EFFECTS OF QUARRY BLASTING TOWARDS THE RESIDENTIAL AREA AT KANGKAR PULAI

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This project report is dedicated to,

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Dr. Rini Asnida bt. Abdullah;

My beloved parents,
Rama and Malar;

My dear UMS lecturers,
Mr. Mohd. Ali Yusof bin Mohd. Husin
Madam Hennie Fitria W. Soehady E.;

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ABSTRACT

The drill and blast technique have been widely used recently due to demand for natural building materials such as rock aggregates namely granites. However, the intensity of blasting effects has been questioned on its validity towards the nearby affected residential areas. An attempt incorporating empirical methods established by previous researches to quantitatively asses these effects have delivered such a promising solution to this problem. By using these methods, the safety of the studied residential areas from blasting impacts can be compared and assessed with regards to the blast design parameters implemented in the quarries. In this study, the blasting effects from two quarries, known as Quarry A and B have been assessed based on the constant location of the residential areas namely Taman Pulai Hijauan (TPH) and Taman Bandar Baru Kangkar Pulai (TBBKP) respectively. The blasting effects are highly dependent on the maximum instantaneous charge in blast holes (Q) which are dependent on parameters like number of blast holes, charge per column, Powder Factor and number of blast per delay. A simple correlation was successfully established using the multiple regression analysis from the SPSS software. Besides that, assessments on blasting impacts are done such as ground vibration and air blast empirically where the final outputs of these assessments in terms of Peak Particle Velocity (PPV) and air blast (dBL) were evaluated based on the safety limits set by JMG and DOE. This study was able to show that with an increase of the independent variables, the Q value rises significantly. The average mean of Q from Quarry A (181.07 kg) was much higher than Quarry B (180.22 kg). The correlations made for each quarry showed that Quarry A had a better regression line with lower standard error due to the high number of blast data obtained during the monitoring period of about 1 year and 8 months. While, the impact assessments showed higher PPV value at higher Q holding blast holes in Quarry A where some of the blasts has exceeded the safe limit of DOE compared to Quarry B and decreases with increasing distance. The similar relationship was observed for the air blast assessments. Nevertheless, all of the blasts produced are relatively within safe limits which are less than 3 mm/s (DOE), less than 5 mm/s (JMG) and less than 125 dBL. Thus, extra precaution can be taken by estimating the suitable Q value such as A (97.66 kg) and B (271.68 – 495.01 kg) to maintain safe blasting operations and prevent damages to the nearby residential areas.

ABSTRAK

Teknik gerudi dan letupan telah digunakan secara meluas baru-baru ini disebabkan oleh permintaan untuk bahan binaan semula jadi seperti agregat batu seperti granite. Walaubagaimanapun, keamatan kesan letupan telah dipersoalkan atas kesahihannya terhadap kawasan perumahan yang berdekatan. Cubaan menggunakan keadah empirikal daripada pengkaji dahulu untuk menilai kesan-kesan tersebut secara kuantitatif telah memberi penyelesaian yang realistik untuk masalah ini. Keselamatan kawasan perumahan dikaji dari kesan letupan boleh dibandingkan dan dinilai dari segi parameter rekabentuk peletupan dilaksanakan di kuari. Dalam kajian ini, kesan letupan dari dua kuari dikenali sebagai Kuari A dan B telah dinilai berdasarkan lokasi yang tetap dari kawasan perumahan masing-masing iaitu Taman Pulai Hijauan (TPH) dan Taman Bandar Baru Kangkar Pulai (TBBKP). Kesan letupan adalah sangat bergantung kepada *maximum instantaneous charge* (Q) yang bergantung kepada parameter seperti nombor lubang letupan, caj per lubang, *Powder Factor* dan bilangan letupan setiap kelewatan. Korelasi mudah telah berjaya ditubuhkan dibuat dengan menggunakan analisis regresi berganda dari perisian SPSS. Selain itu, penilaian ke atas kesan letupan dilakukan seperti getaran tanah dan letupan udara secara empirical. Penilaian dari segi *Peak Particle Velocity* (PPV) dan letupan udara (dBL) telah dinilai berdasarkan had keselamatan yang ditetapkan oleh JMG dan DOE. Hasil kajian ini menunjukkan bahawa dengan peningkatan pembolehubah bebas, nilai Q akan meningkat. Nilai purata Q Kuari A (181.07 kg) adalah lebih tinggi daripada Kuari B (180.22 kg). Korelasi yang dibuat menunjukkan bahawa Kuari A mempunyai garisan regresi yang lebih baik dengan ralat piawai yang lebih rendah kerana jumlah yang tinggi data letupan diperolehi semasa tempoh pemantauan kira-kira 1 tahun dan 8 bulan. Manakala, penilaian impak menunjukkan nilai PPV lebih tinggi pada lubang letupan pegangan Q lebih tinggi dalam Kuari A di mana sebahagian daripada letupan telah melebihi had selamat DOE berbanding Kuari B dan berkurangan dengan peningkatan jarak. Hubungan yang sama telah dilihat dalam penilaian letupan udara. Walaubagaimanapun, semua letupan berada dalam had yang selamat iaitu kurang daripada 3 mm/s (DOE), 5 mm/s (JMG) dan 125 dBL. Oleh itu, langkah berjaga-jaga boleh diambil dengan menganggarkan nilai Q yang sesuai seperti A (97.66 kg) dan B (271,68-495,01 kg) untuk memastikan operasi letupan yang selamat.

