SUBSURFACE EVALUATION USING GEOPHYSICAL METHOD IN GRANITE FORMATION

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DEDICATION

To my beloved mother and family

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ABSTRACT

More accurate underground information is needed in determining the layers of rock and soil for excavation work. This study was conducted to evaluate the use of seismic refraction method and 2-D electrical resistivity in determining the sub-surface layer of rock and soil. The information from the borehole is also used as a comparison of the accuracy of the information. However, borehole data is only in the drilled location which causes the information obtained is not comprehensive. Incomplete information will result in delays in project implementation when the bedrock layer is found while work on the site is in progress. The need for more accurate sub-surface information can also assist geotechnical engineers in determining surface excavation work, especially in granite formation areas. The study was conducted on three (3) resistivity lines and seven (7) seismic lines at the proposed site of the construction of the Research Complex in Universiti Pertahanan Nasional Malaysia, Sungai Besi. Resistivity data were analyzed using Res2Dinv software and seismic refraction using ReflexW software. The results clearly show through 2-D resistivity of the presence of granite layer at shallow depth with a resistance value of less than 1000 ohm-m and the ripping method for excavation work is appropriate. Through the seismic method shows the thickness of the rippable layer is in the range of less than 15m. Seismic data show a good correlation with borehole data. While the correlation of the resistivity data with the borehole data, there is a slight difference that may be due to the position of the borehole which is not aligned with the seismic line. The conclusion of this study shows that the 2-D resistivity method and seismic refraction is able to provide more accurate sub-surface information especially for the bedrock profile in determining the surface excavation method in addition to the borehole.

ABSTRAK

Maklumat permukaan bawah tanah yang lebih tepat diperlukan dalam menentukan lapisan batu dan tanah untuk kerja-kerja penggalian. Kajian ini dilakukan bagi menilai penggunaan kaedah pembiasan seismik dan keberintangan elektrik 2-D dalam menentukan lapisan subpermukaan batu dan tanah. Maklumat dari lubang jara juga digunakan sebagai perbandingan ketepatan maklumat. Namun maklumat lubang jara hanyalah di lokasi yang digerudi sahaja yang menyebabkan maklumat yang diperolehi tidak menyeluruh. Hasil maklumat yang tidak menyeluruh akan menyebabkan kelewatan kepada pelaksanaan projek bila batu dasar ditemui sewaktu kerja di tapak sedang berjalan. Keperluan kepada maklumat subpermukaan yang lebih tepat juga dapat membantu jurutera geoteknikal dalam menentukan kerja-kerja pengorekan permukaan terutama di kawasan formasi granit. Kajian dibuat ke atas tiga (3) garisan keberintangan dan tujuh (7) garisan seismik di tapak cadangan Pembinaan Kompleks Penyelidikan di dalam Universiti Pertahanan Nasional Malaysia, Sungai Besi. Data keberintangan dianalisa menggunakan perisian Res2Dinv dan pembiasan seismik menggunakan perisian ReflexW. Hasil kajian menunjukkan dengan jelas melalui 2-D keberintangan kehadiran lapisan granit pada kedalaman cetek dengan nilai keberintangan kurang dari 1000 ohm-m dan penggunaan kaedah merobek bagi kerja pengorekan batu adalah sesuai. Melalui kaedah seismik menunjukkan ketebalan lapisan boleh robek adalah dalam julat kurang dari 15m. Data seismik menunjukkan korelasi yang baik dengan data lubang jara. Manakala korelasi data keberintangan dengan lubang jara terdapat sedikit perbezaan yang mungkin disebabkan oleh kedudukan lubang jara yang bukan sejajar dengan garisan seismik. Kesimpulan kajian ini menunjukkan kaedah 2-D keberintangan elektrik dan pembiasan seismik berupaya memberikan maklumat subpermukaan lebih tepat terutama untuk profil batuan dasar dalam menentukan kaedah pengorekan permukaan disamping lubang jara.

