Faculty of Engineering

UNCONFINED COMPRESSIVE STRENGTH OF CEMENT STABILIZED PEAT WITH RUBBER CHIPS AND SAND FILLER MIXED AT VARIOUS WATER TO ADDITIVE RATIO

Venessa Anak Ajon

Bachelor of Engineering with Honours
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This project report which entitled **"UNCONFINED COMPRESSIVE STRENGTH OF CEMENT STABILIZED PEAT WITH RUBBER CHIPS AND SAND FILLER MIXED AT VARIOUS WATER TO ADDITIVE RATIO"** was prepared and submitted by **VENESSA ANAK AJON (58219)** as a partial fulfilment of the requirement for degree of Bachelor of Engineering with Honours in Civil Engineering is hereby read and approved by:

28th August 2020

Assoc. Prof. Ir Dr. Siti Noor Linda Binti Taib

(Project Supervisor)

Date

UNCONFINED COMPRESSIVE STRENGTH OF CEMENT STABILIZED PEAT WITH RUBBER CHIPS AND SAND FILLER MIXED AT VARIOUS WATER TO ADDITIVE RATIO

VENESSA ANAK AJON

A report submitted in partial fulfillment of the requirement

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Specially dedicated for my beloved parents and loved ones.

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ABSTRACT

Peat is known to be a very problematic soil as it has high natural moisture content, high compressibility and low shear strength, high degree of spatial variability and high permeability which requires special considerations for construction over them. In Malaysia, peat soils cover 2,457,730 ha (7.45%) of Malaysia's total land area which is 32,975,800 ha. Due to the geotechnical problems of peat soil, previous researchers have found several methods to improve the behaviour of peat soil by using chemical stabilization method. In this study, peat samples were collected from Kampung Meranek, Kota Samarahan, Sarawak and was classified under H8 (Sapric Peat) according to Von Post Humification scale. The samples were mixed at its natural moisture content with the addition of cement, constant percentage of rubber chips and constant percentage of siliceous sand. A suitable mixing water- additive ratio of 2.0, 2.5 and 3.0 had been chosen to determine the optimum strength of peat soil and the samples were cured at a curing period of 7, 14 and 28 days respectively. After those curing periods, the compressive strength of samples were obtained by conducting unconfined compressive strength (UCS) test in the laboratory. The results of strength gained that had been obtained from this study indicated that water-additive ratio of 2.0 is the optimum ratio as it achieved the highest maximum strength at curing period of 28 days. This study had proven that the compressive strength of peat increases with the inclusion of cement, rubber chips and sand at a specific water-additive ratio through curing period.

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LIST OF SYMBOLS

CaO	calcium oxide
g	gram
ha	hectare
HCl	hydrochloric acid
kPa	kilopascal
MgO	magnesium oxide
mL	mililiter
mm	milimeter
mm/min	milimeter per minute
O_2	oxygen
r/min	rotation per minute
s	second
S	sulphur
kgm^{-3}	kilogram per cubic metre
°C	degree Celcius

m	miccrometer
$(CaSO_4)$	calcium sulphate
$(Ca(OH)^2)$	hydrated lime
(C^2S)	dicalcium silicate
(C^3A)	tricalcium
(C^3S)	tricalcium silicate
(C^4A)	tetra calcium alumino- ferrite
(C^2SH^x, C^4AH^x)	hydrated calcium silicate

LIST OF ABBREVIATIONS

ASTM	American Society for Testing and Materials
BS	British Standard
FA	fly ash
FC	fiber content
LL	liquid limit
OC	organic content
OPC	ordinary Portland cement
PI	plasticity index
PL	plastic limit
QL	quick lime
UCS	Unconfined Compressive Strength
W/C	water to cement ratio
W/A	water additive rati

CHAPTER 1

INTRODUCTION

1.1 Background of Study

Peat is represented as a disintegrated plant remains which have been build up and preserved under conditions that are lack of aeration and contains a high water content. It refers to highly organic soils that originates primarily from plant remains where it has a dark to brown black colour, a spongy consistency and an organic odour. In Malaysia, peat soils are usually dark reddish brown to black in colour and are comprised of loose, partially decomposed leaves, roots, twigs and low-mineral tree trunks. When drained, the peat is a compact soil layer, formed of partially large pieces of wood and tree trunks (Zainorabidin & Wijeyesekera, 2008). Peat has been known as a very problematic soil and there are a few characteristics of peat which have to be improved for construction to be built over them and the characteristics include high natural moisture content, low shear strength, high compressibility, high degree of spatial variability and high permeability as compared to clay (Huat et al.,2014).

The general problems facing the construction of peat and organic soils include limited accessibility and challenging traffic ability, expectations of very large settlements over an extended time and potential problems with stability. Construction of road on peat or organic soil, whether technically or contractually obligated, has often posed challenges to engineers, contractors and policymakers. The key limit requirements for engineers are stability and acceptable settlement, both as function of the time, in terms of serviceability limits (Huat et al.,2014). Geotechnical considerations are linked to many of the road embankments and culvert faults. A range of innovative approaches have been implemented by engineers such as the conventional displacement construction method for engineering construction over soft clays. However, this method of road construction is time consuming as the filling materials take time to sink down to the firm bearing stratum due to buoyancy force (high water table level). The long- term road embankment settling and paving deformations lead to dangerous, low riding condition and high cost of road maintenance. (Tang, 2016).

