FACULTY OF ENGINEERING

DEPARTMENT OF WATER RESOURCES ENGINEERING

FINAL YEAR PROJECT REPORT

ANALYSIS OF THE MECHANICAL PROPERTIES OF SISAL FIBER REINFORCED CLAY FOR SOIL ENHANCEMENT

CASE STUDY: Nanguddi village, Busitema sub county, Busia District.

By

NAME: NAKIRYA FRIDAH

REG. NUMBER: BU/UP/2018/3651

Email: fnakirya910@gmail.com

TEL. NUMBER: 0701517250/ 0771928078

SUPERVISORS

MR. TIGALANA DAN AND MR. TUMUSIIME GODIAS

This Final Year Project report is submitted to the department of water resources engineering in partial fulfillment of the requirement for the award of the degree of Bachelors of Science in water resources Engineering of Busitema University

NOVEMBER 2022

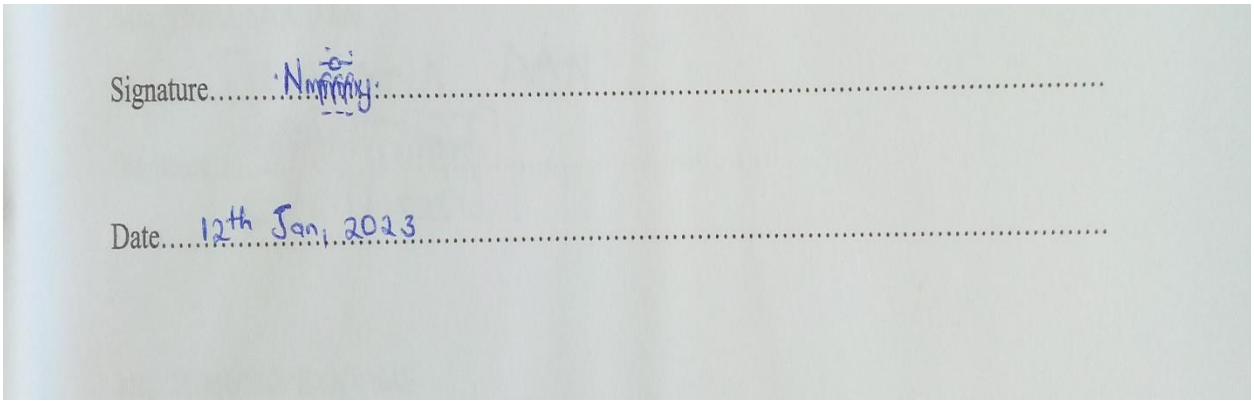
Abstract

Geotechnical engineers face various problems while designing clay foundations due to low shearing strength, low bearing capacity and excessive settlement. So, they overcome that with different engineering works but in this project, I chose sisal fibers to improve the parameters of the soil, this method is cost effective and environmentally friendly. Clay samples were taken from Nanguddi village, Busitema subcounty, Busia district. The sisal fibers were obtained from Shaule village in Busitema sub-county and were used for reinforcement. The sisal fibers were treated with benzoylation treatment and its strength tested. To review the engineering properties of the soil, various laboratory tests were carried out like Atterberg limit tests, natural moisture content, particle size distribution, specific gravity, Standard Proctor compaction test. The sisal fibers were chopped into different fiber length of 0.0 cm, 0.3 cm, 1.0 cm, 1.7 cm and 2.0 cm and varied in different percentages of 0.5%, 0.9%, 1.8% and 2.6% and 3.0% by weight of soil samples and they were randomly distributed and compacted to the maximum dry density at the optimum moisture content. The effect of fiber addition on the soil was evaluated by performing an undrained unconsolidated triaxial shear test. The results indicate that with a fiber length of 1.1cm and content of 2.1%, sisal fiber-reinforced clay is 49.5% stronger than nonreinforced clay. The results of these tests have clearly shown a significant improvement in the failure deviator stress and undrained shear strength of the studied soil. It can be concluded that sisal fiber can be considered as a good earth reinforcement material

Key words: clay, sisal fiber, Atterberg limit, particle size distribution, standard proctor compaction unconsolidated undrained triaxial shear.