TABLE OF CONTENTS

CHAPTER	TITLE		PAGE
	DECLARATION		ii
	DEDICATION		iii
	ACKNOWLEDGEMENTS		iv
	ASTRACT		v
	ABSTRAK		vi
	TABLE OF CONTENTS		vii
	LIST OF TABLES		xi
	LIST OF FIGURES		xiii
	LIST OF ABBREVIATIONS & SYMBOLS		xix
	LIST OF APPENDICES		xxi
1	**INTRODUCTION**		1
	1.1	Overview	1
	1.2	Background of Problem	2
	1.3	Problem Statement	4
	1.4	Objective of Study	5
	1.5	Scope of Study	6
	1.6	Significance of Study	7
	1.7	Outline of Project Report	7

2 **LITERATURE REVIEW** 9

2.1 Introduction 9

2.2 History of Quarry Blasting Industry 10

2.3 Case Histories 13

2.3.1 Case History 1 – Nonmetal Mine, USA 15

2.3.2 Case History 2 – Rix's Creek Mine, Australia 17

2.3.3 Case History 3 – Langat Basin, Malaysia 19

2.3.4 Case History 4 – Tanjung Bungah, Malaysia 21

2.4 Parameters Affecting Quarry Blasting 22

2.4.1 Blast Design Parameters 23

2.4.1.1 Blast Geometry 24

2.4.1.2 Types of Explosive 29

2.4.1.3 Powder Factor 32

2.4.1.4 Detonation 34

2.5 Effects of Quarry Blasting 37

2.5.1 Flyrock 39

2.5.1.1 Assessing Effects of Flyrock 40

2.5.2 Ground Vibrations 46

2.5.2.1 Assessing Effects of Ground Vibrations 44

2.5.3 Air Blast 50

2.5.3.1 Assessing Effects of Air Blast 51

2.6 Concluding Remarks 55

3 RESEARCH METHODOLOGY 56

3.1 Introduction 56

3.2 Overview of Methodology 57

3.3 Site Observation 58

3.4 Data Collection 62

3.5 Data Analysis 63

3.6 Concluding Remarks 68

4 DATA ANALYSIS AND DISCUSSION 69

4.1 Introduction 69

4.2 Relationship between Blast Design Parameter and Effects of Blasting 70

4.2.1 Effects of Number of Blast Holes towards the Q Value 72

4.2.2 Effects of Charge per Column towards the Q Value 75

4.2.3 Effects of Powder Factor towards the Q Value 77

4.2.4 Effects of Number of Blast per Delay towards the Q Value 82

4.2.5 Statistical Package for Social Science (SPSS) Analysis 84

4.3 Assessments on Effects of Quarry Blasting 85

4.3.1 Ground Vibration Assessments 86

4.3.2 Air Blast Assessments 97

4.4 Safety of Affected Residential Areas

		from Quarry Blasting	100
	4.5	Concluding Remarks	105
5	**CONCLUSION AND RECOMMENDATION**		108
	5.1	Overview	108
	5.2	Conclusions	109
	5.3	Significance of Project Report Contribution	111
	5.4	Recommendation	112
REFERENCES			114
APPENDICES (A - B)			128 - 129

