SHEAR STRENGTH PARAMETERS OF IMPROVED ORGANIC SOIL BY CALCIUM BASE STABILIZER

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To my beloved husband, family, lecturers and friends

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ABSTRACT

The stabilization of soils with additives is a chemically modified method that can be used to improve soils with weak engineering properties. The stabilizing mechanisms of non-traditional additives are not fully understood, and their proprietary chemical composition makes it very difficult to evaluate the stabilizing mechanisms and predict their performance. The present research aimed to determine the strength of peat soil stabilized with calcium base stabilizer in different percentage. To determine the physical reaction of SH-85 for the soil stabilization and to determine to microstructural characteristics behavior of organic soils treated with SH-85. Several test will be carried out such as Atterberg Limit, Specific Gravity, Standard Proctor Test and Unconfined Compressive Strength Test (UCS) were performed after time frame 3, 7 and 28 days as curing time with different percentage of SH-85 (3 o 15%), respectively. These tests used to assess the engineering and shear properties of the stabilized organic soil. Apart from the physicochemical characteristics of the stabilized organic, scanning electron microscopy (FESEM) test were also carried out to study the ongoing microstructural changes. Based on the results from UCS test it was found that the specified additives can increase the peat soils strength, as the increment of SH-85 is around 10 times more than untreated soil respectively, which is gained first 7 days of curing. Scanning electron microscopy results shows that the porosity of untreated soil filled by the new cementitious products.

ABSTRAK

Penstabilan tanah dengan bahan tambahan adalah kaedah kimia diubahsuai yang boleh digunakan untuk meningkatkan tanah dengan ciri-ciri kejuruteraan yang lemah. Mekanisme menstabilkan bahan tambahan bukan tradisional tidak difahami sepenuhnya, dan komposisi kimia proprietari mereka menjadikan ia amat sukar untuk menilai mekanisme stabil dan meramalkan prestasi mereka. Kajian ini bertujuan untuk menentukan kekuatan tanah gambut stabil dengan penstabil asas kalsium dalam peratusan yang berbeza. Untuk menentukan reaksi fizikal SH-85 untuk penstabilan tanah dan untuk menentukan ciri-ciri tingkah laku mikrostruktur tanah organik dirawat dengan SH-85. Beberapa ujian akan dijalankan seperti Had Atterberg, graviti spesifik, Standard Proctor dan Ujian Kekuatan Mampatan Tak Terkurung Test (UCS) telah dijalankan selepas tempoh 3, 7 dan 28 hari sebagai mengubati masa dengan peratusan yang berbeza SH-85 (3 to 15 %) masing-masing. Ujian ini digunakan untuk menilai kejuruteraan dan ricih sifat-sifat tanah organik yang stabil. Selain daripada ciri-ciri fizikokimia organik, imbasan mikroskop elektron yang stabil (FESEM) Ujian juga dijalankan untuk mengkaji perubahan mikrostruktur berterusan. Berdasarkan keputusan daripada ujian UCS didapati bahawa bahan tambahan dinyatakan boleh meningkatkan kekuatan tanah gambut, sebagai penambahan SH-85 adalah kira-kira 10 kali lebih banyak daripada tanah yang tidak dirawat masing-masing, yang diperolehi pertama 7 hari pengawetan. Mengimbas keputusan mikroskop elektron menunjukkan bahawa keliangan tanah yang telah dirawat dipenuhi oleh produk bersimen baru.

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LIST OF SYMBOLS

LOI	-	Loss of Ignition
LL	-	Liquid Limit
PL	-	Plastic Limit
PI	-	Plastic Index
Gs	-	Specific Gravity
ρ_w	-	Water Density
ρ_d	-	Dry Density

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CHAPTER 1

INTRODUCTION

1.1 Introduction

Organic soil are identified as a very soft and most difficult with low shear strength, high organic matter, low bearing capacity and high compressibility inherent in the unconsolidated state. These features result in a highly redundant solutions for challenging geotechnical engineers and the construction industry in general. Due to the problematic of natural peat, construction on it has become a very challenging task for geotechnical and civil engineers, the engineers considered the worst soil foundation for supporting a structure based on it because of poor behavior. Peat covering about 2.7 hectares of the land in Malaysia.

