EFFECT OF ECO-PROCESSED POZZOLAN (EPP) AND CALCIUM OXIDE TO PEAT SOIL DRY DENSITY

MOHD SUHARMIN BIN JAMES

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MOHD SUHARMIN BIN JAMES

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BK18110265

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NAME : **MOHD SUHARMIN BIN JAMES**

MATRIC NO. : **BK18110265**

TITLE : **EFFECT OF ECO-PROCESSED POZZOLAN AND CALCIUM OXIDE TO PEAT SOIL DRY DENSITY POZZOLAN (EPP) FOR PEAT SOIL STABILIZATION**

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FIELD : **CIVIL ENGINEERING**

VIVA DATE :

CERTIFIED BY;

SINGLE SUPERVISION Signature

SUPERVISOR

Ir. Ts. Dr. Habib Musa Bin Mohamad _____

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ABSTRACT

Peat is a problematic soil and it is common problem that faced by engineers in construction. The characteristic that has been noted before which is, high moisture content, poor shear strength, great compressibility and long-term settlement. There are several past studies that showing peat soil treated using blended cement or Eco Processed Pozzolan (EPP). Normally, they will mix EPP with some chemical substance or waste material like fly ash, shredded waste tire chips, Calcium Oxide (CaO), Natrium Hydroxide (NaOH) and many others. For this research study, it focusses on stabilizing peat soil using EPP and CaO. There are three main testing that conducted in this research study, which are, Index Properties Testing and Compaction Test. For Index Properties testing, there were five (5) experiment conducted to study the index properties of disturbed peat soil which are, moisture content, fiber content, liquid limit, organic content, pH and specific gravity. Next, for the Compaction Test, using 2.5kg rammer to define optimum mixture of stabilizer that mixed with different volume, 5%, 10%, 15% and 20% of stabilizer. In this study, the expected result is to inspire and in-depth study the use of EPP material and chemical Cao as for peat soil stabilizer for better utilization problematic soil. The main finding was the mixture with the exact amount of moisture, EPP and Cao help stabilizing the soil and cured peat soil. Thus, this study confirms the idea to treat peat with EPP and Cao, enhancing the properties of peat soil and sustain the settlement over loading for period of time accordingly. 20% mixed of EPP and CaO produce the highest dry density, showing that dry density increases linearly with the amount of mixture to stabilize peat.

ABSTRAK

KESAN POZZOLAN (EPP) ECO-PROCESSED DAN KALSIUM OKSIDA KEPADA KEPADAT KERING TANAH GAMBUT

Tanah gambut adalah tanah yang bermasalah dan ia adalah masalah biasa yang dihadapi oleh jurutera dalam pembinaan. Ciri-ciri yang telah dinyatakan sebelum ini ialah, kandungan lembapan yang tinggi, kekuatan ricih yang lemah, kebolehmampatan yang hebat dan penyelesaian jangka panjang. Terdapat beberapa kajian lepas yang menunjukkan tanah gambut dirawat menggunakan simen campuran atau Eco Processed Pozzolan (EPP). Biasanya, mereka akan mencampurkan EPP dengan beberapa bahan kimia atau bahan buangan seperti abu terbang, serpihan tayar yang dicincang, Kalsium Oksida (CaO), Natrium Hidroksida (NaOH) dan lain-lain lagi. Bagi kajian penyelidikan ini, ia akan memberi tumpuan kepada penstabilan tanah gambut menggunakan EPP dan CaO. Terdapat tiga ujian utama yang dijalankan dalam kajian penyelidikan ini iaitu, Pengujian Sifat Indeks dan Ujian Pemadatan. Bagi ujian Sifat Indeks, terdapat lima (5) eksperimen yang dijalankan untuk mengkaji sifat indeks tanah gambut terganggu iaitu, kandungan lembapan, kandungan gentian, had cecair, kandungan organik, pH dan graviti tentu. Seterusnya, untuk Ujian Pemadatan, menggunakan rammer 4.5kg untuk menentukan campuran optimum penstabil yang akan dicampur dengan isipadu yang berbeza, 5%, 10% dan 15% penstabil. Ujian kekuatan ricih tidak bersaliran akan menggunakan ujian triaksial Disatukan Tidak Bersaliran (CU) untuk menentukan kekuatan ricih tanah gambut. Ia akan dijalankan menggunakan tiga beban berbeza, 13kPa, 25kPa dan 50kPa. Dalam kajian ini, hasil yang diharapkan adalah untuk memberi inspirasi dan kajian mendalam tentang penggunaan bahan EPP dan kimia Cao sebagai penstabil tanah gambut untuk penggunaan tanah bermasalah yang lebih baik. Penemuan utama ialah campuran dengan jumlah kelembapan yang tepat, EPP dan Cao membantu menstabilkan tanah dan mengawetkan tanah gambut. Oleh itu, kajian ini mengesahkan idea untuk merawat gambut dengan EPP dan Cao, mempertingkatkan sifat tanah gambut dan mengekalkan petempatan melebihi pemuatan untuk tempoh masa yang sewajarnya. 20% campuran EPP dan CaO menghasilkan ketumpatan kering tertinggi, menunjukkan bahawa ketumpatan kering meningkat secara linear dengan jumlah campuran untuk menstabilkan gambut..

