2	29.7	28.3	9.1	9
Wt of Moistuer (g)	9	13.6	18.6	24.5	2	2.1
Wt of Dry Soil (g)	15	21.4	27.8	34.5	5.8	5.8
Moisture Content (%)	60.00	63.55	66.91	71.01	34.48	36.21

Linear Shrinkage	Initial Length (mm)	No1	140	Final Length (mm)	No 1	119
Linear Shirikage	Initial Length (mm)	No 2	140	Final Length (mm)	No 2	119



Liquid Limit	67
Plastic Limit	35
Plasticity Index	32
Linear Shrinkage (%)	15

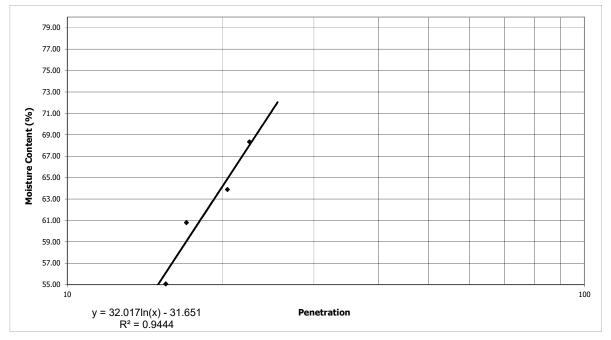
Technician	Mathew Mburu	Verified :	Elly Oyier
Date	30-Sep-20		
Observations:		-	
Conform to the specification	15		
	L		

# **Plasticity Indices**

PROJECT		Late	eritic Gravel	
STUDENT		Anthony	Mugendi Nyagah	
DEPTH		Sample No	NEAT Sample B	Sample time
Test date	24-Sep-20	Lab Ref No		
Specification		In accordan	ce with BS 1377: 1990	

		Liquid Limit			Plasti	c Limit
Container No	1	9	24	41	T4	В
Penetration (mm)	15.5	17	20.4	22.5		
Wt of Container + Wet Soil (g)	54.7	65.6	76.7	89.6	14.8	14.8
Wt of Container + Dry Soil (g)	46	51.8	58.3	65.2	13.4	13.3
Wt of Container (g)	30.2	29.1	29.5	29.5	9.1	8.4
Wt of Moistuer (g)	8.7	13.8	18.4	24.4	1.4	1.5
Wt of Dry Soil (g)	15.8	22.7	28.8	35.7	4.3	4.9
Moisture Content (%)	55.06	60.79	63.89	68.35	32.56	30.61

Linear Shrinkage	Initial Length (mm)	No1	140	Final Length (mm)	No 1	119
Linear Sirinkage	Initial Length (mill)	No 2	140	Final Lengen (min)	No 2	119



Liquid Limit	64
Plastic Limit	32
Plasticity Index	32
Linear Shrinkage (%)	15

Technician	Mathew Mburu	Verified :	Elly Oyier
Date	28-Sep-20		
Observations:			
Conform to the specification	s		

Appendix C4 Grading



# UNIVERSITY OF NAIROBI

DEPARTMENT OF CIVIL & CONSTRUCTION ENGINEERING

# SIEVE ANALYSIS

	Student	Anthony Mugendi Nyag						
San	nple source	Membley quarry, Kiam						
D	epth (m)		SAMPLE No	).	NEAT So	mple A	Sr. No.	
Те	est date:	27-Nov-19		Locatio	n:			
	ecification	According to BS 1377:1	990.		Descriptio	n: Lateriti	c Gravel	
an mass			(gm)	0				
	sample mass + pan		(gm)					
	sample mass ry sample mass +		(gm) (gm)	200		e mass e percent	(gm) (%)	79.2 39.6
	ry sample mass		(gm)	120.8		eptance Criteria	(%)	00.0
	.,		(3)				()	
Sie	eve size (mm)	Retained mass (gm)	% Retain	ied (%)		ive passed itage (%)	Acceptance	
	20	0		<u> </u>			Min(%)	Max (%)
	20	0	0.0			00.0		
	14 10	11.1	0.0 5.0			00.0 )4.5		
	5	40.8	20.			74.1		
	2.36	34.4	20.			4.1 i6.9		
	1.18	16.5	8.3			8.6		
	0.6	7.6	3.1			4.8		
	0.425	3	1.			13.3		
	0.3	3.1	1.0			1.8		
	0.15	3.3	1.3	7	4	0.1		
	0.075	1	0.4	5	:	9.6		
		79.2	39.	6				
		200		GRADIN				
Passing (%)	100       90       80       70       60       50       40       30       20       10       0       0.01	0.1		Sid	1 eves (mm	)	10	
quipment		Sieve set N° :		Shaker N	•		Scale Nº :	
<b>Fechnicia</b>	n	mathew Mburu			Verified :La	. Incharge	Martin Mburu	
Date								
Observati	ions: n to the spec	ifications						



# UNIVERSITY OF NAIROBI

DEPARTMENT OF CIVIL & CONSTRUCTION ENGINEERING

# SIEVE ANALYSIS

Student	Anthony Mugendi Nyag				
Sample source	Membley quarry, Kiam	bu County			
Depth (m)		SAMPLE No.	NEAT Sample B	Sr. No.	
Test date:	25-Sep-20	Locat	ion:		
Specification	According to BS 1377:1		le Description: Lateritio	c Gravel	
-					
an mass		(gm) 0			
nitial dry sample mass + pa nitial dry sample mass		(gm) (gm) 200	Fine mass	(am)	78
Vashed dry sample mass +		(gm) 200 (gm)	Fine percent	(gm) (%)	39.0
Vashed dry sample mass		(gm) 122	Acceptance Criteria	(%)	
	Detained mass (rm)	% Detained (%)	Cumulative passed	Acceptance C	Criteria
Sieve size (mm)	Retained mass (gm)	% Retained (%)	percentage (%)	Min(%)	Max (%)
20	0	0.0	100.0		
14	0	0.0	100.0		
10	28	14.0	86.0		
5	39	19.5	66.5		
2.36	27	13.5	53.0		
1.18	12	6.0	47.0		
0.6	5	2.5	44.5		
0.425	3	1.5	43.0		
0.3	2	1.0	42.0		
0.15	3	1.5	40.5		
0.075	3	1.5	39.0		
	78	39.0			
	200	GRADI	NG CURVE		
		URADI			
100				· · · · · · · · · · · · · · · · · · ·	
90					
80					
70					
8 60					
ହୁ <sub>50</sub>					
60	•				
30					
20					
10					
0 +	0.1		1	10	100
0.01			Sieves (mm)		
			bleves (min)		
0.01				Cost- NO.	
0.01	Sieve set N° :	Shaker	N°	Scale N° :	
0.01 Equipment Technician				Scale N° : Martin Mburu	
0.01 quipment	Sieve set N° :		N°		

	NEAT Sample S	ummary Results	
	Compaction	n Results	
	Sample 1	Sample 2	Average Value
MDD	1666 kg/m <sup>3</sup>	1682 kg/m <sup>3</sup>	1674 kg/m <sup>3</sup>
OMC	24.47%	25.0%	24.74%
	Strength P	roperties	
UCS	257kN/m <sup>2</sup>	257kN/m <sup>2</sup>	257kN/m <sup>2</sup>
CBR (Unsoaked)	99%	-	99%
CBR (Soaked)	39%	39%	39%
	Atterberg	z Limits	
Liquid Limit (LL)	67	64	66
Plastic Limit (PL)	35	32	34
Plasticity Index (PI)	32	32	32
Linear Shrinkage	15	15	15
	Grad	ing	
	39.6	39	39.3

# Appendix D FCD Stabilized Samples

Appendix D1 Compaction Properties (MDD & OMC)

No.

UNIVERSITY OF NAIROBI DEPARTMENT OF CIVIL & CONSTRUCTION ENGINEERING

# Moisture - Density

Sample Tvpe	Mechanical Stat	Mechanical Stabilization of Lateritic Gravel using FCD	using FCD	
- 17 - 1				1975 -
Sample source	Membley Quarr	y, Kiambu County & Upper Kal	Membley Quarry, Kiambu County & Upper Kabete Campus (Dairy farm) UON (FCD)	000
Sample Date	03-Jan-20	Sample No	Depth	T
Test date	03-Jan-20	Sample Description	3% FCD	1825
Specification	In accordance wi	with BS 1377: 1990		1750
				1675

		-									
Wt of Mould (g)	4700	Volume	Volume of Mould (I)		0.956		1600				
Test No		NMC	1	2	£	4		<b>A</b>		/	
Wt of mould + wet material (g)	aterial (g)		6500	6615	6640	6540	c7c1 w/£				
Wt wet material (g)			1800	1915	1940	1840	1450 (Kġ				
Wet density (kg/m <sup>3</sup> )			1883	2003	2029	1925	MDC 1375				
			Moist	Moisture content			1300				
Container No			50	107	53	223	ONCT				
Wt of container + wet material (g)	t material (g)		282.70	276.80	263.00	255.70	1225				
Wt of container (g)			92.40	95.10	91.80	79.50	1150				
Wt of container + dry material (g)	material (g)		249.10	241.30	226.40	212.40	1075				
Wt dry material (g)			156.70	146.20	134.60	132.90	2001				
Wt of moisture (g)			33.60	35.50	36.60	43.30	1000	19.0	23.0 27.0	31.0	35.0
Moisture content (%)			21.44	24.28	27.19	32.58					
Dry density (kg/m <sup>3</sup> )			1550	1612	1595	1452			Moist	Moisture Content (%)	ent (%)

25.25	1613
Optimum Moisture Content (%)	Maximum Dry Density (kg/m³)

Technician	Mathew Mburu	Verified :	Martin mburu
Date	04-Jan-20		
Observations:			
Conform to the specifications			

43.0

DEPARTMENT OF CIVIL & CONSTRUCTION ENGINEERING UNIVERSITY OF NAIROBI

# Moisture - Density

Sample Type	Mechanical Stabili;	Mechanical Stabilization of Lateritic Gravel using FCD	sing FCD			
Sample source	Membley Quarry,	Kiambu County & Upper Kab	Membley Quarry, Kiambu County & Upper Kabete Campus (Dairy farm) UON (FCD)	1750		
Sample Date	07 - Jan - 20	Sample No	Depth	1675		
hew	07 - Jan - 20	Sample Description	6% FCD			
Specification	In accordance with BS 1377: 1990	BS 1377: 1990		1600		
	+			1525		
Wt of Mould (a)	0027		D OFF		8	

												1	
								1	1525			/	_
Wt of Mould (g)	4700	Volume	Volume of Mould (I)		0.956					X		/	
Test No		NMC	1	2	3	4			1450				
Wt of mould + wet material (g)	srial (g)		6450	6558	6593	6555			L				/
Wt wet material (g)			1750	1858	1893	1855			c/21				-
Wet density (kg/m <sup>3</sup> )			1831	1944	1980	1940		MDC	1300				
			Moist	isture content			-						
Container No			181	213	198	222			1225				
Wt of container + wet material (g)	naterial (g)		212.00	295.00	211.50	211.20		-	1150				
Wt of container (g)			79.70	92.50	84.90	79.10		•	001				
Wt of container + dry material (g)	aterial (g)		188.10	254.10	183.60	179.80		Ē	1075				
Wt dry material (g)			108.40	161.60	98.70	100.70							
Wt of moisture (g)			23.90	40.90	27.90	31.40		-	1000 15.0 19.0	.0 23.0	0 27.0	0 31.0	35.0
Moisture content (%)			22.05	25.31	28.27	31.18							
Dry density (kg/m <sup>3</sup> )			1500	1551	1544	1479					Moist	Moisture Content (%)	it (%)

26.39	1553
Optimum Moisture Content (%)	Maximum Dry Density (kg/m³)

Technician	Mathew Mburu	Verified :	Martin Mburu
Date	08-Jan-20		
Observations:			
Conform to the specifications	SI		

43.0

39.0

DEPARTMENT OF CIVIL & CONSTRUCTION ENGINEERING UNIVERSITY OF NAIROBI

# Moisture - Density

Sample Type	Mechanical Stabil	ilization of Lateritic Gravel using FCD	el using FCD		
Sample source	Membley Quarry,	, Kiambu County & Upper k	Kiambu County & Upper Kabete (Dairy farm) UON (FCD)	1750 -	
Sample Date	07-Jan-20	Sample No	Depth	1675	
Test date	07-Jan-20	Sample Description	9% FCD		
Specification	In accordance with BS 1377: 1990	h BS 1377: 1990		1600	

							1525			$\left( \right)$	
Wt of Mould (g)	4700	Volume	Volume of Mould (I)		0.956						ø
Test No		NMC	1	2	3	4	<b>ئ)</b> 1450		~		
Wt of mould + wet material (g)	(g) I		6430	6555	6577	6525					
Wt wet material (g)			1730	1855	1877	1825	ری تم) (				
Wet density (kg/m <sup>3</sup> )			1810	1940	1963	1909	<b>MD</b> [				
			Moist	Moisture content							
Container No			50	58	61	68	1225				
Wt of container + wet material (g)	srial (g)		264.20	271.80	278.80	250.40	1150				
Wt of container (g)			92.60	93.70	93.70	92.50	0011				
Wt of container + dry material (g)	rial (g)		230.80	233.80	234.30	209.60	1075				
Wt dry material (g)			138.20	140.10	140.60	117.10					
Wt of moisture (g)			33.40	38.00	44.50	40.80	1000	19.0	23.0	27.0	31.0 35.0
Moisture content (%)			24.17	27.12	31.65	34.84					
Dry density (kg/m³)			1457	1526	1491	1416			Σ	oisture Co	Moisture Content (%)

28.31	1532
Optimum Moisture Content (%)	Maximum Dry Density (kg/m <sup>3</sup> )

echnician	Mathew Mburu	Verified :	Martin Mburu
ate	08-Jan-20		
bservations:			

43.0

39.0

UNIVERSITY OF NAIROBI DEPARTMENT OF CIVIL & CONSTRUCTION ENGINEERING

# Moisture - Density

Sample Type	Machanical Stabi	Machanical Stabilization of Latanitic Cuaval veina ECD			
antipie i she		ITALION OF FAIRING OF AVEL AS			
Sample source	Membley Quarry,	Kiambu County & Upper Kab	Kiambu County & Upper Kabete Campus (Dairy farm) UON (FCD)	1750	
Sample Date	07-Jan-20	Sample No	Depth	1675	
Test date	07-Jan-20	Sample Description	12% FCD		
Specification	In accordance with	h BS 1377: 1990		1600	
	_			1676	
	_			CZCT	

Wt of Mould (g)	4700	Volum	Volume of Mould (I)		0.956					
Test No		NMC	1	2	с	4	1	1450		
Wt of mould + wet material (g)	terial (g)		6390	6500	6535	6505				ø
Wt wet material (g)			1690	1800	1835	1805		ریا مرکا نیکا (		
Wet density (kg/m <sup>3</sup> )			1768	1883	1919	1888		1300		
			Moist	ture content						
Container No			223	208	63	216		1225		
Wt of container + wet material (g)	material (g)		211.40	209.60	250.00	198.40		1150		
Wt of container (g)			79.60	78.80	92.90	79.10		0011		
Wt of container + dry material (g)	naterial (g)		185.30	180.90	212.60	167.90		1075		+
Wt dry material (g)			105.70	102.10	119.70	88.80				
Wt of moisture (g)			26.10	28.70	37.40	30.50		1000 +	27.0 31.0	35.0
Moisture content (%)			24.69	28.11	31.24	34.35				
Dry density (kg/m <sup>3</sup> )			1418	1470	1463	1405		y = 0.0093x <sup>o</sup> - 3.4553x <sup>2</sup> + 1/8.19x <b>Muistube Content (%)</b> R <sup>2</sup> = 1	bistube Conter	ıt (%)

29.5	1474
Optimum Moisture Content (%)	Maximum Dry Density (kg/m <sup>3</sup> )

echnician	Mathew Mburu	Verified :	Martin Mburu
ate	08-Jan-20		
bservations:		-	

43.0

**Appendix D2 Strength Properties (UCS)** 

## **UNIVERSITY OF NAIROBI** WORKING SHEET (HIGHWAYS LABORATORY) **UCS TEST** SPECIMEN 1 Date:17-Jan-2020 No. of days cured: **Project: Mechanical Stabilization of Lateritic Gravel** 0 Anthony Mugendi Nyagah Mould No.: No. of days soaked: Student: 0 SAMPLE DETAILS DATA MDD 1613 Do =152mm STABILIZED 25.25 Туре OMC Stabilizer Lo mm 127 3% FCD NMC 9.2 0.0181 $\mathbf{m}^2$ Ao = (152x152x3.14)/4% 0 0.00275 Volume = AoLo m Stabilizer = NON Deflection Defl. E=L/L0 1-E A=(Ao)/1-E Stress UCS TEST Load Q KN/m<sup>2</sup> KN mm 0.01810 0.00 0.0000 1 0 0 0.9925 0.01824 0.95 0.0075 0.69854 38 340 0.01842 2.22 0.0175 0.9825 1.2521 68 320 0.01856 87 3.18 0.0250 0.975 1.62114 300 4.13 0.01871 2.3065 123 0.0325 0.9675 280 260 6.35 0.0500 0.95 0.01905 2.2406 118 240 0.01810 0.00 0 0.0000 1.0000 0 220 0.01810 0.00 0 1.0000 0 0 Stress KN/m<sup>2</sup> 200 0.01810 0 0.00 0.0000 1.0000 0 180 160 140 120 100 80 60 40 20 MOULDING MOISTURE CONTENT 0 -0.0600Tin No. 61 Tin +Wet soil 249.8 Tin + Dry soil 217 Wt of Tin 93.6 Wt of Moisture 32.8 Strain Wt. of dry soil 123.4 **Moisture content** 26.6 RESULTS Specification Result Results $123 \text{ KN/m}^2$ **Unconfined Compressive Strength**

Estimated Elastic Modulus
Tested By: Mathew & Nyagah
Checked By: Martin Mburu

## **UNIVERSITY OF NAIROBI** WORKING SHEET (HIGHWAYS LABORATORY) **UCS TEST** SPECIMEN 2 **Project: Mechanical Stabilization of Lateritic Gravel** Date: 17-Jan-2020 No. of days cured: 0 Student: Anthony Mugendi Nyagah Mould No.: No. of days soaked: 0 DATA SAMPLE DETAILS MDD 1613 Do =152mm STABILIZED 25.25 Туре OMC Stabilizer Lo mm 127 3% FCD NMC 9.2 0.0181 $\mathbf{m}^2$ Ao = (152x152x3.14)/4% 0 0.00275 Volume = AoLo m Stabilizer = NON Deflection Defl. E=L/L0 1-E A=(Ao)/1-E Stress UCS TEST Load Q KN/m<sup>2</sup> KN mm 0.01810 0.00 0.0000 1 0 0 0.01819 72 0.64 0.0050 0.995 1.30482 340 0.01828 1.27 0.0100 0.99 2.8337 155 320 0.01838 1.91 219 0.0150 0.985 4.0199 300 2.54 0.01847 4.45484 241 0.0200 0.98 280 260 3.18 0.0250 0.975 0.01856 4.2176 227 240 0.01810 0.00 0 0.0000 1.0000 0 220 0.01810 0.00 0 1.0000 0 0 Stress KN/m<sup>2</sup> 200 0.01810 0 0.00 0.0000 1.0000 0 180 160 140 120 100 80 60 40 20 MOULDING MOISTURE CONTENT 0 Tin No. 61 Tin +Wet soil 249.8 Tin + Dry soil 217 Wt of Tin 93.6 Wt of Moisture 32.8 Strain Wt. of dry soil 123.4 **Moisture content** 26.6 RESULTS

 Results
 Specification
 Result

 Unconfined Compressive Strength
 241 KN/m<sup>2</sup>

 Estimated Elastic Modulus
 Tested By: Mathew & Nyagah
 Checked By: Martin Mburu

## **UNIVERSITY OF NAIROBI** WORKING SHEET (HIGHWAYS LABORATORY) **UCS TEST SPECIMEN 3** Date: 17-Jan-2020 No. of days cured: **Project: Mechanical Stabilization of Lateritic Gravel** 0 Anthony Mugendi Nyagah Mould No.: No. of days soaked: Student: 0 SAMPLE DETAILS DATA MDD 1613 STABILIZED Do =152mm 25.25 Туре OMC Stabilizer Lo mm 127 3% FCD NMC 9.2 0.0181 Ao = (152x152x3.14)/4% 0 m 0.00275 Volume = AoLo m Stabilizer = NON Deflection Defl. E=L/L0 1-E A=(Ao)/1-E Stress UCS TEST Load Q KN/m<sup>2</sup> KN mm 0.01810 0.00 0.0000 1 0 0 0.01819 0.64 0.0050 0.995 1.09394 60 340 0.01828 1.27 0.0100 0.99 2.3724 130 320 0.01838 1.91 201 0.0150 0.985 3.6904 300 2.54 0.01847 4.57346 248 0.0200 0.98 280 260 3.18 0.0250 0.975 0.01856 4.45484 240 240 0.01810 0.00 0 0.0000 1.0000 0 220 0.01810 0.00 0 1.0000 0 0 Stress KN/m<sup>2</sup> 200 0.01810 0 0.00 0.0000 1.0000 0 180 160 140 120 100 80 60 40 20 MOULDING MOISTURE CONTENT 0 - 0.0600 - 0.0550 - 0.04500 - 0.0450 - 0.0350 - 0.0350 - 0.0250 - 0.0250 - 0.0150 - 0.0150 - 0.0050 Tin No. 61 Tin +Wet soil 249.8 Tin + Dry soil 217 Wt of Tin 93.6 Wt of Moisture 32.8 Strain Wt. of dry soil 123.4 **Moisture content** 26.6 RESULTS Specification Result Results 248 KN/m<sup>2</sup> **Unconfined Compressive Strength**

Estimated Elastic Modulus
Tested By: Mathew & Nyagah
Checked By: Martin Mburu

## **UNIVERSITY OF NAIROBI** WORKING SHEET (HIGHWAYS LABORATORY) **UCS TEST** SPECIMEN 4 Date: 17-Jan-2020 No. of days cured: **Project: Mechanical Stabilization of Lateritic Gravel** 0 Anthony Mugendi Nyagah Mould No.: No. of days soaked: Student: 0 SAMPLE DETAILS DATA MDD 1613 Do =152mm STABILIZED 25.25 Туре OMC Stabilizer Lo mm 127 3% FCD NMC 9.2 0.0181 Ao = (152x152x3.14)/4% 0 m 0.00275 Volume = AoLo m Stabilizer = NON Deflection Defl. E=L/L0 1-E A=(Ao)/1-E Stress UCS TEST Load Q KN/m<sup>2</sup> KN mm 0.01810 0.00 0.0000 1 0 0 0.32 0.9975 0.01815 29 0.0025 0.5272 340 0.01824 0.95 0.0075 0.9925 1.79248 98 320 0.01833 1.59 173 0.0125 0.9875 3.1632 300 2.22 0.01842 3.8881 211 0.0175 0.9825 280 260 2.54 0.0200 0.01847 3.7563 203 0.98 240 0.01810 0.00 0 0.0000 1.0000 0 220 0.01810 0.00 0 1.0000 0 0 Stress KN/m<sup>2</sup> 200 0.01810 0 0.00 0.0000 1.0000 0 180 160 140 120 100 80 60 40 20 MOULDING MOISTURE CONTENT 0 -0.0600 -0.0550 -0.04500 -0.0400 -0.03500 -0.03500 -0.02500 -0.02500 -0.02500 -0.02500 -0.02500 -0.02500 -0.02500 -0.02500 -0.02500 -0.02500 -0.02500 -0.02500 -0.02500 -0.02500 -0.02500 -0.02500 -0.02500 -0.02500 -0.02500 -0.02500 -0.02500 -0.02500 -0.02500 -0.02500 -0.02500 -0.02500 -0.02500 -0.02500 -0.02500 -0.02500 -0.02500 -0.02500 -0.02500 -0.02500 -0.02500 -0.02500 -0.02500 -0.02500 -0.02500 -0.02500 -0.02500 -0.02500 -0.02500 -0.02500 -0.02500 -0.02500 -0.02500 -0.02500 -0.02500 -0.02500 -0.02500 -0.02500 -0.02500 -0.02500 -0.02500 -0.02500 -0.02500 -0.02500 -0.02500 -0.02500 -0.02500 -0.02500 -0.02500 -0.02500 -0.02500 -0.02500 -0.02500 -0.02500 -0.02500 -0.02500 -0.02500 -0.02500 -0.02500 -0.02500 -0.02500 -0.02500 -0.02500 -0.02500 -0.02500 -0.02500 -0.02500 -0.02500 -0.02500 -0.02500 -0.02500 -0.02500 -0.02500 -0.02500 -0.02500 -0.02500 -0.02500 -0.02500 -0.02500 -0.02500 -0.02500 -0.02500 -0.02500 -0.02500 -0.02500 -0.02500 -0.02500 -0.02500 -0.02500 -0.02500 -0.02500 -0.02500 -0.02500 -0.02500 -0.02500 -0.02500 -0.02500 -0.02500 -0.02500 -0.02500 -0.02500 -0.02500 -0.02500 -0.02500 -0.02500 -0.02500 -0.02500 -0.02500 -0.02500 -0.02500 -0.02500 -0.02500 -0.02500 -0.02500 -0.02500 -0.02500 -0.02500 -0.02500 -0.02500 -0.02500 -0.02500 -0.02500 -0.02500 -0.02500 -0.02500 -0.02500 -0.02500 -0.02500 -0.02500 -0.02500 -0.02500 -0.02500 -0.02500 -0.02500 -0.02500 -0.02500 -0.02500 -0.02500 -0.02500 -0.02500 -0.02500 -0.02500 -0.02500 -0.02500 -0.02500 -0.02500 -0.02500 -0.02500 -0.02500 -0.02500 -0.02500.0050 Tin No. 61 Tin +Wet soil 249.8 Tin + Dry soil 217 Wt of Tin 93.6 Wt of Moisture 32.8 Strain Wt. of dry soil 123.4 **Moisture content** 26.6 RESULTS Specification Result Results

 Unconfined Compressive Strength
 211 KN/m<sup>2</sup>

 Estimated Elastic Modulus
 Tested By: Mathew & Nyagah

## **UNIVERSITY OF NAIROBI** WORKING SHEET (HIGHWAYS LABORATORY) **UCS TEST SPECIMEN 5** Date: 17-Jan-2020 No. of days cured: **Project: Mechanical Stabilization of Lateritic Gravel** 0 Anthony Mugendi Nyagah Mould No.: No. of days soaked: Student: 0 SAMPLE DETAILS DATA MDD 1613 Do =152mm STABILIZED 25.25 Туре OMC Stabilizer Lo mm 127 3% FCD NMC 9.2 0.0181 Ao = (152x152x3.14)/4% 0 m 0.00275 Volume = AoLo m Stabilizer = NON Deflection Defl. E=L/L0 1-E A=(Ao)/1-E Stress UCS TEST Load Q KN/m<sup>2</sup> KN mm 0.01810 0.00 0.0000 1 0 0 0.32 0.9975 0.01815 31 0.0025 0.55356 340 0.01824 0.95 0.0075 0.9925 1.8452 101 320 0.01833 1.59 169 300 0.0125 0.9875 3.0973 2.22 0.01842 3.8222 207 0.0175 0.9825 280 260 2.54 0.0200 0.01847 3.79584 206 0.98 240 0.01810 0.00 0 0.0000 1.0000 0 220 0.01810 0.00 0 1.0000 0 0 Stress KN/m<sup>2</sup> 200 0.01810 0 0.00 0.0000 1.0000 0 180 160 140 120 100 80 60 40 20 MOULDING MOISTURE CONTENT 0 $\begin{array}{c} -0.0600\\ -0.0550\\ -0.04500\\ -0.0350\\ -0.0250\\ -0.0250\\ -0.0250\\ -0.0200\\ -0.0050\\ 0.0000\\ \end{array}$ Tin No. 61 Tin +Wet soil 249.8 Tin + Dry soil 217 Wt of Tin 93.6 Wt of Moisture 32.8 Strain Wt. of dry soil 123.4 **Moisture content** 26.6 RESULTS Specification Result Results

 Unconfined Compressive Strength
 207 KN/m<sup>2</sup>

 Estimated Elastic Modulus
 Tested By: Mathew & Nyagah

 Checked By: Martin Mburu

## UNIVERSITY OF NAIROBI WORKING SHEET (HIGHWAYS LABORATORY) UCS TEST **SPECIMEN 6** Project: Mechanical Stabilization of Lateritic Gravel Date: 17-Jan-2020 No. of days cured: 0 **Client:** Anthony Mugendi Nyagah Mould No.: No. of days soaked: 0 DATA SAMPLE DETAILS MDD 1613 Do =152mm STABILIZED OMC 25.25 Туре Stabilizer Lo mm 127 3% FCD NMC 9.2 m<sup>2</sup> 0.0181 Ao =(152x152x3.14)/4 % 0 Volume = <u>AoLo</u> 0.00275 m<sup>3</sup> Deflection Stabilizer = NON Defl. E=L/L0 1-E A=(Ao)/1-E Stress UCS TEST Load Q KN/m<sup>2</sup> KN mm 0.01810 0.00 0.0000 0 1 0 0.32 0.9975 0.01815 36 340 0.0025 0.659 0.01824 119 0.95 0.0075 0.9925 2.1747 320 0.01833 1.59 0.0125 0.9875 3.4927 191 300 0.01842 223 2.22 0.0175 0.9825 4.11216 280 260 2.54 0.0200 0.98 0.01847 3.87492 210 240 0.01810 0.00 0.0000 1.0000 0 0 220 0.01810 0.00 0 1.0000 0 0 Stress KN/m<sup>2</sup> 200 0.00 0.01810 0.0000 1.0000 0 0 180 160 140 120 100 80 60 40 20 MOULDING MOISTURE CONTENT 0 $\begin{array}{c} -0.0550\\ -0.04500\\ -0.0400\\ -0.0350\\ -0.0350\\ -0.0350\\ -0.0250\\ -0.0250\\ -0.0150\\ -0.0150\\ \end{array}$ - 0.0050 - 0.0000 Tin No. 61 060 Tin +Wet soil 249.8 Tin + Dry soil 217 Wt of Tin 93.6 Wt of Moisture 32.8 Strain 123.4 Wt. of dry soil **Moisture content** 26.6 RESULTS Results Specification Result **Unconfined Compressive Strength** 223 KN/m<sup>2</sup>

Mathew & Mburu

Tested By:

Checked By:

Martin Mburu

**Estimated Elastic Modulus** 

#### **UNIVERSITY OF NAIROBI** WORKING SHEET (HIGHWAYS LABORATORY) **UCS TEST** SPECIMEN 7 Date: 17-Jan-2020 No. of days cured: **Project: Mechanical Stabilization of lateritic Gravel** 0 Student: Anthony Mugendi Nyagah Mould No.: No. of days soaked: 0 DATA SAMPLE DETAILS MDD 1613 STABILIZED Do =152mm 25.25 Туре OMC Stabilizer Lo mm 127 3% FCD NMC 9.2 0.0181 $\mathbf{m}^2$ Ao = (152x152x3.14)/4% 0 0.00275 Volume = AoLo m Stabilizer = NON Deflection Defl. E=L/L0 1-E A=(Ao)/1-E Stress UCS TEST Load Q KN/m<sup>2</sup> KN mm 0.01810 0.00 0.0000 1 0 0 0.32 0.9975 0.01815 0.0025 0.60628 33 340 0.01824 0.95 0.0075 0.9925 1.89792 104 320 0.01833 1.59 175 300 0.0125 0.9875 3.20274 2.22 0.01842 4.0199 0.0175 0.9825 218 280 260 2.54 0.0200 0.01847 3.90128 211 0.98 240 0.01810 0.00 0 0.0000 1.0000 0 220 0.01810 0.00 0 1.0000 0 0 Stress KN/m<sup>2</sup> 200 0.01810 0 0.00 0.0000 1.0000 0 180 160 140 120 100 80 60 40 20 MOULDING MOISTURE CONTENT 0 $\begin{array}{c} -0.0600\\ -0.0550\\ -0.04500\\ -0.0350\\ -0.0250\\ -0.0250\\ -0.0250\\ -0.0150\\ -0.0050\\ -0.0050\\ -0.0050\\ -0.0050\\ -0.0000\\ -0.0000\\ -0.0000\\ -0.0000\\ -0.000\\ -0.000\\ -0.000\\ -0.000\\ -0.000\\ -0.000\\ -0.000\\ -0.00\\ -0.00\\ -0.00\\ -0.00\\ -0.00\\ -0.00\\ -0.00\\ -0.00\\ -0.00\\ -0.00\\ -0.00\\ -0.00\\ -0.00\\ -0.00\\ -0.00\\ -0.00\\ -0.00\\ -0.00\\ -0.00\\ -0.00\\ -0.00\\ -0.00\\ -0.00\\ -0.00\\ -0.00\\ -0.00\\ -0.00\\ -0.00\\ -0.00\\ -0.00\\ -0.00\\ -0.00\\ -0.00\\ -0.00\\ -0.00\\ -0.00\\ -0.00\\ -0.00\\ -0.00\\ -0.00\\ -0.00\\ -0.00\\ -0.00\\ -0.00\\ -0.00\\ -0.00\\ -0.00\\ -0.00\\ -0.00\\ -0.00\\ -0.00\\ -0.00\\ -0.00\\ -0.00\\ -0.00\\ -0.00\\ -0.00\\ -0.00\\ -0.00\\ -0.00\\ -0.00\\ -0.00\\ -0.00\\ -0.00\\ -0.00\\ -0.00\\ -0.00\\ -0.00\\ -0.00\\ -0.00\\ -0.00\\ -0.00\\ -0.00\\ -0.00\\ -0.00\\ -0.00\\ -0.00\\ -0.00\\ -0.00\\ -0.00\\ -0.00\\ -0.00\\ -0.00\\ -0.00\\ -0.00\\ -0.00\\ -0.00\\ -0.00\\ -0.00\\ -0.00\\ -0.00\\ -0.00\\ -0.00\\ -0.00\\ -0.00\\ -0.00\\ -0.00\\ -0.00\\ -0.00\\ -0.00\\ -0.00\\ -0.00\\ -0.00\\ -0.00\\ -0.00\\ -0.00\\ -0.00\\ -0.00\\ -0.00\\ -0.00\\ -0.00\\ -0.00\\ -0.00\\ -0.00\\ -0.00\\ -0.00\\ -0.00\\ -0.00\\ -0.00\\ -0.00\\ -0.00\\ -0.00\\ -0.00\\ -0.00\\ -0.00\\ -0.00\\ -0.00\\ -0.00\\ -0.00\\ -0.00\\ -0.00\\ -0.00\\ -0.00\\ -0.00\\ -0.00\\ -0.00\\ -0.00\\ -0.00\\ -0.00\\ -0.00\\ -0.00\\ -0.00\\ -0.00\\ -0.00\\ -0.00\\ -0.00\\ -0.00\\ -0.00\\ -0.00\\ -0.00\\ -0.00\\ -0.00\\ -0.00\\ -0.00\\ -0.00\\ -0.00\\ -0.00\\ -0.00\\ -0.00\\ -0.00\\ -0.00\\ -0.00\\ -0.00\\ -0.00\\ -0.00\\ -0.00\\ -0.00\\ -0.00\\ -0.00\\ -0.00\\ -0.00\\ -0.00\\ -0.00\\ -0.00\\ -0.00\\ -0.00\\ -0.00\\ -0.00\\ -0.00\\ -0.00\\ -0.00\\ -0.00\\ -0.00\\ -0.00\\ -0.00\\ -0.00\\ -0.00\\ -0.00\\ -0.00\\ -0.00\\ -0.00\\ -0.00\\ -0.00\\ -0.00\\ -0.00\\ -0.00\\ -0.00\\ -0.00\\ -0.00\\ -0.00\\ -0.00\\ -0.00\\ -0.00\\ -0.00\\ -0.00\\ -0.00\\ -0.00\\ -0.00\\ -0.00\\ -0.00\\ -0.00\\ -0.00\\ -0.00\\ -0.00\\ -0.00\\ -0.00\\ -0.00\\ -0.00\\ -0.00\\ -0.00\\ -0.00\\ -0.00\\ -0.00\\ -0.00\\ -0.00\\ -0.00\\ -0.00\\ -0.00\\ -0.00\\ -0.00\\ -0.00\\ -0.00\\ -0.00\\ -0.00\\ -0.00\\ -0.00\\ -0.00\\ -0.00\\ -0.00\\ -0.00\\ -0.00\\ -0.00\\ -0.00\\ -0.00\\ -0.00\\ -0.00\\ -0.00\\ -0.00\\ -0.00\\ -0.00\\ -0.00\\ -0.00\\ -0.00\\ -0.00\\ -0.00\\ -0.00\\ -0.00\\ -0.00\\ -0.00\\ -0.00\\ -0.00\\ -0.00\\ -0.0$ Tin No. 61 Tin +Wet soil 249.8 Tin + Dry soil 217 Wt of Tin 93.6 Wt of Moisture 32.8 Strain Wt. of dry soil 123.4 **Moisture content** 26.6 RESULTS Specification Result Results 218 KN/m<sup>2</sup> **Unconfined Compressive Strength Estimated Elastic Modulus**

Tested By: Mathew & Nyagah Checked

Checked By: Martin Mburu

### **UNIVERSITY OF NAIROBI WORKING SHEET** (HIGHWAYS LABORATORY) **UCS TEST SPECIMEN 1** Project: Mechanical Stabilization of Lateritic Gravel Date: 06-Jan-2020 No. of days cured: 0 Student: Anthony Mugendi Nyagah Mould No.: No. of days soaked: 0 DATA SAMPLE DETAILS MDD Do =152mm STABILIZED OMC Туре Stabilizer 127 6% FCD NMC Lo mm m<sup>2</sup> Ao =(152x152x3.14)/4 0.0181 % 0 0.00275 Volume = AoLo m<sup>3</sup>

1553

26.39

9.2

Volume =				]	m					0.00275			<b>D A</b>			
Stabilizer =	NON										Defl.		Deflec	tion		
			UCS	S ТЕ	ST							E=L/L0	1-E	A=(Ao)/1-1	E S Load	tress
											mm				KN	KN/n
											0.00	0.0000	1	0.01810	0	0
	340		—	_	-		_	_			0.32	0.0025	0.9975	0.01815	0.9226	51
	320		+	_				+	Н		0.64	0.0050	0.995	0.01819	2.7019	14
	300	$\left  - \right $	+	_		$\left  \right $		+	H		0.95	0.0075	0.9925	0.01824	4.4153	24
	280	$\left  \right $	+	+	-	$\left  \right $		+	H		1.27	0.0100	0.99	0.01828	5.7992	31
	260	$\left  \right $	+	+	+	$\left  \right $		╉	H		1.59	0.0125	0.9875	0.01833	5.272	28
	240							╈			0.00	0.0000	1.0000	0.01810	0	0
	220							╈			0.00	0	1.0000	0.01810	0	0
Stress KN/m <sup>2</sup>	200								П		0.00	0.0000	1.0000	0.01810	0	0
ss K	180 160															
Stree			4													
0)	140		$\top$													
	120		$\uparrow$													
	100 80															
	60															
	40	-														
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	0	0.0	, <u>o</u>	-0.0	0.0			0.0	- 0.0300 - 0.0270		Tin No.				61	
		000	206	000	12	ן קריק	021	024	027		Tin +Wet so				257	
			, 0	0	00		0	0	00		Tin + Dry so	oil			219.3	
											Wt of Tin Wt of Moist	uro			<u>93.6</u> 37.7	
					S	trair	1				Wt of Moist				125.7	
											Moisture con				30.0	
											RESULTS			-		
	Unconfin	ed Cr	mpr		esult e Str		h				Specification			Res 317 K	$\frac{1}{N/m^2}$	
	Unconfined Compressive Strength Estimated Elastic Modulus													<b>J</b> 1 / <b>N</b>	1 1/ 111	
	Lotinate									Tested		/ & Nyagah		Checked By		n Mbur

#### **UNIVERSITY OF NAIROBI** WORKING SHEET (HIGHWAYS LABORATORY) **UCS TEST** SPECIMEN 2 Date: 06-Jan-2020 No. of days cured: **Project: Mechanical Stabilization of Lateritic Gravel** 0 Anthony Mugendi Nyagah Mould No.: No. of days soaked: Student: 0 SAMPLE DETAILS DATA MDD 1553 Do =152mm STABILIZED 26.39 Туре OMC Stabilizer Lo mm 127 6% FCD NMC 9.2 0.0181 $\mathbf{m}^2$ Ao = (152x152x3.14)/4% 0 0.00275 Volume = AoLo m Stabilizer = NON Deflection Defl. E=L/L0 1-E A=(Ao)/1-E Stress UCS TEST Load Q KN/m<sup>2</sup> KN mm 0.01810 0.00 0.0000 1 0 0 0.32 0.9975 0.01815 122 0.0025 2.21424 340 0.01819 0.64 0.0050 0.995 3.5586 196 320 0.01824 0.95 253 0.0075 0.9925 4.613 300 1.27 0.01828 5.272 288 0.0100 0.99 280 260 1.59 0.0125 0.9875 0.01833 5.08748 278 é 240 0.01810 0.00 0 0.0000 1.0000 0 220 0.01810 0.00 0 1.0000 0 0 Stress KN/m<sup>2</sup> 200 0.01810 0 0.00 0.0000 1.0000 0 180 160 140 120 100 80 60 40 20 **MOULDING MOISTURE CONTENT** 0 - 0.0300 - 0.0270 - 0.0240 - 0.0210 - 0.0180 - 0.0150 - 0.0120 - 0.0090 - 0.0090 - 0.0060 0.0000 Tin No. 61 Tin +Wet soil 257 Tin + Dry soil 219.3 Wt of Tin 93.6 Wt of Moisture 37.7 Strain Wt. of dry soil 125.7 **Moisture content** 30.0 RESULTS Results Specification Result **288** KN/m<sup>2</sup> **Unconfined Compressive Strength Estimated Elastic Modulus**

Tested By: Mathew & Nyagah Checked By:

Martin Mburu

#### **UNIVERSITY OF NAIROBI** WORKING SHEET (HIGHWAYS LABORATORY) **UCS TEST** SPECIMEN 3 Date: 06-Jan-2020 No. of days cured: **Project: Mechanical Stabilization of Lateritic Gravel** 0 Anthony Mugendi Nyagah Mould No.: No. of days soaked: Student: 0 SAMPLE DETAILS DATA MDD 1553 Do =152mm STABILIZED 26.39 Туре OMC Stabilizer Lo mm 127 6% FCD NMC 9.2 0.0181 $\mathbf{m}^2$ Ao = (152x152x3.14)/4% 0 0.00275 Volume = AoLo m Stabilizer = NON Deflection Defl. E=L/L0 1-E A=(Ao)/1-E Stress UCS TEST Load Q KN/m<sup>2</sup> KN mm 0.01810 0.00 0.0000 1 0 0 0.32 0.9975 0.01815 73 0.0025 1.318 340 0.01819 0.64 0.0050 0.995 2.636 145 320 0.01824 0.95 181 0.0075 0.9925 3.295 300 1.27 0.01828 3.4268 187 0.0100 0.99 280 260 1.59 0.0125 0.9875 0.01833 3.38726 185 240 0.01810 0.00 0 0.0000 1.0000 0 220 0.01810 0.00 0 1.0000 0 0 Stress KN/m<sup>2</sup> 200 0.01810 0 0.00 0.0000 1.0000 0 180 160 140 120 100 80 60 40 20 **MOULDING MOISTURE CONTENT** 0 - 0.0300 - 0.0270 - 0.0240 - 0.0210 - 0.0180 - 0.0180 - 0.0150 - 0.0150 - 0.0120 - 0.0090 0.0000 0.0030 Tin No. 61 Tin +Wet soil 257 Tin + Dry soil 219.3 Wt of Tin 93.6 Wt of Moisture 37.7 Strain Wt. of dry soil 125.7 **Moisture content** 30.0 RESULTS Results Specification Result 187 KN/m<sup>2</sup> **Unconfined Compressive Strength Estimated Elastic Modulus**

Tested By: Mathew & Nyagah Check

Checked By: Martin Mburu

	UNIV	/ERS	SIT	'Y (	<b>DF</b>	NA	IR	OF	BI									
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					1									UCS 7	ГЕЅТ			
		1		COCH.									SP	ECIMEN	[4			
Project: N	Mechanic	al Stał	oiliza	ation	of L	ate	ritic	Gra	vel		Date	e: 06-Jan-	2020	No. of da	ays cure	d:		0
Student:	Antho	ny Mu	gend	li Ny	ragah	l					Mou	ld No.:		No. of da		ed:		0
			D	ATA									SAMI	PLE DETAI	LS		MDD	1553
Do =152n	nm											Туре		STABIL			OMC	26.39
Lo	150 0 1	0.74	mm						127	1		Stabilizer %		3% F	CD		NMC	9.2
Ao =(152)		1)/4		$m^2$ $m^3$					0.018			<i>7</i> 0	-	0				
Volume = Stabilizer =				m					0.002	3		Defl.		Deflec	tion			
Stubilizer												Den.					1	
		цс	CS TI	EGT									E=L/L0	1-E	A=(A	o)/1-E		ress
			,0 11	-01														Q
												mm	ļ	ļ			KN	KN/m <sup>2</sup>
												0.00	0.0000	1	0.01		0	0
	340		П	Τ	Т		П					0.32	0.0025	0.9975	0.01		1.318	73
	320	++-	╆╋	+	╆╋	+	+					0.64	0.0050	0.995	0.01	819	2.66236	146
	300		$\vdash$	+	$\vdash$	_		_				0.95	0.0075	0.9925	0.01	824	3.8222	210
	280		$\vdash$	+		_	$\left  \right $	_				1.27	0.0100	0.99	0.01	828	4.4812	245
	260		┢┼┥	+	++	+	$\left  \right $	_				1.59	0.0125	0.9875	0.01	833	4.40212	240
	240		⊢∤	┺ <u>┣</u> ━	++	_		_				0.00	0.0000	1.0000	0.01	810	0	0
	220		$\square$	$\perp$	$\square$							0.00	0	1.0000	0.01	810	0	0
-13	200		•															-
N/N												0.00	0.0000	1.0000	0.01	810	0	0
×	180		$\square$		$\square$													
Stress KN/m <sup>2</sup>	160		$\square$	+	++													
Sti	140	+ + #	╢	+	++	_		_										
	120		$\square$	$\perp$	$\square$													
	100																T	
	80	-	$\square$	+	++													
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	20		$\square$	$\perp$	$\square$					l								
	0									ſ		N	MOULDI	NG MOI	STURE	CONT	TENT	
	0	0.0	0.0	, <u>o</u> ;	0.0	- 0.0	0.0	0.0			Tin	No.					61	
		- 0.0030 - 0.0000	106 106	012	018 015	021	027	030				+Wet soil					257	
		000	50	00	00	0	00	0			Tin W4	<u>+ Dry soil</u> of Tin					219.3 93.6	
												of Moistur	re				<u>95.0</u> 37.7	
				S	train							of dry soi					125.7	
												sture cont					30.0	
											R	ESULTS						
				Result	ts						_	ecification		<b></b>		Result		
	Unconfine	ed Comp	pressi	ve Str	rength	1									24	45 KN	$/\mathrm{m}^2$	
	Estimated	l Elastic	Mod	ulus														
									Test	ed B	y:	Mathew a	& Nyagał	1	Check	ed By:	Martin	n Mburu

# UNIVERSITY OF NAIROBI (HIGHWAYS LABORATORY)

## WORKING SHEET

## UCS TEST

				4						SP	ECIMEN	5			
Project: N	/lechanical St	abiliz	ation	of la	eritic	Gravel					No. of da	ys cured:			0
Student:	Anthony			Vyagal	1			Mou	Id No.:			iys soaked	1:		0
<b>D</b>		E	ATA			<u> </u>				SAMP	LE DETAI			MDD	15
Do =152n	ım						107		Type Stabilizer		STABIL			OMC	26.
Lo A o -(152)	x152x3.14)/4	mr	m m <sup>2</sup>				127 0.0181		Stabilizer		6% F0 0	UD		NMC	
Volume =			m <sup>3</sup>				0.00275		/0		0				
Stabilizer =									Defl.		Deflec	tion			
														~	
	ι	JCS T	EST							E=L/L0	1-E	A=(A0)/	/1-Е		ress Q
									<u>mm</u> 0.00	0.0000	1	0.018	10	<u>KN</u>	KN/m 0
	340					_			0.00	0.0000	0.9975	0.018		0.659	36
				[					0.52	0.0023	0.9973	0.018		1.1862	65
	320			$\uparrow \uparrow$	$\square$			-							
	300								0.95	0.0075	0.9925	0.0182		1.7793	98
	280								1.27	0.0100	0.99	0.0182		2.7678	151
	260								1.59	0.0125	0.9875	0.0183	33	3.1632	173
	240								1.91	0.0150	0.9850	0.0183	38	3.53224	192
	220					-			2.22	0.0175	0.9825	0.0184	42	3.4268	18
l/m²	200					_			0.00	0.0000	1.0000	0.0181	10	0	0
X	180					—									
Stress KN/m <sup>2</sup>	160		<b>-</b>												
S	140					_									
	120 -	+	+	++	$\left  \right $										
	100	- +													
	80		+	++	$\left  \right $										
	60	/	_			_									
	40	/	_	++	$\left  \cdot \right $										
	20		_	++	$\left  \cdot \right $										
	o 🖊									10ULDI	NG MOI	STURE C	CONT		
	0.0000		0.0	0.01	0.0270 0.0240			Tin ]	<u>No.</u> +Wet soil					<u>61</u> 257	
	000	000	20	80 50	10	300 00			+ Wet son + Dry soil					219.3	
								Wt o	of Tin					93.6	
			•	train					of Moistur					37.7	
			3	ualli					of dry soil sture cont					<u>125.7</u> 30.0	
									<u>sture cont</u> RESULTS	ent		I		30.0	
			Resul	ts					ecification				Result		
	Unconfined Co	mpress	ive St	rength									2 KN/		
	Estimated Elas	tic Moo	lulus												
							Tested ]	By:	Mathew &	& Nyagał	ı	Checked	l By:	Martii	1 Mbur

#### **UNIVERSITY OF NAIROBI** WORKING SHEET (HIGHWAYS LABORATORY) **UCS TEST SPECIMEN 6** Date: 06-Jan-2020 No. of days cured: **Project: Mechanical Stabilization of Lateritic Gravel** 0 Mould No.: No. of days soaked: Student: Anthony Mugendi Nyagah 0 SAMPLE DETAILS DATA MDD 1553 Do =152mm STABILIZED 26.39 Туре OMC Stabilizer Lo mm 127 6% FCD NMC 9.2 0.0181 $\mathbf{m}^2$ Ao = (152x152x3.14)/4% 0 0.00275 Volume = AoLo m Stabilizer = NON Deflection Defl. E=L/L0 1-E A=(Ao)/1-E Stress UCS TEST Load Q KN/m<sup>2</sup> KN mm 0.01810 0.00 0.0000 1 0 0 0.32 0.9975 0.01815 109 0.0025 1.977 340 0.01819 0.64 0.0050 0.995 3.6904 203 320 0.01824 0.95 253 0.0075 0.9925 4.613 300 1.27 0.01828 5.4038 296 0.0100 0.99 280 260 1.59 0.0125 0.9875 0.01833 5.272 288 é 240 0.01810 0.00 0 0.0000 1.0000 0 220 0.01810 0.00 0 1.0000 0 0 Stress KN/m<sup>2</sup> 200 0.01810 0 0.00 0.0000 1.0000 0 180 160 140 120 100 80 60 40 20 **MOULDING MOISTURE CONTENT** 0 - 0.0300 - 0.0270 - 0.0240 - 0.0210 - 0.0180 - 0.0150 - 0.0120 - 0.0090 - 0.0090 - 0.0060 0.0000 Tin No. 61 Tin +Wet soil 257 Tin + Dry soil 219.3 Wt of Tin 93.6 Wt of Moisture 37.7 Strain Wt. of dry soil 125.7 **Moisture content** 30.0 RESULTS Results Specification Result **296 KN/m<sup>2</sup> Unconfined Compressive Strength Estimated Elastic Modulus** Mathew & Nyagah Checked By: Martin Mburu

Tested By:

#### **UNIVERSITY OF NAIROBI** WORKING SHEET (HIGHWAYS LABORATORY) **UCS TEST** SPECIMEN 7 Date: 06-Jan-2020 No. of days cured: Project: Mechanical Stabilization of Lateritic Gravel 0 Mould No.: No. of days soaked: **Client:** Anthony Mugendi Nyagah 0 SAMPLE DETAILS DATA MDD 1553 Do =152mm STABILIZED 26.39 Туре OMC Stabilizer Lo mm 127 6% FCD NMC 9.2 0.0181 $\mathbf{m}^2$ Ao = (152x152x3.14)/4% 0 0.00275 Volume = AoLo m Stabilizer = NON Deflection Defl. E=L/L0 1-E A=(Ao)/1-E Stress UCS TEST Load Q KN/m<sup>2</sup> KN mm 0.01810 0.00 0.0000 1 0 0 0.32 0.9975 0.01815 102 0.0025 1.8452 340 0.01819 0.64 0.0050 0.995 3.45316 190 320 0.95 0.01824 238 0.0075 0.9925 4.3494 300 1.27 0.01828 5.0084 274 0.0100 0.99 280 260 1.59 0.0125 0.9875 0.01833 4.29668 234 240 0.01810 0.00 0 0.0000 1.0000 0 220 0.01810 0.00 0 1.0000 0 0 Stress KN/m<sup>2</sup> 200 0.01810 0 0.00 0.0000 1.0000 0 180 160 140 120 100 80 60 40 20 **MOULDING MOISTURE CONTENT** 0 - 0.0300 - 0.0270 - 0.0240 - 0.0210 - 0.0180 - 0.0180 - 0.0150 - 0.0120 - 0.0090 - 0.0060 - 0.0030 0.0000 Tin No. 61 Tin +Wet soil 257 Tin + Dry soil 219.3 Wt of Tin 93.6 Wt of Moisture 37.7 Strain Wt. of dry soil 125.7 **Moisture content** 30.0 RESULTS Results Specification Result 274 KN/m<sup>2</sup> **Unconfined Compressive Strength Estimated Elastic Modulus**

Mathew & Nyagah

Tested By:

Checked By:

Martin Mburu

#### **UNIVERSITY OF NAIROBI** WORKING SHEET (HIGHWAYS LABORATORY) **UCS TEST** SPECIMEN 1 Date: 22-Jan-2020 No. of days cured: **Project: Mechanical Stabilization of Lateritic Gravel** 0 Student: Anthony Mugendi Nyagah Mould No.: No. of days soaked: 0 DATA SAMPLE DETAILS MDD 1532 Do =152mm STABILIZED 28.31 Туре OMC Stabilizer Lo mm 127 9% FCD NMC 9.2 0.0181 $\mathbf{m}^2$ Ao = (152x152x3.14)/4% 0 0.00275 Volume = AoLo m Stabilizer = NON Deflection Defl. E=L/L0 1-E A=(Ao)/1-E Stress UCS TEST Load Q KN/m<sup>2</sup> KN mm 0.01810 0.00 0.0000 1 0 0 1.27 0.01828 106 0.0100 0.99 1.93746 340 0.01847 2.54 0.0200 0.98 4.5471 246 320 0.01866 318 3.81 0.0300 0.97 5.931 300 0.01885 5.8651 311 5.08 0.0400 0.96 280 260 6.35 0.0500 0.95 0.01905 5.5356 291 240 0.01810 0.00 0 0.0000 1.0000 0 220 0.01810 0.00 0 1.0000 0 0 Stress KN/m<sup>2</sup> 200 0.01810 0 0.00 0.0000 1.0000 0 180 160 140 120 100 80 60 40 20 MOULDING MOISTURE CONTENT 0 Tin No. 107 Tin +Wet soil 227.5 Tin + Dry soil 196.2 Wt of Tin 95 Wt of Moisture 31.3 Strain Wt. of dry soil 101.2 **Moisture content** 30.9 RESULTS Specification Result Results

 Unconfined Compressive Strength
 318 KN/m<sup>2</sup>

 Estimated Elastic Modulus
 Tested By: Mathew % Nyagah

 Tested By: Mathew % Nyagah
 Checked By: Martin Mburu

#### **UNIVERSITY OF NAIROBI** WORKING SHEET (HIGHWAYS LABORATORY) **UCS TEST** SPECIMEN 2 Date: 22-Jan-2020 No. of days cured: **Project: Mechanical Stabilization of lateritic Gravel** 0 Anthony Mugendi Nyagah Mould No.: No. of days soaked: Student: 0 SAMPLE DETAILS DATA MDD 1532 Do =152mm STABILIZED 28.31 Туре OMC Stabilizer Lo mm 127 9% FCD NMC 9.2 0.0181 $\mathbf{m}^2$ Ao = (152x152x3.14)/4% 0 0.00275 Volume = AoLo m Stabilizer = NON Deflection Defl. E=L/L0 1-E A=(Ao)/1-E Stress UCS TEST Load Q KN/m<sup>2</sup> KN mm 0.01810 0.00 0.0000 1 0 0 0.9925 0.01824 0.95 0.0075 1.0544 58 340 0.01838 1.91 0.0150 0.985 2.71508 148 320 0.01852 224 2.86 0.0225 0.9775 4.1517 300 3.81 0.01866 4.6789 0.0300 0.97 251 280 260 4.76 0.0375 0.01881 0.9625 4.613 245 240 0.01810 0.00 0 0.0000 1.0000 0 220 0.01810 0.00 0 1.0000 0 0 Stress KN/m<sup>2</sup> 200 0.01810 0 0.00 0.0000 1.0000 0 180 160 140 120 100 80 60 40 20 MOULDING MOISTURE CONTENT 0 - 0.0600 - 0.0550 - 0.04500 - 0.0450 - 0.0350 - 0.0350 - 0.0250 - 0.0250 - 0.0150 - 0.0150 Tin No. 107 Tin +Wet soil 227.5 Tin + Dry soil 196.2 Wt of Tin 95 Wt of Moisture 31.3 Strain Wt. of dry soil 101.2 **Moisture content** 30.9 RESULTS Specification Result Results 251 KN/m<sup>2</sup> **Unconfined Compressive Strength Estimated Elastic Modulus** Mathew & Nyagah Checked By: Martin Mburu Tested By:

