

**THE EFFECTIVENESS OF ELECTRODES TYPES ON ELECTRO-  
OSMOSIS IN KAHANG CLAY**

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**A Project report submitted in partial fulfilment of the requirement for the  
award of the degree of Master of Engineering (Civil – Geotechnics)**

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**APRIL 2009**

## ABSTRACT

The main problem face by geotechnical engineering in construction is the low permeability, low strength and low bearing capacity on clayey soil. Sometimes the soil or fill material cannot reach the required specification in geotechnical aspect and need to be improved. In this project electro-osmosis is used to stabilize Kahang clay which is known to have low strength but high compressibility. For that reason, soil improvements have to be undertaken so that loads can be applied without causing settlement or cause of bearing capacity failure. Methods such as lime stabilization, pumping and ploughing are used to stabilize the clay. In addition clay can also be stabilized by applying an external electric current. This phenomenon is called electro osmosis. The process involves passing a direct current through a soil mass to cause changes in the soils properties. Electro-osmosis process can be carried out by using dissolution of the anode material into the soil or introduction of chemicals in solution at anode. This study used the method of dissolution anode material were applied for Kahang Clay treatment. The objectives of this study is to investigate the effect of electro-osmosis on shear strength of Kahang Clay, evaluate the effect of dewatering due to electro-osmosis process and study the effect of various types of electrodes on electro-osmosis. The effectiveness of different type of electrodes namely ferum, aluminium, and cuprum on electro-osmosis are presented. A constant voltage at 30 volts was applied for 672 hours to each different electrodes cell. The strength and dewatering of Kahang Clay were measured according to the different electrodes. The results of Kahang Clay are discussed in following chapter.

## ABSTRAK

Masalah utama yang dialami oleh jurutera geoteknik adalah berkaitan dengan kawasan pembinaan yang mempunyai kebolehtelapan yang rendah, kekuatan ricih yang rendah dan keupayaan galas yang rendah seperti tanah liat. Kadang kala, tanah atau beban tambah tidak dapat mencapai garis panduan atau spesifikasi yang telah ditetapkan dalam aspek geoteknik, oleh itu pembaikan perlu dilakukan. Dalam projek ini, elektro-osmosis digunakan untuk menstabilkan tanah liat Kahang yang sedia maklum mempunyai kekuatan ricih yang rendah tetapi kebolehmampatan yang tinggi. Oleh itu, pembaikan tanah perlu untuk membolehkan tanah menanggung beban tanpa menyebabkan kegagalan seperti mendapan atau kegagalan daya galas. Kaedah kestabilan seperti kestabilan menggunakan kapur, pam, dan pembajakan digunakan untuk menstabilkan tanah liat. Selain itu tanah liat juga boleh distabilkan dengan kaedah menggunakan arus elektrik. Fenomena ini dipanggil elektro-osmosis. Proses ini melibatkan arus merentasi tanah dan menyebabkan perubahan ciri-ciri tanah. Elektro-osmosis boleh dijalankan dengan kaedah pembubaran anod kedalam tanah atau pengenalan cecair kimia pada anod. Dalam kajian ini, kaedah pembubaran anod dijalankan pada tanah liat Kahang. Objektif kajian ini adalah untuk mengetahui kesan elektro-osmosis kepada kekuatan ricih dan pengairan dalam tanah liat Kahang, serta kesan perbezaan penggunaan elektrod yang berlainan dalam elektro-osmosis. Kebolehkesanan menggunakan ferum, aluminium dan kuprum ditunjukkan. voltan tetap sebanyak 30 volt dikenakan selama 672 jam pada setiap elektrod yang berbeza. Kekuatan dan pengairan di ukur. Keputusan dibincangkan didalam bab seterusnya.

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## **CHAPTER I**

### **INTRODUCTION**

#### **1.1 Background Of The Problem**

Rapid development has given rise to the problem of availability of suitable sites for future projects. In natural location and condition, soil provides the foundation to support structures. Soil is also significantly known as one of the basic materials of construction, as witnessed by the existence of earth structures such as dams, dikes, and embankments for roads and airfield. The behavior of soft alluvial soils is influenced by the sources of the parent material, depositional processes, erosion, redeposition, consolidation and fluctuations in groundwater levels. Thus, the need to utilize soils with poor engineering properties for foundation and earthwork construction has increased. Because of that, it is need to ensure the ground under existing structures are strengthen to certify the stability against adjacent excavation, tunneling, and as well as to improve the resistance to seismic.