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ASTM	American Society for Testing and Materials
BS	British Standard
C	Carbon
$CaCo_3$	Calcium Carbonate
CaO	Calcium Oxide
CaOH	Calcium Hydroxide
cm	centi metre
CO_2	Carbon Dioxide
CD	Consolidated Drained
Cu	Copper
CU	Consolidated Undrained
Gs	Specific Gravity
Gt	Gigatonne
LL	Liquid Limit
LOI	Loss of Ignition
POFA	Palm Oil Fuel Ash
ha	Hectares
EPP	Eco Processed Pozzolan
kPa	kilopascal
K	Potassium
b	Boron
H_2O	Water
H_2SO_4	Sulphuric Acid

NaOH	Sodium Hydroxide
UU	Unconsolidated Undrained
Wc	Moisture Content

CHAPTER 1

INTRODUCTION

1.1 Background Study

All soils with organic matter content greater than 20% are called organic soils. Peat is part or all of the decayed remains of dead plants that have accumulated under water for tens of thousands to thousands of years. Due to various factors such as source fiber, temperature and humidity, the content of peat soil varies from place to place. Peat soil is organic soil with an organic content of more than 75% (Huat, 2004). Peat is a mixture of fragmented organic matter formed in wetlands under appropriate climatic and topographical conditions. It comes from vegetation that has undergone chemical changes and fossilization (Edil *et al.*1981). The soil is usually used for the construction of dams, dikes and other soil structures. Foundation improvement is a fast-growing area, because good sites that can be built are increasingly limited (Boobathiraja *et al.*2014). Therefore, soil is a key component of the construction industry. Soft soil has high water content and low workability, which will increase the cost and duration of soft soil projects (Belal *et al.*2014). It is known that soft soil has low strength, high compressibility, and the known water content almost reaches its liquid limit (Khalid *et al.*2014).

Peat soil is originally problematic and belongs to high organic soil according to Deboucha *et al.* (2008). Due to its abnormally high-water level, peat will deform greatly under applied load. High content and organic nature are also one of peat soil characteristics. Compared with mineral soils with similar water content, peat also has very high strength. In order to build a safe, stable and usable road, road engineers must overcome these engineering problems and find suitable solutions to build roads on peat soil stated by Razali *et al* (2013). Peat is affected by instability issues, such as local subsidence and the development of sliding damage. Even in the case of a

moderate increase in load, it will withstand a very large one-time and long-term settlement. Peat soil is a problematic soil, which will become more complicated during the construction process, for example buildings and roads also stated by Razali *et al* (2013).