#### **UNIVERSITY OF NAIROBI** WORKING SHEET (HIGHWAYS LABORATORY) **UCS TEST** SPECIMEN 3 Date: 22-Jan-2020 No. of days cured: **Project: Mechanical Stabilization of Lateritic Gravel** 0 Anthony Mugendi Nyagah Mould No.: No. of days soaked: Student: 0 SAMPLE DETAILS DATA MDD 1532 STABILIZED Do =152mm 28.31 Туре OMC Stabilizer Lo mm 127 9% FCD NMC 9.2 0.0181 $\mathbf{m}^2$ Ao = (152x152x3.14)/4% 0 0.00275 Volume = AoLo m Stabilizer = NON Deflection Defl. E=L/L0 1-E A=(Ao)/1-E Stress UCS TEST Load Q KN/m<sup>2</sup> KN mm 0.01810 0.00 0.0000 1 0 0 0.9925 0.01824 0.95 0.0075 1.2521 69 340 0.01838 1.91 0.0150 0.985 2.74144 149 320 0.01852 226 2.86 0.0225 0.9775 4.19124 300 3.81 0.01866 5.0084 0.0300 0.97 268 280 260 4.76 0.0375 0.01881 4.9425 263 0.9625 240 0.01810 0.00 0 0.0000 1.0000 0 220 0.01810 0.00 0 1.0000 0 0 Stress KN/m<sup>2</sup> 200 0.01810 0 0.00 0.0000 1.0000 0 180 160 140 120 100 80 60 40 20 MOULDING MOISTURE CONTENT 0 $\begin{array}{c} -0.0600\\ -0.0550\\ -0.04500\\ -0.0350\\ -0.0250\\ -0.0250\\ -0.0250\\ -0.0150\\ -0.0050\\ -0.0050\\ -0.0050\\ -0.0050\\ -0.0000\\ -0.0000\\ -0.0000\\ -0.0000\\ -0.000\\ -0.000\\ -0.000\\ -0.000\\ -0.000\\ -0.000\\ -0.000\\ -0.00\\ -0.00\\ -0.00\\ -0.00\\ -0.00\\ -0.00\\ -0.00\\ -0.00\\ -0.00\\ -0.00\\ -0.00\\ -0.00\\ -0.00\\ -0.00\\ -0.00\\ -0.00\\ -0.00\\ -0.00\\ -0.00\\ -0.00\\ -0.00\\ -0.00\\ -0.00\\ -0.00\\ -0.00\\ -0.00\\ -0.00\\ -0.00\\ -0.00\\ -0.00\\ -0.00\\ -0.00\\ -0.00\\ -0.00\\ -0.00\\ -0.00\\ -0.00\\ -0.00\\ -0.00\\ -0.00\\ -0.00\\ -0.00\\ -0.00\\ -0.00\\ -0.00\\ -0.00\\ -0.00\\ -0.00\\ -0.00\\ -0.00\\ -0.00\\ -0.00\\ -0.00\\ -0.00\\ -0.00\\ -0.00\\ -0.00\\ -0.00\\ -0.00\\ -0.00\\ -0.00\\ -0.00\\ -0.00\\ -0.00\\ -0.00\\ -0.00\\ -0.00\\ -0.00\\ -0.00\\ -0.00\\ -0.00\\ -0.00\\ -0.00\\ -0.00\\ -0.00\\ -0.00\\ -0.00\\ -0.00\\ -0.00\\ -0.00\\ -0.00\\ -0.00\\ -0.00\\ -0.00\\ -0.00\\ -0.00\\ -0.00\\ -0.00\\ -0.00\\ -0.00\\ -0.00\\ -0.00\\ -0.00\\ -0.00\\ -0.00\\ -0.00\\ -0.00\\ -0.00\\ -0.00\\ -0.00\\ -0.00\\ -0.00\\ -0.00\\ -0.00\\ -0.00\\ -0.00\\ -0.00\\ -0.00\\ -0.00\\ -0.00\\ -0.00\\ -0.00\\ -0.00\\ -0.00\\ -0.00\\ -0.00\\ -0.00\\ -0.00\\ -0.00\\ -0.00\\ -0.00\\ -0.00\\ -0.00\\ -0.00\\ -0.00\\ -0.00\\ -0.00\\ -0.00\\ -0.00\\ -0.00\\ -0.00\\ -0.00\\ -0.00\\ -0.00\\ -0.00\\ -0.00\\ -0.00\\ -0.00\\ -0.00\\ -0.00\\ -0.00\\ -0.00\\ -0.00\\ -0.00\\ -0.00\\ -0.00\\ -0.00\\ -0.00\\ -0.00\\ -0.00\\ -0.00\\ -0.00\\ -0.00\\ -0.00\\ -0.00\\ -0.00\\ -0.00\\ -0.00\\ -0.00\\ -0.00\\ -0.00\\ -0.00\\ -0.00\\ -0.00\\ -0.00\\ -0.00\\ -0.00\\ -0.00\\ -0.00\\ -0.00\\ -0.00\\ -0.00\\ -0.00\\ -0.00\\ -0.00\\ -0.00\\ -0.00\\ -0.00\\ -0.00\\ -0.00\\ -0.00\\ -0.00\\ -0.00\\ -0.00\\ -0.00\\ -0.00\\ -0.00\\ -0.00\\ -0.00\\ -0.00\\ -0.00\\ -0.00\\ -0.00\\ -0.00\\ -0.00\\ -0.00\\ -0.00\\ -0.00\\ -0.00\\ -0.00\\ -0.00\\ -0.00\\ -0.00\\ -0.00\\ -0.00\\ -0.00\\ -0.00\\ -0.00\\ -0.00\\ -0.00\\ -0.00\\ -0.00\\ -0.00\\ -0.00\\ -0.00\\ -0.00\\ -0.00\\ -0.00\\ -0.00\\ -0.00\\ -0.00\\ -0.00\\ -0.00\\ -0.00\\ -0.00\\ -0.00\\ -0.00\\ -0.00\\ -0.00\\ -0.00\\ -0.00\\ -0.00\\ -0.00\\ -0.00\\ -0.00\\ -0.00\\ -0.00\\ -0.00\\ -0.00\\ -0.00\\ -0.00\\ -0.00\\ -0.00\\ -0.00\\ -0.00\\ -0.00\\ -0.00\\ -0.00\\ -0.00\\ -0.00\\ -0.00\\ -0.00\\ -0.00\\ -0.00\\ -0.00\\ -0.00\\ -0.00\\ -0.00\\ -0.00\\ -0.00\\ -0.00\\ -0.00\\ -0.0$ Tin No. 107 Tin +Wet soil 227.5 Tin + Dry soil 196.2 Wt of Tin 95 Wt of Moisture 31.3 Strain Wt. of dry soil 101.2 **Moisture content** 30.9 RESULTS Specification Result Results **268 KN/m<sup>2</sup> Unconfined Compressive Strength Estimated Elastic Modulus** Mathew & Nyagah Checked By: Martin Mburu

Tested By:

#### **UNIVERSITY OF NAIROBI** WORKING SHEET (HIGHWAYS LABORATORY) UCS TEST **SPECIMEN 4** Project: Mechanical stabilization of Lateritic Gravel Date: 22-Jan-2020 No. of days cured: 0 Anthony Mugendi Nyagah Mould No.: No. of days soaked: student: 0 DATA SAMPLE DETAILS MDD 1532 Do =152mm STABILIZED OMC 28.31 Туре Stabilizer Lo mm 127 9% FCD NMC 9.2 m<sup>2</sup> 0.0181 Ao =(152x152x3.14)/4 % 0 0.00275 Volume = AoLo m<sup>3</sup> Defl. Deflection Stabilizer = NON E=L/L0 1-E A=(Ao)/1-E Stress UCS TEST Load Q KN/m<sup>2</sup> KN mm 0.01810 0.00 0.0000 0 1 0 0.95 0.9925 0.01824 64 340 0.0075 1.15984 0.01838 147 1.91 0.0150 0.985 2.7019 320 0.01852 2.86 0.0225 0.9775 3.8222 206 300 0.01866 3.7563 201 3.81 0.0300 0.97 280 0.01881 260 4.76 0.0375 0.9625 3.295 175 240 0.01810 0.00 0.0000 1.0000 0 0 220 0.01810 0.00 0 1.0000 0 0 Stress KN/m<sup>2</sup> 200 0.00 0.01810 0.0000 1.0000 0 0 180 160 140 120 100 80 60 40 20 MOULDING MOISTURE CONTENT 0 $\begin{array}{c} -0.0550\\ -0.04500\\ -0.0400\\ -0.0350\\ -0.0350\\ -0.0350\\ -0.0250\\ -0.0250\\ -0.0150\\ -0.0100\\ \end{array}$ - 0.0050 - 0.0000 Tin No. 107 060 Tin +Wet soil 227.5 Tin + Dry soil 196.2 Wt of Tin 95 Wt of Moisture 31.3 Strain Wt. of dry soil 101.2 **Moisture content** 30.9

 Results
 Specification
 Result

 Unconfined Compressive Strength
 206 KN/m<sup>2</sup>

 Estimated Elastic Modulus
 Tested By:
 Mathew & Nyagah

#### **UNIVERSITY OF NAIROBI** WORKING SHEET (HIGHWAYS LABORATORY) UCS TEST **SPECIMEN 5** Date: 22-Jan-2020 **Project: Mechanical Stabilization of Lateritic Gravel** No. of days cured: 0 Anthony Mugendi Nyagah Mould No.: No. of days soaked: Student: 0 SAMPLE DETAILS DATA MDD 1532 STABILIZED Do =152mm 28.31 Туре OMC Stabilizer Lo mm 127 9% FCD NMC 9.2 0.0181 Ao = (152x152x3.14)/4% 0 m 0.00275 Volume = AoLo m Stabilizer = NON Deflection Defl. E=L/L0 1-E A=(Ao)/1-E Stress UCS TEST Load Q KN/m<sup>2</sup> KN mm 0.01810 0.00 0.0000 1 0 0 0.9925 0.01824 0.95 0.0075 1.5157 83 340 0.01838 1.91 0.0150 0.985 3.15002 171 320 0.01852 213 2.86 0.0225 0.9775 3.94082 300 0.01866 3.8881 208 3.81 0.0300 0.97 280 260 4.76 0.0375 0.01881 3.5586 189 0.9625 240 0.01810 0.00 0 0.0000 1.0000 0 220 0.01810 0.00 0 1.0000 0 0 Stress KN/m<sup>2</sup> 200 0.01810 0 0.00 0.0000 1.0000 0 180 160 140 120 100 80 60 40 20 MOULDING MOISTURE CONTENT 0 $\begin{array}{c} -0.0600\\ -0.0550\\ -0.04500\\ -0.0350\\ -0.0250\\ -0.0250\\ -0.0250\\ -0.0150\\ -0.0050\\ -0.0050\\ -0.0050\\ -0.0050\\ -0.0000\\ -0.0000\\ -0.0000\\ -0.0000\\ -0.000\\ -0.000\\ -0.000\\ -0.000\\ -0.000\\ -0.000\\ -0.000\\ -0.00\\ -0.00\\ -0.00\\ -0.00\\ -0.00\\ -0.00\\ -0.00\\ -0.00\\ -0.00\\ -0.00\\ -0.00\\ -0.00\\ -0.00\\ -0.00\\ -0.00\\ -0.00\\ -0.00\\ -0.00\\ -0.00\\ -0.00\\ -0.00\\ -0.00\\ -0.00\\ -0.00\\ -0.00\\ -0.00\\ -0.00\\ -0.00\\ -0.00\\ -0.00\\ -0.00\\ -0.00\\ -0.00\\ -0.00\\ -0.00\\ -0.00\\ -0.00\\ -0.00\\ -0.00\\ -0.00\\ -0.00\\ -0.00\\ -0.00\\ -0.00\\ -0.00\\ -0.00\\ -0.00\\ -0.00\\ -0.00\\ -0.00\\ -0.00\\ -0.00\\ -0.00\\ -0.00\\ -0.00\\ -0.00\\ -0.00\\ -0.00\\ -0.00\\ -0.00\\ -0.00\\ -0.00\\ -0.00\\ -0.00\\ -0.00\\ -0.00\\ -0.00\\ -0.00\\ -0.00\\ -0.00\\ -0.00\\ -0.00\\ -0.00\\ -0.00\\ -0.00\\ -0.00\\ -0.00\\ -0.00\\ -0.00\\ -0.00\\ -0.00\\ -0.00\\ -0.00\\ -0.00\\ -0.00\\ -0.00\\ -0.00\\ -0.00\\ -0.00\\ -0.00\\ -0.00\\ -0.00\\ -0.00\\ -0.00\\ -0.00\\ -0.00\\ -0.00\\ -0.00\\ -0.00\\ -0.00\\ -0.00\\ -0.00\\ -0.00\\ -0.00\\ -0.00\\ -0.00\\ -0.00\\ -0.00\\ -0.00\\ -0.00\\ -0.00\\ -0.00\\ -0.00\\ -0.00\\ -0.00\\ -0.00\\ -0.00\\ -0.00\\ -0.00\\ -0.00\\ -0.00\\ -0.00\\ -0.00\\ -0.00\\ -0.00\\ -0.00\\ -0.00\\ -0.00\\ -0.00\\ -0.00\\ -0.00\\ -0.00\\ -0.00\\ -0.00\\ -0.00\\ -0.00\\ -0.00\\ -0.00\\ -0.00\\ -0.00\\ -0.00\\ -0.00\\ -0.00\\ -0.00\\ -0.00\\ -0.00\\ -0.00\\ -0.00\\ -0.00\\ -0.00\\ -0.00\\ -0.00\\ -0.00\\ -0.00\\ -0.00\\ -0.00\\ -0.00\\ -0.00\\ -0.00\\ -0.00\\ -0.00\\ -0.00\\ -0.00\\ -0.00\\ -0.00\\ -0.00\\ -0.00\\ -0.00\\ -0.00\\ -0.00\\ -0.00\\ -0.00\\ -0.00\\ -0.00\\ -0.00\\ -0.00\\ -0.00\\ -0.00\\ -0.00\\ -0.00\\ -0.00\\ -0.00\\ -0.00\\ -0.00\\ -0.00\\ -0.00\\ -0.00\\ -0.00\\ -0.00\\ -0.00\\ -0.00\\ -0.00\\ -0.00\\ -0.00\\ -0.00\\ -0.00\\ -0.00\\ -0.00\\ -0.00\\ -0.00\\ -0.00\\ -0.00\\ -0.00\\ -0.00\\ -0.00\\ -0.00\\ -0.00\\ -0.00\\ -0.00\\ -0.00\\ -0.00\\ -0.00\\ -0.00\\ -0.00\\ -0.00\\ -0.00\\ -0.00\\ -0.00\\ -0.00\\ -0.00\\ -0.00\\ -0.00\\ -0.00\\ -0.00\\ -0.00\\ -0.00\\ -0.00\\ -0.00\\ -0.00\\ -0.00\\ -0.00\\ -0.00\\ -0.00\\ -0.00\\ -0.00\\ -0.00\\ -0.00\\ -0.00\\ -0.00\\ -0.00\\ -0.00\\ -0.00\\ -0.00\\ -0.00\\ -0.00\\ -0.00\\ -0.00\\ -0.00\\ -0.00\\ -0.00\\ -0.00\\ -0.00\\ -0.00\\ -0.00\\ -0.00\\ -0.00\\ -0.00\\ -0.00\\ -0.00\\ -0.00\\ -0.00\\ -0.00\\ -0.0$ Tin No. 201 Tin +Wet soil 227.3 191.2 Tin + Dry soil Wt of Tin 78.1 Wt of Moisture 36.1 Strain Wt. of dry soil 113.1 **Moisture content** 31.9 RESULTS Specification Result Results 213 KN/m<sup>2</sup> **Unconfined Compressive Strength Estimated Elastic Modulus**

Mathew & Nyagah

Tested By:

Checked By:

Martin Mburu

#### **UNIVERSITY OF NAIROBI** WORKING SHEET (HIGHWAYS LABORATORY) **UCS TEST SPECIMEN 6** Date: 22-Jan-2020 No. of days cured: **Project: Mechanical Stabilization of Lateritic Gravel** 0 Student: Anthony Mugendi Nyagah Mould No.: No. of days soaked: 0 DATA SAMPLE DETAILS MDD 1532 Do =152mm STABILIZED 28.31 Туре OMC Stabilizer Lo mm 127 9% FCD NMC 9.2 0.0181 $\mathbf{m}^2$ Ao = (152x152x3.14)/4% 0 0.00275 Volume = AoLo m Stabilizer = NON Deflection Defl. E=L/L0 1-E A=(Ao)/1-E Stress UCS TEST Load Q KN/m<sup>2</sup> KN mm 0.01810 0.00 0.0000 1 0 0 0.01819 0.64 0.0050 0.995 0.9885 54 340 0.01828 1.27 0.0100 0.99 2.21424 121 320 0.01838 1.91 186 0.0150 0.985 3.4268 300 2.54 0.01847 4.3494 0.0200 0.98 235 280 260 3.18 0.0250 0.975 0.01856 4.2835 231 240 0.01810 0.00 0 0.0000 1.0000 0 220 0.01810 0.00 0 1.0000 0 0 Stress KN/m<sup>2</sup> 200 0.01810 0 0.00 0.0000 1.0000 0 180 160 140 120 100 80 60 40 20 MOULDING MOISTURE CONTENT 0 $\begin{array}{c} -0.0600\\ -0.0550\\ -0.04500\\ -0.0350\\ -0.0250\\ -0.0250\\ -0.0250\\ -0.0150\\ -0.0050\\ -0.0050\\ -0.0050\\ -0.0050\\ -0.0000\\ -0.0000\\ -0.0000\\ -0.0000\\ -0.000\\ -0.000\\ -0.000\\ -0.000\\ -0.000\\ -0.000\\ -0.000\\ -0.00\\ -0.00\\ -0.00\\ -0.00\\ -0.00\\ -0.00\\ -0.00\\ -0.00\\ -0.00\\ -0.00\\ -0.00\\ -0.00\\ -0.00\\ -0.00\\ -0.00\\ -0.00\\ -0.00\\ -0.00\\ -0.00\\ -0.00\\ -0.00\\ -0.00\\ -0.00\\ -0.00\\ -0.00\\ -0.00\\ -0.00\\ -0.00\\ -0.00\\ -0.00\\ -0.00\\ -0.00\\ -0.00\\ -0.00\\ -0.00\\ -0.00\\ -0.00\\ -0.00\\ -0.00\\ -0.00\\ -0.00\\ -0.00\\ -0.00\\ -0.00\\ -0.00\\ -0.00\\ -0.00\\ -0.00\\ -0.00\\ -0.00\\ -0.00\\ -0.00\\ -0.00\\ -0.00\\ -0.00\\ -0.00\\ -0.00\\ -0.00\\ -0.00\\ -0.00\\ -0.00\\ -0.00\\ -0.00\\ -0.00\\ -0.00\\ -0.00\\ -0.00\\ -0.00\\ -0.00\\ -0.00\\ -0.00\\ -0.00\\ -0.00\\ -0.00\\ -0.00\\ -0.00\\ -0.00\\ -0.00\\ -0.00\\ -0.00\\ -0.00\\ -0.00\\ -0.00\\ -0.00\\ -0.00\\ -0.00\\ -0.00\\ -0.00\\ -0.00\\ -0.00\\ -0.00\\ -0.00\\ -0.00\\ -0.00\\ -0.00\\ -0.00\\ -0.00\\ -0.00\\ -0.00\\ -0.00\\ -0.00\\ -0.00\\ -0.00\\ -0.00\\ -0.00\\ -0.00\\ -0.00\\ -0.00\\ -0.00\\ -0.00\\ -0.00\\ -0.00\\ -0.00\\ -0.00\\ -0.00\\ -0.00\\ -0.00\\ -0.00\\ -0.00\\ -0.00\\ -0.00\\ -0.00\\ -0.00\\ -0.00\\ -0.00\\ -0.00\\ -0.00\\ -0.00\\ -0.00\\ -0.00\\ -0.00\\ -0.00\\ -0.00\\ -0.00\\ -0.00\\ -0.00\\ -0.00\\ -0.00\\ -0.00\\ -0.00\\ -0.00\\ -0.00\\ -0.00\\ -0.00\\ -0.00\\ -0.00\\ -0.00\\ -0.00\\ -0.00\\ -0.00\\ -0.00\\ -0.00\\ -0.00\\ -0.00\\ -0.00\\ -0.00\\ -0.00\\ -0.00\\ -0.00\\ -0.00\\ -0.00\\ -0.00\\ -0.00\\ -0.00\\ -0.00\\ -0.00\\ -0.00\\ -0.00\\ -0.00\\ -0.00\\ -0.00\\ -0.00\\ -0.00\\ -0.00\\ -0.00\\ -0.00\\ -0.00\\ -0.00\\ -0.00\\ -0.00\\ -0.00\\ -0.00\\ -0.00\\ -0.00\\ -0.00\\ -0.00\\ -0.00\\ -0.00\\ -0.00\\ -0.00\\ -0.00\\ -0.00\\ -0.00\\ -0.00\\ -0.00\\ -0.00\\ -0.00\\ -0.00\\ -0.00\\ -0.00\\ -0.00\\ -0.00\\ -0.00\\ -0.00\\ -0.00\\ -0.00\\ -0.00\\ -0.00\\ -0.00\\ -0.00\\ -0.00\\ -0.00\\ -0.00\\ -0.00\\ -0.00\\ -0.00\\ -0.00\\ -0.00\\ -0.00\\ -0.00\\ -0.00\\ -0.00\\ -0.00\\ -0.00\\ -0.00\\ -0.00\\ -0.00\\ -0.00\\ -0.00\\ -0.00\\ -0.00\\ -0.00\\ -0.00\\ -0.00\\ -0.00\\ -0.00\\ -0.00\\ -0.00\\ -0.00\\ -0.00\\ -0.00\\ -0.00\\ -0.00\\ -0.00\\ -0.00\\ -0.00\\ -0.00\\ -0.00\\ -0.00\\ -0.00\\ -0.00\\ -0.00\\ -0.00\\ -0.00\\ -0.00\\ -0.00\\ -0.00\\ -0.00\\ -0.00\\ -0.00\\ -0.00\\ -0.00\\ -0.0$ Tin No. 201 Tin +Wet soil 227.3 191.2 Tin + Dry soil Wt of Tin 78.1 Wt of Moisture 36.1 Strain Wt. of dry soil 113.1 **Moisture content** 31.9 RESULTS Specification Result Results 235 KN/m<sup>2</sup> **Unconfined Compressive Strength**

Mathew & Nyagah

Tested By:

Checked By:

Martin Mburu

**Estimated Elastic Modulus** 

#### **UNIVERSITY OF NAIROBI** WORKING SHEET (HIGHWAYS LABORATORY) **UCS TEST** SPECIMEN 7 Date: 22-Jan-2020 No. of days cured: Project: Mechanical stabilization of Lateritic Gravel 0 Mould No.: No. of days soaked: Student: Anthony Mugendi Nyagah 0 SAMPLE DETAILS DATA MDD 1532 STABILIZED Do =152mm 28.31 Туре OMC Stabilizer Lo mm 127 9% FCD NMC 9.2 0.0181 Ao = (152x152x3.14)/4% 0 m 0.00275 Volume = AoLo m Stabilizer = NON Deflection Defl. E=L/L0 1-E A=(Ao)/1-E Stress UCS TEST Load Q KN/m<sup>2</sup> KN mm 0.01810 0.00 0.0000 1 0 0 0.9925 0.01824 0.95 0.0075 1.7134 94 340 0.01838 1.91 0.0150 0.985 3.8222 208 320 0.01852 278 2.86 0.0225 0.9775 5.1402 300 0.01866 5.272 283 3.81 0.0300 0.97 280 260 4.76 0.0375 0.01881 5.1402 273 0.9625 240 0.01810 0.00 0 0.0000 1.0000 0 220 0.01810 0.00 0 1.0000 0 0 Stress KN/m<sup>2</sup> 200 0.01810 0 0.00 0.0000 1.0000 0 180 160 140 120 100 80 60 40 20 MOULDING MOISTURE CONTENT 0 $\begin{array}{c} -0.0600\\ -0.0550\\ -0.04500\\ -0.0350\\ -0.0250\\ -0.0250\\ -0.0250\\ -0.0150\\ -0.0050\\ -0.0050\\ -0.0050\\ -0.0050\\ -0.0000\\ -0.0000\\ -0.0000\\ -0.0000\\ -0.000\\ -0.000\\ -0.000\\ -0.000\\ -0.000\\ -0.000\\ -0.000\\ -0.00\\ -0.00\\ -0.00\\ -0.00\\ -0.00\\ -0.00\\ -0.00\\ -0.00\\ -0.00\\ -0.00\\ -0.00\\ -0.00\\ -0.00\\ -0.00\\ -0.00\\ -0.00\\ -0.00\\ -0.00\\ -0.00\\ -0.00\\ -0.00\\ -0.00\\ -0.00\\ -0.00\\ -0.00\\ -0.00\\ -0.00\\ -0.00\\ -0.00\\ -0.00\\ -0.00\\ -0.00\\ -0.00\\ -0.00\\ -0.00\\ -0.00\\ -0.00\\ -0.00\\ -0.00\\ -0.00\\ -0.00\\ -0.00\\ -0.00\\ -0.00\\ -0.00\\ -0.00\\ -0.00\\ -0.00\\ -0.00\\ -0.00\\ -0.00\\ -0.00\\ -0.00\\ -0.00\\ -0.00\\ -0.00\\ -0.00\\ -0.00\\ -0.00\\ -0.00\\ -0.00\\ -0.00\\ -0.00\\ -0.00\\ -0.00\\ -0.00\\ -0.00\\ -0.00\\ -0.00\\ -0.00\\ -0.00\\ -0.00\\ -0.00\\ -0.00\\ -0.00\\ -0.00\\ -0.00\\ -0.00\\ -0.00\\ -0.00\\ -0.00\\ -0.00\\ -0.00\\ -0.00\\ -0.00\\ -0.00\\ -0.00\\ -0.00\\ -0.00\\ -0.00\\ -0.00\\ -0.00\\ -0.00\\ -0.00\\ -0.00\\ -0.00\\ -0.00\\ -0.00\\ -0.00\\ -0.00\\ -0.00\\ -0.00\\ -0.00\\ -0.00\\ -0.00\\ -0.00\\ -0.00\\ -0.00\\ -0.00\\ -0.00\\ -0.00\\ -0.00\\ -0.00\\ -0.00\\ -0.00\\ -0.00\\ -0.00\\ -0.00\\ -0.00\\ -0.00\\ -0.00\\ -0.00\\ -0.00\\ -0.00\\ -0.00\\ -0.00\\ -0.00\\ -0.00\\ -0.00\\ -0.00\\ -0.00\\ -0.00\\ -0.00\\ -0.00\\ -0.00\\ -0.00\\ -0.00\\ -0.00\\ -0.00\\ -0.00\\ -0.00\\ -0.00\\ -0.00\\ -0.00\\ -0.00\\ -0.00\\ -0.00\\ -0.00\\ -0.00\\ -0.00\\ -0.00\\ -0.00\\ -0.00\\ -0.00\\ -0.00\\ -0.00\\ -0.00\\ -0.00\\ -0.00\\ -0.00\\ -0.00\\ -0.00\\ -0.00\\ -0.00\\ -0.00\\ -0.00\\ -0.00\\ -0.00\\ -0.00\\ -0.00\\ -0.00\\ -0.00\\ -0.00\\ -0.00\\ -0.00\\ -0.00\\ -0.00\\ -0.00\\ -0.00\\ -0.00\\ -0.00\\ -0.00\\ -0.00\\ -0.00\\ -0.00\\ -0.00\\ -0.00\\ -0.00\\ -0.00\\ -0.00\\ -0.00\\ -0.00\\ -0.00\\ -0.00\\ -0.00\\ -0.00\\ -0.00\\ -0.00\\ -0.00\\ -0.00\\ -0.00\\ -0.00\\ -0.00\\ -0.00\\ -0.00\\ -0.00\\ -0.00\\ -0.00\\ -0.00\\ -0.00\\ -0.00\\ -0.00\\ -0.00\\ -0.00\\ -0.00\\ -0.00\\ -0.00\\ -0.00\\ -0.00\\ -0.00\\ -0.00\\ -0.00\\ -0.00\\ -0.00\\ -0.00\\ -0.00\\ -0.00\\ -0.00\\ -0.00\\ -0.00\\ -0.00\\ -0.00\\ -0.00\\ -0.00\\ -0.00\\ -0.00\\ -0.00\\ -0.00\\ -0.00\\ -0.00\\ -0.00\\ -0.00\\ -0.00\\ -0.00\\ -0.00\\ -0.00\\ -0.00\\ -0.00\\ -0.00\\ -0.00\\ -0.00\\ -0.00\\ -0.00\\ -0.00\\ -0.00\\ -0.00\\ -0.00\\ -0.00\\ -0.00\\ -0.00\\ -0.00\\ -0.00\\ -0.0$ Tin No. 201 Tin +Wet soil 227.3 191.2 Tin + Dry soil Wt of Tin 78.1 Wt of Moisture 36.1 Strain Wt. of dry soil 113.1

 Moisture content
 31.9

 Results
 Result

 Unconfined Compressive Strength
 283 KN/m<sup>2</sup>

 Estimated Elastic Modulus
 Tested By: Mathew & Nyagah
 Checked By: Martin Mburu

#### **UNIVERSITY OF NAIROBI** WORKING SHEET (HIGHWAYS LABORATORY) **UCS TEST** SPECIMEN 1 Project: Mechanical Stabilization of Lateritic Gravel Date:23-Jan-2020 No. of days cured: 0 Anthony Mugendi Nyagah Mould No.: No. of days soaked: Student: 0 DATA SAMPLE DETAILS 1474 MDD Do =152mm STABILIZED OMC 29.43 Туре Stabilizer Lo mm 127 12% FCD NMC 9.2 m<sup>2</sup> 0.0181 % 0 Ao = (152x152x3.14)/40.00275 Volume = AoLo m<sup>3</sup> Defl. Deflection Stabilizer = NON A=(Ao)/1-E E=L/L0 1-E Stress UCS TEST Load Q KN/m<sup>2</sup> KN mm 0.01810 0.00 0.0000 1 0 0 0.95 0.0075 0.9925 0.01824 1.2521 69 340 0.985 0.01838 2.8996 158 1.91 0.0150 320 0.0225 0.9775 0.01852 224 2.86 4.1517 300 0.01866 3.81 0.0300 4.4812 240 280 0.97 0.01881 260 4.76 0.0375 0.9625 4.3494 231 240 0.01810 0.00 0.0000 1.0000 0 0 220 0.01810 0 0.00 0 1.0000 0 Stress KN/m<sup>2</sup> 200 0.00 0.01810 0 0.0000 1.0000 0 180 160 140

120							
80							
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888888888888888888 8888888888888888888	Т	in + Dry soil				183.6	
	W	/t of Tin				76	
	W	t of Moistur/	·e			31.5	
Strain	W	/t. of dry soil	l			107.6	
	N	loisture cont	ent			29.3	
		RESULTS					
Results		Specification			Result		
Unconfined Compressive Strength					240 KN/	$m^2$	
Estimated Elastic Modulus							
	Tested By:	Mathew &	& Nyagah	l	Checked By:	Martin	Mburu

#### **UNIVERSITY OF NAIROBI** WORKING SHEET (HIGHWAYS LABORATORY) **UCS TEST** SPECIMEN 2 Date: 23-Jan-2020 No. of days cured: **Project: Mechanical Stabilization of Lateritic Gravel** 0 Mould No.: No. of days soaked: Student: Anthony Mugendi Nyagah 0 SAMPLE DETAILS DATA MDD 1474 Do =152mm STABILIZED 29.43 Туре OMC Stabilizer Lo mm 127 12% FCD NMC 9.2 0.0181 Ao = (152x152x3.14)/4% 0 m 0.00275 Volume = AoLo m Stabilizer = NON Deflection Defl. E=L/L0 1-E A=(Ao)/1-E Stress UCS TEST Load Q KN/m<sup>2</sup> KN mm 0.01810 0.00 0.0000 1 0 0 0.9925 0.01824 51 0.95 0.0075 0.9226 340 0.01838 1.91 0.0150 0.985 2.06926 113 320 0.01852 157 2.86 0.0225 0.9775 2.91278 300 3.81 0.01866 2.8337 152 0.0300 0.97 280 260 4.76 0.0375 0.01881 2.7019 144 0.9625 240 0.01810 0.00 0 0.0000 1.0000 0 220 0.01810 0.00 0 1.0000 0 0 Stress KN/m<sup>2</sup> 200 0.01810 0 0.00 0.0000 1.0000 0 180 160 140 120 100 80 60 40 20 MOULDING MOISTURE CONTENT 0 $\begin{array}{c} -0.0600\\ -0.0550\\ -0.04500\\ -0.0350\\ -0.0250\\ -0.0250\\ -0.0250\\ -0.0150\\ -0.0050\\ -0.0050\\ -0.0050\\ -0.0050\\ -0.0000\\ -0.0000\\ -0.0000\\ -0.0000\\ -0.000\\ -0.000\\ -0.000\\ -0.000\\ -0.000\\ -0.000\\ -0.000\\ -0.00\\ -0.00\\ -0.00\\ -0.00\\ -0.00\\ -0.00\\ -0.00\\ -0.00\\ -0.00\\ -0.00\\ -0.00\\ -0.00\\ -0.00\\ -0.00\\ -0.00\\ -0.00\\ -0.00\\ -0.00\\ -0.00\\ -0.00\\ -0.00\\ -0.00\\ -0.00\\ -0.00\\ -0.00\\ -0.00\\ -0.00\\ -0.00\\ -0.00\\ -0.00\\ -0.00\\ -0.00\\ -0.00\\ -0.00\\ -0.00\\ -0.00\\ -0.00\\ -0.00\\ -0.00\\ -0.00\\ -0.00\\ -0.00\\ -0.00\\ -0.00\\ -0.00\\ -0.00\\ -0.00\\ -0.00\\ -0.00\\ -0.00\\ -0.00\\ -0.00\\ -0.00\\ -0.00\\ -0.00\\ -0.00\\ -0.00\\ -0.00\\ -0.00\\ -0.00\\ -0.00\\ -0.00\\ -0.00\\ -0.00\\ -0.00\\ -0.00\\ -0.00\\ -0.00\\ -0.00\\ -0.00\\ -0.00\\ -0.00\\ -0.00\\ -0.00\\ -0.00\\ -0.00\\ -0.00\\ -0.00\\ -0.00\\ -0.00\\ -0.00\\ -0.00\\ -0.00\\ -0.00\\ -0.00\\ -0.00\\ -0.00\\ -0.00\\ -0.00\\ -0.00\\ -0.00\\ -0.00\\ -0.00\\ -0.00\\ -0.00\\ -0.00\\ -0.00\\ -0.00\\ -0.00\\ -0.00\\ -0.00\\ -0.00\\ -0.00\\ -0.00\\ -0.00\\ -0.00\\ -0.00\\ -0.00\\ -0.00\\ -0.00\\ -0.00\\ -0.00\\ -0.00\\ -0.00\\ -0.00\\ -0.00\\ -0.00\\ -0.00\\ -0.00\\ -0.00\\ -0.00\\ -0.00\\ -0.00\\ -0.00\\ -0.00\\ -0.00\\ -0.00\\ -0.00\\ -0.00\\ -0.00\\ -0.00\\ -0.00\\ -0.00\\ -0.00\\ -0.00\\ -0.00\\ -0.00\\ -0.00\\ -0.00\\ -0.00\\ -0.00\\ -0.00\\ -0.00\\ -0.00\\ -0.00\\ -0.00\\ -0.00\\ -0.00\\ -0.00\\ -0.00\\ -0.00\\ -0.00\\ -0.00\\ -0.00\\ -0.00\\ -0.00\\ -0.00\\ -0.00\\ -0.00\\ -0.00\\ -0.00\\ -0.00\\ -0.00\\ -0.00\\ -0.00\\ -0.00\\ -0.00\\ -0.00\\ -0.00\\ -0.00\\ -0.00\\ -0.00\\ -0.00\\ -0.00\\ -0.00\\ -0.00\\ -0.00\\ -0.00\\ -0.00\\ -0.00\\ -0.00\\ -0.00\\ -0.00\\ -0.00\\ -0.00\\ -0.00\\ -0.00\\ -0.00\\ -0.00\\ -0.00\\ -0.00\\ -0.00\\ -0.00\\ -0.00\\ -0.00\\ -0.00\\ -0.00\\ -0.00\\ -0.00\\ -0.00\\ -0.00\\ -0.00\\ -0.00\\ -0.00\\ -0.00\\ -0.00\\ -0.00\\ -0.00\\ -0.00\\ -0.00\\ -0.00\\ -0.00\\ -0.00\\ -0.00\\ -0.00\\ -0.00\\ -0.00\\ -0.00\\ -0.00\\ -0.00\\ -0.00\\ -0.00\\ -0.00\\ -0.00\\ -0.00\\ -0.00\\ -0.00\\ -0.00\\ -0.00\\ -0.00\\ -0.00\\ -0.00\\ -0.00\\ -0.00\\ -0.00\\ -0.00\\ -0.00\\ -0.00\\ -0.00\\ -0.00\\ -0.00\\ -0.00\\ -0.00\\ -0.00\\ -0.00\\ -0.00\\ -0.00\\ -0.00\\ -0.00\\ -0.00\\ -0.00\\ -0.00\\ -0.00\\ -0.00\\ -0.00\\ -0.00\\ -0.00\\ -0.00\\ -0.00\\ -0.00\\ -0.00\\ -0.00\\ -0.0$ Tin No. 195 Tin +Wet soil 215.1 Tin + Dry soil 183.6 Wt of Tin 76 Wt of Moisture 31.5 Strain Wt. of dry soil 107.6 **Moisture content** 29.3 RESULTS Specification Result Results 157 KN/m<sup>2</sup> **Unconfined Compressive Strength Estimated Elastic Modulus**

Tested By: Mathew & Nyagah Checked By

Checked By: Martin Mburu

#### **UNIVERSITY OF NAIROBI** WORKING SHEET (HIGHWAYS LABORATORY) **UCS TEST SPECIMEN 3** Date: 23-Jan-2020 No. of days cured: **Project: Mechanical Stabilization of lateritic Gravel** 0 Mould No.: No. of days soaked: Student: Anthony Mugendi Nyagah 0 SAMPLE DETAILS DATA MDD 1474 Do =152mm STABILIZED 29.43 Туре OMC Stabilizer Lo mm 127 12% FCD NMC 9.2 0.0181 Ao = (152x152x3.14)/4% 0 m 0.00275 Volume = AoLo m Stabilizer = NON Deflection Defl. E=L/L0 1-E A=(Ao)/1-E Stress UCS TEST Load Q KN/m<sup>2</sup> KN mm 0.01810 0.00 0.0000 1 0 0 0.9925 0.01824 0.95 0.0075 1.1203 61 340 0.01838 1.91 0.0150 0.985 2.1747 118 320 0.01852 162 2.86 0.0225 0.9775 2.99186 300 3.81 0.01866 2.8996 0.0300 0.97 155 280 260 4.76 0.0375 0.01881 2.7678 147 0.9625 240 0.01810 0.00 0 0.0000 1.0000 0 220 0.01810 0.00 0 1.0000 0 0 Stress KN/m<sup>2</sup> 200 0.01810 0 0.00 0.0000 1.0000 0 180 160 140 120 100 80 60 40 20 MOULDING MOISTURE CONTENT 0 $\begin{array}{c} -0.0600\\ -0.0550\\ -0.04500\\ -0.0350\\ -0.0250\\ -0.0250\\ -0.0250\\ -0.0150\\ -0.0050\\ -0.0050\\ -0.0050\\ -0.0050\\ -0.0000\\ -0.0000\\ -0.0000\\ -0.0000\\ -0.000\\ -0.000\\ -0.000\\ -0.000\\ -0.000\\ -0.000\\ -0.000\\ -0.00\\ -0.00\\ -0.00\\ -0.00\\ -0.00\\ -0.00\\ -0.00\\ -0.00\\ -0.00\\ -0.00\\ -0.00\\ -0.00\\ -0.00\\ -0.00\\ -0.00\\ -0.00\\ -0.00\\ -0.00\\ -0.00\\ -0.00\\ -0.00\\ -0.00\\ -0.00\\ -0.00\\ -0.00\\ -0.00\\ -0.00\\ -0.00\\ -0.00\\ -0.00\\ -0.00\\ -0.00\\ -0.00\\ -0.00\\ -0.00\\ -0.00\\ -0.00\\ -0.00\\ -0.00\\ -0.00\\ -0.00\\ -0.00\\ -0.00\\ -0.00\\ -0.00\\ -0.00\\ -0.00\\ -0.00\\ -0.00\\ -0.00\\ -0.00\\ -0.00\\ -0.00\\ -0.00\\ -0.00\\ -0.00\\ -0.00\\ -0.00\\ -0.00\\ -0.00\\ -0.00\\ -0.00\\ -0.00\\ -0.00\\ -0.00\\ -0.00\\ -0.00\\ -0.00\\ -0.00\\ -0.00\\ -0.00\\ -0.00\\ -0.00\\ -0.00\\ -0.00\\ -0.00\\ -0.00\\ -0.00\\ -0.00\\ -0.00\\ -0.00\\ -0.00\\ -0.00\\ -0.00\\ -0.00\\ -0.00\\ -0.00\\ -0.00\\ -0.00\\ -0.00\\ -0.00\\ -0.00\\ -0.00\\ -0.00\\ -0.00\\ -0.00\\ -0.00\\ -0.00\\ -0.00\\ -0.00\\ -0.00\\ -0.00\\ -0.00\\ -0.00\\ -0.00\\ -0.00\\ -0.00\\ -0.00\\ -0.00\\ -0.00\\ -0.00\\ -0.00\\ -0.00\\ -0.00\\ -0.00\\ -0.00\\ -0.00\\ -0.00\\ -0.00\\ -0.00\\ -0.00\\ -0.00\\ -0.00\\ -0.00\\ -0.00\\ -0.00\\ -0.00\\ -0.00\\ -0.00\\ -0.00\\ -0.00\\ -0.00\\ -0.00\\ -0.00\\ -0.00\\ -0.00\\ -0.00\\ -0.00\\ -0.00\\ -0.00\\ -0.00\\ -0.00\\ -0.00\\ -0.00\\ -0.00\\ -0.00\\ -0.00\\ -0.00\\ -0.00\\ -0.00\\ -0.00\\ -0.00\\ -0.00\\ -0.00\\ -0.00\\ -0.00\\ -0.00\\ -0.00\\ -0.00\\ -0.00\\ -0.00\\ -0.00\\ -0.00\\ -0.00\\ -0.00\\ -0.00\\ -0.00\\ -0.00\\ -0.00\\ -0.00\\ -0.00\\ -0.00\\ -0.00\\ -0.00\\ -0.00\\ -0.00\\ -0.00\\ -0.00\\ -0.00\\ -0.00\\ -0.00\\ -0.00\\ -0.00\\ -0.00\\ -0.00\\ -0.00\\ -0.00\\ -0.00\\ -0.00\\ -0.00\\ -0.00\\ -0.00\\ -0.00\\ -0.00\\ -0.00\\ -0.00\\ -0.00\\ -0.00\\ -0.00\\ -0.00\\ -0.00\\ -0.00\\ -0.00\\ -0.00\\ -0.00\\ -0.00\\ -0.00\\ -0.00\\ -0.00\\ -0.00\\ -0.00\\ -0.00\\ -0.00\\ -0.00\\ -0.00\\ -0.00\\ -0.00\\ -0.00\\ -0.00\\ -0.00\\ -0.00\\ -0.00\\ -0.00\\ -0.00\\ -0.00\\ -0.00\\ -0.00\\ -0.00\\ -0.00\\ -0.00\\ -0.00\\ -0.00\\ -0.00\\ -0.00\\ -0.00\\ -0.00\\ -0.00\\ -0.00\\ -0.00\\ -0.00\\ -0.00\\ -0.00\\ -0.00\\ -0.00\\ -0.00\\ -0.00\\ -0.00\\ -0.00\\ -0.00\\ -0.00\\ -0.00\\ -0.00\\ -0.00\\ -0.00\\ -0.00\\ -0.00\\ -0.00\\ -0.00\\ -0.00\\ -0.00\\ -0.00\\ -0.00\\ -0.0$ Tin No. 195 Tin +Wet soil 215.1 Tin + Dry soil 183.6 Wt of Tin 76 Wt of Moisture 31.5 Strain Wt. of dry soil 107.6 **Moisture content** 29.3 RESULTS Specification Result Results $155 \text{ KN/m}^2$ **Unconfined Compressive Strength Estimated Elastic Modulus** Mathew & Nyagah Checked By: Martin Mburu Tested By:

#### **UNIVERSITY OF NAIROBI** WORKING SHEET (HIGHWAYS LABORATORY) **UCS TEST** SPECIMEN 4 Date: 23-jan-2020 No. of days cured: **Project: Mechanical Stabilization of Lateritic Gravel** 0 Mould No.: No. of days soaked: Student: Anthony Mugendi Nyagah 0 SAMPLE DETAILS DATA MDD 1474 Do =152mm STABILIZED 29.43 Туре OMC Stabilizer Lo mm 127 12% FCD NMC 9.2 0.0181 Ao = (152x152x3.14)/4% 0 m 0.00275 Volume = AoLo m Stabilizer = NON Deflection Defl. E=L/L0 1-E A=(Ao)/1-E Stress UCS TEST Load Q KN/m<sup>2</sup> KN mm 0.01810 0.00 0.0000 1 0 0 0.9925 0.01824 0.95 0.0075 1.1862 65 340 0.01838 1.91 0.0150 0.985 2.31968 126 320 0.01852 178 2.86 0.0225 0.9775 3.295 300 3.81 0.01866 3.46634 186 0.0300 0.97 280 260 4.76 0.0375 0.01881 3.3609 179 0.9625 240 0.01810 0.00 0 0.0000 1.0000 0 220 0.01810 0.00 0 1.0000 0 0 Stress KN/m<sup>2</sup> 200 0.01810 0 0.00 0.0000 1.0000 0 180 160 140 120 100 80 60 40 20 MOULDING MOISTURE CONTENT 0 $\begin{array}{c} -0.0600\\ -0.0550\\ -0.04500\\ -0.0350\\ -0.0250\\ -0.0250\\ -0.0250\\ -0.0150\\ -0.0050\\ -0.0050\\ -0.0050\\ -0.0050\\ -0.0000\\ -0.0000\\ -0.0000\\ -0.0000\\ -0.000\\ -0.000\\ -0.000\\ -0.000\\ -0.000\\ -0.000\\ -0.000\\ -0.00\\ -0.00\\ -0.00\\ -0.00\\ -0.00\\ -0.00\\ -0.00\\ -0.00\\ -0.00\\ -0.00\\ -0.00\\ -0.00\\ -0.00\\ -0.00\\ -0.00\\ -0.00\\ -0.00\\ -0.00\\ -0.00\\ -0.00\\ -0.00\\ -0.00\\ -0.00\\ -0.00\\ -0.00\\ -0.00\\ -0.00\\ -0.00\\ -0.00\\ -0.00\\ -0.00\\ -0.00\\ -0.00\\ -0.00\\ -0.00\\ -0.00\\ -0.00\\ -0.00\\ -0.00\\ -0.00\\ -0.00\\ -0.00\\ -0.00\\ -0.00\\ -0.00\\ -0.00\\ -0.00\\ -0.00\\ -0.00\\ -0.00\\ -0.00\\ -0.00\\ -0.00\\ -0.00\\ -0.00\\ -0.00\\ -0.00\\ -0.00\\ -0.00\\ -0.00\\ -0.00\\ -0.00\\ -0.00\\ -0.00\\ -0.00\\ -0.00\\ -0.00\\ -0.00\\ -0.00\\ -0.00\\ -0.00\\ -0.00\\ -0.00\\ -0.00\\ -0.00\\ -0.00\\ -0.00\\ -0.00\\ -0.00\\ -0.00\\ -0.00\\ -0.00\\ -0.00\\ -0.00\\ -0.00\\ -0.00\\ -0.00\\ -0.00\\ -0.00\\ -0.00\\ -0.00\\ -0.00\\ -0.00\\ -0.00\\ -0.00\\ -0.00\\ -0.00\\ -0.00\\ -0.00\\ -0.00\\ -0.00\\ -0.00\\ -0.00\\ -0.00\\ -0.00\\ -0.00\\ -0.00\\ -0.00\\ -0.00\\ -0.00\\ -0.00\\ -0.00\\ -0.00\\ -0.00\\ -0.00\\ -0.00\\ -0.00\\ -0.00\\ -0.00\\ -0.00\\ -0.00\\ -0.00\\ -0.00\\ -0.00\\ -0.00\\ -0.00\\ -0.00\\ -0.00\\ -0.00\\ -0.00\\ -0.00\\ -0.00\\ -0.00\\ -0.00\\ -0.00\\ -0.00\\ -0.00\\ -0.00\\ -0.00\\ -0.00\\ -0.00\\ -0.00\\ -0.00\\ -0.00\\ -0.00\\ -0.00\\ -0.00\\ -0.00\\ -0.00\\ -0.00\\ -0.00\\ -0.00\\ -0.00\\ -0.00\\ -0.00\\ -0.00\\ -0.00\\ -0.00\\ -0.00\\ -0.00\\ -0.00\\ -0.00\\ -0.00\\ -0.00\\ -0.00\\ -0.00\\ -0.00\\ -0.00\\ -0.00\\ -0.00\\ -0.00\\ -0.00\\ -0.00\\ -0.00\\ -0.00\\ -0.00\\ -0.00\\ -0.00\\ -0.00\\ -0.00\\ -0.00\\ -0.00\\ -0.00\\ -0.00\\ -0.00\\ -0.00\\ -0.00\\ -0.00\\ -0.00\\ -0.00\\ -0.00\\ -0.00\\ -0.00\\ -0.00\\ -0.00\\ -0.00\\ -0.00\\ -0.00\\ -0.00\\ -0.00\\ -0.00\\ -0.00\\ -0.00\\ -0.00\\ -0.00\\ -0.00\\ -0.00\\ -0.00\\ -0.00\\ -0.00\\ -0.00\\ -0.00\\ -0.00\\ -0.00\\ -0.00\\ -0.00\\ -0.00\\ -0.00\\ -0.00\\ -0.00\\ -0.00\\ -0.00\\ -0.00\\ -0.00\\ -0.00\\ -0.00\\ -0.00\\ -0.00\\ -0.00\\ -0.00\\ -0.00\\ -0.00\\ -0.00\\ -0.00\\ -0.00\\ -0.00\\ -0.00\\ -0.00\\ -0.00\\ -0.00\\ -0.00\\ -0.00\\ -0.00\\ -0.00\\ -0.00\\ -0.00\\ -0.00\\ -0.00\\ -0.00\\ -0.00\\ -0.00\\ -0.00\\ -0.00\\ -0.00\\ -0.00\\ -0.00\\ -0.00\\ -0.00\\ -0.00\\ -0.00\\ -0.00\\ -0.00\\ -0.0$ Tin No. 195 Tin +Wet soil 215.1 Tin + Dry soil 183.6 Wt of Tin 76 Wt of Moisture 31.5 Strain Wt. of dry soil 107.6 **Moisture content** 29.3 RESULTS Results Specification Result 186 KN/m<sup>2</sup> **Unconfined Compressive Strength Estimated Elastic Modulus**

Mathew & Nyagah

Tested By:

Checked By:

Martin Mburu

#### **UNIVERSITY OF NAIROBI** WORKING SHEET (HIGHWAYS LABORATORY) **UCS TEST SPECIMEN 5** Date: 23-Jan-2020 No. of days cured: **Project: Mechanical Stabilization of Lateritic Gravel** 0 Anthony Mugendi Nyagah Mould No.: No. of days soaked: Student: 0 SAMPLE DETAILS DATA MDD 1474 Do =152mm STABILIZED 29.43 Туре OMC Stabilizer Lo mm 127 12% FCD NMC 19.3 0.0181 Ao = (152x152x3.14)/4% 0 m 0.00275 Volume = AoLo m Stabilizer = NON Deflection Defl. E=L/L0 1-E A=(Ao)/1-E Stress UCS TEST Load Q KN/m<sup>2</sup> KN mm 0.01810 0.00 0.0000 1 0 0 0.9925 0.01824 72 0.95 0.0075 1.318 340 0.01838 1.91 0.0150 0.985 2.5042 136 320 0.01852 177 2.86 0.0225 0.9775 3.28182 300 3.81 0.01866 3.1632 170 0.0300 0.97 280 260 4.76 0.0375 0.01881 2.9655 158 0.9625 240 0.01810 0.00 0 0.0000 1.0000 0 220 0.01810 0.00 0 1.0000 0 0 Stress KN/m<sup>2</sup> 200 0.01810 0 0.00 0.0000 1.0000 0 180 160 140 120 100 80 60 40 20 MOULDING MOISTURE CONTENT 0 $\begin{array}{c} -0.0600\\ -0.0550\\ -0.04500\\ -0.0350\\ -0.0250\\ -0.0250\\ -0.0250\\ -0.0150\\ -0.0050\\ -0.0050\\ -0.0050\\ -0.0050\\ -0.0000\\ -0.0000\\ -0.0000\\ -0.0000\\ -0.000\\ -0.000\\ -0.000\\ -0.000\\ -0.000\\ -0.000\\ -0.000\\ -0.00\\ -0.00\\ -0.00\\ -0.00\\ -0.00\\ -0.00\\ -0.00\\ -0.00\\ -0.00\\ -0.00\\ -0.00\\ -0.00\\ -0.00\\ -0.00\\ -0.00\\ -0.00\\ -0.00\\ -0.00\\ -0.00\\ -0.00\\ -0.00\\ -0.00\\ -0.00\\ -0.00\\ -0.00\\ -0.00\\ -0.00\\ -0.00\\ -0.00\\ -0.00\\ -0.00\\ -0.00\\ -0.00\\ -0.00\\ -0.00\\ -0.00\\ -0.00\\ -0.00\\ -0.00\\ -0.00\\ -0.00\\ -0.00\\ -0.00\\ -0.00\\ -0.00\\ -0.00\\ -0.00\\ -0.00\\ -0.00\\ -0.00\\ -0.00\\ -0.00\\ -0.00\\ -0.00\\ -0.00\\ -0.00\\ -0.00\\ -0.00\\ -0.00\\ -0.00\\ -0.00\\ -0.00\\ -0.00\\ -0.00\\ -0.00\\ -0.00\\ -0.00\\ -0.00\\ -0.00\\ -0.00\\ -0.00\\ -0.00\\ -0.00\\ -0.00\\ -0.00\\ -0.00\\ -0.00\\ -0.00\\ -0.00\\ -0.00\\ -0.00\\ -0.00\\ -0.00\\ -0.00\\ -0.00\\ -0.00\\ -0.00\\ -0.00\\ -0.00\\ -0.00\\ -0.00\\ -0.00\\ -0.00\\ -0.00\\ -0.00\\ -0.00\\ -0.00\\ -0.00\\ -0.00\\ -0.00\\ -0.00\\ -0.00\\ -0.00\\ -0.00\\ -0.00\\ -0.00\\ -0.00\\ -0.00\\ -0.00\\ -0.00\\ -0.00\\ -0.00\\ -0.00\\ -0.00\\ -0.00\\ -0.00\\ -0.00\\ -0.00\\ -0.00\\ -0.00\\ -0.00\\ -0.00\\ -0.00\\ -0.00\\ -0.00\\ -0.00\\ -0.00\\ -0.00\\ -0.00\\ -0.00\\ -0.00\\ -0.00\\ -0.00\\ -0.00\\ -0.00\\ -0.00\\ -0.00\\ -0.00\\ -0.00\\ -0.00\\ -0.00\\ -0.00\\ -0.00\\ -0.00\\ -0.00\\ -0.00\\ -0.00\\ -0.00\\ -0.00\\ -0.00\\ -0.00\\ -0.00\\ -0.00\\ -0.00\\ -0.00\\ -0.00\\ -0.00\\ -0.00\\ -0.00\\ -0.00\\ -0.00\\ -0.00\\ -0.00\\ -0.00\\ -0.00\\ -0.00\\ -0.00\\ -0.00\\ -0.00\\ -0.00\\ -0.00\\ -0.00\\ -0.00\\ -0.00\\ -0.00\\ -0.00\\ -0.00\\ -0.00\\ -0.00\\ -0.00\\ -0.00\\ -0.00\\ -0.00\\ -0.00\\ -0.00\\ -0.00\\ -0.00\\ -0.00\\ -0.00\\ -0.00\\ -0.00\\ -0.00\\ -0.00\\ -0.00\\ -0.00\\ -0.00\\ -0.00\\ -0.00\\ -0.00\\ -0.00\\ -0.00\\ -0.00\\ -0.00\\ -0.00\\ -0.00\\ -0.00\\ -0.00\\ -0.00\\ -0.00\\ -0.00\\ -0.00\\ -0.00\\ -0.00\\ -0.00\\ -0.00\\ -0.00\\ -0.00\\ -0.00\\ -0.00\\ -0.00\\ -0.00\\ -0.00\\ -0.00\\ -0.00\\ -0.00\\ -0.00\\ -0.00\\ -0.00\\ -0.00\\ -0.00\\ -0.00\\ -0.00\\ -0.00\\ -0.00\\ -0.00\\ -0.00\\ -0.00\\ -0.00\\ -0.00\\ -0.00\\ -0.00\\ -0.00\\ -0.00\\ -0.00\\ -0.00\\ -0.00\\ -0.00\\ -0.00\\ -0.00\\ -0.00\\ -0.00\\ -0.00\\ -0.00\\ -0.00\\ -0.00\\ -0.00\\ -0.00\\ -0.00\\ -0.00\\ -0.00\\ -0.00\\ -0.00\\ -0.0$ Tin No. 195 Tin +Wet soil 215.1 Tin + Dry soil 183.6 Wt of Tin 76 Wt of Moisture 31.5 Strain Wt. of dry soil 107.6 **Moisture content** 29.3 RESULTS Specification Result Results 177 KN/m<sup>2</sup> **Unconfined Compressive Strength Estimated Elastic Modulus** Mathew & Nyagah Checked By: Martin Mburu

Tested By:

#### **UNIVERSITY OF NAIROBI** WORKING SHEET (HIGHWAYS LABORATORY) **UCS TEST SPECIMEN 6** Date: 23-Jan-2020 No. of days cured: Project: Mechanical stabilization of Lateritic Gravel 0 Mould No.: No. of days soaked: Student: Anthony Mugendi Nyagah 0 SAMPLE DETAILS DATA MDD 1474 Do =152mm STABILIZED 29.43 Туре OMC Stabilizer Lo mm 127 12% FCD NMC 19.3 0.0181 Ao = (152x152x3.14)/4% 0 m 0.00275 Volume = AoLo m Stabilizer = NON Deflection Defl. E=L/L0 1-E A=(Ao)/1-E Stress UCS TEST Load Q KN/m<sup>2</sup> KN mm 0.01810 0.00 0.0000 1 0 0 0.9925 0.01824 0.95 0.0075 1.1203 61 340 0.01838 1.91 0.0150 0.985 2.5042 136 320 0.01852 196 2.86 0.0225 0.9775 3.6245 300 3.81 0.01866 3.96718 0.0300 0.97 213 280 260 4.76 0.0375 0.01881 3.7563 200 0.9625 240 0.01810 0.00 0 0.0000 1.0000 0 220 0.01810 0.00 0 1.0000 0 0 Stress KN/m<sup>2</sup> 200 0.01810 0 0.00 0.0000 1.0000 0 180 160 140 120 100 80 60 40 20 MOULDING MOISTURE CONTENT 0 $\begin{array}{c} -0.0600\\ -0.0550\\ -0.04500\\ -0.0350\\ -0.0250\\ -0.0250\\ -0.0250\\ -0.0150\\ -0.0050\\ -0.0050\\ -0.0050\\ -0.0050\\ -0.0000\\ -0.0000\\ -0.0000\\ -0.0000\\ -0.000\\ -0.000\\ -0.000\\ -0.000\\ -0.000\\ -0.000\\ -0.000\\ -0.00\\ -0.00\\ -0.00\\ -0.00\\ -0.00\\ -0.00\\ -0.00\\ -0.00\\ -0.00\\ -0.00\\ -0.00\\ -0.00\\ -0.00\\ -0.00\\ -0.00\\ -0.00\\ -0.00\\ -0.00\\ -0.00\\ -0.00\\ -0.00\\ -0.00\\ -0.00\\ -0.00\\ -0.00\\ -0.00\\ -0.00\\ -0.00\\ -0.00\\ -0.00\\ -0.00\\ -0.00\\ -0.00\\ -0.00\\ -0.00\\ -0.00\\ -0.00\\ -0.00\\ -0.00\\ -0.00\\ -0.00\\ -0.00\\ -0.00\\ -0.00\\ -0.00\\ -0.00\\ -0.00\\ -0.00\\ -0.00\\ -0.00\\ -0.00\\ -0.00\\ -0.00\\ -0.00\\ -0.00\\ -0.00\\ -0.00\\ -0.00\\ -0.00\\ -0.00\\ -0.00\\ -0.00\\ -0.00\\ -0.00\\ -0.00\\ -0.00\\ -0.00\\ -0.00\\ -0.00\\ -0.00\\ -0.00\\ -0.00\\ -0.00\\ -0.00\\ -0.00\\ -0.00\\ -0.00\\ -0.00\\ -0.00\\ -0.00\\ -0.00\\ -0.00\\ -0.00\\ -0.00\\ -0.00\\ -0.00\\ -0.00\\ -0.00\\ -0.00\\ -0.00\\ -0.00\\ -0.00\\ -0.00\\ -0.00\\ -0.00\\ -0.00\\ -0.00\\ -0.00\\ -0.00\\ -0.00\\ -0.00\\ -0.00\\ -0.00\\ -0.00\\ -0.00\\ -0.00\\ -0.00\\ -0.00\\ -0.00\\ -0.00\\ -0.00\\ -0.00\\ -0.00\\ -0.00\\ -0.00\\ -0.00\\ -0.00\\ -0.00\\ -0.00\\ -0.00\\ -0.00\\ -0.00\\ -0.00\\ -0.00\\ -0.00\\ -0.00\\ -0.00\\ -0.00\\ -0.00\\ -0.00\\ -0.00\\ -0.00\\ -0.00\\ -0.00\\ -0.00\\ -0.00\\ -0.00\\ -0.00\\ -0.00\\ -0.00\\ -0.00\\ -0.00\\ -0.00\\ -0.00\\ -0.00\\ -0.00\\ -0.00\\ -0.00\\ -0.00\\ -0.00\\ -0.00\\ -0.00\\ -0.00\\ -0.00\\ -0.00\\ -0.00\\ -0.00\\ -0.00\\ -0.00\\ -0.00\\ -0.00\\ -0.00\\ -0.00\\ -0.00\\ -0.00\\ -0.00\\ -0.00\\ -0.00\\ -0.00\\ -0.00\\ -0.00\\ -0.00\\ -0.00\\ -0.00\\ -0.00\\ -0.00\\ -0.00\\ -0.00\\ -0.00\\ -0.00\\ -0.00\\ -0.00\\ -0.00\\ -0.00\\ -0.00\\ -0.00\\ -0.00\\ -0.00\\ -0.00\\ -0.00\\ -0.00\\ -0.00\\ -0.00\\ -0.00\\ -0.00\\ -0.00\\ -0.00\\ -0.00\\ -0.00\\ -0.00\\ -0.00\\ -0.00\\ -0.00\\ -0.00\\ -0.00\\ -0.00\\ -0.00\\ -0.00\\ -0.00\\ -0.00\\ -0.00\\ -0.00\\ -0.00\\ -0.00\\ -0.00\\ -0.00\\ -0.00\\ -0.00\\ -0.00\\ -0.00\\ -0.00\\ -0.00\\ -0.00\\ -0.00\\ -0.00\\ -0.00\\ -0.00\\ -0.00\\ -0.00\\ -0.00\\ -0.00\\ -0.00\\ -0.00\\ -0.00\\ -0.00\\ -0.00\\ -0.00\\ -0.00\\ -0.00\\ -0.00\\ -0.00\\ -0.00\\ -0.00\\ -0.00\\ -0.00\\ -0.00\\ -0.00\\ -0.00\\ -0.00\\ -0.00\\ -0.00\\ -0.00\\ -0.00\\ -0.00\\ -0.00\\ -0.00\\ -0.00\\ -0.00\\ -0.00\\ -0.00\\ -0.00\\ -0.00\\ -0.0$ Tin No. 195 Tin +Wet soil 215.1 Tin + Dry soil 183.6 Wt of Tin 76 Wt of Moisture 31.5 Strain Wt. of dry soil 107.6 **Moisture content** 29.3 RESULTS Specification Result Results 213 KN/m<sup>2</sup> **Unconfined Compressive Strength Estimated Elastic Modulus**

 Ius
 Tested By:
 Mathew & Nyagah
 Checked By:
 Martin Mburu

#### **UNIVERSITY OF NAIROBI** WORKING SHEET (HIGHWAYS LABORATORY) **UCS TEST** SPECIMEN 7 **Project: Mechanical Stabilization of lateritic Gravel** Date: 23-Jan-2020 No. of days cured: 0 Student: Anthony Mugendi Nyagah Mould No.: No. of days soaked: 0 SAMPLE DETAILS DATA MDD 1474 Do =152mm STABILIZED 29.43 Туре OMC Stabilizer Lo mm 127 12% FCD NMC 9.2 0.0181 Ao = (152x152x3.14)/4% 0 m 0.00275 Volume = AoLo m Stabilizer = NON Deflection Defl. E=L/L0 1-E A=(Ao)/1-E Stress UCS TEST Load Q KN/m<sup>2</sup> KN mm 0.01810 0.00 0.0000 1 0 0 0.9925 0.01824 0.95 0.0075 1.15984 64 340 0.01838 1.91 0.0150 0.985 2.636 143 320 0.01852 196 2.86 0.0225 0.9775 3.6245 300 3.81 0.01866 3.8222 205 0.0300 0.97 280 260 4.76 0.0375 0.01881 3.6904 196 0.9625 240 0.01810 0.00 0 0.0000 1.0000 0 220 0.01810 0.00 0 1.0000 0 0 Stress KN/m<sup>2</sup> 200 0.01810 0 0.00 0.0000 1.0000 0 180 160 140 120 100 80 60 40 20 MOULDING MOISTURE CONTENT 0 $\begin{array}{c} -0.0600\\ -0.0550\\ -0.04500\\ -0.0350\\ -0.0250\\ -0.0250\\ -0.0250\\ -0.0150\\ -0.0050\\ -0.0050\\ -0.0050\\ -0.0050\\ -0.0000\\ -0.0000\\ -0.0000\\ -0.0000\\ -0.000\\ -0.000\\ -0.000\\ -0.000\\ -0.000\\ -0.000\\ -0.000\\ -0.00\\ -0.00\\ -0.00\\ -0.00\\ -0.00\\ -0.00\\ -0.00\\ -0.00\\ -0.00\\ -0.00\\ -0.00\\ -0.00\\ -0.00\\ -0.00\\ -0.00\\ -0.00\\ -0.00\\ -0.00\\ -0.00\\ -0.00\\ -0.00\\ -0.00\\ -0.00\\ -0.00\\ -0.00\\ -0.00\\ -0.00\\ -0.00\\ -0.00\\ -0.00\\ -0.00\\ -0.00\\ -0.00\\ -0.00\\ -0.00\\ -0.00\\ -0.00\\ -0.00\\ -0.00\\ -0.00\\ -0.00\\ -0.00\\ -0.00\\ -0.00\\ -0.00\\ -0.00\\ -0.00\\ -0.00\\ -0.00\\ -0.00\\ -0.00\\ -0.00\\ -0.00\\ -0.00\\ -0.00\\ -0.00\\ -0.00\\ -0.00\\ -0.00\\ -0.00\\ -0.00\\ -0.00\\ -0.00\\ -0.00\\ -0.00\\ -0.00\\ -0.00\\ -0.00\\ -0.00\\ -0.00\\ -0.00\\ -0.00\\ -0.00\\ -0.00\\ -0.00\\ -0.00\\ -0.00\\ -0.00\\ -0.00\\ -0.00\\ -0.00\\ -0.00\\ -0.00\\ -0.00\\ -0.00\\ -0.00\\ -0.00\\ -0.00\\ -0.00\\ -0.00\\ -0.00\\ -0.00\\ -0.00\\ -0.00\\ -0.00\\ -0.00\\ -0.00\\ -0.00\\ -0.00\\ -0.00\\ -0.00\\ -0.00\\ -0.00\\ -0.00\\ -0.00\\ -0.00\\ -0.00\\ -0.00\\ -0.00\\ -0.00\\ -0.00\\ -0.00\\ -0.00\\ -0.00\\ -0.00\\ -0.00\\ -0.00\\ -0.00\\ -0.00\\ -0.00\\ -0.00\\ -0.00\\ -0.00\\ -0.00\\ -0.00\\ -0.00\\ -0.00\\ -0.00\\ -0.00\\ -0.00\\ -0.00\\ -0.00\\ -0.00\\ -0.00\\ -0.00\\ -0.00\\ -0.00\\ -0.00\\ -0.00\\ -0.00\\ -0.00\\ -0.00\\ -0.00\\ -0.00\\ -0.00\\ -0.00\\ -0.00\\ -0.00\\ -0.00\\ -0.00\\ -0.00\\ -0.00\\ -0.00\\ -0.00\\ -0.00\\ -0.00\\ -0.00\\ -0.00\\ -0.00\\ -0.00\\ -0.00\\ -0.00\\ -0.00\\ -0.00\\ -0.00\\ -0.00\\ -0.00\\ -0.00\\ -0.00\\ -0.00\\ -0.00\\ -0.00\\ -0.00\\ -0.00\\ -0.00\\ -0.00\\ -0.00\\ -0.00\\ -0.00\\ -0.00\\ -0.00\\ -0.00\\ -0.00\\ -0.00\\ -0.00\\ -0.00\\ -0.00\\ -0.00\\ -0.00\\ -0.00\\ -0.00\\ -0.00\\ -0.00\\ -0.00\\ -0.00\\ -0.00\\ -0.00\\ -0.00\\ -0.00\\ -0.00\\ -0.00\\ -0.00\\ -0.00\\ -0.00\\ -0.00\\ -0.00\\ -0.00\\ -0.00\\ -0.00\\ -0.00\\ -0.00\\ -0.00\\ -0.00\\ -0.00\\ -0.00\\ -0.00\\ -0.00\\ -0.00\\ -0.00\\ -0.00\\ -0.00\\ -0.00\\ -0.00\\ -0.00\\ -0.00\\ -0.00\\ -0.00\\ -0.00\\ -0.00\\ -0.00\\ -0.00\\ -0.00\\ -0.00\\ -0.00\\ -0.00\\ -0.00\\ -0.00\\ -0.00\\ -0.00\\ -0.00\\ -0.00\\ -0.00\\ -0.00\\ -0.00\\ -0.00\\ -0.00\\ -0.00\\ -0.00\\ -0.00\\ -0.00\\ -0.00\\ -0.00\\ -0.00\\ -0.00\\ -0.00\\ -0.00\\ -0.00\\ -0.00\\ -0.00\\ -0.00\\ -0.00\\ -0.00\\ -0.0$ Tin No. 195 Tin +Wet soil 215.1 Tin + Dry soil 183.6 Wt of Tin 76 Wt of Moisture 31.5 Strain Wt. of dry soil 107.6 **Moisture content** 29.3 RESULTS Specification Result Results 205 KN/m<sup>2</sup> **Unconfined Compressive Strength Estimated Elastic Modulus**

Mathew & Nyagah Checked By: Tested By:

Martin Mburu

Appendix D3 Strength Properties (CBR)

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#### UNIVERSITY OF NAIROBI **WORKING SHEET** (HIGHWAYS LABORATORY) **CBR TEST** (AASHTO T193:1990) **3% FCD SAMPLE 2** Project: Mechanical Stabilization of Lateritic Gravel using FCD Tested: 21/1/2020 Date soaked: 17/01/2020 Date Moulded: Mould No.: 17/01/2020 Student.: Anthony Mugendi Nyagah SWELL DATA SAMPLE DETAILS MDD 1613 25.25 Initial gauge Reading STABILIZED OMC (div) 0 Туре **Final gauge Reading** (div) 18 Stabilizer FCD NMC 9.2 Difference 18 (div) % **Ring Factor** 0.01 Swell % 0.18 Gauge Factor:0.0005 inches/Div Penetration Bot Тор Standard CBR% of the plunger (KN) (KN) Load(KN) **CBR TEST** Bott. Тор (mm) 0 0 0.00 0.64 0.90101 0.795 15.00 1.27 1.72253 1.9478 2.25253 2.544 1.91 14.00 21 22 2.54 2.78254 2.915 13.2 13.00 3.18 3.2463 3.3126 12.00 3.81 3.57755 3.6173 3.84256 4.45 3.8558 11.00 5.08 4.10756 4.0943 20.0 21 20 10.00 5.72 4.37257 4.3063 6.35 4.53157 4.5051 9.00 Force in KN 8.00 7.00 **Moulding Data** Wt.of Mould + Wet soil g 6.00 Wt. of Mould g 5.00 **Moisture** Content % 4.00 Wet Density Kg/m<sup>3</sup> 3.00 **Drv Densitv** Kg/m<sup>3</sup> % MDD 2.00 MOULDING MOISTURE CONTENT 1.00 Tin No. 201 0.00 Tin +Wet soil 239 $\begin{array}{c} 3 \\ - 1 \\ - 1 \\ - 2 \\ - 2 \\ - 2 \\ - 2 \\ - 2 \\ - 2 \\ - 2 \\ - 2 \\ - 2 \\ - 2 \\ - 2 \\ - 2 \\ - 2 \\ - 2 \\ - 2 \\ - 2 \\ - 2 \\ - 2 \\ - 2 \\ - 2 \\ - 2 \\ - 2 \\ - 2 \\ - 2 \\ - 2 \\ - 2 \\ - 2 \\ - 2 \\ - 2 \\ - 2 \\ - 2 \\ - 2 \\ - 2 \\ - 2 \\ - 2 \\ - 2 \\ - 2 \\ - 2 \\ - 2 \\ - 2 \\ - 2 \\ - 2 \\ - 2 \\ - 2 \\ - 2 \\ - 2 \\ - 2 \\ - 2 \\ - 2 \\ - 2 \\ - 2 \\ - 2 \\ - 2 \\ - 2 \\ - 2 \\ - 2 \\ - 2 \\ - 2 \\ - 2 \\ - 2 \\ - 2 \\ - 2 \\ - 2 \\ - 2 \\ - 2 \\ - 2 \\ - 2 \\ - 2 \\ - 2 \\ - 2 \\ - 2 \\ - 2 \\ - 2 \\ - 2 \\ - 2 \\ - 2 \\ - 2 \\ - 2 \\ - 2 \\ - 2 \\ - 2 \\ - 2 \\ - 2 \\ - 2 \\ - 2 \\ - 2 \\ - 2 \\ - 2 \\ - 2 \\ - 2 \\ - 2 \\ - 2 \\ - 2 \\ - 2 \\ - 2 \\ - 2 \\ - 2 \\ - 2 \\ - 2 \\ - 2 \\ - 2 \\ - 2 \\ - 2 \\ - 2 \\ - 2 \\ - 2 \\ - 2 \\ - 2 \\ - 2 \\ - 2 \\ - 2 \\ - 2 \\ - 2 \\ - 2 \\ - 2 \\ - 2 \\ - 2 \\ - 2 \\ - 2 \\ - 2 \\ - 2 \\ - 2 \\ - 2 \\ - 2 \\ - 2 \\ - 2 \\ - 2 \\ - 2 \\ - 2 \\ - 2 \\ - 2 \\ - 2 \\ - 2 \\ - 2 \\ - 2 \\ - 2 \\ - 2 \\ - 2 \\ - 2 \\ - 2 \\ - 2 \\ - 2 \\ - 2 \\ - 2 \\ - 2 \\ - 2 \\ - 2 \\ - 2 \\ - 2 \\ - 2 \\ - 2 \\ - 2 \\ - 2 \\ - 2 \\ - 2 \\ - 2 \\ - 2 \\ - 2 \\ - 2 \\ - 2 \\ - 2 \\ - 2 \\ - 2 \\ - 2 \\ - 2 \\ - 2 \\ - 2 \\ - 2 \\ - 2 \\ - 2 \\ - 2 \\ - 2 \\ - 2 \\ - 2 \\ - 2 \\ - 2 \\ - 2 \\ - 2 \\ - 2 \\ - 2 \\ - 2 \\ - 2 \\ - 2 \\ - 2 \\ - 2 \\ - 2 \\ - 2 \\ - 2 \\ - 2 \\ - 2 \\ - 2 \\ - 2 \\ - 2 \\ - 2 \\ - 2 \\ - 2 \\ - 2 \\ - 2 \\ - 2 \\ - 2 \\ - 2 \\ - 2 \\ - 2 \\ - 2 \\ - 2 \\ - 2 \\ - 2 \\ - 2 \\ - 2 \\ - 2 \\ - 2 \\ - 2 \\ - 2 \\ - 2 \\ - 2 \\ - 2 \\ - 2 \\ - 2 \\ - 2 \\ - 2 \\ - 2 \\ - 2 \\ - 2 \\ - 2 \\ - 2 \\ - 2 \\ - 2 \\ - 2 \\ - 2 \\ - 2 \\ - 2 \\ - 2 \\ - 2 \\ - 2 \\ - 2 \\ - 2 \\ - 2 \\ - 2 \\ - 2 \\ - 2 \\ - 2 \\ - 2 \\ - 2 \\ - 2 \\ - 2 \\ - 2 \\ - 2 \\ - 2 \\ - 2 \\ - 2 \\ - 2 \\ - 2 \\ - 2 \\ - 2 \\ - 2 \\ - 2 \\ - 2 \\ - 2 \\ - 2 \\ - 2 \\ - 2 \\ - 2 \\ - 2 \\ - 2 \\ - 2 \\ - 2 \\ - 2 \\ - 2 \\ - 2 \\ - 2 \\ - 2 \\ - 2 \\ - 2 \\ - 2 \\ - 2 \\ - 2 \\ - 2 \\ - 2 \\ - 2 \\ - 2 \\ - 2 \\ - 2 \\ - 2 \\ - 2 \\ - 2 \\ - 2 \\ - 2 \\ - 2 \\ - 2 \\ - 2 \\ - 2 \\ - 2 \\ - 2 \\ - 2 \\ - 2 \\ - 2 \\ - 2 \\ - 2 \\ - 2 \\ - 2 \\ - 2 \\ - 2 \\ - 2 \\ - 2 \\ - 2 \\ - 2 \\ - 2 \\ - 2 \\ - 2 \\ - 2 \\ - 2 \\ - 2 \\ - 2 \\ - 2 \\ - 2 \\ - 2 \\ - 2 \\ - 2 \\ - 2 \\ - 2 \\ - 2 \\ - 2 \\ - 2 \\ - 2 \\ - 2 \\ - 2 \\ - 2 \\ - 2 \\ - 2 \\ - 2 \\ - 2 \\ - 2 \\ - 2 \\ - 2 \\ - 2 \\ - 2 \\ - 2 \\ -$ Tin + Dry soil 205.8 Wt of Tin 78.3 33.2 Wt of Moisture Penetration in mm Wt. of dry soil 127.5 **Moisture content** 26.04 RESULTS Penetration(mm) Standard Force(KN) Specification CBR%(top) CBR%(bott.) 2.5 13.2 22 21 20 20 21 5 CBR =22% Checked: Martin Mburu

#### UNIVERSITY OF NAIROBI **WORKING SHEET** (HIGHWAYS LABORATORY) **CBR TEST** (AASHTO T193:1990) **3% FCD SAMPLE 3 Tested:** 21/1/2020 Project: Mechanical Stabilization of lateritic Gravel using FCD Date soaked: 17/01/2020 Date Moulded: Mould No.: 17/01/2020 Client.: Anthony Mugendi Nyagah SWELL DATA SAMPLE DETAILS MDD 1613 25.25 Initial gauge Reading STABILIZED OMC (div) 0 Туре **Final gauge Reading** (div) 18 Stabilizer FCD NMC 9.2 Difference 18 (div) % **Ring Factor** 0.01 Swell % 0.18 Gauge Factor:0.0005 inches/Div Penetration Bot Тор Standard CBR% of the plunger (KN) Load(KN) (KN) **CBR TEST** Bott. Тор (mm) 0 0 0.00 0.64 0.53001 0.6095 15.00 1.06 1.27 1.25877 2.22603 1.4708 1.91 14.00 21 15 2.54 2.72954 2.014 13.2 13.00 3.18 3.20655 2.544 12.00 3.81 3.57755 2.8885 4.45 3.84256 3.2463 11.00 20.0 5.08 4.05456 3.5643 20 18 10.00 5.72 4.24006 3.8426 4.42557 9.00 6.35 4.0413 Force in KN 8.00 7.00 **Moulding Data** Wt.of Mould + Wet soil g 6.00 Wt. of Mould g 5.00 **Moisture** Content % 4.00 Wet Density Kg/m<sup>3</sup> 3.00 **Drv Densitv** Kg/m<sup>3</sup> % MDD 2.00 MOULDING MOISTURE CONTENT 1.00 Tin No. 201 0.00 Tin +Wet soil 239 $\begin{array}{c} 3 \\ - 1 \\ - 1 \\ - 2 \\ - 2 \\ - 2 \\ - 2 \\ - 2 \\ - 2 \\ - 2 \\ - 2 \\ - 2 \\ - 2 \\ - 2 \\ - 2 \\ - 2 \\ - 2 \\ - 2 \\ - 2 \\ - 2 \\ - 2 \\ - 2 \\ - 2 \\ - 2 \\ - 2 \\ - 2 \\ - 2 \\ - 2 \\ - 2 \\ - 2 \\ - 2 \\ - 2 \\ - 2 \\ - 2 \\ - 2 \\ - 2 \\ - 2 \\ - 2 \\ - 2 \\ - 2 \\ - 2 \\ - 2 \\ - 2 \\ - 2 \\ - 2 \\ - 2 \\ - 2 \\ - 2 \\ - 2 \\ - 2 \\ - 2 \\ - 2 \\ - 2 \\ - 2 \\ - 2 \\ - 2 \\ - 2 \\ - 2 \\ - 2 \\ - 2 \\ - 2 \\ - 2 \\ - 2 \\ - 2 \\ - 2 \\ - 2 \\ - 2 \\ - 2 \\ - 2 \\ - 2 \\ - 2 \\ - 2 \\ - 2 \\ - 2 \\ - 2 \\ - 2 \\ - 2 \\ - 2 \\ - 2 \\ - 2 \\ - 2 \\ - 2 \\ - 2 \\ - 2 \\ - 2 \\ - 2 \\ - 2 \\ - 2 \\ - 2 \\ - 2 \\ - 2 \\ - 2 \\ - 2 \\ - 2 \\ - 2 \\ - 2 \\ - 2 \\ - 2 \\ - 2 \\ - 2 \\ - 2 \\ - 2 \\ - 2 \\ - 2 \\ - 2 \\ - 2 \\ - 2 \\ - 2 \\ - 2 \\ - 2 \\ - 2 \\ - 2 \\ - 2 \\ - 2 \\ - 2 \\ - 2 \\ - 2 \\ - 2 \\ - 2 \\ - 2 \\ - 2 \\ - 2 \\ - 2 \\ - 2 \\ - 2 \\ - 2 \\ - 2 \\ - 2 \\ - 2 \\ - 2 \\ - 2 \\ - 2 \\ - 2 \\ - 2 \\ - 2 \\ - 2 \\ - 2 \\ - 2 \\ - 2 \\ - 2 \\ - 2 \\ - 2 \\ - 2 \\ - 2 \\ - 2 \\ - 2 \\ - 2 \\ - 2 \\ - 2 \\ - 2 \\ - 2 \\ - 2 \\ - 2 \\ - 2 \\ - 2 \\ - 2 \\ - 2 \\ - 2 \\ - 2 \\ - 2 \\ - 2 \\ - 2 \\ - 2 \\ - 2 \\ - 2 \\ - 2 \\ - 2 \\ - 2 \\ - 2 \\ - 2 \\ - 2 \\ - 2 \\ - 2 \\ - 2 \\ - 2 \\ - 2 \\ - 2 \\ - 2 \\ - 2 \\ - 2 \\ - 2 \\ - 2 \\ - 2 \\ - 2 \\ - 2 \\ - 2 \\ - 2 \\ - 2 \\ - 2 \\ - 2 \\ - 2 \\ - 2 \\ - 2 \\ - 2 \\ - 2 \\ - 2 \\ - 2 \\ - 2 \\ - 2 \\ - 2 \\ - 2 \\ - 2 \\ - 2 \\ - 2 \\ - 2 \\ - 2 \\ - 2 \\ - 2 \\ - 2 \\ - 2 \\ - 2 \\ - 2 \\ - 2 \\ - 2 \\ - 2 \\ - 2 \\ - 2 \\ - 2 \\ - 2 \\ - 2 \\ - 2 \\ - 2 \\ - 2 \\ - 2 \\ - 2 \\ - 2 \\ - 2 \\ - 2 \\ - 2 \\ - 2 \\ - 2 \\ - 2 \\ - 2 \\ - 2 \\ - 2 \\ - 2 \\ - 2 \\ - 2 \\ - 2 \\ - 2 \\ - 2 \\ - 2 \\ - 2 \\ - 2 \\ - 2 \\ - 2 \\ - 2 \\ - 2 \\ - 2 \\ - 2 \\ - 2 \\ - 2 \\ - 2 \\ - 2 \\ - 2 \\ - 2 \\ - 2 \\ - 2 \\ - 2 \\ - 2 \\ - 2 \\ - 2 \\ - 2 \\ - 2 \\ - 2 \\ - 2 \\ - 2 \\ - 2 \\ - 2 \\ - 2 \\ - 2 \\ - 2 \\ - 2 \\ - 2 \\ - 2 \\ - 2 \\ - 2 \\ - 2 \\ - 2 \\ - 2 \\ - 2 \\ - 2 \\ - 2 \\ - 2 \\ - 2 \\ - 2 \\ - 2 \\ - 2 \\ - 2 \\ - 2 \\ - 2 \\ - 2 \\ - 2 \\ - 2 \\ - 2 \\ - 2 \\ - 2 \\ - 2 \\ - 2 \\ - 2 \\ - 2 \\ - 2 \\ - 2 \\ - 2 \\ - 2 \\ - 2 \\ - 2 \\ - 2 \\ - 2 \\ - 2 \\ - 2 \\ - 2 \\ - 2 \\ - 2 \\ - 2 \\ - 2 \\ - 2 \\ - 2 \\ - 2 \\ - 2 \\ - 2 \\ - 2 \\ - 2 \\ - 2 \\ - 2 \\ - 2 \\ - 2 \\ - 2 \\ - 2 \\ - 2 \\ - 2 \\ - 2 \\ - 2 \\ - 2 \\ - 2 \\ - 2 \\ - 2 \\ - 2 \\ - 2 \\ - 2 \\ -$ Tin + Dry soil 205.8 Wt of Tin 78.3 33.2 Wt of Moisture Penetration in mm Wt. of dry soil 127.5 **Moisture content** 26.04 RESULTS Penetration(mm) Standard Force(KN) Specification CBR%(top) CBR%(bott.) 2.5 13.2 15 21 20 18 20 5 CBR =21% Checked: Martin Mburu

#### UNIVERSITY OF NAIROBI **WORKING SHEET** (HIGHWAYS LABORATORY) **CBR TEST** (AASHTO T193:1990) **3% FCD SAMPLE 4 Tested:** 21/1/2020 Project: Mechanical stabilization of lateritic Gravel using FCD Date soaked: 17/01/2020 Date Moulded: Mould No.: 17/01/2020 Student.: Anthony Mugendi Nyagah SWELL DATA SAMPLE DETAILS MDD 1613 Initial gauge Reading 25.25 STABILIZED OMC (div) 0 Туре **Final gauge Reading** (div) 18 Stabilizer FCD NMC 9.2 Difference 18 (div) % **Ring Factor** 0.01 Swell % 0.18 Gauge Factor:0.0005 inches/Div Penetration Bot Тор Standard CBR% of the plunger (KN) (KN) Load(KN) **CBR TEST** Bott. Тор (mm) 0 0 0.00 0.64 0.46376 0.7023 15.00 1.06002 1.27 1.2588 1.48402 1.91 1.6563 14.00 15 2.54 1.92128 2.12 13.2 16 13.00 3.18 2.31879 2.4645 12.00 3.81 2.65004 2.7825 2.94154 4.45 3.074 11.00 20.0 5.08 3.18005 3.2728 16 **16** 10.00 5.72 3.3788 3.4451 6.35 3.64381 9.00 3.6968 Force in KN 8.00 7.00 **Moulding Data** Wt.of Mould + Wet soil g 6.00 Wt. of Mould g 5.00 % **Moisture Content** 4.00 Wet Density Kg/m<sup>3</sup> 3.00 **Drv Densitv** Kg/m<sup>3</sup> % MDD 2.00 MOULDING MOISTURE CONTENT 1.00 Tin No. 201 0.00 Tin +Wet soil 239 $\begin{array}{c} 3 \\ - 1 \\ - 1 \\ - 2 \\ - 2 \\ - 2 \\ - 2 \\ - 2 \\ - 2 \\ - 2 \\ - 2 \\ - 2 \\ - 2 \\ - 2 \\ - 2 \\ - 2 \\ - 2 \\ - 2 \\ - 2 \\ - 2 \\ - 2 \\ - 2 \\ - 2 \\ - 2 \\ - 2 \\ - 2 \\ - 2 \\ - 2 \\ - 2 \\ - 2 \\ - 2 \\ - 2 \\ - 2 \\ - 2 \\ - 2 \\ - 2 \\ - 2 \\ - 2 \\ - 2 \\ - 2 \\ - 2 \\ - 2 \\ - 2 \\ - 2 \\ - 2 \\ - 2 \\ - 2 \\ - 2 \\ - 2 \\ - 2 \\ - 2 \\ - 2 \\ - 2 \\ - 2 \\ - 2 \\ - 2 \\ - 2 \\ - 2 \\ - 2 \\ - 2 \\ - 2 \\ - 2 \\ - 2 \\ - 2 \\ - 2 \\ - 2 \\ - 2 \\ - 2 \\ - 2 \\ - 2 \\ - 2 \\ - 2 \\ - 2 \\ - 2 \\ - 2 \\ - 2 \\ - 2 \\ - 2 \\ - 2 \\ - 2 \\ - 2 \\ - 2 \\ - 2 \\ - 2 \\ - 2 \\ - 2 \\ - 2 \\ - 2 \\ - 2 \\ - 2 \\ - 2 \\ - 2 \\ - 2 \\ - 2 \\ - 2 \\ - 2 \\ - 2 \\ - 2 \\ - 2 \\ - 2 \\ - 2 \\ - 2 \\ - 2 \\ - 2 \\ - 2 \\ - 2 \\ - 2 \\ - 2 \\ - 2 \\ - 2 \\ - 2 \\ - 2 \\ - 2 \\ - 2 \\ - 2 \\ - 2 \\ - 2 \\ - 2 \\ - 2 \\ - 2 \\ - 2 \\ - 2 \\ - 2 \\ - 2 \\ - 2 \\ - 2 \\ - 2 \\ - 2 \\ - 2 \\ - 2 \\ - 2 \\ - 2 \\ - 2 \\ - 2 \\ - 2 \\ - 2 \\ - 2 \\ - 2 \\ - 2 \\ - 2 \\ - 2 \\ - 2 \\ - 2 \\ - 2 \\ - 2 \\ - 2 \\ - 2 \\ - 2 \\ - 2 \\ - 2 \\ - 2 \\ - 2 \\ - 2 \\ - 2 \\ - 2 \\ - 2 \\ - 2 \\ - 2 \\ - 2 \\ - 2 \\ - 2 \\ - 2 \\ - 2 \\ - 2 \\ - 2 \\ - 2 \\ - 2 \\ - 2 \\ - 2 \\ - 2 \\ - 2 \\ - 2 \\ - 2 \\ - 2 \\ - 2 \\ - 2 \\ - 2 \\ - 2 \\ - 2 \\ - 2 \\ - 2 \\ - 2 \\ - 2 \\ - 2 \\ - 2 \\ - 2 \\ - 2 \\ - 2 \\ - 2 \\ - 2 \\ - 2 \\ - 2 \\ - 2 \\ - 2 \\ - 2 \\ - 2 \\ - 2 \\ - 2 \\ - 2 \\ - 2 \\ - 2 \\ - 2 \\ - 2 \\ - 2 \\ - 2 \\ - 2 \\ - 2 \\ - 2 \\ - 2 \\ - 2 \\ - 2 \\ - 2 \\ - 2 \\ - 2 \\ - 2 \\ - 2 \\ - 2 \\ - 2 \\ - 2 \\ - 2 \\ - 2 \\ - 2 \\ - 2 \\ - 2 \\ - 2 \\ - 2 \\ - 2 \\ - 2 \\ - 2 \\ - 2 \\ - 2 \\ - 2 \\ - 2 \\ - 2 \\ - 2 \\ - 2 \\ - 2 \\ - 2 \\ - 2 \\ - 2 \\ - 2 \\ - 2 \\ - 2 \\ - 2 \\ - 2 \\ - 2 \\ - 2 \\ - 2 \\ - 2 \\ - 2 \\ - 2 \\ - 2 \\ - 2 \\ - 2 \\ - 2 \\ - 2 \\ - 2 \\ - 2 \\ - 2 \\ - 2 \\ - 2 \\ - 2 \\ - 2 \\ - 2 \\ - 2 \\ - 2 \\ - 2 \\ - 2 \\ - 2 \\ - 2 \\ - 2 \\ - 2 \\ - 2 \\ - 2 \\ - 2 \\ - 2 \\ - 2 \\ - 2 \\ - 2 \\ - 2 \\ - 2 \\ - 2 \\ - 2 \\ - 2 \\ - 2 \\ - 2 \\ - 2 \\ - 2 \\ - 2 \\ - 2 \\ - 2 \\ - 2 \\ - 2 \\ - 2 \\ - 2 \\ - 2 \\ - 2 \\ - 2 \\ - 2 \\ - 2 \\ - 2 \\ - 2 \\ - 2 \\ - 2 \\ - 2 \\ - 2 \\ - 2 \\ - 2 \\ - 2 \\ - 2 \\ - 2 \\ - 2 \\ - 2 \\ - 2 \\ - 2 \\ - 2 \\ - 2 \\ - 2 \\ - 2 \\ - 2 \\ - 2 \\ - 2 \\ - 2 \\ - 2 \\ - 2 \\ - 2 \\ - 2 \\ - 2 \\ - 2 \\ - 2 \\ - 2 \\ - 2 \\ - 2 \\ - 2 \\ - 2 \\ - 2 \\ - 2 \\ - 2 \\ - 2 \\ - 2 \\ -$ Tin + Dry soil 205.8 Wt of Tin 78.3 Wt of Moisture 33.2 Penetration in mm Wt. of dry soil 127.5 **Moisture content** 26.04 RESULTS Penetration(mm) Standard Force(KN) Specification CBR%(top) CBR%(bott.) 2.5 13.2 16 15 20 16 16 5 CBR =16% **Checked:** Martin Mburu

#### UNIVERSITY OF NAIROBI **WORKING SHEET** (HIGHWAYS LABORATORY) **CBR TEST** (AASHTO T193:1990) **3% FCD SAMPLE 5 Tested:** 21/1/2020 Project: Mechanical stabilization of Lateritic Gravel using FCD Date soaked: 17/01/2020 Date Moulded: Mould No.: 17/01/2020 Student.: Anthony Mugendi Nyagah SWELL DATA SAMPLE DETAILS MDD 1613 25.25 Initial gauge Reading STABILIZED OMC (div) 0 Туре **Final gauge Reading** (div) 18 Stabilizer FCD NMC 9.2 Difference 18 (div) % **Ring Factor** 0.01 Swell % 0.18 Gauge Factor:0.0005 inches/Div Penetration Bot Тор Standard CBR% of the plunger (KN) (KN) Load(KN) **CBR TEST** Bott. Тор (mm) 0 0 0.00 0.64 0.72876 0.5963 15.00 1.27 1.52377 1.2588 2.12003 1.855 1.91 14.00 13.2 20 18 2.54 2.63679 2.385 13.00 3.04755 3.18 2.7825 12.00 3.81 3.3523 3.18 4.45 3.6173 3.4583 11.00 20.0 5.08 3.88231 3.7498 19 19 10.00 4.04131 4.0016 5.72 4.17381 9.00 6.35 4.2401 Force in KN 8.00 7.00 **Moulding Data** Wt.of Mould + Wet soil g 6.00 Wt. of Mould g 5.00 % **Moisture Content** 4.00 Wet Density Kg/m<sup>3</sup> 3.00 **Drv Densitv** Kg/m<sup>3</sup> % MDD 2.00 MOULDING MOISTURE CONTENT 1.00 Tin No. 201 0.00 Tin +Wet soil 239 $\begin{array}{c} 3 \\ - 1 \\ - 1 \\ - 2 \\ - 2 \\ - 2 \\ - 2 \\ - 2 \\ - 2 \\ - 2 \\ - 2 \\ - 2 \\ - 2 \\ - 2 \\ - 2 \\ - 2 \\ - 2 \\ - 2 \\ - 2 \\ - 2 \\ - 2 \\ - 2 \\ - 2 \\ - 2 \\ - 2 \\ - 2 \\ - 2 \\ - 2 \\ - 2 \\ - 2 \\ - 2 \\ - 2 \\ - 2 \\ - 2 \\ - 2 \\ - 2 \\ - 2 \\ - 2 \\ - 2 \\ - 2 \\ - 2 \\ - 2 \\ - 2 \\ - 2 \\ - 2 \\ - 2 \\ - 2 \\ - 2 \\ - 2 \\ - 2 \\ - 2 \\ - 2 \\ - 2 \\ - 2 \\ - 2 \\ - 2 \\ - 2 \\ - 2 \\ - 2 \\ - 2 \\ - 2 \\ - 2 \\ - 2 \\ - 2 \\ - 2 \\ - 2 \\ - 2 \\ - 2 \\ - 2 \\ - 2 \\ - 2 \\ - 2 \\ - 2 \\ - 2 \\ - 2 \\ - 2 \\ - 2 \\ - 2 \\ - 2 \\ - 2 \\ - 2 \\ - 2 \\ - 2 \\ - 2 \\ - 2 \\ - 2 \\ - 2 \\ - 2 \\ - 2 \\ - 2 \\ - 2 \\ - 2 \\ - 2 \\ - 2 \\ - 2 \\ - 2 \\ - 2 \\ - 2 \\ - 2 \\ - 2 \\ - 2 \\ - 2 \\ - 2 \\ - 2 \\ - 2 \\ - 2 \\ - 2 \\ - 2 \\ - 2 \\ - 2 \\ - 2 \\ - 2 \\ - 2 \\ - 2 \\ - 2 \\ - 2 \\ - 2 \\ - 2 \\ - 2 \\ - 2 \\ - 2 \\ - 2 \\ - 2 \\ - 2 \\ - 2 \\ - 2 \\ - 2 \\ - 2 \\ - 2 \\ - 2 \\ - 2 \\ - 2 \\ - 2 \\ - 2 \\ - 2 \\ - 2 \\ - 2 \\ - 2 \\ - 2 \\ - 2 \\ - 2 \\ - 2 \\ - 2 \\ - 2 \\ - 2 \\ - 2 \\ - 2 \\ - 2 \\ - 2 \\ - 2 \\ - 2 \\ - 2 \\ - 2 \\ - 2 \\ - 2 \\ - 2 \\ - 2 \\ - 2 \\ - 2 \\ - 2 \\ - 2 \\ - 2 \\ - 2 \\ - 2 \\ - 2 \\ - 2 \\ - 2 \\ - 2 \\ - 2 \\ - 2 \\ - 2 \\ - 2 \\ - 2 \\ - 2 \\ - 2 \\ - 2 \\ - 2 \\ - 2 \\ - 2 \\ - 2 \\ - 2 \\ - 2 \\ - 2 \\ - 2 \\ - 2 \\ - 2 \\ - 2 \\ - 2 \\ - 2 \\ - 2 \\ - 2 \\ - 2 \\ - 2 \\ - 2 \\ - 2 \\ - 2 \\ - 2 \\ - 2 \\ - 2 \\ - 2 \\ - 2 \\ - 2 \\ - 2 \\ - 2 \\ - 2 \\ - 2 \\ - 2 \\ - 2 \\ - 2 \\ - 2 \\ - 2 \\ - 2 \\ - 2 \\ - 2 \\ - 2 \\ - 2 \\ - 2 \\ - 2 \\ - 2 \\ - 2 \\ - 2 \\ - 2 \\ - 2 \\ - 2 \\ - 2 \\ - 2 \\ - 2 \\ - 2 \\ - 2 \\ - 2 \\ - 2 \\ - 2 \\ - 2 \\ - 2 \\ - 2 \\ - 2 \\ - 2 \\ - 2 \\ - 2 \\ - 2 \\ - 2 \\ - 2 \\ - 2 \\ - 2 \\ - 2 \\ - 2 \\ - 2 \\ - 2 \\ - 2 \\ - 2 \\ - 2 \\ - 2 \\ - 2 \\ - 2 \\ - 2 \\ - 2 \\ - 2 \\ - 2 \\ - 2 \\ - 2 \\ - 2 \\ - 2 \\ - 2 \\ - 2 \\ - 2 \\ - 2 \\ - 2 \\ - 2 \\ - 2 \\ - 2 \\ - 2 \\ - 2 \\ - 2 \\ - 2 \\ - 2 \\ - 2 \\ - 2 \\ - 2 \\ - 2 \\ - 2 \\ - 2 \\ - 2 \\ - 2 \\ - 2 \\ - 2 \\ - 2 \\ - 2 \\ - 2 \\ - 2 \\ - 2 \\ - 2 \\ - 2 \\ - 2 \\ - 2 \\ - 2 \\ - 2 \\ - 2 \\ - 2 \\ - 2 \\ - 2 \\ - 2 \\ - 2 \\ - 2 \\ - 2 \\ - 2 \\ - 2 \\ - 2 \\ - 2 \\ - 2 \\ - 2 \\ - 2 \\ - 2 \\ - 2 \\ - 2 \\ - 2 \\ - 2 \\ - 2 \\ - 2 \\ - 2 \\ - 2 \\ - 2 \\ - 2 \\ - 2 \\ - 2 \\ - 2 \\ - 2 \\ - 2 \\ - 2 \\ - 2 \\ - 2 \\ - 2 \\ - 2 \\ - 2 \\ - 2 \\ - 2 \\ - 2 \\ - 2 \\ - 2 \\ - 2 \\ - 2 \\ -$ Tin + Dry soil 205.8 Wt of Tin 78.3 33.2 Wt of Moisture Penetration in mm Wt. of dry soil 127.5 **Moisture content** 26.04 RESULTS Penetration(mm) Standard Force(KN) Specification CBR%(top) CBR%(bott.) 2.5 13.2 18 20 20 19 19 5 CBR =20% Checked: Martin Mburu

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#### UNIVERSITY OF NAIROBI **WORKING SHEET** (HIGHWAYS LABORATORY) **CBR TEST** (AASHTO T193:1990) **3% FCD SAMPLE 7** Project: Mechanical Stabilization of Lateritic Gravel using FCD Tested: 21/1/2020 Date soaked: 17/01/2020 **Date Moulded:** Mould No.: 17/01/2020 Student.: Anthony Mugendi Nyagah SWELL DATA SAMPLE DETAILS MDD 1613 Initial gauge Reading 25.25 STABILIZED OMC (div) 0 Туре **Final gauge Reading** (div) 18 Stabilizer FCD NMC 9.2 Difference 18 (div) % **Ring Factor** 0.01 Swell % 0.18 Gauge Factor:0.0005 inches/Div Penetration Bot Тор Standard CBR% of the plunger (KN) (KN) Load(KN) **CBR TEST** Bott. Тор (mm) 0 0 0.00 0.64 0.55651 0.6625 15.00 1.27 1.19252 1.166 1.85503 1.59 1.91 14.00 13.2 2.54 2.19953 2.0538 17 16 13.00 2.59704 3.18 2.544 12.00 3.81 2.88854 2.915 4.45 3.1403 3.2065 11.00 20.0 5.08 3.31255 3.4451 17 17 10.00 5.72 3.5113 3.7498 6.35 3.71006 3.9751 9.00 Force in KN 8.00 7.00 **Moulding Data** Wt.of Mould + Wet soil g 6.00 Wt. of Mould g 5.00 % **Moisture Content** 4.00 Wet Density Kg/m<sup>3</sup> 3.00 **Drv Densitv** Kg/m<sup>3</sup> % MDD 2.00 MOULDING MOISTURE CONTENT 1.00 Tin No. 201 0.00 Tin +Wet soil 239 $\begin{array}{c} 3 \\ - 1 \\ - 1 \\ - 2 \\ - 2 \\ - 2 \\ - 2 \\ - 2 \\ - 2 \\ - 2 \\ - 2 \\ - 2 \\ - 2 \\ - 2 \\ - 2 \\ - 2 \\ - 2 \\ - 2 \\ - 2 \\ - 2 \\ - 2 \\ - 2 \\ - 2 \\ - 2 \\ - 2 \\ - 2 \\ - 2 \\ - 2 \\ - 2 \\ - 2 \\ - 2 \\ - 2 \\ - 2 \\ - 2 \\ - 2 \\ - 2 \\ - 2 \\ - 2 \\ - 2 \\ - 2 \\ - 2 \\ - 2 \\ - 2 \\ - 2 \\ - 2 \\ - 2 \\ - 2 \\ - 2 \\ - 2 \\ - 2 \\ - 2 \\ - 2 \\ - 2 \\ - 2 \\ - 2 \\ - 2 \\ - 2 \\ - 2 \\ - 2 \\ - 2 \\ - 2 \\ - 2 \\ - 2 \\ - 2 \\ - 2 \\ - 2 \\ - 2 \\ - 2 \\ - 2 \\ - 2 \\ - 2 \\ - 2 \\ - 2 \\ - 2 \\ - 2 \\ - 2 \\ - 2 \\ - 2 \\ - 2 \\ - 2 \\ - 2 \\ - 2 \\ - 2 \\ - 2 \\ - 2 \\ - 2 \\ - 2 \\ - 2 \\ - 2 \\ - 2 \\ - 2 \\ - 2 \\ - 2 \\ - 2 \\ - 2 \\ - 2 \\ - 2 \\ - 2 \\ - 2 \\ - 2 \\ - 2 \\ - 2 \\ - 2 \\ - 2 \\ - 2 \\ - 2 \\ - 2 \\ - 2 \\ - 2 \\ - 2 \\ - 2 \\ - 2 \\ - 2 \\ - 2 \\ - 2 \\ - 2 \\ - 2 \\ - 2 \\ - 2 \\ - 2 \\ - 2 \\ - 2 \\ - 2 \\ - 2 \\ - 2 \\ - 2 \\ - 2 \\ - 2 \\ - 2 \\ - 2 \\ - 2 \\ - 2 \\ - 2 \\ - 2 \\ - 2 \\ - 2 \\ - 2 \\ - 2 \\ - 2 \\ - 2 \\ - 2 \\ - 2 \\ - 2 \\ - 2 \\ - 2 \\ - 2 \\ - 2 \\ - 2 \\ - 2 \\ - 2 \\ - 2 \\ - 2 \\ - 2 \\ - 2 \\ - 2 \\ - 2 \\ - 2 \\ - 2 \\ - 2 \\ - 2 \\ - 2 \\ - 2 \\ - 2 \\ - 2 \\ - 2 \\ - 2 \\ - 2 \\ - 2 \\ - 2 \\ - 2 \\ - 2 \\ - 2 \\ - 2 \\ - 2 \\ - 2 \\ - 2 \\ - 2 \\ - 2 \\ - 2 \\ - 2 \\ - 2 \\ - 2 \\ - 2 \\ - 2 \\ - 2 \\ - 2 \\ - 2 \\ - 2 \\ - 2 \\ - 2 \\ - 2 \\ - 2 \\ - 2 \\ - 2 \\ - 2 \\ - 2 \\ - 2 \\ - 2 \\ - 2 \\ - 2 \\ - 2 \\ - 2 \\ - 2 \\ - 2 \\ - 2 \\ - 2 \\ - 2 \\ - 2 \\ - 2 \\ - 2 \\ - 2 \\ - 2 \\ - 2 \\ - 2 \\ - 2 \\ - 2 \\ - 2 \\ - 2 \\ - 2 \\ - 2 \\ - 2 \\ - 2 \\ - 2 \\ - 2 \\ - 2 \\ - 2 \\ - 2 \\ - 2 \\ - 2 \\ - 2 \\ - 2 \\ - 2 \\ - 2 \\ - 2 \\ - 2 \\ - 2 \\ - 2 \\ - 2 \\ - 2 \\ - 2 \\ - 2 \\ - 2 \\ - 2 \\ - 2 \\ - 2 \\ - 2 \\ - 2 \\ - 2 \\ - 2 \\ - 2 \\ - 2 \\ - 2 \\ - 2 \\ - 2 \\ - 2 \\ - 2 \\ - 2 \\ - 2 \\ - 2 \\ - 2 \\ - 2 \\ - 2 \\ - 2 \\ - 2 \\ - 2 \\ - 2 \\ - 2 \\ - 2 \\ - 2 \\ - 2 \\ - 2 \\ - 2 \\ - 2 \\ - 2 \\ - 2 \\ - 2 \\ - 2 \\ - 2 \\ - 2 \\ - 2 \\ - 2 \\ - 2 \\ - 2 \\ - 2 \\ - 2 \\ - 2 \\ - 2 \\ - 2 \\ - 2 \\ - 2 \\ - 2 \\ - 2 \\ - 2 \\ - 2 \\ - 2 \\ - 2 \\ - 2 \\ - 2 \\ - 2 \\ - 2 \\ - 2 \\ - 2 \\ - 2 \\ - 2 \\ - 2 \\ - 2 \\ - 2 \\ - 2 \\ - 2 \\ - 2 \\ - 2 \\ - 2 \\ - 2 \\ - 2 \\ - 2 \\ - 2 \\ - 2 \\ - 2 \\ - 2 \\ - 2 \\ - 2 \\ - 2 \\ - 2 \\ - 2 \\ - 2 \\ - 2 \\ - 2 \\ - 2 \\ - 2 \\ - 2 \\ - 2 \\ - 2 \\ - 2 \\ - 2 \\ - 2 \\ - 2 \\ - 2 \\ - 2 \\ - 2 \\ - 2 \\ -$ Tin + Dry soil 205.8 Wt of Tin 78.3 33.2 Wt of Moisture Penetration in mm Wt. of dry soil 127.5 **Moisture content** 26.04 RESULTS Penetration(mm) Standard Force(KN) Specification CBR%(top) CBR%(bott.) 2.5 13.2 16 17 20 17 17 5 CBR =17% Checked: Martin Mburu

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#### UNIVERSITY OF NAIROBI **WORKING SHEET** (HIGHWAYS LABORATORY) **CBR TEST** (AASHTO T193:1990) 6% FCD SAMPLE 2 Project: Mechanical Stabilization of Lateritic Gravel using FCD Tested: 17/12/2019 Date soaked: 29/11/2019 Date Moulded: Mould No.: 29/11/2019 Student.: Anthony Mugendi Nyagah SWELL DATA SAMPLE DETAILS 1553 MDD Initial gauge Reading STABILIZED OMC 26.39 (div) 0 Туре **Final gauge Reading** (div) 12 Stabilizer FCD NMC 9.2 Difference (div) 12 % **Ring Factor** 0.01 Swell % 0.12 Gauge Factor:0.0005 inches/Div Penetration Bot Тор Standard CBR% of the plunger (KN) (KN) Load(KN) **CBR TEST** Bott. Тор (mm) 0 0 0.00 0.64 0.53001 2.014 15.00 1.27 1.32502 3.9088 2.41154 5.1013 1.91 14.00 13.2 27 44 2.54 3.57755 5.7638 13.00 5.9626 3.18 4.63757 12.00 3.81 5.16758 6.0686 5.49883 4.45 6.1613 11.00 20.0 5.08 5.76384 6.3601 29 32 10.00 5.98909 6.4131 5.72 6.35 6.26734 9.00 6.6251 Force in KN 8.00 7.00 **Moulding Data** Wt.of Mould + Wet soil g 6.00 Wt. of Mould g 5.00 **Moisture** Content % 4.00 Wet Density Kg/m<sup>3</sup> 3.00 **Drv Densitv** Kg/m<sup>3</sup> % MDD 2.00 MOULDING MOISTURE CONTENT 1.00 Tin No. 184 0.00 Tin +Wet soil 214.3 $\begin{array}{c} 3 \\ - 1 \\ - 1 \\ - 2 \\ - 2 \\ - 2 \\ - 2 \\ - 2 \\ - 2 \\ - 2 \\ - 2 \\ - 2 \\ - 2 \\ - 2 \\ - 2 \\ - 2 \\ - 2 \\ - 2 \\ - 2 \\ - 2 \\ - 2 \\ - 2 \\ - 2 \\ - 2 \\ - 2 \\ - 2 \\ - 2 \\ - 2 \\ - 2 \\ - 2 \\ - 2 \\ - 2 \\ - 2 \\ - 2 \\ - 2 \\ - 2 \\ - 2 \\ - 2 \\ - 2 \\ - 2 \\ - 2 \\ - 2 \\ - 2 \\ - 2 \\ - 2 \\ - 2 \\ - 2 \\ - 2 \\ - 2 \\ - 2 \\ - 2 \\ - 2 \\ - 2 \\ - 2 \\ - 2 \\ - 2 \\ - 2 \\ - 2 \\ - 2 \\ - 2 \\ - 2 \\ - 2 \\ - 2 \\ - 2 \\ - 2 \\ - 2 \\ - 2 \\ - 2 \\ - 2 \\ - 2 \\ - 2 \\ - 2 \\ - 2 \\ - 2 \\ - 2 \\ - 2 \\ - 2 \\ - 2 \\ - 2 \\ - 2 \\ - 2 \\ - 2 \\ - 2 \\ - 2 \\ - 2 \\ - 2 \\ - 2 \\ - 2 \\ - 2 \\ - 2 \\ - 2 \\ - 2 \\ - 2 \\ - 2 \\ - 2 \\ - 2 \\ - 2 \\ - 2 \\ - 2 \\ - 2 \\ - 2 \\ - 2 \\ - 2 \\ - 2 \\ - 2 \\ - 2 \\ - 2 \\ - 2 \\ - 2 \\ - 2 \\ - 2 \\ - 2 \\ - 2 \\ - 2 \\ - 2 \\ - 2 \\ - 2 \\ - 2 \\ - 2 \\ - 2 \\ - 2 \\ - 2 \\ - 2 \\ - 2 \\ - 2 \\ - 2 \\ - 2 \\ - 2 \\ - 2 \\ - 2 \\ - 2 \\ - 2 \\ - 2 \\ - 2 \\ - 2 \\ - 2 \\ - 2 \\ - 2 \\ - 2 \\ - 2 \\ - 2 \\ - 2 \\ - 2 \\ - 2 \\ - 2 \\ - 2 \\ - 2 \\ - 2 \\ - 2 \\ - 2 \\ - 2 \\ - 2 \\ - 2 \\ - 2 \\ - 2 \\ - 2 \\ - 2 \\ - 2 \\ - 2 \\ - 2 \\ - 2 \\ - 2 \\ - 2 \\ - 2 \\ - 2 \\ - 2 \\ - 2 \\ - 2 \\ - 2 \\ - 2 \\ - 2 \\ - 2 \\ - 2 \\ - 2 \\ - 2 \\ - 2 \\ - 2 \\ - 2 \\ - 2 \\ - 2 \\ - 2 \\ - 2 \\ - 2 \\ - 2 \\ - 2 \\ - 2 \\ - 2 \\ - 2 \\ - 2 \\ - 2 \\ - 2 \\ - 2 \\ - 2 \\ - 2 \\ - 2 \\ - 2 \\ - 2 \\ - 2 \\ - 2 \\ - 2 \\ - 2 \\ - 2 \\ - 2 \\ - 2 \\ - 2 \\ - 2 \\ - 2 \\ - 2 \\ - 2 \\ - 2 \\ - 2 \\ - 2 \\ - 2 \\ - 2 \\ - 2 \\ - 2 \\ - 2 \\ - 2 \\ - 2 \\ - 2 \\ - 2 \\ - 2 \\ - 2 \\ - 2 \\ - 2 \\ - 2 \\ - 2 \\ - 2 \\ - 2 \\ - 2 \\ - 2 \\ - 2 \\ - 2 \\ - 2 \\ - 2 \\ - 2 \\ - 2 \\ - 2 \\ - 2 \\ - 2 \\ - 2 \\ - 2 \\ - 2 \\ - 2 \\ - 2 \\ - 2 \\ - 2 \\ - 2 \\ - 2 \\ - 2 \\ - 2 \\ - 2 \\ - 2 \\ - 2 \\ - 2 \\ - 2 \\ - 2 \\ - 2 \\ - 2 \\ - 2 \\ - 2 \\ - 2 \\ - 2 \\ - 2 \\ - 2 \\ - 2 \\ - 2 \\ - 2 \\ - 2 \\ - 2 \\ - 2 \\ - 2 \\ - 2 \\ - 2 \\ - 2 \\ - 2 \\ - 2 \\ - 2 \\ - 2 \\ - 2 \\ - 2 \\ - 2 \\ - 2 \\ - 2 \\ - 2 \\ - 2 \\ - 2 \\ - 2 \\ - 2 \\ - 2 \\ - 2 \\ - 2 \\ - 2 \\ - 2 \\ - 2 \\ - 2 \\ - 2 \\ - 2 \\ - 2 \\ - 2 \\ - 2 \\ - 2 \\ - 2 \\ - 2 \\ - 2 \\ - 2 \\ - 2 \\ - 2 \\ - 2 \\ - 2 \\ - 2 \\ - 2 \\ - 2 \\ - 2 \\ - 2 \\ - 2 \\ - 2 \\ - 2 \\ - 2 \\ - 2 \\ - 2 \\ - 2 \\ - 2 \\ - 2 \\ - 2 \\ - 2 \\ - 2 \\ - 2 \\ - 2 \\ - 2 \\ - 2 \\ - 2 \\ - 2 \\ - 2 \\ - 2 \\ - 2 \\ - 2 \\ - 2 \\ - 2 \\ - 2 \\ -$ Tin + Dry soil 184.6 Wt of Tin 78.8 Wt of Moisture 33.6 Penetration in mm Wt. of dry soil 127.1 **Moisture content** 26.44 RESULTS Penetration(mm) Standard Force(KN) Specification CBR%(top) CBR%(bott.) 2.5 13.2 44 27 20 32 29 5 CBR =44% Checked: Martin Mburu