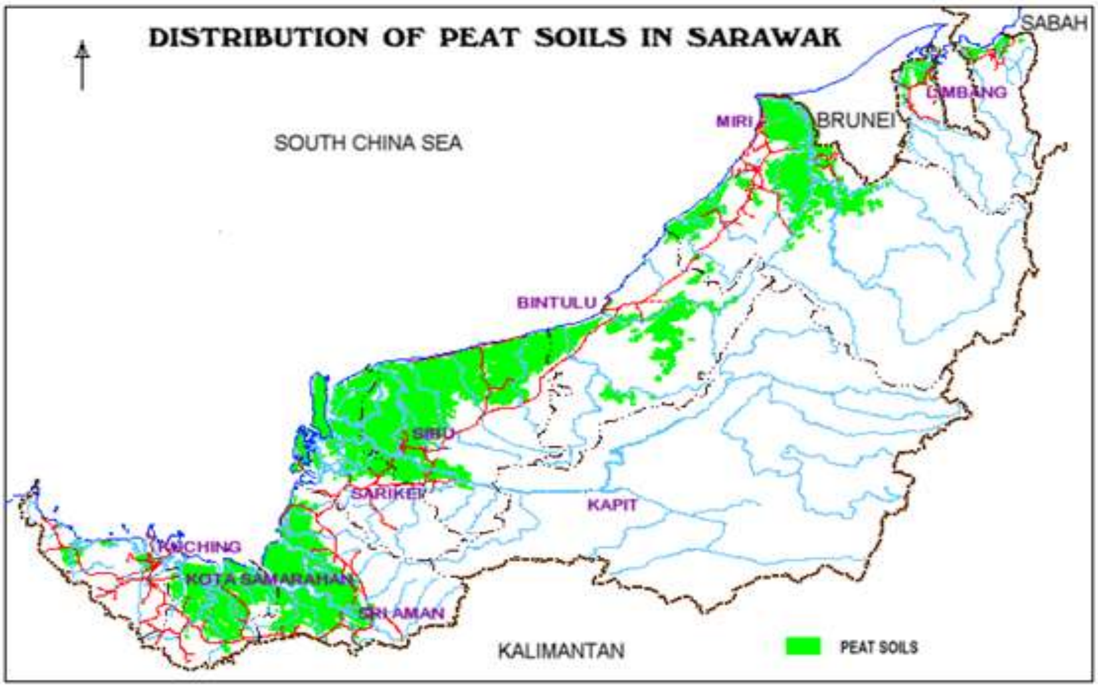
According to Muttalib, et al. (1991) and the State Government of Sarawak (1990) stated that Sarawak has the largest area of peat, which is about 16,500 km^2 which accounts for 13% of the total area of the country with 90% of them have a depth of 1 m. Figure 1.1 shows the peat areas in Sarawak.

The important features found in peatlands also contributes to the consolidation and strength of soil. Consolidation process will take a long time because due to the composition of the peat, which is not homogeneous and contains organic matter. In addition, soil stability problems are expected due to the physical characteristics of peat or organic soil, high humidity and contains approximately 50 to 90% organic matter (Jarret, 1997).

As demand for land increases and a limited supply, construction on weak soils such as peat inevitable. The investigation has shown that, peat pooling experience placement instability and long-term low and large when subjected to even a moderate increase in costs. There are many studies that happen to find the best method to stabilize and improve the soil. Methods mainly focused on the modification and stabilization of peat. Stabilization of peat which is intended to increase the strength of the soil is soft and highly compressible. The objective of a stable and modify the peat is to enhance the ability to perform well with increased strength and reduce excessive settlement when the soil is subject to the load of the structure.

There are many methods of stabilization and improvement of soft soil and one of them is using the additive. There are different types of additives that can be found. Chemical additives or chemical stabilization always involves soft soil treatment with certain types of chemicals, which when added to the soil will cause a chemical reaction between soil particles and chemical reagents. This chemical reaction to improve the physical properties and soil engineering such as moisture content, consistency of limits, strength and volume change, among others.

Replacement of peat with quality soil is still widely practiced when construction was underway on the possibility of large peat or organic deposits even this effort has led to the design of the economy because it does not require large amounts of land transport quality. Therefore, the objective of this study is to measure some important engineering and index properties indices peat or organic and study the effect of different percentages of calcium base stabilizer (SH-85) on soil in terms of its strength.



(Geological Survey Malaysia, Sarawak)