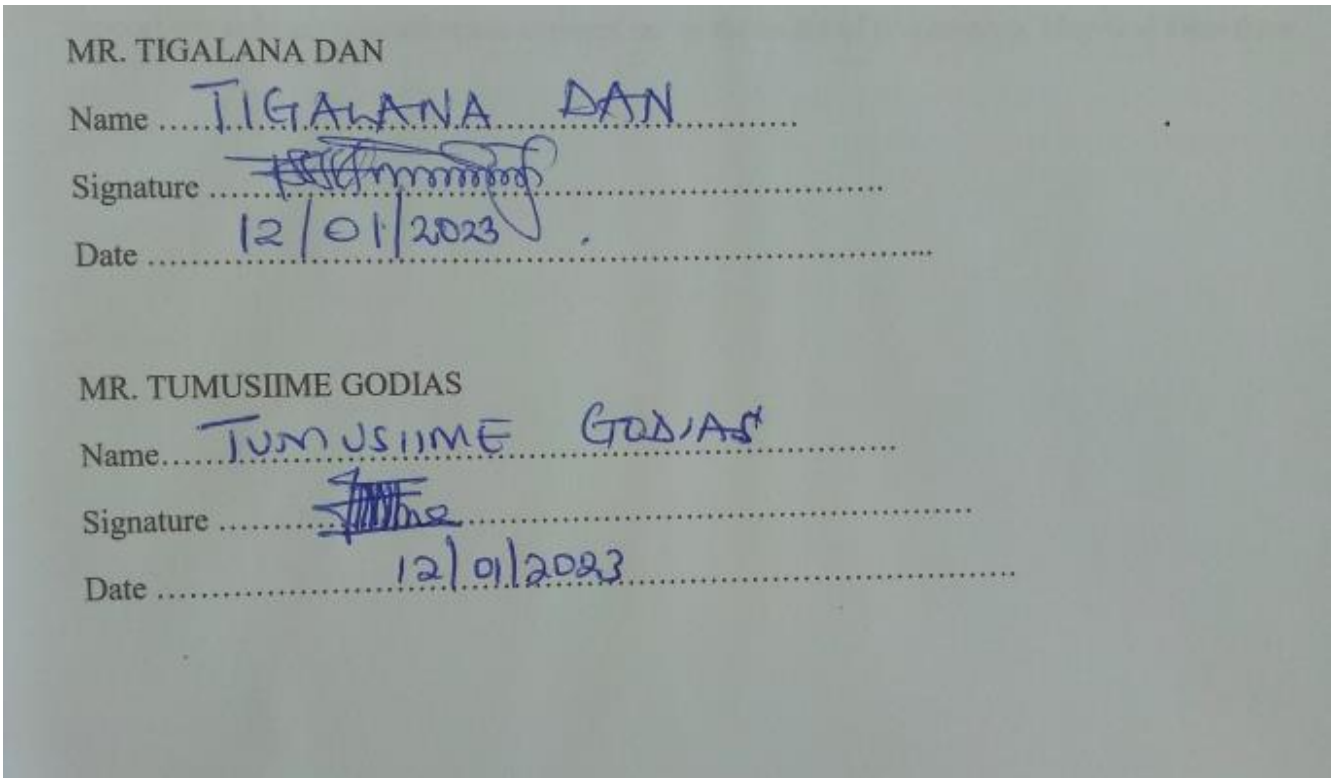
Declaration

I NAKIRYA FRIDAH declare that the information provided in this report is my original work and it has never been presented for any academic award



Approval

This is to approve that this report is written and presented by NAKIRYA FRIDAH, a final year student with registration number BU/UP/2018/3651 in the presence of;



MR. TIGALANA DAN

Name ..... TIGALANA DAN .....

Signature .....

Date ..... 12/01/2023 .....

MR. TUMUSIIME GODIAS

Name..... TUMUSIIME GODIAS .....

Signature .....

Date ..... 12/01/2023 .....

