

**THE EFFECT OF TREE INDUCED SUCTION ON  
SLOPE STABILITY ANALYSIS**

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### **STUDENT'S DECLARATION**

I hereby declare that the work in this 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 Universiti Malaysia Pahang or any other institutions.



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## ABSTRAK

Pada masa kini, banyak masalah melibatkan kegagalan cerun berlaku kerana pemotongan tumbuh-tumbuhan. Kewujudan pokok di atas cerun sangat penting untuk meningkatkan kestabilan cerun. Kajian ini merangkumi penyiasatan di zon aktif akar pokok (*Alstonia Angustiloba*) yang terletak di atas cerun untuk mengurangkan lembapan di dalam tanah sekaligus meningkatkan kekuatan rincih cerun. Sedutan matrik tanah yang berhasil di kawasan sekitar cerun dipengaruhi oleh pengambilan air pokok adalah fokus utama kajian ini kerana ia boleh mempengaruhi faktor keselamatan cerun. Penyelidikan ini mengambil beberapa pendekatan iaitu pemantauan di lapangan untuk pengumpulan data sedutan tanah dan data hujan, ujikaji-ujikaji makmal untuk klasifikasi tanah dan penentuan parameter kekuatan rincih tanah, penyelidikan bawah tanah menggunakan pengimejan resistiviti elektrik, pemetaan digital menggunakan kenderaan udara tanpa pemandu dan pengesahan corak sedutan tanah sebenar dengan pemodelan berangka. Pemantauan di lapangan yang dijalankan bagi mengumpul data sedutan matrik di cerun dilakukan dalam dua keadaan; tanpa kewujudan pokok dan dengan kewujudan pokok yang terletak di atas cerun. Sifat kekuatan rincih tanah tidak tepu diuji dibawah tahap tekanan yang berbeza dengan menggunakan kaedah CIU bergantung kepada nilai sebenar sedutan matrik yang direkodkan semasa pemantauan di lapangan. Corak profil sedutan matrik mendedahkan bahawa kebanyakannya perubahan sedutan matrik adalah lebih besar berdekatan batang pokok berdekatan (1.1 m) dan pada kedalaman yang cetek (0.25 m). Sebagai tambahan, Pengimejan Resistiviti Elektrik (PRE) telah dilakukan terhadap dua susun atur (melintang dan menegak) di kawasan cerun untuk memperoleh imej bawah tanah cerun. Dua protokol dari PRE telah dipilih iaitu protocol Wenner dan Schlumberger. Imej yang diperoleh dari PRE ini akan dibandingkan dengan kontor sedutan tanah tidak tepu yang dijana oleh perisian GiD. Kajian ini turut menggunakan kaedah moden untuk pemetaan cerun menggunakan kenderaan udara tanpa pemandu (KUTP). Dapatkan ini juga menggunakan faktor keselamatan (FS) pada 18 Februari 2018 dan 22 Februari 2018 ke dalam peta untuk melihat kestabilan harian cerun dan ini merupakan novelty utama kajian ini. Di akhirnya, simulasi berangka dijalankan berdasarkan keputusan makmal untuk mendapatkan nilai yang paling sesuai bagi menunjukkan pengambilan air daripada pokok di cerun tanah pada waktu kering. Faktor keselamatan terhadap kegagalan cerun pada 19 Februari 2018 telah bertambah sehingga 53 % pada cerun dengan pokok di atas cerun berbanding dengan cerun tanpa pokok. Hasil perbandingan antara kontor sedutan dan kontor PRE ini membuktikan kontor sedutan tanah lebih sesuai untuk menerangkan berkenaan kestabilan cerun manakala kontor dari PRE lebih sesuai untuk menentukan kandungan bawah tanah berdasarkan keupayaan bahan untuk menahan atau membenarkan aliran arus elektrik. Kajian ini telah mengesahkan dapatan dari pemantauan PRE dengan ciri tanah di kawasan Kolej Matrikulasi Pahang. PRE membuktikan kewujudan tanah liat di bawah tanah yang bertepatan dengan kandungan tanah liat yang tinggi (22.8 %). Akhirnya, persetujuan telah dicapai antara simulasi pemodelan berangka dan sedutan sebenar yang dikumpul daripada kerja pemantauan lapangan dengan perbezaan kecil sebanyak 5 % sahaja. Kajian ini membuktikan penglibatan pokok tunggal yang ketara di atas cerun dalam menambah kestabilan cerun dengan cara mengurangkan kelembapan semulajadi di dalam tanah itu sendiri.

## ABSTRACT

Nowadays, many problems regarding slope failure happened due to cutting down of vegetation. The existence of tree on top of slope is very important to increase soil slope stability. This study explore the influence of active root tree zone (*Alstonia Angustiloba*) located on top of a slope to reduce soil moisture content thus increase the shear strength of soil slope. Soil matric suction generated at the vicinity of the slope due to tree water uptake is the main focus of this study since it will influence the factor of safety (FOS) of slope. This research employed several approaches i.e field monitoring work for soil suction and rainfall collection, laboratory works for soil classification and determining the shear strength parameters of the soil, subsurface investigation using electrical resistivity imaging (ERI), digital mapping using unmanned aerial vehicle (UAV) and verification of actual soil suction pattern with numerical modelling. Field monitoring works were carried out to obtain soil suction data at the selected slope with two conditions (without and with tree on top of the slope). The unsaturated shear strength behaviour under different stress level was investigated, by conducting consolidated isotropic undrained (CIU) test by replicating the actual matric suction monitored at the study area. From this suction pattern, it was proven that the majority of suction changes were greater at the proximity of the tree trunk (1.1 m) and at a shallow depth of 0.25 m. In addition, Electrical Resistivity Imaging (ERI) was conducted on two layouts (horizontal and vertical) of the slope to obtain the subsurface images of the slope. This ERI survey applies two protocols known as Wenner protocol and Schlumberger protocol. These images from ERI were compared to unsaturated soil suction contour generated using GiD software. This study also implement modern methods for soil slope mapping by using unmanned aerial vehicle (UAV). The findings also applied the safety values (FOS) on 18<sup>th</sup> February 2018 and 22<sup>nd</sup> February 2018 into the map to study the daily stability values of the slope and considered as the main novelty of this study. Finally, numerical simulation modelling was applied based on the laboratory results to obtain most appropriate condition to replicate tree water uptake within soil slope during dry period. The factor of safety (FOS) of soil slope in 19th February 2018 with tree on top of it reached up to 53 % higher compare to slope without tree. From the results of comparison between suction contour and ERI contour, soil suction contour proved to be more suitable in term of stability analysis, while the ERI contour is more suitable to detect underlying materials underneath the soil based on the ability of materials to resist or allow electric current flow. This study verified the finding from ERI survey with the soil properties of Pahang Matriculation College. ERI prove the existence of clay in the soil which verified the high clay contents (22.8 %) in the soil itself. Finally, an acceptable agreement has been achieved between simulation of numerical modelling and actual suction collected from field monitoring work with a small difference of 5 % only. This research proved high influenced of single tree on top of soil slope to increase soil slope stability by decreasing the existence moisture in the soil itself.

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