



UNIVERSITI PUTRA MALAYSIA

***STABILIZATION OF PEAT SOIL USING ELECTROCHEMICAL
INJECTION TECHNIQUE***

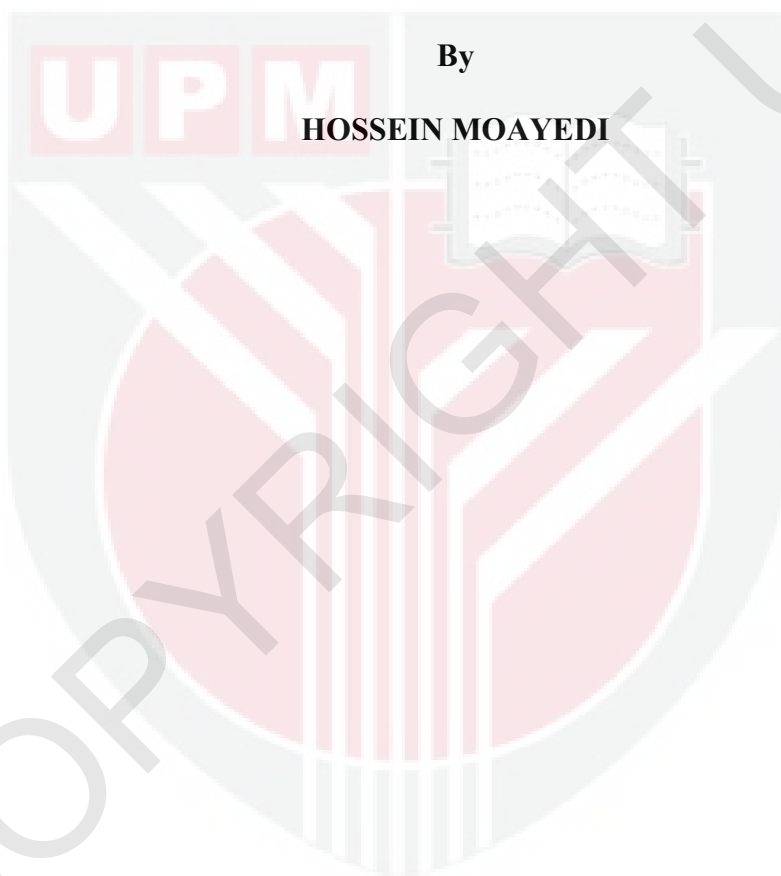
HOSSEIN MOAYEDI

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**STABILIZATION OF PEAT SOIL USING ELECTROCHEMICAL
INJECTION TECHNIQUE**

By

HOSSEIN MOAYEDI



**Thesis Submitted to the School of Graduate Studies, Universiti Putra Malaysia,
in Fulfillment of the Requirements for the Degree of Doctor of Philosophy**

October 2012

Dedicated to

My beloved family



Abstract of thesis presented to the Senate of Universiti Putra Malaysia in fulfillment of the requirement for the degree of Doctor of Philosophy

STABILIZATION OF PEAT SOIL USING ELECTROCHEMICAL INJECTION TECHNIQUE

By

HOSSEIN MOAYEDI

October 2012

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Faculty : Engineering

The peat soils are naturally very soft and undergo large settlements. Due to its low shear strength and high compressibility, such soils are geotechnically problematic. To improve the physicochemical characteristics of the peat soil, electrokinetic (EK) injection technique was used by applying a direct electrical potential across the soil specimens. Four chemical reagents namely, sodium silicate (Na_2SiO_3), calcium oxide (CaO), calcium chloride (CaCl_2), and aluminium hydroxide ($\text{Al}(\text{OH})_3$) were used as chemical stabilizers. A series of unconfined compressive strength (UCS), pH, water content, microstructure analysis, surface electrical charge, and rheology on the treated soil were conducted. The UCS values for stabilized peat soil samples were optimized at the 8, 6, 6, and 4%, of sodium silicate, calcium oxide, calcium chloride, and aluminum hydroxide respectively. However, the UCS values were decreased beyond the mentioned percentages for all the samples. The surface electrical charge properties of the peat treated with chemical stabilizers in different molarities and pH were also investigated. The average natural pH of peat soil samples was found to be

equal to 5.93 with ζ potential of -17.05 mV. The chemical stabilizer type and concentration showed an important effect on the surface electrical charge of peat soil particles. Lastly, a large scale EK equipment was developed to inject chemical stabilizer through the baseline peat soil in order to enhance its undrained shear strength, pH, and moisture content characteristics. The undrained shear strength (measured by van shear test), soil pH, and moisture content of treated soil with the large EK instrument were measured. It was found that the undrained shear strength of treated soils was increased by interparticle cementation caused by the electrochemical injection of ions into the soil under the DC field. It can be concluded that injecting chemical stabilizer by using the EK technique could significantly increase the treated soil shear strength and decrease its moisture content.

Abstrak tesis yang dikemukakan kepada Senat Universiti Putra Malaysia sebagai memenuhi keperluan untuk ijazah Doktor Falsafah.