TABLE OF CONTENTS

LIST OF TABLES

LIST OF FIGURES

LIST OF ABBREVIATIONS

BH	-	Borehole
1-D	-	One-Dimensional
2-D	-	Two-Dimensional
UPNM	-	Universiti Pertahanan Nasional Malaysia
P-wave	-	Compressional wave
km/sec	-	Kilometre per second
RQD	-	Rock Quality Designation
GPS	-	Global Positioning System
RS	-	Resistivity survey
m/s	-	Metre per second
m	-	Metre
R	-	Resistivity
C	-	Current
P	-	Potential electrode
G	-	Geophone
SP	-	Shot Point
ITM	-	Intercept – Time Method
GRM	-	Generalised reciprocal method
SRT	-	Seismic refraction tomography
V	-	Voltage
I	-	current

LIST OF SYMBOLS

Ωm	-	Ohm meter
<	-	Less than
>	-	More than

LIST OF APPENDICES

CHAPTER 1

INTRODUCTION

1.1 Introduction

The subsurface characteristic determine from borehole data alone is not adequate since the boreholes are located at varies location and distance from one to another. Geophysical method such as 2-D electrical resistivity method and seismic refraction method were used to provide continuous subsurface information along lines of investigation of the study area.

However, where the construction development is on weathered sedimentary rock area, an accurate bedrock profile plays a very significant role in the excavation assessment. Surface excavation works in tropically weathered sedimentary rock mass have been reported to be difficult and also cause conflicts between engineers and engineering clients. These uncertainties include selection of the excavation method, the types of machineries and rate of excavatability. These decisions are very important as they influence and evaluate the expense and time needed to complete the whole project. Miscalculated costs or decisions taken during the preliminary design may lead to unnecessary expenses and project delays. (Liang, Mohamad, Komoo and Chau-Khun, 2015).

Fundamentally, there are many considerations to be included in determining on the most effective form of excavation to be used, including the type of project, the type and characteristics of the rock mass properties of the intact rock material and the desired stability of the exposed rock surface upon completion (Edy Tonnizam, M. et al., 2005). The planning of an excavation project relies greatly on the knowledge of geological and geotechnical conditions of the site. An appropriate investigation able to provide a picture and assessment as realistic as possible of conditions to be

encountered. Therefore, the correlation data of borehole and geophysical survey will make the subsurface information more effective.

1.2 Background of Study

The study was carried out at proposed new building for research complex inside Universiti Pertahanan Nasional Malaysia, Sungai Besi, Kuala Lumpur. 2-D electrical resistivity and seismic refraction method were carried out to identify the subsurface profile and estimate the depth of the granite body at the study area. There are four (4) boreholes had been carried out earlier as shown in Figure 1.1 to determine the soil properties. Three (3) resistivity survey lines and another seven (7) seismic lines were within the study area (Figure 1.2). However, for the purpose of this study only borehole 3 (BH3) and borehole 4 (BH4) data used which is closed to the survey line and located inside the new building layout.