LIST OF TABLES

TABLE.	TITLE	PAGE
Table 2.1	The suitability of blast hole diameter based on the UCS values of rock.	25
Table 2.2	Product quality of quarry blasting based on BSR value (Explosives Engineers' Guide, 2017). .	28
Table 2.3	Vibration intensity based on different explosive agents (Matheu, 1984).	29
Table 2.4	Comparison of constants from various countries.	48
Table 2.5	Comparison of threshold limit of PPV in various countries.	49
Table 2.6	Structural damage in relation to PPV values based on DOE (2007).	50
Table 2.7	Effects of air blast overpressure (Ladegaard-Pedersen and Dally, 1973).	52
Table 3.1	Comparison of used parameters for blasting works in respective quarries.	62
Table 3.2	Calculation example to obtain Q value.	65
Table 3.3	Calculation example to obtain PPV value of ground vibrations.	66
Table 3.4	Calculation example to obtain A value of	

	blasting induced air blast.	67
Table 4.1	Data comparison of number of blast holes with volume of rock and Q.	74
Table 4.2	Constant variables used in this study.	76
Table 4.3	Classification of rock breakage difficulty at studied quarries (Dick *et al.*, 1987).	78
Table 4.4	Effects of number of blast per delay on the ground vibrations.	83
Table 4.5	Type of variables and data used for the SPSS analysis.	84
Table 4.6	Frequency and PPV values based on the age of buildings (USBM, 1980).	90
Table 4.7	Comparison of data analysed between studied quarries.	101
Table 4.8	End results of SPPS analysis.	106
Table 4.9	Comparison of safety limit for both studied quarries.	106

LIST OF FIGURES

FIGURE	TITLE	PAGE
Figure 2.1	Monuments that are made up from products of mining activities (Vleet, 2011).	11
Figure 2.2	Summarized data of fatal injuries in the United States (NIOSH, 2000).	14
Figure 2.3	Numerical data from 2009 to 2015 (Health and Safety Authority, 2018).	15
Figure 2.4	Total number of accidents by sector as of October 2017 (DOSH, 2017).	15
Figure 2.5	View of the limestone quarry in Livingston County (U.S. Department of Interior, 1993).	16
Figure 2.6	Data of PPV values for each blast during the monitoring period (Gad *et al.*, 2005).	18
Figure 2.7	Structural cracks induced by blasts that exceeded the PPV's limit value (Gad *et al.*, 2005).	19
Figure 2.8	The inversely proportional relationship between dustfall level and distance from the nearest quarry (Pereira and Ng, 2004).	20
Figure 2.9	Possible occurrence of landslide due to vibration triggered by blasting activity (Chow, 2018).	21

Figure2.10 The parameters that influence the quarry blasting works. 23
Figure2.11 Pathway of quarry blasting. 24
Figure2.12 The blast geometries and 'rule of thumb' that influence the blasting operation (modified from Explosives Engineers' Guide, 2017). 26
Figure2.13 The effect of burden sizes on blasting (modified from Berta, 1985). 27
Figure2.14 Relationship between type of explosives with burden and blast hole diameter (Rajpot, 2009). 30
Figure2.15 Interpolation of ANFO density with blast hole diameter to obtain 7.47 kg/m of charged column in blast hole (red cloud). 31
Figure2.16 Stemming dimensions in a blast hole. 32
Figure2.17 Relationship between MFS and PF (Prasad *et al.*, 2015). 33
Figure2.18 Flyrock risks based on PF values (modified from *Jimeno et al.*, 1995). 34
Figure2.19 Available methods to fire blast holes. 35
Figure2.20 A complete set of the Non Electrical detonation system (Tatiya, 2013). 36
Figure2.21 Fixed Non Electrical detonation in blast holes (Zhendong *et al.*, 2016) 37
Figure2.22 The major effects of blasting to the surrounding environment. 38
Figure2.23 A simple diagram on causes of blast damage (Wylie and Mah, 2004). 38
Figure2.24 Wild flyrock about 350 m from Masai quarry

