

PEAT SOIL TREATMENT USING  
TRANSFORMED EGG SHELLS (TES) AS  
CHEMICAL STABILIZER

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PEAT SOIL TREATMENT USING TRANSFORMED EGG SHELLS (TES) AS  
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Thesis submitted in fulfilment of the requirements  
for the award of the degree of  
B. Eng (Hons.) Civil Engineering

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24 JUNE 2016

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**LIST OF ABBREVIATIONS**

TES            Transformed Egg Shells

UCS            Unconfined Shear Strength

ASTM          American Society for Testing and Materials

BS              British Standard

ASSHTO        American Association of State Highway and Transportation Officials

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## **ABSTRACT**

Organic soil is abundant in Malaysia due to tropical climate and topographical conditions. Generally, organic soil is low in shear strength due to high moisture retention property. Among all the practices, in-situ soil stabilization is found to be effective in treating soil. Researchers strive in finding sustainable and effective substitute to the conventional stabilizers: quicklime. Transformed egg shells were thought to be a potential substitute to quicklime. Calcium rich egg shells can be treated under complete disinfection and combustion to produce Calcium Oxide (CaO) component. Meanwhile, Calcium Carbonate is component that can be obtained by disinfection and grinding of egg shells. Transformed egg shells possess similar physical and chemical properties as in quicklime. In this study, transformed egg shells were tested in stabilizing organic soil from Pekan, Pahang. Unconfined shear strength (UCS) was conducted by investigating peak shear strength of soil stabilized after curing for 7, 14 and 28 days respectively. Results show that transformed egg shells have significant potential to stabilize organic soil for construction purpose.

## **ABSTRAK**

Tanah organik banyak dijumpai di dalam Malaysia kerana iklim tropika dan keadaan topografi yang sesuai. Secara umumnya, tanah organik rendah dalam kekuatan kerana kebolehan memerangkap air. Penstabilan tanah menggunakan bahan kimia didapati berkesan dalam merawat tanah. Penyelidik berusaha dalam mencari pengganti yang mampan dan berkesan kepada penstabil konvensional: serbuk kapur. Transformasi kulit telur berpotensi menjadi pengganti serbuk kapur. Kulit telur kaya dalam kalsium boleh akan dirawat dengan pembasmian kuman dan pembakaran untuk menghasilkan kalsium oksida (CaO). Sementara itu, Kalsium Karbonat boleh diperolehi dengan pembasmian kuman dan pengisaran kulit telur. Transformasi Kulit telur memiliki sifat-sifat fizikal dan kimia yang serupa seperti kapur. Dalam kajian ini, kulit telur diuji dalam penstabilan tanah organik dari Pekan, Pahang. kekuatan puncak dikaji selepas pengawetan selama 7, 14 dan 28 hari. Keputusan menunjukkan bahawa transformasi kulit telur mempunyai potensi yang besar dalam menstabilkan tanah organik.

## **CHAPTER 1**

### **INTRODUCTION**

#### **1.1 BACKGROUND OF STUDY**

From a geotechnical engineer's context, peat is defined as soil containing over 75% organic content. Peat soil can normally be found in and around swampy areas or wetlands. Peat soil covers 415 million hectares of the total earth surface (Adon, et al., 2012). Malaysia's coverage of peat soil land is about 2.59 million hectares (Ali & Duraisamy, 2011). Generally, peat soil has some common physical characteristics, such as dark brownish colour humus, sponginess and a distinguishing organic odour.

According to Amu & Salami (2010), soil stabilization is a process to improve and stabilize the engineering properties of soil by changing at least one of the soil characteristics. The stabilization concept has been developed nearly a thousand year ago in Rome and Egypt, where lime mixture was used. However, modern soil stabilization started after cement was practically used as a type of chemical stabilizer for clay in 1915 (Wang, 2002). A century later, deep soil mixing using chemical stabilization is still recognized as the most economical and effective measure to improve engineering soil characteristics. Combining lime with Ordinary Portland Cement is still the greatest trend. Cement column with pozzolanic material binders (fly ash or lime) and soil mass stabilization are the common industrial practises in shear strength and compressibility improvement on soft soil like peat (Euro Soil Stab, 2002). Chemical binders stabilize the peat soil by altering the physicochemical properties of the soil. It indirectly improves the sediment resistance of the peat soil.