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#### UNIVERSITY OF NAIROBI **WORKING SHEET** (HIGHWAYS LABORATORY) **CBR TEST** (AASHTO T193:1990) 6% FCD SAMPLE 4 Project: Mechanical Stabilization of Lateritic Gravel using FCD Tested: 17/12/2019 Date soaked: 29/11/2019 Date Moulded: Mould No.: 29/11/2019 Student.: Anthony Mugendi Nyagah SWELL DATA SAMPLE DETAILS 1553 MDD Initial gauge Reading STABILIZED OMC 26.39 (div) 0 Туре **Final gauge Reading** (div) 12 Stabilizer FCD NMC 9.2 Difference (div) 12 % **Ring Factor** 0.01 Swell % 0.12 Gauge Factor:0.0005 inches/Div Penetration Bot Тор Standard CBR% of the plunger (KN) (KN) Load(KN) **CBR TEST** Bott. Тор (mm) 0 0 0.00 0.64 0.59626 2.0538 15.00 1.27 1.35152 4.3991 2.51754 6.2276 1.91 14.00 13.2 30 53 2.54 3.97506 7.0226 13.00 5.03508 3.18 7.2876 12.00 3.81 5.63134 7.5261 6.09509 7.8176 4.45 11.00 20.0 5.08 6.3071 8.0826 32 **40** 10.00 5.72 6.3866 8.3476 6.35 8.5066 9.00 6.4926 Force in KN 8.00 7.00 **Moulding Data** Wt.of Mould + Wet soil g 6.00 Wt. of Mould g 5.00 % **Moisture Content** 4.00 Wet Density Kg/m<sup>3</sup> 3.00 **Drv Densitv** Kg/m<sup>3</sup> % MDD 2.00 MOULDING MOISTURE CONTENT 1.00 Tin No. 184 0.00 Tin +Wet soil 214.3 $\begin{array}{c} 3 \\ - 1 \\ - 1 \\ - 2 \\ - 2 \\ - 2 \\ - 2 \\ - 2 \\ - 2 \\ - 2 \\ - 2 \\ - 2 \\ - 2 \\ - 2 \\ - 2 \\ - 2 \\ - 2 \\ - 2 \\ - 2 \\ - 2 \\ - 2 \\ - 2 \\ - 2 \\ - 2 \\ - 2 \\ - 2 \\ - 2 \\ - 2 \\ - 2 \\ - 2 \\ - 2 \\ - 2 \\ - 2 \\ - 2 \\ - 2 \\ - 2 \\ - 2 \\ - 2 \\ - 2 \\ - 2 \\ - 2 \\ - 2 \\ - 2 \\ - 2 \\ - 2 \\ - 2 \\ - 2 \\ - 2 \\ - 2 \\ - 2 \\ - 2 \\ - 2 \\ - 2 \\ - 2 \\ - 2 \\ - 2 \\ - 2 \\ - 2 \\ - 2 \\ - 2 \\ - 2 \\ - 2 \\ - 2 \\ - 2 \\ - 2 \\ - 2 \\ - 2 \\ - 2 \\ - 2 \\ - 2 \\ - 2 \\ - 2 \\ - 2 \\ - 2 \\ - 2 \\ - 2 \\ - 2 \\ - 2 \\ - 2 \\ - 2 \\ - 2 \\ - 2 \\ - 2 \\ - 2 \\ - 2 \\ - 2 \\ - 2 \\ - 2 \\ - 2 \\ - 2 \\ - 2 \\ - 2 \\ - 2 \\ - 2 \\ - 2 \\ - 2 \\ - 2 \\ - 2 \\ - 2 \\ - 2 \\ - 2 \\ - 2 \\ - 2 \\ - 2 \\ - 2 \\ - 2 \\ - 2 \\ - 2 \\ - 2 \\ - 2 \\ - 2 \\ - 2 \\ - 2 \\ - 2 \\ - 2 \\ - 2 \\ - 2 \\ - 2 \\ - 2 \\ - 2 \\ - 2 \\ - 2 \\ - 2 \\ - 2 \\ - 2 \\ - 2 \\ - 2 \\ - 2 \\ - 2 \\ - 2 \\ - 2 \\ - 2 \\ - 2 \\ - 2 \\ - 2 \\ - 2 \\ - 2 \\ - 2 \\ - 2 \\ - 2 \\ - 2 \\ - 2 \\ - 2 \\ - 2 \\ - 2 \\ - 2 \\ - 2 \\ - 2 \\ - 2 \\ - 2 \\ - 2 \\ - 2 \\ - 2 \\ - 2 \\ - 2 \\ - 2 \\ - 2 \\ - 2 \\ - 2 \\ - 2 \\ - 2 \\ - 2 \\ - 2 \\ - 2 \\ - 2 \\ - 2 \\ - 2 \\ - 2 \\ - 2 \\ - 2 \\ - 2 \\ - 2 \\ - 2 \\ - 2 \\ - 2 \\ - 2 \\ - 2 \\ - 2 \\ - 2 \\ - 2 \\ - 2 \\ - 2 \\ - 2 \\ - 2 \\ - 2 \\ - 2 \\ - 2 \\ - 2 \\ - 2 \\ - 2 \\ - 2 \\ - 2 \\ - 2 \\ - 2 \\ - 2 \\ - 2 \\ - 2 \\ - 2 \\ - 2 \\ - 2 \\ - 2 \\ - 2 \\ - 2 \\ - 2 \\ - 2 \\ - 2 \\ - 2 \\ - 2 \\ - 2 \\ - 2 \\ - 2 \\ - 2 \\ - 2 \\ - 2 \\ - 2 \\ - 2 \\ - 2 \\ - 2 \\ - 2 \\ - 2 \\ - 2 \\ - 2 \\ - 2 \\ - 2 \\ - 2 \\ - 2 \\ - 2 \\ - 2 \\ - 2 \\ - 2 \\ - 2 \\ - 2 \\ - 2 \\ - 2 \\ - 2 \\ - 2 \\ - 2 \\ - 2 \\ - 2 \\ - 2 \\ - 2 \\ - 2 \\ - 2 \\ - 2 \\ - 2 \\ - 2 \\ - 2 \\ - 2 \\ - 2 \\ - 2 \\ - 2 \\ - 2 \\ - 2 \\ - 2 \\ - 2 \\ - 2 \\ - 2 \\ - 2 \\ - 2 \\ - 2 \\ - 2 \\ - 2 \\ - 2 \\ - 2 \\ - 2 \\ - 2 \\ - 2 \\ - 2 \\ - 2 \\ - 2 \\ - 2 \\ - 2 \\ - 2 \\ - 2 \\ - 2 \\ - 2 \\ - 2 \\ - 2 \\ - 2 \\ - 2 \\ - 2 \\ - 2 \\ - 2 \\ - 2 \\ - 2 \\ - 2 \\ - 2 \\ - 2 \\ - 2 \\ - 2 \\ - 2 \\ - 2 \\ - 2 \\ - 2 \\ - 2 \\ - 2 \\ - 2 \\ - 2 \\ - 2 \\ - 2 \\ - 2 \\ - 2 \\ - 2 \\ - 2 \\ - 2 \\ - 2 \\ - 2 \\ - 2 \\ - 2 \\ - 2 \\ - 2 \\ - 2 \\ - 2 \\ - 2 \\ - 2 \\ - 2 \\ - 2 \\ - 2 \\ - 2 \\ - 2 \\ - 2 \\ - 2 \\ - 2 \\ - 2 \\ - 2 \\ - 2 \\ - 2 \\ - 2 \\ - 2 \\ - 2 \\ - 2 \\ - 2 \\ - 2 \\ - 2 \\ - 2 \\ - 2 \\ - 2 \\ - 2 \\ - 2 \\ - 2 \\ -$ Tin + Dry soil 184.6 Wt of Tin 78.8 Wt of Moisture 33.6 Penetration in mm Wt. of dry soil 127.1 **Moisture content** 26.44 RESULTS Penetration(mm) Standard Force(KN) Specification CBR%(top) CBR%(bott.) 2.5 13.2 53 30 20 40 32 5 CBR =53% Checked: Martin Mburu

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#### UNIVERSITY OF NAIROBI **WORKING SHEET** (HIGHWAYS LABORATORY) **CBR TEST** (AASHTO T193:1990) 6% FCD SAMPLE 6 Project: Mechanical Stabilization of Lateritic Gravel Using FCD Tested: 17/12/2019 Date soaked: 29/11/2019 Date Moulded: Mould No.: 29/11/2019 student.: Anthony Mugendi Nyagah SWELL DATA SAMPLE DETAILS 1553 MDD Initial gauge Reading STABILIZED OMC 26.39 (div) 0 Туре **Final gauge Reading** (div) 12 Stabilizer FCD NMC 9.2 Difference (div) 12 % **Ring Factor** 0.01 Swell % 0.12 Gauge Factor:0.0005 inches/Div Penetration Bot Тор Standard CBR% of the plunger (KN) (KN) Load(KN) **CBR TEST** Bott. Тор (mm) 0 0 0.00 0.64 0.79501 1.431 15.00 1.27 1.78878 4.7701 3.07405 5.5651 1.91 14.00 30 43 2.54 3.97506 5.6976 13.2 13.00 3.18 4.37257 6.3601 12.00 3.81 4.47857 7.0226 4.53157 7.2876 4.45 11.00 20.0 5.08 4.63757 7.3804 23 37 10.00 5.72 4.70382 7.5791 4.71707 7.8441 9.00 6.35 Force in KN 8.00 7.00 **Moulding Data** Wt.of Mould + Wet soil g 6.00 Wt. of Mould g 5.00 **Moisture** Content % 4.00 Wet Density Kg/m<sup>3</sup> 3.00 **Drv Densitv** Kg/m<sup>3</sup> % MDD 2.00 MOULDING MOISTURE CONTENT 1.00 Tin No. 184 0.00 Tin +Wet soil 214.3 $\begin{array}{c} 3 \\ - 1 \\ - 1 \\ - 2 \\ - 2 \\ - 2 \\ - 2 \\ - 2 \\ - 2 \\ - 2 \\ - 2 \\ - 2 \\ - 2 \\ - 2 \\ - 2 \\ - 2 \\ - 2 \\ - 2 \\ - 2 \\ - 2 \\ - 2 \\ - 2 \\ - 2 \\ - 2 \\ - 2 \\ - 2 \\ - 2 \\ - 2 \\ - 2 \\ - 2 \\ - 2 \\ - 2 \\ - 2 \\ - 2 \\ - 2 \\ - 2 \\ - 2 \\ - 2 \\ - 2 \\ - 2 \\ - 2 \\ - 2 \\ - 2 \\ - 2 \\ - 2 \\ - 2 \\ - 2 \\ - 2 \\ - 2 \\ - 2 \\ - 2 \\ - 2 \\ - 2 \\ - 2 \\ - 2 \\ - 2 \\ - 2 \\ - 2 \\ - 2 \\ - 2 \\ - 2 \\ - 2 \\ - 2 \\ - 2 \\ - 2 \\ - 2 \\ - 2 \\ - 2 \\ - 2 \\ - 2 \\ - 2 \\ - 2 \\ - 2 \\ - 2 \\ - 2 \\ - 2 \\ - 2 \\ - 2 \\ - 2 \\ - 2 \\ - 2 \\ - 2 \\ - 2 \\ - 2 \\ - 2 \\ - 2 \\ - 2 \\ - 2 \\ - 2 \\ - 2 \\ - 2 \\ - 2 \\ - 2 \\ - 2 \\ - 2 \\ - 2 \\ - 2 \\ - 2 \\ - 2 \\ - 2 \\ - 2 \\ - 2 \\ - 2 \\ - 2 \\ - 2 \\ - 2 \\ - 2 \\ - 2 \\ - 2 \\ - 2 \\ - 2 \\ - 2 \\ - 2 \\ - 2 \\ - 2 \\ - 2 \\ - 2 \\ - 2 \\ - 2 \\ - 2 \\ - 2 \\ - 2 \\ - 2 \\ - 2 \\ - 2 \\ - 2 \\ - 2 \\ - 2 \\ - 2 \\ - 2 \\ - 2 \\ - 2 \\ - 2 \\ - 2 \\ - 2 \\ - 2 \\ - 2 \\ - 2 \\ - 2 \\ - 2 \\ - 2 \\ - 2 \\ - 2 \\ - 2 \\ - 2 \\ - 2 \\ - 2 \\ - 2 \\ - 2 \\ - 2 \\ - 2 \\ - 2 \\ - 2 \\ - 2 \\ - 2 \\ - 2 \\ - 2 \\ - 2 \\ - 2 \\ - 2 \\ - 2 \\ - 2 \\ - 2 \\ - 2 \\ - 2 \\ - 2 \\ - 2 \\ - 2 \\ - 2 \\ - 2 \\ - 2 \\ - 2 \\ - 2 \\ - 2 \\ - 2 \\ - 2 \\ - 2 \\ - 2 \\ - 2 \\ - 2 \\ - 2 \\ - 2 \\ - 2 \\ - 2 \\ - 2 \\ - 2 \\ - 2 \\ - 2 \\ - 2 \\ - 2 \\ - 2 \\ - 2 \\ - 2 \\ - 2 \\ - 2 \\ - 2 \\ - 2 \\ - 2 \\ - 2 \\ - 2 \\ - 2 \\ - 2 \\ - 2 \\ - 2 \\ - 2 \\ - 2 \\ - 2 \\ - 2 \\ - 2 \\ - 2 \\ - 2 \\ - 2 \\ - 2 \\ - 2 \\ - 2 \\ - 2 \\ - 2 \\ - 2 \\ - 2 \\ - 2 \\ - 2 \\ - 2 \\ - 2 \\ - 2 \\ - 2 \\ - 2 \\ - 2 \\ - 2 \\ - 2 \\ - 2 \\ - 2 \\ - 2 \\ - 2 \\ - 2 \\ - 2 \\ - 2 \\ - 2 \\ - 2 \\ - 2 \\ - 2 \\ - 2 \\ - 2 \\ - 2 \\ - 2 \\ - 2 \\ - 2 \\ - 2 \\ - 2 \\ - 2 \\ - 2 \\ - 2 \\ - 2 \\ - 2 \\ - 2 \\ - 2 \\ - 2 \\ - 2 \\ - 2 \\ - 2 \\ - 2 \\ - 2 \\ - 2 \\ - 2 \\ - 2 \\ - 2 \\ - 2 \\ - 2 \\ - 2 \\ - 2 \\ - 2 \\ - 2 \\ - 2 \\ - 2 \\ - 2 \\ - 2 \\ - 2 \\ - 2 \\ - 2 \\ - 2 \\ - 2 \\ - 2 \\ - 2 \\ - 2 \\ - 2 \\ - 2 \\ - 2 \\ - 2 \\ - 2 \\ - 2 \\ - 2 \\ - 2 \\ - 2 \\ - 2 \\ - 2 \\ - 2 \\ - 2 \\ - 2 \\ - 2 \\ - 2 \\ - 2 \\ - 2 \\ - 2 \\ - 2 \\ - 2 \\ - 2 \\ - 2 \\ - 2 \\ - 2 \\ - 2 \\ - 2 \\ - 2 \\ - 2 \\ - 2 \\ - 2 \\ - 2 \\ - 2 \\ - 2 \\ - 2 \\ - 2 \\ - 2 \\ - 2 \\ - 2 \\ - 2 \\ - 2 \\ - 2 \\ - 2 \\ - 2 \\ - 2 \\ - 2 \\ - 2 \\ - 2 \\ - 2 \\ - 2 \\ - 2 \\ - 2 \\ - 2 \\ - 2 \\ - 2 \\ - 2 \\ - 2 \\ -$ Tin + Dry soil 184.6 Wt of Tin 78.3 Wt of Moisture 33.6 Penetration in mm Wt. of dry soil 127.1 **Moisture content** 26.44 RESULTS Penetration(mm) Standard Force(KN) Specification CBR%(top) CBR%(bott.) 2.5 13.2 43 30 20 37 23 5 CBR =43% Checked: Martin Mburu

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								CB	R =56	%			Checl	ked:	Marti	n Mburı	1

#### UNIVERSITY OF NAIROBI **WORKING SHEET** (HIGHWAYS LABORATORY) **CBR TEST** (AASHTO T193:1990) **9% FCD SAMPLE 1** Project: Mechanical Stabilization of Lateritic Gravel using FCD Tested: 21/1/2020 Date soaked: 17/01/2020 Date Moulded: Mould No.: 17/01/2020 Student.: Anthony Mugendi Nyagah SWELL DATA SAMPLE DETAILS 1532 MDD Initial gauge Reading STABILIZED OMC 28.31 (div) 0 Туре **Final gauge Reading** (div) 22 Stabilizer FCD NMC 14.3 Difference (div) 22 % **Ring Factor** 0.01 Swell % 0.22 Gauge Factor:0.0005 inches/Div Penetration Bot Тор Standard CBR% of the plunger (KN) (KN) Load(KN) **CBR TEST** Bott. Тор (mm) 0 0 0.00 0.64 1.19252 1.325 15.00 1.27 1.98753 2.7825 2.65004 4.2401 1.91 14.00 24 37 2.54 3.18005 4.9026 13.2 13.00 3.74981 3.18 5.1941 3.81 3.97506 5.3133 12.00 4.17381 4.45 5.4326 11.00 20.0 5.08 4.37257 5.6711 22 28 10.00 5.72 4.50507 5.9626 9.00 6.35 4.61107 6.2276 Force in KN 8.00 7.00 **Moulding Data** Wt.of Mould + Wet soil g 6.00 Wt. of Mould g 5.00 **Moisture** Content % 4.00 Wet Density Kg/m<sup>3</sup> 3.00 **Drv Densitv** Kg/m<sup>3</sup> % MDD 2.00 MOULDING MOISTURE CONTENT 1.00 Tin No. 107 0.00 Tin +Wet soil 227.5 $\begin{array}{c} 3 \\ - 1 \\ - 1 \\ - 2 \\ - 2 \\ - 2 \\ - 2 \\ - 2 \\ - 2 \\ - 2 \\ - 2 \\ - 2 \\ - 2 \\ - 2 \\ - 2 \\ - 2 \\ - 2 \\ - 2 \\ - 2 \\ - 2 \\ - 2 \\ - 2 \\ - 2 \\ - 2 \\ - 2 \\ - 2 \\ - 2 \\ - 2 \\ - 2 \\ - 2 \\ - 2 \\ - 2 \\ - 2 \\ - 2 \\ - 2 \\ - 2 \\ - 2 \\ - 2 \\ - 2 \\ - 2 \\ - 2 \\ - 2 \\ - 2 \\ - 2 \\ - 2 \\ - 2 \\ - 2 \\ - 2 \\ - 2 \\ - 2 \\ - 2 \\ - 2 \\ - 2 \\ - 2 \\ - 2 \\ - 2 \\ - 2 \\ - 2 \\ - 2 \\ - 2 \\ - 2 \\ - 2 \\ - 2 \\ - 2 \\ - 2 \\ - 2 \\ - 2 \\ - 2 \\ - 2 \\ - 2 \\ - 2 \\ - 2 \\ - 2 \\ - 2 \\ - 2 \\ - 2 \\ - 2 \\ - 2 \\ - 2 \\ - 2 \\ - 2 \\ - 2 \\ - 2 \\ - 2 \\ - 2 \\ - 2 \\ - 2 \\ - 2 \\ - 2 \\ - 2 \\ - 2 \\ - 2 \\ - 2 \\ - 2 \\ - 2 \\ - 2 \\ - 2 \\ - 2 \\ - 2 \\ - 2 \\ - 2 \\ - 2 \\ - 2 \\ - 2 \\ - 2 \\ - 2 \\ - 2 \\ - 2 \\ - 2 \\ - 2 \\ - 2 \\ - 2 \\ - 2 \\ - 2 \\ - 2 \\ - 2 \\ - 2 \\ - 2 \\ - 2 \\ - 2 \\ - 2 \\ - 2 \\ - 2 \\ - 2 \\ - 2 \\ - 2 \\ - 2 \\ - 2 \\ - 2 \\ - 2 \\ - 2 \\ - 2 \\ - 2 \\ - 2 \\ - 2 \\ - 2 \\ - 2 \\ - 2 \\ - 2 \\ - 2 \\ - 2 \\ - 2 \\ - 2 \\ - 2 \\ - 2 \\ - 2 \\ - 2 \\ - 2 \\ - 2 \\ - 2 \\ - 2 \\ - 2 \\ - 2 \\ - 2 \\ - 2 \\ - 2 \\ - 2 \\ - 2 \\ - 2 \\ - 2 \\ - 2 \\ - 2 \\ - 2 \\ - 2 \\ - 2 \\ - 2 \\ - 2 \\ - 2 \\ - 2 \\ - 2 \\ - 2 \\ - 2 \\ - 2 \\ - 2 \\ - 2 \\ - 2 \\ - 2 \\ - 2 \\ - 2 \\ - 2 \\ - 2 \\ - 2 \\ - 2 \\ - 2 \\ - 2 \\ - 2 \\ - 2 \\ - 2 \\ - 2 \\ - 2 \\ - 2 \\ - 2 \\ - 2 \\ - 2 \\ - 2 \\ - 2 \\ - 2 \\ - 2 \\ - 2 \\ - 2 \\ - 2 \\ - 2 \\ - 2 \\ - 2 \\ - 2 \\ - 2 \\ - 2 \\ - 2 \\ - 2 \\ - 2 \\ - 2 \\ - 2 \\ - 2 \\ - 2 \\ - 2 \\ - 2 \\ - 2 \\ - 2 \\ - 2 \\ - 2 \\ - 2 \\ - 2 \\ - 2 \\ - 2 \\ - 2 \\ - 2 \\ - 2 \\ - 2 \\ - 2 \\ - 2 \\ - 2 \\ - 2 \\ - 2 \\ - 2 \\ - 2 \\ - 2 \\ - 2 \\ - 2 \\ - 2 \\ - 2 \\ - 2 \\ - 2 \\ - 2 \\ - 2 \\ - 2 \\ - 2 \\ - 2 \\ - 2 \\ - 2 \\ - 2 \\ - 2 \\ - 2 \\ - 2 \\ - 2 \\ - 2 \\ - 2 \\ - 2 \\ - 2 \\ - 2 \\ - 2 \\ - 2 \\ - 2 \\ - 2 \\ - 2 \\ - 2 \\ - 2 \\ - 2 \\ - 2 \\ - 2 \\ - 2 \\ - 2 \\ - 2 \\ - 2 \\ - 2 \\ - 2 \\ - 2 \\ - 2 \\ - 2 \\ - 2 \\ - 2 \\ - 2 \\ - 2 \\ - 2 \\ - 2 \\ - 2 \\ - 2 \\ - 2 \\ - 2 \\ - 2 \\ - 2 \\ - 2 \\ - 2 \\ - 2 \\ - 2 \\ - 2 \\ - 2 \\ - 2 \\ - 2 \\ - 2 \\ - 2 \\ - 2 \\ - 2 \\ - 2 \\ - 2 \\ - 2 \\ - 2 \\ - 2 \\ - 2 \\ - 2 \\ - 2 \\ - 2 \\ - 2 \\ - 2 \\ - 2 \\ - 2 \\ - 2 \\ - 2 \\ - 2 \\ - 2 \\ - 2 \\ - 2 \\ - 2 \\ - 2 \\ - 2 \\ - 2 \\ - 2 \\ - 2 \\ - 2 \\ - 2 \\ - 2 \\ - 2 \\ - 2 \\ - 2 \\ - 2 \\ - 2 \\ - 2 \\ - 2 \\ - 2 \\ - 2 \\ - 2 \\ -$ Tin + Dry soil 196.2 Wt of Tin 95 31.3 Wt of Moisture Penetration in mm Wt. of dry soil 101.2 **Moisture content** 30.93 RESULTS Penetration(mm) Standard Force(KN) Specification CBR%(top) CBR%(bott.) 2.5 13.2 37 24 20 28 22 5 CBR =37% **Checked:** Martin Mburu

#### UNIVERSITY OF NAIROBI **WORKING SHEET** (HIGHWAYS LABORATORY) **CBR TEST** (AASHTO T193:1990) 9% FCD SAMPLE 2 Project: Mechanical Stabilization of Lateritic Gravel using FCD Tested: 21/1/2020 Date soaked: 17/01/2020 Date Moulded: Mould No.: 17/01/2020 Student.: Anthony Mugendi Nyagah SWELL DATA SAMPLE DETAILS 1532 MDD Initial gauge Reading STABILIZED OMC 28.31 (div) 0 Туре **Final gauge Reading** (div) 22 Stabilizer FCD NMC 14.3 Difference (div) 22 % **Ring Factor** 0.01 Swell % 0.22 Gauge Factor:0.0005 inches/Div Penetration Bot Тор Standard CBR% of the plunger (KN) (KN) Load(KN) **CBR TEST** Bott. Тор (mm) 0 0 0.00 0.64 0.95401 0.795 15.00 1.27 1.85503 1.3913 2.71629 1.9875 1.91 14.00 13.2 24 19 2.54 3.1138 2.5175 13.00 3.18 3.44505 3.0475 3.81 3.71006 3.5246 12.00 3.90881 3.8426 4.45 11.00 20.0 5.08 4.04131 4.1076 20 21 10.00 5.72 4.17381 4.5051 4.7701 4.37257 9.00 6.35 Force in KN 8.00 7.00 **Moulding Data** Wt.of Mould + Wet soil g 6.00 Wt. of Mould g 5.00 **Moisture** Content % 4.00 Wet Density Kg/m<sup>3</sup> 3.00 **Drv Densitv** Kg/m<sup>3</sup> % MDD 2.00 MOULDING MOISTURE CONTENT 1.00 Tin No. 107 0.00 Tin +Wet soil 227.5 $\begin{array}{c} 3 \\ - 1 \\ - 1 \\ - 2 \\ - 2 \\ - 2 \\ - 2 \\ - 2 \\ - 2 \\ - 2 \\ - 2 \\ - 2 \\ - 2 \\ - 2 \\ - 2 \\ - 2 \\ - 2 \\ - 2 \\ - 2 \\ - 2 \\ - 2 \\ - 2 \\ - 2 \\ - 2 \\ - 2 \\ - 2 \\ - 2 \\ - 2 \\ - 2 \\ - 2 \\ - 2 \\ - 2 \\ - 2 \\ - 2 \\ - 2 \\ - 2 \\ - 2 \\ - 2 \\ - 2 \\ - 2 \\ - 2 \\ - 2 \\ - 2 \\ - 2 \\ - 2 \\ - 2 \\ - 2 \\ - 2 \\ - 2 \\ - 2 \\ - 2 \\ - 2 \\ - 2 \\ - 2 \\ - 2 \\ - 2 \\ - 2 \\ - 2 \\ - 2 \\ - 2 \\ - 2 \\ - 2 \\ - 2 \\ - 2 \\ - 2 \\ - 2 \\ - 2 \\ - 2 \\ - 2 \\ - 2 \\ - 2 \\ - 2 \\ - 2 \\ - 2 \\ - 2 \\ - 2 \\ - 2 \\ - 2 \\ - 2 \\ - 2 \\ - 2 \\ - 2 \\ - 2 \\ - 2 \\ - 2 \\ - 2 \\ - 2 \\ - 2 \\ - 2 \\ - 2 \\ - 2 \\ - 2 \\ - 2 \\ - 2 \\ - 2 \\ - 2 \\ - 2 \\ - 2 \\ - 2 \\ - 2 \\ - 2 \\ - 2 \\ - 2 \\ - 2 \\ - 2 \\ - 2 \\ - 2 \\ - 2 \\ - 2 \\ - 2 \\ - 2 \\ - 2 \\ - 2 \\ - 2 \\ - 2 \\ - 2 \\ - 2 \\ - 2 \\ - 2 \\ - 2 \\ - 2 \\ - 2 \\ - 2 \\ - 2 \\ - 2 \\ - 2 \\ - 2 \\ - 2 \\ - 2 \\ - 2 \\ - 2 \\ - 2 \\ - 2 \\ - 2 \\ - 2 \\ - 2 \\ - 2 \\ - 2 \\ - 2 \\ - 2 \\ - 2 \\ - 2 \\ - 2 \\ - 2 \\ - 2 \\ - 2 \\ - 2 \\ - 2 \\ - 2 \\ - 2 \\ - 2 \\ - 2 \\ - 2 \\ - 2 \\ - 2 \\ - 2 \\ - 2 \\ - 2 \\ - 2 \\ - 2 \\ - 2 \\ - 2 \\ - 2 \\ - 2 \\ - 2 \\ - 2 \\ - 2 \\ - 2 \\ - 2 \\ - 2 \\ - 2 \\ - 2 \\ - 2 \\ - 2 \\ - 2 \\ - 2 \\ - 2 \\ - 2 \\ - 2 \\ - 2 \\ - 2 \\ - 2 \\ - 2 \\ - 2 \\ - 2 \\ - 2 \\ - 2 \\ - 2 \\ - 2 \\ - 2 \\ - 2 \\ - 2 \\ - 2 \\ - 2 \\ - 2 \\ - 2 \\ - 2 \\ - 2 \\ - 2 \\ - 2 \\ - 2 \\ - 2 \\ - 2 \\ - 2 \\ - 2 \\ - 2 \\ - 2 \\ - 2 \\ - 2 \\ - 2 \\ - 2 \\ - 2 \\ - 2 \\ - 2 \\ - 2 \\ - 2 \\ - 2 \\ - 2 \\ - 2 \\ - 2 \\ - 2 \\ - 2 \\ - 2 \\ - 2 \\ - 2 \\ - 2 \\ - 2 \\ - 2 \\ - 2 \\ - 2 \\ - 2 \\ - 2 \\ - 2 \\ - 2 \\ - 2 \\ - 2 \\ - 2 \\ - 2 \\ - 2 \\ - 2 \\ - 2 \\ - 2 \\ - 2 \\ - 2 \\ - 2 \\ - 2 \\ - 2 \\ - 2 \\ - 2 \\ - 2 \\ - 2 \\ - 2 \\ - 2 \\ - 2 \\ - 2 \\ - 2 \\ - 2 \\ - 2 \\ - 2 \\ - 2 \\ - 2 \\ - 2 \\ - 2 \\ - 2 \\ - 2 \\ - 2 \\ - 2 \\ - 2 \\ - 2 \\ - 2 \\ - 2 \\ - 2 \\ - 2 \\ - 2 \\ - 2 \\ - 2 \\ - 2 \\ - 2 \\ - 2 \\ - 2 \\ - 2 \\ - 2 \\ - 2 \\ - 2 \\ - 2 \\ - 2 \\ - 2 \\ - 2 \\ - 2 \\ - 2 \\ - 2 \\ - 2 \\ - 2 \\ - 2 \\ - 2 \\ - 2 \\ - 2 \\ - 2 \\ - 2 \\ - 2 \\ - 2 \\ - 2 \\ - 2 \\ - 2 \\ - 2 \\ - 2 \\ - 2 \\ - 2 \\ - 2 \\ - 2 \\ - 2 \\ - 2 \\ - 2 \\ - 2 \\ - 2 \\ - 2 \\ - 2 \\ - 2 \\ - 2 \\ - 2 \\ - 2 \\ - 2 \\ - 2 \\ - 2 \\ - 2 \\ - 2 \\ - 2 \\ - 2 \\ - 2 \\ - 2 \\ - 2 \\ - 2 \\ - 2 \\ - 2 \\ - 2 \\ - 2 \\ - 2 \\ - 2 \\ - 2 \\ - 2 \\ -$ Tin + Dry soil 196.2 Wt of Tin 95 31.3 Wt of Moisture Penetration in mm Wt. of dry soil 101.2 **Moisture content** 30.93 RESULTS Penetration(mm) Standard Force(KN) Specification CBR%(top) CBR%(bott.) 2.5 13.2 19 24 20 21 20 5 CBR =24% Checked: Martin Mburu

#### UNIVERSITY OF NAIROBI **WORKING SHEET** (HIGHWAYS LABORATORY) **CBR TEST** (AASHTO T193:1990) **9% FCD SAMPLE 3** Project: Mechanical Stabilization of Lateritic Gravel using FCD Tested: 21/1/2020 Date soaked: 17/01/2020 Date Moulded: Mould No.: 17/01/2020 Student.: Anthony Mugendi Nyagah SWELL DATA SAMPLE DETAILS 1532 MDD Initial gauge Reading STABILIZED OMC 28.31 (div) 0 Туре **Final gauge Reading** (div) 22 Stabilizer FCD NMC 14.3 Difference (div) 22 % **Ring Factor** 0.01 Swell % 0.22 Gauge Factor:0.0005 inches/Div Penetration Bot Тор Standard CBR% of the plunger (KN) (KN) Load(KN) **CBR TEST** Bott. Тор (mm) 0 0 0.00 0.64 0.66251 0.9275 15.00 1.27 1.52377 1.8815 2.31879 1.91 2.65 14.00 13.2 22 27 2.54 2.94154 3.5113 13.00 3.18 3.5113 4.0943 12.00 3.81 3.90881 4.5051 4.24006 4.45 4.8363 11.00 20.0 5.08 4.50507 5.1676 23 26 10.00 4.70382 5.72 5.3663 6.35 4.87607 5.5916 9.00 Force in KN 8.00 7.00 **Moulding Data** Wt.of Mould + Wet soil g 6.00 Wt. of Mould g 5.00 **Moisture** Content % 4.00 Wet Density Kg/m<sup>3</sup> 3.00 **Drv Densitv** Kg/m<sup>3</sup> % MDD 2.00 MOULDING MOISTURE CONTENT 1.00 Tin No. 107 0.00 Tin +Wet soil 227.5 $\begin{array}{c} 3 \\ - 1 \\ - 1 \\ - 2 \\ - 2 \\ - 2 \\ - 2 \\ - 2 \\ - 2 \\ - 2 \\ - 2 \\ - 2 \\ - 2 \\ - 2 \\ - 2 \\ - 2 \\ - 2 \\ - 2 \\ - 2 \\ - 2 \\ - 2 \\ - 2 \\ - 2 \\ - 2 \\ - 2 \\ - 2 \\ - 2 \\ - 2 \\ - 2 \\ - 2 \\ - 2 \\ - 2 \\ - 2 \\ - 2 \\ - 2 \\ - 2 \\ - 2 \\ - 2 \\ - 2 \\ - 2 \\ - 2 \\ - 2 \\ - 2 \\ - 2 \\ - 2 \\ - 2 \\ - 2 \\ - 2 \\ - 2 \\ - 2 \\ - 2 \\ - 2 \\ - 2 \\ - 2 \\ - 2 \\ - 2 \\ - 2 \\ - 2 \\ - 2 \\ - 2 \\ - 2 \\ - 2 \\ - 2 \\ - 2 \\ - 2 \\ - 2 \\ - 2 \\ - 2 \\ - 2 \\ - 2 \\ - 2 \\ - 2 \\ - 2 \\ - 2 \\ - 2 \\ - 2 \\ - 2 \\ - 2 \\ - 2 \\ - 2 \\ - 2 \\ - 2 \\ - 2 \\ - 2 \\ - 2 \\ - 2 \\ - 2 \\ - 2 \\ - 2 \\ - 2 \\ - 2 \\ - 2 \\ - 2 \\ - 2 \\ - 2 \\ - 2 \\ - 2 \\ - 2 \\ - 2 \\ - 2 \\ - 2 \\ - 2 \\ - 2 \\ - 2 \\ - 2 \\ - 2 \\ - 2 \\ - 2 \\ - 2 \\ - 2 \\ - 2 \\ - 2 \\ - 2 \\ - 2 \\ - 2 \\ - 2 \\ - 2 \\ - 2 \\ - 2 \\ - 2 \\ - 2 \\ - 2 \\ - 2 \\ - 2 \\ - 2 \\ - 2 \\ - 2 \\ - 2 \\ - 2 \\ - 2 \\ - 2 \\ - 2 \\ - 2 \\ - 2 \\ - 2 \\ - 2 \\ - 2 \\ - 2 \\ - 2 \\ - 2 \\ - 2 \\ - 2 \\ - 2 \\ - 2 \\ - 2 \\ - 2 \\ - 2 \\ - 2 \\ - 2 \\ - 2 \\ - 2 \\ - 2 \\ - 2 \\ - 2 \\ - 2 \\ - 2 \\ - 2 \\ - 2 \\ - 2 \\ - 2 \\ - 2 \\ - 2 \\ - 2 \\ - 2 \\ - 2 \\ - 2 \\ - 2 \\ - 2 \\ - 2 \\ - 2 \\ - 2 \\ - 2 \\ - 2 \\ - 2 \\ - 2 \\ - 2 \\ - 2 \\ - 2 \\ - 2 \\ - 2 \\ - 2 \\ - 2 \\ - 2 \\ - 2 \\ - 2 \\ - 2 \\ - 2 \\ - 2 \\ - 2 \\ - 2 \\ - 2 \\ - 2 \\ - 2 \\ - 2 \\ - 2 \\ - 2 \\ - 2 \\ - 2 \\ - 2 \\ - 2 \\ - 2 \\ - 2 \\ - 2 \\ - 2 \\ - 2 \\ - 2 \\ - 2 \\ - 2 \\ - 2 \\ - 2 \\ - 2 \\ - 2 \\ - 2 \\ - 2 \\ - 2 \\ - 2 \\ - 2 \\ - 2 \\ - 2 \\ - 2 \\ - 2 \\ - 2 \\ - 2 \\ - 2 \\ - 2 \\ - 2 \\ - 2 \\ - 2 \\ - 2 \\ - 2 \\ - 2 \\ - 2 \\ - 2 \\ - 2 \\ - 2 \\ - 2 \\ - 2 \\ - 2 \\ - 2 \\ - 2 \\ - 2 \\ - 2 \\ - 2 \\ - 2 \\ - 2 \\ - 2 \\ - 2 \\ - 2 \\ - 2 \\ - 2 \\ - 2 \\ - 2 \\ - 2 \\ - 2 \\ - 2 \\ - 2 \\ - 2 \\ - 2 \\ - 2 \\ - 2 \\ - 2 \\ - 2 \\ - 2 \\ - 2 \\ - 2 \\ - 2 \\ - 2 \\ - 2 \\ - 2 \\ - 2 \\ - 2 \\ - 2 \\ - 2 \\ - 2 \\ - 2 \\ - 2 \\ - 2 \\ - 2 \\ - 2 \\ - 2 \\ - 2 \\ - 2 \\ - 2 \\ - 2 \\ - 2 \\ - 2 \\ - 2 \\ - 2 \\ - 2 \\ - 2 \\ - 2 \\ - 2 \\ - 2 \\ - 2 \\ - 2 \\ - 2 \\ - 2 \\ - 2 \\ - 2 \\ - 2 \\ - 2 \\ - 2 \\ - 2 \\ - 2 \\ - 2 \\ - 2 \\ - 2 \\ - 2 \\ - 2 \\ - 2 \\ - 2 \\ - 2 \\ - 2 \\ - 2 \\ - 2 \\ - 2 \\ - 2 \\ - 2 \\ - 2 \\ - 2 \\ - 2 \\ - 2 \\ - 2 \\ - 2 \\ - 2 \\ - 2 \\ - 2 \\ - 2 \\ - 2 \\ - 2 \\ - 2 \\ - 2 \\ - 2 \\ - 2 \\ - 2 \\ - 2 \\ - 2 \\ - 2 \\ - 2 \\ - 2 \\ -$ Tin + Dry soil 196.2 Wt of Tin 95 31.3 Wt of Moisture Penetration in mm Wt. of dry soil 101.2 **Moisture content** 30.93 RESULTS Penetration(mm) Standard Force(KN) Specification CBR%(top) CBR%(bott.) 2.5 13.2 27 22 20 26 23 5 CBR =27% **Checked:** Martin Mburu

#### UNIVERSITY OF NAIROBI **WORKING SHEET** (HIGHWAYS LABORATORY) **CBR TEST** (AASHTO T193:1990) **9% FCD SAMPLE 4 Tested:** 21/1/2020 Project: Mechanical stabilization of Lateritic Gravel using FCD Date soaked: 17/01/2020 Date Moulded: Mould No.: 17/01/2020 student.: Anthony Mugendi Nyagah SWELL DATA SAMPLE DETAILS 1532 MDD Initial gauge Reading STABILIZED OMC 28.31 (div) 0 Туре **Final gauge Reading** (div) 22 Stabilizer FCD NMC 14.3 Difference (div) 22 % **Ring Factor** 0.01 Swell % 0.22 Gauge Factor:0.0005 inches/Div Penetration Bot Тор Standard CBR% of the plunger (KN) (KN) Load(KN) **CBR TEST** Bott. Тор (mm) 0 0 0.00 0.64 0.92751 0.9275 15.00 1.27 1.72253 1.5238 2.25253 1.9875 1.91 14.00 13.2 21 19 2.54 2.75604 2.5175 13.00 3.15355 3.18 2.915 3.81 3.3788 3.1535 12.00 4.45 3.5378 3.4186 11.00 20.0 5.08 3.71006 3.6041 19 18 10.00 3.84256 3.7233 5.72 3.97506 9.00 6.35 3.8426 Force in KN 8.00 7.00 **Moulding Data** Wt.of Mould + Wet soil g 6.00 Wt. of Mould g 5.00 % **Moisture Content** 4.00 Wet Density Kg/m<sup>3</sup> 3.00 **Drv Densitv** Kg/m<sup>3</sup> % MDD 2.00 MOULDING MOISTURE CONTENT 1.00 Tin No. 107 0.00 Tin +Wet soil 227.5 $\begin{array}{c} 3 \\ - 1 \\ - 1 \\ - 2 \\ - 2 \\ - 2 \\ - 2 \\ - 2 \\ - 2 \\ - 2 \\ - 2 \\ - 2 \\ - 2 \\ - 2 \\ - 2 \\ - 2 \\ - 2 \\ - 2 \\ - 2 \\ - 2 \\ - 2 \\ - 2 \\ - 2 \\ - 2 \\ - 2 \\ - 2 \\ - 2 \\ - 2 \\ - 2 \\ - 2 \\ - 2 \\ - 2 \\ - 2 \\ - 2 \\ - 2 \\ - 2 \\ - 2 \\ - 2 \\ - 2 \\ - 2 \\ - 2 \\ - 2 \\ - 2 \\ - 2 \\ - 2 \\ - 2 \\ - 2 \\ - 2 \\ - 2 \\ - 2 \\ - 2 \\ - 2 \\ - 2 \\ - 2 \\ - 2 \\ - 2 \\ - 2 \\ - 2 \\ - 2 \\ - 2 \\ - 2 \\ - 2 \\ - 2 \\ - 2 \\ - 2 \\ - 2 \\ - 2 \\ - 2 \\ - 2 \\ - 2 \\ - 2 \\ - 2 \\ - 2 \\ - 2 \\ - 2 \\ - 2 \\ - 2 \\ - 2 \\ - 2 \\ - 2 \\ - 2 \\ - 2 \\ - 2 \\ - 2 \\ - 2 \\ - 2 \\ - 2 \\ - 2 \\ - 2 \\ - 2 \\ - 2 \\ - 2 \\ - 2 \\ - 2 \\ - 2 \\ - 2 \\ - 2 \\ - 2 \\ - 2 \\ - 2 \\ - 2 \\ - 2 \\ - 2 \\ - 2 \\ - 2 \\ - 2 \\ - 2 \\ - 2 \\ - 2 \\ - 2 \\ - 2 \\ - 2 \\ - 2 \\ - 2 \\ - 2 \\ - 2 \\ - 2 \\ - 2 \\ - 2 \\ - 2 \\ - 2 \\ - 2 \\ - 2 \\ - 2 \\ - 2 \\ - 2 \\ - 2 \\ - 2 \\ - 2 \\ - 2 \\ - 2 \\ - 2 \\ - 2 \\ - 2 \\ - 2 \\ - 2 \\ - 2 \\ - 2 \\ - 2 \\ - 2 \\ - 2 \\ - 2 \\ - 2 \\ - 2 \\ - 2 \\ - 2 \\ - 2 \\ - 2 \\ - 2 \\ - 2 \\ - 2 \\ - 2 \\ - 2 \\ - 2 \\ - 2 \\ - 2 \\ - 2 \\ - 2 \\ - 2 \\ - 2 \\ - 2 \\ - 2 \\ - 2 \\ - 2 \\ - 2 \\ - 2 \\ - 2 \\ - 2 \\ - 2 \\ - 2 \\ - 2 \\ - 2 \\ - 2 \\ - 2 \\ - 2 \\ - 2 \\ - 2 \\ - 2 \\ - 2 \\ - 2 \\ - 2 \\ - 2 \\ - 2 \\ - 2 \\ - 2 \\ - 2 \\ - 2 \\ - 2 \\ - 2 \\ - 2 \\ - 2 \\ - 2 \\ - 2 \\ - 2 \\ - 2 \\ - 2 \\ - 2 \\ - 2 \\ - 2 \\ - 2 \\ - 2 \\ - 2 \\ - 2 \\ - 2 \\ - 2 \\ - 2 \\ - 2 \\ - 2 \\ - 2 \\ - 2 \\ - 2 \\ - 2 \\ - 2 \\ - 2 \\ - 2 \\ - 2 \\ - 2 \\ - 2 \\ - 2 \\ - 2 \\ - 2 \\ - 2 \\ - 2 \\ - 2 \\ - 2 \\ - 2 \\ - 2 \\ - 2 \\ - 2 \\ - 2 \\ - 2 \\ - 2 \\ - 2 \\ - 2 \\ - 2 \\ - 2 \\ - 2 \\ - 2 \\ - 2 \\ - 2 \\ - 2 \\ - 2 \\ - 2 \\ - 2 \\ - 2 \\ - 2 \\ - 2 \\ - 2 \\ - 2 \\ - 2 \\ - 2 \\ - 2 \\ - 2 \\ - 2 \\ - 2 \\ - 2 \\ - 2 \\ - 2 \\ - 2 \\ - 2 \\ - 2 \\ - 2 \\ - 2 \\ - 2 \\ - 2 \\ - 2 \\ - 2 \\ - 2 \\ - 2 \\ - 2 \\ - 2 \\ - 2 \\ - 2 \\ - 2 \\ - 2 \\ - 2 \\ - 2 \\ - 2 \\ - 2 \\ - 2 \\ - 2 \\ - 2 \\ - 2 \\ - 2 \\ - 2 \\ - 2 \\ - 2 \\ - 2 \\ - 2 \\ - 2 \\ - 2 \\ - 2 \\ - 2 \\ - 2 \\ - 2 \\ - 2 \\ - 2 \\ - 2 \\ - 2 \\ - 2 \\ - 2 \\ - 2 \\ - 2 \\ - 2 \\ - 2 \\ - 2 \\ - 2 \\ - 2 \\ - 2 \\ - 2 \\ - 2 \\ - 2 \\ - 2 \\ - 2 \\ - 2 \\ - 2 \\ - 2 \\ - 2 \\ - 2 \\ - 2 \\ - 2 \\ - 2 \\ - 2 \\ - 2 \\ - 2 \\ - 2 \\ - 2 \\ - 2 \\ - 2 \\ - 2 \\ - 2 \\ - 2 \\ - 2 \\ - 2 \\ - 2 \\ - 2 \\ - 2 \\ - 2 \\ - 2 \\ - 2 \\ -$ Tin + Dry soil 196.2 Wt of Tin 95 31.3 Wt of Moisture Penetration in mm Wt. of dry soil 101.2 **Moisture content** 30.93 RESULTS Penetration(mm) Standard Force(KN) Specification CBR%(top) CBR%(bott.) 2.5 13.2 19 21 20 18 19 5 CBR =21% Checked: Martin Mburu

#### UNIVERSITY OF NAIROBI **WORKING SHEET** (HIGHWAYS LABORATORY) **CBR TEST** (AASHTO T193:1990) **9% FCD SAMPLE 5** Project: Mechanical Stabilization of Lateritic Gravel using FCD Tested: 21/1/2020 Date soaked: 17/01/2020 Date Moulded: Mould No.: 17/01/2020 Student.: Anthony Mugendi Nyagah SWELL DATA SAMPLE DETAILS 1532 MDD Initial gauge Reading STABILIZED OMC 28.31 (div) 0 Туре **Final gauge Reading** (div) 22 Stabilizer FCD NMC 14.3 Difference (div) 22 % **Ring Factor** 0.01 Swell % 0.22 Gauge Factor:0.0005 inches/Div Penetration Bot Тор Standard CBR% of the plunger (KN) (KN) Load(KN) **CBR TEST** Bott. Тор (mm) 0 0 0.00 0.64 0.92751 1.2588 15.00 1.27 1.93453 2.12 2.65004 1.91 2.9415 14.00 13.2 25 27 2.54 3.25955 3.5776 13.00 3.18 3.71006 4.0016 12.00 3.81 3.97506 4.3328 4.17381 4.6111 4.45 11.00 20.0 5.08 4.37257 4.8098 22 24 10.00 5.72 4.51832 5.0086 9.00 6.35 4.66407 5.1013 Force in KN 8.00 7.00 **Moulding Data** Wt.of Mould + Wet soil g 6.00 Wt. of Mould g 5.00 **Moisture** Content % 4.00 Wet Density Kg/m<sup>3</sup> 3.00 **Drv Densitv** Kg/m<sup>3</sup> % MDD 2.00 MOULDING MOISTURE CONTENT 1.00 Tin No. 201 0.00 Tin +Wet soil 227.3 $\begin{array}{c} 3 \\ - 1 \\ - 1 \\ - 2 \\ - 2 \\ - 2 \\ - 2 \\ - 2 \\ - 2 \\ - 2 \\ - 2 \\ - 2 \\ - 2 \\ - 2 \\ - 2 \\ - 2 \\ - 2 \\ - 2 \\ - 2 \\ - 2 \\ - 2 \\ - 2 \\ - 2 \\ - 2 \\ - 2 \\ - 2 \\ - 2 \\ - 2 \\ - 2 \\ - 2 \\ - 2 \\ - 2 \\ - 2 \\ - 2 \\ - 2 \\ - 2 \\ - 2 \\ - 2 \\ - 2 \\ - 2 \\ - 2 \\ - 2 \\ - 2 \\ - 2 \\ - 2 \\ - 2 \\ - 2 \\ - 2 \\ - 2 \\ - 2 \\ - 2 \\ - 2 \\ - 2 \\ - 2 \\ - 2 \\ - 2 \\ - 2 \\ - 2 \\ - 2 \\ - 2 \\ - 2 \\ - 2 \\ - 2 \\ - 2 \\ - 2 \\ - 2 \\ - 2 \\ - 2 \\ - 2 \\ - 2 \\ - 2 \\ - 2 \\ - 2 \\ - 2 \\ - 2 \\ - 2 \\ - 2 \\ - 2 \\ - 2 \\ - 2 \\ - 2 \\ - 2 \\ - 2 \\ - 2 \\ - 2 \\ - 2 \\ - 2 \\ - 2 \\ - 2 \\ - 2 \\ - 2 \\ - 2 \\ - 2 \\ - 2 \\ - 2 \\ - 2 \\ - 2 \\ - 2 \\ - 2 \\ - 2 \\ - 2 \\ - 2 \\ - 2 \\ - 2 \\ - 2 \\ - 2 \\ - 2 \\ - 2 \\ - 2 \\ - 2 \\ - 2 \\ - 2 \\ - 2 \\ - 2 \\ - 2 \\ - 2 \\ - 2 \\ - 2 \\ - 2 \\ - 2 \\ - 2 \\ - 2 \\ - 2 \\ - 2 \\ - 2 \\ - 2 \\ - 2 \\ - 2 \\ - 2 \\ - 2 \\ - 2 \\ - 2 \\ - 2 \\ - 2 \\ - 2 \\ - 2 \\ - 2 \\ - 2 \\ - 2 \\ - 2 \\ - 2 \\ - 2 \\ - 2 \\ - 2 \\ - 2 \\ - 2 \\ - 2 \\ - 2 \\ - 2 \\ - 2 \\ - 2 \\ - 2 \\ - 2 \\ - 2 \\ - 2 \\ - 2 \\ - 2 \\ - 2 \\ - 2 \\ - 2 \\ - 2 \\ - 2 \\ - 2 \\ - 2 \\ - 2 \\ - 2 \\ - 2 \\ - 2 \\ - 2 \\ - 2 \\ - 2 \\ - 2 \\ - 2 \\ - 2 \\ - 2 \\ - 2 \\ - 2 \\ - 2 \\ - 2 \\ - 2 \\ - 2 \\ - 2 \\ - 2 \\ - 2 \\ - 2 \\ - 2 \\ - 2 \\ - 2 \\ - 2 \\ - 2 \\ - 2 \\ - 2 \\ - 2 \\ - 2 \\ - 2 \\ - 2 \\ - 2 \\ - 2 \\ - 2 \\ - 2 \\ - 2 \\ - 2 \\ - 2 \\ - 2 \\ - 2 \\ - 2 \\ - 2 \\ - 2 \\ - 2 \\ - 2 \\ - 2 \\ - 2 \\ - 2 \\ - 2 \\ - 2 \\ - 2 \\ - 2 \\ - 2 \\ - 2 \\ - 2 \\ - 2 \\ - 2 \\ - 2 \\ - 2 \\ - 2 \\ - 2 \\ - 2 \\ - 2 \\ - 2 \\ - 2 \\ - 2 \\ - 2 \\ - 2 \\ - 2 \\ - 2 \\ - 2 \\ - 2 \\ - 2 \\ - 2 \\ - 2 \\ - 2 \\ - 2 \\ - 2 \\ - 2 \\ - 2 \\ - 2 \\ - 2 \\ - 2 \\ - 2 \\ - 2 \\ - 2 \\ - 2 \\ - 2 \\ - 2 \\ - 2 \\ - 2 \\ - 2 \\ - 2 \\ - 2 \\ - 2 \\ - 2 \\ - 2 \\ - 2 \\ - 2 \\ - 2 \\ - 2 \\ - 2 \\ - 2 \\ - 2 \\ - 2 \\ - 2 \\ - 2 \\ - 2 \\ - 2 \\ - 2 \\ - 2 \\ - 2 \\ - 2 \\ - 2 \\ - 2 \\ - 2 \\ - 2 \\ - 2 \\ - 2 \\ - 2 \\ - 2 \\ - 2 \\ - 2 \\ - 2 \\ - 2 \\ - 2 \\ - 2 \\ - 2 \\ - 2 \\ - 2 \\ - 2 \\ - 2 \\ - 2 \\ - 2 \\ - 2 \\ - 2 \\ - 2 \\ - 2 \\ - 2 \\ - 2 \\ - 2 \\ - 2 \\ - 2 \\ - 2 \\ - 2 \\ - 2 \\ - 2 \\ - 2 \\ - 2 \\ - 2 \\ - 2 \\ - 2 \\ - 2 \\ - 2 \\ - 2 \\ - 2 \\ - 2 \\ - 2 \\ - 2 \\ - 2 \\ - 2 \\ - 2 \\ - 2 \\ - 2 \\ - 2 \\ - 2 \\ - 2 \\ - 2 \\ - 2 \\ - 2 \\ - 2 \\ - 2 \\ - 2 \\ - 2 \\ - 2 \\ -$ Tin + Dry soil 191.2 Wt of Tin 78.1 Wt of Moisture 36.1 Penetration in mm Wt. of dry soil 113.1 **Moisture content** 31.92 RESULTS Penetration(mm) Standard Force(KN) Specification CBR%(top) CBR%(bott.) 2.5 13.2 27 25 20 24 22 5 CBR =27% **Checked:** Martin Mburu

