JABATAN BANGUNAN

UNIVERSITI TEKNOLOGI MARA

PERAK

INSTALLATION OF SOIL NAILING SYSTEM AT SLOPE AREA

Prepared by:

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UNIVERSITY TECHNOLOGI MARA

PERAK

NOVEMBER 2011

It is recommended that the report practical training is provided

By

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Title

INSTALLATION OF SOIL NAILING SYSTEM AT SLOPE AREA

Accepted in partial fulfillment of the requirements for obtaining a Diploma in Building

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JABATAN BANGUNAN

FAKULTI SENIBINA, PERANCANGAN DAN UKU

UNIVERSITI TEKNOLOGI MARA

PERAK

NOVEMBER 2011

DECLARATION OF STUDENT

It is with this, the work of Practical Training Report this writing was produced entirely by me except as disclosed through practical exercises that I did for five months from 31st October, 2011 to 31st March 2012 at Pembinaan Petasih Sdn. Bhd. It is also as one of the conditions of passing the course, DBN 307 and received in partial fulfillment of the requirements for obtaining a Diploma in Building.

Name : Muhammad Shah Redza Bin Zamani

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Date : 15 December 2011

ACKNOWLEDGEMENT

In the Name of Allah, Most Gracious, Most Merciful who gave me the opportunity to gain knowledge and then be able to prepare this report is the result of my experience of practical training for five months with the company Pembinaan Petasih Sdn. Bhd. Blessings on the Prophet SAW and all friends and members.

I express my gratitude to all who have helped me in giving guidance, knowledge and opportunities either directly or indirectly over me through this practical training. Special thanks to Miss Rafizah Bte Mohamed Nordin, my supervise lecturer from Building Department UiTM Seri Iskandar as much information and guidance and assist me in preparing this practical training report.

Also thank you to Mr. Hj Yacob Bin Sammot as Managing Director of Pembinaan Petasih Sdn Bhd. for his great help, the opportunity, guidance, discussion and the information related to the topic that I have selected as main topics practical training report. In addition, appreciation is also given to Mr. Nurazwan Bin Kamaruzaman as Supervisor of Pembinaan Petasih Sdn. Bhd. for giving me a lot of support during my practical training.

Last but not least, special appreciation is given to my parents for the support and encouragement, all family members gave a lot of enthusiasm and support and friends who were willing to share information and always at my side through thick and thin during practical training. I pray to Allah SWT for all the knowledge and experience can be shared, and all benefit from it into something useful to future generations.

ABSTRACT

This report briefly describes the methods and processes involved in the construction of slope stabilization which apply soil nailing system. It also explains the types of materials and machines used. This report is produced during the practical training within five months in the company Pembinaan Petasih Sdn. Bhd. This report is based on projects done in the district of Gombak. This project is under the supervision of the JKR Gombak. For the methods of this slope stabilization, found that each of the work done is not as easy to execute. Each of the construction process is done in detail to avoid error due to this construction project. In conclusion, it is hoped that this report can be explained in more detail to the reader about the installation of soil nailing system to provide slope stabilization.

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LIST OF ABBREVIATION

BRC	Bar Reinforced Concrete
CIDB	Construction Industry Development Board
cm	Centimeter
FHWA	Federal Highway Administration
FRIM	Forest Research Institude Malaysia
FRP	Fiber Reinforce Plastic
JKR	Jabatan Kerja Raya
m	Meter
mm	Milimeter
MRR2	Kuala Lumpur Middle Ring Road 2
OSHA	Officer of Safety and Health
PKK	Pusat Khidmat Kontraktor
PVC	Polyvinyl Chloride
QC	Quality Control
SOCSO	Social Security Organization
THK	Thickness
TUDM	Tentera Udara Di Raja Malaysia
UPVC	Unplasticied Polyvinyl Chloride

CHAPTER 1

INTRODUCTION

1.1 PREFACE

Soil nailing essentially involves reinforcing and strengthening of existing grounds by installing closely-spaced steel bars, called 'nails', into a slope as construction proceeds from 'top-down'. This process creates a reinforced section that is in itself stable and able to retain the ground behind it. The reinforcements are passive and develop their reinforcing action through nail-ground interactions as the ground deforms during and following construction. In Malaysia, commonly referred codes of practice and design manuals for design of soil nailing are:

1. British Standard BS8006: 1995, Code of Practice for Strengthened/Reinforced Soils and Other Fills.
2. U.S. Department of Transportation, Federal Highway Administration (FHWA 1998), Manual for Design & Construction Monitoring of Soil Nail Walls.

