EXPERIMENTAL INVESTIGATION ON THE UNDRAINED SHEAR STRENGTH CHARACTERISTIC OF PEAT STABILIZED WITH ECO PROCESS POZZOLAN

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FACULTY OF ENGINEERING UNIVERSITI MALAYSIA SABAH 2022

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ABSTRACT

Peat bogs are an important ecosystem that contributes significantly to global climate stability. Peat from Malaysia is tropical peat. This peat has distinct features that distinguish it from other types of peat. This soil is normally dark reddish-brown to black and made up of partially decomposed leaves, branches, twigs, and tree trunks with a low mineral content in its natural state. These are created by the buildup of disintegrating plant fragments that have been preserved by insufficient aeration and high water content. Peat soils are found in many regions and are defined in a variety of ways, both qualitatively and quantitatively. Due to its high water content, high compressibility, and low shear strength, peat is one of the challenging foundation soils of poor quality. Peat is an inadequate soil for sustaining foundations in its natural condition due to its high moisture content (>100%), high compressibility (0.9-1.5), and poor shear strength (5-20 kPa). Peat soil is a type of soil that is used in agriculture and is ideal for growing vegetables and fruits. Its characteristics have changed as a result of its carbon components and significant vacuum spaces, and it cannot carry enormous loads. The objective of this study is to determine the index properties of Klias, Beaufort peat soil, to determine the effect of EPP mixture in peat soil, and to access the behavior of undrained shear strength of stabilized peat with EPP. In this study, the index qualities of peat soil will be investigated using the BS 1377-8:1990 standard. Ph, specific gravity, organic content, moisture content, liquid limit, and fiber content are the index qualities. A chemical stabilizer of Eco pozzolan has been used to mix in a sample of peat soil. The method has been accomplished by mixing 10%, 20%, and 30% and 40% of EPP respectively. To determine which amount of EPP was the most successful in stabilizing peat soil, a comparison of vaa ried mixture of EPP percent will be made. One load will be used in the triaxial compression test for consolidated undrained which was 50kPa. The most important discovery was that combining peat soil with a higher concentration of EPP than cement stabilized the soil sample, resulting in minimal settlement over time. As a result, this research backs up

the hypothesis that adding EPP to peat soil with the use of a binder or cement can improve the qualities of soft peat soil while also sustaining settlement over time.