#### UNIVERSITY OF NAIROBI **WORKING SHEET** (HIGHWAYS LABORATORY) **CBR TEST** (AASHTO T193:1990) **9% FCD SAMPLE 6** Project: Mechanical Stabilization of Lateritic Gravel using FCD Tested: 21/1/2020 Date soaked: 17/01/2020 Date Moulded: Mould No.: 17/01/2020 Client.: Anthony Mugendi Nyagah SWELL DATA SAMPLE DETAILS 1532 MDD Initial gauge Reading STABILIZED OMC 28.31 (div) 0 Туре **Final gauge Reading** (div) 22 Stabilizer FCD NMC 14.3 Difference (div) 22 % **Ring Factor** 0.01 Swell % 0.22 Gauge Factor:0.0005 inches/Div Penetration Bot Тор Standard CBR% of the plunger (KN) (KN) Load(KN) **CBR TEST** Bott. Тор (mm) 0 0 0.00 0.64 0.74201 1.2985 15.00 1.27 1.59002 2.385 2.25253 1.91 3.4186 14.00 13.2 24 31 2.54 3.1403 4.1076 13.00 3.18 3.60405 4.6376 12.00 3.81 3.92206 4.9821 4.10756 4.45 5.2736 11.00 20.0 5.08 4.33282 5.5651 22 28 10.00 5.72 4.50507 5.9228 4.70382 9.00 6.35 6.2276 Force in KN 8.00 7.00 **Moulding Data** Wt.of Mould + Wet soil g 6.00 Wt. of Mould g 5.00 **Moisture** Content % 4.00 Wet Density Kg/m<sup>3</sup> 3.00 **Drv Densitv** Kg/m<sup>3</sup> % MDD 2.00 MOULDING MOISTURE CONTENT 1.00 Tin No. 201 0.00 Tin +Wet soil 227.3 $\begin{array}{c} 3 \\ - 1 \\ - 1 \\ - 2 \\ - 2 \\ - 2 \\ - 2 \\ - 2 \\ - 2 \\ - 2 \\ - 2 \\ - 2 \\ - 2 \\ - 2 \\ - 2 \\ - 2 \\ - 2 \\ - 2 \\ - 2 \\ - 2 \\ - 2 \\ - 2 \\ - 2 \\ - 2 \\ - 2 \\ - 2 \\ - 2 \\ - 2 \\ - 2 \\ - 2 \\ - 2 \\ - 2 \\ - 2 \\ - 2 \\ - 2 \\ - 2 \\ - 2 \\ - 2 \\ - 2 \\ - 2 \\ - 2 \\ - 2 \\ - 2 \\ - 2 \\ - 2 \\ - 2 \\ - 2 \\ - 2 \\ - 2 \\ - 2 \\ - 2 \\ - 2 \\ - 2 \\ - 2 \\ - 2 \\ - 2 \\ - 2 \\ - 2 \\ - 2 \\ - 2 \\ - 2 \\ - 2 \\ - 2 \\ - 2 \\ - 2 \\ - 2 \\ - 2 \\ - 2 \\ - 2 \\ - 2 \\ - 2 \\ - 2 \\ - 2 \\ - 2 \\ - 2 \\ - 2 \\ - 2 \\ - 2 \\ - 2 \\ - 2 \\ - 2 \\ - 2 \\ - 2 \\ - 2 \\ - 2 \\ - 2 \\ - 2 \\ - 2 \\ - 2 \\ - 2 \\ - 2 \\ - 2 \\ - 2 \\ - 2 \\ - 2 \\ - 2 \\ - 2 \\ - 2 \\ - 2 \\ - 2 \\ - 2 \\ - 2 \\ - 2 \\ - 2 \\ - 2 \\ - 2 \\ - 2 \\ - 2 \\ - 2 \\ - 2 \\ - 2 \\ - 2 \\ - 2 \\ - 2 \\ - 2 \\ - 2 \\ - 2 \\ - 2 \\ - 2 \\ - 2 \\ - 2 \\ - 2 \\ - 2 \\ - 2 \\ - 2 \\ - 2 \\ - 2 \\ - 2 \\ - 2 \\ - 2 \\ - 2 \\ - 2 \\ - 2 \\ - 2 \\ - 2 \\ - 2 \\ - 2 \\ - 2 \\ - 2 \\ - 2 \\ - 2 \\ - 2 \\ - 2 \\ - 2 \\ - 2 \\ - 2 \\ - 2 \\ - 2 \\ - 2 \\ - 2 \\ - 2 \\ - 2 \\ - 2 \\ - 2 \\ - 2 \\ - 2 \\ - 2 \\ - 2 \\ - 2 \\ - 2 \\ - 2 \\ - 2 \\ - 2 \\ - 2 \\ - 2 \\ - 2 \\ - 2 \\ - 2 \\ - 2 \\ - 2 \\ - 2 \\ - 2 \\ - 2 \\ - 2 \\ - 2 \\ - 2 \\ - 2 \\ - 2 \\ - 2 \\ - 2 \\ - 2 \\ - 2 \\ - 2 \\ - 2 \\ - 2 \\ - 2 \\ - 2 \\ - 2 \\ - 2 \\ - 2 \\ - 2 \\ - 2 \\ - 2 \\ - 2 \\ - 2 \\ - 2 \\ - 2 \\ - 2 \\ - 2 \\ - 2 \\ - 2 \\ - 2 \\ - 2 \\ - 2 \\ - 2 \\ - 2 \\ - 2 \\ - 2 \\ - 2 \\ - 2 \\ - 2 \\ - 2 \\ - 2 \\ - 2 \\ - 2 \\ - 2 \\ - 2 \\ - 2 \\ - 2 \\ - 2 \\ - 2 \\ - 2 \\ - 2 \\ - 2 \\ - 2 \\ - 2 \\ - 2 \\ - 2 \\ - 2 \\ - 2 \\ - 2 \\ - 2 \\ - 2 \\ - 2 \\ - 2 \\ - 2 \\ - 2 \\ - 2 \\ - 2 \\ - 2 \\ - 2 \\ - 2 \\ - 2 \\ - 2 \\ - 2 \\ - 2 \\ - 2 \\ - 2 \\ - 2 \\ - 2 \\ - 2 \\ - 2 \\ - 2 \\ - 2 \\ - 2 \\ - 2 \\ - 2 \\ - 2 \\ - 2 \\ - 2 \\ - 2 \\ - 2 \\ - 2 \\ - 2 \\ - 2 \\ - 2 \\ - 2 \\ - 2 \\ - 2 \\ - 2 \\ - 2 \\ - 2 \\ - 2 \\ - 2 \\ - 2 \\ - 2 \\ - 2 \\ - 2 \\ - 2 \\ - 2 \\ - 2 \\ - 2 \\ - 2 \\ - 2 \\ - 2 \\ - 2 \\ - 2 \\ - 2 \\ - 2 \\ - 2 \\ - 2 \\ - 2 \\ - 2 \\ - 2 \\ - 2 \\ - 2 \\ - 2 \\ - 2 \\ - 2 \\ - 2 \\ - 2 \\ - 2 \\ - 2 \\ - 2 \\ - 2 \\ - 2 \\ - 2 \\ - 2 \\ - 2 \\ - 2 \\ - 2 \\ - 2 \\ - 2 \\ - 2 \\ - 2 \\ - 2 \\ - 2 \\ - 2 \\ - 2 \\ - 2 \\ - 2 \\ - 2 \\ - 2 \\ - 2 \\ - 2 \\ - 2 \\ - 2 \\ - 2 \\ - 2 \\ - 2 \\ - 2 \\ - 2 \\ - 2 \\ - 2 \\ - 2 \\ - 2 \\ - 2 \\ - 2 \\ - 2 \\ - 2 \\ -$ Tin + Dry soil 191.2 Wt of Tin 78.1 Wt of Moisture 36.1 Penetration in mm Wt. of dry soil 113.1 **Moisture content** 31.92 RESULTS Penetration(mm) Standard Force(KN) Specification CBR%(top) CBR%(bott.) 2.5 13.2 31 24 20 28 22 5 CBR =31% **Checked:** Martin Mburu

#### UNIVERSITY OF NAIROBI **WORKING SHEET** (HIGHWAYS LABORATORY) **CBR TEST** (AASHTO T193:1990) **9% FCD SAMPLE 7** Project: Mechanical Stabilization of Lateritic Gravel using FCD Tested: 21/1/2020 Date soaked: 17/01/2020 Date Moulded: Mould No.: 17/01/2020 Student.: Anthony Mugendi Nyagah SWELL DATA SAMPLE DETAILS 1532 MDD Initial gauge Reading STABILIZED OMC 28.31 (div) 0 Туре **Final gauge Reading** (div) 22 Stabilizer FCD NMC 14.3 Difference (div) 22 % **Ring Factor** 0.01 Swell % 0.22 Gauge Factor:0.0005 inches/Div Penetration Bot Тор Standard CBR% of the plunger (KN) Load(KN) (KN) **CBR TEST** Bott. Тор (mm) 0 0 0.00 0.64 0.95401 1.59 15.00 1.27 1.98753 3.18 3.31255 3.9751 1.91 14.00 30 34 2.54 3.97506 4.5051 13.2 13.00 3.18 4.50507 4.9026 12.00 3.81 4.90257 5.1676 5.19408 4.45 5.4326 11.00 20.0 5.08 5.39283 5.6711 27 28 10.00 5.72 5.56508 5.7241 5.69759 5.8566 9.00 6.35 Force in KN 8.00 7.00 **Moulding Data** Wt.of Mould + Wet soil g 6.00 Wt. of Mould g 5.00 **Moisture** Content % 4.00 Wet Density Kg/m<sup>3</sup> 3.00 **Drv Densitv** Kg/m<sup>3</sup> % MDD 2.00 MOULDING MOISTURE CONTENT 1.00 Tin No. 201 0.00 Tin +Wet soil 227.3 $\begin{array}{c} 3 \\ - 1 \\ - 1 \\ - 2 \\ - 2 \\ - 2 \\ - 2 \\ - 2 \\ - 2 \\ - 2 \\ - 2 \\ - 2 \\ - 2 \\ - 2 \\ - 2 \\ - 2 \\ - 2 \\ - 2 \\ - 2 \\ - 2 \\ - 2 \\ - 2 \\ - 2 \\ - 2 \\ - 2 \\ - 2 \\ - 2 \\ - 2 \\ - 2 \\ - 2 \\ - 2 \\ - 2 \\ - 2 \\ - 2 \\ - 2 \\ - 2 \\ - 2 \\ - 2 \\ - 2 \\ - 2 \\ - 2 \\ - 2 \\ - 2 \\ - 2 \\ - 2 \\ - 2 \\ - 2 \\ - 2 \\ - 2 \\ - 2 \\ - 2 \\ - 2 \\ - 2 \\ - 2 \\ - 2 \\ - 2 \\ - 2 \\ - 2 \\ - 2 \\ - 2 \\ - 2 \\ - 2 \\ - 2 \\ - 2 \\ - 2 \\ - 2 \\ - 2 \\ - 2 \\ - 2 \\ - 2 \\ - 2 \\ - 2 \\ - 2 \\ - 2 \\ - 2 \\ - 2 \\ - 2 \\ - 2 \\ - 2 \\ - 2 \\ - 2 \\ - 2 \\ - 2 \\ - 2 \\ - 2 \\ - 2 \\ - 2 \\ - 2 \\ - 2 \\ - 2 \\ - 2 \\ - 2 \\ - 2 \\ - 2 \\ - 2 \\ - 2 \\ - 2 \\ - 2 \\ - 2 \\ - 2 \\ - 2 \\ - 2 \\ - 2 \\ - 2 \\ - 2 \\ - 2 \\ - 2 \\ - 2 \\ - 2 \\ - 2 \\ - 2 \\ - 2 \\ - 2 \\ - 2 \\ - 2 \\ - 2 \\ - 2 \\ - 2 \\ - 2 \\ - 2 \\ - 2 \\ - 2 \\ - 2 \\ - 2 \\ - 2 \\ - 2 \\ - 2 \\ - 2 \\ - 2 \\ - 2 \\ - 2 \\ - 2 \\ - 2 \\ - 2 \\ - 2 \\ - 2 \\ - 2 \\ - 2 \\ - 2 \\ - 2 \\ - 2 \\ - 2 \\ - 2 \\ - 2 \\ - 2 \\ - 2 \\ - 2 \\ - 2 \\ - 2 \\ - 2 \\ - 2 \\ - 2 \\ - 2 \\ - 2 \\ - 2 \\ - 2 \\ - 2 \\ - 2 \\ - 2 \\ - 2 \\ - 2 \\ - 2 \\ - 2 \\ - 2 \\ - 2 \\ - 2 \\ - 2 \\ - 2 \\ - 2 \\ - 2 \\ - 2 \\ - 2 \\ - 2 \\ - 2 \\ - 2 \\ - 2 \\ - 2 \\ - 2 \\ - 2 \\ - 2 \\ - 2 \\ - 2 \\ - 2 \\ - 2 \\ - 2 \\ - 2 \\ - 2 \\ - 2 \\ - 2 \\ - 2 \\ - 2 \\ - 2 \\ - 2 \\ - 2 \\ - 2 \\ - 2 \\ - 2 \\ - 2 \\ - 2 \\ - 2 \\ - 2 \\ - 2 \\ - 2 \\ - 2 \\ - 2 \\ - 2 \\ - 2 \\ - 2 \\ - 2 \\ - 2 \\ - 2 \\ - 2 \\ - 2 \\ - 2 \\ - 2 \\ - 2 \\ - 2 \\ - 2 \\ - 2 \\ - 2 \\ - 2 \\ - 2 \\ - 2 \\ - 2 \\ - 2 \\ - 2 \\ - 2 \\ - 2 \\ - 2 \\ - 2 \\ - 2 \\ - 2 \\ - 2 \\ - 2 \\ - 2 \\ - 2 \\ - 2 \\ - 2 \\ - 2 \\ - 2 \\ - 2 \\ - 2 \\ - 2 \\ - 2 \\ - 2 \\ - 2 \\ - 2 \\ - 2 \\ - 2 \\ - 2 \\ - 2 \\ - 2 \\ - 2 \\ - 2 \\ - 2 \\ - 2 \\ - 2 \\ - 2 \\ - 2 \\ - 2 \\ - 2 \\ - 2 \\ - 2 \\ - 2 \\ - 2 \\ - 2 \\ - 2 \\ - 2 \\ - 2 \\ - 2 \\ - 2 \\ - 2 \\ - 2 \\ - 2 \\ - 2 \\ - 2 \\ - 2 \\ - 2 \\ - 2 \\ - 2 \\ - 2 \\ - 2 \\ - 2 \\ - 2 \\ - 2 \\ - 2 \\ - 2 \\ - 2 \\ - 2 \\ - 2 \\ - 2 \\ - 2 \\ - 2 \\ - 2 \\ - 2 \\ - 2 \\ - 2 \\ - 2 \\ - 2 \\ - 2 \\ - 2 \\ - 2 \\ - 2 \\ - 2 \\ - 2 \\ - 2 \\ - 2 \\ - 2 \\ - 2 \\ - 2 \\ - 2 \\ - 2 \\ - 2 \\ - 2 \\ - 2 \\ - 2 \\ - 2 \\ - 2 \\ - 2 \\ - 2 \\ - 2 \\ - 2 \\ - 2 \\ - 2 \\ - 2 \\ - 2 \\ - 2 \\ - 2 \\ - 2 \\ - 2 \\ - 2 \\ - 2 \\ - 2 \\ - 2 \\ - 2 \\ - 2 \\ - 2 \\ - 2 \\ - 2 \\ - 2 \\ -$ Tin + Dry soil 191.2 Wt of Tin 78.1 Wt of Moisture 36.1 Penetration in mm Wt. of dry soil 113.1 **Moisture content** 31.92 RESULTS Penetration(mm) Standard Force(KN) Specification CBR%(top) CBR%(bott.) 2.5 13.2 34 30 20 28 27 5 CBR =34% **Checked:** Martin Mburu

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	Penetrat	tion(mm	)		St	anda	rd l	Forc	e(K	<u>(N)</u>						Spe	ci	fication		CBR	%(top)	(	CBR%(bo	ott.)
	2	2.5					13	.2													22		21	
		5		Τ			2	0													21		21	
												Ċ	BF	<b>₹</b> =2	22 7	<u></u>				Checl	ked:	Martin	n Mburu	ı

#### UNIVERSITY OF NAIROBI **WORKING SHEET** (HIGHWAYS LABORATORY) **CBR TEST** (AASHTO T193:1990) 12% FCD SAMPLE 2 Project: Mechanical Stabilization of Lateritic Gravel using FCD Tested: 28/1/2020 Date soaked: 24/01/2020 Date Moulded: Mould No.: 24/01/2020 Student.: Anthony Mugendi Nyagah SWELL DATA SAMPLE DETAILS 1474 MDD 29.43 Initial gauge Reading STABILIZED OMC (div) 0 Туре **Final gauge Reading** (div) 22 Stabilizer FCD NMC 9.2 Difference (div) 22 % **Ring Factor** 0.01 Swell % 0.22 Penetration Bot Тор Standard Gauge Factor:0.0005 inches/Div CBR% of the plunger (KN) (KN) Load(KN) **CBR TEST** Bott. Тор (mm) 0 0 0.00 0.64 1.19252 1.1925 15.00 1.27 2.22603 2.385 3.18005 1.91 3.7763 14.00 13.2 29 35 2.54 3.88231 4.5713 13.00 3.18 4.50507 5.1146 3.81 4.90257 5.6976 12.00 5.30008 4.45 6.1481 11.00 20.0 5.08 5.65784 6.5058 **28** 33 10.00 6.02884 6.7709 5.72 6.29385 7.1021 9.00 6.35 Force in KN 8.00 7.00 **Moulding Data** Wt.of Mould + Wet soil g 6.00 Wt. of Mould g 5.00 **Moisture** Content % 4.00 Wet Density Kg/m<sup>3</sup> 3.00 **Drv Densitv** Kg/m<sup>3</sup> % MDD 2.00 MOULDING MOISTURE CONTENT 1.00 Tin No. 213 0.00 Tin +Wet soil 232 $\begin{array}{c} 3 \\ - 1 \\ - 1 \\ - 2 \\ - 2 \\ - 2 \\ - 2 \\ - 2 \\ - 2 \\ - 2 \\ - 2 \\ - 2 \\ - 2 \\ - 2 \\ - 2 \\ - 2 \\ - 2 \\ - 2 \\ - 2 \\ - 2 \\ - 2 \\ - 2 \\ - 2 \\ - 2 \\ - 2 \\ - 2 \\ - 2 \\ - 2 \\ - 2 \\ - 2 \\ - 2 \\ - 2 \\ - 2 \\ - 2 \\ - 2 \\ - 2 \\ - 2 \\ - 2 \\ - 2 \\ - 2 \\ - 2 \\ - 2 \\ - 2 \\ - 2 \\ - 2 \\ - 2 \\ - 2 \\ - 2 \\ - 2 \\ - 2 \\ - 2 \\ - 2 \\ - 2 \\ - 2 \\ - 2 \\ - 2 \\ - 2 \\ - 2 \\ - 2 \\ - 2 \\ - 2 \\ - 2 \\ - 2 \\ - 2 \\ - 2 \\ - 2 \\ - 2 \\ - 2 \\ - 2 \\ - 2 \\ - 2 \\ - 2 \\ - 2 \\ - 2 \\ - 2 \\ - 2 \\ - 2 \\ - 2 \\ - 2 \\ - 2 \\ - 2 \\ - 2 \\ - 2 \\ - 2 \\ - 2 \\ - 2 \\ - 2 \\ - 2 \\ - 2 \\ - 2 \\ - 2 \\ - 2 \\ - 2 \\ - 2 \\ - 2 \\ - 2 \\ - 2 \\ - 2 \\ - 2 \\ - 2 \\ - 2 \\ - 2 \\ - 2 \\ - 2 \\ - 2 \\ - 2 \\ - 2 \\ - 2 \\ - 2 \\ - 2 \\ - 2 \\ - 2 \\ - 2 \\ - 2 \\ - 2 \\ - 2 \\ - 2 \\ - 2 \\ - 2 \\ - 2 \\ - 2 \\ - 2 \\ - 2 \\ - 2 \\ - 2 \\ - 2 \\ - 2 \\ - 2 \\ - 2 \\ - 2 \\ - 2 \\ - 2 \\ - 2 \\ - 2 \\ - 2 \\ - 2 \\ - 2 \\ - 2 \\ - 2 \\ - 2 \\ - 2 \\ - 2 \\ - 2 \\ - 2 \\ - 2 \\ - 2 \\ - 2 \\ - 2 \\ - 2 \\ - 2 \\ - 2 \\ - 2 \\ - 2 \\ - 2 \\ - 2 \\ - 2 \\ - 2 \\ - 2 \\ - 2 \\ - 2 \\ - 2 \\ - 2 \\ - 2 \\ - 2 \\ - 2 \\ - 2 \\ - 2 \\ - 2 \\ - 2 \\ - 2 \\ - 2 \\ - 2 \\ - 2 \\ - 2 \\ - 2 \\ - 2 \\ - 2 \\ - 2 \\ - 2 \\ - 2 \\ - 2 \\ - 2 \\ - 2 \\ - 2 \\ - 2 \\ - 2 \\ - 2 \\ - 2 \\ - 2 \\ - 2 \\ - 2 \\ - 2 \\ - 2 \\ - 2 \\ - 2 \\ - 2 \\ - 2 \\ - 2 \\ - 2 \\ - 2 \\ - 2 \\ - 2 \\ - 2 \\ - 2 \\ - 2 \\ - 2 \\ - 2 \\ - 2 \\ - 2 \\ - 2 \\ - 2 \\ - 2 \\ - 2 \\ - 2 \\ - 2 \\ - 2 \\ - 2 \\ - 2 \\ - 2 \\ - 2 \\ - 2 \\ - 2 \\ - 2 \\ - 2 \\ - 2 \\ - 2 \\ - 2 \\ - 2 \\ - 2 \\ - 2 \\ - 2 \\ - 2 \\ - 2 \\ - 2 \\ - 2 \\ - 2 \\ - 2 \\ - 2 \\ - 2 \\ - 2 \\ - 2 \\ - 2 \\ - 2 \\ - 2 \\ - 2 \\ - 2 \\ - 2 \\ - 2 \\ - 2 \\ - 2 \\ - 2 \\ - 2 \\ - 2 \\ - 2 \\ - 2 \\ - 2 \\ - 2 \\ - 2 \\ - 2 \\ - 2 \\ - 2 \\ - 2 \\ - 2 \\ - 2 \\ - 2 \\ - 2 \\ - 2 \\ - 2 \\ - 2 \\ - 2 \\ - 2 \\ - 2 \\ - 2 \\ - 2 \\ - 2 \\ - 2 \\ - 2 \\ - 2 \\ - 2 \\ - 2 \\ - 2 \\ - 2 \\ - 2 \\ - 2 \\ - 2 \\ - 2 \\ - 2 \\ - 2 \\ - 2 \\ - 2 \\ - 2 \\ - 2 \\ - 2 \\ - 2 \\ - 2 \\ - 2 \\ - 2 \\ - 2 \\ - 2 \\ - 2 \\ - 2 \\ - 2 \\ - 2 \\ - 2 \\ - 2 \\ - 2 \\ - 2 \\ - 2 \\ - 2 \\ - 2 \\ - 2 \\ - 2 \\ - 2 \\ - 2 \\ - 2 \\ - 2 \\ - 2 \\ - 2 \\ - 2 \\ - 2 \\ - 2 \\ - 2 \\ - 2 \\ - 2 \\ - 2 \\ - 2 \\ - 2 \\ - 2 \\ - 2 \\ - 2 \\ - 2 \\ - 2 \\ - 2 \\ - 2 \\ - 2 \\ - 2 \\ - 2 \\ - 2 \\ - 2 \\ - 2 \\ -$ 196.6 Tin + Dry soil Wt of Tin 92.8 35.4 Wt of Moisture Penetration in mm Wt. of dry soil 103.8 **Moisture content** 34.10 RESULTS Penetration(mm) Standard Force(KN) Specification CBR%(top) CBR%(bott.) 29 2.5 13.2 35 20 28 33 5 CBR =35% **Checked:** Martin Mburu

#### UNIVERSITY OF NAIROBI **WORKING SHEET** (HIGHWAYS LABORATORY) **CBR TEST** (AASHTO T193:1990) 12% FCD SAMPLE 3 Project: Mechanical Stabilization of Lateritic Gravel using FCD Tested: 28/1/2020 Date soaked: 24/01/2020 Date Moulded: Mould No.: 24/01/2020 Student.: Anthony Mugendi Nyagah SWELL DATA SAMPLE DETAILS 1474 MDD Initial gauge Reading 29.43 STABILIZED OMC (div) 0 Туре **Final gauge Reading** (div) 22 Stabilizer FCD NMC 9.2 Difference (div) 22 % **Ring Factor** 0.01 Swell % 0.22 Gauge Factor:0.0005 inches/Div Penetration Bot Тор Standard CBR% of the plunger (KN) (KN) Load(KN) **CBR TEST** Bott. Тор (mm) 0 0 0.00 0.64 0.53001 0.6228 15.00 1.1925 1.27 1.06002 1.66953 1.91 1.7225 14.00 16 2.54 2.05378 2.12 13.2 16 13.00 3.18 2.38504 2.491 12.00 3.81 2.71629 2.862 2.99455 4.45 3.18 11.00 20.0 5.08 3.20655 3.4451 16 17 10.00 5.72 3.55105 3.7101 3.72331 3.9486 9.00 6.35 Force in KN 8.00 7.00 **Moulding Data** Wt.of Mould + Wet soil g 6.00 Wt. of Mould g 5.00 % **Moisture Content** 4.00 Wet Density Kg/m<sup>3</sup> 3.00 **Drv Densitv** Kg/m<sup>3</sup> % MDD 2.00 MOULDING MOISTURE CONTENT 1.00 Tin No. 184 0.00 Tin +Wet soil 223.8 $\begin{array}{c} 3 \\ - 1 \\ - 1 \\ - 2 \\ - 2 \\ - 2 \\ - 2 \\ - 2 \\ - 2 \\ - 2 \\ - 2 \\ - 2 \\ - 2 \\ - 2 \\ - 2 \\ - 2 \\ - 2 \\ - 2 \\ - 2 \\ - 2 \\ - 2 \\ - 2 \\ - 2 \\ - 2 \\ - 2 \\ - 2 \\ - 2 \\ - 2 \\ - 2 \\ - 2 \\ - 2 \\ - 2 \\ - 2 \\ - 2 \\ - 2 \\ - 2 \\ - 2 \\ - 2 \\ - 2 \\ - 2 \\ - 2 \\ - 2 \\ - 2 \\ - 2 \\ - 2 \\ - 2 \\ - 2 \\ - 2 \\ - 2 \\ - 2 \\ - 2 \\ - 2 \\ - 2 \\ - 2 \\ - 2 \\ - 2 \\ - 2 \\ - 2 \\ - 2 \\ - 2 \\ - 2 \\ - 2 \\ - 2 \\ - 2 \\ - 2 \\ - 2 \\ - 2 \\ - 2 \\ - 2 \\ - 2 \\ - 2 \\ - 2 \\ - 2 \\ - 2 \\ - 2 \\ - 2 \\ - 2 \\ - 2 \\ - 2 \\ - 2 \\ - 2 \\ - 2 \\ - 2 \\ - 2 \\ - 2 \\ - 2 \\ - 2 \\ - 2 \\ - 2 \\ - 2 \\ - 2 \\ - 2 \\ - 2 \\ - 2 \\ - 2 \\ - 2 \\ - 2 \\ - 2 \\ - 2 \\ - 2 \\ - 2 \\ - 2 \\ - 2 \\ - 2 \\ - 2 \\ - 2 \\ - 2 \\ - 2 \\ - 2 \\ - 2 \\ - 2 \\ - 2 \\ - 2 \\ - 2 \\ - 2 \\ - 2 \\ - 2 \\ - 2 \\ - 2 \\ - 2 \\ - 2 \\ - 2 \\ - 2 \\ - 2 \\ - 2 \\ - 2 \\ - 2 \\ - 2 \\ - 2 \\ - 2 \\ - 2 \\ - 2 \\ - 2 \\ - 2 \\ - 2 \\ - 2 \\ - 2 \\ - 2 \\ - 2 \\ - 2 \\ - 2 \\ - 2 \\ - 2 \\ - 2 \\ - 2 \\ - 2 \\ - 2 \\ - 2 \\ - 2 \\ - 2 \\ - 2 \\ - 2 \\ - 2 \\ - 2 \\ - 2 \\ - 2 \\ - 2 \\ - 2 \\ - 2 \\ - 2 \\ - 2 \\ - 2 \\ - 2 \\ - 2 \\ - 2 \\ - 2 \\ - 2 \\ - 2 \\ - 2 \\ - 2 \\ - 2 \\ - 2 \\ - 2 \\ - 2 \\ - 2 \\ - 2 \\ - 2 \\ - 2 \\ - 2 \\ - 2 \\ - 2 \\ - 2 \\ - 2 \\ - 2 \\ - 2 \\ - 2 \\ - 2 \\ - 2 \\ - 2 \\ - 2 \\ - 2 \\ - 2 \\ - 2 \\ - 2 \\ - 2 \\ - 2 \\ - 2 \\ - 2 \\ - 2 \\ - 2 \\ - 2 \\ - 2 \\ - 2 \\ - 2 \\ - 2 \\ - 2 \\ - 2 \\ - 2 \\ - 2 \\ - 2 \\ - 2 \\ - 2 \\ - 2 \\ - 2 \\ - 2 \\ - 2 \\ - 2 \\ - 2 \\ - 2 \\ - 2 \\ - 2 \\ - 2 \\ - 2 \\ - 2 \\ - 2 \\ - 2 \\ - 2 \\ - 2 \\ - 2 \\ - 2 \\ - 2 \\ - 2 \\ - 2 \\ - 2 \\ - 2 \\ - 2 \\ - 2 \\ - 2 \\ - 2 \\ - 2 \\ - 2 \\ - 2 \\ - 2 \\ - 2 \\ - 2 \\ - 2 \\ - 2 \\ - 2 \\ - 2 \\ - 2 \\ - 2 \\ - 2 \\ - 2 \\ - 2 \\ - 2 \\ - 2 \\ - 2 \\ - 2 \\ - 2 \\ - 2 \\ - 2 \\ - 2 \\ - 2 \\ - 2 \\ - 2 \\ - 2 \\ - 2 \\ - 2 \\ - 2 \\ - 2 \\ - 2 \\ - 2 \\ - 2 \\ - 2 \\ - 2 \\ - 2 \\ - 2 \\ - 2 \\ - 2 \\ - 2 \\ - 2 \\ - 2 \\ - 2 \\ - 2 \\ - 2 \\ - 2 \\ - 2 \\ - 2 \\ - 2 \\ - 2 \\ - 2 \\ - 2 \\ - 2 \\ - 2 \\ - 2 \\ - 2 \\ - 2 \\ - 2 \\ - 2 \\ - 2 \\ - 2 \\ - 2 \\ - 2 \\ - 2 \\ - 2 \\ - 2 \\ - 2 \\ - 2 \\ - 2 \\ - 2 \\ - 2 \\ - 2 \\ - 2 \\ - 2 \\ - 2 \\ - 2 \\ - 2 \\ - 2 \\ - 2 \\ - 2 \\ - 2 \\ - 2 \\ - 2 \\ - 2 \\ - 2 \\ - 2 \\ - 2 \\ - 2 \\ - 2 \\ - 2 \\ - 2 \\ - 2 \\ - 2 \\ - 2 \\ - 2 \\ - 2 \\ - 2 \\ - 2 \\ - 2 \\ - 2 \\ -$ Tin + Dry soil 187.7 Wt of Tin 78.6 Wt of Moisture 36.1 Penetration in mm Wt. of dry soil 109.1 **Moisture content** 33.09 RESULTS Penetration(mm) Standard Force(KN) Specification CBR%(top) CBR%(bott.) 2.5 13.2 16 16 20 16 17 5 CBR =17% **Checked:** Martin Mburu

#### UNIVERSITY OF NAIROBI **WORKING SHEET** (HIGHWAYS LABORATORY) **CBR TEST** (AASHTO T193:1990) 12% FCD SAMPLE 4 Tested: 28/1/2020 Project: Mechanical stabilization of Lateritic Gravel using FCD Date soaked: 24/01/2020 Date Moulded: Mould No.: 24/01/2020 Student.: Anthony Mugendi Nyagah SWELL DATA SAMPLE DETAILS 1474 MDD 29.43 Initial gauge Reading STABILIZED OMC (div) 0 Туре **Final gauge Reading** (div) 22 Stabilizer FCD NMC 9.2 Difference (div) 22 % **Ring Factor** 0.01 Swell % 0.22 Gauge Factor:0.0005 inches/Div Penetration Bot Тор Standard CBR% of the plunger (KN) (KN) Load(KN) **CBR TEST** Bott. Тор (mm) 0 0 0.00 0.64 1.39127 1.7888 15.00 1.27 2.49104 3.4451 3.2993 1.91 4.6773 14.00 13.2 30 42 2.54 3.90881 5.4988 13.00 3.18 4.37257 6.2276 3.81 4.70382 6.8239 12.00 5.03508 4.45 7.3804 11.00 20.0 39 5.08 5.30008 7.7911 27 10.00 5.72 5.56508 8.0164 6.35 5.75059 8.3741 9.00 Force in KN 8.00 7.00 **Moulding Data** Wt.of Mould + Wet soil g 6.00 Wt. of Mould g 5.00 **Moisture** Content % 4.00 Wet Density Kg/m<sup>3</sup> 3.00 **Drv Densitv** Kg/m<sup>3</sup> % MDD 2.00 MOULDING MOISTURE CONTENT 1.00 Tin No. 184 0.00 Tin +Wet soil 223.8 $\begin{array}{c} 3 \\ - 1 \\ - 1 \\ - 2 \\ - 2 \\ - 2 \\ - 2 \\ - 2 \\ - 2 \\ - 2 \\ - 2 \\ - 2 \\ - 2 \\ - 2 \\ - 2 \\ - 2 \\ - 2 \\ - 2 \\ - 2 \\ - 2 \\ - 2 \\ - 2 \\ - 2 \\ - 2 \\ - 2 \\ - 2 \\ - 2 \\ - 2 \\ - 2 \\ - 2 \\ - 2 \\ - 2 \\ - 2 \\ - 2 \\ - 2 \\ - 2 \\ - 2 \\ - 2 \\ - 2 \\ - 2 \\ - 2 \\ - 2 \\ - 2 \\ - 2 \\ - 2 \\ - 2 \\ - 2 \\ - 2 \\ - 2 \\ - 2 \\ - 2 \\ - 2 \\ - 2 \\ - 2 \\ - 2 \\ - 2 \\ - 2 \\ - 2 \\ - 2 \\ - 2 \\ - 2 \\ - 2 \\ - 2 \\ - 2 \\ - 2 \\ - 2 \\ - 2 \\ - 2 \\ - 2 \\ - 2 \\ - 2 \\ - 2 \\ - 2 \\ - 2 \\ - 2 \\ - 2 \\ - 2 \\ - 2 \\ - 2 \\ - 2 \\ - 2 \\ - 2 \\ - 2 \\ - 2 \\ - 2 \\ - 2 \\ - 2 \\ - 2 \\ - 2 \\ - 2 \\ - 2 \\ - 2 \\ - 2 \\ - 2 \\ - 2 \\ - 2 \\ - 2 \\ - 2 \\ - 2 \\ - 2 \\ - 2 \\ - 2 \\ - 2 \\ - 2 \\ - 2 \\ - 2 \\ - 2 \\ - 2 \\ - 2 \\ - 2 \\ - 2 \\ - 2 \\ - 2 \\ - 2 \\ - 2 \\ - 2 \\ - 2 \\ - 2 \\ - 2 \\ - 2 \\ - 2 \\ - 2 \\ - 2 \\ - 2 \\ - 2 \\ - 2 \\ - 2 \\ - 2 \\ - 2 \\ - 2 \\ - 2 \\ - 2 \\ - 2 \\ - 2 \\ - 2 \\ - 2 \\ - 2 \\ - 2 \\ - 2 \\ - 2 \\ - 2 \\ - 2 \\ - 2 \\ - 2 \\ - 2 \\ - 2 \\ - 2 \\ - 2 \\ - 2 \\ - 2 \\ - 2 \\ - 2 \\ - 2 \\ - 2 \\ - 2 \\ - 2 \\ - 2 \\ - 2 \\ - 2 \\ - 2 \\ - 2 \\ - 2 \\ - 2 \\ - 2 \\ - 2 \\ - 2 \\ - 2 \\ - 2 \\ - 2 \\ - 2 \\ - 2 \\ - 2 \\ - 2 \\ - 2 \\ - 2 \\ - 2 \\ - 2 \\ - 2 \\ - 2 \\ - 2 \\ - 2 \\ - 2 \\ - 2 \\ - 2 \\ - 2 \\ - 2 \\ - 2 \\ - 2 \\ - 2 \\ - 2 \\ - 2 \\ - 2 \\ - 2 \\ - 2 \\ - 2 \\ - 2 \\ - 2 \\ - 2 \\ - 2 \\ - 2 \\ - 2 \\ - 2 \\ - 2 \\ - 2 \\ - 2 \\ - 2 \\ - 2 \\ - 2 \\ - 2 \\ - 2 \\ - 2 \\ - 2 \\ - 2 \\ - 2 \\ - 2 \\ - 2 \\ - 2 \\ - 2 \\ - 2 \\ - 2 \\ - 2 \\ - 2 \\ - 2 \\ - 2 \\ - 2 \\ - 2 \\ - 2 \\ - 2 \\ - 2 \\ - 2 \\ - 2 \\ - 2 \\ - 2 \\ - 2 \\ - 2 \\ - 2 \\ - 2 \\ - 2 \\ - 2 \\ - 2 \\ - 2 \\ - 2 \\ - 2 \\ - 2 \\ - 2 \\ - 2 \\ - 2 \\ - 2 \\ - 2 \\ - 2 \\ - 2 \\ - 2 \\ - 2 \\ - 2 \\ - 2 \\ - 2 \\ - 2 \\ - 2 \\ - 2 \\ - 2 \\ - 2 \\ - 2 \\ - 2 \\ - 2 \\ - 2 \\ - 2 \\ - 2 \\ - 2 \\ - 2 \\ - 2 \\ - 2 \\ - 2 \\ - 2 \\ - 2 \\ - 2 \\ - 2 \\ - 2 \\ - 2 \\ - 2 \\ - 2 \\ - 2 \\ - 2 \\ - 2 \\ - 2 \\ - 2 \\ - 2 \\ - 2 \\ - 2 \\ - 2 \\ - 2 \\ - 2 \\ - 2 \\ - 2 \\ - 2 \\ - 2 \\ - 2 \\ - 2 \\ - 2 \\ - 2 \\ - 2 \\ - 2 \\ - 2 \\ - 2 \\ - 2 \\ - 2 \\ - 2 \\ - 2 \\ - 2 \\ - 2 \\ - 2 \\ - 2 \\ - 2 \\ - 2 \\ - 2 \\ - 2 \\ - 2 \\ - 2 \\ - 2 \\ - 2 \\ - 2 \\ - 2 \\ - 2 \\ - 2 \\ - 2 \\ - 2 \\ - 2 \\ - 2 \\ - 2 \\ - 2 \\ - 2 \\ - 2 \\ - 2 \\ - 2 \\ - 2 \\ - 2 \\ - 2 \\ - 2 \\ - 2 \\ - 2 \\ - 2 \\ -$ Tin + Dry soil 187.7 Wt of Tin 78.6 Wt of Moisture 36.1 Penetration in mm Wt. of dry soil 109.1 **Moisture content** 33.09 RESULTS Penetration(mm) Standard Force(KN) Specification CBR%(top) CBR%(bott.) 2.5 13.2 30 42 20 27 39 5 CBR = 42%**Checked:** Martin Mburu

#### UNIVERSITY OF NAIROBI **WORKING SHEET** (HIGHWAYS LABORATORY) **CBR TEST** (AASHTO T193:1990) 12% FCD SAMPLE 5 Project: Mechanical Stabilization of Lateritic Gravel using FCD Tested: 28/1/2020 Date soaked: 24/01/2020 Date Moulded: Mould No.: 24/01/2020 Student.: Anthony Mugendi Nyagah SWELL DATA SAMPLE DETAILS 1474 MDD 29.43 Initial gauge Reading STABILIZED OMC (div) 0 Туре **Final gauge Reading** (div) 22 Stabilizer FCD NMC 9.2 Difference (div) 22 % **Ring Factor** 0.01 Swell % 0.22 Gauge Factor:0.0005 inches/Div Penetration Bot Тор Standard CBR% of the plunger (KN) (KN) Load(KN) **CBR TEST** Bott. Тор (mm) 0 0 0.00 0.64 1.08652 0.8215 15.00 1.27 1.96103 1.7225 2.58379 1.91 2.5175 14.00 23 24 2.54 3.04755 3.18 13.2 13.00 3.18 3.4053 3.6571 12.00 3.81 3.69681 4.1076 3.97506 4.45 4.4521 11.00 20.0 5.08 4.18706 4.7966 21 24 10.00 5.72 4.39907 5.0351 6.35 4.57132 9.00 5.2471 Force in KN 8.00 7.00 **Moulding Data** Wt.of Mould + Wet soil g 6.00 Wt. of Mould g 5.00 **Moisture** Content % 4.00 Wet Density Kg/m<sup>3</sup> 3.00 **Drv Densitv** Kg/m<sup>3</sup> % MDD 2.00 MOULDING MOISTURE CONTENT 1.00 Tin No. 213 0.00 Tin +Wet soil 232 $\begin{array}{c} 3 \\ - 1 \\ - 1 \\ - 2 \\ - 2 \\ - 2 \\ - 2 \\ - 2 \\ - 2 \\ - 2 \\ - 2 \\ - 2 \\ - 2 \\ - 2 \\ - 2 \\ - 2 \\ - 2 \\ - 2 \\ - 2 \\ - 2 \\ - 2 \\ - 2 \\ - 2 \\ - 2 \\ - 2 \\ - 2 \\ - 2 \\ - 2 \\ - 2 \\ - 2 \\ - 2 \\ - 2 \\ - 2 \\ - 2 \\ - 2 \\ - 2 \\ - 2 \\ - 2 \\ - 2 \\ - 2 \\ - 2 \\ - 2 \\ - 2 \\ - 2 \\ - 2 \\ - 2 \\ - 2 \\ - 2 \\ - 2 \\ - 2 \\ - 2 \\ - 2 \\ - 2 \\ - 2 \\ - 2 \\ - 2 \\ - 2 \\ - 2 \\ - 2 \\ - 2 \\ - 2 \\ - 2 \\ - 2 \\ - 2 \\ - 2 \\ - 2 \\ - 2 \\ - 2 \\ - 2 \\ - 2 \\ - 2 \\ - 2 \\ - 2 \\ - 2 \\ - 2 \\ - 2 \\ - 2 \\ - 2 \\ - 2 \\ - 2 \\ - 2 \\ - 2 \\ - 2 \\ - 2 \\ - 2 \\ - 2 \\ - 2 \\ - 2 \\ - 2 \\ - 2 \\ - 2 \\ - 2 \\ - 2 \\ - 2 \\ - 2 \\ - 2 \\ - 2 \\ - 2 \\ - 2 \\ - 2 \\ - 2 \\ - 2 \\ - 2 \\ - 2 \\ - 2 \\ - 2 \\ - 2 \\ - 2 \\ - 2 \\ - 2 \\ - 2 \\ - 2 \\ - 2 \\ - 2 \\ - 2 \\ - 2 \\ - 2 \\ - 2 \\ - 2 \\ - 2 \\ - 2 \\ - 2 \\ - 2 \\ - 2 \\ - 2 \\ - 2 \\ - 2 \\ - 2 \\ - 2 \\ - 2 \\ - 2 \\ - 2 \\ - 2 \\ - 2 \\ - 2 \\ - 2 \\ - 2 \\ - 2 \\ - 2 \\ - 2 \\ - 2 \\ - 2 \\ - 2 \\ - 2 \\ - 2 \\ - 2 \\ - 2 \\ - 2 \\ - 2 \\ - 2 \\ - 2 \\ - 2 \\ - 2 \\ - 2 \\ - 2 \\ - 2 \\ - 2 \\ - 2 \\ - 2 \\ - 2 \\ - 2 \\ - 2 \\ - 2 \\ - 2 \\ - 2 \\ - 2 \\ - 2 \\ - 2 \\ - 2 \\ - 2 \\ - 2 \\ - 2 \\ - 2 \\ - 2 \\ - 2 \\ - 2 \\ - 2 \\ - 2 \\ - 2 \\ - 2 \\ - 2 \\ - 2 \\ - 2 \\ - 2 \\ - 2 \\ - 2 \\ - 2 \\ - 2 \\ - 2 \\ - 2 \\ - 2 \\ - 2 \\ - 2 \\ - 2 \\ - 2 \\ - 2 \\ - 2 \\ - 2 \\ - 2 \\ - 2 \\ - 2 \\ - 2 \\ - 2 \\ - 2 \\ - 2 \\ - 2 \\ - 2 \\ - 2 \\ - 2 \\ - 2 \\ - 2 \\ - 2 \\ - 2 \\ - 2 \\ - 2 \\ - 2 \\ - 2 \\ - 2 \\ - 2 \\ - 2 \\ - 2 \\ - 2 \\ - 2 \\ - 2 \\ - 2 \\ - 2 \\ - 2 \\ - 2 \\ - 2 \\ - 2 \\ - 2 \\ - 2 \\ - 2 \\ - 2 \\ - 2 \\ - 2 \\ - 2 \\ - 2 \\ - 2 \\ - 2 \\ - 2 \\ - 2 \\ - 2 \\ - 2 \\ - 2 \\ - 2 \\ - 2 \\ - 2 \\ - 2 \\ - 2 \\ - 2 \\ - 2 \\ - 2 \\ - 2 \\ - 2 \\ - 2 \\ - 2 \\ - 2 \\ - 2 \\ - 2 \\ - 2 \\ - 2 \\ - 2 \\ - 2 \\ - 2 \\ - 2 \\ - 2 \\ - 2 \\ - 2 \\ - 2 \\ - 2 \\ - 2 \\ - 2 \\ - 2 \\ - 2 \\ - 2 \\ - 2 \\ - 2 \\ - 2 \\ - 2 \\ - 2 \\ - 2 \\ - 2 \\ - 2 \\ - 2 \\ - 2 \\ - 2 \\ - 2 \\ - 2 \\ - 2 \\ - 2 \\ - 2 \\ - 2 \\ - 2 \\ - 2 \\ - 2 \\ - 2 \\ - 2 \\ - 2 \\ - 2 \\ - 2 \\ - 2 \\ - 2 \\ - 2 \\ - 2 \\ - 2 \\ - 2 \\ - 2 \\ - 2 \\ - 2 \\ - 2 \\ - 2 \\ - 2 \\ - 2 \\ - 2 \\ - 2 \\ - 2 \\ - 2 \\ - 2 \\ - 2 \\ - 2 \\ - 2 \\ - 2 \\ - 2 \\ - 2 \\ - 2 \\ - 2 \\ - 2 \\ - 2 \\ - 2 \\ - 2 \\ - 2 \\ - 2 \\ - 2 \\ - 2 \\ - 2 \\ - 2 \\ - 2 \\ - 2 \\ - 2 \\ -$ 196.6 Tin + Dry soil Wt of Tin 92.8 35.4 Wt of Moisture Penetration in mm Wt. of dry soil 103.8 **Moisture content** 34.10 RESULTS Penetration(mm) Standard Force(KN) Specification CBR%(top) CBR%(bott.) 2.5 13.2 23 24 20 21 24 5 CBR =24% Checked: Martin Mburu

#### UNIVERSITY OF NAIROBI **WORKING SHEET** (HIGHWAYS LABORATORY) **CBR TEST** (AASHTO T193:1990) 12% FCD SAMPLE 6 Project: Mechanical Stabilization of Lateritic Gravel using FCD Tested: 28/1/2020 Date soaked: 24/01/2020 Date Moulded: Mould No.: 24/01/2020 Student.: Anthony Mugendi Nyagah SWELL DATA SAMPLE DETAILS 1474 MDD 29.43 Initial gauge Reading STABILIZED OMC (div) 0 Туре **Final gauge Reading** (div) 22 Stabilizer FCD NMC 9.2 Difference (div) 22 % **Ring Factor** 0.01 Swell % 0.22 Gauge Factor:0.0005 inches/Div Penetration Bot Тор Standard CBR% of the plunger (KN) (KN) Load(KN) **CBR TEST** Bott. Тор (mm) 0 0 0.00 0.64 0.99377 1.2588 15.00 1.27 1.98753 2.5175 2.38504 3.5113 1.91 14.00 21 32 2.54 2.78254 4.1738 13.2 13.00 3.18 3.0873 4.7436 3.81 3.31255 5.1676 12.00 5.4988 4.45 3.44505 11.00 20.0 29 5.08 3.64381 5.8301 18 10.00 3.81606 5.72 6.2276 3.97506 9.00 6.35 6.4926 Force in KN 8.00 7.00 **Moulding Data** Wt.of Mould + Wet soil g 6.00 Wt. of Mould g 5.00 % **Moisture Content** 4.00 Wet Density Kg/m<sup>3</sup> 3.00 **Drv Densitv** Kg/m<sup>3</sup> % MDD 2.00 MOULDING MOISTURE CONTENT 1.00 Tin No. 184 0.00 Tin +Wet soil 223.8 $\begin{array}{c} 3 \\ - 1 \\ - 1 \\ - 2 \\ - 2 \\ - 2 \\ - 2 \\ - 2 \\ - 2 \\ - 2 \\ - 2 \\ - 2 \\ - 2 \\ - 2 \\ - 2 \\ - 2 \\ - 2 \\ - 2 \\ - 2 \\ - 2 \\ - 2 \\ - 2 \\ - 2 \\ - 2 \\ - 2 \\ - 2 \\ - 2 \\ - 2 \\ - 2 \\ - 2 \\ - 2 \\ - 2 \\ - 2 \\ - 2 \\ - 2 \\ - 2 \\ - 2 \\ - 2 \\ - 2 \\ - 2 \\ - 2 \\ - 2 \\ - 2 \\ - 2 \\ - 2 \\ - 2 \\ - 2 \\ - 2 \\ - 2 \\ - 2 \\ - 2 \\ - 2 \\ - 2 \\ - 2 \\ - 2 \\ - 2 \\ - 2 \\ - 2 \\ - 2 \\ - 2 \\ - 2 \\ - 2 \\ - 2 \\ - 2 \\ - 2 \\ - 2 \\ - 2 \\ - 2 \\ - 2 \\ - 2 \\ - 2 \\ - 2 \\ - 2 \\ - 2 \\ - 2 \\ - 2 \\ - 2 \\ - 2 \\ - 2 \\ - 2 \\ - 2 \\ - 2 \\ - 2 \\ - 2 \\ - 2 \\ - 2 \\ - 2 \\ - 2 \\ - 2 \\ - 2 \\ - 2 \\ - 2 \\ - 2 \\ - 2 \\ - 2 \\ - 2 \\ - 2 \\ - 2 \\ - 2 \\ - 2 \\ - 2 \\ - 2 \\ - 2 \\ - 2 \\ - 2 \\ - 2 \\ - 2 \\ - 2 \\ - 2 \\ - 2 \\ - 2 \\ - 2 \\ - 2 \\ - 2 \\ - 2 \\ - 2 \\ - 2 \\ - 2 \\ - 2 \\ - 2 \\ - 2 \\ - 2 \\ - 2 \\ - 2 \\ - 2 \\ - 2 \\ - 2 \\ - 2 \\ - 2 \\ - 2 \\ - 2 \\ - 2 \\ - 2 \\ - 2 \\ - 2 \\ - 2 \\ - 2 \\ - 2 \\ - 2 \\ - 2 \\ - 2 \\ - 2 \\ - 2 \\ - 2 \\ - 2 \\ - 2 \\ - 2 \\ - 2 \\ - 2 \\ - 2 \\ - 2 \\ - 2 \\ - 2 \\ - 2 \\ - 2 \\ - 2 \\ - 2 \\ - 2 \\ - 2 \\ - 2 \\ - 2 \\ - 2 \\ - 2 \\ - 2 \\ - 2 \\ - 2 \\ - 2 \\ - 2 \\ - 2 \\ - 2 \\ - 2 \\ - 2 \\ - 2 \\ - 2 \\ - 2 \\ - 2 \\ - 2 \\ - 2 \\ - 2 \\ - 2 \\ - 2 \\ - 2 \\ - 2 \\ - 2 \\ - 2 \\ - 2 \\ - 2 \\ - 2 \\ - 2 \\ - 2 \\ - 2 \\ - 2 \\ - 2 \\ - 2 \\ - 2 \\ - 2 \\ - 2 \\ - 2 \\ - 2 \\ - 2 \\ - 2 \\ - 2 \\ - 2 \\ - 2 \\ - 2 \\ - 2 \\ - 2 \\ - 2 \\ - 2 \\ - 2 \\ - 2 \\ - 2 \\ - 2 \\ - 2 \\ - 2 \\ - 2 \\ - 2 \\ - 2 \\ - 2 \\ - 2 \\ - 2 \\ - 2 \\ - 2 \\ - 2 \\ - 2 \\ - 2 \\ - 2 \\ - 2 \\ - 2 \\ - 2 \\ - 2 \\ - 2 \\ - 2 \\ - 2 \\ - 2 \\ - 2 \\ - 2 \\ - 2 \\ - 2 \\ - 2 \\ - 2 \\ - 2 \\ - 2 \\ - 2 \\ - 2 \\ - 2 \\ - 2 \\ - 2 \\ - 2 \\ - 2 \\ - 2 \\ - 2 \\ - 2 \\ - 2 \\ - 2 \\ - 2 \\ - 2 \\ - 2 \\ - 2 \\ - 2 \\ - 2 \\ - 2 \\ - 2 \\ - 2 \\ - 2 \\ - 2 \\ - 2 \\ - 2 \\ - 2 \\ - 2 \\ - 2 \\ - 2 \\ - 2 \\ - 2 \\ - 2 \\ - 2 \\ - 2 \\ - 2 \\ - 2 \\ - 2 \\ - 2 \\ - 2 \\ - 2 \\ - 2 \\ - 2 \\ - 2 \\ - 2 \\ - 2 \\ - 2 \\ - 2 \\ - 2 \\ - 2 \\ - 2 \\ - 2 \\ - 2 \\ - 2 \\ - 2 \\ - 2 \\ - 2 \\ - 2 \\ - 2 \\ - 2 \\ - 2 \\ - 2 \\ - 2 \\ - 2 \\ - 2 \\ - 2 \\ - 2 \\ - 2 \\ - 2 \\ - 2 \\ - 2 \\ - 2 \\ - 2 \\ - 2 \\ - 2 \\ - 2 \\ - 2 \\ - 2 \\ - 2 \\ - 2 \\ - 2 \\ - 2 \\ - 2 \\ - 2 \\ - 2 \\ - 2 \\ - 2 \\ - 2 \\ - 2 \\ - 2 \\ - 2 \\ - 2 \\ - 2 \\ - 2 \\ - 2 \\ - 2 \\ - 2 \\ - 2 \\ -$ Tin + Dry soil 187.7 Wt of Tin 78.6 Wt of Moisture 36.1 Penetration in mm Wt. of dry soil 109.1 **Moisture content** 33.09 RESULTS Penetration(mm) Standard Force(KN) Specification CBR%(top) CBR%(bott.) 2.5 13.2 32 24 20 28 22 5 CBR =32% **Checked:** Martin Mburu

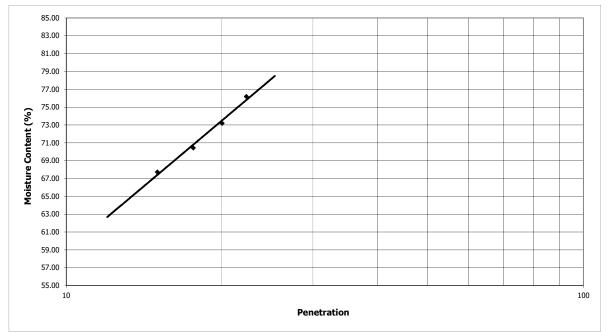
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Appendix D4 Atterberg Limits

PROJECT	Mech	Mechanical Stabilization of Lateritic Gravel using FCD									
STUDENT		Anthony mugendi Nyagah									
DEPTH		Sample No	3% STAB	Sample time							
Test date	03-Jan-20	Lab Ref No									
Specification	In accordance with BS 1377: 1990										

		Liquid Limit			Plastic Limit		
Container No	15	26	38	8	7F	2B	
Penetration (mm)	15	17.6	20	22.3			
Wt of Container + Wet Soil (g)	50.5	62.3	72	83.7	16	16	
Wt of Container + Dry Soil (g)	41.9	49.2	53.7	59.7	14.1	14.1	
Wt of Container (g)	29.2	30.6	28.7	28.2	9	9	
Wt of Moistuer (g)	8.6	13.1	18.3	24	1.9	1.9	
Wt of Dry Soil (g)	12.7	18.6	25	31.5	5.1	5.1	
Moisture Content (%)	67.72	70.43	73.20	76.19	37.25	37.25	

Linear Shrinkage	Initial Length (mm)	No1	140	Final Length (mm)	No 1	116
Linear Sinnikage	Initial Length (Initi)	No 2	140	Final Length (mm)	No 2	116



Liquid Limit	73
Plastic Limit	37
Plasticity Index	36
Linear Shrinkage (%)	17

Technician	Mathew Mburu	Verified :	Elly Oyier
Date	06-Jan-20		
Observations:		-	
Conform to the specification	s		

PROJECT	Mech	Mechanical stabilization of Lateritic Gravel using FCD									
STUDENT		Anthony Mugendi Nyagah									
DEPTH		Sample No	6% STAB	Sample time							
Test date	20-Feb-20	Lab Ref No									
Specification	In accordance with BS 1377: 1990										

		Liquid Limit									
Container No	10	17	13	7	AA	R					
Penetration (mm)	15.1	17.2	20.3	22.9							
Wt of Container + Wet Soil (g)	50.1	59.2	70	90.4	15.2	15.2					
Wt of Container + Dry Soil (g)	42.1	46.8	53.2	63.8	13.6	13.6					
Wt of Container (g)	29.5	28.1	29.2	27.7	9.2	9.3					
Wt of Moistuer (g)	8	12.4	16.8	26.6	1.6	1.6					
Wt of Dry Soil (g)	12.6	18.7	24	36.1	4.4	4.3					
Moisture Content (%)	63.49	66.31	70.00	73.68	36.36	37.21					

Linear Shrinkage	Initial Length (mm)	No1	140	Final Length (mm)	No 1	116
Linear Shi likage	Initial Length (Initi)	No 2	140	Final Length (mm)	No 2	116



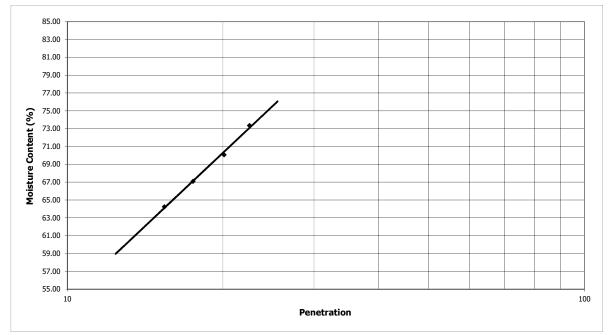
Liquid Limit	70
Plastic Limit	37
Plasticity Index	33
Linear Shrinkage (%)	17

Technician	Mathew I	Mburu	Verified :	Elly Oyier
Date	21-Feb-2	0		
Observations:				
Conform to the specifications	:			

PROJECT	Mechanical Stabilization of Lateritic Gravel using FCD					
STUDENT		Anthony	Mugendi Nyagah			
DEPTH		Sample No	9% STAB	Sample time		
Test date	20-Feb-20	Lab Ref No				
Specification	In accordance with BS 1377: 1990					

		Plastic Limit				
Container No	11	27	32	46	К2	13
Penetration (mm)	15.4	17.5	20.1	22.5		
Wt of Container + Wet Soil (g)	53.9	65.9	78	87.1	14.8	14.8
Wt of Container + Dry Soil (g)	44.2	50	58.1	62.6	13.2	13.1
Wt of Container (g)	29.1	26.3	29.7	29.2	9.2	8.9
Wt of Moistuer (g)	9.7	15.9	19.9	24.5	1.6	1.7
Wt of Dry Soil (g)	15.1	23.7	28.4	33.4	4	4.2
Moisture Content (%)	64.24	67.09	70.07	73.35	40.00	40.48

Linear Shrinkage	Initial Length (mm)	No1	140	Final Length (mm)	No 1	120
Linear Shirikage	Initial Length (Initi)	No 2	140	Final Length (mm)	No 2	120



Liquid Limit	70
Plastic Limit	40
Plasticity Index	30
Linear Shrinkage (%)	14

Technician	Mathew Mburu	Verified :	Elly Oyier
Date	21-Feb-20		
Observations:			
Conform to the specification	ns		
	L.		