Both the designer and constructor are involved together during the works, e.g. QA/QC by designer during construction, etc. The division of responsibilities presented in this report only highlights the responsibilities of each party for which they exert the greatest influence. The implication of top-down construction sequence and excavation of slope prior to installation of soil nails on the performance of the soil nails will also be discussed.

1.2 SELECTION OF REPORT TITLE

Throughout the practical training period, I've been assigned by my supervisor to supervise the construction areas and sites that are under the supervisor's duty. There are several sites such as at the MRR2, Kepong which is a project that involves constructing a slope stabilization works. There is also a project located in the FRIM area, where I was asked to help supervise a site where the contractors are slope stabilization using soil nailing. Even though there are not many sites to be supervised, I took this opportunity to ensure that every site is supervised each day so that the construction process finishes as given in the quotation and work order documents.

My topic for this practical report was chosen from another construction site that is still in the clearing up stage when the writer was at Jalan Ulu Yam – Sungai Tua, Daerah Gombak, Selangor Darul Ehsan. Soil nailing work will be done in the early of February. This project is construct slope stabilization works. This project is under JKR Gombak and student has to write a letter to JKR to be allowed inside the construction site and the letter has been approved. The topic of study will be relevant because the soli nailing process will be starting soon and the topic seems to be interesting to me.

1.3 OBJECTIVE OF STUDY

The objectives of study are to know and learn more about soil nailing works that is done on the construction site. Specifically the objectives are:

1. To know the types of soil nail used in the construction site during the early period of the construction process.
2. To learn about the equipments and machine that used for each stages of the soil nailing on the construction site.
3. To identify the method of installing soil nailing at slope area.

1.4 SCOPE OF STUDY

This scope of study covered soil nailing works on the mention site from preliminary work until the end of work. Furthermore, to explain a bit about sub-contractor that involves in this construction works.

This scope of study also explains about the construction and all circumstance required and should be concern about the detail of the soil nailing works. Besides that, the studies are only focus on the project at Jalan Ulu Yam – Sungai Tua, Daerah Gombak, Selangor Darul Ehsan implemented by Syarikat Pembinaan Petasih Sdn. Bhd.

1.5 METHOD OF STUDY

Generally, this report has been prepared by applying the following method:

1. REFERENCE BOOKS

As the whole of this report has been prepared by refer some reference books. These methods are focusing more on theory and facts. This method also simplifies the process to search more information.

2. INTERNET

Using internet also has been use to prepared this report. There is a huge amount of information available on the internet for just about every subject about construction. It also makes discussion about this report with other people much easier.

3. INTERVIEW

Interviews are one of the best ways to produces information more efficient and effective. This method need to interview unskilled worker or other skilled worker such as the engineer that has experience about the construction to gain more valuable information.

4. OBSERVATION

Observation is a good method for learning and ability of respondents to report and the data that has been collect from observation are more accurate and obvious.

CHAPTER 2

COMPANY BACKGROUND

2.1 INTRODUCTION

Pembinaan Petasih Sdn Bhd is a construction company fully operated by bumiputera. This company owned by Hj Yacob Bin Sammot. This company was established with the purpose to secure business opportunities in construction. It was also established to increase business as well as members of credible local entrepreneurs in this field and to meet the challenges of making Malaysia a developed nation state in 2020 soon.

This company implemented various projects such as thermoplactic painting, house renovation, slope stabilization and install drainage system, construction and repairing building and roads for to government departments and private.