Dedication

I dedicate this final project report to my parents **Mr. Jebero James** and **Mrs. Constance Tawulya Jebero**, my brother Nagulyo Paul, my other siblings and friends whose sacrifice, guidance and support towards my education has exposed me to the world of Engineering. May God bless them.

Acknowledgements
Above all I thank the Almighty God for His love, care, provisions, good health, protection and for bringing me this far.

I highly appreciate the entire staff in the department of Water Resources Engineering Busitema University for giving me knowledge in the field of Water resources. I am very grateful to Mr. Tigalana Dan and Mr. Tumusiime Godias, my supervisors who gave me all the necessary guidance, advice and encouragement during the preparation of this report, May the Almighty God bless them abundantly.

In a special way, I thank all my friends and colleagues for the assistance they have given me up to final stage of this report.

And lastly credit goes to my parents whose efforts and prayers have enabled me come this far.

Table of Contents

Contents

List of Figures

List of Tables

List of equations

Acronyms

UU……. Unconsolidated undrained

% ……Percentage

ASTM……. American Society of Testing and Materials

W% ……Percentage of water content

C ……. Cohesion of soil

Ɵ ……...Angle of internal friction

t ……. Shear stress of soil

MDD……Maximum Dry Density.

BS……. British Standard

P.L……Plastic Limit

L.L……Liquid Limit

P. I……. plasticity index

OMC……. optimum moisture content

CCD……central composite design

PDM……...Parish Development Model

SDGs……...Sustainable Development Goals

NDP……. National Development Plan

DOE……...Design of Experiments

RSM……. Response Surface Methodology

NaOH……sodium hydroxide

CHAPTER 1 : INTRODUCTION

This chapter includes the following; background of the study, statement of the problem, significance of the study, objectives of the study, the justification and scope of the study.

1.1 Background

The construction of buildings and other civil structures on soft or soft soil is very risky geotechnically because such soil is prone to differential settlement, low shear strength and high compressibility. Improving soil bearing capacity can be accomplished by various soil improvement techniques such as soil stabilization, application of reinforced tillage techniques, among others. The reinforced tillage technique is considered an effective soil improvement method due to its cost savings, adaptability and regenerative properties. (Prabakar and Ramachandran, 2002).

Soil stabilization is the process of improving the strength, durability and workability of soil by enhancing the properties of its particles to become more resistible to loading and to become stable enough so it can be used for construction. So, to work with soils, we need to have proper knowledge about their properties and factors which affect their behavior. The process of soil stabilization helps to achieve the required properties in a soil needed for the construction work. (Astm and Drained, 2018)

Different soil types have different settlement requirements and it is very expensive to completely replace the bottom layer. Well-designed foundations produce stress-strain states in the soil that are neither in the linear elastic range nor in the range normally associated with perfect ductility. Thus, in order to accurately predict the settlement under the support of the foundation on the ground, it is necessary to perform a more realistic analysis than the simple elastic analysis and to be able to compare settlement between the settlement for reinforced and unreinforced soil conditions. Soil reinforcement is the thing to look for in these cases as it improves the strength of the soil thereby increasing its bearing capacity, it is more economical in cost and energy to increase the soil bearing capacity than choosing to dig deep or rafting foundation, sometimes also used to prevent soil erosion or dust formation, is useful especially in dry weather (Asaduzzaman, Muhammad and Islam, 2014)

The study of soil improvement is very important for the geotechnical engineer to support the soil and prevent it from bending under the loading of the structure of the building. Cement and lime often used as chemicals for the purpose of soil improvement, however as time passed the prices of these two materials increased, and the production of cement is pollutant to the environment, that's why this research helped a lot in minimizing the excessive use of cement for engineering purposes.

Al Mosawe et al., (2011) presented the results of improving soft clay soil (i.e. Kaolin) by compacted fly ash. The results show that there is a noticeable improving in the behavior of square footing settlement and California bearing capacity ratio (BCR) of (1.3) in average but also without controlling the initial settlement. It can be concluded from the above study that reinforcement can

CHAPTER 7 REFERENCES

‘20200507233317956 7gaurav-Expansive soil and its parameters_compressed.pdf’ (no date).