ABSTRAK

SIASATAN EKSPERIMEN TERHADAP CIRI-CIRI KEKUATAN RICIH TAK TARISAN PENSTABILAN GAMBUT MENGGUNAKAN ECO PROSES POZZOLAN

Tanah gambut merupakan ekosistem penting yang menyumbang secara signifikan kepada kestabilan iklim global. Gambut dari Malaysia ialah gambut tropika. Gambut ini mempunyai ciri tersendiri yang membezakannya daripada jenis gambut lain. Tanah ini biasanya berwarna coklat kemerahan gelap hingga hitam dan terdiri daripada daun, dahan, ranting, dan batang pokok yang reput separa dengan kandungan mineral yang rendah dalam keadaan semula jadi. Ini dicipta oleh pembentukan serpihan tumbuhan yang hancur yang telah dipelihara oleh pengudaraan yang tidak mencukupi dan kandungan air yang tinggi. Tanah gambut ditemui di banyak kawasan dan ditakrifkan dalam pelbagai cara, secara kualitatif dan kuantitatif. Disebabkan kandungan airnya yang tinggi, kebolehmampatan yang tinggi, dan kekuatan ricih yang rendah, gambut merupakan salah satu tanah asas yang mencabar dan berkualiti rendah. Tanah gambut adalah tanah yang tidak mencukupi untuk mengekalkan asas dalam keadaan semula jadi kerana kandungan lembapannya yang tinggi (>100%), kebolehmampatan yang tinggi (0.9-1.5), dan kekuatan ricih yang lemah (5-20 kPa). Tanah gambut adalah sejenis tanah yang digunakan dalam pertanian dan sesuai untuk menanam sayur-sayuran dan buah-buahan. Ciri-cirinya telah berubah akibat daripada komponen karbonnya dan ruang vakum yang ketara, dan ia tidak boleh membawa beban yang besar. Objektif kajian ini adalah untuk menentukan sifat indeks tanah gambut Klias, Beaufort, untuk menentukan kesan campuran EPP dalam tanah gambut, dan untuk mengakses tingkah laku kekuatan ricih tak berdraina gambut stabil dengan EPP. Dalam kajian ini, kualiti indeks tanah gambut akan disiasat menggunakan piawaian BS 1377-8:1990. Ph, graviti tentu, kandungan organik, kandungan lembapan, had cecair dan kandungan gentian adalah kualiti indeks. Penstabil kimia Eco pozzolan telah digunakan untuk mencampurkan dalam sampel tanah gambut. Kaedah ini telah dicapai dengan mencampurkan 10%, 20%, dan 30% dan 40% EPP masing-masing. Untuk menentukan jumlah EPP yang paling berjaya dalam menstabilkan tanah gambut, perbandingan campuran varia sebanyak peratus EPP akan dibuat. Satu beban akan digunakan dalam ujian mampatan triaksial untuk tersatukan tidak berdraina iaitu 50kPa. Penemuan yang paling penting ialah menggabungkan tanah gambut dengan kepekatan EPP yang lebih tinggi daripada simen menstabilkan sampel tanah, menghasilkan penyelesaian minimum dari semasa ke semasa. Hasilnya, penyelidikan ini menyokong hipotesis bahawa penambahan EPP pada tanah gambut dengan

penggunaan pengikat atau simen boleh meningkatkan kualiti tanah gambut lembut di samping mengekalkan petempatan dari semasa ke semasa.

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LIST OF ABBREVIATIONS

ASTM	American Society for Testing and Materials
BS	British Standard
CU	consolidated undrained
LL	Liquid Limit
mm	millimeter
PU	polyurethane
σ_c	Pre-consolidation Pressure
ϵa	Axial strain
Δu	Excess pore pressure
Wc	Moisture Content

CHAPTER 1

INTRODUCTION

1.1 Background of Study

Peat is the surface organic layer of soil that is made up of partially decomposed organic matter, mostly from plant material, that has accumulated due to waterlogging, oxygen deficiency, high acidity, and nutrient deficiency. Peat is a brownish-black substance formed by decomposed organic matter that has accumulated over thousands of years in the absence of oxygen and under waterlogged conditions. These aid in its formation. Peat is soil that contains at least 65 percent organic matter, according to the strict definition. Tropical peatlands can be found all over the world, but they are most commonly found in river valleys and estuaries. Peat swamps are found in a few places in Africa and parts of Central America, but South-East Asia contains more than 60% of the world's tropical peatlands. The largest of these are the peat swamp forests on the islands of Borneo (which belong to Indonesia, Malaysia, and Brunei Darussalam) (Leete, 2006). The total area of peat soil in Malaysia is about 2.6 million hectares (26,000 km2), of which about 13 % are in the peninsular Malaysia, over 80 % in Sarawak, and about 5 % in Sabah (Heijden *et.al*, 1994).

The typical situation is the formation of peat mounds between two rivers. Rivers have natural dams in their floodplain stage, as the dyke moved away from the river, a slender alluvial layer was left, which there were Submerged by river water. On these mineral soils, freshwater swamp forests are formed. flood Along the edge of the river gradually decreases as you move away from the river, Preventing the development of peat. This separates the "soil-derived" peat that receives nutrient input from river water, from "heterogeneous" peat or swamp, they only accept

water input in the form of water rainfall. The result is a dome-shaped peat zone formed between the two rivers. Among the relatively young domes, there is a very limited central swamp plain, but in the older swamp plain, the swamp plain is vast. Figure 1 depicts a cross-section of a peat dome in Miri Division, Sarawak, as well as a diagrammatic representation of a highly developed dome with a large central bog plain

