

PETROLOGICAL AND STRENGTH PROPERTIES OF GRANITE IN JOHOR

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To awesome **Father in Heaven**

To my beloved father and mother
WONG NGIE SING & YU SIONG ONG

To my dearest siblings

Tony Wong Ming Wei

Cindy Wong Ming Hie

Raymond Wong Ming Siang

Thanks for the endless love and patience

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ABSTRACT

The study described in this paper is performed on igneous rock at Bukit Waha, Kota Tinggi, Johor. The texture and mineralogy of the granite and the physical properties of aggregates in terms of strength are assessed. This study aim to investigate and evaluate the influence of petrological of the rock encountered at an existing quarry hill in Bukit Waha to the strength properties of the rock. Petrography was quantified from thin sections with a polarizing microscope to determine the rock texture and grain size distribution. Laboratory works such as Point Load Test, Brazillian Test, and Uniaxial Compressive Strength (UCS) Test were performed in accordance to the International Society for Rock Mechanics (ISRM) to obtain the relevant parameters. Through this study, there will be an understanding on the effect of petrological of the rock material to the strength properties and the correlation between the strength parameters of granite. Results show that there is significant factor between tensile strength and UCS in a ratio of 1 to 10. Meanwhile, for point load index, $I_{S(50)}$ and UCS correlated, the correction factor is 15, within the range of correction factor determined by other researchers.

ABSTRAK

Dalam kertas kerja ini, kajian telah dijalankan ke atas batuan igneus di Bukit Waha, Kota Tinggi, Johor. Tekstur dan mineralogi granit dan sifat fizikal agregat dari segi kekuatan dinilai. Matlamat untuk kajian ini adalah untuk menyiasat dan menilai perpengaruh petrologi batu yang berada di kuari yang sedia ada di Bukit Waha kepada sifat kekuatan batu itu. Petrografi batuan dilakukan melalui keratan nipis dengan mikroskop polarisasi untuk menentukan tekstur batu dan taburan saiz butiran. Kerja makmal seperti Ujian Beban Titik, Ujian Brazillian, dan Ujian Kekuatan Mampatan Sepaksi telah dilakukan berdasarkan International Society for Rock Mechanics (ISRM) untuk memperolehi parameter yang berkaitan. Melalui kajian ini, kefahaman mengenai pengaruh petrografi batu ke atas sifat kekuatan dan korelasi di antara parameter kekuatan granit dapat diteliti. Hasil kajian menunjukkan bahawa terdapat factor yang signifikan antara kekuatan tegangan dan kekuatan mampatan sepaksi dalam nisbah satu kepada sepuluh. Sementara itu, faktor pembetulan 15 telah dijumpai dalam korelasi antara nilai beban titik dan kekuatan mampatan sepaksi, dalam lingkungan faktor pembetulan yang ditentukan oleh penyelidik-penyelidik lain.

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LIST OF SYMBOLS

UCS	-	Uniaxial compressive strength
I_S	-	Point load strength index
$I_{S(50)}$	-	Point load strength index at 50 mm in diameter
LA	-	Los Angeles abrasion loss
SiO_2	-	Silicon dioxide
P	-	Peak Load
D	-	Core diameter
De	-	Equivalent core diameter
W	-	Width of specimen
F, K	-	Size correction factor
T^*_0	-	Tensile strength
$CI_{95\%}$	-	Confidence Interval at 95%
R^2	-	Linear Regression value
A_0	-	Initial cross-sectional area

CHAPTER 1

INTRODUCTION

1.1 Background

Petrology is the study of rocks of their occurrence, composition, and origin. Petrography is concerned primarily with the detailed description and classification of rocks. A petrological description includes definition of the unit in which the rock occurs, its attitude and structure, its mineralogy and chemical composition, and conclusion regarding its origin. Smart *et al.* (1982) had found a close correlation between uniaxial strength and quartz content. They found that the increase of quartz in rock material would increase the strength. Grain size and mineralogical measurement using thin section will be performed traditionally with a polarizing microscope. The petrographical properties, compared with the strength properties of rocks can assist in aggregates quality estimation and exploration for aggregates.

Rock characteristics especially the strength has been widely used as a basic for classification of rock material for engineering purpose. The strength parameter of rock material is a useful source of information to predict the performance during pre and post construction of the rock engineering. Other properties such as porosity, density, mineralogy, moisture content, and degree of cementation are related to the rock strength. The different rock forming processes in igneous, sedimentary and metamorphic rocks had resulted different of strength, both in rock mass and material properties.

Strength of rock can be divided into two general types which are tensile strength and compressive strength. Compressive strength is the capacity of a material to withstand axially directed compressive force (Jaeger, 1979). The most common measure of compressive strength is the uniaxial compressive strength (UCS) or unconfined compressive strength. Meanwhile, the tensile strength of rock material is normally defined by the ultimate strength in tension, in which the maximum tensile stress the rock material can bear (Jaeger, 1979). Rock material generally has a low tensile strength. The low tensile strength is due to the existence of microcracks in the rock. There is variation of UCS, point load strength index and tensile strength for different rock types. The UCS, tensile strength and point load index for granite range from 100 to 300 MPa, 7 to 25 MPa, and 5 to 15 MPa respectively.

The point load test is intended as an index test for the strength classification of rock materials with which is correlated (Zacoeb and Ishibashi, 2009). In order to estimate UCS indirectly, index-to-strength conversion factors are constructed (ISRM, 1985). Although ISRM suggested that the ratio between uniaxial compressive strength (UCS) and point load strength (I_s) varies between 20 and 25, many researchers have found different ratios. The derived ratios between UCS and I_s by different researchers exhibit a very large range; the ratio for the equations using the zero-intercept varies between 8.6 and 29 (Kahraman et al., 2012). As for the tensile strength, ISRM (1985) suggested ratio 1 to 10 for the correlation of tensile strength to compressive strength, agreed by most researchers.

1.2 Problem Statement

Quarries in Johor mainly consist of igneous rock but they may formed by chemically acidic or alkaline magma. Some of the igneous rocks are fine or coarse in grains. The problematic factors concerning aggregates mainly are too high content of fines, low rock strength and low durability. Thus, it is utmost important to assess the suitability of the rock to be quarried through the understanding of the petrology. The petrology of rock will definitely influence the strength properties of rock. In this

study, the role play by aggregates with respect to the petrology of rock can reveal the suitability of the rock in term of strength as aggregates for construction purposes.

1.3 Objectives

The aim of this study is to investigate the strength properties of the granite. In order to achieve the stated aim, the following objectives are outlined for this project:

- 1) To examine the petrology of the rock found at Bukit Waha, Kota Tinggi.
- 2) To investigate the strength properties of granite and correlation between them.

1.4 Scope Of Study

The research study is going to be carried out within the following scope:

- 1) This study is conducted on an existing quarry site which is located at PTD 819 and PTD 820, Bukit Waha, Kota Tinggi, Johor.
- 2) The study is carried out based on physical observation, petrography examination, and also the physical properties tests including Point Load Test, Brazillian Test, and Uniaxial Compressive Strength Test.

1.5 Significance Of Study

This project provides more understanding in the suitability of the quarry as the qualified aggregates. The applied petrographic and physical methods of

aggregate testing make possible to determine whether the aggregate is strong. Correlation between point load strength index, Brazillian tensile strength and uniaxial compressive strength is important for ease of evaluating rock properties particularly during preliminary design stage. Evaluation on the relationship between the petrology of the rock and strength properties involved is essential for the estimation of aggregate performance thus assist in the selection of aggregates used.

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