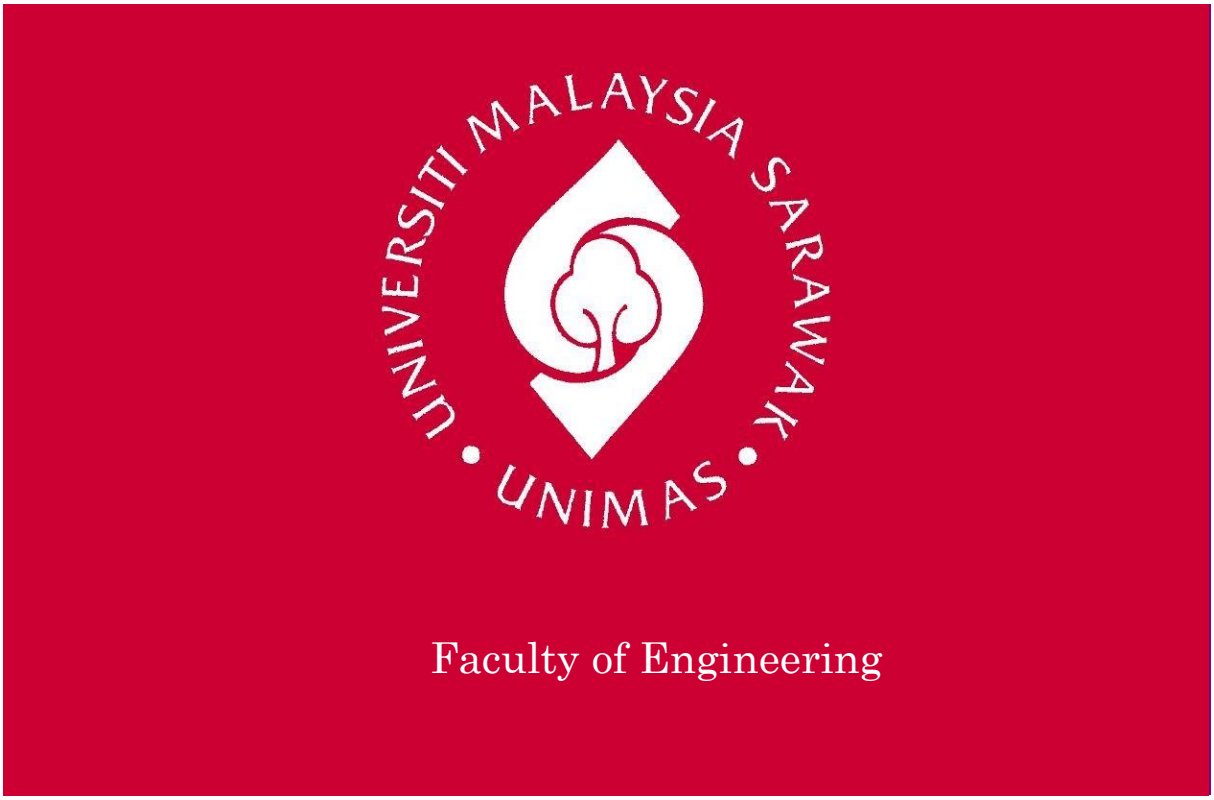

STUDY ON CORRELATION OF DIFFERENT PEAT SOIL GEOTECHNICAL AND INDEX PROPERTIES

Jennyfer Joys John

Bachelor of Engineering with Honours

(Civil Engineering)

2020

UNIVERSITI MALAYSIA SARAWAK

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Date submitted

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This project report which entitled **"STUDY ON CORRELATION OF DIFFERENT PEAT SOIL GEOTECHNICAL AND INDEX PROPERTIES"** was prepared and submitted by **JENNYFER JOYS JOHN (56203)** as a partial fulfilment of the requirement for degree of Bachelor of Engineering with Honours in Civil Engineering is hereby read and approved by:

10th August 2020

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

(Project Supervisor)

Date

STUDY ON CORRELATION OF DIFFERENT PEAT SOIL GEOTECHNICAL AND INDEX PROPERTIES

JENNYFER JOYS JOHN

A report submitted in partial fulfilment of the requirement

For the degree of Bachelor of Engineering with Honors

(Civil Engineering)

Faculty of Engineering

Universiti Malaysia Sarawak

2020

Dedicated to my beloved parents, family and friends,

For their love, endless support, encouragement & sacrifices.

