SOME MECHANICAL AND CHEMICAL PROPERTIES OF CEMENT STABILIZED MALAYSIAN SOFT CLAY

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JUDUL: **SOME MECHANICAL AND CHEMICAL PROPERTIES OF CEMENT STABILIZED MALAYSIAN SOFT CLAY.**

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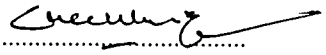
Signature	:	
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SOME MECHANICAL AND CHEMICAL PROPERTIES OF CEMENT STABILIZED MALAYSIAN SOFT CLAY

HO MEEI HOAN

A project report submitted in partial fulfillment of the
requirement for the award of the degree of
Master of Engineering (Civil-Geotechnics)

Faculty of Civil and Environmental Engineering
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DECEMBER 2008

"I hereby declare that this project report entitled "Some Mechanical and Chemical Properties of Cement Stabilized Malaysian Soft Clay" is the result of my own work, except as cited in the references. The project report has not been accepted for any degree and is not concurrently submitted in the candidature of any other degree."

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All Glory, Honour and Praise be unto the Lord Jesus Christ,
my Lord and Saviour.

Specially dedicated to my beloved daddy, Garry Ho Fon Khiong,
mummy, Mary Chee Inn Lai and my only sibling, brother Michael Ho
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For God so loved the world that He gave His One and Only Son,
that whoever believes in Him shall not perish but have eternal life.

- John 3 :16 -

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ABSTRACT

Soft clays are defined as cohesive soil whose water content is higher than its liquid limits. Materials such as these display extremely low yield stresses, high compressibility, low strength, low permeability and consequently low quality for construction. Thus, soil-cement mixing is adopted to improve the ground conditions by enhancing the strength and deformation characteristics of the soft clays. For the above mentioned reasons, a series of laboratory tests were carried out to study some fundamental mechanical and chemical properties of cement stabilized soft clay. The test specimens were prepared by varying the portion of ordinary Portland cement to the soft clay sample retrieved from the test site of RECESS (Research Centre for Soft Soil) at UTHM. Comparisons were made for both mechanical and chemical properties by relating the effects of cement stabilized clay of homogeneous and columnar system specimens for 0, 5 and 10 % cement and curing for 3, 28 and 56 days. The mechanical properties examined included one-dimensional compressibility and undrained shear strength, while the chemical properties included pH values and the percentage of oxide concentration. For the mechanical properties, both homogeneous and columnar system specimens were prepared to examine the effect of different cement contents and curing periods on the stabilized soil. The one-dimensional compressibility test was conducted using an oedometer, while a direct shear box was used for measuring the undrained shear strength. Chemical properties of the stabilized material were examined using the X-Ray Fluorescence (XRF) method to obtain the percentage of oxide concentration while a pH meter was used to determine the pH values. The chemical study was also to ascertain the extent of leaching effect from the stabilized column to the surrounding soils. The higher the value of cement content, the greater is the enhancement of the yield stress and the decrease of compression index. The value of cement content in a specimen is a more

active parameter than the curing period. It can be proposed the following relationship for RECESS soft clay from this study: $\sigma_y' = 1.5871\ \tau$. The chemical results showed that cement-stabilized column give environmental effects to the soil surrounding the column. The pH values for cement content of 5 % and 10 % in the soil-cement column specimens gradually decreases with the curing days for both consolidated and without consolidated specimens. Soil-cement column specimen with consolidation gave a higher pH compare to the specimens without consolidation. Major to minor relative values of the percentage of oxide concentrations are $SiO_2 > Al_2O_3 > Fe_2O_3 > SO_3 > K_2O > CaO$.