**PENSTABILAN TANAH GAMBUT DENGAN MENGGUNAKAN KAEDAH
SUNTIKAN ELEKTROKIMIA**

Oleh

HOSSEIN MOAYEDI

Oktober 2012

Pengerusi : Profesor Bujang Bin Kim Huat, PhD

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Tanah organik secara semula jadinya merupakan tanah yang sangat lembut dan mengalami mendapan yang besar. Tanah itu mengalami masalah geoteknikal disebabkan oleh kekuatan ricih yang rendah dan kebolehmampatan yang tinggi. Teknik suntikan elektrokinetik (EK) telah digunakan dengan menggunakan aliran elektrik dengan merentasi spesimen tanah ntuk memperbaiki ciri-ciri fizikokimia pada tanah organik. Empat bahan uji kationik iaitu, natrium silikat (Na_2SiO_3), kalsium oksida (CaO), kalsium klorida (CaCl_2), dan aluminium hidroksida ($\text{Al}(\text{OH})_3$) telah digunakan sebagai penstabil kationik. Tanah yang dirawat akan dijalankan beberapa siri ujian yang terdiri daripada ujian kekuatan mampatan (UCS), pH, kandungan air, analisis mikrostruktur, caj permukaan elektrik dan reologi. Nilai-nilai UCS bagi sampel tanah organik meningkat sehingga 8, 6, 6, dan 4%, masing-masing bagi natrium silikat, oksida kalsium, kalsium klorida, dan aluminium hidroksida.

Walaupun bagaimanapun, untuk keseluruhan sampel hasil UCS menurun agak mendadak melebihi peratusan yang disebut. Sifat-sifat permukaan cas elektrik tanah organik yang dirawat dengan penstabil kationik dalam kepekatan dan pH yang berbeza telah dikaji. Purata pH semulajadi sampel tanah organik didapati sama rata kepada 5.93 dengan ζ potensi -17.05 mV. Jenis spesies kationik dan kepekatan menunjukkan kesan yang penting atas permukaan aliran elektrik zarah tanah organik. Lastly, peralatan EK berskala besar telah dibentuk untuk menyuntik monovalent dan multivalent melalui tanah organik untuk meningkatkan kekuatan ricih tak tersalir, pH, dan ciri-ciri kandungan lembapan. Kekuatan ricih tak tersalir (diukur melalui ujian van ricih), pH tanah, dan kandungan lembapan tanah yang dirawat diukur dengan instrumen berskala besar EK. Didapati bahawa kekuatan ricih taktersalir untuk tanah yang dirawat meningkat melalui penyemenan antara partikel yang disebabkan oleh suntikan elektrokimia ion ke dalam tanah di bawah bidang DC. Penstabil kationik yang disuntik oleh teknik EK ketara juga boleh meningkatkan kekuatan ricih tanah yang dirawat dan mengurangkan kandungan lembapan.

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Hossein Moayedi
2 November 2012

I certify that a Thesis Examination Committee has met on Nov. 2012 to conduct the final examination of Hossein Moayedi on his thesis entitled “Stabilization of Peat Soil Using Electrochemical Injection” in accordance with the Universities and University Colleges Act 1971 and the Constitution of the Universiti Putra Malaysia [P.U.(A) 106] 15 March 1998. The Committee recommends that the student be awarded the Doctor of Philosophy.

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DECLARATION

I declare that the thesis is my original work except for quotations and citations which have been duly acknowledged. I also declare that it has not been previously, or is not concurrently, submitted for any other degree at Universiti Putra Malaysia or at any other institution.

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Date: 17 October 2012

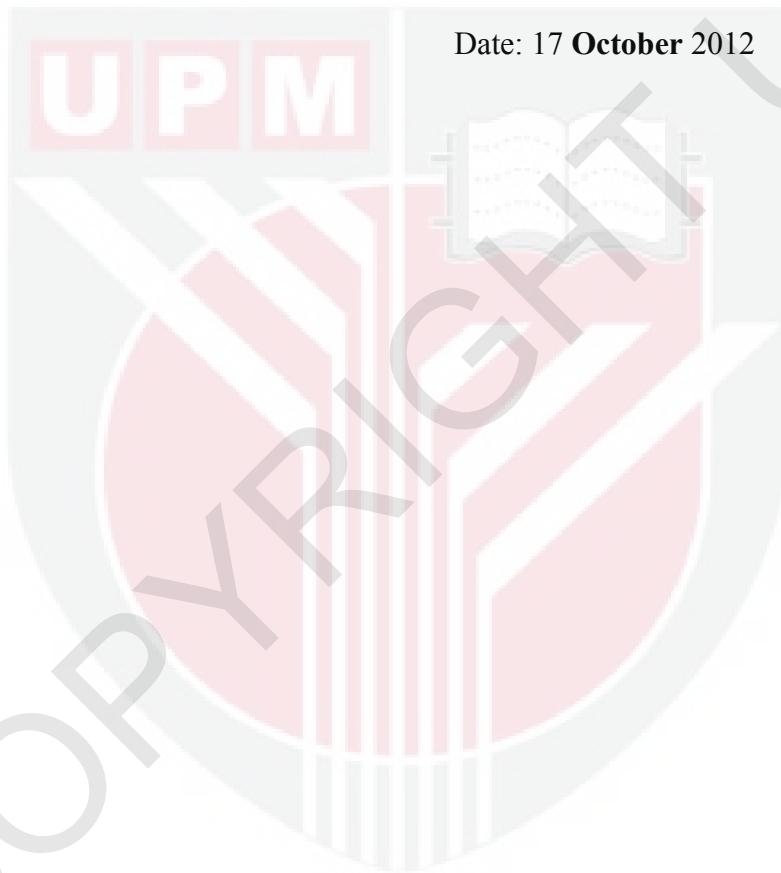


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