PROJECT	Mech	Mechanical Stabilization of Latertic Gravel using FCD					
STUDENT		Anthony	Mugendi Nyagah				
DEPTH		Sample No	12% STAB	Sample time			
Test date	20-Feb-20	Lab Ref No					
Specification	In accordance with BS 1377: 1990						

		Plastic Limit				
Container No	2	30	33	24	DD	Q
Penetration (mm)	15.6	17.6	19	22.7		
Wt of Container + Wet Soil (g)	48.1	59.8	70.3	87.7	15.3	15.3
Wt of Container + Dry Soil (g)	39.9	45.9	52.6	62.1	13.6	13.6
Wt of Container (g)	27.9	26.4	28.7	29.1	9.5	9.3
Wt of Moistuer (g)	8.2	13.9	17.7	25.6	1.7	1.7
Wt of Dry Soil (g)	12	19.5	23.9	33	4.1	4.3
Moisture Content (%)	68.33	71.28	74.06	77.58	41.46	39.53

Linear Shrinkage	Initial Length (mm)	No1	140	Final Length (mm)	No 1	122
Linear Shirikaye	Initial Length (Initi)	No 2	140	Final Length (mm)	No 2	122



Liquid Limit	74
Plastic Limit	40
Plasticity Index	34
Linear Shrinkage (%)	13

Technician	Mathew Mburu	Verified :	Elly Oyier
Date	21-Feb-20		
Observations:		-	
Conform to the specification	s		

Appendix D5 Grading



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Sample source	Anthony Mugendi Nya						
	Membley Quarry, Kiar				Kabete Campu		N (FCD)
Depth (m)		SAMPLE No.	3%	FCD		Sr. No.	
Test date:	30-Jan-20	La	ocation:				
Specification	According to BS 1377:	1990. <b>S</b>	ample Des	cription:	FCD Mecha	nical Stabilized San	nple
		(2002)					
9an mass nitial dry sample mass + pa	an	(gm) (gm)	0				
nitial dry sample mass		(gm)	200	Fine ma	ISS	(gm)	82.1
Vashed dry sample mass	- pan	(gm)		Fine per		(%)	41.1
Nashed dry sample mass		(gm)	117.9	Accepta	ance Criteria	(%)	
				Cumulative p	bossod	Acceptance	Critoria
Sieve size (mm)	Retained mass (gm)	% Retained (%)		percentage		Min(%)	Max (%)
20	0	0.0		100.0			
14	0	0.0		100.0			
10	2.3	1.2		98.9			
5	28	14.0		84.9			
2.36	33.2	16.6		68.3			
1.18	22.4	11.2		57.1			
0.6	13.2	6.6		50.5			
0.425	6.5	3.3		47.2			
0.3	4	2.0		45.2			
0.15	5.1	2.6		42.7			
0.075	3.2	1.6		41.1			
	82.1	41.1					
	200	GR	ADING CU	RVE			
100							
90							
80							
70							
					×		
<b>60</b>							
<b>2</b> 50							
a							
30							
20							
10							
0							
0.01	0.1			1		10	100
			Sieves	: (mm)			
quipment	Sieve set N° :	Sh	naker N°			Scale N° :	
	Mathew Mburu			ied :Lab. In	ncharge	Martin Mburu	
Technician	30-Jan-20						
Technician Date	50 0 an 20						



DEPARTMENT OF CIVIL & CONSTRUCTION ENGINEERING

	Antho	-	-		-	-																								
Sample sou		oley G	luar	ry,	Ki	ambu C			teri	tic	_			per l	Cabe	ete	Can	npu	ıs (	Da	iry					-CL	)			
Depth (m						SAN	PLE N	lo.			69	% F	CD									Sr	۰. N	10.						
Test date	: 24-Jo	in-20							Loc	ati	on:																			
Specificati	on Accor	rding t	ro B	S 1	37	7:1990.			Sa	nplo	e D	esci	ript	ion:	F۵	:D I	Nec	hai	nico	al s	Stab	ilize	ed s	5ar	nple	2				
						(am)				0			_																	
an mass itial dry sample mas	s + pan					(gm) (gm)				0			_																	
itial dry sample mas						(gm)			2	00			Fi	ne mas	ss								(g	m)				85		
ashed dry sample r	ass + pan					(gm)							Fi	ne per	cent									%)				42.5	5	
ashed dry sample r	ass					(gm)			1	15			A	ccepta	nce C	Criter	а						('	%)						
Sieve size (mr	n) Re	etained	mass	(gn	ר)		% Reta	ained	(%)					ative p		d						Ac	cept	anc	e Cri	teria	I			
						_								entage	(%)					N	1in(%)						M	ax ('	%)	
20			0			_		0.0						100.0																
14			0			_		0.0						100.0																
10			0			-		).0 2 9			-			100.0 86.2			+							+						
5			7.6			-		3.8 。。			-						+							+						
2.36			7.6 22			-		8.8 1 0			-			67.4 56.4			+							+						
1.18 0.6			22 1.8			_		1.0 5.9			⊢			56.4 50.5			+			L				+			_			
0.6			.7					5.9 2.4			-			48.2			+							+						
0.425			.1			-		2.4 2.1			-			46.1			+							+						
0.15			.6					2.3			-			43.8			+							+						
0.075			.6			_		1.3			-			42.5																
			35				4	2.5																						
			00																					1						
								6	GRA	DIN	NG	CUR	ΝE																	
100																														
																				$\mathbf{P}$		•	ľ							
90																			M	+										
80				+			_	-		_		++-					X	+		+								_		
70							_	_							/	$\checkmark$	_													
8 60 -																														
Passing (%)								+	-	-							-													
SG 40				•			_	-									-	-		+										-
<b>a</b> <sub>30</sub>							_											-		_										
20																														
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										S	iev	es	(mr	n)																
	Sieve se	- T							Shak	er M										-	ale N°									
			hew N	Nbui	ru						Ve	rifie	d :L	ab. In	char	ge				Ma	artin	Mbur	u							
quipment 'echnician Date			Tan-2	^																										



DEPARTMENT OF CIVIL & CONSTRUCTION ENGINEERING

		Student	Anthony		-																			
Test date:         03-Jan-20         Location:           Sepel/Effection         According to BS 1377:1990,         Sample Description:         FCD Mechanical Stabilized Sample           nmass         (gm)         0         0         0         00           fill dy sample mass + pan         (gm)         200         Prie mass         (gm)         00.5           saled dy sample mass + pan         (gm)         100.5         Accorptance Criteria         (%)         45.3           saled dy sample mass + pan         (gm)         % Retained (%)         Cumulative passed         Accorptance Criteria         (%)         46.3           saled dy sample mass         100.5         Accorptance Criteria         (%)         Marc(%)         100.0         100.0         100.0         100.0         100.0         100.0         100.0         100.0         100.0         100.0         100.0         100.0         100.0         100.0         100.0         100.0         100.0         100.0         100.0         100.0         100.0         100.0         100.0         100.0         100.0         100.0         100.0         100.0         100.0         100.0         100.0         100.0         100.0         100.0         100.0         100.0         100.0         100.		•	Memble	y Qu	Jarry	y, K				tic G	_		oper	Kabet	te C	amp	us (	Dairy				CD)		
Specification         According to 85 1377:1990.         Sample Description:         FCD Mechanical Stabilized Sample           an mass         (pm)         0         0         0         0         0         0         0         0         0         0         0         0         0         0         0         0         0         0         0         0         0         0         0         0         0         0         0         0         0         0         0         0         0         0         0         0         0         0         0         0         0         0         0         0         0         0         0         0         0         0         0         0         0         0         0         0         0         0         0         0         0         0         0         0         0         0         0         0         0         0         0         0         0         0         0         0         0         0         0         0         0         0         0         0         0         0         0         0         0         0         0         0         0         0         0	D	epth (m)					SAM	PLE No.			9%	FCD							Sr	. No				
an mass         (gm)         0           faile d'y sample mass + pan         (gm)         200         Fine mass         (gm)         00.5           lashed dy sample mass + pan         (gm)         200         Fine percent         (%)         45.3           lashed dy sample mass + pan         (gm)         100.5         Acceptance Citris         (%)           seated dy sample mass         (gm)         100.5         Acceptance Citris         (%)           seated dy sample mass         (gm)         100.5         Acceptance Citris         (%)           seated dy sample mass         (gm)         100.5         Acceptance Citris         (%)           seated dy sample mass         (gm)         0.0         0.0         100.0         (m)           seated dy sample mass         (gm)         0.0         0.0         100.0         (m)         (mas)           seated dy sample mass         (gm)         10.0         100.0         (m)         (mas)         (mas)           seated dy sample mass         (gm)         12.2         7.9         (m)         (mas)         (mas)           seated dy sample mass         (gm)         12.2         (gm)         (gm)         (gm)         (gm)         (gm)         (gm) <th>Te</th> <th>est date:</th> <th>03-Jan-</th> <th>-20</th> <th></th> <th></th> <th></th> <th></th> <th>Loc</th> <th>atio:</th> <th>n:</th> <th></th>	Te	est date:	03-Jan-	-20					Loc	atio:	n:													
mini dry sample mass + pan         (pm)         200         Pine mass         (pm)         90.5           tabled dry sample mass + pan         (pm)         100.5         Acceptance Criteria         (%)         45.3           tabled dry sample mass + pan         (pm)         100.5         Acceptance Criteria         (%)         45.3           tabled dry sample mass         (pm)         100.5         Acceptance Criteria         (%)         45.3           tabled dry sample mass         (pm)         100.5         Acceptance Criteria         (%)         Marc(1           20         0         0         0.0         100.0         IntroMarc(1         Marc(1)           110         4.3         2.2         7.9         90.0         IntroIntroIntroMarc(1)           0.6         15.4         7.7         85.2         IntroIntroIntroIntroIntroIntroIntroIntroIntroIntroIntroIntroIntroIntroIntroIntroIntroIntroIntroIntro <tdintro<td>IntroIntroIntro<tdintro<td>IntroIntroIntroIntroIntroIntroIntroIntroIntroIntro<tdintro<tdintro<tdintro<td>Intro<tdintro<tdintro<tdintro<tdintro<td>Intro<tdintro<tdintro<tdintro<tdintro<tdintro<tdintro<tdintro<tdintro<tdintro<tdintro<tdintro<tdintro<tdintro<tdintro<tdintro<tdintro<tdintro<tdintro<tdintro<tdintro<tdintro<tdintro<tdintro<tdintro<tdintro<tdintro<tdintro<tdintro<tdintro<tdintro<tdintro<tdintro<tdintro<tdintr< th=""><th>Spe</th><th>ecification</th><th>Accordi</th><th>ing to</th><th>BS</th><th>137</th><th>7:1990.</th><th></th><th>Sa</th><th>mple</th><th>Des</th><th>script</th><th>ion:</th><th>FC</th><th>) M</th><th>ech</th><th>nico</th><th>ıl Sta</th><th>bilize</th><th>ed Sa</th><th>mple</th><th></th><th></th><th></th></tdintro<tdintro<tdintro<tdintro<tdintro<tdintro<tdintro<tdintro<tdintro<tdintro<tdintro<tdintro<tdintro<tdintro<tdintro<tdintro<tdintro<tdintro<tdintro<tdintro<tdintro<tdintro<tdintro<tdintro<tdintro<tdintro<tdintro<tdintro<tdintro<tdintro<tdintro<tdintro<tdintro<tdintr<></tdintro<tdintro<tdintro<tdintro<td></tdintro<tdintro<tdintro<td></tdintro<td></tdintro<td>	Spe	ecification	Accordi	ing to	BS	137	7:1990.		Sa	mple	Des	script	ion:	FC	) M	ech	nico	ıl Sta	bilize	ed Sa	mple			
Vertified J warninge mass + pan         (pm)         200         Prive mass         (pm)         90.5           ashed dy sample mass + pan         (pm)         100.5         Acceptance Criteria         (%)         45.3           ashed dy sample mass + pan         (pm)         100.5         Acceptance Criteria         (%)         45.3           ashed dy sample mass         (pm)         100.5         Acceptance Criteria         (%)         45.3           ashed dy sample mass         (pm)         100.5         Acceptance Criteria         (%)         45.3           ashed dy sample mass         (pm)         100.5         Acceptance Criteria         (%)         45.3           ashed dy sample mass         (pm)         100.0         100.0         100.0         100.0         100.0         100.0         100.0         100.0         100.0         100.0         100.0         100.0         100.0         100.0         100.0         100.0         100.0         100.0         100.0         100.0         100.0         100.0         100.0         100.0         100.0         100.0         100.0         100.0         100.0         100.0         100.0         100.0         100.0         100.0         100.0         100.0         100.0         100.0 </td <td></td> <td></td> <td>-</td> <td></td> <td></td> <td></td> <td>()</td> <td></td> <td></td> <td>0</td> <td></td>			-				()			0														
Bit dry sample mass         (gm)         200         File mass         (gm)         90.5           aahed dry sample mass         (gm)         109.5         Acceptance Criteria         (%)         45.3           aahed dry sample mass         (gm)         109.5         Acceptance Criteria         (%)         45.3           sahed dry sample mass         (gm)         109.5         Acceptance Criteria         (%)         45.3           Sieve size (mm)         Retained mass (gm)         % Retained (%)         Cumulative passed percentage (%)         Acceptance Criteria         (%)           14         0         0.0         100.0         100.0         100.0         100.0         100.0         100.0         100.0         100.0         100.0         100.0         100.0         100.0         100.0         100.0         100.0         100.0         100.0         100.0         100.0         100.0         100.0         100.0         100.0         100.0         100.0         100.0         100.0         100.0         100.0         100.0         100.0         100.0         100.0         100.0         100.0         100.0         100.0         100.0         100.0         100.0         100.0         100.0         100.0         100.0         100.			n							0														
Seve size (mm)         Retained mass (gm)         109.5         Acceptance Citeria         (%)           20         0         0         0.0         100.0         Mar(%)         Acceptance Citeria         (%)           20         0         0         0.0         100.0         Mar(%)         Mar(%)         Mar(%)         Mar(%)           20         0         0.0         0.0         100.0         Mar(%)         Mar(%)         Mar(%)         Mar(%)           2.36         30.2         11.8         2.4         12.0         65.2			·						2	00		F	ine ma	SS						(gm)			90.5	
Seve size (mm)         Retained mass (gm)         % Retained (%)         Currulative passed percentage (%)         Acceptance Criteria Min(%)         Acceptance Criteria           20         0         0.0         100.0         100.0         100.0         100.0           10         4.3.3         2.2         15.1         7.9         90.0         100.0         100.0           2.36         30.2         15.1         7.9         90.0         100.0         100.0           0.68         15.4         7.9         90.0         100.0         100.0         100.0           0.425         6.0         15.4         7.9         90.0         100.0         100.0           0.43         5.6         2.8         49.4         10.0         100.0         100.0           0.0375         3.1.1         14.5         14.5         10.0         10.0         10.0           200         GRADINE CURVE           0         0.5         14.5         10.0         10.0         10.0           0.0075         3.1.1         14.5         10.0         10.0         10.0           0.00         0.1         1         10.0         10.0         10.0           0.00	ashed di	ry sample mass +	pan				(gm)					F	ine per	cent									45.3	
Serve size (mm)         Reclamed mass (gm)         % Reclamed (%)         percentage (%)         Mm (%)	ashed di	ry sample mass					(gm)		10	9.5		A	ccepta	nce Cri	teria					(%)				
Sever size (m)         Relamed mass (gm)         % relamed (%)         percentage (%)         Mer(%)         Max (*)           20         0         0.0         100.0																								
20         0         00         100         4.3         100         4.3         100         4.3         100         4.3         100         4.3         100         4.3         100         4.3         100         100         4.3         100         100         4.3         100         100         4.3         100         100         4.3         100         100         4.3         100         100         4.3         100         100         100         100         100         100         100         100         100         100         100         100         100         100         100         100         100         100         100         100         100         100         100         100         100         100         100         100         100         100         100         100         100         100         100         100         100         100         100         100         100         100         100         100         100         100         100         100         100         100         100         100         100         100         100         100         100         100         100         100         100         10	Sie	eve size (mm)	Reta	ined m	nass (o	am)		% Retaine	d (%)										Ac	ceptan	ce Crite	eria		
14       0         10       4.3         5       15.7         2.36       30.2         1.18       24         0.6       15.1         1.18       24         0.425       6         0.3       5.6         0.15       5.2         0.075       3.1         0.6       16.4         0.075       3.1         0.00       0         0.00       0         0.01       0.01         0.02       0.01         0.02       0.01         0.02       0.01         0.02       0.02         0.03       0.05         0.05       2.6         46.8       0         0.075       3.1         0.16       45.3         0.01       0         0.01       0         0.02       0         0.02       0         0.02       0         0.02       0         0.02       0         0.03       0         0.04       0         0.05       0         0.1									( )			perc		(%)				Min(%	6)			Ν	/lax (%	6)
10       4.3       2.2       97.9																								
5       115.7         2.36       30.2         1.18       24         0.6       15.4         0.425       6         0.3       5.6         0.15       5.2         0.075       3.1         90.5       30.5         90.5       30.5         0.075       3.1         90.5       30.5         0.075       3.1         90.5       3.1         90.5       3.1         90.5       1.6         45.3																								
2.36       30.2         1.18       24         0.6       15.4         0.425       6         0.3       5.6         0.15       5.2         0.075       3.1         1.6       45.3         200       CRADING CURVE         GRADING CURVE         0       0.0         0.0       0.1         1.6       45.3         0.0       0.1         0.0       0.1         0.075       3.1         0.075       0.5         200       CRADING CURVE         O         O         Sign colspan="2">Sign colspan="2"Sign colspa="Sign colspa="Sign colspan="2"Sign colspa="Sign colspan="2"Sign c							_														-			
1.18       24         0.6       15.4         0.425       6         0.3       5.6         0.15       5.2         0.075       3.1         0.05       200         GRADING CURVE         GRADING CURVE         00       0.1       0.1       0.1       0.1       0.1       0.1       0.1       0.1       0.1       0.1       0.1       0.1       0.1       0.1       0.1       0.1       0.1       0.1       0.1       0.1       0.1       0.1       0.1       0.1       0.1       0.1       0.1       0.1       0.1       0.1       0.1       0.1       0.1       0.1       0.1       0.1       0.1       0.1       0.1       0.1       0.1       0.1       0.1       0.1       0.1       0.1       0.1       0.1       0.1       0.1       0.1       0.1       0.1       0.1       0.1       0.1       0.1       0.1       0.1       0.1       0.1       0.1       0.1       0.1       0.1       0.1       0.1       0.1       0.1       0.1       0.1       0.1       0.1       0.1       0.1       0.1       0.1       0.1																								
0.6       15.4         0.3       5.6         0.15       5.2         0.075       3.1         300       28         46.8       1         0.05       200         GRADING CURVE																								
0.425       6         0.3       5.6         0.15       5.2         0.075       3.1         0.075       3.1         0.075       3.1         0.075       3.1         0.075       3.1         0.075       3.1         0.075       3.1         0.075       3.1         0.075       3.1         0.075       3.1         0.075       3.1         0.075       3.1         0.075       3.1         0.075       3.1         0.075       3.1         0.075       3.1         0.075       3.1         0.15       5.2         0.075       3.1         0.15       5.2         0.15       5.2         0.15       5.2         0.15       5.2         0.15       5.2         0.15       5.2         0.15       5.2         0.15       5.2         0.15       5.2         0.15       5.2         0.15       5.2         0.15       5.2         0.15       5.2 <td></td> <td>-</td> <td></td> <td>1</td> <td></td> <td></td> <td>·</td> <td></td> <td></td> <td></td>																-		1			·			
0.3       6.6         0.15       5.2         0.075       3.1         1.6       45.3         200       GRADING CURVE         GRADING CURVE         00       00         GRADING CURVE         OPE																								
0.075       3.1       16       45.3         200       GRADING CURVE         0       00       00       00         0       00       00       00       00         0       00       00       00       00         0       00       00       00       00         0       00       00       00       00         0       00       00       00       00         00       00       00       00       00         00       00       00       00       00         00       00       00       00       00         00       00       00       00       00         00       00       00       00       00         00       00       00       00       00         00       00       00       00       00         00       00       00       00       00         00       00       00       00       00         00       00       00       00       00         00       00       00       00       00         00       00 </td <td></td>																								
90.5     45.3       GRADING CURVE       Improve the set N°:       improve the set N°:     improve the set N°:		0.15		5.2	2			2.6					46.8											
200     GRADING CURVE       100     00       90     00       90     00       90     00       90     00       90     00       90     00       90     00       90     00       90     00       90     00       90     00       90     00       90     00       90     00       90     00       90     00       90     00       90     00       90     00       90     00       90     00       90     00       90     00       90     00       90     00       90     00       90     00       90     00       90     00       90     00       90     00       90     00       90     00       90     00       90     00       90     00       90     00       90     00       90     00       90     00       90     00		0.075		3.1	1			1.6					45.3											
GRADING CURVE				90.	5			45.3																
import       Sieve set N°:       Shaker N°       Scale N°:         schnickan       Mathew Mburu       Verified :Lab. Incharge       Martin Mburu         tberrortions:       berrortions:       berrortions				200	D																			
9       9       9       9       9       9       9       9       9       9       9       9       9       9       9       9       9       9       9       9       9       9       9       9       9       9       9       9       9       9       9       9       9       9       9       9       9       9       9       9       9       9       9       9       9       9       9       9       9       9       9       9       9       9       9       9       9       9       9       9       9       9       9       9       9       9       9       9       9       9       9       9       9       9       9       9       9       9       9       9       9       9       9       9       9       9       9       9       9       9       9       9       9       9       9       9       9       9       9       9       9       9       9       9       9       9       9       9       9       9       9       9       9       9       9       9       9       9       9									GRA	DIN	G CI	URVE												
y       y       y       y       y       y       y       y       y       y       y       y       y       y       y       y       y       y       y       y       y       y       y       y       y       y       y       y       y       y       y       y       y       y       y       y       y       y       y       y       y       y       y       y       y       y       y       y       y       y       y       y       y       y       y       y       y       y       y       y       y       y       y       y       y       y       y       y       y       y       y       y       y       y       y       y       y       y       y       y       y       y       y       y       y       y       y       y       y       y       y       y       y       y       y       y       y       y       y       y       y       y       y       y       y       y       y       y       y       y       y       y       y       y       y       y       y       y       y		100																	-	-				
<b>a b b b c c c c c c c c c c c c c c c c c c c c c c c c c c c c c c c c c c c c c c c c c c c c c c c c c c c c c c c c c c c c c c c c c c c c c c c c c c c c c c c c c c c c c c c c c c c c c c c c c c c c c c c c c c c c c c c c c c c c c c c c c c c c c c c c c c c c c c c c c c c c c c c c c c c c c c c c c c c c c c c c c c c c c c c c c c c c c c c c c c c c c c</b>																	$\square$		•	Ĭ				
y       y       y       y       y       y       y       y       y       y       y       y       y       y       y       y       y       y       y       y       y       y       y       y       y       y       y       y       y       y       y       y       y       y       y       y       y       y       y       y       y       y       y       y       y       y       y       y       y       y       y       y       y       y       y       y       y       y       y       y       y       y       y       y       y       y       y       y       y       y       y       y       y       y       y       y       y       y       y       y       y       y       y       y       y       y       y       y       y       y       y       y       y       y       y       y       y       y       y       y       y       y       y       y       y       y       y       y       y       y       y       y       y       y       y       y       y       y       y		90														1								
		80														-								
30     20     10     10     10       10     0.1     1     10       Sieves (mm)	-	70							_					~								_		
30     20     10     10     10       10     0.1     1     10       Sieves (mm)	8	60										-				_						_		
30     20     10     10     10       10     0.1     1     10       Sieves (mm)	ğ	50							-	-														
30     20     10     10     10       10     0.1     1     10       Sieves (mm)	Sir					•	-																	
30     20     10     10     10       10     0.1     1     10       Sieves (mm)	Sas																							
10     0       0     0.1       0.01     0.1       Sieves (mm)	-	30																						
0     0.1     1     10       Sieves (mm)       uuipment     Sieve set N° :     Shaker N°     Scale N° :       sechnician     Mathew Mburu     Verified :Lab. Incharge     Martin Mburu       ate     03-Jan-20     Servations:		20							_													_		
0.01 0.1 1 10 Sieves (mm) uipment Sieve set N°: Scale		10			+											_	+					_		
0.01 0.1 1 10 Sieves (mm) ujupment Sieve set N°: Scale		0																						
puipment     Sieve set N°:     Shaker N°     Scale N°:       echnician     Mathew Mburu     Verified :Lab. Incharge     Martin Mburu       ate     03-Jan-20     Scale N°:     Scale N°:						C	).1					1						10						10
uipment Sieve set N°: Shaker N° Scale N°: Scale N°: echnician Mathew Mburu Verified :Lab. Incharge Martin Mburu ate 03-Jan-20 bservations:										Si	eve	s (mi	m)											
echnician Mathew Mburu Verified :Lab. Incharge Martin Mburu ate 03-Jan-20 bservations:												- (	,											
echnician Mathew Mburu Verified :Lab. Incharge Martin Mburu ate 03-Jan-20 bservations:											_								-					
ate 03-Jan-20 Ibservations:									Shal	ker N°		<b>C</b> 1 1	. <b>.</b>											
Ubservations:		n				buru					veri	Tied :L	ab. Ir	icnarge	2			Martin	MDUI	u				
		ions:		03-10	ur1-20						J													
			ifications																					
		ii io ine spec																						



DEPARTMENT OF CIVIL & CONSTRUCTION ENGINEERING

Sample source Depth (m)		mbu Count	(l atonitio /	Snowell L	nner Kehe	to Commun	(Daim Form	) LIAN	
Dedtr (m)	Membley Quarry, Kia			_		re campus			
		SAMPLE N		12% FC	b		Sr	. No.	
Test date:	24-Jan-20		Locatio						
Specification	According to BS 1377:	1990.	Sample	e Descrip	tion: FCl	) Mechan	ical Stabilize	d Sample	2
an mass		(gm)	0						
nitial dry sample mass + pa	n	(gm)							
itial dry sample mass		(gm)	200		ine mass			(gm)	93.1
/ashed dry sample mass +	pan	(gm)	100.0		Fine percent	itaria		(%)	46.6
/ashed dry sample mass		(gm)	106.9		Acceptance Cr	literia		(%)	
				Cum	ulative passed		Acc	eptance Cri	teria
Sieve size (mm)	Retained mass (gm)	% Retai	ined (%)		centage (%)		Min(%)		Max (%)
20	0		.0		100.0				
14	0		.0		100.0				
10	2		.0		99.0				
5	20.1		0.1		89.0				
2.36	31.2		5.6		73.4		1		
1.18	22.5	-	l.3 -		62.1				
0.6	13.4	-	.7		55.4				
0.425	5.2		.6		52.8				
0.3	4.1		.1		50.8				
0.15	5.3		.7		48.1				
0.075	3.1	-	.6	ļ	46.6				
	93.1 200	46	5.6	L					
	200		GRADIN	IG CURVI	E				
100								•	
100									
90									
80						$\land \vdash$			
70					•				
60									
.2 50	• • • • • • • • • • • • • • • • • • •	-							
<b>S</b> 40									
<b>d</b> 30									
20									
10									
0									
0.01	0.1		Si	eves (m	ım)		10		1(
quipment	Sieve set N° :		Shaker N	٩			Scale N° :		
	Mathew Mburu			Verified :	Lab. Incharge	2	Martin Mburu	1	
echnician	24-Jan-20								

### **Summary of FCD Stabilized Results**

Compa	action Properties	
Stabilized Material	MDD (kg/m <sup>3</sup> )	OMC (%)
3% FCD Stabilized	1613	25.25
6% FCD Stabilized	1553	26.39
9% FCD Stabilized	1532	28.31
12% FCD Stabilized	1474	29.50

#### Strength Properties UCS (kN/m<sup>2</sup>)

			-	-				
 FCD	Sample1	Sample2	Sample3	Sample4	Sample5	Sample6	Sample7	Average
 3%	123	241	248	211	207	223	218	245
6%	317	288	187	245	192	296	274	300
9%	318	251	268	206	213	235	283	267
12%	240	157	155	186	177	213	205	213

Strength Properties CBR (%)

 FCD	Sample1	Sample2	Sample3	Sample4	Sample5	Sample6	Sample7	Average
3%	21	22	21	16	20	23	17	22
6%	53	44	48	53	44		56	54
9%	37	24	27	_21	27	31	34	34
12%	22		17		24	_32	28	25

Atterberg Limits FCD Liquid Limit Plastic Limit Plasticity Index Linear Shrinkage 3% 37 36 73 17 70 37 33 17 6% 9% 70 30 40 14 74 34 12% 40 13

G	rading
FCD	% of fines
3%	41.1
6%	42.5
9%	45.3
12%	46.6

### Appendix E CDA Stabilized Samples

Appendix E1 Compaction Properties (MDD & OMC)

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# Moisture - Density

Sample Type	Chemical stabilizat	Chemical stabilization of the Lateritic Gravel			
Sample source	Membley Quarry, k	liambu County (Natural Gra	Membley Quarry,Kiambu County (Natural Gravel)&Upper Kabete Campus (Dairy farm) UON (CDA)		
Sample Date	10-Mar-20	Sample No	Depth	- 0¢/1	
Test date	10-Mar-20	Sample Description	3% CDA		
Specification	In accordance with	with BS 1377: 1990	-	1675	
				1	

Wt of Mould (g)	4700	Volume	Volume of Mould (I)		0.956				1600			
Test No		NMC	1	2	e	4	ß	( <sub>2</sub>				
Wt of mould + wet material (g)	(6)		6435	6550	6635	6695	6675	w/f				
Wt wet material (g)			1735	1850	1935	1995	1975	<sup>ў</sup> я) с	1525			
Wet density (kg/m <sup>3</sup> )			1815	1935	2024	2087	2066	MDI				
	-		Moist	isture content					1160	•		
Container No		195	223	197	204	184	216		0041			
Wt of container + wet material (g)		244.10	135.70	151.70	164.70	150.60	163.50					
Wt of container (g)		78.60	79.70	78.10	79.80	78.90	79.20		1375			
Wt of container + dry material (g)		223.20	126.70	138.60	148.10	135.30	143.80					
Wt dry material (g)		144.60	47.00	60.50	68.30	56.40	64.60					
Wt of moisture (g)		20.90	9.00	13.10	16.60	15.30	19.70		1300	19.00	23.00	27.00
Moisture content (%)		14.45	19.15	21.65	24.30	27.13	30.50					
Dry density (kg/m³)			1523	1591	1628	1642	1583				Moisture C	Moisture Content (%)

26.2	1642
Optimum Moisture Content (%)	Maximum Dry Density (kg/m³)

Technician	Mathew Mburu	Verified :	Martin Mburu
Date	11-Mar-20		
Observations:		1	
Conform to the specifications	S		

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DEPARTMENT OF CIVIL & CONSTRUCTION ENGINEERING UNIVERSITY OF NAIROBI

# Moisture - Density

Comple Time	-ilidato locimody	Constructed and the astro-tilidate locimod			
addi addunc		THOM OF THE PRIETING OF UVER			
Sample source	Membley Quarry, K	Kiambu County (Natural Gra	kiambu County (Natural Gravel) & Upper Kabete Campus (Dairy Farm) UON (CDA)	1760	
Sample Date	10-Mar-20	Sample No	Depth	06/1	
Test date	10-Mar-20	Sample Description 6% CDA	6% CDA		
Specification	In accordance with	n BS 1377: 1990		1675	

Wt of Mould (g) 4700	Volume	Volume of Mould (I)		0.956			1600			
Test No	NMC	1	2	8	4	5	( <sub>E</sub>			
Wt of mould + wet material (g)		6405	6515	6640	6685	6620	w/f		<b>~</b>	
Wt wet material (g)		1705	1815	1940	1985	1920	ر (Ký			
Wet density (kg/m <sup>3</sup> )		1783	1899	2029	2076	2008	IDM			
		Moist	isture content				1160			
Container No	195	62	222	183	107	198	OCTI			
Wt of container + wet material (g)	244.10	164.80	153.80	168.10	169.80	161.50				
Wt of container (g)	78.60	94.70	79.20	79.00	95.30	85.00	1375			
Wt of container + dry material (g)	223.20	153.50	140.30	150.50	153.60	143.70				
Wt dry material (g)	144.60	58.80	61.10	71.50	58.30	58.70				
Wt of moisture (g)	20.90	11.30	13.50	17.60	16.20	17.80	1300	0 19.00	23.00	27.00
Moisture content (%)	14.45	19.22	22.09	24.62	27.79	30.32				
Dry density (kg/m³)		1496	1555	1628	1625	1541			Moisture (	Moisture Content (%)

26.6	1638
Optimum Moisture Content (%)	Maximum Dry Density (kg/m <sup>3</sup> )

Technician	Mathew Mburu	Verified :	Martin Mburu
Date	11-Mar-20		
Observations:		1	
Conform to the specifications	. Si		

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DEPARTMENT OF CIVIL & CONSTRUCTION ENGINEERING

# Moisture - Density

Sample Type	Chemical Stabilization	ization of L	of Lateritic Gravel					
Sample source	Membley Quarry, kiam	'y, kiambu C	county (Natural Gr	avel) & Upper Ko	bete Campus (Dairy	mbu County (Natural Gravel) & Upper Kabete Campus (Dairy Farm) UON (CDA)	1760	 
Sample Date	10-Mar-20	Sample No	e No		Depth	th.	00/17	
Test date	10-Mar-20	Sample	iample Description	9% CDA				 
Specification	In accordance with BS	ith BS 1377	1377: 1990				1675	
Wt of Mould (q)	4700	Volume	olume of Mould (1)	0.956				 
					•		ODOT	

Wt of Mould (g) 4700	Volu	Volume of Mould (I)		0.956			1600				1
Test No	NMC	1	7	m	4	5		2			/
Wt of mould + wet material (g)		6410	6510	6615	6660	6605	u/f		•		
Wt wet material (g)		1710	1810	1915	1960	1905	) (K	2			
Wet density (kg/m³)		1789	1893	2003	2050	1993	MDI		×		
		Moist	isture content				1				
Container No	195	208	201	181	58	63	Ct-1	2			
Wt of container + wet material (g)	244.10	157.50	161.00	149.40	169.10	173.60					
Wt of container (g)	78.60	78.80	78.30	79.80	93.80	93.00	1375	<sup>5</sup>			
Wt of container + dry material (g)	223.20	144.60	145.80	135.20	152.50	154.00					
Wt dry material (g)	144.60	65.80	67.50	55.40	58.70	61.00					
Wt of moisture (g)	20.90	12.90	15.20	14.20	16.60	19.60	1300	00	19.00 23	23.00 27.00	90 31.00
Moisture content (%)	14.45	19.60	22.52	25.63	28.28	32.13				:	
Dry density (kg/m <sup>3</sup> )		1496	1545	1594	1598	1508				Moisture	Moisture Content (%)
	-	-									

27.4	1602
Optimum Moisture Content (%)	Maximum Dry Density (kg/m³)

Technician	Mathew Mburu	Verified :	Martin Mburu
Date	11-Mar-20		
Observations:		1	
Conform to the specification	s		

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35.00

DEPARTMENT OF CIVIL & CONSTRUCTION ENGINEERING UNIVERSITY OF NAIROBI

# Moisture - Density

Sample Type	Chemical Stabiliza	Chemical Stabilization of the Lateritic Gravel				
Sample source	Membley Quarry,	Kiambu County (Natural Gr	Membley Quarry, Kiambu County (Natural Gravel) & Upper Kabete Campus (Dairy Farm) UON (CDA)			
Sample Date	10-Mar-20	Sample No	Depth	1600 -		
Test date	10-Mar-20	Sample Description	12% CDA			<b>`</b>
Specification	In accordance with BS 1377: 1990	1 BS 1377: 1990				>
				1575		
Wt of Mould (g)	4700	Volume of Mould (I)	0.956	CZCT		

Wt of Mould (g)         4700         Volume of Mould (l)         0.956           Test No         NMC         1         2         3         4           Wt of mould + wet material (g)         NMC         1         2         3         4           Wt of mould + wet material (g)         NMC         1735         1830         1915         1965           Wt wet material (g)         N         1735         1815         1914         2003         2055           Wt wet material (g)         N         1915         1914         2003         2055           Wt wet material (g)         195         1815         1914         2003         2055           Wt of container No         195         98         106         133         165           Wt of container + wet material (g)         244.10         196.70         199.10         221.70         197.30           Wt of container + wet material (g)         78.60         111.40         109.80         108.10           Wt of container + wet material (g)         233.20         181.70         182.40         197.30           Wt of container (g)         144.60         71.30         21.40         23.40         20.30           Wt of moisture (g)         144	0.956 3 4		1525		
4700         Volume of Mould (I)         0.956           st No         NMC         1         2         3           vet material (g)         NMC         1         2         3           vet material (g)         1735         1830         1915         1915           (g)         1735         1815         1914         2003            (m <sup>3</sup> )         195         98         106         133         133           /m <sup>3</sup> )         195         98         106         133         133           + wet material (g)         244.10         196.70         199.10         221.70         133           + wet material (g)         244.10         196.70         199.10         221.70         133           (g)         78.60         110.40         111.40         199.80         166         133           (g)         78.60         181.70         182.40         198.30         198.30         198.30         198.30         198.30         198.30         198.30         198.40         198.30         198.30         198.30         198.30         198.30         198.30         198.30         198.30         198.40         198.30         198.30         198.40	0.956 3 4		C7CT		
loNMC123material (g)NMC123material (g) $(6435)$ $(6530)$ $(6615)$ 3material (g) $(1735)$ $(1830)$ $(1915)$ $(1915)$ $(1915)$ $(1735)$ $(1815)$ $(1914)$ $2003$ $(1133)$ $(195)$ $(1914)$ $(1914)$ $(203)$ $(1133)$ $(195)$ $(196)$ $(196)$ $(196)$ $(133)$ $(191)$ $(241)$ $(196)$ $(199)$ $(133)$ $(111)$ $(196)$ $(111)$ $(199)$ $(193)$ $(111)$ $(196)$ $(111)$ $(191)$ $(193)$ $(111)$ $(191)$ $(111)$ $(191)$ $(193)$ $(111)$ $(111)$ $(111)$ $(191)$ $(193)$ $(111)$ $(111)$ $(111)$ $(193)$ $(111)$ $(111)$ $(111)$ $(111)$ $(193)$ $(111)$ $(111)$ $(111)$ $(111)$ $(193)$ $(111)$ $(111)$ $(111)$ $(111)$ $(111)$ $(193)$ $(111)$ $(111)$ $(111)$ $(111)$ $(193)$ $(111)$ $(111)$ $(111)$ $(111)$ $(193)$ $(111)$ $(111)$ $(111)$ $(111)$ $(111)$ $(111)$ $(111)$ $(111)$ $(111)$ $(111)$ $(111)$ $(111)$ $(111)$ $(111)$ $(111)$ $(111)$ $(111)$ $(111)$ $(111)$ $(111)$ $(111)$ $(111)$ $(111)$ $(111)$ $(111)$	3 4				
material (g) $6435$ $6530$ $6615$ $6135$ $6530$ $6615$ $6615$ $6135$ $6815$ $6135$ $1830$ $1915$ $1915$ $1915$ $1915$ $1915$ $1915$ $1915$ $1915$ $1915$ $1915$ $1915$ $1915$ $1915$ $1915$ $1915$ $1915$ $1915$ $1915$ $1915$ $2003$ $1015$ $2003$ $2003$ $2003$ $2003$ $2010$ $2010$ $1914$ $2003$ $2010$ $100$ $2010$ $100$ $2010$ $100$ $2010$ $100$ $2010$ $100$ $2010$ $100$ $2010$ $100$ $200$ $100$ $200$ $100$ $200$ $100$ $200$ $100$ $200$ $100$ $200$ $100$ $200$ $100$ $200$ $100$ $200$ $100$ $200$ $100$ $100$ $100$ $200$ $100$ $100$ $100$ $100$ $100$ $1000$ $100$ $100$		5	(ε	)	
0 $1735$ $1830$ $1915$ $1915$ $1915$ $1915$ $2003$ $$ 1         1         1         1         1 $2003$ $$ $$ $$ $$ $$ $$ $$ $$ $$ $$ $$ $$ $$ $$ $$ $$ $$ $$ $$ $$ $$ $$ $$ $$ $$ $$ $$ $$ $$ $$ $$ $$ $$ $$ $$ $$ $$ $$ $$ $$ $$ $$ $$ $$ $$ $$ $$ $$ $$ $$ $$ $$ $$ $$ $$ $$ $$ $$ $$ $$ $$ $$ $$ $$ $$ $$ $$ $$ $$ $$ $$ $$ $$	6015 6665	6560	w/6		
()         1815         1914         2003           Moisture content         Moisture content         133           ret material (g)         244.10         196.70         133           ret material (g)         244.10         196.70         199.10         221.70           ret material (g)         78.60         110.40         111.40         109.80           ry material (g)         223.20         181.70         182.40         198.30           ry material (g)         223.20         181.70         182.40         23.40           ry material (g)         20.90         15.00         16.70         23.40           d)         144.65         21.04         23.52         26.44	1915 1965	1860	1450 Iter		
Moisture content           195         98         106         133           let material (g)         244.10         196.70         199.10         221.70           ret material (g)         244.10         196.70         199.10         221.70           ret material (g)         243.10         196.70         199.10         221.70           ry material (g)         233.20         181.70         182.40         198.30           ry material (g)         223.20         181.70         182.40         288.50           ry material (g)         20.90         15.00         16.70         23.40           abs         144.65         21.04         23.52         26.44	2003 2055	1946	IQM		
195         98         106         133           ret material (g) $244.10$ $196.70$ $199.10$ $221.70$ ret material (g) $78.60$ $110.40$ $111.40$ $109.80$ ry material (g) $223.20$ $181.70$ $182.40$ $198.30$ ry material (g) $223.20$ $181.70$ $182.40$ $198.30$ ry material (g) $223.20$ $181.70$ $182.40$ $28.50$ ry material (g) $71.30$ $71.00$ $88.50$ $88.50$ ry material (g) $144.60$ $71.30$ $21.00$ $23.40$ $88.50$ ry material (g) $14.45$ $21.04$ $23.52$ $26.44$ $23.54$	itent				
Act material (g) $244.10$ $196.70$ $199.10$ $221.70$ $78.60$ $110.40$ $111.40$ $109.80$ $ry$ material (g) $223.20$ $181.70$ $182.40$ $198.30$ $ry$ material (g) $223.20$ $181.70$ $182.40$ $198.30$ $ry$ material (g) $223.20$ $181.70$ $182.40$ $28.50$ $144.60$ $71.30$ $71.00$ $88.50$ $20.90$ $15.00$ $16.70$ $23.40$ $\bullet$ $14.45$ $21.04$ $23.52$ $26.44$	133 165	171			
78.60         110.40         111.40         109.80           ry material (g)         223.20         181.70         182.40         198.30           144.60         71.30         71.00         88.50         23.40           20.90         15.00         16.70         23.40         14.45           10         14.45         21.04         23.52         26.44	221.70 197.30	230.80	1375		
ry material (g)         223.20         181.70         182.40         198.30           144.60         71.30         71.00         88.50           20.90         15.00         16.70         23.40           14.45         21.04         23.52         26.44	109.80 108.10	110.00			
144.60         71.30         71.00         88.50           20.90         15.00         16.70         23.40           14.45         21.04         23.52         26.44	198.30 177.00	201.80			
20.90         15.00         16.70         23.40           14.45         21.04         23.52         26.44	88.50 68.90	91.80			
14.45 21.04 23.52 26.44	23.40 20.30	29.00	1300 + 15.00	19.00 23.00	0 27.00
	26.44 29.46	31.59		:	
Dry density (kg/m <sup>3</sup> ) 1499 1550 1584 1588	1584 1588	1479		MOIST	Moisture Content (%)

27.6	1601
Optimum Moisture Content (%)	Maximum Dry Density (kg/m <sup>3</sup> )

Technician	Mathew Mburu	Verified :	Martin Mburu
Date	11-Mar-20		
Observations:		]	
Conform to the specifications	S		

35.00

No.

UNIVERSITY OF NAIROBI DEPARTMENT OF CIVIL & CONSTRUCTION ENGINEERING

# Moisture - Density

Sample Type	Chemical Stabilization of	zation of the Lateritic Gravel			
Sample source	Membley Quarry, Kiambu	r,Kiambu County (Natural Gra	ı County (Natural Gravel) & Upper Kabete Campus (Dairy Farm) UON (CDA)	1750	
Sample Date	10-Mar-20	Sample No	Depth		
Test date	10-Mar-20	Sample Description	15% CDA	1675	
Specification	In accordance wi	In accordance with BS 1377: 1990			
Wt of Mould (g)	4700	Volume of Mould ()	0.956	1600	

Wt of Mould (g)	4700	Volume	Volume of Mould (I)		0.956				1600				
Test No		NMC	1	2	8	4	5	( <sub>ɛ</sub> u				(	
Wt of mould + wet material (g)	ial (g)		6380	6495	6580	6620	6570	ı/6y	1676			י <u>ו</u>	/
Wt wet material (g)			1680	1795	1880	1920	1870	) ac	C7CT				
Wet density (kg/m <sup>3</sup> )			1757	1878	1967	2008	1956	ш					~
			Moisture c	ture content					1450				
Container No		195	151	50	161	134	146						
Wt of container + wet material (g)	terial (g)	244.10	197.50	203.00	214.10	221.10	199.40						
Wt of container (g)		78.60	109.10	92.70	105.90	103.80	106.70		1375				
Wt of container + dry material (g)	terial (g)	223.20	182.10	181.70	191.40	194.70	177.00						
Wt dry material (g)		144.60	73.00	89.00	85.50	90.90	70.30		1300				
Wt of moisture (g)		20.90	15.40	21.30	22.70	26.40	22.40		15.00	19.00	23.00	27.00	31.00
Moisture content (%)		14.45	21.10	23.93	26.55	29.04	31.86				Moisture Content (%)	ntent (%)	
Dry density (kg/m <sup>3</sup> )			1451	1515	1554	1556	1483						

27.8	1560
Optimum Moisture Content (%)	Maximum Dry Density (kg/m³)

Technician	Mathew Mburu	Verified :	Martin Mburu
Date	11-Mar-20		
Observations:		1	
Conform to the specification	8		

**Appendix E2 Strength Properties (UCS)** 

#### UNIVERSITY OF NAIROBI WORKING SHEET (HIGHWAYS LABORATORY) **UCS TEST** SPECIMEN 1 **Project: Chemical Stabilization of Lateritic Gravel** Date: 21-Sept-2020 No. of days cured: 7 Student: Anthony Mugendi Nyagah Mould No.: No. of days soaked: 0 DATA SAMPLE DETAILS MDD 1642 Do =152mm STABILIZED Туре OMC 26.2 Stabilizer Lo mm 127 3% CDA NMC 9.2 $\mathbf{m}^2$ 0.0181 Ao = (152x152x3.14)/4% 0 0.00275 Volume = AoLo m Stabilizer = CDA Defl. Deflection E=L/L0 1-E A=(Ao)/1-E Stress UCS TEST Load Q KN/m<sup>2</sup> KN mm 0.01810 0.00 0.0000 1 0 0 0.32 0.9975 0.01815 33 0.0025 0.60628 450 0.01819 0.64 0.0050 0.995 1.8452 101 400 0.01824 0.95 188 0.0075 0.9925 3.4268 1.27 0.01828 4.8766 267 0.0100 0.99 350 1.59 0.0125 0.9875 0.01833 5.8651 320 0.01838 1.91 6.59 359 0.0150 0.9850 300 0.01842 2.22 0.0175 0.9825 7.1172 386 Stress KN/m<sup>2</sup> 2.54 0.01847 392 7.23582 0.0200 0.9800 250 0.01852 6.94586 2.86 0.0225 0.9775 375 200 150 100 50 MOULDING MOISTURE CONTENT 0 · 0.04 · 0.036 · 0.032 · 0.028 · 0.024 · 0.024 · 0.024 · 0.024 · 0.024 · 0.024 · 0.024 · 0.024 · 0.024 · 0.036 · 0.036 · 0.036 · 0.036 · 0.036 · 0.036 · 0.036 · 0.036 · 0.036 · 0.036 · 0.036 · 0.036 · 0.036 · 0.036 · 0.036 · 0.032 · 0.032 · 0.032 · 0.032 · 0.032 · 0.032 · 0.032 · 0.032 · 0.032 · 0.032 · 0.032 · 0.032 · 0.032 · 0.032 · 0.032 · 0.032 · 0.032 · 0.032 · 0.032 · 0.032 · 0.032 · 0.032 · 0.032 · 0.032 · 0.032 · 0.032 · 0.032 · 0.032 · 0.032 · 0.032 · 0.032 · 0.032 · 0.032 · 0.032 · 0.032 · 0.032 · 0.032 · 0.032 · 0.032 · 0.032 · 0.032 · 0.032 · 0.032 · 0.032 · 0.032 · 0.032 · 0.032 · 0.032 · 0.032 · 0.032 · 0.032 · 0.032 · 0.032 · 0.032 · 0.032 · 0.032 · 0.032 · 0.032 · 0.032 · 0.032 · 0.032 · 0.032 · 0.032 · 0.032 · 0.032 · 0.032 · 0.032 · 0.032 · 0.032 · 0.032 · 0.032 · 0.032 · 0.032 · 0.032 · 0.032 · 0.032 · 0.032 · 0.032 · 0.032 · 0.032 · 0.032 · 0.032 · 0.032 · 0.032 · 0.032 · 0.032 · 0.032 · 0.032 · 0.032 · 0.032 · 0.032 · 0.032 · 0.032 · 0.032 · 0.032 · 0.032 · 0.032 · 0.032 · 0.032 · 0.032 · 0.032 · 0.032 · 0.032 · 0.032 · 0.032 · 0.032 · 0.032 · 0.032 · 0.032 · 0.032 · 0.032 · 0.032 · 0.032 · 0.032 · 0.032 · 0.032 · 0.032 · 0.032 · 0.032 · 0.032 · 0.032 · 0.032 · 0.032 · 0.032 · 0.032 · 0.032 · 0.032 · 0.032 · 0.032 · 0.032 · 0.032 · 0.032 · 0.032 · 0.032 · 0.032 · 0.032 · 0.032 · 0.032 · 0.032 · 0.032 · 0.032 · 0.032 · 0.032 · 0.032 · 0.032 · 0.032 · 0.032 · 0.032 · 0.032 · 0.032 · 0.032 · 0.032 · 0.032 · 0.032 · 0.032 · 0.032 · 0.032 · 0.032 · 0.032 · 0.032 · 0.032 · 0.032 · 0.032 · 0.032 · 0.032 · 0.032 · 0.032 · 0.032 · 0.032 · 0.032 · 0.032 · 0.032 · 0.032 · 0.032 · 0.032 · 0.032 · 0.032 · 0.032 · 0.032 · 0.032 · 0.032 · 0.032 · 0.032 · 0.032 · 0.032 · 0.032 · 0.032 · 0.032 · 0.032 · 0.032 · 0.032 · 0.032 · 0.032 · 0.032 · 0.032 · 0.032 · 0.032 · 0.032 · 0.032 · 0.032 · 0.032 · 0.032 · 0.032 · 0.032 · 0.032 · 0.032 · 0.032 · 0.032 · 0.032 · 0.032 · 0.032 · 0.032 · 0.032 · 0.032 · 0.032 · 0.032 · 0.032 · 0.032 · 0.032 · 0.032 · 0.032 · 0.032 · 0.032 · 0.032 · 0.032 · 0.032 · 0.032 · 0.032 0 Tin No. 181 Tin +Wet soil 136.7 Tin + Dry soil 121.4 Wt of Tin 78.4 Wt of Moisture 15.3 Strain Wt. of dry soil 43 **Moisture content** 35.6 RESULTS Results Specification Result **392** KN/m<sup>2</sup> **Unconfined Compressive Strength**

Mathew & Nyagah

Tested By:

Checked By:

Martin Mburu

**Estimated Elastic Modulus** 

(HIGHWAYS LABORATORY)

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### WORKING SHEET

#### UCS TEST

				SP	ECIMEN	2			
	Chemical Stabilization of Lateritic G	ravel	Date: 21-Sept-	-2020		ays cured:	7		
Student:	Anthony Mugendi Nyagah		Mould No.:			ays soaked:		0	
<b>.</b>	DATA		┥┝───	SAMF	PLE DETAI		MDD	16	
Do =152m		105	Type Stabilizer		STABIL		OMC	2	
Lo A a -(152-	<u>mm</u> (152x3.14)/4 m <sup>2</sup>	127 0.0181	Stabilizer %		3% C	DA	NMC		
$\frac{A0 - (152)}{Volume} =$		0.00275	70		v				
Stabilizer =			Defl.		Deflec	tion			
	UCS TEST			E=L/L0	1-E	A=(Ao)/1-E		ress	
								Q	
			mm	0.0000		0.01810	KN	KN/n	
	450		0.00	0.0000	1 0.9975	0.01810	0.8567	0 47	
	450								
			0.64	0.0050	0.995	0.01819	1.977	10	
	400		0.95	0.0075	0.9925	0.01824	3.295	18	
			1.27	0.0100	0.99	0.01828	4.4812	24	
	350		1.59	0.0125	0.9875	0.01833	5.77284	31	
			1.91	0.0150	0.9850	0.01838	6.59	35	
	300 -		2.22	0.0175	0.9825	0.01842	7.1172	38	
/m <sup>2</sup>	250		2.54	0.0200	0.9800 0.01847		7.3149	39	
KN K	250		2.86	0.0225	0.9775	0.01852	7.01176	37	
Stress KN/m²									
	200								
	150								
	100								
	50								
	o <b>-</b>		Ν	10ULDI	NG MOI	STURE CON	TENT		
	- 0.032 - 0.028 - 0.028 - 0.016 - 0.012 - 0.018 - 0.008		Tin No.		181				
	1008 1012 1012 1012 1012 1012 1012 1012	4 G	Tin +Wet soil				136.7		
			<u>Tin + Dry soil</u> Wt of Tin				121.4 78.4		
			Wt of Moistur	·e			15.3		
	Strain		Wt. of dry soi				43		
	r		Moisture cont	ent			35.6		
			<b>RESULTS</b>						
	Results		Specification			Resu			
	Unconfined Compressive Strength					<b>396 K</b> I	N/m <sup>*</sup>		
	Estimated Elastic Modulus	Tested	By: Mathew a			Checked By:		n Mbuı	

(HIGHWAYS LABORATORY)

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### WORKING SHEET

#### UCS TEST

Ductor	Thomas 1 St	ahi!!		the st	Lat		C		D-4	. <b>)1</b> 94		ECIMEN		1.		7	
	Chemical Sta					ritic	Gravel			e: 21-Sept-	-2020	No. of da	•		7		
Student:	Anthony N	luge		vyag TA	ah				Mou	ild No.:	SAMP	No. of da LE DETAI		ed:		0 16	
Do =152n	ım		DA				I		-	Trme	54.01	STABIL			MDD OMC	2	
Do -15211 Lo	1111		mm					127	-	Type Stabilizer		3% Cl			NMC	2	
	x152x3.14)/4			m <sup>2</sup>				0.0181		%		0			Time		
Volume =		•		m <sup>3</sup>				0.00275									
Stabilizer =			-							Defl.		Deflec	tion				
											E=L/L0	1-F	A=(Ao	)/1_F	St	ress	
		UC	S TE	ST							L L/LU	1 12	11 (110	<i>,</i> ,,,,,,,,,,,,,,,,,,,,,,,,,,,,,,,,,,,	Load		
										mm					KN	∝ KN/n	
										0.00	0.0000	1	0.018	210	0	0	
	400 -									0.32	0.0000	0.9975	0.018		0.9226	51	
	-00																
										0.64	0.0050	0.995	0.018		2.00336	11	
	350 -	+		╞			+			0.95	0.0075	0.9925	0.018		2.87324	15	
										1.27	0.0100	0.99	0.018	828	3.6904	20	
	300 -	$\left  \right $	+	$\left  \right $	+	$\left  \cdot \right $	+			1.59	0.0125	0.9875	0.018	833	4.3494	23	
										1.91	0.0150	0.9850	0.018	838	4.90296	26	
	250 -	++	_/	$\left  \right $	_	$\left  \right $				2.22	0.0175	0.9825	0.018	842	5.56196	30	
l/m²			ľ							2.54	0.0200	0.9800	0.018	847	6.30004	34	
X X X	200 -	$\square$	/							2.86	0.0225	0.9775	0.018	852	5.94418	32	
Stress KN/m <sup>2</sup>			/														
	150 -	-															
	100																
	100			+			+										
	50 -	╉		+	+	$\square$	+		-								
									MOULDIN Tin No.			NG MOISTURE CONT			181		
	- 0.04 - 0.036 - 0.022 - 0.022 - 0.016 - 0.004 - 0.004 - 0.004								Tin No. Tin +Wet soil					181			
		04 04 04 04 04 04 04 04 04 04 04							Tin + Wet soll Tin + Dry soil						136.7 121.4		
									Wto	Wt of Tin				<u> </u>			
				_	_					Wt of Moisture							
				St	rain					of dry soil					43		
	r								Mois	sture cont	ent				35.6		
			Р					-		ESULTS				Dest			
	Unconfined (	Comp		esults e Stro					Sp	ecification			34	Result			
	Estimated El				~			1									
	•							Tested	By:	Mathew &	& Nyagah	i	Checke	d By:	Martin	n Mbu	

(HIGHWAYS LABORATORY)

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## WORKING SHEET

#### UCS TEST

					SP	ECIMEN	1		
Project: (	hemical Stabilizat	tion of Lateritic Gra	vel	Date: 21-Sept	-2020	No. of da	ays cured:		7
Student:	Anthony Mugend			Mould No.:			ays soaked:		0
		DATA			SAMP	LE DETAI	LS	MDD	16
Do =152m	m			Туре		STABIL		OMC	2
Lo	m		127	Stabilizer		6% Cl	DA	NMC	
	152x3.14)/4	$\frac{m^2}{m^3}$	0.0181	%		0			
Volume = Stabilizer = (		m	0.00275	Defl.		Deflec	tion		
Jubilizer	CDI					Denee		-	
	UCS	TEST			E=L/L0	1-E	A=(Ao)/1-E		tress
	000								Q
				mm				KN	KN/n
				0.00	0.0000	1	0.01810	0	0
	450			0.32	0.0025	0.9975	0.01815	0.9226	51
		┥┥┓		0.64	0.0050	0.995	0.01819	3.0314	16
	400			0.95	0.0075	0.9925	0.01824	4.4812	24
				1.27	0.0100	0.99	0.01828	6.0628	33
	350			1.59	0.0125	0.9875	0.01833	7.1172	38
	300 -			1.91	0.0150	0.9850	0.01838	7.67076	41
				2.22	0.0175	0.9825	0.01842	7.88164	42
ζ. M	250			2.54	0.0200	0.9800	0.01847	7.52578	40
s Kl				2.86	0.0225	0.9775	0.01852	6.94586	37
Stress KN/m <sup>2</sup>	200								
	<mark>/</mark>								
	150								
	100								
	50								
				N	IOULDI	NG MOI	STURE CON	TENT	
				Tin No.				<u>61</u>	
	008	- 0.036 - 0.036 - 0.032 - 0.028 - 0.024 - 0.024 - 0.02 - 0.016	2	Tin +Wet soil				142.8	
	÷ 30 k			Tin + Dry soil				129.1	
				Wt of Tin Wt of Moistur				92.3	
		Strain		Wt of Moistur Wt. of dry soi				<u>13.7</u> 36.8	
				Moisture cont				30.8	
			1	RESULTS					
		Results		Specification			Resu		
	Unconfined Compress						<b>428 K</b> I	N/m <sup>2</sup>	
	Estimated Elastic Mo	dulus	Tested		& Nyagah		Checked By		n Mbu