ABSTRAK

Tanah liat lembut didefinasikan sebagai tanah melekit di mana kandungan air dalam tanah adalah lebih tinggi daripada had cecair. Kandungan tanah seperti ini menunjukkan tekanan rintangan yang sangat rendah, kebolehmampatan yang tinggi, kekuatan yang rendah, kebolehtelapan yang rendah dan juga mempunyai kualiti yang rendah untuk pembinaan. Oleh itu, campuran tanah-simen digunapakai untuk memperbaiki keadaan tanah dengan menambah kekuatan dan membaiki sifat-sifat deformasi tanah liat lembut. Seperti sebab-sebab yang dinyatakan di atas, satu siri ujian makmal untuk mendapat sifat-sifat asas mekanikal dan kimia dijalankan bagi tanah liat lembut yang distabilkan oleh simen. Spesimen-spesimen disediakan dengan menambah beberapa kandungan simen Portland biasa dengan tanah liat lembut yang diperolehi dari tapak ujian RECESS (Research Centre for Soft Soil) di UTHM. Perbandingan dilakukan untuk sifat mekanikal dan kimia dengan menghubungkait kesan tanah yang distabilkan sama ada homogenus ataupun sistem tiang bagi 0, 5 and 10 % simen dan tempoh awet selama 3, 28 dan 56 hari. Ujian untuk sifat-sifat mekanikal termasuklah ujian satu-dimensi pemadatan dan ujian kekuatan ricih tak tersalir, manakala, ujian pH dan ujian peratusan kepekatan oksida dilakukan bagi mengenalpasti sifat kimia. Bagi sifat mekanikal, kedua-dua spesimen homogenus and sistem tiang telah disediakan untuk menguji kesan-kesan ke atas tanah yang distabilkan dengan perubahan kandungan simen dan tempoh awet. Ujian satu-dimensi pemadatan dijalankan menggunakan oedometer, sementara ujian kekuatan ricih menggunakan kotak ricih terus untuk mengukur kekuatan ricih tak-tersalir. Sifat kimia untuk tanah distabilkan diuji dengan menggunakan kaedah pendaflour sinar-X (XRF) untuk memperoleh peratusan kepekatan oksida, sementara meter pH digunakan untuk mendapatkan nilai pH. Ujian kimia dijalankan untuk mengetahui kesan daripada aliran kandungan dalam tanah yang distabilkan kepada tanah yang

disekeliling. Semakin tinggi nilai kandingan simen, maka semakin tinggi tekanan rintangan dan pengurangan indeks kompresi. Nilai kandungan simen di dalam satu spesimen merupakan parameter yang lebih aftif daripada tempoh awat. Dapat disyorkan bahawa hubungan tanah lembut RECESS daripada kajian ini adalah seperti berikut: $\sigma_y' = 1.5871\ \tau$. Ujian kimia menunjukkan sistem tiang tanah yang distabilkan memberi kesan kepada alam sekitar iaitu terhadap tanah di sekeliling tiang tersebut. Nilai pH untuk spesimen tanah-simen sistem tiang 5 % dan 10 % kandungan simen semakin menurun dengan penambahan tempoh awet bagi kedua-dua spesimen yang dipadatkan dan tanpa pemadatan. Spesimen tanah-simen sistem tiang yang dipadatkan memberikan nilai pH yang lebih tinggi berbanding dengan spesimen yang tidak dipadatkan.Nilat relatif daripada terbanyak ke paling sedikit peratusan kandungan oksida adalah $SiO_2 > Al_2O_3 > Fe_2O_3 > SO_3 > K_2O > CaO$.

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°	-	Degree
km^2	-	Kilometer square
%	-	Percent
et al.	-	And other people
RECESS	-	Research Centre for Soft Soil
XRF	-	X-ray Fluorescence
UTHM	-	Universiti Tun Hussein Onn Malaysia
m	-	Meters
$Mg_3(OH)_6$	-	Brucite
$Al_2(OH)_6$	-	Gibbsite
μm	-	Micrometer
nm	-	Nanometer
MH	-	Micaceous, Diatomaceous fine sandy or silty soils or elastic silts
pH	-	A measurement of the acid or alkaline level
Δσ	-	Total stress
Δσ'	-	Increase in the effective stress
Δμ	-	Increase in the pore water pressure
log	-	Logarithm
C_c	-	Compression index
C_r	-	Recompression index
t	-	Number of days after the installation of columns
$\Delta c_{u,total}(t)$	-	Total strength increment
$\Delta c_{u,thix}(t)$	-	Strength increment due to thixotropy