In Malaysia, peat soils cover 2,457,730 ha which is 7.45% of Malaysia's total land area (32,975,800 ha). Sarawak has the largest area of peat soils in Malaysia which is 1,697,847 ha and it has a percentage of 69.08 % of the total peatland area in Malaysia, followed by Peninsular Malaysia that has an area of 642,918 ha which is equal to 26.16%. Meanwhile, Sabah has a peat area of 116,965 ha which is equal to 4.76 % (Jon Davies, Usha Mathhew, Sarala Aikanathan & Chik and Gabriel Chong, 2010). In every location, the content of peat soil will be influenced by the origin of fiber, degree of humification and temperature (Kazemian, Huat, Prasad, & Barghchi, 2011). Additionally, drainage will also influence the degree of decomposition, shrinkage and consolidation behaviour of the soil.

Table 1.1: The area (ha) of peat soil in the region of Peninsula Malaysia, Sarawak and Sabah (from Jon Davies, Usha Mathhew, Sarala Aikanathan & Chik and Gabriel Chong, 2010)

REGION	ha	%
SARAWAK	1,697,847	69.08
PENINSULAR MALAYSIA	642,918	26.16
SABAH	116,965	4.76
TOTAL	2,457,730	

Von Post Humification scale is used in order to categorize peat soils based on their fibre content and also degree of humification or decomposition. Peat soil will be identified according to the degree of humification scale which is ranging from H1 to

H10 and it is divided into three categories as given in Table 1.2. By referring to the parameters given, engineers would be able to understand the complex behaviour of peat soil. According to Huat (2014), loss of organic matter (gas or in solution), the disappearance of physical structure and change in chemical state is involved in decomposition or humification.

Table 1.2: Classification of peat soil based on degree of humification (from Alaska Department of Transportation, 2007)

Name	Fiber Content	Degree of Humidification
Fibric Peat	>67%	$H_1 - H_3$
Hemic Peat	33% - 67%	$H_4 - H_6$
Sapric Peat	<33%	$H_7 - H_{10}$

1.2 Problem Statement

Peat soils are known as geotechnically problematic because it has a high water content, low shear strength and also high in compressibility which make it not suitable for construction activities. It is very challenging for development projects to be built on peat soils because of its poor quality and settlement. The loads that are induced by the structures constructed on peat will result in slip failure and large deformation. Shear strength is one of the important variable in engineering design when it comes to dealing with soil during construction. As the water content of peat soil is high, it causes the shear strength to become lower. Based on previous studies, one of the option which can be applied to overcome the construction problem and to enhance the strength of peat soil is by doing chemical stabilization using binder materials such as lime and cement where it has been proven that mechanical properties of peat increases after the addition of chemical stabilizers. In this study, peat soil sample will undergo Unconfined Compressive Strength (UCS) test to determine the strength of stabilized peat soil after adding rubber chips, cement and sand as a filler.

1.3 Objective of the Study

The objectives of conducting this study are:

a) to investigate the strength development in peat by addition of different dosage of cement, maintained percentage of rubber chips and siliceous sand;

b) to investigate suitable mixing water- additive ratio involving filler material; and

c) to analyze the geotechnical properties of stabilized peat via UCS.

1.4 Scope of Study

This study is focused on the stabilization of peat soil by addition of different dosage of cement using suitable mixing water- additive ratio involving filler material and rubber chips. The peat sample will be taken from Kampung Meranek, Kota Samarahan, Sarawak in a laboratory condition where its moisture content will be retained from the original peat. Geotechnical properties of peat such as moisture content, organic content, fiber content, specific gravity, liquid limit and pH will be determined by carrying out several tests on peat and UCS test will also be performed to determine the strength of stabilized peat. The stabilized samples will be cured at 7, 14 and 28 days and the optimum water- additive mixing ratio of stabilized peat will be determined.

1.5 Significance of Study

The importance of performing this study is to establish an effective way to stabilize peat soil by addition of different dosage of cement using suitable mixing water- additive ratio involving filler and rubber chips for the purpose of obtaining the maximum strength of peat mixture after being stabilized.

1.6 Organization of Thesis

In this thesis, there will be five chapters altogether. Chapter 1 will be representing about background of study, problem statement, objectives of study, scope of study, significance of study and organization of thesis. In Chapter 2, literature review are discussed which outlines the definition of peat, properties of Malaysian peat soil, classification of peat and the most common stabilizers that are used for stabilization of peat soil in the previous studies.

Chapter 3 will touch on the research methodology of the thesis and will be discussing on the laboratory tests that will be conducted to determine the physical and geotechnical properties of peat soil sample and also to determine the strength of peat after it is being stabilized. The best mixing proportion that is proposed in this study will also be included inside this chapter.

Next, Chapter 4 will be discussing on the results that have been obtained from this study followed by the discussion. The results from the selected stabilizers that are used will be presented and the optimum mixing quantity will be obtained. Geotechnical properties of peat that are obtained from UCS test will also be discussed in this chapter.

Finally, Chapter 5 will be discussing on the conclusion of the findings from the study and also recommendations will be provided for future improvements of work.