(HIGHWAYS LABORATORY)

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# WORKING SHEET

#### UCS TEST

			-		ECIMEN		1	
	Chemical Stabilization of Lateritic G	ravel	Date: 21/09/20	)20		ays cured:		7
Student:	Anthony Mugendi Nyagah		Mould No.:			ays soaked:	<u> </u>	0
	DATA		┥┝───	SAMP	PLE DETAI		MDD	16
Do =152n			Type Stabilizer		STABIL		OMC	2
Lo A. (152)	$\frac{mm}{x152x3.14)/4}$ m <sup>2</sup>	127 0.0181	Stabilizer		<u>6% C</u> 0	DA	NMC	
	· · ·	0.0181	/0		0			
Volume = Stabilizer =		0.00275	Defl.		Deflec	tion		
Jubilizer			Den					
	UCS TEST			E=L/L0	1-E	A=(Ao)/1-E		tress
	0001201						Load	-
			mm				KN	KN/n
			0.00	0.0000	1	0.01810	0	0
	500		0.32	0.0025	0.9975	0.01815	1.1862	65
			0.64	0.0050	0.995	0.01819	2.636	14
	450		0.95	0.0075	0.9925	0.01824	4.0858	22
	400		1.27	0.0100	0.99	0.01828	5.931	32
			1.59	0.0125	0.9875	0.01833	7.249	39
	350		1.91	0.0150	0.9850	0.01838	7.93436	43
	300		2.22	0.0175	0.9825	0.01842	8.1057	44
N/m <sup>2</sup>	300		2.54	0.0200	0.9800	0.01847	7.92118	42
Stress KN/m <sup>2</sup>	250		2.86	0.0225	0.9775	0.01852	7.01176	37
Stre	200							
	200							
	150	_						
	100							
	50							
			Ν	AOULDI	NG MOI	STURE CON	ГЕNT	
	- 0.038 - 0.032 - 0.028 - 0.016 - 0.012 - 0.018 - 0.018 - 0.008	0.0	Tin No.				61	
	)232 )232 )224 )12 )12 )12 )12	4 0	Tin +Wet soil				142.8	
			<u>Tin + Dry soil</u> Wt of Tin				129.1 92.3	
			Wt of 11n Wt of Moistur	*e			92.3	
	Strain		Wt of Moistal Wt. of dry soi				36.8	
			Moisture cont				37.2	
			RESULTS	-		<u> </u>	=	
	Results		Specification			Resu		
	Unconfined Compressive Strength				ļ	440 KN	N/m <sup>2</sup>	
	Estimated Elastic Modulus	Tested	By: Mathew			Checked By:		n Mbu

#### UNIVERSITY OF NAIROBI WORKING SHEET (HIGHWAYS LABORATORY) **UCS TEST** SPECIMEN 3 **Project: Chemical Stabilization of Lateritic Gravel** Date: 21-Sept-2020 No. of days cured: 7 student: Anthony Mugendi Nyagah Mould No.: No. of days soaked: 0 DATA SAMPLE DETAILS MDD 1638 Do =152mm STABILIZED Туре OMC 26.6 Stabilizer Lo mm 127 6% CDA NMC 9.2 $\mathbf{m}^2$ 0.0181 Ao = (152x152x3.14)/4% 0 0.00275 Volume = AoLo m Stabilizer = CDA Deflection Defl. E=L/L0 1-E A=(Ao)/1-E Stress UCS TEST Load Q KN/m<sup>2</sup> KN mm 0.01810 0.00 0.0000 1 0 0 0.32 0.9975 0.01815 125 0.0025 2.26696 450 0.01819 0.64 0.0050 0.995 4.45484 245 400 0.01824 0.95 325 0.0075 0.9925 5.931 1.27 0.01828 6.9854 382 0.0100 0.99 350 1.59 0.0125 0.9875 0.01833 7.6444 417 0.01838 1.91 0.0150 0.9850 7.8421 427 300 0.01842 2.22 0.0175 0.9825 7.85528 426 Stress KN/m<sup>2</sup> 0.01847 2.54 414 7.6444 0.0200 0.9800 250 0.01852 7.13038 2.86 0.0225 0.9775 385 200 150 100 50 MOULDING MOISTURE CONTENT 0 - 0.04 - 0.036 - 0.032 - 0.028 - 0.028 - 0.024 - 0.02 - 0.016 - 0.012 - 0.012 - 0.0012 - 0.008 0 Tin No. 61 Tin +Wet soil 142.8 Tin + Dry soil 129.1 Wt of Tin 92.3 Wt of Moisture 13.7 Strain Wt. of dry soil 36.8 **Moisture content** 37.2 RESULTS Results Specification Result 427 KN/m<sup>2</sup> **Unconfined Compressive Strength**

Mathew & Nyagah Checked By: Martin Mburu Tested By:

**Estimated Elastic Modulus** 

	UNIV	/ER	SIT	'Y (	OF	N	AI	RO	BI									
		HIGHV							Ī					WOR	KING	SHI	сет	
	(1	mont	L.	J	0101		(1)											
					T									UCS 7	FEST			
		~			a.								SP	ECIMEN	1			
Project: C	hemical	Stabi	ilizati	ion c	of La	ater	itic	Gra	vel		Date	21-Sept-	-2020	No. of da	iys cured	l:		7
Student:	Anthony	y Mug	gendi	Nya	gah						Moul	d No.:		No. of da	ys soake	ed:		0
			D	DATA	-						] [		SAMP	LE DETA	AILS		MDD	1602
Do =152m	m										] [	Туре		STABIL	IZED		OMC	27.4
Lo			mn							127	] [	Stabilizer		<b>9% C</b>	DA		NMC	9.2
Ao =(152x	152x3.14	4)/4		m <sup>2</sup>						0.0181		%		0				
Volume =				m <sup>3</sup>						0.00275								
Stabilizer = C	CDA										I	Defl.		Deflec	tion			
													Е ТЛА	1 1		)/1 E	54	
		U	cs т	EST							1		E=L/L0	1-12	A=(Ao	у/1-E		ress Q
											1							
												mm	0.000		0.07	210	KN	KN/m <sup>2</sup>
												0.00	0.0000	1	0.018		0	0
	550 -						Т		1			0.32	0.0025	0.9975	0.018		1.8452	102
												0.64	0.0050	0.995	0.018	819	3.8222	210
	500 -											0.95	0.0075	0.9925	0.018	824	5.6674	311
	450 -		+	-	-		+					1.27	0.0100	0.99	0.018	828	7.5785	415
	400 -		-									1.59	0.0125	0.9875	0.018	833	8.8965	485
	400											1.91	0.0150	0.9850	0.018	838	9.1601	498
~	350 -		+			$\square$	+					2.22	0.0175	0.9825	0.018	842	8.61972	468
(N/m	300 -											2.54	0.0200	0.9800	0.018		8.3034	450
Stress KN/m <sup>2</sup>												2.86	0.0225	0.9775	0.018	552	8.2375	445
Stre	250 -																	
	200 -	- +	++	_		$\square$	+		-									
	150 -																	
	100 -	┝┿┨╌	++			$\vdash$	+	+	$\left  \right $									
	50 -																ļ	
											·			NCMO	OTUDE	CONT	TINT	
	0		+		$\left  \right $			$\frac{1}{2}$	-		Tin N		IOULDI	NG MOI	SIUKE	CONT	ENT 24	
		0.004	1.00	.01	.02	02	.03	.03	04			-Wet soil					196.5	
		4	∞ N	0	4	> 00	Ň	0				· Dry soil					190.5	
											Wt o	f Tin					95	
												f Moistur					16	
				S	Strair	ı						of dry soil					85.5	
	·										Mois	ture cont	ent				18.7	
											RE	SULTS						
				Resu							Spec	ification				Result		
	Unconfi	ined (	Comp	press	ive	Stre	engt	h							49	8 KN	$/m^2$	
	Estimat	ed El	astic	Mo	վոր	s												
	Estimat	cu Li		11100														

(HIGHWAYS LABORATORY)

# X

# WORKING SHEET

### UCS TEST

					SPI	ECIMEN	2		
Project: (	Chemical Stabilization of Lateritic Grav	el				No. of da	ys cured:		7
Student:	Anthony Mugendi Nyagah		Mou	ld No.:			ys soaked:		0
	DATA				SAMP	LE DETAI	LS	MDD	16
Do =152n	nm			Туре		STABIL		OMC	2
Lo	mm	127	_	Stabilizer		<b>9% C</b>	DA	NMC	
	$\frac{x152x3.14}{4}$ m <sup>2</sup>	0.0181	-	%		0			
<u>Volume =</u> Stabilizer =		0.00275		Defl.		Deflec	tion	1	
stabilizer =	CDA		-	Dell.		Denec		-	
					E=L/L0	1-E	A=(Ao)/1-E	St	tress
	UCS TEST							Load	Q
				mm				KN	KN/m
				0.00	0.0000	1	0.01810	0	0
				0.32	0.0025	0.9975	0.01815	0.9226	51
	500			0.64	0.0050	0.995	0.01819	2.2406	123
				0.95	0.0075	0.9925	0.01824	3.92764	21
	450			1.27	0.0100	0.99	0.01828	5.4697	29
	400			1.59	0.0125	0.9875	0.01833	7.4467	40
	400			1.91	0.0150	0.9850	0.01838	8.6988	47
	350			2.22	0.0175	0.9825	0.01842	9.0283	49
N/m²	300			2.54	0.0200	0.9800	0.01847	8.46156	45
Stress KN/m <sup>2</sup>				2.86	0.0225	0.9775	0.01852	8.06616	43
Stree	250								
	200								
								-	
	150							-	
	100								
	50								
				N	<b>IOULDI</b>	NG MOI	STURE CON	FENT	
	0.036 0.036 0.028 0.028 0.028 0.024 0.016 0.012 0.0012 0.0012 0.004		Tin 1					24	
	04 04 04			+Wet soil				196.5	
			1 in - Wt o	+ Dry soil of Tin				<u>180.5</u> 95	)
				of Moistur	·e			16	
	Strain			of dry soil				85.5	
				sture cont				18.7	
				<u>ESULTS</u>					
	Results Unconfined Compressive Strength		Spo	ecification			Resul 490 KN		
	Estimated Elastic Modulus						JU III	/	
	Estimated Elastic Modulus	Tested I		Mathew &	0 NT. 1		Checked By:	N	n Mbur

(HIGHWAYS LABORATORY)

# 

# WORKING SHEET

### UCS TEST

		1		1 al	-						SP	ECIMEN	3			
Project: (	Chemical S	tabil	lizati	on o	f Lat	eritic	Grave	l	Date	e: 21-Sept-	-2020	No. of da	ys cured:		7	
Student:	Anthony I	Muge	endi 1	Nyag	gah				Mou	ld No.:		No. of da	ys soaked:		0	
			D	ATA					]		SAMP	LE DETAI	LS	MD	)	16
Do =152n	nm									Туре		STABIL	IZED	OM	C	2
Lo			mm					127		Stabilizer		9% CI	DA	NM	5	
	x152x3.14)/	4		$m^2$				0.0181	4	%		0				
Volume =				m <sup>3</sup>				0.00275								
Stabilizer =	CDA									Defl.		Deflec	tion			
											E=L/L0	1-E	A=(Ao)/1-	·E	Stress	
		UC	CS TE	EST									(),	Loa		
										mm				KN		/m
									<u> </u>	0.00	0.0000	1	0.01810			0
	550 -									0.32	0.0025	0.9975	0.01815			<u>9</u> 4
									<u> </u>	0.64	0.0050	0.995	0.01819			212
	500 -		$\left  \right $			+	++			0.95	0.0075	0.9925	0.01824			311
	450 -		ľ							1.27	0.0100	0.99	0.01828			107
	100									1.59	0.0125	0.9875	0.01833	8.632	-	171
	400 -		17	+			++			1.91	0.0150	0.9850	0.01838	9.160	1 4	198
	350 -			_	$\left  \right $	++				2.22	0.0175	0.9825	0.01842	9.186	46 4	199
N/m²	300 -	•								2.54	0.0200	0.9800	0.01847	8.856	96 4	180
s K	300									2.86	0.0225	0.9775	0.01852	8.474	74 4	158
Stress KN/m <sup>2</sup>	250 -					+	++									
	200 -	-	$\left  \right $	_	$\left  \right $	++										
	150 -															
	150 -								<u> </u>							
	100 -	<u> </u>		_		+										
	50 -															
	50											NG MOI				
	0 🔶	+				+			Tin		IOULDI	NG MUI	STURE CO	2	1	
	0	0.00	0.01	0.01	0.02	0.03	- 0.04			+Wet soil				190		
		4	ω N	о <sup>.</sup>	4	00 Ň	0			+ Wet son + Dry soil				190		
									Wt o	of Tin				9	5	_
				-						of Moistur				1		
				S	train					of dry soi				85		
	<b></b>								Mois	sture cont	ent			18	.7	
									<u>R</u>	ESULTS						
	Unconfined	Com		Result					Sp	ecification				sult KN/m <sup>2</sup>		
	Estimated E				ength								477 1	N1 \/ III		
								Tested I	By:	Mathew &	& Nyagah	11	Checked E	By: Ma	rtin Mb	ur

#### UNIVERSITY OF NAIROBI WORKING SHEET (HIGHWAYS LABORATORY) **UCS TEST** SPECIMEN 1 **Project: Chemical Stabilization of Lateritic Gravel** Date: 21-Sept-2020 No. of days cured: 7 Student: Anthony Mugendi Nyagah Mould No.: No. of days soaked: 0 DATA SAMPLE DETAILS MDD 1601 Do =152mm STABILIZED Туре OMC 27.6 Stabilizer Lo mm 127 12% CDA NMC 9.2 $\mathbf{m}^2$ 0.0181 Ao = (152x152x3.14)/4% 0 0.00275 Volume = AoLo m Stabilizer = CDA Deflection Defl. E=L/L0 1-E A=(Ao)/1-E Stress UCS TEST Load Q KN/m<sup>2</sup> KN mm 0.01810 0.00 0.0000 1 0 0 0.32 0.9975 0.01815 138 0.0025 2.5042 600 0.01819 0.64 0.0050 0.995 5.0084 275 550 0.01824 0.95 383 0.0075 0.9925 6.9854 500 1.27 0.01828 8.1057 443 0.0100 0.99 1.59 0.0125 0.9875 0.01833 9.1601 500 450 0.01838 1.91 0.0150 0.9850 9.38416 511 400 0.01842 2.22 0.0175 0.9825 9.8191 533 Stress KN/m<sup>2</sup> 350 2.54 0.01847 544 10.04316 0.0200 0.9800 0.01852 8.58018 2.86 0.0225 0.9775 463 300 250 200 150 100 50 **MOULDING MOISTURE CONTENT** 0 - 0.04 - 0.036 - 0.032 - 0.028 - 0.024 - 0.024 - 0.024 - 0.024 - 0.016 - 0.012 - 0.016 - 0.008 0 Tin No. 62 Tin +Wet soil 159 Tin + Dry soil 142 Wt of Tin 93.1 Wt of Moisture 17 Strain Wt. of dry soil 48.9 **Moisture content** 34.8 RESULTS Results Specification Result 544 KN/m<sup>2</sup> **Unconfined Compressive Strength Estimated Elastic Modulus**

Tested By: Mathew & Nyagah Checked By:

ecked By: Martin Mburu

#### UNIVERSITY OF NAIROBI WORKING SHEET (HIGHWAYS LABORATORY) **UCS TEST** SPECIMEN 2 **Project: Chemical Stabilization of Lateritic Gravel** Date: 21-Sept-2020 No. of days cured: 7 Student: Anthony Mugendi Nyagah Mould No.: No. of days soaked: 0 DATA SAMPLE DETAILS MDD 1601 Do =152mm STABILIZED Туре OMC 27.6 Stabilizer Lo mm 127 12% CDA NMC 9.2 $\mathbf{m}^2$ 0.0181 Ao = (152x152x3.14)/4% 0 0.00275 Volume = AoLo m Stabilizer = CDA Defl. Deflection E=L/L0 1-E A=(Ao)/1-E Stress UCS TEST Load Q KN/m<sup>2</sup> KN mm 0.01810 0.00 0.0000 1 0 0 0.32 0.9975 0.01815 0.0025 1.21256 67 500 0.01819 0.64 0.0050 0.995 2.636 145 450 0.01824 0.95 210 0.0075 0.9925 3.8222 1.27 0.01828 4.90296 268 0.0100 0.99 400 1.59 0.0125 0.9875 0.01833 6.3264 345 0.01838 1.91 394 0.0150 0.9850 7.249 350 0.01842 2.22 0.0175 0.9825 7.908 429 300 Stress KN/m<sup>2</sup> 2.54 0.01847 458 8.46156 0.0200 0.9800 0.01852 2.86 0.0225 0.9775 8.06616 436 250 200 150 100 50 MOULDING MOISTURE CONTENT 0 - 0.04 - 0.036 - 0.032 - 0.028 - 0.028 - 0.024 - 0.02 - 0.016 - 0.012 - 0.012 - 0.0012 - 0.008 0 Tin No. 62 Tin +Wet soil 159 Tin + Dry soil 142 Wt of Tin 93.1 Wt of Moisture 17 Strain Wt. of dry soil 48.9 **Moisture content** 34.8 RESULTS Results Specification Result

 Unconfined Compressive Strength
 458 KN/m<sup>2</sup>

 Estimated Elastic Modulus
 Tested By: Mathew & Nyagah

#### UNIVERSITY OF NAIROBI WORKING SHEET (HIGHWAYS LABORATORY) **UCS TEST** SPECIMEN 3 **Project: Chemical Stabilization of Lateritic Gravel** Date: 21-Sept-2020 No. of days cured: 7 Student: Anthony Mugendi Nyagah Mould No.: No. of days soaked: 0 DATA SAMPLE DETAILS MDD 1601 Do =152mm STABILIZED Туре OMC 27.6 Stabilizer Lo mm 127 12% CDA NMC 9.2 $\mathbf{m}^2$ 0.0181 Ao = (152x152x3.14)/4% 0 0.00275 Volume = AoLo m Stabilizer = CDA Defl. Deflection E=L/L0 1-E A=(Ao)/1-E Stress UCS TEST Load Q KN/m<sup>2</sup> KN mm 0.01810 0.00 0.0000 1 0 0 0.32 0.9975 0.01815 182 0.0025 3.295 450 0.01819 0.64 0.0050 0.995 4.3494 239 400 0.01824 0.95 267 0.0075 0.9925 4.8766 1.27 0.01828 5.5356 303 0.0100 0.99 350 1.59 0.0125 0.9875 0.01833 331 6.0628 0.01838 1.91 0.0150 0.9850 6.4582 351 300 0.01842 2.22 0.0175 0.9825 6.7218 365 Stress KN/m<sup>2</sup> 0.01847 2.54 382 7.0513 0.0200 0.9800 250 0.01852 2.86 0.0225 0.9775 6.7877 367 200 150 100 50 MOULDING MOISTURE CONTENT 0 - 0.04 - 0.036 - 0.032 - 0.028 - 0.028 - 0.024 - 0.02 - 0.016 - 0.012 - 0.012 - 0.0012 - 0.008 0 Tin No. 62 Tin +Wet soil 159 Tin + Dry soil 142 Wt of Tin 93.1 Wt of Moisture 17 Strain Wt. of dry soil 48.9 **Moisture content** 34.8 RESULTS Results Specification Result **382** KN/m<sup>2</sup> **Unconfined Compressive Strength Estimated Elastic Modulus**

Tested By: Mathew & Nyagah Checked By

Checked By: Martin Mburu

#### UNIVERSITY OF NAIROBI WORKING SHEET (HIGHWAYS LABORATORY) UCS TEST SPECIMEN 1 Project: Chemical Stabilization of Lateritic Gravel Date: 21-Sept-2020 No. of days cured: 7 No. of days soaked: Student: Anthony Mugendi Nyagah Mould No.: 0 DATA SAMPLE DETAILS MDD 1560 Do =152mm **STABILIZED** 27.8 Туре OMC Stabilizer Lo mm 127 15% CDA NMC 9.2 $m^2$ 0.0181 Ao =(152x152x3.14)/4 % 0 0.00275 Volume = AoLo m<sup>3</sup> Deflection Stabilizer = CDA Defl. E=L/L0 1-E A=(Ao)/1-E Stress UCS TEST Load Q KN/m<sup>2</sup> mm KN 0.01810 0.00 0.0000 0 1 0 0.32 0.9975 0.01815 145 400 0.0025 2.636 0.01819 225 0.64 0.0050 0.995 4.0858 0.01824 0.95 0.0075 0.9925 5.1402 282 350 0.01828 5.7992 317 1.27 0.0100 0.99 1.59 0.0125 0.9875 0.01833 6.3264 345 300 0.01838 1.91 359 0.0150 0.9850 6.59 0.01842 2.22 0.0175 0.9825 6.7877 368 250 Stress KN/m<sup>2</sup> 0.01847 2.54 0.0200 0.9800 6.60318 358 0.01852 2.86 0.0225 0.9775 6.35276 343 200 150 100 50 MOULDING MOISTURE CONTENT 0 - 0.04 - 0.036 - 0.028 - 0.028 - 0.024 - 0.024 - 0.016 - 0.016 - 0.004 0 Tin No. 140 Tin +Wet soil 166.3 Tin + Dry soil 149.8 Wt of Tin 104.4 Wt of Moisture 16.5 Strain Wt. of dry soil 45.4 **Moisture content** 36.3 RESULTS Results Specification Result **368 KN/m<sup>2</sup> Unconfined Compressive Strength**

Estimated Elastic Modulus
Tested By: Mathew &Nyagah
Checked By: Martin Mburu

	UNIV (		łWAY								-				WOR	KING SHI	EET	
			À	100 m	K	1									UCS 7	ГЕST		
					2A	Ļ								SP	ECIMEN	2		
Project:	Chemical	Sta	biliza	atic	on o	f lat	erit	ic (	Grav	vel		Date	e: 21-Sept	-2020	No. of da	ays cured:		7
Student:													ıld No.:		No. of da	ays soaked:		0
				DA	ТA					_				SAME	PLE DETAI	LS	MDD	15
Do =152	mm												Type Stabilizer		STABIL		OMC	2
$L_0 = (15)$	2x152x3.14	1)/4	n	nm	m <sup>2</sup>					_	127 0.0181	-	Stabilizer %		<u>15% C</u> 0	DA	NMC	
Volume		+)/4			m <sup>3</sup>						0.00275		70		v			
Stabilizer =					4					╈	-	1	Defl.	1	Deflec	tion		
														E I CA	1 F			
			ucs	ТЕ	ST							1		E=L/L0	1-E	A=(Ao)/1-E	St Load	ress IO
												1	mm				KN	∝ KN/m
													0.00	0.0000	1	0.01810	0	
	400	<b>—</b>		_		гт		-	_	7			0.32	0.0025	0.9975	0.01815	1.7793	98
													0.64	0.0050	0.995	0.01819	3.295	181
	350		+	$\downarrow$				$\downarrow$					0.95	0.0075	0.9925	0.01824	4.2176	231
					4								1.27	0.0100	0.99	0.01828	5.0084	274
	300		+	┟	-	$\left  \cdot \right $	+	+	_	-			1.59	0.0125	0.9875	0.01833	5.4038	295
			<b>/</b>										1.91	0.0150	0.9850	0.01838	6.0628	330
2	250	$\left  \right $	+	╉		$\square$	+	+		-			2.22	0.0175	0.9825	0.01842	6.4582	351
KN/IT			/										2.54	0.0200	0.9800 0.9775	0.01847 0.01852	6.7218 6.48456	364 350
Stress KN/m <sup>2</sup>	200			╈			+	+		1				0.0220	0151110			0.50
Stre																		
	150	$\square$		t				╈		1								
	100																	
	100	Ī																
	50			╞				$\downarrow$										
	0					$\square$			$\bot$			Tin		OULDI	NG MOI	STURE CONT	ENT 140	
		) 	0.008	).01:	0.01	0.02	0.02	0.03	).03(	).04			<u>no.</u> +Wet soil				140	
		÷	<u> </u>	N	0)	4	• 00	N	0)			Tin	+ Dry soil				149.8	
													of Tin of Moistur				104.4	
					S	train	1						of Moistu of dry soi				<u>16.5</u> 45.4	
													sture con				36.3	
													RESULTS			•		
				R	esult	S							ecification			Result		
	Unconfin	ed Co	ompre	essiv	e Str	engt	h									364 KN	$/m^2$	
	Estimated	l Ela	stic M	lodu	lus		_	_		_								

#### UNIVERSITY OF NAIROBI WORKING SHEET (HIGHWAYS LABORATORY) **UCS TEST** SPECIMEN 3 **Project: Chemical Stabilization of Lateritic Gravel** Date: 21-Sept-2020 No. of days cured: 7 Student: Anthony Mugendi Nyagah Mould No.: No. of days soaked: 0 DATA SAMPLE DETAILS MDD 1560 Do =152mm STABILIZED Туре OMC 27.8 Stabilizer Lo mm 127 15% CDA NMC 9.2 $\mathbf{m}^2$ 0.0181 Ao = (152x152x3.14)/4% 0 0.00275 Volume = AoLo m Stabilizer = CDA Defl. Deflection E=L/L0 1-E A=(Ao)/1-E Stress UCS TEST Load Q KN/m<sup>2</sup> KN mm 0.01810 0.00 0.0000 1 0 0 0.32 0.9975 0.01815 0.0025 1.4498 80 400 0.01819 0.64 0.0050 0.995 3.1632 174 0.01824 0.95 267 0.0075 0.9925 4.8766 350 1.27 0.01828 5.9969 328 0.0100 0.99 1.59 0.0125 0.9875 0.01833 6.3923 349 300 0.01838 1.91 359 0.0150 0.9850 6.59 0.01842 2.22 0.0175 0.9825 6.61636 359 250 Stress KN/m<sup>2</sup> 2.54 0.01847 350 6.47138 0.0200 0.9800 0.01852 5.94418 2.86 0.0225 0.9775 321 200 150 100 50 MOULDING MOISTURE CONTENT 0 - 0.04 - 0.036 - 0.032 - 0.028 - 0.028 - 0.024 - 0.02 - 0.016 - 0.012 - 0.012 - 0.0012 - 0.008 0 Tin No. 140 Tin +Wet soil 166.3 Tin + Dry soil 149.8 Wt of Tin 104.4 Wt of Moisture 16.5 Strain Wt. of dry soil 45.4 **Moisture content** 36.3 RESULTS Results Specification Result 359 KN/m<sup>2</sup> **Unconfined Compressive Strength Estimated Elastic Modulus**

Tested By: Mathew &Nyagah Checked By

Checked By: Martin Mburu

Appendix E3 Strength Properties (CBR)

UNIVERSITY	OF NAIROBI												
(HIGHWAYS	LABORATORY)								WO	RKIN	NG S	HEE	Г
3									CDD	TEST	г		
								( ) , ( )	-				
	A CONTRACT							(AAS			1990)		
								CDA SAN					
Project: Chemical Stabiliz		avel					ed: 07/09/2	.020		oaked:			8/2020
Student.: Anthony Mugendi						Mou	ld No.:	CAMPLE		Moulded	d:	1	8/2020
Initial gauge Reading	SWELL DATA (div)		20	20			Tours	SAMPLE				MDD OMC	164 26.
Final gauge Reading	(div)		3.8 4.7				Type Stabilizer		STABI CI			NMC	20. 9.
Difference	(div)		4./				Stabilizer %		u	JA		NMC	9.
Ring Factor	(uiv)		0.0				Swell %		0.0	09			
	actor:0.0005 inches/Div	1	010	/1		Pene	tration	Bot	Тор	Standa	ırd		
							e plunger	(KN)	-	Load(H		СВ	R%
	CBR TEST						(mm)	` ´	Ì Í	Ì		Bott.	Тор
							0.00	0	0				
							0.64	0.90101	3.8426				
15.00			П	٦			1.27	2.25253					
14.00			++	_			1.91	3.71006	8.4139				
13.00 -							2.54	4.50507	8.8114	13	<b>5.2</b>	34	67
							3.18	4.87607					
12.00			Ħ		-		3.81	4.92907					
11.00	<del></del>		++	-			4.45	5.00858		20		0.5	40
10.00							5.08	5.03508		20	.0	25	48
							5.72	5.06158					
<b>2</b> 9.00			Ħ		-		6.35	5.12783	9.9642				
<b>.E</b> 8.00			+	-									
9.00 9.00 9.00 7.00 9.00 7.00	<u> </u>		$\downarrow$					M	ouldin	σ Data			
ድ <sub>6.00</sub>	/				-	Wt.o	f Mould + V		<u>s</u>				
			П				of Mould	ee son	g	2			
5.00	┼┼┟╆╄┽┥╼╄╛		Ħ				sture Conte	nt	%	, D		1	
4.00	┽┧┦┼┼┼┼┼		++	-		Wet	Density	1	Kg/m <sup>3</sup>				
3.00			$\square$				Density		Kg/m <sup>3</sup>				
	🖌				Ľ	Diyi	Density		<u>Kg/m</u> % MI	n			
2.00			П		Γ		MOU	LDING			CONT	ENT	
1.00	++++++		++	-		Tin I		LDING				58	
0.00			11				+Wet soil					148.3	
0.0 0.5 C	1.50 2.50 1.50 2.50 2.50 2.50 2.50 2.50 2.50 2.50 2	ກ <u>ດ</u> ດ ກວບ	.7 .5	10			+ Dry soil					136.8	
000		o ö	οč	Ó			f Tin					93.7	
	Penetration in mm	h				Wt o	f Moisture					11.5	
						Wt. o	of dry soil					43.1	
						Mois	sture conten	t				26.67	
					RES	ULTS							
Penetration(mm)	Standard Force(H	KN)	<u> </u>			Spec	cification			%(top)	(	CBR%(bo	ott.)
2.5	13.2		<u> </u>							57 10		34	
5	20		CE	<u></u>	(=0)	,				48		25	
			CB	3K =	67%	0			Check	ked:	Martii	n Mburu	l

UNIVERSIT	NIVERSITY OF NAIRO (HIGHWAYS LABORATORY)																			
(HIGHWAY	S LAB	BORAT	<b>FORY</b>	)												WO	RKIN	NG S	HEE	Г
5	ka.	-	Ĩ																	
A.	Yo.	s M														CBR	TES	Γ		
	X	2													(AAS	НТО '	<b>T193:</b>	1990)		
	CODING C	Sec.	3.0			Γ								3% (	DA SAN	MPLE	2			
Project: Chemical Stabi	lizatio	on of	later	itic	Gı	rave	el					Tes	ste	<b>d:</b> 07/09/2	.020	Date s	oaked:		31/0	8/2020
Student.: Anthony Mug	endi Ny	yagah										Mou	ulo	d No.:		Date I	Moulde	d:		8/2020
	SWI	ELL D										_			SAMPLE	E DETAI	LS		MDD	
Initial gauge Reading			(div	/					7.6					Туре			LIZED		OMC	
Final gauge Reading			(div	<b>'</b> )		_			7.8			_	-	Stabilizer		Cl	DA		NMC	9
Difference		((	div)			_			0.1			_	┢	%		0.0	010			
Ring Factor	e Facto		05 :	hee/	n:				0.0	1		Pon	ot.	Swell % ration	Bot	0.0 <b>Top</b>	019 Standa	ard		
Gaug	e racio	.0.00	ine inc	nes/.	VIV									plunger	Боі (KN)	-	Load(		CR	R%
	(	CBR	TEST	г								July 1		(mm)	(111)	(	Loau()		Bott.	Top
		ODIX		•										0.00	0	0			Dotti	10
														0.64	0.92751	-				
15.00						<b>—</b>			Т					1.27	2.12003	3.1138				
14.00 -	$\rightarrow$	++	$\downarrow \downarrow$											1.91	3.44505	4.2666				
12.00														2.54	4.37257	5.1411	13	8.2	33	39
13.00			$\square$											3.18	5.03508	5.3928				
12.00		++	++			+		┽	+	-				3.81	5.40608					
11.00	++	++	++	+		+		+	+	_				4.45	5.53858					
10.00			Ш											5.08	5.59158			).0	28	32
														5.72	5.69759				-	
<b>2</b> 9.00						$\top$	Π	╡	1					6.35	5.79034	6.6251				
<b>.⊆</b> 8.00 -	++		++			+		+	+	-										
9.00	++	++	++			_	$\square$	$\downarrow$	+	_					M	ouldin	ι σ Data			
<b>د</b>						+						Wt.e	of	Mould +		<u>ourunn</u>	<u> </u>			
					- 🔶	-   •	-							f Mould		g	5			
5.00 -						+		┓	1			Moi	ist	ure Conte	nt	%	, 0			
4.00	+	44	++	+		+	$\vdash$	+	+	-		Wet	t D	Density	]	Kg/m <sup>3</sup>				
3.00	-4	4	++			$\perp$		_	_					ensity		Kg/m <sup>3</sup>				
2.00												DIJ	-	ensity		% MI	DD			
	X													MOU	LDING			CONT	ENT	
1.00			++			+	Ħ	╡	╈			Tin	N	0.					53	
0.00			<u>++</u>	$\square$					+			Tin	+	Wet soil					163.4	
0.50	1.50	2.50	3.50	1.00	- 0	50.50	2 Q 2 Q	7.0	2.5	3.00				Dry soil					148.4	
		20	20		. 0	0		. 0	. ၂	0		Wto							91.9	
		Pen	etratio	on i	n m	m						_		Moisture					15	
												_		f dry soil				ļ	56.5	
														ure conten	t				26.37	
	<del></del>	~		.1.5		<i>a</i> 2	2	T			RE	SULTS		<b>6 1</b> .		CBE	0/ (1	I	CDD4/ 2	
Penetration(mm) 2.5		S	standa			e(KN	)	+				Spe	eci	fication			%(top) 39		CBR%(bo 33	ott.)
				13.2	4												37	1	33	
5				20				+									32		28	

UNIVERSI	ΓY O	<b>F</b> N	AI	RC	)B	Ι														
(HIGHWA)	YS LAE	BORAT	ORY)													WO	RKIN	NG S	HEE	Г
	4 10 M		A A												(AAS]		TES: T193:1			
	- mint		5.											20/ 0	DA SAN			.,,,,		
Denie 4. Chamie al Stat			T . 4 .		. 0							T	4 -	<b>3%</b> C d: 07/09/2			-		21/0	
Project: Chemical Stab Student.: Anthony Mu			Late	riti	сG	rav	el					-		a: 07/09/2 I No.:	.020		oaked: Moulde			8/2020 1/2019
Student.: Anthony Mu	-	yagan ELL D	ATA									WIOU	Г	1 110.:	SAMPLE			u.	MDD	1/2019
Initial gauge Reading	511		(div	)		Т		1	3.0	6		1	F	Туре	5/101 EI		LIZED		OMC	26
Final gauge Reading			(div						3.0			1	F	Stabilizer			DA		NMC	- 20
Difference		(d	liv)	/					0	-			F	%						
Ring Factor			,					(	0.0	1		1		Swell %			0			
	ge Facto	or:0.00	05 inc	hes/l	Div							Pene	etı	ration	Bot	Тор	Standa	ard		
												of th	ne	plunger	(KN)	-	Load(l	KN)	CB	BR%
		CBR	TEST	-									(	(mm)					Bott.	Top
														0.00	0	0				
														0.64	0.86126					
15.00				П					Τ	٦				1.27		3.7366	-			
14.00 -	┼┼┼	++	++	╀┤			$\mathbb{H}$	+	+	-				1.91	3.47155				2.0	
13.00	$\square$		$\square$				Ц		_	4				2.54	3.97506		13	3.2	30	42
10.00														3.18	4.24006					
12.00 -				П			П		Т	7				3.81	4.35932					
11.00 -	+++		++				H	+	+	-				4.45 5.08	4.42557 4.49182			).0	22	31
10.00 -	+++		++	++			$\square$	+	+	4				5.72	4.49182					51
- 9.00														6.35	4.66407					
<b>X</b> 3.00														0.00	4.00407	0.5450				
. <b>_</b> 8.00 -							H		+	1										
9.00	+++		++	+			$\mathbb{H}$	+	+	-					M	louldin	g Data			
й <sub>6.00</sub>	$\downarrow\downarrow\downarrow\downarrow$			$\square$								Wt.o	of	Mould + V	Wet soil	1	g			
5.00												Wt.	of	Mould		g				
5.00 -						- •	•			1		Mois	istı	ure Conte	nt	%	, 0			
4.00 -	H		1 H				H	+	+	-		Wet	t D	ensity	]	Kg/m <sup>3</sup>				
3.00 -	+++	4	++	+			$\square$	-	+	-		Drv	D	ensity		Kg/m <sup>3</sup>				
2.00 -	14.4						Ц							v		% MI	DD			
														MOU	LDING	MOIS	TURE (	CONT	ENT	
1.00 -				П			Π		T			Tin	N	0.					53	
0.00 🎸								-	-			Tin ·	+1	Wet soil					163.4	
0.00	1.50 0.50	2.50	3.50	1.0C		5.50		20.7	7.50	3.OC		_		Dry soil					148.4	
	200	20			.0			. 0	0	0		Wt o							91.9	
		Pene	etratio	on ir	n m	m								Moisture				<u> </u>	15	
														dry soil					56.5	
														ure conten	t			I	26.37	
<b>n</b>		~	4. *	17		<u>a</u> 2-		-			RE	SULTS				OPT	0/ (/ )		CDDA( 2	
Penetration(mm	1)	S	tandaı			(KN	)	+				Spe	ecif	ication			%(top) 42	- '	<u>CBR%(bo</u> 30	ott.)
2.5								_										1		
5	netration(mm)         Standard Force           2.5         13.2           5         20															1	31		22	

UNIVERSITY	OF NAIROBI	-										
(HIGHWAYS L	ABORATORY)							WO	RKIN	IG SI	HEE	Γ
3	1											
								CBR	TEST	Γ		
	Charles In						(AASI	нто '	Т193:1	990)		
	MBS C. TOW					6% C	DA SAN	MPLE	1	· · · ·		
Project: Chemical Stabiliza	tion of Lateritic Gr	avel			Test	ted: 07/09/2	020	Date s	oaked:		31/08	8/2020
Student.: Anthony Mugendi N					Mou	ld No.:		Date I	Moulded	l:	24/08	8/2020
	WELL DATA						SAMPLE	E DETAI	LS		MDD	163
Initial gauge Reading	(div)		4.2			Туре		STABI	LIZED		OMC	26
Final gauge Reading	(div)		4.8			Stabilizer		CI	DA		NMC	9
Difference	(div)	_	0.5			%						
Ring Factor			0.0	)1		Swell %	D (		058			
Gauge Fa	ctor:0.0005 inches/Div					tration	Bot	Top	Standa Logd(k		CD	D0/
	CBR TEST				orth	e plunger (mm)	(KN)	(KN)	Load(K	NN)	Bott.	R% Top
	ODIA LEO L					(mm) 0.00	0	0			םטוו.	10
						0.64	0.92751	-	<u> </u>			
15.00				-		1.27	2.38504					
14.00						1.91	3.84256					
14.00			Π			2.54	4.63757		13.	.2	35	46
13.00	+++++++++		++	-		3.18	5.16758	6.6914				
12.00	++++++++++++++++++++++++++++++++++++		++	_		3.81	5.56508	6.9564				
11.00	+ $+$ $+$ $+$ $+$ $+$ $+$ $+$ $+$ $+$		$\square$			4.45	5.80359	7.0226				
						5.08	6.05534		20.	.0	30	36
10.00			$\square$			5.72	6.28059					
<b>S</b> 9.00	++++++++++++++++++++++++++++++++++++		++	-		6.35	6.53235	7.4864				
<u> </u>	++++++++		++	_								
S 9.00							N		Dete			
Ŭ <sup>1</sup>					Wto	of Mould + V		ouldin	<u> </u>		r	
6.00			$\square$			of Mould	wet son	g	5			
5.00 -	┼╱┼╎		++	-		sture Conte	nt	<u> </u>	'n			
4.00 -			++			Density		Kg/m <sup>3</sup>				
3.00						e e		2				
					Dry	Density		<u>Kg/m³</u> % MI	00			
2.00						MOL	LDING			ONTI	FNT	
1.00	++++++++		++	-	Tin I		LDING	MOIS	IUKEC		184	
0.00						+Wet soil					215.6	
0.01	1.500 A 2.500	л о о л о (л	7.7	1.00		+ Dry soil					186.5	
222	22222222222	500	ĕ ç	ŏŏ		of Tin					78.6	
	Depetertien in more	-				of Moisture					29.1	
	Penetration in mm	I				of dry soil					107.9	
					Mois	sture conten	t				26.97	
					RESULTS							
Penetration(mm)	Standard Force(H	KN)			Spee	cification		CBR	%(top)	0	CBR%(bo	ott.)
2.5	13.2								46		35	
5	20								36		30	
			CB	8 <b>R</b> = -	46%			Check	ked:	Martin	n Mburu	l

UNIVE	RSITY C	)F N	AII	RO	B	[													
(HIC	GHWAYS LAI	BORAT	ORY)												WO	RKIN	NG S	HEE	Г
			A STATE											,	НТО	TEST			
Destinate Charrie	1 64 - 1 - 22 42		<b>F</b> . 4	•	C		1				<b>T</b> .	. 4	ed: 07/09/2	CDA SAN				21/0	
Project: Chemica Student.: Anth			Later	ritic	G	rave	el.						d No.:	.020		oaked: Moulde	d.		8/2020 8/2020
Student Anu	ony Mugendi N	ELL DA	АТА								IVIO	Γ	u 110	SAMPLE			u.	MDD	163
Initial gauge Rea			(div)	)		Т		0	.03			ŀ	Туре	SAME LE		LIZED		OMC	26.
Final gauge Read	-		(div)					-	 5.3			ŀ	Stabilizer			DA		NMC	9.
Difference		(d	<u> </u>	/					.27			ŀ	%		0.			1	
<b>Ring Factor</b>									.01			Ī	Swell %	1	0.0	627			
	Gauge Fact	or:0.000	)5 inch	1es/D	iv						Per	ıet	tration	Bot	Тор	Standa	ard		
											of t	he	e plunger	(KN)	-	Load(I	KN)	CB	R%
		CBR T	FEST										(mm)					Bott.	Тор
													0.00	0	0				
													0.64	0.99377	1.3913				
1	5.00				Τ	П	Т	Τ	Π				1.27		3.5776				
1	4.00	++	++	$\vdash$	+	++	+	+	Н				1.91	3.64381	5.4326				
1	3.00												2.54	4.24006			8.2	32	50
													3.18	4.59782					
1	2.00			H		$\square$	+	┢	Π				3.81	4.73032					
1	1.00		++	$\left  \right $	+	++	+	+	$\vdash$				4.45	4.84957				25	20
1	0.00					Ш							5.08	4.96883		20	).0	25	38
													5.72	5.10133					
N N	9.00					П		T	Π				6.35	5.22058	7.7911				
<b>..</b>	8.00	++	$\left  \right $	$\vdash$		H	-	+	Η										
Force in KN	7.00	++	╞┾┙	4	T		_	+	$\square$					M	louldin	σ Data			
Ъ	6.00										Wt	.of	f Mould + V			<u>g 2 a aa</u>			
													f Mould		g	•			
	5.00					ΤŤ		+	Н		Mo	oist	ture Conte	nt		, 0			
	4.00		$\vdash$		+	++	+	+	$\vdash$		We	et I	Density		Kg/m <sup>3</sup>				
	3.00	4		$\square$		$\square$							Density		Kg/m <sup>3</sup>				
												y I	Jensity		% MI	מנ			
	2.00					Π			Π				MOL	LDING			CONT	ENT	
	1.00	++	$\left  \right $	$\vdash$	+	╉╋	+	+	$\square$		Tin	N		LDING	11015			184	
	0.00			ĻĻ									Wet soil					215.6	
	1.50 0.50 0.00	200	ມິດ ວິທີດ	4.4 7.0	5.0	ບົດ	0 0 0 0	7.0	ч о л с	0			Dry soil					186.5	
	0000	0000	5 ö ö	őő	õ	őč	õ	õ	őč	5			f Tin				1	78.6	
		Dono	tratio	n in	m	n					Wt	of	f Moisture					29.1	
		rene	ะแสแบ	71 III	1111	11					Wt	. 0	f dry soil					107.9	
													ture conten	ıt				26.97	
										R	ESULT								
Penetrat	ion(mm)	St	andar	d Fo	rce(	KN)					Sp	oeci	ification		CBR	%(top)	(	CBR%(bo	ott.)
2	.5			13.2												50		32	
	5			20				L								38		25	
								C	BR	= 5	0%				Check	ked:	Martin	1 Mburu	1

UNIVERSITY	OF NAIROBI												
(HIGHWAYS L	ABORATORY)								WO	RKIN	IG S	HEE	Г
3	1 1												
	S RA								CBR	TEST	Γ		
	Charles 1							(AAS	HTO	Г193:1	1990)		
	TOOL .						6% (	DA SAN	APLE 3	3			
Project: Chemical Stabiliza	tion of Lateritic Gra	avel				Test	ted: 07/09/2	2020	Date s	oaked:		31/08	8/2020
Student.: Anthony Mugendi	Nyagah					Mou	ld No.:		Date N	Moulded	1:	24/08	8/2020
	WELL DATA	-						SAMPLE	DETAI	LS		MDD	163
Initial gauge Reading	(div)		5.				Туре		STABI			OMC	26
Final gauge Reading	(div)		6.3				Stabilizer		CI	DA		NMC	9
Difference	(div)		0.8				%		0.0				
Ring Factor			0.0	01		Dono	Swell %	Bot	0.0 <b>Top</b>	Standa	rd		
Gauge Fa	ctor:0.0005 inches/Div						e plunger	воі (KN)	-	Standa Load(F		CR	R%
	CBR TEST						(mm)	(15.1)	(1217)	Loau(I	мч У	Bott.	Top
	OBICIEOT						0.00	0	0			Dott.	10
							0.64	1.06002	1.484				
15.00		<u> </u>					1.27	2.51754	3.9751				
14.00	+++++++		$\square$				1.91	3.86906	6.0951				
							2.54	4.45207	7.3141	13	.2	34	55
13.00 -							3.18	4.63757	7.6851				
12.00	++++++++		╉	_			3.81	4.77007	8.0826				
11.00	++++++++	$\rightarrow$	++				4.45	4.83632					
10.00 -							5.08	4.92907		20	.0	25	41
							5.72	5.02183					
<b>Ş</b> 9.00			+				6.35	5.19408	8.4139				
. <b>드</b> 8.00	┼┼┼┟┟┟╪╪╪		+	_									
9.00		$\rightarrow$	$\square$					M	ouldin	n Data			
<b>Č</b>						Wto	of Mould + V		<u>ourum</u>			T	
0.00							of Mould	vet son	g	2			
5.00 -	<mark>┦┼<u>╞</u>╞┥┽</mark> ┾┤	◆ݱ¶	+			-	sture Conte	nt	%	, D			
4.00		++	+				Density		Kg/m <sup>3</sup>				
3.00							ě		2				
						DIY	Density		Kg/m³ % MI	n			
2.00			$\square$				MOL	LDING			ONT	ENT	
1.00	++++++++		+	_		Tin I						184	
0.00	+ $+$ $+$ $+$ $+$ $+$ $+$ $+$ $+$ $+$		11				+Wet soil					215.6	
0.5	5.50 5.00 4.50 4.00 3.50 2.50 2.50 2.50	100	7.0 0.7	1.0			+ Dry soil					186.5	
ÓÓŌ		000	οć	00			of Tin					78.6	
	Penetration in mm					Wt o	of Moisture					29.1	
							of dry soil					107.9	
							sture conter	ıt				26.97	
	-		-		RE	SULTS			r				
Penetration(mm)	Standard Force(K	(N)	<u> </u>			Spee	cification		-	%(top)	(	CBR%(bo	ott.)
2.5	13.2		<u> </u>							55		34	
5	20		CE			D /				41	N	25	
			ICF	BR =	55	%			Check	ted:	Martii	n Mburu	L

UNIVERSITY	OF NAIROBI												
(HIGHWAYS L	ABORATORY)								WO	RKIN	NG S	HEE	Г
2									CBR	TEST	Г		
	Lot.							(AAS	бнто	<b>T193:</b> 1	1990)		
and the second se	T LOWER							6 CDA SA					
Project: Chemical Stabiliza		el					ed: 07/0	9/2020		soaked:			8/2020
Student.: Anthony Mugendi N						Mou	ld No.:	0 + <b>3 5 5 5</b>		Moulde	d:	1	8/2020
	WELL DATA		2.0					SAMPL	E DETAI			MDD	160 27.
Initial gauge Reading Final gauge Reading	(div) (div)		2.0				Туре			LIZED		OMC	
Difference	(div)		2.9				Stabilize %	er	C	DA		NMC	9.
Ring Factor	(uiv)		0.9				Swell %	6	0.0	093			
	ctor:0.0005 inches/Div		0.0	/1		Pene	tration	Bot	Тор	Standa	ard		
Guagera					_		e plunge		~	Load(1		CB	R%
	CBR TEST						(mm)	( )	( )		.,	Bott.	Тор
							0.00	0	0				
							0.64	1.1262	7 2.5175				
15.00			П				1.27	2.2260	3 6.4926				
14.00			$\square$				1.91	3.0740	5 7.6851				
							2.54	3.6438	1 8.6126	13	8.2	28	65
13.00 -			П				3.18	4.2135	6 9.3679				
12.00 -	++++++++++++++++++++++++++++++++++++		$\vdash$	-			3.81	4.3725	7 9.9907				
11.00			$\square$				4.45	4.5050	7 10.309				
10.00							5.08	4.6905			).0	23	52
10.00							5.72	4.9025					
<b>3</b> 9.00							6.35	5.0748	3 11.077				
9.00 9.00 9.00 9.00 7.00	╞╞╱╡╞┼╞┝┝╞			_	-								
<b>9</b> 7.00									/ auldin	a Data			
Le L	1				-	W/t o	fMould	+ Wet soil	/louldin				
6.00							of Mould		g	5			
5.00 -	<del>╎╎╎╎╷╷╷╷╻╻</del>	-	$\vdash$	_			sture Con		<u> </u>	6			
4.00			$\square$					itent	Kg/m <sup>3</sup>	•			
2 00							Density						
3.00						Dry	Density		Kg/m <sup>°</sup>				
2.00					Г		M	DULDING	<u>% Ml</u>		CONT	FNT	
1.00	+ $+$ $+$ $+$ $+$ $+$ $+$ $+$ $+$ $+$		$\vdash$	_		Tin I		JULDING		TUKE		107	
0.00			$\square$				+Wet soil					227.5	
0.0.1	- 2.50 2.50 5.50 2.50 5.50 5.50 5.50 5.50		- - -	i œ			+ Dry soi					196.2	
888		388	38	88			f Tin					95	
							f Moistu	re				31.3	
	Penetration in mm						of dry soi					101.2	
							sture con				1	30.93	
					_	ULTS					•		
Penetration(mm)	Standard Force(KN)	)					cification		CBR	%(top)		CBR%(bo	ott.)
2.5	13.2									65		28	
5	20									52		23	
			CB	BR =	65%	6			Check	ked:	Marti	n Mburu	1

UNIVERSITY	OF NAIROBI											
(HIGHWAYS	LABORATORY)							WO	RKIN	[ <b>G</b> S]	HEE	Γ
2									TEST			
	State .						(AASI	HTO '	Т193:1	990)		
	UTTI LINE .						DA SAN	APLE 2	2			
Project: Chemical Stabili		avel				ed: 07/09/2	020		oaked:			8/2020
Student.: Anthony Muger					Mou	ld No.:	CAMPLE		Moulded	:		8/2020
Initial gauge Reading	SWELL DATA (div)	1	0			Tours	SAMPLE	STABI			MDD OMC	160 27
Final gauge Reading	(div)		22			Type Stabilizer		CI			NMC	9
Difference	(div)		22			Stabilizer %		U	JA		NNC	2
Ring Factor	(uiv)		0.0			Swell %		0.1	22			
	Factor:0.0005 inches/Div		0.0		Pene	tration	Bot		Standa	rd		
					-	e plunger	(KN)		Load(K		CB	R%
	CBR TEST					(mm)	Ì,	` ´	Ì	<i>.</i>	Bott.	Top
						0.00	0	0				
						0.64	1.39127	2.12				
15.00			П			1.27	3.04755	5.0351				
14.00	<del>                     </del>	++	++	_		1.91	4.43882					
13.00 -						2.54	4.95557		13.	.2	38	53
						3.18	5.07483					
12.00			$\square$			3.81	5.22058					
11.00			+	-		4.45	5.28683			•	27	47
10.00			$\square$			5.08 5.72	5.40608 5.56508		20.	U	21	4/
9.00 -						6.35	5.69759					
00.0			Π			0.55	3.07737	10.150				
. <b>E</b> 8.00			$\square$									
<b>2</b> 7.00 -	┟┼┟┟┦┼┼┼┼┤		+	_			Μ	ouldin	g Data			
й 6.00			$\square$		Wt.o	f Mould + V		ş				
5.00	╽╽╽╻╻╺┝╸┝				Wt. o	of Mould		g				
5.00			П		Mois	ture Contei	nt	%	Ď			
4.00 -			+		Wet	Density	]	Kg/m <sup>3</sup>				
3.00	┢┫┥┥┥	++	++	_	Dry l	Density		Kg/m <sup>3</sup>				
2.00			$\square$			· ·		% MI	DD			
100						MOU	LDING	MOIS	TURE C	CONTI	ENT	
1.00			Π		Tin N	No.					107	
0.00	<u>- + + + + + + + + + + + + + + + + + + +</u>	100	11			-Wet soil					227.5	
0.50	1.500 1.500 1.500 1.500	000	00	200		- Dry soil					196.2	
				_	Wto						95	
	Penetration in mm					f Moisture					31.3	
						of dry soil	4				101.2	
						ture conten	ι				30.93	
Donaturation (mar)	Standard Fore-IV	N)	1		RESULTS Spec	ification		CDD	%(ton)	~	BD0/ /L-	stt )
Penetration(mm) 2.5	Standard Force(K	u <b>v</b> )	-		Spec	Incation			%(top) 53		<u>BR%(bc</u> 38	л.)
5	20		-						47		27	
5	20		CB	BR = 5	20/			Check		Martin		

UNIV	ERSIT	Y C	)F I	NAI	R(	)B	BI													
	(HIGHWAY	S LA	BORA	TORY	)											WO	RKIN	NG S	HEE	Г
	N.	La Part		Z												-	TES			
	1	X	1	4											(AAS	НТО '	<b>T193:</b> 1	1990)		
		Seatter	Deta										9	9% C	CDA SAN	<b>MPLE</b>	3			
Project: Chen					riti	c (	Grav	<b>el</b>					ted: 07		2020		oaked:			8/2020
Student.:	Anthony Mu	Ģ										Mou	ld No	).:			Moulde	d:	1	8/2020
Initial gauge l	Dooding	SW	'ELL	DATA	<u>,</u>		-					_	т		SAMPLE				MDD	160 27
Final gauge R				(div (div	/		_		-	).6 .02		_	Ty Stabi	-	-		LIZED DA		OMC NMC	- 27
Difference	eaung			(div)	)					.02		_	Stabi			U	DA		NMC	
Ring Factor				uivj					-	.42		_	Swel			0.0	842			
Tring Tactor	Gaus	e Fact	or:0.0	005 inc	hes/	Div			0	.01		Pene	etration		Bot		Standa	ard		
L	ouu	, uct			- 2.01	- • ·							e plung		(KN)	-	Load(		CB	R%
			CBR	TEST	Г								(mm)	-	Ì,	( )	,	,	Bott.	Top
													0.00		0	0				•
													0.64		1.32502	3.8426				
	15.00	П			Т	П		П	Т	П			1.27		3.44505	7.0226				
	14.00	$\square$	++	$\rightarrow$		$\square$		$\square$		Ц			1.91		4.37257	9.2751				
	13.00 -												2.54		4.90257	10.269	13	3.2	37	<b>78</b>
	13.00		П			П		П		Π			3.18		5.30008	10.322				
	12.00	$\left  \right $	++		+	┢┼		++	+	Н			3.81		5.56508					
	11.00	$\left  \right $	++	++		$\square$				$\square$			4.45		5.80359	10.375				
	10.00			╶┿┿			+						5.08		6.04209		20	).0	30	52
													5.72		6.25409	1				
Ş	9.00		11			H		Ħ		Η			6.35		6.55885	10.6				
i.	8.00	$\left  \right $	4+		+	$\vdash$	-	┢┼┥	+	Н										
Force in KN	7.00	$\square$	$\square$			Ц		Ш		Ц		-			M	ouldin	g Data			
Foi								•				Wto	f Moul	ld + V	Wet soil		g Data g			
	6.00					71	T	П		П		_	of Mou		vet son	g	5			
	5.00	H/H	+	1+	+	$\mathbb{H}$	+	┢┼	+	Н			sture C		nt	<u> </u>	/o			
	4.00		4	$\rightarrow$		$\square$		$\square$		Ц			Densit			Kg/m <sup>3</sup>	•			
	3.00	#												•		2				
												Dry	Density	y		Kg/m <sup>°</sup> % MI			-	
	2.00					H		Ħ		Н				ΜΟΙΙ	LDING			CONT	FNT	
	1.00	FH	++		+	$\vdash$		++	+	Н		Tin I		100	LDING	mons	TURE		107	
	0.00		$\square$			$\square$		Ļļ		Ц			+Wet s	oil					227.5	
	0.0	о <u>г</u> ол лоп		3.50	4 0 0	∠ с л ⊂	່ວ	ດ ດີ ດີ	7.0	ч о л с			+ Dry s					1	196.2	
	50	5 õ č	νõč	ōōö	ōč	5 č	õõ	5 Ö	ō	50	)		of Tin					1	95	
			De	netrati	on i	n m	hm						of Mois	ture					31.3	
			rei	neuali								Wt.	of dry s	soil					101.2	
												Mois	sture co	onten	t				30.93	
											RI	ESULTS								
Pene	etration(mm	)		Standa	rd F	orc	e(KN	0				Spe	cificatior	n			%(top)		CBR%(bo	ott.)
	2.5		$\vdash$		13.	2			_								78		37	
	5				20	)											52		30	
			$\bot$						С	BR	=78	%				Check	ked:	Marti	n Mburu	l

