TWO-DIMENSIONAL ELECTRICAL RESISTIVITY ANALYSIS FOR BOULDERS DETECTION

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A report submitted in partial fulfillment of the
requirements for the award of the degree of
Master of Engineering (Civil – Geotechnic)

Faculty of Civil Engineering
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JANUARY, 2014

To my beloved family, lecturers and friends

ACKNOWLEDGEMENT

First of all, I am so grateful towards ALLAH S.W.T that bestowed me the strength and opportunity to finish my report. In the process of preparing and completing this report, I was in contact either directly or indirectly with many people, academicians and supplier. They have contributed towards my understanding and thought.

In particular, I wish to express my greatest appreciation to my supervisor, Dr. Roslli Noor Mohamed for his encouragement, guidance, critics and motivations. Without his continued support and interest, this report would have been the same as presented here.

At the same moment, I am grateful to all my family members for their support and encouragement. My sincere appreciations also to my beloved wife, Norlizawati Binti Hassan and not forgetting to all technicians, especially Mr. Nawawi, Mr. Azmil and Mr. Zahanuddin for their technical advices and supports. Their kindness, experiences and knowledge are really helps me to solve some problems in my study during the laboratory works.

I also indebted to Faculty of Civil Engineering, University Technology Malaysia for giving me an opportunity to gain the experience, widen my knowledge, and the facilities provided to me had simplified my work throughout the study period.

I hope my findings in the study will expand the knowledge in this field and contribute to all of us in future.

ABSTRACT

Variety of methods has been used to determine the condition of ground profile these days. Conventional Boreholes and JKR probes has been used to predict the ground profile underneath and obtaining geotechnical parameter data for designing purposes. Profiling can be enhanced using two-dimensional Electrical Resistivity to conduct imaginary assessment profiling of specific ground condition. A soil investigation comprises of boreholes, probes and two dimensional resistivity test has been conducted through series of assessment before commencement of project rural road Jalan Masuk ke Kg Org Asli Chennah ke Kg Esok, Jempol, Negeri Sembilan. This project involved massive earthwork and construction of elevated structure through Hutan Simpan Lata Kijang. Prior to the existing site condition consist of boulders and erratic ground profile, the need for effective site investigation is highly considered. Conventional soil investigation method is inadequate to predict ground profile accurately in terms of bedrock profiling compared to two dimensional electrical resistivity methods. Therefore, combination of these methods hopefully can utilize the capabilities of each method in order to produce reasonable cost estimation and optimized design

ABSTRAK

Aktiviti pembinaan semakin pesat berkembang di kebanyakan negara maju dan membangun. Maka, secara tidak langsung penghasilan bahan terbuang daripada aktiviti pembinaan dan kerja perobohan menjadi semakin meruncing. Memandangkan pembuangan bahan tersebut dilakukan secara salah, ramai penyelidik dan jurutera konkrit menyarankan alternatif lain iaitu dengan penggunaan semula bahan terbuang tersebut yang bukan sahaja lebih menguntungkan malah memelihara alam sekitar dan mengelakkan masalah pengurangan agregat semulajadi. Kajian telah dijalankan untuk menentukan kesan penggantian agregat halus semulajadi (pasir) dengan agregat halus konkrit terbuang dalam penghasilan konkrit baru. Kadar penggantian iaitu sebanyak 0%, 25%, 50%, 75%, dan 100% konkrit terbuang terhadap kandunagn pasir di dalam campuran konkrit telah disediakan. Analisis ayak, graviti tentu dan air ujian penyerapan telah diuji untuk memeriksa ciri-ciri agregat halus dikitar semula. Dalam usaha untuk mencapai objektif, ujian bagi sampel konkrit telah dijalankan dalam dua kategori iaitu Ujian Konkrit Segar dan Ujian Ketahanan Konkrit. Untuk Ujian Konkrit Segar, ujian kejatuhan telah dijalankan untuk mengukur tahap kebolehkerjaan konkrit segar. Terdapat beberapa Ujian Ketahanan Konkrit dijalankan seperti kekuatan mampatan, kekuatan lenturan, ketumpatan kiub dan ujian halaju denyutan ultrasonik. Kekuatan mampatan dan lenturan konkrit yang mengandungi agregat konkrit terbuang didapati menurun dengan pertambahan kadar penggantian. Walaubagaimanapun, selepas umur 28 hari, kekuatan mampatan konkrit hampir sama dengan konkrit kawalan dengan perbezaan hanya 2% - 3%. Jelas sekali dapat diperhatikan pada kadar penggantian 25% konkrit terbuang. Sementara itu, kajian mendapati agregat terbuang menyerap lebih banyak air berbanding dengan agregat semulajadi. Oleh itu, dapat disimpulkan penghasilan konkrit berdasarkan agregat halus konkrit terbuang adalah tidak mustahil kerana sifat-sifatnya adalah hampir sama dengan sifat konkrit biasa.