2.1 COMPANY HISTORY

Pembinaan Petasih Sdn Bhd was established on 16 July 2008 with registration no SA 0093371-W. This company located at Lot 1084, Jalan 1, Kepong Ulu, 52109, Kepong, Selangor Darul Ehsan. This company is registered with PKK began in the class f in 2008 and has a lot to take tenders issued by government departments and private, and did all the work successfully. (Source: Pembinaan Petasih Sdn Bhd).

Pembinaan Petasih Sdn Bhd is a step towards a greater intensity when the ride was a higher level of class C with the Pusat Khidmat Kontraktor (PKK) and is also registered with the Lembaga Pembangunan Industri Pembinaan Malaysia (CIDB).

2.3 COMPANY OBJECTIVES

The objectives of this company are:

1. Provide efficient, quality and effective services.
2. Making the company successful and respected
3. Build good and lasting relations with other company.

2.4 ORGANIZATION CHART

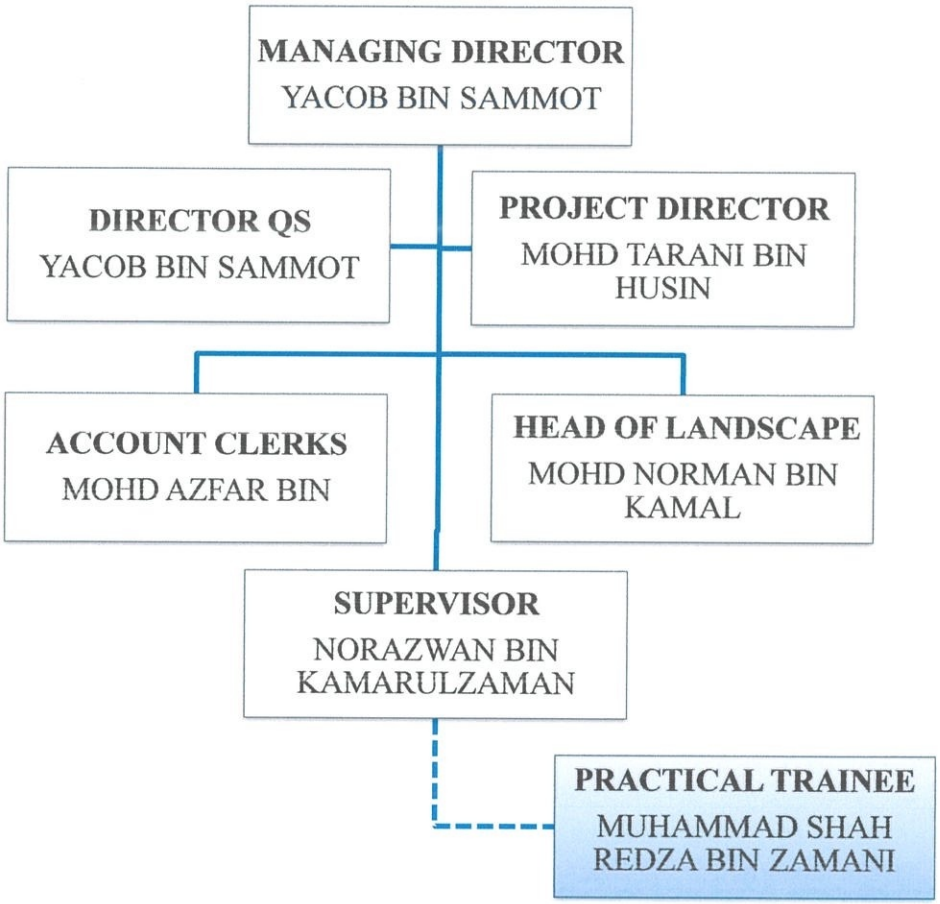

Table 2.4.1: Company organization chart

Source: Pembinaan Petasih Sdn. Bhd.

