CHARACTERIZATION OF GRANITIC SUBSURFACE PROFILE BY BOREHOLE LOGGING AND SEISMIC REFRACTION METHOD

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DEDICATION

This project report is dedicated to my late mother, Dr. Norzarina binti Idris, who taught me for always give our best in whatever we are working on in the time she was around, my father, Dr. Ahmadol bin Mohd Yusof, who gives the best opinion especially on life lessons, and to all my younger sisters, who continuously morally support me during good and tough times and for theirs prayers.

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ABSTRACT

Due to tropical climate in nature of Malaysia, related region experience extreme weathering process that lead to unique subsurface profile. As weathering process proceed from the surface down and inwards, from joint surfaces and other percolation paths, the intensity of the weathering generally reduces as depth increases. The seismic refraction method had been used to determine the rock characteristic of the study area. This study aim to characterize the granitic area by seismic refraction method and boreholes information at Sungai Long Quarry, Cheras. This study involve 6 lines of seismic refraction and 6 boreholes that were drilled on the same paths. The study was conducted by using the ABEM MK-8 (seismograph), a 6.5kg sledgehammer with a steel plate and 24 channels geophones. EasyRefract software been used to process the seismic refraction survey data, which based on primary waves velocities distributed from seismograph. Results obtained from the conventional borehole logging, which are the N-value Standard Penetration Test, Core Recovery Ratio and Rock Quality Designation, were evaluated and correlated with primary wave velocity for subsurface interpretation. Results were found that the correlation between Core Rock Recovery give better correlation with seismic velocity value as compared to Rock Quality Designation. Correlation of both ground investigation exhibit an indicator for producing N-values prediction especially in a tropical granitic setting environment. N-values 50 of each boreholes recorded between 1140m/s to 1513m/s whereas N-values below 50 were recorded less than 800m/s. In addition, the highly weathered zone interpreted in the survey lines could be related to the medium dense to dense material that exist on top of boulder. On the other hand, N-value shows fair correlation to seismic velocity which exhibit value less than 1500m/s. Generally, both RQD of 0% to 97% and CRR of 33% to 100% values shows seismic velocity values, which ranges from 750 m/s to 2100m/s. The wide range of value is due to thick soil profile before reaching the bedrock. Hence, some masking affect contributed to the variation of depth.

ABSTRAK

Iklim tropika lembap menyebabkan profil subpermukaan yang unik akibat daripada proses luluhawa ekstrim. Kajian ini bertujuan membuat perbandingan antara kaedah pembiasan seismik dan informasi lubang bor di sebuah kawasan granit iaitu Kuari Sungai Long, Cheras. Kajian melibatkan 6 garis survei seismik dan 6 lubang bor yang digerudi di garisan sama. Kajian ini dijalankan dengan menggunakan seismograf model ABEM MK-8, 6.5kg penukul dan plat besi berserta 24 saluran geofon. Perisian EasyRefract telah digunakan bagi memproses data survei pembiasan seismik, di mana halaju gelombang P yang dihasilkan melalui seismograf digunakan sebagai rujukan utama. Hasil daripada keadah konvensional penggerudian lubang bor, di mana parameter yang digunakan adalah nilai-N, nisbah pemulihan teras (CRR) dan penunjukan kualiti batuan (RQD) bagi sampel batuan, telah dinilai dan dikorelasi dengan halaju gelombang P bagi memberikan gambaran lebih jelas akan tafsiran ciri-ciri batuan granitik. Hasil kajian menunjukkan korelasi antara bacaan nisbah pemulihan teras (CRR) bagi sampel batuan dengan bacaan halaju geolombang P seismik memberi korelasi yang lebih baik berbanding bacaan penunjukan kualiti batuan (RQD). Hasil daripada dua kaedah yang berbeza ini memberi ramalan kaitan antara nilai-N bagi kawasan granit luluhawa tropika. Nilai-N 50 di merekodkan nilai halaju gelombang P antara 1140m/s hingga 1513m/s manakala nilai-N kurang dari 50 merekodkan bacaan halaju gelombang P kurang dari 800m/s. Selain daripada itu, interpretasi zon luluhawa tinggi daripada hasil seismik dapat dikaitkan dengan kewujudan lapisan sederhana padat ke padat yang teletak di atas batu bundar. Korelasi antara nilai-N dan halaju gelombang P menunjukkan korelasi sederhana, di mana nilai yang direkodkan adalah kurang daripada 1500m/s. Umumnya, kedua-dua bacaan parameter penunjukan kualiti batuan (RQD) antara 0% hingga 97% dan nisbah pemulihan teras (CRR) antara 33% hingga 100% menujukkan nilai halaju gelombang P dalam lingkungan 750m/s ke 2100m/s. Julat bacaan nilai yang tinggi adalah disebabkan oleh lapisan tanah yang tebal yang terletak di bahagian atas subpermukaan tanah. Kesan penyamaran halaju yang berbeza boleh menyebabkan kekeliruan kedalaman bahan yang berbeza.