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W_1	-	Steel mould with sample
W_2	-	The empty steel mould
W_a	-	Weight in air
W_w	-	Weight in water
L	-	Path length between the test face
t	-	transit time

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CHAPTER 1

INTRODUCTION

1.1 Introduction

Variety of methods has been used to determine the condition of ground profile these days. Conventional Boreholes and JKR probes used to predict the ground profile underneath and obtaining geotechnical parameter data for designing purposes while combination with two-dimensional resistivity provides extra information about the ground profile. However , in order to have a complete assessment of the soil profile underneath, the conventional borehole need to be aligned and arranged as close as possible from each other. Therefore it is not practical and so uneconomical to provide large amount of boreholes in a certain distance.

Geotechnical investigations are performed by geotechnical engineers or engineering geologists to obtain information on the physical properties of soil and rock around a site to design earthworks and foundations for proposed structures and for repair of distress to earthworks and structures caused by subsurface conditions. This type of investigation is called a site investigation. Additionally, Geotechnical investigations are also used to measure the thermal resistivity of soils or backfill materials required for underground transmission lines, oil and gas pipelines, radioactive waste disposal, and solar thermal storage facilities.

A geotechnical investigation will include surface exploration and subsurface exploration of a site. Sometimes, geophysical methods are used to obtain data about sites. Subsurface exploration usually involves soil sampling and laboratory tests of the soil samples retrieved. Surface exploration can include geologic mapping, geophysical methods, and photogrammetry, or it can be as simple as a geotechnical professional walking around on the site to observe the physical conditions at the site. To obtain information about the soil conditions below the surface, some form of subsurface exploration is required. Methods of observing the soils below the surface, obtaining samples, and determining physical properties of the soils and rocks include test pits, trenching (particularly for locating faults and slide planes), boring, and in situ tests.

Exploration geophysics is the applied branch of geophysics which uses surface methods to measure the physical properties of the subsurface Earth, along with the anomalies in these properties, in order to detect or infer the presence and position of ore minerals, hydrocarbons, geothermal reservoirs, groundwater reservoirs, and other geological structures. Exploration geophysics is the practical application of physical methods (such as seismic, gravitational, magnetic, electrical and electromagnetic) to measure the physical properties of rocks, and in particular, to detect the measurable physical differences between rocks that contain ore deposits or hydrocarbons and those without. Exploration geophysics can be used to directly detect the target style of mineralization, via measuring its physical properties directly. For example one may measure the density contrasts between iron ore and silicate wall rocks, or may measure the electrical conductivity contrast between conductive sulfide minerals and barren silicate minerals.

1.2 Problem Statement

In this study, the main reason of combining conventional boreholes drilling and two-dimensional resistivity is to determine exact ground profile of the site, boulders detection and ground water level detection. There are few problems arising during preliminary stage pertaining to determination of boulders location and quantities, together with type of foundation and cost estimation as well. During the first phase adjacent to the current phase 2 road development, significant amount of boulders has been visually detected during earthwork. This has alerted the Head Of Project Team (JKR) to conduct detail assessment on current ground profile since elevation of the works is more than 100m. Preliminary boreholes result depicting shallow bedrock founded between 12m to 26m from original ground level with traces of highly weathered granite at certain depths between (10m to 15m). This would lead to inaccurate cost estimation and changes in preliminary design and other problems. Therefore, the geotechnical data obtained from the preliminary result is inadequate and extensive ground investigation is needed.