site (Edy *et al.*, 2013). 39
Figure2.25 Flyrock induced damages (Edy *et al.*, 2013). 40
Figure2.26 Maximum traveling distance of flyrock (L in metres) as a function of PF and blast hole diameter (d) (Swedish Detonic Research Foundation, 1975). 41
Figure2.27 Parameters involved in Equation 2.2 (Raina *et al.*, 2010). 42
Figure2.28 Relationship between Lmax and B (Eze, 2014). 43
Figure2.29 Damages induced by ground vibration (Moore, 2016). 44
Figure2.30 Wave amplitude structural damages (Belcher and Cottingham, 1994). 45
Figure2.31 PPV blast monitoring instrumentation. 46
Figure2.32 Formula used to obtain Q value. 48
Figure2.33 Damages by air blast overpressure (Murray and Holbert, 2015). 51
Figure2.34 Instrumentation to monitor air blast frequency (Sigicom, 2013). 53
Figure2.35 Air blast frequency ranges (Aloui *et al.*, 2016). 53
Figure2.36 Relationship between PPV and air blast frequency (Siskind *et al.*, 1980). 54
Figure2.37 Summarized version of issue regarding this study. 55
Figure 3.1 Flowchart of operational framework that will be used in this study. 57

Figure 3.2	Location of study area (image soften due to restriction).	58
Figure 3.3	Geological background of study area (black box) (JMG, 2004).	59
Figure 3.4	Blasted granite boulders rich with quartz.	60
Figure 3.5	Aerial view of Quarry A site and TPH (monitoring point).	60
Figure 3.6	Aerial view of Quarry B site and TBBKP (monitoring point).	61
Figure 3.7	Blast face of Quarry A.	61
Figure 3.8	Assessments on effect of blasting in the data analysis stage.	63
Figure 3.9	An example of a double blast where more than one hole is blasted at time delay of less than 7 ms.	65
Figure 4.1	Effecting parameters on the Q value of blast.	71
Figure 4.2	The relationship between Q value and number of blast holes.	72
Figure 4.3	The relationship between Q value and charge per column.	75
Figure 4.4	The relationship between Q value and Powder Factor (PF).	77
Figure 4.5	Rock breakage mechanism initiated from a charged blast hole with explosives and PF (modified from Wylie and Mah, 2004),	80
Figure 4.6	Tensional failure of rock mass during blast (Beicher and Cottingham, 1994).	80
Figure 4.7	Site and rock mass condition before	

	production blast.	81
Figure 4.8	Site and rock mass condition after production blast.	81
Figure 4.9	The relationship between Q value and number of blast per delay.	82
Figure4.10	The relationship between PPV and Q value.	87
Figure4.11	The relationship between PPV and distance.	88
Figure4.12	The relationship between PPV and frequency via USBM method.	91
Figure4.13	The distribution of the frequency from Quarry A blasting operation.	92
Figure4.14	The distribution of the frequency from Quarry B blasting operation.	92
Figure4.15	The PPV values from both quarries according to various threshold values.	94
Figure4.16	The distribution of the frequency from Quarry A blasting operation based on DOE limits.	96
Figure4.17	The distribution of the PPV values from Quarry A blasting operation based on DOE limits.	96
Figure4.18	The relationship between PPV and distance.	98
Figure4.19	The air blast values from both quarries according to USBM safe limit.	99
Figure4.20	The Q value required to induce 3 mm/s ground vibrations.	103
Figure4.21	The air blast values expected from the 3 mm/s blast induced ground vibrations.	104