Asaduzzaman, M., Muhammad, ; and Islam, I. (2014) ‘Soil Improvement By Using Bamboo Reinforcement’, *American Journal of Engineering Research (AJER)*, 03(August 2015), pp. 362–368. Available at: www.ajer.org.

Astm, D. and Drained, C. (2018) ‘Triaxial Shear Test Triaxial Shear Test Triaxial Shear Test’, (C), pp. 1–29.

Central Materials Laboratory (2000) ‘Laboratory Testing Manual 2000’, *Laboratory Testing Manual, Central Materials Laboratory- Tanzania*, pp. 1–320.

Cerato, A.B. and Lutenegger, A.J. (2005) ‘Activity , Relative Activity and Specific Surface Area of Fine-Grained Soils Activité , Activité Relative et Superficie Spécifique de Sols Granuleux Fins Activity , Relative Activity and Specific Surface Area of Fine-Grained Soils Activité , Activité Rela’, (September).

Elarabi, H. (no date) ‘INTERNATIONAL SOCIETY FOR SOIL MECHANICS AND’. doi:10.3233/978-1-61499-656-9-341.

Firoozi, Ali Akbar, Firoozi, Ali Asghar and Baghini, M.S. (2016) ‘A Review of Clayey Soils’, (December).

Gaafer *et al.* (2015) ‘Soil improvement techniques’, 6(12), pp. 217–222. Available at: file:///C:/Users/700030580/Downloads/50555_62_1_Soil-Improvement-Techniques.pdf.

Hansbo, S. (2018) ‘Foundation engineering’.

Ibrahim, I.D. *et al.* (2016) ‘Mechanical properties of sisal fibre-reinforced polymer composites: A review’, *Composite Interfaces*, 23(1), pp. 15–36. doi:10.1080/09276440.2016.1087247.

Kanayama, M. and Kawamura, S. (2019) ‘Effect of Waste Bamboo Fiber Addition on Mechanical Properties of Soil’, *Open Journal of Civil Engineering*, 09(03), pp. 173–184. doi:10.4236/ojce.2019.93012.

Krithiga, N. *et al.* (2017) ‘Soil Stabilization Using Lime and Flyash’, *Ingternational journal of civil engineering*, 7(special issue April), pp. 510–518.

Kumi, N. and Abiodun, B.J. (2021) ‘Unit cost analysis for road construction sustainability : A case study of national road in West Java Province , Indonesia Unit cost analysis for road construction sustainability : A case study of national road in West Java Province , Indonesia’. doi:10.1088/1757-899X/1122/1/012008.

Mahdi, S. *et al.* (2012) ‘A simple review of soil reinforcement by using natural and synthetic fibers’, 30, pp. 100–116. doi:10.1016/j.conbuildmat.2011.11.045.

Mechanics, A.S. (no date) *No Title*.

Mechanics, S. *et al.* (no date) ‘No Title’.

Millogo, Y. *et al.* (2017) 'Contribute to the Reinforcement of Earth Blocks To cite this version ': doi:10.3390/ma8052332.

Mishra, R. *et al.* (2019) 'Use of Sisal Fibre in Flexible Pavement for Reducing of Soil Settlement Effect', *Hbrppublication.Com*, 2(3), pp. 1–5. Available at: http://hbrppublication.com/OJS/index.php/JESSDE/article/view/1097.

Olawoye, B. and Researcher, I.S. (2016) 'A COMPREHENSIVE HANDOUT ON CENTRAL COMPOSITE DESIGN (CCD)', (July).

Savage, P.F. (2007) 'EVALUATION OF POSSIBLE SWELLING POTENTIAL OF SOIL', (July), pp. 277–283.

Warda, M.A. *et al.* (2020) 'Optimum Sustainable Mix Proportions of High Strength Concrete by Using Taguchi Method', *Frattura ed Integrità Strutturale*, 14(54), pp. 211–225. doi:10.3221/IGF-ESIS.54.16.