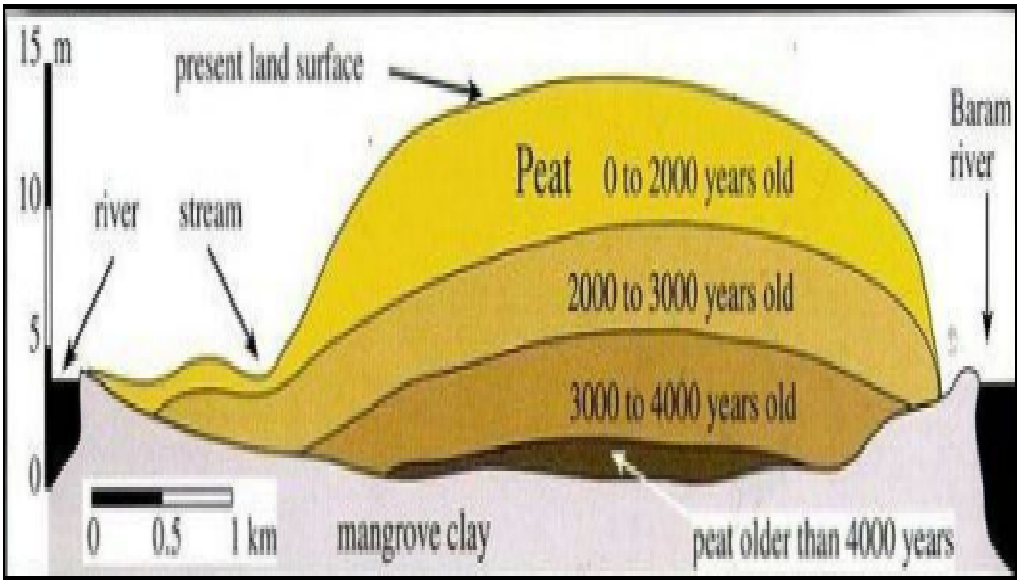

Figure 1.1 : Cross-section of a highly-developed peat dome

Source : Hazebroek and Kashim (2000)

Peat soil is found in deep layers in some regions, has a low shear strength, and has a high compressive deformation, making construction work on the deposit extremely challenging. In its natural form, peat soil is unsuitable for sustaining foundations. In Peninsular Malaysia, a test was carried out on peatland (Wong *et al.*, 2008). The water retention capacity of this peat was discovered to be quite high, and the soil was categorized as H4 by the Von Post classification system.

The largest areas of peat soil in Sabah are found on the Klias Peninsula and in the Kinabatangan–Segama Valleys. The main focus of the distribution sample of peat soil will be taken care of in Klias, Beaufort for this study. Infrastructure

construction such as roads in peaty soil is not a major issue in Sabah because associated peatlands are primarily used for agriculture.