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ABSTRACT

Peatlands are spread across 2.4 million hectares in Malaysia and 1,65 million hectares in Sarawak and smaller regions in the Asian Peninsula and North Borneo. Peat is regarded within the building industry as one of the most troublesome soil. Construction on peat soils has proven to be a challenge for civil engineers as this type of soil has very low bearing capacity and is heavily settled. This situation could trigger potential problems with the structure's stability. High organic content, high water content, high void ratio and high peat compressibility characteristics also naturally affect the impact of uneven subgrade settlement ground surfaces. It has caused damage to buildings and infrastructure structures. In this study, the correlation of geotechnical properties and shear strength of peat soils was studied by gathering the data from past researchers. Geotechnical properties test for this study is done by using the peat samples that taken form Kampung Meranek, Sarawak. From the result, data attained was then gathered with other tropical peat data from literature review in order to study on correlating parameters relationship. The result show that, the value of organic content, fiber content and moisture content decreases as the degree of humifcation increases. Also the results show that, the organic content increases as the specific gravity decreases and as the bulk density increases, the lower the organic content. Moisture content affect both compression index and organic content by showing increasing data trend. From all the result, the correlation between compression index and moisture content has shown the best correlation with the R^2 value of 0.90 which is good. The shear strength of the peat was also studied in this research. From several results, the shear strength of the peat increases as the curing period increases. Most of the peat reached its maximum strength at 28 days. From the empirical equation, it is proven that the shear strength of the peat also increases as the percentage of binder's increases. Binder alone shown to have lower shear strength compared to cement stabilized peat mixed with other types of binders.

Keywords: Peat, humification, shear strength, curing, binder, cement, binder dosage.

ABSTRAK

Tanah gambut tersebar di beberapa bahagian di seluruh dunia, dengan cadangan meliputi sekitar 2.4 juta hektar di Malaysia, dan 1.65 juta hektar di Sarawak dan kawasan yang lebih kecil di Semenanjung Asia dan Borneo Utara. Gambut dianggap dalam industri bangunan sebagai salah satu tanah yang paling menyusahkan. Membangun tanah gambut telah membuktikan aktiviti yang bermasalah bagi jurutera awam kerana bentuk tanah ini mempunyai daya tahan yang sangat rendah. Keadaan ini boleh menyebabkan masalah dengan kestabilan struktur untuk masa depan. Kandungan organik yang tinggi, kandungan air yang tinggi, nisbah kekosongan tinggi dan ciri-ciri kebolehmampatan yang tinggi dari gambut secara semula jadi mempengaruhi kesan penempatan lapisan bawah tanah yang tidak rata di permukaan turapan bergerak. Ia telah menyebabkan kerosakan pada bangunan dan struktur infrastruktur. Dalam kajian ini,sifat geoteknik dan kekuatan ricih tanah gambut dikaji dengan mengumpulkan data dari penyelidik masa lalu. Ujian sifat geoteknik dilakukan di makmal dengan menggunakan sampel gambut dari Kampung Meranek, Sarawak. Dari hasilnya, data yang diperoleh kemudian dikumpulkan dengan data gambut tropika yang lain dari tinjauan literatur untuk mengkaji hubungan parameter. Hasilnya menunjukkan bahawa, nilai kandungan organik, kandungan serat dan kadar kelembapan menurun apabila tahap pelembapan meningkat. Selain itu, kandungan organik meningkat apabila graviti spesifik berkurang dan semakin bertambah kepadatannya, semakin rendah kandungan organiknya. Kandungan kelembapan mempengaruhi kedua-dua indeks pemampatan dan kandungan organik dengan menunjukkan peningkatan aliran data. Dari semua hasilnya,hubungan antara indeks mampatan dan kandungan kelembapan telah menunjukkan korelasi terbaik dengan nilai R^2 0.90 yang baik. Kekuatan ricih gambut juga telah dikaji. Dari beberapa hasil, kekuatan ricih gambut meningkat ketika tempoh pengawetan meningkat. Sebilangan besar gambut mencapai kekuatan maksimum pada 28 hari. Hasil juga terbukti bahawa kekuatan ricih gambut juga meningkat apabila peratusan pengikat meningkat. Pengikat sahaja terbukti mempunyai kekuatan lebih rendah berbanding gambut yang stabil pada simen yang dicampur dengan jenis pengikat lain.