Malaysia has about 2.6 Million Hectares of peatlands, of which about 70% (1.6 Mil. a) are located in Sarawak. Tropical peatland forest is a unique dual ecosystem rain forests and peatlands. Its topography is greatly affected by hydrological conditions, which in turn determines the vegetation structure and species composition and type of peat. Tropical peatland forests are divided into six (6) phased communities and three (3) main forest types, namely mixed peat swamp forest (PC1), Alan Forest (PC2 and PC3) and Padang Alan Forest (PC4). The following describes their formation and development control factors, characteristics and classification. Some insights on conservation and sustainable development. It also provides regulations for the use of peat in Malaysia. So far, the tropical peatland in Malaysia is still a largely unknown ecosystem and one of the under-researched environments in the world. Hydrology is the main factor that affects the formation and function of peatland ecosystems by affecting forest types and nutrient flow, referring to Meiling (2016).

Figure 1.1: Distribution of Lowland Peatlands in Malaysia

(Source: Department of Agriculture Malaysia 2002; Department of Irrigation and Drainage Sarawak 2014)

However, from an engineering standpoint, the characteristics and behaviors of Sabah peat soil are similar to other tropical peat soils found in Sarawak and Peninsular Malaysia. Even when treated to a moderate load, peat causes major challenges in building due to its long-term consolidation settlements (Duraisamy *et al.*2007).

Table 1.1: Distribution of Peat in Malaysia

State	Area (ha)
Sarawak	1,657,600
Johor	228,960
Pahang	219,561
Selangor	194,300
Perak	107,500
Terengganu	81,245
Sabah	86,000
Kelantan	7,400
Negeri Sembilan	6,300
Total	2,588,866

(Source: Mutalib *et al.*1991)

