APPLICATION OF ELECTRICAL RESISTIVITY IMAGING TECHNIQUE IN SLOPE STABILITY STUDY OF GRANITIC RESIDUAL SOILS IN THE CAMERON HIGHLANDS, PAHANG

By

LAU KIEN LIONG

Thesis Submitted to the School of Graduate Studies, Universiti Putra Malaysia, in Fulfilment of the Requirement for the Degree of Master of Science

December 2005

DEDICATION

Dedicated especially to Beloved Family Members and Chit Chit

Abstract of thesis presented to the Senate of Universiti Putra Malaysia in fulfilment of the requirement for the degree of Master of Science

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Chairman : Associate Professor Shaharin Ibrahim, PhD

Faculty : Science

This thesis reports on the result of an empirical study to use electrical resistivity imaging technique in the assessment of ultimate shear strength (USS) and the dynamic cone penetration resistance (DCPR) of residual soil derived from the weathering product of granitic rock. The study also attempts to identify the depth and lateral extent of possible slip surface of sloping ground in Main Range Granite especially on the cut slope, bordering the federal road in Cameron Highlands. Soil samples were taken from the field and its petrophysical, electrical resistivity, USS and DCPR were studied in laboratory. In the field, electrical resistivity imaging (ERI) survey, USS and DCPR probing have also been carried out. The result of cross-correlation between USS and resistivity and the ERI-USS and DCPR from laboratory and field investigations were integrated to obtain relationships, which were applied to determine the USS and the DCPR of residual soil from the electrical resistivity inversion data obtained from the study area. The residual soil was derived from the weathering of Main Range granitic rock, Cameron Highlands. Soil classification results show that the soil in the study area comprised of mainly sandy

soil. This study shows that the resistivity, x and the USS, y was related by an equation y = 2.81Ln(x) + 30.29. The DCPR is related to the USS by; DCPR = 0.07(USS) + 6.88. The present work is applicable for soil at moisture content between 6% and 30%. Result of field survey and 2-D subsurface ERI and subsequence translation of ERI into USS and DCPR also indicated that the depth of the sliding surface of the failed slopes were about 1 m – 1.5 m below ground surface. The boundary between the translated and intact soil was at the USS of about 200 kPa and DCPR value of 30 J cm^{-2} per 10 cm penetration. The present study have shown that it is possible to estimate the USS and DCPR of the residual soil and to predict the depth and lateral extent of the possible slip surface using electrical resistivity imaging survey at lower cost and wider coverage of survey area.

Abstrak tesis yang dikemukakan kepada Senat Universiti Putra Malaysia sebagai memenuhi keperluan untuk ijazah Master Sains.

PENGGUNAAN KAEDAH PENGIMEJAN KERINTANGAN ELEKTRIK DI DALAM KAJIAN KESTABILAN TANAH BAKI BATUAN GRANIT DI CAMERON HIGHLANDS, PAHANG

Oleh

LAU KIEN LIONG

Disember 2005

Pengerusi: **Profesor Madya Shaharin Ibrahim, PhD**

Fakulti: **Sains**

Tesis ini melaporkan hasil dari satu kajian empirikal mengenai penggunaan teknik pengimejan kerintangan elektrik bagi penilaian kekuatan ricih maksimum (USS) serta rintangan tusukan kon dinamik (DCPR) bagi tanah baki yang terbentuk hasil daripada proses luluhawa batuan granit (*Main Range Granite*) serta mengenalpasti kedalaman serta kelangsungan mengufuk permukaan gelinciran yang mungkin terbentuk di dalam tanah baki granit yang cerun terutama pada permukaan pemotongan yang bersempadan dengan Jalan Persekutuan di Cameron Highlands. Sampel tanah telah dikutip dari kawasan kajian dan telah diuji di makmal untuk sifat-sifat petrofizikal, kerintangan elektrik, USS serta DCPR. Di lapangan, tinjauan pengimejan kerintangan elektrik (ERI), USS dan DCPR telah dilaksanakan. Hasil kajian korelasi antara USS dan kerintangan elektrik serta korelasi kerintangan elektrik – USS dan DCPR yang diperolehi dari kajian di makmal dan di lapangan telah diintegrasikan dan kaitan ini telah digunakan dalam penentuan USS serta DCPR tanah baki berdasarkan kepada data songsangan kerintangan elektrik yang diperolehi di kawasan lapangan. Tanah baki yang dikaji adalah terbentuk

daripada proses luluhawa batuan granit Banjaran Titiwangsa di Cameron Highlands. Keputusan ujian kelasifikasi tanah menunjukkan bahawa tanah baki dari kawasan kajian adalah terdiri daripada tanah pasir berlempung yang memiliki indeks plastik yang tinggi (CH). Kajian ini juga menunjukkan bahawa hubungan antara kerintangan elektrik, x dan USS**,** y adalah y = 2.81Ln(x) + 30.29. Nilai DCPR boleh diperolehi dari USS dengan menggunakan kaitan DCPR = 0.07(USS) + 6.88. Hasil kajian ini menunjukkan bahawa hubungan ini boleh digunakan untuk tanah yang memiliki kandungan air antara 6% - 30%. Hasil dari kerja lapangan dan pengimejan ERI 2-D sub-permukaan serta terjemah nilai kerintangan kepada nilai USS dan DCPR menunjukkan bahawa kedalaman permukaan gelinciran pada permukaan yang gagal adalah kira-kira 1 m – 1.5 m di bawah permukaan bumi. Sempadan antara tanah yang menggelunsur dan tanah yang utuh adalah pada USS kira-kira 200 kPa dan nilai DCPR 30 J cm^{-2} per 10 cm penusukan. Kajian ini menunjukkan bahawa teknik pengimejan kerintangan elektrik berupaya menilai USS dan DCPR tanah baki serta menentukan kedalaman dan kelangsungan mengufuk permukaan gelinciran yang telah terbentuk pada kos yang rendah dan rantau peninjauan yang lebih luas.

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I certify that an Examination Committee has met on 16th December 2005 to conduct the final examination of Lau Kien Liong on his Master of Science thesis entitled " Application of Electrical Resistivity Imaging Technique in Slope Stability Study of Granitic Residual Soils in the Cameron Highlands, Pahang" in accordance with Universiti Pertanian Malaysia (Higher Degree) Act 1980 and Universiti Pertanian Malaysia (Higher Degree) Regulations 1981. The Committee recommends that the candidate be awarded the relevant degree. Members of the Examination Committee are as follows:

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DECLARATION

I hereby declare that the thesis is based on my original work except for quotations and citations, which have been duly acknowledged. I also declare that it has not been previously or concurrently submitted for any other degree at UPM or other institutions.

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LAU KIEN LIONG

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