Nowadays, peat soil researchers are working on finding better substitutes to replace lime and Ordinary Portland Cement to reduce the usage of natural raw resources. Egg shell is one of the most common wastes on Earth. Most egg shells will be disposed in landfills. Every year, thousands of dollars are spent on land use and transportation fees. From a newspaper survey, Malaysia is one of the biggest egg consumption country. On average, one Malaysian will use 320 eggs per year (The Star Online, 2011). Egg shell is categorised as a food-product waste that is rich in natural calcium mineral. It is made up of over 95%  $\text{CaCO}_3$ . Phosphorus and magnesium are the secondary contents in the egg shell (King`ori, 2011). Egg shell can become substitute to lime. Egg shell has been used in replacing lime in cement researches, which showed positive results for most of the experiments.

To test the workability of egg shell in peat soil treatment, the egg shell will be prepared in two forms: egg shell ash and raw egg shell powder. Transformed egg shells will act as agents in stabilizing the overall performance of the peat soil. However, this paper will focus the study on shear force improvement shown by peat soil added with the transformed egg shells, in comparison to peat soil added industrially manufactured lime powder.

## **1.2 PROBLEM STATEMENT**

Peat soil is categorised as a type of “problematic soil” and is not well explored or studied. High water content, high compressibility and low shear strength are the greatest concern for peat soil. Difficulty in conducting on-field tests and sampling for laboratory tests is mostly caused by the instability and extreme sensitivity of peat soil upon minor loading. Besides, peat is normally located in waterlogged areas, which has frequently prevented machinery from entering the peat land for sampling work. Constructions on peat land always face the problem of immediate and long term settlement when no appropriate treatment is taken on the soil. Nowadays, the scarcity of land due to rapid urbanization and lack of better land for construction has led to inevitable development of peat land.

Chemical admixtures, including cement, lime and fly ash, are the best solutions that geotechnical engineers have to improve the problematic peat soil. However, both cement and lime productions are energy consuming, of which 50% goes to combustion during lime production. In the near future, shortage of limestone may happen due to the massive demand for limestone in Ordinary Portland cement production. According to Bliss et al. (2008), United States' cement production has been unable to support its own market requirement in 2006 due to clinker shortage. Limestone is a type of non-renewable natural raw material. New limestone mining and production plants need about 2 years to build and the mining permission may take more than 8 years before any exploration on limestone can start. Moreover, the quarries and cement batching plants are usually not welcomed by nearby residential citizens. The rejection by citizen will cause delays in lime production, in turn causing the production to fall below the demand amount.

Considering the high possibility of limestone shortage in the future global market, substitutes to the limestone like oyster shell, common seashell and egg shell were thought of and researched on. Some fields, including pharmaceutical, physiochemical, biodiesel and construction industries, took part in utilizing egg shell as substitute for lime. Egg shell has been proven to be effective as a potential substitute to lime in treating cohesionless lateritic soil (Amu & Salami, 2010). Therefore, there is a need to study the applicability of egg shell in peat soil treatment. It is because the unique characteristics of the peat soil, high fibre content and high water content, may affect the function of the egg shell as binder.

Peat soil is soft soil with extreme sensitivity. At the same time, the properties of the soil vary for different sites. Peat soil in different locations will encounter different geographical conditions including humidity, climate, vegetation nature and contact with water sources. As a result, the degree of humidification of the organic plantation remnant will be different. The engineering properties are directly affected by the degree of the loss of organic content in humidification. Hence, the results from studies are specific to each particular peat soil sample area.