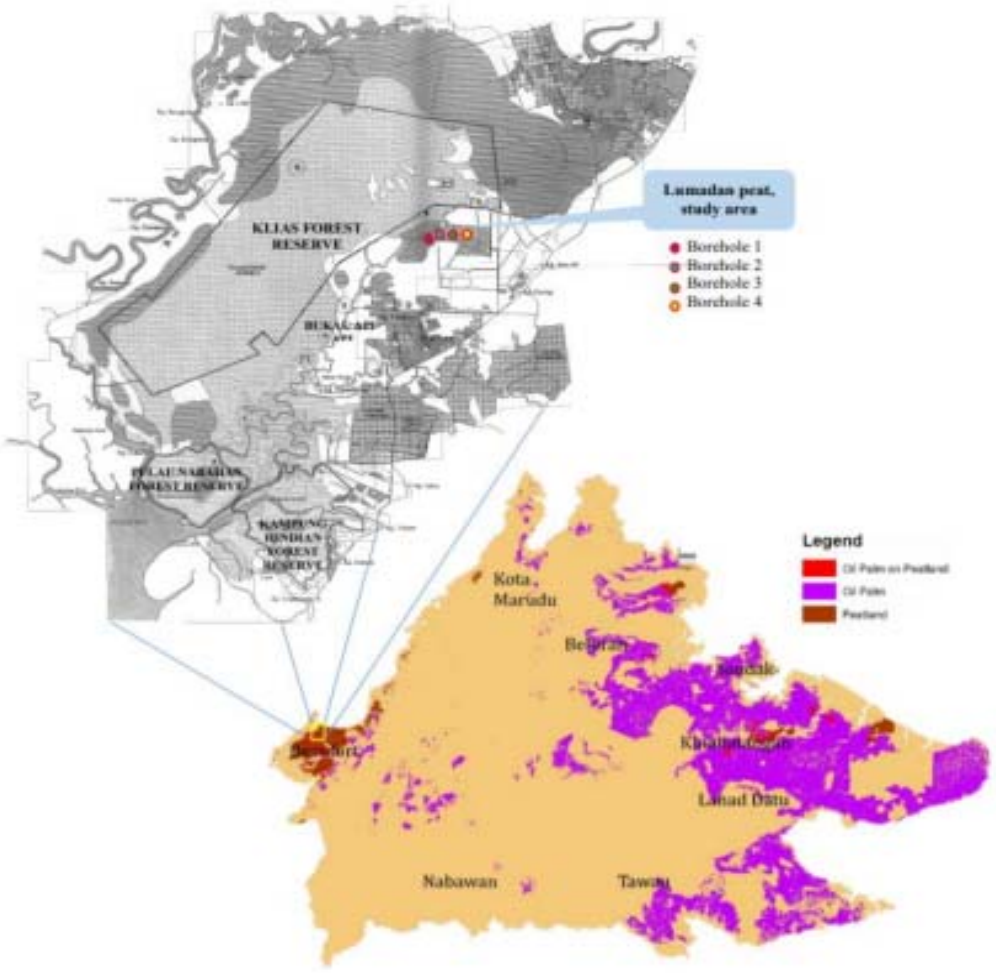

Figure 1.2 : Distribution of Peatland in Sabah

Source : Modified by Habib (2015)

In this study, the method to stabilize the peat soil is by using polyurethane by undergoing an injection method. Polyurethane (PU) foam is non-toxic, has an infinite life span, and is not harmful to the environment. PU is a chemical compound that is commonly used in the polymer industry, such as resilience foam seating, rigid foam insulation panels, and microcellular foam seals. To determine the shear strength of the stabilized peat soil, a triaxial compression test is carried out on consolidated undrained (CU).

1.2 Problem Statement

Organic soil and peat soil are not suitable for building foundations due to their different mineral composition and structure. The difference between organic soil and peat soil is that the range of organic matter content in organic soil is different, while the organic matter content in peat soil exceeds "75%" (Kazemian, 1970).

Peat is one of the problematic or challenging foundation soil of poor quality due to its very high amount of water content, high compressibility, and low shear strength. Peat is made up of decomposed plant fragments, and the unfavorable characteristics of peat soil deposits make them unsuitable for developing long-term infrastructure for a variety of engineering projects.

Peat is considered unsuitable soil for supporting foundations in its natural state. Peat soil is used in agriculture and is an excellent soil type for growing vegetables and fruits. However, using it as a foundation or base for construction is a different story because its properties have changed as a result of its carbon compounds and high void spaces, and it cannot carry large loads.

The challenges faced by engineers in peat road construction include the outcome of limited accessibility and stability issues (Zainorabidin *et.al*, 2003). Many engineers have encountered problems during to do construction on a peat soil deposit. This problem can be solved by doing a chemical stabilizing agent which is polyurethane. This method will be done by the injection method. Thus, this method could increase the shear strength of the soil by undergoing a triaxial compression test. The expected resuof for this research is the undrained shear strength of the peat soil will be increased by using the chemical substance which is polyurethane. Thus, stabilization of soil will occur.