1.3 Objective

To verify exact boulders location and quantity from resistivity image profile with conventional soil profile The objectives of the study can be listed as below :

i) To analyze resistivity value for ground profile imaging from two-dimensional resistivity method
ii) To determine ground profile using SPT-N value from Conventional Borehole result
iii) To verify exact boulders location and quantity from resistivity image profile with conventional soil profile

1.4 Scope of Study

The scope of the study consists of soil exploration using conventional method together with 2 Dimensional Resistivity method at road development near Jelebu, Negeri Sembilan. The length of proposed road is about 5.1km consist of standard R4 JKR guideline with lane width of 3.0m. The study is focused on analysing the profile of the soil underneath and adjacent slope with the main purpose of detecting any presence of boulders and shallow bedrock. Other type of data that can also be obtained are groundwater level, perch water table, type of soil and others. The output of this study is to have ground imaging profile from resistivity method and verified by conventional method from borehole drilling.

REFERENCES

Asian Institute of Technology, School of Environment, Resources and Development, Thailand, 2008. *Report on Reduce, Reuse and Recycled (3R) Practices in Construction and Demolition Waste Management in Asia*. Retrieved date: January 15, 2009.
Website: http://www.3rkh.net/3rkh/files/3RKH_C&D_waste_FinalReport.pdf

Barai S.V., Rakshvir M., 2006. *Studies on recycled aggregates-based concrete.* Published by: SAGE. On behalf of: International Solid Waste Association

Begum, R., Siwar C., Pereira J., and Jaafar A. H., 2006. *A benefit–cost analysis on the economic feasibility of construction waste minimisation:* The case of Malaysia. Resources, Conservation and Recycling, Elsevier Science Ltd. Volume 48, Issue 1, pp. 86-98.

Chandra S., 2004. *Implications of using recycled construction and demolition waste as aggregate in concrete*, Session lead paper, International Conference on Sustainable Waste Management and Recycling, Kingston University, London.

Chandra S., 2005. *Cement Concrete Compos 2005*. Conference Report. 27(6): pp 738–741.

Chen, H.J., Yen, T. and Chen, K.H., 2002. *Use of building rubbles as recycled aggregates*. Cement and Concrete Research, 33(1), pp 1–8.

Environmental Council of Concrete Organizations, 1999. Illinois. Review: February 3, 2009. Website: http://www.ecco.org/pdfs/Ev22.pdf

Gilpin Robinson Jr R, Menzie D.W., Hyun H. 2004. *Recycling of construction debris as aggregate in the Mid-Atlantic Region, USA*. Resources Conservation and Recycling 42(3): pp 275–294.

Katz A., 2003. *Properties of concrete made with recycled aggregate from partially hydrated old concrete*. Cement and Concrete Research 33:703–711.

Khalaf F.M. and DeVenny A.S., 2004. *Recycling of demolished masonry rubble as coarse aggregate in Concrete*: review. ASCE J Mater Civil Eng pp.331–430.

Khalaf F.M. and DeVenny A.S., 2005. *Properties of New Recycled Clay Brick Aggregate*. ASCE.

Kofoworola O.F., and Gheewala S.H. Estimation *of Construction Waste Generation and Management in Thailand*. Science Direct.

Nagataki, S., Gokce, A. & Saeki, T., 2000. *Effects of Recycled Aggregate Characteristics on Performance Parameters of Recycled Aggregate*, Canmet/ACI Conference, American Concrete Institute Publication, USA

Nagataki S, Gokce A, Saeki T, Hisada M., 2004. *Assessment of recycling process induced damage sensitivity of recycled concrete aggregates.* Cement Concrete Research 34:965–971.

Poon C.S., Shui Z.H., Lam L, Fok H, Kou S.C., 2004. *Influence of moisture states of natural and recycled aggregates on the slump and compressive strength of concrete.* Cement Concrete Research 34:31–36.

Rakshvir, M., 2003. *Studies on Recycled Aggregates. India*.

Rao A., 2005. *Experimental Investigation on Use of Recycled Aggregates in Mortar and Concrete.*.

Rao A., Jha K.N., and Misra S., 2006. *Use of Aggregates from Recycled Construction and Demolition Waste in Concrete. Resources, Conservation, and Recycling. Science Direct*.

Swamy R.N., 1983. *Concrete Technology and Design Volume 1*: New Concrete Materials. University of Sheffield.

Topcu B.I, Guncan F.N., 1995. *Using waste concrete as aggregate*. Cement Concrete Research 1995;25(7):1385–1390.

Topcu, I.B., 1997. *Physical and mechanical properties of concrete produced with waste concrete.* Cement and Concrete Research, **27**(12), 1817–1823