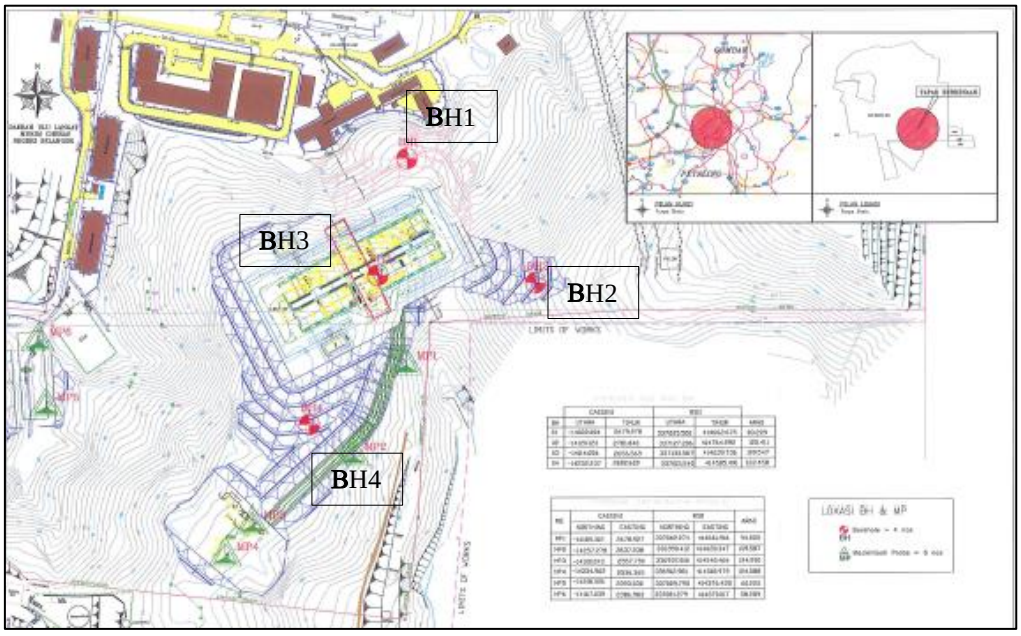

Figure 1.1 Layout plan for borehole location

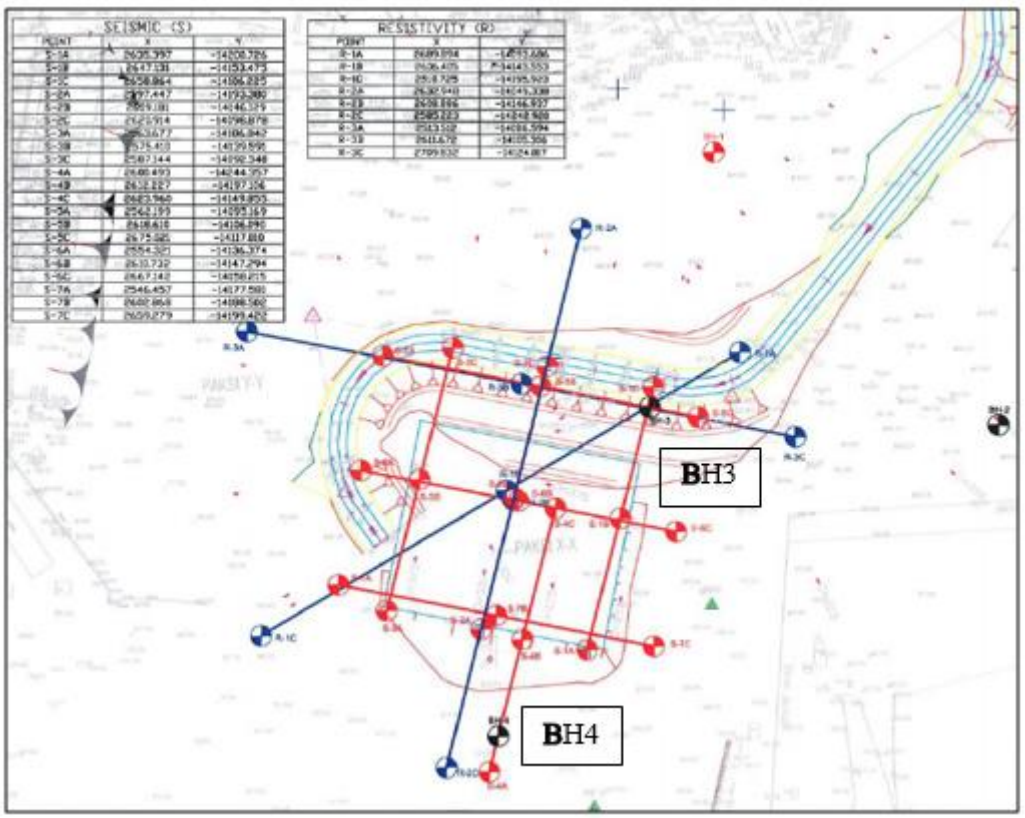

Figure 1.2 Layout for 3 resistivity and 7 seismic refraction survey lines

1.3 Problem Statement

Surface excavation is one of the most common problems that can cause conflict between contractors and customers in construction work if they do not agree on the price of rock and soil excavation. This is because the terms "rock" and "soil" are not clearly defined in the contract agreement (Mohamad, E.T. et al, 2015). The term “hard material” that is normally used in contract documents is very confusing as its cover a wide spectrum of materials ranging from dense soil to fresh rock. Similarly, the word "weathered rock" and its method of excavation have been subjectively and differently described. Further complication may arise in sedimentary rock masses where different layers of rock are interbedding, thus might be misjudged during the early excavation assessment. The weathering profile is highly depends on the nature of the rocks. Most of the existing rippability measurement techniques are less reliable because they do not take into account the weathering condition of different rock mass layers. For the economic assessment of the site during the preliminary stage, a more appropriate and

practical rippability assessment method is required (Mohamad, E.T. et al, 2015). Normally, the blasting approach will only be deemed necessary if the physical limit of ripping is reached or the cost of ripping is uneconomic.

Reliable subsurface information is vital for many civil engineering purposes. Among most conventional ways to investigate the subsurface parameter is mainly determined from boreholes data. However, the information retrieved from bore log only provides information at a discrete location. Often information from several boreholes will be linked as a cross section to illustrate subsurface profile of a wider area. However, information obtained from borehole data is limited by the bore holes which are in different locations and distances.

Instead, geophysical methods such as 2-D resistivity and seismic refraction method have been introduced to improve the soil subsurface information because it provides continuous information along lines of investigation. The traditional geotechnical approach for the use of boreholes has been combined with the seismic velocity system to provide an appropriate correlation. Correlated data can be used to categorise excavation machineries on the basis of the available systematic research technique to estimate rock rippability. The collected seismic velocity profile will be used to view the rock layer inside ranges classified as rippable.

1.4 Objective of Study