Figure 1.1 Distribution of Peatland in Sarawak

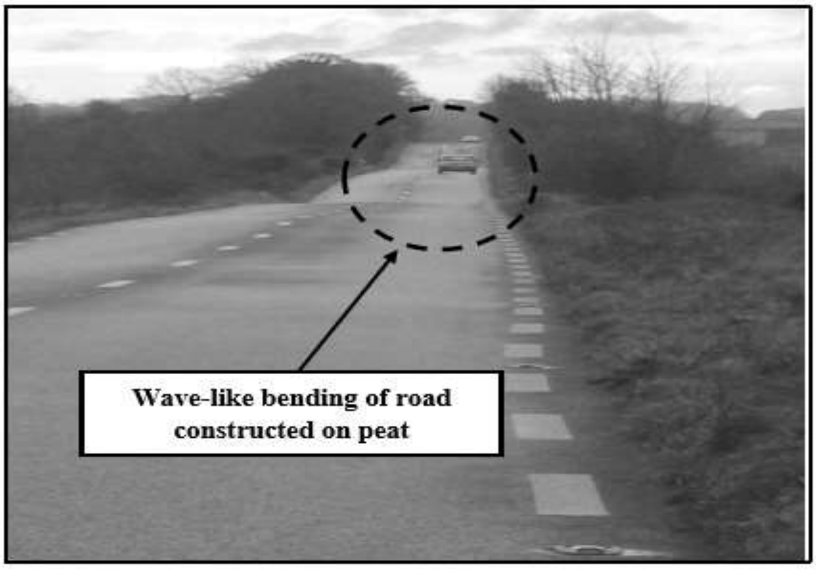
1.2 Problem Statement

Constructing buildings on peaty ground involves the risk of ground failure and extreme residual settlement (Tang et al., 2007). Unique properties of peat or organic, namely low bearing capacity and high compressibility, are different from that of clays. Even lightweight structures constructed on peat, such as one - story buildings settle significantly. If heavier buildings are constructed on untreated peat or organic ground, they would be subject to excessive bearing failure and the post construction total and differential settlements would be excessive resulting in their serious damage. Roads constructed on peat tend to float as shown in Figure 1.2 (Osario et al., 2008).

In addition, due to high water content of peat, these soils are susceptible to drought. Figure 1.3 shows failure of peat dikes in Netherlands (Nterekas, 2009). Thus, this problematic soil is very unsuitable for supporting foundations in its natural state. Consequently, there is need to increase the bearing capacity of peat soils using an appropriate ground improvement technique.

Moreover, in comparison with clays, peat is more difficult to stabilize due to lower solid content and lower pH. In peat soil stabilization using chemical binders like cement and lime, it is obvious that high organic matter in peat retards the hydration and reactions of chemical stabilization process (Ani et al., 2013). This happens when black humus acid (a component of organic matter) reacts with calcium released from the cement hydrolysis (Chen and Wang, 2006). Therefore, it is necessary to determine the optimum binder type and amount in peat soil stabilization.

Therefore, in this research attempts have been made to evaluate the effects of chemical stabilizer (SH-85) on the undergoing changes within the physical and chemical properties of the peat or organic.



(Osario et al., 2008)

Figure 1.2 Extreme Undulations on N62 Rampart Road, Ireland

(Nterekas, 2009)
Figure 1.3 Failure of peat dyke due to drought in Netherlands

1.3 Objective

The main objectives of this project are described as follows:

i. To determine the strength of soil stabilized using calcium base stabilizer (SH-85) under different percentage.

ii. To determine the physical reaction of calcium base stabilizer for soil stabilization.

iii. To determine the microstructural behavior of peat soils treated with calcium base stabilizer.

1.4 Scope of Study

The present study is focused on the study of the optimum calcium base stabilizer (SH-85) to be used in soil stabilization of organic soils. Soil samples (organic soil) are taken around the area of Mukah, Sarawak.

The basic tests were performed based on the BS 1377 (1990). To obtain microstructural characteristics of peat which was treated with calcium base stabilizer several tests were conducted, for the soil engineering properties, Atterberg Limit and Specific Gravity, Unconfined Compressive Strength Test (UCS), Standard Proctor Test. FESEM were conducted to determine the microstructural behavior of peat treated with different percentage of SH-85.

1.5 Significance of the Study

Using calcium base stabilizer to improve the bearing capacity of peaty should be alternative methods for the stabilization of peat in Malaysia. One of the most important benefits to be derived from this study is that soil stabilization is less expensive and time saving.

1.6 Thesis organization

The thesis consists of five chapters. Chapter 1 presents the background, problem statements, objectives, scope, and significance of this research. Chapter 2 reviews previous studies related to this study. Topics such as organic soil properties, stabilization results regarding organic soils are discussed. Chapter 3 describes the research methodology including various unconfined compression tests treated peat mixed with different percentage of SH-85. Equipment and procedures of the testing are illustrated.

In Chapter 4, the results from the engineering properties tests and physiochemical properties are presented and discussed. The results cover several issues such as the optimum calcium base stabilizer of the stabilized ground, peat soil strength mixed with stabilizer. The results from UCS tests on the curing of 3, 7 and 28 days are also presented. The effects of percentage and curing time of the SH-85, microstructural characteristics of organic soil mixed with different SH-85 are discussed. Finally, chapter 5 lists the conclusions and recommendations for future research on organic.

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