Kata kunci: Gambut, pelembapan, kekuatan ricih, pengawetan, pengikat, simen, dos pengikat.

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Cc	Primary Compression Index
DoH	Degree of Humification
FA	Fly ash
FC	Fiber content, %
FP	Fiber polyester
G_s	Specific gravity
LL	Liquid limit, %
LS	Linear shrinkage, %
OC	Organic content, %
OPC	Ordinary Portland cement
QL	Gypsum
R^2	Percentage increment of every binder
RC	Rubber chips
UCS	Unconfined compressive strength
w	Moisture content, %
W/C	Water to cement ratio
p	Bulk density (kN/m^3)

CHAPTER 1

INTRODUCTION

1.1 Background

Peat is found throughout the globe in many countries which constitute about 3% of the earth's land surface, Canada and Russia are the two nations with 170 million and 150 million hectares of broad peatland ((Duraisamy 2008; Huat 2004) respectively. Table 1.1 shows the worldwide distribution of layers of peats.

Table 1.1: Percentage of peat in different countries (Mesri & Ajlouni 2007).

Rank	Country	Peat Area (10^6 x ha)	Peat Area Order %
1	Finland	10.4	33.5
2	Canada	170	18.4
3	Republic of Ireland	1.2	17.2
4	Sweden	7.6	17.1
5	Indonesia	26	13.7
6	Northern Ireland	0.2	12.7
7	Scotland	0.8	10.4
8	Iceland	1.0	9.7
9	Norway	3.0	9.4
10	Malaysia	3.0	8.0
11	Wales	0.2	7.7
12	The Netherlands	0.3	7.4

13	Russia	150	6.7
14	Germany	1.7	4.8
15	Poland	1.4	4.4

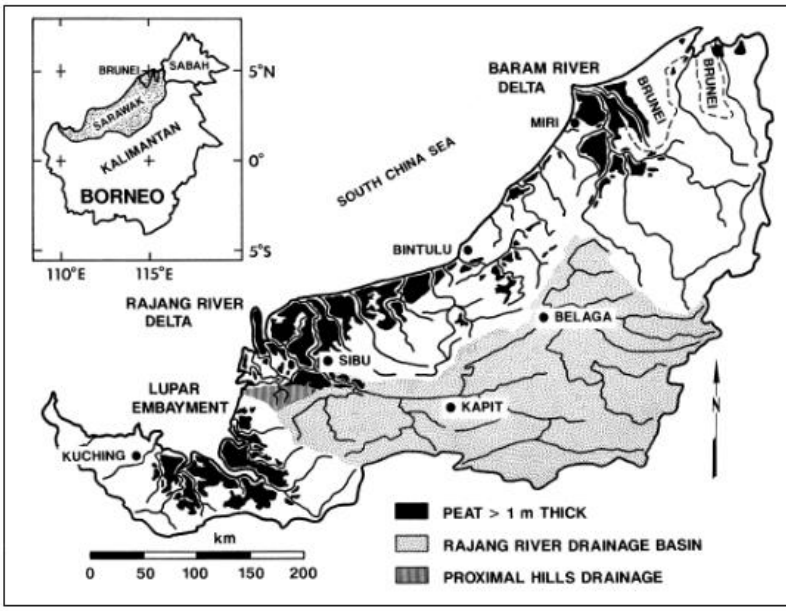
Peat can also be found in tropical climates, wherever the conditions are ideal for its growth. Tropical peatlands are spread across Africa and parts of Central America, and Southeast Asia is estimated to be projected to counter two-third of the world's total area of 30 million ha. Peatlands are develop around the world, covering about 2.4 million hectares in Malaysia, and 1.65 million hectares in Sarawak and smaller regions in the Asian Peninsula and North Borneo (Adnan Zainorabidin & Wijeyesekera, 2007). The range of peat soils is found mainly along the coastal areas of near Johor, Pahang, Selangor and Perak (Duraisamy, 2016). From the distribution of peatlands in Malaysia, Sarawak is the largest contributor of peat soils as it represents 13% of the state area and one of the coastal swamps areas that endured waterlogging much of the year (Aminur & Kolay, 2009).