The aim of this study is to evaluate the accuracy of the result between 2-D electrical resistivity and seismic refraction method for subsurface evaluation of the study area which is represented by the following objectives;

(a) To identify the subsurface profile through 2-D electrical resistivity and seismic refraction method and compared to borehole data for estimating the depth of granite body.

(b) To produce profile imaging for better bedrock profile and thickness in determining of surface excavation method.

1.5 Scope of Study

The study was carried out within the following scope and limitation:

(a) The study focused on the data collected from a proposed construction site for the development of Research Complex at Universiti Pertahanan Nasional Malaysia, Sungai Besi, Kuala Lumpur.

(b) The borehole log data used in this study was from the previous soil investigation and only focused on borehole no 3 (BH3) and no 4. (BH4).

(c) The assessment of the survey using geophysical survey consists of three (3) resistivity survey lines and seven (7) seismic lines within the study area.

1.6 Significance of Study

This study will be significant in encouraging to have a more reliable subsurface information in determining surface excavation method. The use of 2-D electrical resistivity and seismic refraction method as an enhancement to borehole data will provide more accurate subsurface characteristics exploration in a wider area of the site. By adopting more reliable prediction, the total cost of projects can be minimised due to more efficient and economical excavation method. This study will also be beneficial to the client and contractor of the project related to construction cost which geotechnical engineer can select an appropriate method and machinery for excavation works.

1.7 Structure of Report

The structure of this report consists of five (5) chapter which every chapter will explained and discussed about the research in detail. The summary of each chapter are as follows;

1.7.1 Chapter One

The outline of the research is explained in this chapter. This chapter explained about the research background as a guidance for reader to know about the research that have been done. The chapter also explained the selection of the research area, the aim from the research and the significance of the research to the department.

1.7.2 Chapter Two

In this chapter two, it is consisting of the literature review and factual information related to subsurface evaluation that support this research. This chapter outlines information on the boreholes data, geophysical survey and excavation.

1.7.3 Chapter Three

Chapter three discussed on how to achieve and obtained the objectives of this study. This also include the method used in data collection and the data correlation. The methodology flowchart used to guide the study and initiates the flow of process to completion.

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