LIST OF ABBREVIATIONS & SYMBOLS

JMG		Jabatan Mineral & Geosains (Malaysia)
DOE	-	Department of Environment (Malaysia)
AQ	-	Quarry A
BQNF	-	Quarry B North Face
BQSF	-	Quarry B South Face
TPH	-	Taman Pulai Hijauan
TBBKP	-	Taman Bandar Baru Kangkar Pulai
ANFO	-	Ammonium Nitrate – Fuel Oil
DOSH	-	Department of Safety & Health (Malaysia)
NIOSH	-	National Institute of Occupational Safety and Health
PPV	-	Peak Particle Velocity
B	-	Burden
PF	-	Powder Factor
NONEL	-	Non Electrical detonation method
Q	-	Maximum Instantaneous Charge
USBM	-	United States Bureau of Mining
SPSS	-	Statistical Package for Social Science

m	-	metres
km	-	kilometers
mm	-	millimeters
kg	-	kilograms
g/m^2d	-	grams per square meter per day

MPa	-	Mega Pascal's
m/s	-	metres per second
ms	-	milliseconds
dBL	-	decibels
Hz	-	Hertz

LIST OF APPENDICES

APPENDIX	TITLE	PAGE
A	Result output of multiple regression analysis for Quarry A.	128
B	Result output of multiple regression analysis for Quarry B.	129

CHAPTER 1

INTRODUCTION

1.1 Overview

Malaysia has been facing a boom in demand recently for resources such as land space and building materials to cater to the country's increasing population. These require the clearance or leveling of hilly area through the surface excavation process (Yilmaz *et al.*, 2016). However, not all the Earth material can be normally excavated using a backhoe. Many contractors have spent heavy coins on alternative method like drill and blast technique due to the high strength and volume of rock.

Blasting contractors should try to minimize the impact of quarry blasting on surrounding environment and the public. This is due to the effect of blasting that induces strong ground motions, flyrock and air blast pressure that may lead to major accidents (Sharma, 2017). As we are aware, the current limited land space forces the placement of blasting quarries to be nearer to residential

area. Thus, organizations such as the local Councils, Enforcers, Mineral & Geoscience Department (JMG) and Department of Environment (DOE) need to be more attentive during blasting activities. This is to ensure blasting is done according to the approved safe guidelines, especially by controlling the blast design parameters.

1.2 Background of Problem

The safety of surrounding environment is the utmost important aspect to be considered when an engineer designs the blast parameters required for blasting. Here, the help of instrumentation system located at strategic places in the surrounding environment allows only a mere prediction of frequency, air pressure and vibration models induced by the blast. A general hypothesis that can be made is that the effects of quarry blasting are much higher if the instrumentations are located nearer to the blast surface. This hypothesis caused Malaysia to brand the quarry activities as heavy industry and has set a minimum buffer zone limit of 500 metres from the intended blasting area to the nearest residential or industrial area (Environmental Requirements: A Guide for Investors, 2010).

But, this limit has been on the stake when a tragic blast caused a flyrock incident to occur on the 19th of July 2013 at Masai quarry near Seri Alam, Johor, Malaysia. Flyrock are rocks ejected from the blast surface at high speed that may cause injuries and damages to surrounding environment, people, buildings and vehicles. This massive explosion caused rocks and boulders to rain down on the nearest industrial park located at Jalan Bukit 2 which is 700 metres from the site. It was a fatal accident in which a factory worker was killed, 10 people were injured, 18 cars and 14 factories were damaged (Edy *et al.*, 2013).

It is stated that one of the main reasons that this incident occurred was the inappropriate design of blast geometry. At the Masai quarry, blasted granitic rocks generally tend to have high rock strength. So, in order to blast these rocks, a greater weight of explosive charge is needed to increase blast efficiency (Sazid and Singh, 2012). But, if the burden provided by the blast surface is insufficient, then greater energy will be released to the surrounding environment via rock fragments causing flyrock issue to occur. The lack of understanding in this blast design parameters by the explosive engineers will definitely harm the surrounding environment.