According to Table 1.2, peatlands are spread across 2.4 million hectares in Malaysia (Adnan Zainorabidin & Wijeyesekera, 2007). Approximately 8% of the 3.2 mil ha of the total land area of the country was occupied by peat. According to Wetland International (2010), peat soils may occur in lowland and highland areas, but there are not extensive highland peat soils. Most of the lowland peats developed along the coast, behind the growing coastline of mangroves. Such forms of peat deposits are generally referred to as basins (produced on high ground) and peats in the valley (built in the low ground) (Kalantari, 2017). Table 1.2 outlines the nature and distribution of peat areas in Malaysia.

Table 1.2: Total area of Peat Soil in Malaysia (International, 2010).

Region	**Total Area of Peat (ha)**	**%**
Sarawak	1,697,847	69.08
Peninsular Malaysia	642,918	26.16
Sabah	116,965	4.76
Total	2,457,730	

Figure 1.1 shows the peat distribution in Sarawak. The figure indicates that most of the peat is located in coastal areas where water sources such as rivers or seas exist. From the distribution of peatlands in Malaysia, Sarawak is the largest contributor of peat soils as it represents 13% of the state area and one of the regions of coastal swamps that experienced waterlogged most of the year (Aminur & Kolay, 2009). According to Zainorabidin, Adnan, Mohamad, & Musa (2017), Sarawak serves Malaysia's most significant peat soil area of 1.7 ha followed by the peninsular of Malaysia. Due to the massive volume of peat field, the number of infrastructure issues and delay of progress in Sarawak's overall development is growing. It can be supported by Aminur & Kolay (2009) that the inferior peat soil surface would will cause difficult development of transport networks across Sarawak.



Division	Area (ha.)
Kuching	23 059
Kota Samarahan	192 775
Sri Aman	283 076
Sibu	540 800
Sarikei	169 900
Bintulu	146 121
Miri	276 579
Limbang	25 300
TOTAL	**1 657 600**

Figure 1.1: Distribution of peat in Sarawak (Sa'don et al., 2015)

Peat is often described as troublesome soil due to its poor characteristics that are low in shear strength, high compressibility and high natural water content. The organic content of the peat can reach up to 75%. The original contents present in peat are the remains of partly decomposed and disintegrated plant. The peat is unable to bear so much weight because of its special geotechnical properties. In addition, properties of the peat is varies from in any different location due to factors such as the fibre composition,

temperature, climate, and humidity (Huat, 2004). Decomposition (humification) is the loss of organic matter which causes the disappearance of the peat structure and changing the primary chemical composition of peat.

According to Kazemian et al. (2011), the peat usually has insufficient shear strength, and the determination of shear strength is somehow a challenging task in geotechnical engineering. Hence, if the building is constructed on poor soil, a lot of issue might occur after the construction finished. The building will be cracked because of the settlement of the ground (Hassan, 2015). It is, therefore necessary to consider an alternative in improving the intensity of soil since nowadays lands are very costly and limited.

1.2 Problem Statement

Peat is regarded within the building industry as one of the most troublesome soil. Building on peat soils has proved a problematic activity for engineers since this form of soil has low bearing ability and highly settled. In settlement analysis, the long-term parameters of peat compressibility are undervalued or neglected. This condition could trigger potential issues with the stability of the structure. Next, the high organic and moisture content, high void ratio and high compressibility also naturally affect the impact of irregular subgrade settlement on the surfaces of mobile pavements. It has disruption or damage to buildings and infrastructure structures.