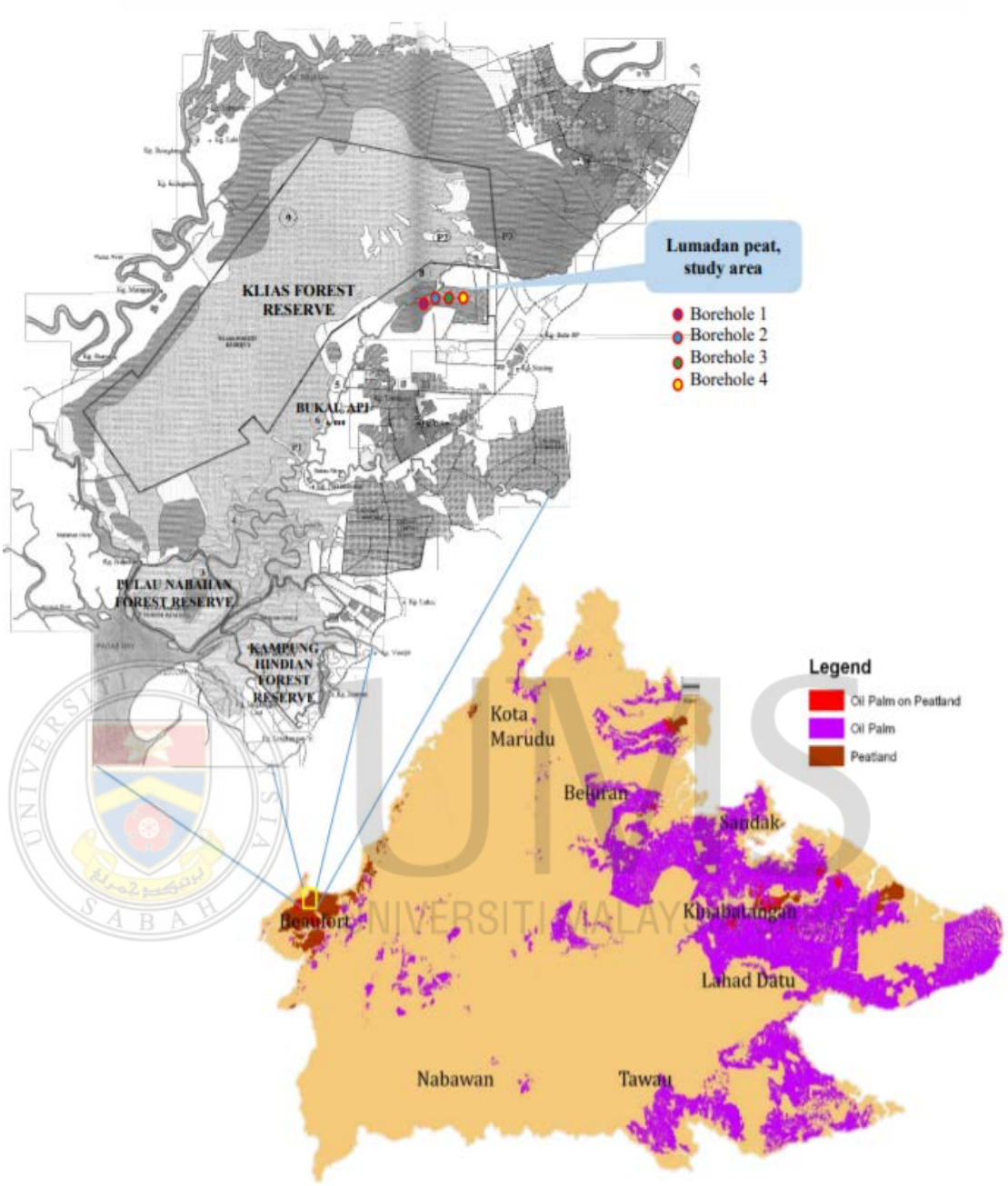


Figure 1.2: Distribution of Peatland in Sabah

(Source: Robert *et al.* (1998); Hamzah and Rashid (2015)

Figure 1.2 showing distribution of Peatland in Sabah. For this research, it focusing in Klias, Beaufort in order to make study about peat soil.

Eco Process Pozzolan (EPP) is made by calcining Spent Bleaching Earth (SBE), which is a by-product of the edible oil manufacturing process. According to Asrah *et al.*

(2020). It is recently used as a blended cement and the pretreatment method of palm oil generates SBE as waste material in the refinery plant. Cement stabilization is the most common stabilization methods adopted for soil treatment.

Chemical stabilization is a major category of soil stabilization, which involves the use of chemical reagents to trigger reactions in the soil to change its geotechnical engineering characteristic, which is stated by James *et al.* (2016). In this study, chemical stabilizer that used is Calcium Oxide (CaO). CaO naturally an absorbent. For instance, at room temperature, CaO will spontaneously absorb carbon dioxide from the atmosphere, thereby reversing the reaction. It also absorbs water, converts itself into calcium hydroxide and releases heat in the process. The bubbling that accompanies the reaction is the source of its name "quick" or live lime. There is no study before using Cao as stabilizer. The only calcium used for stabilizer before is Calcium Hydroxide (CaOH).

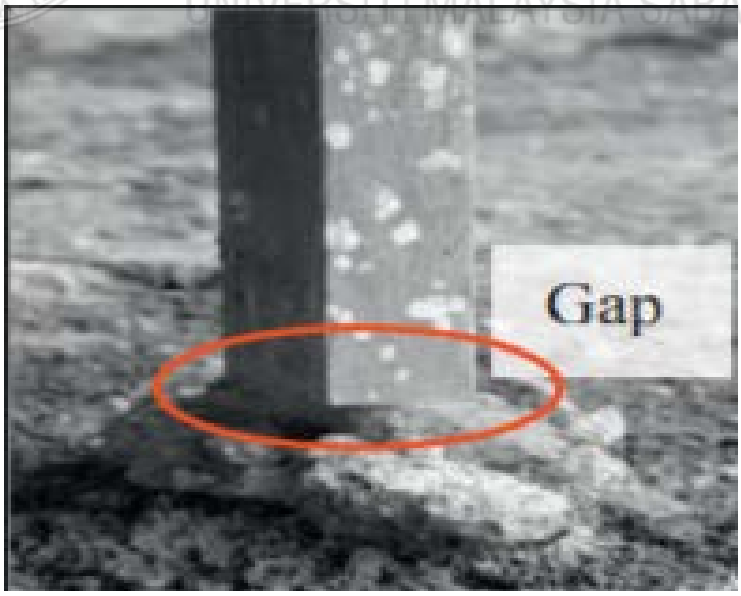
Soil compaction is the process by which the soil is subjected to mechanical stress and is densified. Soil consists of solid particles and voids filled with water and air. This means that according to Mintek Resources (2020), soil compaction is used to compact the soil by reducing the void space or air volume between soil particles. This test usually conducted in lab using the compactor equipment. The soil will be compacted and the strength will be tested. In other words, soil compaction occurs when soil particles are pressed together to reduce the space between them. The resulting highly compacted soil has very little space and has a higher unit weight than non-compacted soil.