UNIVERSITY	OF NAIROBI											
(HIGHWAYS LA	BORATORY)							WO	RKIN	IG S	HEE	Г
3								CBR	TEST	Г		
4 A S	2.4						(AASI	нто '	Т193:1	990)		
						12%	CDA SA			,		
Project: Chemical stabilizat	ion of Lateritic Grav	el			Tes	ted: 10/09/2			oaked:		03/0	9/2020
Student.: Anthony Mugendi N						Id No.:	.020		Moulded	1:		8/2020
	WELL DATA						SAMPLE				MDD	160
Initial gauge Reading	(div)		0			Туре		STABI	LIZED		OMC	27
Final gauge Reading	(div)		22	2		Stabilizer		CI	DA		NMC	9
Difference	(div)		22	2		%						
Ring Factor			0.0	)1		Swell %		0.1				
Gauge Fac	tor:0.0005 inches/Div					etration	Bot	Top	Standa			<b>D</b> 07
	CBR TEST				of th	e plunger (mm)	(KN)	(KN)	Load(k	NN)	CB Bott.	BR% Top
	CDR 1E31					0.00	0	0			DULL.	10
						0.64	1.08652					
15.00			п	-		1.27	2.78254	1				
14.00			$\square$			1.91	4.29306	6.4926				
						2.54	5.36633	7.8441	13	.2	41	59
13.00 -			Ħ			3.18	6.25409	8.8776				
12.00		++	┼┼	-		3.81	6.8901	9.2751				
11.00	+++++++++	++	$\square$	_		4.45		9.5136				
10.00			Ш			5.08	7.75137		20	.0	39	<b>48</b>
						5.72	8.02962					
9.00			Ħ			6.35	8.25487	9.8846				
.= 8.00	┝┼┟┼┼┼┟┢		┼┼	-								
9.00 9.00 9.00 7.00 9.00		++	$\vdash$	_			M	ouldin	g Data			
ድ <sub>6.00</sub>					Wt.o	of Mould + V		\$	0			
	<b>∕   ∳</b>				Wt.	of Mould		g				
5.00			П		Moi	sture Conte		%	Ó			
4.00			H	-	Wet	Density	]	Kg/m <sup>3</sup>				
3.00		++	⊢∔	_	Drv	Density		Kg/m <sup>3</sup>				
2.00		$\square$	$\square$			e		% MI	DD			
4.00						MOU	LDING	MOIS	TURE (	CONT	ENT	
1.00			П		Tin						184	
	<u>↓ ↓ ↓ ↓ ↓ ↓ ↓ ↓</u> → ℕ ₩ ₩ ₩ ₩ ₩ ₩ ₩ ₩ ₩ ₩ ₩ ₩ ₩ ₩ ₩ ₩ ₩	+   	   \	100		+Wet soil					223.8	
1.00	50000	0.50		000		+ Dry soil					187.7	
						of Tin					78.6	
	Penetration in mm					of Moisture of dry soil					36.1	
						of ary soll sture conten	nt .				33.09	
				1	RESULTS		ii ii				55.09	
Penetration(mm)	Standard Force(KN	Ø		-		cification		CBR	%(top)	(	CBR%(bo	ott.)
2.5	13.2	,			- Spe				59		41	
5	20								48		39	
			CB	BR = 5	59%			Check	ked:	Martir	n Mburu	1

UNIVERSITY	OF NAIROBI												
(HIGHWAYS L	ABORATORY)								WO	RKIN	IG S	HEE	Γ
3	1												
									CBR	TEST	Γ		
*	Sand 1							(AAS	HTO '	Г193:1	<b>1990)</b>		
	Bach an						12% (	CDA SA	MPLE	2			
Project: Chemical Stabiliza	tion of Lateritic Gr	avel				Test	ed: 10/09/2	.020	Date s	oaked:		03/09	9/2020
Client.: Anthony Mugendil N							ld No.:			Moulded	1:	27/08	8/2020
	WELL DATA							SAMPLE	DETAI	LS		MDD	160
Initial gauge Reading	(div)		0	)			Туре		STABI	LIZED		OMC	27
Final gauge Reading	(div)		22	2			Stabilizer		CI	DA		NMC	9
Difference	(div)		22	2			%						
Ring Factor			0.0	)1			Swell %		0.				
Gauge Fa	ctor:0.0005 inches/Div						tration	Bot	Тор	Standa			D.O.
					•	of the	e plunger	(KN)	(KN)	Load(F	SN)	-	R%
	CBR TEST				-		(mm)	0	0			Bott.	Тор
					-		0.00	0 1.13952	0 3.5776				
15.00				_	-		1.27	2.31879					
44.00					-		1.27	3.97506					
14.00			$\square$				2.54	5.43258		13	.2	41	72
13.00 -	++++++++++++++++++++++++++++++++++++		╉╋	-			3.18	6.6251					
12.00 -	+ $+$ $+$ $+$ $+$ $+$ $+$ $+$ $+$ $+$		++	_			3.81	7.22136	9.9774				
11.00							4.45	7.68512	10.004				
							5.08	7.95012	10.123	20	.0	40	51
10.00 -			++				5.72	8.21512	10.335				
<b>Z</b> 9.00	┼┟┦┼┼┼┼┼┤		++	_			6.35	8.48013	10.68				
<b>E</b> 8.00		~ ^	$\downarrow$		_								
9.00 9.00 7.00 9.00					_								
			Π			<b>N</b> 74	CN4 11 1		ouldin			T T	
6.00							<u>f Mould + V</u> of Mould	wet soll	{	5			
5.00	┼┼╀┼┼┼┼┤		++	_			sture Conte	nt	<u> </u>				
4.00	╎┟┟╎╎╎		$\square$							U			
2.00							Density		Kg/m <sup>3</sup>				
3.00			Π		Ľ	Dry	Density		Kg/m <sup>3</sup>				
2.00			+		Г		MOU	IDINC	% MI			ENT	
1.00	+++++++		++	_	-	Tin N		LDING	MOIS	IUKE	JUNI	213	
0.00							NO. ⊦Wet soil					232	
0.0.0	- 2.50 - 2.50	ກຸ່ວຸ່ວ	22	1 .00			+ Dry soil					196.6	
888		888	86	88			f Tin					92.8	
	Denset 11						f Moisture					35.4	
	Penetration in mm	1					of dry soil					103.8	
							ture conten	t				34.10	
					RESU	JLTS							
Penetration(mm)	Standard Force(F	KN)				Spec	cification		CBR	%(top)	(	CBR%(bo	ott.)
2.5	13.2									72		41	
5	20									51		40	
			CB	BR =	72%	•			Check	ked:	Martin	n Mburu	l

(HIGHWA	VSIAE																			
	15 LAL	SORA	TORY	)												WO	RKIN	NG S	HEE	Г
	Le se															-	TES			
1	$\mathbf{X}$	4	2												(AAS			1990)		
	A-CON	and the	1												CDA SA					
Project: Chemical Stat				erit	ic (	Gra	vel	l						<b>d:</b> 10/09/2	2020		oaked:			9/2020
Student.: Anthony Mu	<u> </u>		DATA									NIO	oulo	d No.:	SAMPLE		Moulde	d:	27/08 MDD	<sup>8/2020</sup>
Initial gauge Reading	5 W I	ELLI	div	)						0			ŀ	Туре	SAMPLE		LS LIZED		OMC	27
Final gauge Reading			(div	/						22			ŀ	Stabilizer			DA		NMC	 9
Difference		(	div)	)						22			F	%		0.			ittile	,
Ring Factor										.01			F	Swell %		0.	22			
	ige Facto	or:0.0	005 in	ches	/Div	7						Per	net	ration	Bot	Тор	Standa	ard		
												of t	the	plunger	(KN)	(KN)	Load(l	KN)	CB	R%
		CBR	TES	Г										(mm)					Bott.	То
														0.00	0	0				
15.00														0.64	1.32502					
15.00				Τ	Π									1.27	2.91504					
14.00 -	+++	++		+	$\mathbb{H}$		╈	╈	+	$\vdash$				1.91	4.37257			3.2	40	82
13.00 -	+++	++	++	+	$\left  \cdot \right $		+	+	-					2.54	5.30008 5.96259			0.2	40	02
12.00 -		$\square$			Ц									3.18 3.81	6.3601					
														4.45	1	12.030				
11.00			++		Н									5.08	6.7576			).0	34	61
10.00 -	+++	╈	++	+	┼┤		╈	+	+	$\vdash$				5.72	6.95636					
Z 9.00 -	+++	+	++	+	$\square$		+	+						6.35	7.08886	12.164				
<b>Y</b> <b>L</b> 8.00																				
e.	11/																			
<b>2</b> 7.00						7	T	T								louldin	g Data			
6.00 -	┼╢┼	++			╀┦		+	+	+	$\vdash$				Mould + V	Wet soil		5			
5.00 -	+			+	$\square$		+	+	+					f Mould ure Conte	nt	<u> </u>	/			
4.00 -																	0			
														Density		Kg/m <sup>3</sup>				
3.00 -					Π							Dr	y D	ensity		Kg/m <sup>°</sup>				
2.00 -				+	┼┤		╈			$\vdash$				MOU	LDING	% MI		CONT	ENT	
1.00		++	++	+	$\left\{ \cdot \right\}$		+	+	+	$\vdash$		Tir	N		LDING	MUIS	IUKE		184	
0.00	111				$\square$									0. Wet soil					223.8	
Ċ.	0 <u></u> 0 0 0	200	ω ω Ο σ	4.0	о 4 о 7	רט ח כי כי	6 C	о 5	7	ч о л с	5			Dry soil					187.7	
ŏ	.50 0 0 0	õõ	õõ	ŏ	őč	ŏŏ	ŏ	õ	õ	5 6	5			Tin					78.6	
		Po-	netrati	or	in r	nm								Moisture					36.1	
		rer	1011 8(1	011										f dry soil					109.1	
												Mo	oist	ure conten	t				33.09	
											R	ESULT	r <u>s</u>							
Penetration(mn	n)	5	Standa			e(K	N)		<u> </u>			Sp	oeci	fication			%(top)		CBR%(bo	ott.)
				13	.2				1							8	82	I	40	
2.5				2					-								61	1	34	

UNIVERSIT	Y O	)F I	NA	IR	<b>RO</b>	B	[															
(HIGHWAY	S LAB	BORA	TOR	Y)														WO	RKIN	NG S	HEE	Г
	K Street																(AAS]		TES T193:1			
	- CONTRACT	Sta														15% (	CDA SA	MPLE	1			
Project: Chemical Stabi	ilizatio	on o	f La	ter	itic	G	rav	el						Test	te	<b>d:</b> 10/09/2	020	Date s	oaked:		03/09	9/2020
Client.: Anthony Mugend	i Nyaga	ıh												Mou	ıld	d No.:		Date I	Moulde	d:	27/0	8/2020
	SWI	ELL	DAT	A													SAMPLE	E DETAI	LS		MDD	1560
Initial gauge Reading			(di							0	)					Туре		STAB	LIZED		OMC	27.8
Final gauge Reading				iv)						22						Stabilizer		C	DA		NMC	9.2
Difference		(	(div)							22						%						
Ring Factor										0.0	)1			n		Swell %	<b>D</b> .	1	22			
Gaug	e Facto	or:0.0	005 ii	nch	es/Di	iv							-			ration	Bot	Тор	Standa			
			, TF	<b>э</b> т										oi th		plunger	(KN)	(KN)	Load(l	NIN)	CB Bott.	R%
		CBR	RTES	51											(	(mm) 0.00	0	0			вон.	Тор
																0.64	1.85503					
15.00			_			_				_	_					1.27		5.1676				
																1.91	4.37257					
14.00 -				Π												2.54	5.49883			8.2	42	80
13.00		╉				ſ		-	+	+	-					3.18	6.55885		1			
12.00 -		++	$\square$	$\square$	+		$\square$		_	_						3.81	7.28761					
11.00 -																4.45	7.71162	13.051				
11.00				Π						Τ						5.08	8.08262	13.118	20	).0	40	66
10.00 -		╈		⊢	+		+		+	┥						5.72	8.54638	13.581				
<b>z</b> 9.00 -		$+\!\!\!\!\!\!\!\!\!\!\!\!\!\!\!\!\!\!\!\!\!\!\!\!\!\!\!\!\!\!\!\!\!\!\!\!$		$\square$	+		$\square$		_	_	_					6.35	9.03664	14.045				
<b>X</b> <b>E</b> 8.00																						
<b>e</b>		/			-																	
0.00				Ť.			Π											louldin	g Data			
<b>LL</b> 6.00		+	A	$\vdash$	+	-	+	-	+	+	-					Mould + V	Wet soil		g			
5.00 -		11	<u> </u>	Ц						_						f Mould		g				
4.00														Mois	sti	ure Conte		%	0			
4.00 -		Π		Π			Π							Wet	D	Density		Kg/m <sup>3</sup>				
3.00 -		+		⊢	+				+	+				Dry	D	ensity		Kg/m <sup>3</sup>				
2.00 -	4	++		$\square$	+	_	+	_	_	_	_							% MI				
1.00 -																	LDING	MOIS	TURE (	CONT		
														Tin l							184	
0.00			 ა	ן ו 4 ט		ן סוס	н ла	n o		+	1 00 —					Wet soil					223.8	
00.00	1.50	000	300	лО	50	00	50 C		18	o O	38					Dry soil					187.7	
														Wt o	-						78.6	
		Per	netra	tior	n in	mr	n								-	Moisture					36.1	
																f dry soil	+				109.1 33.09	
												D				ure conten	ι			I	33.09	
Penetration(mm)			Stand	land	For		KND	<u> </u>	Т			K	ES	Sno		fication		CDD	%(top)		CBR%(bo	<b></b>
2.5	'		Stand		1 F or 13.2	ce(	ni)	,	╉					spe	cII	ncation			80		<u>42</u>	nt.)
5					20				╉										66		42	
3					-0				H			= 80								1	υF	

UNIVERSI	ГҮ О	)F I	NAI	R(	DB	BI													
(HIGHWA	YS LAB	30RA	TORY	)											WO	RKIN	NG S	HEE	Г
			T											(AAS]		TEST T193:1			
-	Stillart	22	Pro-										15% (	CDA SA			,		
Project: Chemical Stat	vilizati	on o	f I ata	rit	ic C	lrav	ام				Tost	tod	: 10/09/2			zoaked:		02/0	9/2020
Client.: Anthony Muge			1 Lau	.110		11 a v	CI						No.:	.020		Moulde			8/2020
		-	DATA										1.000	SAMPLE				MDD	15
Initial gauge Reading			(div	r)					0				Туре			LIZED		ОМС	27
Final gauge Reading			(div	<i>i</i> )				2	2				Stabilizer		Cl	DA		NMC	9
Difference		(	(div)	ć				2	2				%						
Ring Factor								0.	01				Swell %			22			
Gau	ige Facto	or:0.0	005 in	:hes/	/Div						Pene	etra	ation	Bot	Тор	Standa	ard		
											of th	ie p	olunger	(KN)	(KN)	Load(l	KN)	-	R%
		CBR	R TES	Г								(r	nm)					Bott.	Тој
												(	0.00	0	0				
													0.64	1.19252					
15.00		Т			Π			Τ	Π				1.27	2.38504					
14.00 -	+++	++		+	⊢	+	$\vdash$	╋	Н				1.91		9.4076			20	0.0
13.00 -	+++	++	$ \rightarrow  $		$\square$			_	Ц				2.54	5.03508			8.2	38	80
12.00 -													3.18	5.30008	10.839	1		-	
12.00		Π			П			Τ	Π				3.81		10.865 10.918			-	
11.00 -		+	##	+	H	T	+	╈	Н				4.45 5.08	6.42635			).0	32	55
10.00 -	+++	-4	++	_	$\vdash$			+	Н				5.72		11.263			52	55
- 9.00 -					Ш								5.7 <u>2</u> 5.35	7.02261	-				
¥	117														11021				
.e 8.00 -		+			H			$\top$	H										
- 00.8 II X - 00.8 II X - 00.7 CG	┼┼╢	++	-+-+	+	$\mathbb{H}$		-	+	Н					Μ	ouldin	g Data			
й <sub>6.00</sub> –	$+ \parallel +$	++	++		4				Ц		Wt.o	of N	Mould + V	Wet soil	Į	g			
5.00 -			, let								Wt.	of I	Mould		g				
5.00 -		1	$\square$		П			Τ			Mois	stu	re Conte		%	0			
4.00 -		*		+	H			╈	Н		Wet	De	ensity	]	Kg/m <sup>3</sup>				
3.00 -	╢┟	<u>'</u>		_	$\vdash$			+	H		Dry	De	ensity		Kg/m <sup>3</sup>				
2.00 -	۶										v		v		% MI	DD			
													MOU	LDING	MOIS	TURE (	CONT	ENT	
1.00					H			$\top$	Η		Tin I	No	•					213	
0.00 🐇	$\mathbf{H}$							1	Ц		Tin -	+W	vet soil					232	
0.0(	1.50 0.50	2.00	3.00	1.00	4 U.	500	, 5 0 0 0	202	ч <u>В</u> .О(		Tin -	+ D	Dry soil					196.6	
	200	00		50				50			Wt o							92.8	
		Per	netrati	on i	in m	nm					-		Moisture					35.4	
													dry soil				ļ	103.8	
													re conten	t				34.10	
		<u> </u>	~ .			~-		T		RE	SULTS					<b></b>	1		
Penetration(mn	n)		Standa			e(KN	)	+			Spee	cifi	cation			%(top)		CBR%(b)	ott.)
2.5		<u> </u>		13.				┢								80 55		<u>38</u> 32	
5		1		20	,			1								33	1	32	

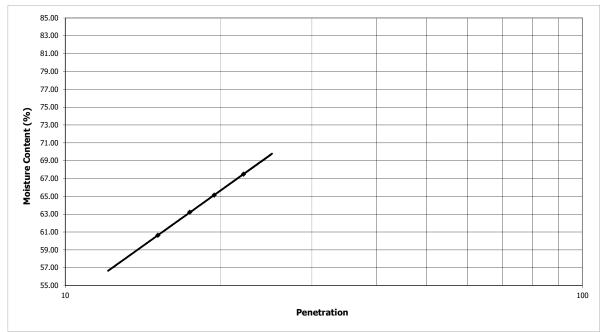
UNIVERSIT	Y OF NAIROBI											
(HIGHWAY	'S LABORATORY)							WO	RKIN	IG S	HEE	Г
							(AAS]		TEST T193:1			
						15% (	CDA SA			,		
Project: Chemical Stabi	ilization of Lateritic Cr	aval			Test	ed: 10/09/2			oaked:		02/0	9/2020
Client.: Anthony Muger						d No.:	020		Moulded	1:		8/2020
, , , , ,	SWELL DATA						SAMPLE	E DETAI	LS		MDD	156
Initial gauge Reading	(div)		0			Туре		STABI	LIZED		омс	27
Final gauge Reading	(div)		22			Stabilizer		CI	DA		NMC	9
Difference	(div)		22			%						
Ring Factor			0.0	1		Swell %			22			
Gaug	e Factor:0.0005 inches/Div				-	tration	Bot		Standa			
						e plunger	(KN)	(KN)	Load(K	KN)	_	R%
	CBR TEST					(mm)					Bott.	Тор
						0.00	0	0				
15.00 -				_		0.64	-	1.9213				
	<b>││││││</b> <del>│<del>│<del>│</del><del>│</del></del></del>	++-				1.27		5.1676 9.2751	-			
14.00 -			++			1.91 2.54	5.83009			2	44	99
13.00 -			++	-		3.18		14.178		• 4		
12.00		$\square$	$\square$	_		3.81	-	14.575				
44.00						4.45		14.588				
11.00 -			T			5.08	7.42011		20	.0	37	73
10.00 -			╉╋	-		5.72	7.61887	14.615				
<b>z</b> 9.00 –	<b>╶┼┼<u>╢</u>┼┼┼┼┼┤</b>	++	++	_		6.35	7.75137	14.628				
<b>L</b> 8.00 –												
9.00		<b>*</b> •	Π									
<b>2</b> 7.00			$^{++}$					louldin	g Data			
<b>LL</b> 6.00	┝┼╢┼┟╱┊┼┼┼┼┤		┼┼	-		f Mould + V	Wet soil		5			
5.00 -		$\rightarrow$	$\square$	_		f Mould		g	,			
4.00						ture Conte		%	0			
4.00 -			П		Wet 1	Density		Kg/m <sup>3</sup>				
3.00 -			++	-	Dry I	Density		Kg/m <sup>3</sup>				
2.00 -			++	-	-			% MI				
1.00			$\square$				LDING	MOIS	TURE C	CONT		
					Tin N						184	
0.00	- <u>-</u> ν ν ν ω ω + + ν ν	1 0 0 ·		.8		Wet soil					223.8	
00	50000000000000000000000000000000000000	000	000	00		Dry soil					78.6	
					Wt of	f 11n f Moisture					36.1	
	Penetration in mm	I				f dry soil					109.1	
						ture conten	t				33.09	
				R	ESULTS	ui e conten	•				55.07	
Penetration(mm)	) Standard Force(k	(N)	1	<u>_</u>		ification		CBR	%(top)	(	CBR%(bo	ott.)
2.5	13.2	/	İ		- <b>F</b> C	-			99		44	,
5	20		l						73		37	
			CB	R = 9	9%			Check	ced:	Marti	n Mburu	l

Appendix E4 Atterberg Limits

PROJECT	Chemie	cal Stabilization of	Lateritic Gravel u	sing the CDA
STUDENT		Anthony	Mugendi Nyagah	
DEPTH		Sample No	3% STAB	Sample time
Test date	22-Sep-20	Lab Ref No		
Specification		In accordanc	e with BS 1377: 1990	

		Liquid Limit			Plasti	c Limit
Container No	29	4	15	1	J	T4
Penetration (mm)	15.1	17.4	19.4	22.1		
Wt of Container + Wet Soil (g)	53.5	74.2	82.9	91.5	15	15
Wt of Container + Dry Soil (g)	43.8	56.5	61.6	66.8	13.5	13.4
Wt of Container (g)	27.8	28.5	28.9	30.2	9.3	9.1
Wt of Moistuer (g)	9.7	17.7	21.3	24.7	1.5	1.6
Wt of Dry Soil (g)	16	28	32.7	36.6	4.2	4.3
Moisture Content (%)	60.63	63.21	65.14	67.49	35.71	37.21

Linear Shrinkage	Initial Length (mm)	No1	140	Final Length (mm)	No 1	116
Linear Similkage	Initial Length (mm)	No 2	140	Final Length (mm)	No 2	116



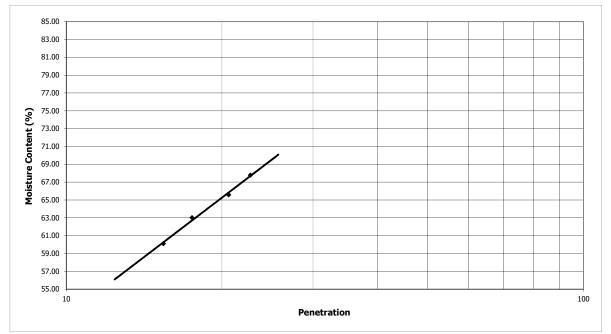
Liquid Limit	66
Plastic Limit	36
Plasticity Index	29
Linear Shrinkage (%)	17

Technician	Mathew Mburu	Verified :	Elly Oyier
Date	24-Sep-20		
Observations:		_	
Conform to the specification	15		

PROJECT	Chemical Stabilization of Lateritic Gravel Using the CDA					
STUDENT	Anthony Mugendi Nyagah					
DEPTH	Sample No 6% STAB Sample time					
Test date	22-Sep-20 Lab Ref No					
Specification	In accordance with BS 1377: 1990					

		Plastic Limit				
Container No	41	33	30	10	В	R
Penetration (mm)	15.4	17.5	20.6	22.7		
Wt of Container + Wet Soil (g)	57.1	68.6	79.2	89	16.7	16.7
Wt of Container + Dry Soil (g)	46.7	53.1	59	65	14.3	14.7
Wt of Container (g)	29.4	28.5	28.2	29.6	7.5	9.2
Wt of Moistuer (g)	10.4	15.5	20.2	24	2.4	2
Wt of Dry Soil (g)	17.3	24.6	30.8	35.4	6.8	5.5
Moisture Content (%)	60.12	63.01	65.58	67.80	35.29	36.36

Linear Shrinkage	Initial Length (mm)	No1	140	Final Length (mm)	No 1	116
Linear Shirikage	Initial Length (mm)	No 2	140	Final Length (mm)	No 2	116



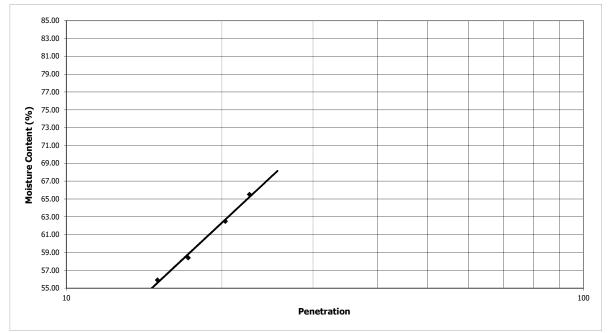
Liquid Limit	65
Plastic Limit	36
Plasticity Index	29
Linear Shrinkage (%)	17

Technician	Mathew Mburu	Verified :	Elly Oyier
Date	24-Sep-20		
Observations:		-	
Conform to the specification	s		

PROJECT	Chemical Stabilization of Lateritic Gravel using the CDA					
STUDENT	Anthony Mugendi Nyagah					
DEPTH	Sample No 9% STAB Sample time					
Test date	23-Sep-20 Lab Ref No					
Specification	In accordance with BS 1377: 1990					

		Plastic Limit				
Container No	13	26	5	29	13	1P
Penetration (mm)	15	17.2	20.3	22.6		
Wt of Container + Wet Soil (g)	57.8	68.4	80.8	89.7	12.7	12.7
Wt of Container + Dry Soil (g)	47.4	54.5	61.8	65.2	11.8	11.6
Wt of Container (g)	28.8	30.7	31.4	27.8	9	8.1
Wt of Moistuer (g)	10.4	13.9	19	24.5	0.9	1.1
Wt of Dry Soil (g)	18.6	23.8	30.4	37.4	2.8	3.5
Moisture Content (%)	55.91	58.40	62.50	65.51	32.14	31.43

Linear Shrinkage	Initial Length (mm)	No1	140	Final Length (mm)	No 1	120
Linear Shirikaye	Initial Length (Initi)	No 2	140	Final Length (mm)	No 2	120



Liquid Limit	62
Plastic Limit	32
Plasticity Index	30
Linear Shrinkage (%)	14

Technician	Mathew Mburu	Verified :	Elly Oyier
Date	25-Sep-20		
Observations:		-	
Conform to the specification	s		

PROJECT	Chemi	Chemical Stabilization of Lateritic Gravel using the CDA							
CHAINAGE		Anthony	Mugendi Nyagah						
DEPTH		Sample No	12% STAB	Sample time					
Test date	23-Sep-20	Lab Ref No							
Specification		In accordanc	e with BS 1377: 1990						

		Plastic Limit				
Container No	33	17	тх	46	R	ZB
Penetration (mm)	15.2	17.4	19.8	22.6		
Wt of Container + Wet Soil (g)	42.6	55.5	61.3	79.2	14.5	14.5
Wt of Container + Dry Soil (g)	37.5	45.2	44	59.2	13.2	13.1
Wt of Container (g)	28.6	27.8	16	29.2	9.2	9
Wt of Moistuer (g)	5.1	10.3	17.3	20	1.3	1.4
Wt of Dry Soil (g)	8.9	17.4	28	30	4	4.1
Moisture Content (%)	57.30	59.20	61.79	66.67	32.50	34.15

Linear Shrinkage	Initial Length (mm)	No1	140	Final Length (mm)	No 1	122
Linear Shi nikaye	Initial Length (min)	No 2	140	Final Length (mm)	No 2	122



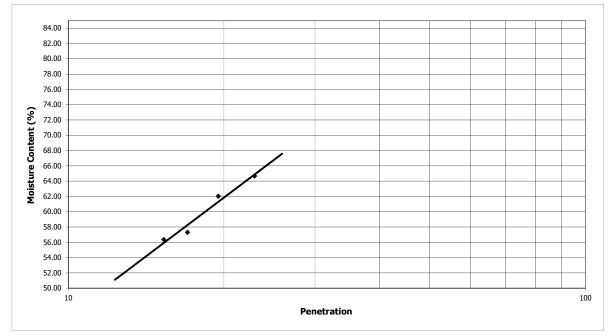
Liquid Limit	63
Plastic Limit	33
Plasticity Index	29
Linear Shrinkage (%)	13

Technician	Mathew Mburu	Verified :	Elly Oyier
Date	25-Sep-20		
Observations:		-	
Conform to the specification	s		

PROJECT	Chemic	cal Stabilization of	Lateritic Gravel us	sing the CDA
STUDENT		Anthony	Mugendi Nyagah	
DEPTH		Sample No	15% STAB	Sample time
Test date	23-Sep-20	Lab Ref No		·
Specification		In accordanc	e with BS 1377: 1990	

		Plastic Limit				
Container No	15	32	3	2	XL	7F
Penetration (mm)	15.3	17	19.5	22.9		
Wt of Container + Wet Soil (g)	48.1	59.6	69.5	79.3	12.7	12.7
Wt of Container + Dry Soil (g)	41	48.6	54.3	58.8	11.9	11.8
Wt of Container (g)	28.4	29.4	29.8	27.1	9.3	9
Wt of Moistuer (g)	7.1	11	15.2	20.5	0.8	0.9
Wt of Dry Soil (g)	12.6	19.2	24.5	31.7	2.6	2.8
Moisture Content (%)	56.35	57.29	62.04	64.67	30.77	32.14

Linear Shrinkage	Initial Length (mm)	No1	140	Final Length (mm)	No 1	122
Linear Shirikaye	Initial Length (Initi)	No 2	140	Final Length (mm)	No 2	122



Liquid Limit	62
Plastic Limit	31
Plasticity Index	30
Linear Shrinkage (%)	13

Technician	Mathew Mburu	Verified :	Elly Oyier
Date	25-Sep-20		
Observations:			
Conform to the specification	ns		
	· · ·		

Appendix E5 Grading



DEPARTMENT OF CIVIL & CONSTRUCTION ENGINEERING

-	Student	Anthony Mu	-						14.1					
	ple source	Membley qu	Jarry				_			ampus (Dai			(CDA)	
	epth (m)			S	AMPLE N			DA SAN	NPLE A		Sr.	No.		
	st date:	25-Sep-20				Locati								
Spe	cification	According t	o BS 1	.377:19	90.	Sampl	e Descr	ription:	Lateritic	c Gravel so	oil Stabil	ized wi	th CDA	
an mass				(g	ım)	0								
	ample mass + par	ı			im)									
	ample mass y sample mass +	pan			im) im)	200		Fine ma Fine per				(gm) (%)		7.5 3.8
	y sample mass	pan			im)	122.5			ince Criteria			(%)		
						Cu	imulative p	assed		Acce	ptance Cr	riteria		
Siev	Sieve size (mm) Retained mass (gi		n)	% Retai	ned (%)		percentage		Mir	n(%)		Max	: (%)	
	20	C			0	.0		100.0						
	14	C			0.			100.0						
	10	3.			1.			98.1						
	5 2.36	33				6.7 9.0		81.5 62.5						
	1.18	20				).2		52.3						
	0.6	1			5			47.3			I			
	0.425	4.	1		2	.1		45.2						
	0.3	4			2			43.2						
	0.15	5				.5		40.7						
	0.075	3.			2	.0 3.8		38.8						
		20			30	0.0								
						GRADIN	NG CUR	VE						
	100										•	•		
	90													
	80									$\star$				
_	70													
8	60								×					
Passing (%)	50							-						
ssii	40				•									
Ba														
	30													
	20													
	10													
	0.01			0.1			1				0			10
	0.01			0.1		-					0			10
						5	ieves (	(mm)						
quipment		Sieve set N° :				Shaker 1					2 N° :			
echnician	l		iew Mbu	iru			Verifie	d :Lab. Ir	ncharge	Elly	Oyier			
		25-5	ep-20											
ate bservatio														



DEPARTMENT OF CIVIL & CONSTRUCTION ENGINEERING

Sample source Depth (m) Test date: Specification	Membley quarry kiam	gah		• • •		<b>.</b> ·	4 m
Test date:							(CDA)
		SAMPLE No.		DA SAM	PLE B	Sr. No.	
Specification	25-Sep-20		Location:				
	According to BS 1377:	1990.	Sample Des	ription:	Lateritic Gra	vel soil Stabilized v	with CDA
an mass		(gm)	0				
itial dry sample mass + pan		(gm)					
itial dry sample mass		(gm)	200	Fine mas		(gm)	78.5
/ashed dry sample mass + pa /ashed dry sample mass	an	(gm)	121.5	Fine perc	ent ce Criteria	(%)	39.3
asheu ury sample mass		(gm)	121.5	Acceptar		(70)	
Sieve size (mm)	Retained mass (gm)	% Retaine	d (%)	Cumulative pa		Acceptance	Criteria
			<b>u</b> ( <i>ii</i> )	percentage	(%)	Min(%)	Max (%)
20	0	0.0		100.0			
<u>14</u> 10	0 8.5	0.0 4.3		100.0 95.8			
5	31.2	4.3		80.2			
2.36	36.7	18.4		61.8			
1.18	18.1	9.1		52.8			
0.6	10	5.0		47.8		<u> </u>	· · ·
0.425	4.3	2.2		45.6			
0.3	3.8	1.9		43.7			
0.15	5	2.5		41.2			
0.075	3.9	2.0		39.3			
	78.5	39.3					
	200		GRADING CU	RVE			
100							
100							
90							
80							
70							
<b>60</b>					×		
<b>2</b> 50				•			
si si							
30							
20							
10							
0							
0.01	0.1		1			10	100
0.01			Sieves	(mm)			
0.01							
			Shaker N°			Scale N° :	-
quipment	Sieve set N° :						
quipment rechnician	Sieve set N° : Mathew Mburu 25-Sep-20			ed :Lab. Ind	harge	Elly Oyier	



DEPARTMENT OF CIVIL & CONSTRUCTION ENGINEERING

Sample source		gah				<b>/</b>	( <b>ab</b> )
	Membley quarry kiam	-				npus (Dairy Farm) UoN	(CDA)
Depth (m)		SAMPLE No		% CDA SAN	NPLE A	Sr. No.	
Test date:	25-Sep-20		Location:				
Specification	According to BS 1377:	1990.	Sample D	)escription:	lateritic G	ravel soil Stabilized w	ith CDA
an mass		(gm)	0				
itial dry sample mass + pa	n	(gm)					
itial dry sample mass		(gm)	200	Fine ma		(gm)	76.3
/ashed dry sample mass +	pan	(gm)		Fine per		(%)	38.2
ashed dry sample mass		(gm)	123.7	Accepta	ince Criteria	(%)	
Sieve size (mm)	Retained mass (gm)	% Retain	ed (%)	Cumulative p	assed	Acceptance	Criteria
		70 1 1012111	cu (70)	percentage		Min(%)	Max (%)
20	0	0.0		100.0			
14	0	0.0		100.0			
<u>10</u> 5	3.5 35.6	1.8 17.		98.3 80.5			
2.36	37.7	17.		61.6			
1.18	21.5	10.		50.9			
0.6	11.8	5.9		45.0			I
0.425	4.2	2.1		42.9			
0.3	3.8	1.9		41.0			
0.15	4.7	2.4	۰ [	38.6			
0.075	0.9	0.5	;	38.2			
	76.3	38.	2				
	200						
			GRADING	CURVE			
100						• • • •	
90							
80							
8 60					×		
<b>ව</b> 50							
60 build be							
A 40	•	•					
30							
20							
10							
0							
	0.1			1		10	100
0.01			Siev	ves (mm)			
0.01							
0.01 guipment	Sieve set N° :		Shaker N°			Scale N° :	
	Sieve set N° : Mathew Mburu 25-Sep-20		Shaker N°	erified :Lab. Ir	ncharge	Scale N° : Elly Oyier	



DEPARTMENT OF CIVIL & CONSTRUCTION ENGINEERING

	student	Anthony									<b>14 1</b>				100	
	ple source	Memble	y qua	irry	kiar		-	eritic Gr	-		Kabete Ca	mpus (Do			(CDA)	
	epth (m)					SAMP	LE No.			DA SAN	NPLE B		Sr	. No.		
	st date:	25-Sep						Locatio	n:							
Spe	cification	Accordi	ng to	BS 1	37	7:1990.		Sample	Desci	ription:	Lateritic	Gravel s	oil Stab	oilized v	vith CD	A
an mass						(gm)		0								
tial dry sa	ample mass + pa	n				(gm)										
	ample mass					(gm)		200		Fine ma				(gm)		72.3
	y sample mass + y sample mass	pan				(gm)		127.7		Fine per	rcent Ince Criteria			(%) (%)		36.2
asheu ury	y sample mass					(gm)		121.1		Ассеріа				(70)		
Siev	ve size (mm)	Reta	ined ma	ass (ar	n)	9	6 Retained	(%)		umulative p			Ac	ceptance	Criteria	
0.07				(g.	,			(//)		percentage		М	in(%)		Ν	/lax (%)
	20		0				0.0			100.0						
	14		0				0.0			100.0						
	10		5			_	2.5		-	97.5						
	5 2.36		36 35			_	18.0 17.5			79.5 62.0						
	1.18		35 21.6				17.5 10.8		<u> </u>	62.0 51.2						
	0.6		12.1			_	6.1			45.2		1			I	1
	0.425		5			_	2.5		-	42.7						
	0.3		4.3				2.2			40.5						
	0.15		5.6				2.8		-	37.7						
	0.075		3.1				1.6			36.2						
			72.3				36.2									
_			200						-	-	<u>.</u>				-	
								GRADIN	ig cur	VE						
	100		1 1											•		
	90												1			
	80											*				
	70															
%	60															
p	50															
ŝŝir																
Passing (%)	40			•												
_	30															
	20															
	10															
	0.01				0.	1			1				10			
								Si	eves	(mm)						
										. ,						
quipment		Sieve set N						Shaker N					le N° :			
			Mathe		ıru				Verifie	d :Lab. Ir	ncharge	Elly	0yier			
echnician				. 20												
echnician ate Ibservatio			25-Sep	5-20					-							



DEPARTMENT OF CIVIL & CONSTRUCTION ENGINEERING

Student	Anthony Mugendi Nya	-					-	• • • • •	
Sample source	Membley quarry kiam								(CDA)
Depth (m)		SAMPLE N	lo.	9% CDA	SAM	PLE A	Sr	. No.	
Test date:	25-Sep-20		Locatio	on:					
Specification	According to BS 1377:	1990.	Sample	e Descript	ion:	Lateritic	Gravel soil Stat	oilized wi	th CDA
an mass		(gm)	0						
itial dry sample mass + pa	n	(gm)	0						
itial dry sample mass		(gm)	200		ine mas			(gm)	83.9
ashed dry sample mass +	pan	(gm)			ine perc			(%)	42.0
ashed dry sample mass		(gm)	116.1	A	cceptan	ce Criteria		(%)	
Sieve size (mm)	Retained mass (gm)	% Pota	ined (%)	Cumul	lative pa	issed	Ac	ceptance Cr	iteria
Sieve size (min)	Retained mass (gm)	70 Neta	ineu (70)	perc	entage	(%)	Min(%)		Max (%)
20	0	0	.0		100.0				
14	0	-	.0		100.0				
10	8.1		l.1		96.0				
5	30.5		5.3		80.7				
2.36	31.4		5.7		65.0				
1.18	18.6		0.3		55.7				
0.6	10.7		i.4		50.4				
0.425	4.1		2.1		48.3				
0.3	4		2.0 2.3		46.3 44.1				
0.15	4.5		3 2.1		44.1				
0.075	83.9		2.0		42.0				
	200	4.	2.0						
			GRADIN	IG CURVE					
100								•	
90									
80							•		
70									
8 60					$\nearrow$	~			
ව <sub>50</sub>									
	•	-							
60									
30									
20									
10									
0.01	0.1	1		1			10		10
			Si	ieves (mi	m)				
uipment	Sieve set N° :		Shaker N						
echnician	Mathew Mburu			Verified :L	.ab. Inc	charge	Elly Oyier		
	25-Sep-20								
	Mathew Mburu 25-Sep-20		Shaker N	<sup>j°</sup>	.ab. Inc	:harge	Scale Nº : Elly Oyier		



DEPARTMENT OF CIVIL & CONSTRUCTION ENGINEERING

	Anthony Mugendi Nya	-					
Sample source	Membley quarry kiam						1 (CDA)
Depth (m)		SAMPLE No.		A SAMP	LE B	Sr. No.	
Test date:	25-Sep-20		ocation:				
Specification	According to BS 1377:	1990. <b>S</b>	ample Descri	ption:	Lateritic Gra	vel soil Stabilized	with CDA
an mass		(gm)	0	1			
itial dry sample mass +	pan	(gm)	0	-			
itial dry sample mass		(gm)	200	Fine mass		(gm)	82.3
/ashed dry sample mas		(gm)		Fine perce		(%)	41.2
/ashed dry sample mas	3	(gm)	117.7	Acceptanc	e Criteria	(%)	
Sieve size (mm)	Retained mass (gm)	% Retained (%)		nulative pas		Acceptance	Criteria
		70 T totallou (70)	pe	ercentage (	%)	Min(%)	Max (%)
20	0	0.0		100.0			
14	0	0.0		100.0			
10	5.2	2.6		97.4			
5	26.3	13.2		84.3			
2.36	<u>32</u> 21.7	16.0 10.9		68.3 57.4			
0.6	12.5	6.3		57.4			
0.425	5.3	2.7		48.5			
0.3	4.5	2.3		46.3			
0.15	5.7	2.9		43.4			
0.075	4.5	2.3		41.2			
	82.3	41.2					
	200						
		GR	ADING CURV	Έ			
100						+++	
90							
80							
70							
S 60							
60 60 60 60 60 60 60 60 60 60 60 60 60 6		•					
· · · · · · · · · · · · · · · · · · ·	•						
<b>a</b> 30							
20							
10							
0							
0.01	0.1		1			10	100
			Sieves (r	nm)			
			naker N°			Scale N° :	
quinment	Sieve set Nº .			1			
	Sieve set N° : Mathew Mburu	Sr		Lab Inch	narae	Elly Ovier	
quipment 'echnician Date	Sieve set N° : Mathew Mburu 25-Sep-20	Sr		:Lab. Incl	harge	Elly Oyier	



DEPARTMENT OF CIVIL & CONSTRUCTION ENGINEERING

	Student	Anthony																			
	nple source	Memble	y qua	ırry ł				eritic G	ravel)	& Up	oper k	Cabete	Camp	ous (	Dairy	Farm	) Uol	1 (CE	DA)		
D	epth (m)				:	5AMPLI	ENo.		12%	CDA	SA	MPLE A	٩			Sr.	No.				
Te	est date:	25-Sep-	-20					Locat	ion:												
Spe	ecification	Accordi	ng to	BS 1	377:19	90.		Samp	e Des	cripti	on:	Lateri	tic G	rave	l soil :	Stabi	lized	with	CDA		
		•																			
an mass						gm)		0		_											
	ample mass + par ample mass					gm) gm)		200		Fir	ne mas	6					(gm)			88	
	ry sample mass +	pan				gm)					ne perc						(%)			4.0	
ashed dr	ry sample mass				(	gm)		112		Ac	ceptan	ce Criteria	a				(%)				
Sio	vo aiza (mm)	Potoi	inod me		2)	0/	Potoinod	(0/)		Cumula	ative pa	ssed				Acce	ptance	Criter	ia		
SIE	ve size (mm)	Rela	ined ma	ass (gri	1)	70	Retained	(%)		perce	entage (	%)			Min(%)	)			Ма	x (%)	
	20		0				0.0				100.0										
	14		0				0.0				100.0		_								
	10		5				2.5				97.5										
	5		25				12.5				85.0										
	2.36 1.18		31 18.6				15.5 9.3				69.5 60.2										
	0.6		11.4				9.3 5.7				54.5										
	0.425		5				2.5				52.0										
	0.3		4.5				2.3				49.8										
	0.15		7.1				3.6				46.2										
	0.075		4.4				2.2				44.0		_								
			88				44.0														
			200					GRADI		DVF											
	100															-	•				
	90																				
	80													1							
													1								
3	70											*									
Passing (%)	60									-	-										
ы	50						-	•									_	_			_
ISSI	40			•													_	_			
Po	30																				
	20																				
	10																				
	0.01				0.1				1						10						100
								5	bieves	(mn	n)										
quipment		Sieve set N	1° :					Shaker	N°						Scale N°	:					
echniciar	n		Mathe	w Mbu	ru				Verifi	ied :La	ab. Inc	harge			Elly Oyi	ier					
ate			25-Sep	o-20																	
)bservati																					
Conform	n to the spec	ifications																			



DEPARTMENT OF CIVIL & CONSTRUCTION ENGINEERING

	AMPLE No. Locatic NO. Sample n) 0 n) 0 n) 200 n) 113 % Retained (%) 0.0 0.0 0.0 3.4 12.5 15.7 9.8 5.5 2.2 2.1 3.1 2.4	12% CDA SAMPLE B	itic Gravel soil Stabilized (gm) (%)	with CDA 87 43.5
A-20 ing to BS 1377:199 (gn (gn (gn (gn (gn (gn (gn (gn (gn (gn	Locatic O. Sample n) 0 n) 0 n) 200 n) 113 % Retained (%) 0.0 0.0 0.0 3.4 12.5 15.7 9.8 5.5 2.2 2.1 3.1 2.4	Cumulative passed percentage (%) 100.0 100.0 96.7 84.2 68.5 58.8 53.3 51.1 49.0	itic Gravel soil Stabilized (gm) (%) a (%) Acceptance	87 43.5 e Criteria
ing to BS 1377:199 (gn (gn (gn (gn (gn ained mass (gm)) 0 0 6.7 25 31.3 19.5 11 4.4 4.2 6.1 4.8 87	Sample           n)         0           n)         200           n)         200           n)         113           % Retained (%)         0.0           0.0         0.0           3.4         12.5           15.7         9.8           5.5         2.2           2.1         3.1           2.4	E Description: Later	(gm) (%) a (%) Acceptance	87 43.5 e Criteria
(gn (gn (gn (gn (gn (gn ained mass (gm)) 0 0 6.7 25 31.3 19.5 11 4.4 4.2 6.1 4.8 87	n) 0 n) 0 n) 200 n) 113 % Retained (%) 0.0 0.0 0.0 0.0 3.4 12.5 15.7 9.8 5.5 2.2 2.1 3.1 2.4	Fine mass Fine percent Acceptance Criteri Cumulative passed percentage (%) 100.0 100.0 96.7 84.2 68.5 58.8 53.3 51.1 49.0	(gm) (%) a (%) Acceptance	87 43.5 e Criteria
(gn (gn (gn (gn (gn (gn (gn 0 0 6.7 25 31.3 19.5 11 4.4 4.2 6.1 4.8 87	n) 200 n) 200 n) 113 % Retained (%) 0.0 0.0 0.0 3.4 12.5 15.7 9.8 5.5 2.2 2.1 3.1 2.4	Fine percent           Acceptance Criteri           Cumulative passed percentage (%)           100.0           96.7           84.2           68.5           58.8           53.3           51.1           49.0	(%) a (%) Acceptance	43.5 e Criteria
(gn (gn (gn ained mass (gm)) 0 0 0 6.7 25 31.3 19.5 11 4.4 4.2 6.1 4.8 87	n) 200 n) 200 n) 113 % Retained (%) 0.0 0.0 0.0 3.4 12.5 15.7 9.8 5.5 2.2 2.1 3.1 2.4	Fine percent           Acceptance Criteri           Cumulative passed percentage (%)           100.0           96.7           84.2           68.5           58.8           53.3           51.1           49.0	(%) a (%) Acceptance	43.5 e Criteria
(gn ained mass (gm) 0 0 6.7 25 31.3 19.5 11 4.4 4.2 6.1 4.8 87	n) 113 % Retained (%) 0.0 0.0 3.4 12.5 15.7 9.8 5.5 2.2 2.1 3.1 2.4	Fine percent           Acceptance Criteri           Cumulative passed percentage (%)           100.0           96.7           84.2           68.5           58.8           53.3           51.1           49.0	(%) a (%) Acceptance	43.5 e Criteria
(gn ained mass (gm) 0 0 6.7 25 31.3 19.5 11 4.4 4.2 6.1 4.8 87	n) 113 % Retained (%) 0.0 0.0 3.4 12.5 15.7 9.8 5.5 2.2 2.1 3.1 2.4	Acceptance Criteri Cumulative passed percentage (%) 100.0 100.0 96.7 84.2 68.5 58.8 53.3 51.1 49.0	a (%) Acceptance	e Criteria
ained mass (gm)  0  0  6.7  25  31.3  19.5  11  4.4  4.2  6.1  4.8  87	% Retained (%) 0.0 0.0 3.4 12.5 15.7 9.8 5.5 2.2 2.1 3.1 2.4	Cumulative passed percentage (%) 100.0 96.7 84.2 68.5 58.8 53.3 51.1 49.0	Acceptance	
0 0 6.7 25 31.3 19.5 11 4.4 4.2 6.1 4.8 87	0.0 0.0 3.4 12.5 15.7 9.8 5.5 2.2 2.1 3.1 2.4	percentage (%) 100.0 100.0 96.7 84.2 68.5 58.8 53.3 51.1 49.0		
0 0 6.7 25 31.3 19.5 11 4.4 4.2 6.1 4.8 87	0.0 0.0 3.4 12.5 15.7 9.8 5.5 2.2 2.1 3.1 2.4	100.0 100.0 96.7 84.2 68.5 58.8 53.3 51.1 49.0	Min(%)	Max (%)
0 6.7 25 31.3 19.5 11 4.4 4.2 6.1 4.8 87	0.0 3.4 12.5 15.7 9.8 5.5 2.2 2.1 3.1 2.4	100.0 96.7 84.2 68.5 58.8 53.3 51.1 49.0		
6.7         25         31.3         19.5         11         4.4         4.2         6.1         4.8         87	3.4 12.5 15.7 9.8 5.5 2.2 2.1 3.1 2.4	96.7 84.2 68.5 58.8 53.3 51.1 49.0		
25 31.3 19.5 11 4.4 4.2 6.1 4.8 87	12.5 15.7 9.8 5.5 2.2 2.1 3.1 2.4	84.2 68.5 58.8 53.3 51.1 49.0		
31.3         19.5         11         4.4         4.2         6.1         4.8         87	15.7 9.8 5.5 2.2 2.1 3.1 2.4	68.5 58.8 53.3 51.1 49.0		
19.5         11         4.4         4.2         6.1         4.8         87	9.8 5.5 2.2 2.1 3.1 2.4	58.8 53.3 51.1 49.0		
11 4.4 4.2 6.1 4.8 87	2.2 2.1 3.1 2.4	53.3 51.1 49.0		I I
4.2 6.1 4.8 87	2.1 3.1 2.4	49.0		
6.1 4.8 87	3.1 2.4			
4.8 87	2.4	45.9		
87				
		43.5		
200	43.5			
	GRADIN	IG CURVE		
↓ ↓ ↓ ↓ ↓ ↓ ↓ ↓ ↓ ↓ ↓ ↓ ↓ ↓ ↓ ↓ ↓ ↓ ↓				
0.1		1	10	100
	Si	eves (mm)		
N° :	Shaker N		Scale N° :	
Mathew Mburu		Verified :Lab. Incharge	Elly Oyier	
25-Sep-20				
	0.1	0.1 0.1 Si 0.1 Si 0.1 Si 0.1 Si 0.1 Si 0.1 Si 0.1 Si 0.1 Si 0.1 Si 0.1 Si 0.1 Si 0.1 Si 0.1 Si 0.1 Si 0.1 Si 0.1 Si 0.1 Si 0.1 Si 0.1 Si 0.1 Si 0.1 Si 0.1 Si 0.1 Si 0.1 Si 0.1 Si 0.1 Si 0.1 Si 0.1 Si 0.1 Si 0.1 Si 0.1 Si 0.1 Si 0.1 Si 0.1 Si 0.1 Si 0.1 Si 0.1 Si 0.1 Si 0.1 Si 0.1 Si 0.1 Si 0.1 Si 0.1 Si 0.1 Si 0.1 Si 0.1 Si 0.1 Si 0.1 Si 0.1 Si 0.1 Si 0.1 Si 0.1 Si 0.1 Si 0.1 Si 0.1 Si 0.1 Si 0.1 Si 0.1 Si 0.1 Si 0.1 Si 0.1 Si 0.1 Si 0.1 Si 0.1 Si 0.1 Si 0.1 Si 0.1 Si 0.1 Si 0.1 Si 0.1 Si 0.1 Si 0.1 Si 0.1 Si 0.1 Si 0.1 Si 0.1 Si 0.1 Si 0.1 Si 0.1 Si 0.1 Si 0.1 Si 0.1 Si 0.1 Si 0.1 Si 0.1 Si 0.1 Si 0.1 Si 0.1 Si 0.1 Si 0.1 Si 0.1 Si 0.1 Si 0.1 Si 0.1 Si 0.1 Si 0.1 Si 0.1 Si 0.1 Si 0.1 Si 0.1 Si 0.1 Si 0.1 Si 0.1 Si 0.1 Si 0.1 Si 0.1 Si 0.1 Si 0.1 Si 0.1 Si 0.1 Si 0.1 Si 0.1 Si 0.1 Si Si 0.1 Si 0.1 Si 0.1 Si 0.1 Si 0.1 Si 0.1 Si 0.1 Si 0.1 Si 0.1 Si 0.1 Si 0.1 Si 0.1 Si 0.1 Si 0.1 Si 0.1 Si 0.1 Si 0.1 Si 0.1 Si 0.1 Si 0.1 Si 0.1 Si 0.1 Si 0.1 Si 0.1 Si 0.1 Si 0.1 Si 0.1 Si 0.1 Si 0.1 Si 0.1 Si 0.1 Si 0.1 Si 0.1 Si 0.1 Si 0.1 Si Si Si Si Si Si Si Si Si Si	0.1 I Sieves (mm) N° : Shaker N° Mathew Mburu 25-Sep-20	0.1 1 10 Sieves (mm) N° : Scale № Staker № Staker № Elly Oyier 25-Sep-20



DEPARTMENT OF CIVIL & CONSTRUCTION ENGINEERING

	Anthony Mugendi Nya					
Sample source	Membley quarry kian				ampus (Dairy Farm) UoN	(CDA)
Depth (m)		SAMPLE No.	15% CDA	SAMPLE A	Sr. No.	
Test date:	25-Sep-20	Loca	ation:			
Specification	According to BS 1377:	1990. Sam	ple Description	n: Lateritic	: Gravel soil Stabilized w	vith CDA
an mass		(gm) 0				
nitial dry sample mass + p nitial dry sample mass	an	(gm) (gm) 20	0 Ein	e mass	(gm)	92
Vashed dry sample mass	+ pan	(gm) 20		e percent	(%)	46.0
Vashed dry sample mass	· ·	(gm) 10		eptance Criteria	(%)	
		i				
Sieve size (mm)	Retained mass (gm)	% Retained (%)		ive passed	Acceptance 0	Criteria
Sieve size (mm)	Tretained mass (gm)	70 Retained (70)	percer	itage (%)	Min(%)	Max (%)
20	0	0.0	1	00.0		
14	0	0.0	1	00.0		
10	4.5	2.3	9	7.8		
5	28.4	14.2	1	3.6		
2.36	30.6	15.3		8.3		
1.18	19.3	9.7		8.6		
0.6	10	5.0		3.6		
0.425	4.1	2.1		51.6		
0.3	3.3	1.7		9.9		
0.15	4.8	2.4		7.5		
0.075	3	1.5		6.0		
	92	46.0				
	200					
		GRAD	ING CURVE			
100					• • • • • •	
90						
80						
70						
60 60 40 50 40 60 60 60 60 60 60 60 60 60 60 60 60 60						
			•			
	•	-				
SG 40						
<b>A</b> 30						
20						
10						
0						
0.01	0.1		1		10	10
			Sieves (mm	)		
	Sieve set N° :	Shake	r N <sup>o</sup>		Scale N° :	
quipmont		Shake	Verified :La	Incharge	Elly Oyier	
quipment Technician	Mathew Mburu					



DEPARTMENT OF CIVIL & CONSTRUCTION ENGINEERING

Sample source		gah					
	Membley quarry kiam					npus (Dairy Farm) UoN	(CDA)
Depth (m)		SAMPLE N	o. 1	5% CDA SA	MPLE B	Sr. No.	
Test date:	25-Sep-20		Location	:			
Specification	According to BS 1377:	1990.	Sample (	Description:	Lateritic	Gravel soil Stabilized w	vith CDA
		( )					
an mass nitial dry sample mass + j	220	(gm)	0				
nitial dry sample mass + p	Jan	(gm) (gm)	200	Fine ma	SS	(gm)	85.7
Vashed dry sample mass	+ pan	(gm)		Fine per	cent	(%)	42.9
Vashed dry sample mass		(gm)	114.3	Accepta	nce Criteria	(%)	
Sieve eize (mm)	Potoinod mass (am)	% Potoi	nod (9()	Cumulative p	assed	Acceptance (	Criteria
Sieve size (mm)	Retained mass (gm)	% Retai	ned (%)	percentage	(%)	Min(%)	Max (%)
20	0	0	.0	100.0			
14	0	-	.0	100.0			
10	12.2		.1	93.9			
5	30.1		5.1	78.9			
2.36	31.5		5.8	63.1			
1.18 0.6	9.3		.7	54.5 49.8			
0.425	4.3		.7	43.3			
0.3	3.1	-	.6	46.1			
0.15	4.5	2	.3	43.9			
0.075	2	1	.0	42.9			
	85.7	42	2.9				
	200		GRADING				
90 80 70 60 50 40 30 20 10 0.01			Sie	ves (mm)		10	10
quipment echnician	Sieve set N° :		Shaker N°			Scale N° :	
RCDDICION	Mathew Mburu 25-Sep-20		v	erified :Lab. Ir	charge	Elly Oyier	
)ate	LJ-JCP-LU						

Compa	ction Properties	
Stabilized Material	MDD (kg/m <sup>3</sup> )	OMC (%)
3% CDA Stabilized	1642	26.20
6% CDA Stabilized	1638	26.60
9% CDA Stabilized	1602	27.40
12% CDA Stabilized	1601	27.60
15% CDA Stabilized	1560	27.80

Strength Properties UCS (kN/m<sup>2</sup>)

	Suchguli	Toperties oc		
CDA	Sample 1	Sample 2	Sample 3	Average
3%	392	396	341	376
6%	428	440	427	432
9%	498	490	499	496
12%	544	458	382	420
15%	368	364	359	364

Strength Properties CBR (%)

	Buengui	r toperties er	<b>DI(</b> /0)	
CDA	Sample 1	Sample 2	Sample 3	Average
3%	67	39	42	41
6%	46	50	55	50
9%	65	53	78	59
12%	59	72	82	77
15%	80	80	99	86

Atterberg Limits

		-	•	
FCD	Liquid Limit	Plastic Limit	Plasticity Index	Linear Shrinkage
3%	66	36	29	17
6%	65	36	29	17
9%	62	32	30	14
12%	63	33	29	13
15%	62	31	30	13

Grading (% of fines)					
CDA	Sample A	Sample B	Average Value		
3%	38.8	39.3	39.1		
6%	38.2	36.2	37.2		
9%	42.0	41.2	41.6		
12%	44.0	43.5	43.8		
15%	46.0	42.9	44.5		