Therefore, engineers must come up with a way to address the soft soil in areas with peat soils before any development can be undertaken. In other words, peat soil is an extremely fragile soil that is prone to instability, so it is not appropriate to be developed because the engineers know it as the problematic soil. There are different approaches used to maximize the strength of peat soil. The typical forms that engineers use when working with this issue soil is either to extract the peat deposits and substitute such grounds with more vigorous soils or to push the piles (end bearing) through the peat layer to the more supporting soil layers below (Ibrahim et al., 2014). These methods, however, have a high financial cost. Therefore, the peat stabilization method as a relatively new ground improvement method for soft soils is applied and use to increase peat strength, improve

the properties of deformation and economical-friendly. In this study, the knowledge of the correlation of the geotechnical properties and shear strength of peat soil is studied. It is important to allow the engineers to understand the properties of the grounds when loaded and recommendations for proper engineering solutions should be presentable and suit the condition of peat soil.

1.3 Objectives

The main objective of carrying out this study are:

1. To investigate the relationship between different index parameters via correlation analysis;
2. To determine the relationship between various stabilized peat strengths; and
3. To propose correlation graphs and equations useful for researchers and practitioners.

1.4 Scope of the study

The focus of this study is to find the comparison and correlation of the index properties of the peat by gathering the data of peat index properties from different locations from past researchers. Geotechnical properties test will also be conducted in this study by using the peat samples that taken form Kampung Meranek, Sarawak. Index properties of peat such as moisture content, organic content, fibre content and specific gravity, liquid limit and pH will be determined by carrying out several tests on peat. The strength of the peat is also the main focus of this study. From the UCS test, the data from past researchers are gathered and compared to find the result of the strength of stabilized peat correlated with curing period, type of binders and degree of humification.

1.5 Significance of the Study

Significance of this study includes the identification of direct correlating parameters in geotechnical properties of peat soil and the study of statistical analysis between parameter through R^2 value. Thus, extra knowledge about the characteristics of peat soil can be used and apply in stabilization of peat. Hence, result for the propose correlation graphs and equations found in this study is expected to be useful for researchers and practitioners.

1.6 Thesis structure

This final year project will be divided into six different chapters. Each chapter explains in detail the purpose of this study.

Chapter 1: Background of the study, vital objectives and the scope of this study.

Chapter 2: A literature review that reviews and explains further about this study based on previous researchers. All the related reading materials will be included inside.

Chapter 3: Discussion on the methodology of this study, including the methods and materials used.

Chapter 4: Chapter that consists of the results and analysis from the test done. The results will be explained further in the discussion.

Chapter 5: Conclusions and recommendations related to the research study.

CHAPTER 2

LITERATURE REVIEW

2.1 Introduction of Peat Soil

Peat is an organic soil with a heterogeneous mixture of partly decomposed plant remains with some sand silt and clay content below humidity and anaerobicity (Sa'don et al., 2015). This usually happens when dead vegetation, as in swamps or wetlands, is preserved under a high water table (Kalantari, 2013). Peat soil is the perfect example for the poor soils that have developed on the planet and are categorized as a strongly organic fibrous substance that is partially broken down, including roots, leaves and stems (Lewis et al., 2003). This condition is due to lack of oxygen, and it has been said that peat has unique and distinct geotechnical properties compared clay and sandy soils, which are made up only of soil particles (Roslan Hashim & Islam, 2008b).

In natural form, peat consists of water with primarily no observable strength and decomposed plant fragment (Munro, 2004). Peat is often described as problematic soil due to its low shear strength, high compressibility and high water content. The bearing capability of peat soil is shallow and controlled by the groundwater level and presence of underwater woody debris (Andriesse J. P, 1988). Peat also has a high organic substance that can reach up to more than 75%. The original contents present in peat are the remains of partially decomposed and disintegrated plant. This natural incidence has caused the peat to be incapable of carrying excessive weight, and any construction on the peat soils area is often discouraged wherever possible (Huat, 2006b). The consequences for engineering structures on peat resulting from the high and rapid compressibility are