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LIST OF ABBREVIATIONS

SPT	-	Standard Penetration Test
CRR	-	Core Recovery Ratio
RQD	-	Rock Quality Designation
P-waves	-	Primary Waves
ρ	-	Density of the medium
σ	-	Poisson's ratio
N	-	Shear modulus
E	-	Relation of Young's modulus
i	-	Angle of incidence
r	-	Angle of radius

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CHAPTER 1

INTRODUCTION

1.1 Overview

Subsurface investigation performs as an assessment of obtaining substantial properties of ground. This assessment are aimed to establish that the ground underneath the study area are safe and solid for construction and development planning. Subsurface investigation involve in several ground assessment techniques and illustrate the fundamental of early stage of construction. Results from these several method could give huge impact in the development of the project.

General geology studies include some basic aspects such as rock lithology, structure geology, tectonic of study area and geomorphology studies of the research area. Seismic refraction method has been accounted for bedrock level determination whereas borehole logging comprises the stratigraphy studies of interest area, which will then these both outcomes will be correlated in a single conclusion. Benson and Yuhr (2002) believed that borehole densities are inadequate to identify the geological anomalies. The improvement that were made throughout the years in the geotechnical industry are to adopt the geophysical method as they are way more cost and time effective than drilling boreholes. Geophysical delineate subsoil features and its geological characteristic as well as acting as a preliminary tool for site investigation to reveal areas that should be investigate more with additional borehole drillings.

The seismic refraction method require extra attention to prevent possible risks with regards to data acquisition, analyzing, and interpretation (Steeples and Miller, 1998). Understanding the resolution limits of the techniques and planning seismic surveys around geologic objectives and resolution limits is in part of the key to achieve success and avoiding risk. Ensuring that the methods are cost effective relatively to borehole drilling and other geophysical methods also requires deliberate planning. Selecting appropriate seismic recording equipment, energy sources and data collecting parameters is often important to the selection of processing and interpretation procedures.

1.2 Background Problem

The main uncertainties related to the subsurface investigation are due to lack of knowledge and limitation of the investigations. There are sampling errors, field observation errors, laboratory measurement errors and errors due to temporal limitations. On the other hand, the uncertainties are due to lots of human error involvement. Scientific judgments play a vital role in further adverse component.

Goldsworthy *et al.* (2004) highlighted that failures in foundation are highly depending on quantity and quality of information from geotechnical investigation. Moh (2004) opined that lack of guidance and code of practice towards the site investigation quality would certainly lead to geotechnical failures. It further extends would potentially cause destructive and resulted serious situation to public safety.

Steeples (2000) implied that seismic methods date back to early time of the 20th century and has been use globally in the petroleum business for more than 70 years. The development of technology in both the acquisition and processing has led to substantial progress in the use of shallow seismic measurements since 1980 (Steeples, 2000; Steeples and Miller, 1990). The use of shallow seismic refraction measurements is excellent, particularly for determining the depth or course of geological interfaces for geotechnical investigation (McClymont *et al.*, 2016). However, more researches has to be conducted to establish the effectiveness of seismic refraction technique especially in the tropical granitic area.

The study area is considered as an active quarry developed by a local quarry contractor. The quarry activity involve blasting works to produce aggregates with various sizes. Granite aggregates has been one of the main source in producing great strength of concrete in worldwide. However, there are plans on developing the study area for a mixed-use development project involve in building residential and commercial facilities to the public.

As stated by Lancellota (2009), the importance of field investigation is often underestimate because it may require costly program and surprisingly we generally rely on limited information. He added that it is unsafe and unsatisfactory approach by considering that most failures have been caused by lack of field information and undetected essential features especially the geological information of the field. Hytiris *et al.* (2014) suggested that factors related to ground condition often rise in contractual issues with cost and time concerned on most construction projectss where failure exhibit.

1.3 Objective

This study aims to evaluate the subsurface profile in granitic area through seismic refraction survey and geotechnical techniques in Sungai Long Quarry, Cheras, Selangor. Analysis and interpretation on the study methods outlined were conducted over collection of information for the author to achieve the following objectives study as a track for this project report. The objectives are:

(a) To evaluate the seismic velocity of the subsurface profile at the study site.

(b) To determine the Standard Penetration Test (SPT), Core Recovery Ratio (CRR) and Rock Quality Designation (RQD) from the drilled boreholes.

(c) To evaluate the correlation between geotechnical and seismic velocity parameter of subsurface material.

1.4 Scope

The study focuses on the conventional borehole logging and geophysical method which are two of the important method in ground assessment. Surface seismic refraction has been widely used as supplementary to borehole data. As drilling boreholes provide information only at discrete location and known for its expensive cost, geophysical surveys aid as bridging gaps as well as cost and time effective on deriving distributed subsurface geology information. The seismic refraction survey is a non-destructive test used to evaluate thickness of subsurface layer and measuring the shear wave velocity of the soil and rock strata. Results from the two ground assessment methods were then been correlated to obtain the subsurface profile of the study area.