1.3 Problem Statement

Blast design parameters are controllable parameters that allow explosive engineers to perform efficient and safe blasting in a quarry. The parameters involved are blast surface burden, spacing, bench height, explosive weight, powder column geometry and maximum charge per delay (Blasting Training Module, 2004). With the aid of this blast design, blasting activities can be carried out and analyzed in terms of fragmentation, blast surface stability and environmental safety.

From the previous case history stated in Subchapter 1.2, the problem statement of this study can be justified to prevent the occurrence of flyrock accidents, extreme ground vibration and air blasts at the studied quarry sites. For example, the nearest distance from Quarry A (AQ) to Taman Pulai Hijauan (TPH) is 533 metres while the Quarry B North Face (BQNF) and South Face (BQSF) to Taman Bandar Baru Kangkar Pulai (TBBKP) is about 1585 metres and 889 metres respectively. The granitic rock behavior, blast design parameters used and literally short distanced location of residential area from the quarry site might have some chances of mismatches to occur. Hence, a detailed study must be done based on blast design parameters by analyzing and assessing the aftereffect of the blasting industry with the help of instrumentations installed at the residential areas (Aloui *et al.*, 2016). This will crucially help to

understand the effects of quarry blasting towards the safety of the residential areas studied.

1.4 Objective of Study

The main aim of this project is to investigate the effects of quarry blasting from Quarry A and B towards the nearby residential area. This outcome may contribute to the knowledge of rock blast management by enriching the parameters selection for future blast design refurbishment. The previously stated project aim can be solved by tackling these specific objectives below which are:

a) To identify the blast design parameters that will affect the surrounding environment.

b) To assess the effects of blasting quantitatively based on the blast design parameters obtained.

c) To compare the safety of affected nearby residential areas from the impact of quarry blasting.

1.5 Scope of Study

Although there are many factors that may influence the effect of quarry blasting towards the residential area, this project report focuses on the blast design parameters. These parameters are highly dependent on the critical rock mass classifications at each slope face. Nevertheless, field works and site visits will be done in order to acquire a thorough understanding of the actual blast face direction and blasting reports from the quarry operation team with lesser emphasize on the rock mass classification. With this understanding, the effects of blasting towards the residential areas will be predicted using the given blast design parameters.

In addition to the above, this study is done in limited number of quarries which are the Quarry A and Quarry B. These quarries are located at the peripheral of the granitic Gunung Pulai. Therefore, the data comparison that will be analyzed in this study comprises of information obtained from these two quarries as well as the instrumentation monitoring data from the nearby residential area of TPH (near Quarry A) and TBBKP (near Quarry B).

1.6 Significance of Study

The aftereffects of blasting are highly dangerous and harmful for both human and building structures. This awareness need to be projected to all organizations including community, stakeholders, blasting contractors and government officials. By saying so, this study will highlight the influential blast design parameters which play an important role in maintaining the safety of a residential area situated near quarry sites. Furthermore, this study will assist to identify a safe blast design that will increase the efficiency of a production blast with lesser risk towards the residential area. Hence, this project report shall serve as a stepping stone in order to achieve a more accurate relationship between each parameter of blasting to determine the safe bounds of the blast area.

1.7 Outline of Project Report

This project report is a monograph that consists of a complete set of data interpretation starting from desk studies, literature reviews and site assessments that are finally concluded in the final stage of this study. These steps are shown in the outline of the project report that comprises of 5 chapters as stated below:

- Chapter 1: Introduction
    - Stating the general topic and giving some background. Besides that, outlining and evaluating the current related situation to the topic.

- Chapter 2: Literature Review
    - Summarizing and synthesize the arguments and ideas of others without adding new contributions.

- Chapter 3: Methodology
    - Broad philosophical underpinning to the chosen study methods, including theu sage of qualitative or quantitative methods, or a mixture of both, and their specific reasons.

- Chapter 4: Data Analysis and Discussion
    - To interpret and describe the significance of the findings in light of what was already known about the study problem being investigated, and to explain any new understanding or insights about the problem after taking the findings into consideration.

- Chapter 5: Conclusion and Recommendation
    - Forms an important part of a project debrief which is a key part of the value offered to clients by professional market research.

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