Two main criteria to be taken into account in designing foundation for structures on soils are the bearing capacity and settlement. The pressure that a foundation can impose onto the support without causing over stressing is call bearing capacity and the deformations occurring because of foundation loading usually cause settlement. As these criteria are basically important to ensure safe and stability of foundation design, the engineers must have knowledge about these problems. Therefore, several methods and techniques have been developed to improve and stabilize soils of poor engineering characteristics. The applicability each of these methods and techniques depend on the types of soil, technology and expertise, materials, space, and cost. For example the method that are always used for site improvement are earth moving, compaction and stabilization.

The application of electro-osmosis to improve Kahang clay is the focus of this study. The first application of the techniques in civil engineering was undertaken by Casagrande in 1939 for the dewatering and stabilization of railway construction at Salzgitter, Germany (Casagrande, 1952). Previous applications of electro-osmosis have been used to increase the shear strength and stability of fine-grained soils to simplify excavation and slope construction. The present study considers combining electro-osmosis technique with vertical sand drains for stabilizing highway construction. Although the application succeeded, electro-kinetic dewatering or electro-osmosis has not received wide application, probably because of the high operation costs and expert needed to conduct the process. Principally, electro-osmosis is removing the water collected at the cathode as a result of electro-osmosis, the reduced water content of the soil resulted in an increase of shear strength and a reduction in soil volume.



## 1.2 Problem Statement

The main problem face by geotechnical engineering in construction is the low permeability, low strength and low bearing capacity on clayey soil of soft soil. Sometimes the soil or fill material cannot reach the required specification in geotechnical aspect and need to be improved. In this project electro-osmosis is used to stabilize Kahang clay which is known to have low strength but high compressibility. For that reason, soil improvements have to be undertaken so that loads can be applied without causing failure of collapse, settle or failure cause of bearing capacity. Accordingly several methods have been developed and used to improve and stabilize soft clays such as using natural and chemical additives, surcharging, vertical drains, electro-osmosis and deep foundation such as pile.

Theoretical and practical applications of electro-osmosis have been utilized for many years. The successful applications of electro-osmosis have included slope stability, dewatering, pile driving, and consolidation. In addition, electro-osmosis has been used in electrochemical injection applications, including the use of aluminum anodes and additives such as potassium chloride and aluminum acetate (Lokhart,1983). Although there is a wide range of applications of electro-osmosis, there are many unknowns with respect to ion flow through soil and the resulting changes in soil properties.

The coefficient of permeability and rate of seepage in clay is very small as compared to granular soil. However, in most cases in clay the drainage can be increased by application of an external electric current. This phenomenon is call electro-osmosis. Because of that, applying this method for Kahang Clay could increase the strength of the soil.

### **1.3 Objectives Of Study**

The main objective of study is to increase the strength of clayey soil. This is important to decrease the consolidation occur in the clay at the construction site. The specific objectives of this project are:

- i. To investigate the effect of electro-osmosis on shear strength of Kahang Clay
- ii. To evaluate the effect of dewatering due to electro-osmosis process
- iii. To study the effect of various types of electrodes on electro-osmosis

### **1.4 Scope Of Study**

This study has been carried out in laboratory to obtain the data from the electro-osmosis test. Kahang Clay is used as sample in the experiment.

The scopes of study are:

- i. Experimental works were carried out in Geotechnical laboratory of Faculty of Civil Engineering, UTM
- ii. Different types of electrodes namely aluminium, cuprum, and ferum were used in the experiment. In addition, a controlled sample was prepared as a guide
- iii. Parameters that were measured are shear strength, dewatering, and current with various types of electrode were monitored

## 1.5 Site Location

The location of the sample were collected is in state of Johor. The site is situated at Kahang area near to Jalan Mersing, it take one hour from Kluang. The samples were taken at depth 1.5 to 3 meter deep. The samples were kept in container to bring back to Geotechnical Laboratory of Civil Engineering, UTM. Figure 1.1 and Figure 1.2 shows the site location of Johor and Kahang.



Figure 1.1: Location of Johor state in Malaysia (Source: Google map)

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