1.2Problem Statement

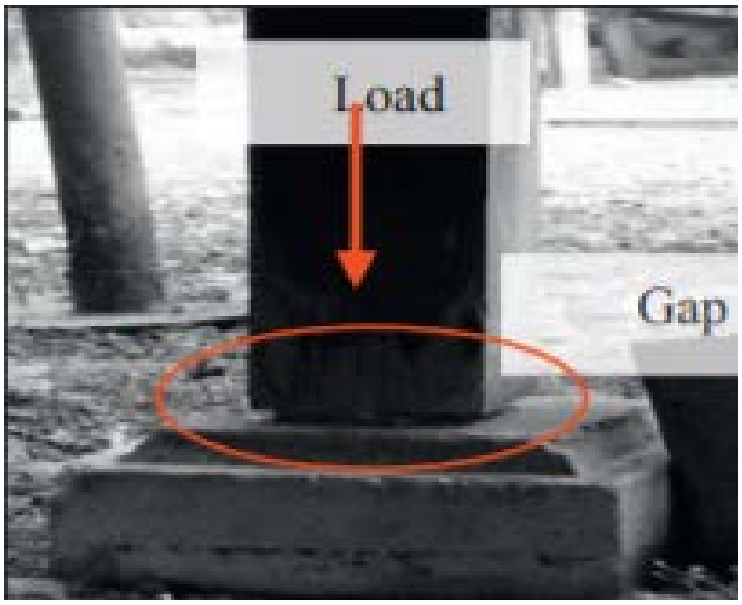
Engineering structures are mostly built-in direct contact with the ground, and the response between soil and structure is called soil-engineering structure interaction. Due to the high-water content (>100%), high compressibility (0.9-1.5) and low shear strength (5-20 kPa) values, peat is considered to be unsuitable for supporting the foundation in its natural state. Peat also contains high organic matter (>75%), large deformation, high compressibility, and high creep amplitude and rate. Settlement is the norm phenomenon in peat soil (Bakar *et al.* 2013).

Due to the engineering characteristics of peat with high water content (over 100%), high compressibility (0.9 to 1.5) and low strength (usually 5 to 20 kPa), peat road construction poses great challenges to road builders. In order to build a safe, stable and usable road, road engineers must overcome these engineering problems and find suitable solutions to build roads on peat soil. The challenges faced by engineers in peat road construction include possibility of limited accessibility and stability issues (Zainorabidin *et al.* 2003). Building construction on peat soil also facing the same problems.

For example, Figure 1.3 below showing Pillars supporting houses built on peat soil. This figure was taken during an on-site investigation in Bali Nipah, Johor in 2011. According to the author's observation, most of the columns here are facing the same problem. It is risky for residents. The figure also shows the load distribution in the column due to the interaction of the soil structure. The gap between the column and the footing can be clearly seen. This is due to the low bearing capacity and the settlement of peat soil to support the load from the superstructure (Bakar *et al.*2013).



(I)



(II)

Figure 1.3: (I) & (II): Settlement on Peat Soil in Parit Nipah Johor

(Source: Bakar, 2011)

Peat soil is problematic soil as every engineer tried to avoid from doing work involving this type of soil. Many problems may happen as the main cause is peat soil such as development of slip failure, local sinking and long-term settlement when load increases. Stabilizing seems the way to solve this problem. CaO and EPP is the chemical substance that be used as stabilizer in order to improve the shear strength and soft condition especially for very low hydraulic conductivity soils.

1.3 Objectives

The study's goal is to anticipate the capabilities of CaO and EPP as peat soil stabilization materials and improvement techniques, as well as the methods' consequences. However, the study's more precise objectives, as listed below, have to be met:

(i) To identify the index properties of peat soil.

(ii) To determine the effect of Calcium Oxide and EPP to the moisture content of peat soil

(iii) To investigate the behavior of dry density of peat mixed with Calcium Oxide and EPP