1.5 Study Location

From the geographical location, the proposed site located at Sungai Long, Mukim of Ulu Langat and approximately of North-East 5km form Cheras, Selangor district (Figure 1). The coordinate of study area is 3.083753 latitude and 101.809574 longitude. Currently, the nearest access to the site location is through the main road via Jalan Kuari Sungai Long. Road access leading to the site considered as accessible by tarred road, however, in-site roads are largely comprise of off-roads and gravel roads. The study area comprises an area of 1.33km^2 and perimeter square of 6.07km.

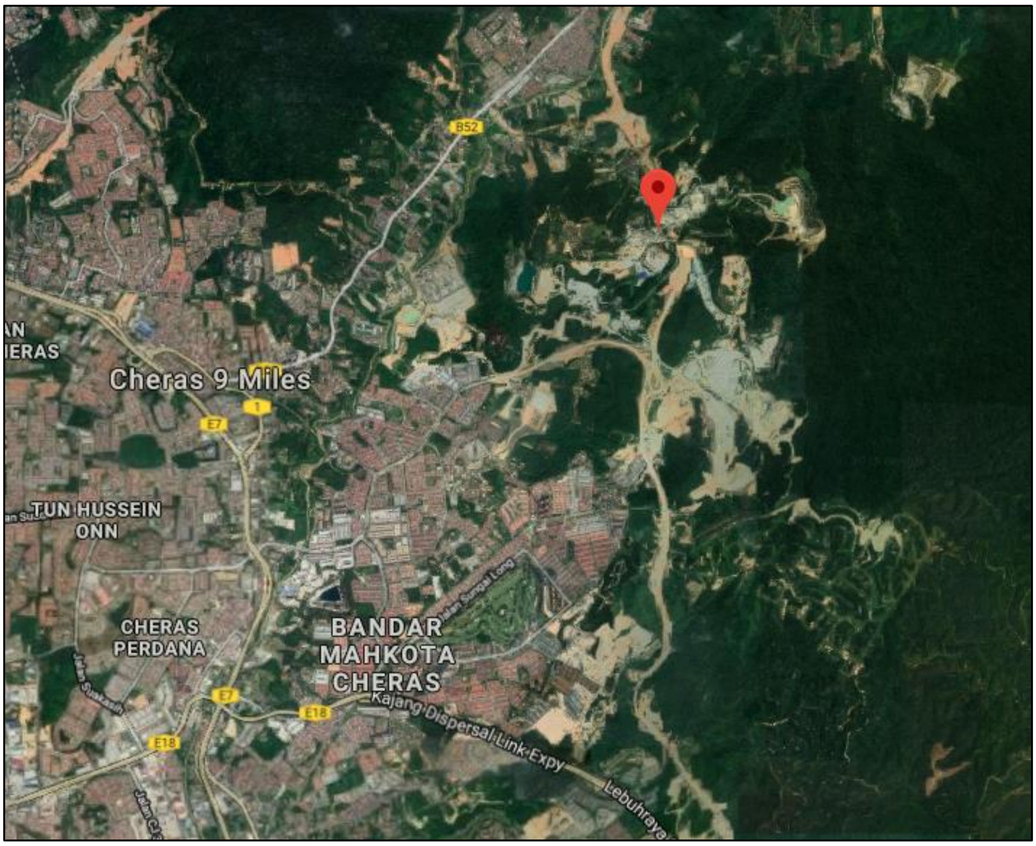

Figure 1. 1 Location of study area in Sungai Long, Cheras, Selangor (Source from Google Earth, 2019).

1.6 Importance of Study

Site investigations are an important process when preparing for construction project plans. The outcomes would certainly help determining the risks and uncertainties of ground behavior. Thus, these help to avoid uncertainties and ground engineering solution can be developed and delivered comprehensively, innovatively with high integration. The information is crucial in sustaining the mineral resources, safe development and urbanizing the structures, preventing losses from geological uncertainties and natural risk and natural resources usage for recreation and tourism (National Research Council, 2001).

Historically, the role of geological surveys was discovery, the mapping of geology maintaining databases related to geological information. The surveys were used to understand the processes at the interfaces between the lithosphere, the hydrosphere, the biosphere and the atmosphere. As highlighted by Coetzee (2012) in CGS Centennial Celebration and Conference, researches and the implementation of solutions are important aspects of a geological survey and the geo-scientific responses it generated. They involve in identifying a problem, describing and solving a problem. Research and understanding are not enough but the aim of studies and research should be to solve problems.

Through subsurface investigation like borehole drilling would certainly help in determining the physical properties of the soil and rock. Rock sample is needed to evaluate the rock type of the study area. In addition to that, geophysical method aiding the subsurface uncertainties between boreholes for a wider portrait of the geological features underneath the study area. Considering that the study area are part of development plan to be encountered in near future, subsurface assessment is vital to be undertaken at this early stage of development.

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