1.3 Objectives

The study's goal is to forecast the ability of Eco process Pozzolan (EPP) as a chemical substance as a peat soil stabilization materials and improvement techniques, as well as the effects of the methods by using a triaxial compression

test on consolidated undrained. However, the following were the more specific study objectives that had to be met:

I. To determine the index properties of Klias, Beaufort peat soil
II. To study the effect of EPP mixture in peat soil
III. To access the behavior of undrained shear strength of stabilized peat with EPP

1.4 Scope of Study

The scope of work includes all of the important work and foremost information to achieve the research's objectives. In Klias, Beaufort, a sample of peat soil has been taken with a measurement of 50mm in diameter. This sample were tested at the Fakulti Sains Dan Sumber Alam (FSSA) and the laboratory of Geotechnics in Fakulti Kejuruteraan (FKJ). All of the labs were located in Universiti Malaysia Sabah.

The index properties for the peat soil were analyzed according to the BS 1377-8:1990. These index properties are Ph, Specific Gravity, moisture content, liquid limit, organic content, and fiber content. By using the chemical substance which is the EPP in the form of a remolded triaxial compression test, the peat soil characteristic before and after the treatment can be analyzed. The remolded soil has mixed by mixing 10%, 20%, 30,% and 40% of the EPP. A comparison with different amounts of EPP percent will be done to analyze which amount of EPP is the most effective to stabilize the peat soil. The triaxial compression test for consolidated undrained will be done by using 1 types of loads which was 50kpa

1.5 Significant of Study

This research was being conducted to envisage the ability of the miniature mold for the settlement behavior with EPP as a peat soil stabilization. This research also

studies the index properties of peat soil to determine its identification and classification. Other than that, to determine its compressibility and its mechanical properties by adding a chemical substance which was EPP. Moreover, a triaxial compression test will be conducted to test each by using different loads to determine the results on consolidated undrained peat soil after the treatment. This method could increase the behavior of the peat soil to be used in the industry.

1.6 Thesis Outline

This section provides an overview of each chapter discussed in this article. The first chapter is the introduction, including seven sub-topics: background research, problem statement, research purpose, research scope, expected results, and research significance.

The second chapter is mainly a literature review of peat soil. This chapter reviews past research on peat soil, including its origin, formation, type, behavior, and characteristics. The comments in this chapter are based on a large number of previous studies conducted by various researchers, and it is acknowledged that it is a sufficient reference due to a high degree of index consistency.

The third chapter focuses on the research methodology. It includes universally applicable application strategies, sample preparation techniques, and mechanical testing procedures. This chapter also goes over the instrument's implementation, specifications, and limitations.

Moreover, Chapter 4 provides and introduces the compression index information of peat soil. The index properties of the peat soil will be explained entirely throughout this chapter in detail.

Finally, Chapter 5 summarizes the conclusions of this research and summarizes the main results and objectives of this research analysis. For future research on this work, there will be an aan additional sbe made for a better research outcome of this work.

CHAPTER 2

LITERATURE REVIEW

2.1 Introduction

Peat is notorious for its long-term consolidation settlement, which poses considerable issues in the construction industry. The biggest problem with this type of construction is anticipating settlement because traditional analysis usually underestimates secondary compression or creep that has been occurring for some time. Peat's compressible qualities make it unsuitable for use as a construction foundation. Low strength frequently leads to stability problems, limiting the applied force or necessitating the application of the load in phases. Large deformation can occur both vertically and horizontally during and after construction, and because to creep, the distortion might last for a long time. As a result, establishing an appropriate technical design and solving this problem requires a good settlement forecast. Even while construction on marginal terrain such as peat has become increasingly necessary for economic reasons, peat-land usage in Malaysia has recently been relatively low. Engineers are hesitant to construct on peat because of the difficulty in gaining access to the site and other concerns related to peat's qualities. As a result, there has been minimal research into peat behavior and the creation of soil improvement strategies for peat soil construction.

When construction must take place on a peat deposit, replacing the peat with good quality soil is still a typical procedure, even though this effort will almost certainly result in an uneconomic design. Approaches have been created to deal with the issues that come with building atop peat bogs (Lea and Brawer, 1963). Surface reinforcement, preloading, chemical stabilization, sand or stone column, pre-fabricated vertical drains, and the use of piles were all considered in the