2.5 LIST OF COMPLETED PROJECT

Below are projects that have been done by this company over past year:

NO	PROJECT	PRICE	PERIOD	AGENCY
1.	Repairing and paving of road at Seksyen 477 FT 005 and the area around	RM449,810.00.	2/12/09 to 4/12/09.	JKR Kuala Selangor
2.	Construct Surau As-Saffi at Selayang Height, Daerah Gombak	RM165,000.00	1/11/09 to 31/12/09	Syarikat Aslam / ICU Jabatan Perdana Menteri
3.	Supply of premix for golf area at TUDM Subang, Daerah Petaling	RM56,000.00	22/2/08 to 14/3/08	JKR TUDM Subang

4.	Provide maintanance around Kelab FRIM	RM24,000.00	1/2/08 to 30/1/09	Kelab FRIM
5.	Sheet Piling supply and install at Jalan Bentong Lama, Gombak, Selangor	RM95,000.00	1/5/09 to 14/5/08	JKR Gombak
6	Management and maintenance of civil engineering works and building the federal government quarters for 128 semi-D units at presint 11, Putrajaya	RM418,600.00	1/6/09 to 31/05/2011	JKR Putrajaya

Table 2.5.1: List of completed project (2008 – 2011)

Source: Pembinaan Petasih Sdn Bhd

CHAPTER 3

CASE STUDY

3.1 INTRODUCTION

Soil nail is commonly used in Malaysian slopes both as stabilization measure for distressed slopes and for very steep cut slopes. The popularity of soil nail slope is due to its technical suitability as an effective slope stabilization method, ease of construction and is relatively maintenance free. As such, soil nail slope of up to more than 25m high is increasingly being used for Malaysian slopes. However, given the great height of such soil nail slopes, a proper and systematic design procedures based on sound fundamentals and confirmed by extensive research is necessary in order to ensure the soil nail slope performs satisfactorily during its service life.(Chow C, 2006).

3.2 PRELIMINARIES AND GENERAL ITEMS

1. Contractual requirements
2. Survey and setting out works
3. Road signboard and traffic management
4. Inspection and testing
5. Progress report
6. Temporary Works
7. Site Cleaning

3.2.1 CONTRACTUAL REQUIREMENT

Allow for the provision of insurance as per contract:

1. Insurance for works including third party liability
2. Workman's compensation (SOCSO)

3.2.2 SURVEY AND SETTING OUT WORKS

Surveying or land surveying is the technique, profession, and science of accurately determining the terrestrial or three-dimensional position of points and the distances and angles between them. These points are usually on the surface of the Earth, and they are often used to establish land maps and boundaries for ownership or governmental purposes.

Setting out shall be as shown in the drawing or as directed by the Engineer. Immediately before drilling or installation of soil nail, the nail head position shall be marked with suitable identifiable pegs or markers on the slope/wall for necessary inspection by the engineer. (Jabatan Kerja Raya, 2005). Levelling also use for primary reference at water-level recording stations is a set of stable bench-marks, installed in locations where their level should not change.(Pacific Island Hydrology Course, 2004) Upon initial set-up of a station, the levels of the relevant parts of the installation are established and recorded by means of accurate levelling.

3.2.3 ROAD SIGNBOARD AND TRAFFIC MANAGEMENT

Road signboard and traffic management involves directing vehicular and pedestrian traffic around a construction zone, accident or other road disruption, thus ensuring the safety of emergency response teams, construction workers and the general public. Road signboards are standardized road signs similar to those used in other nations but with certain distinctions. (**REFER APPENDIX A**).

3.2.4 INSPECTION AND TESTING

Quality control and safety represent increasingly important concerns for project managers. Defects or failures in constructed facilities can result in very large costs. Even with minor defects, re-construction may be required and facility operations impaired. Increased costs and delays are the result. In the worst case, failures may cause personal injuries or fatalities. (W.H.Tang , 2001). Accidents during the construction process can similarly result in personal injuries and large costs. Indirect costs of insurance, inspection and regulation are increasing rapidly due to these increased direct costs. Good project managers try to ensure that the job is done right the first time and that no major accidents occur on the project.

As with cost control, the most important decisions regarding the quality of a completed facility are made during the design and planning stages rather than during construction. It is during these preliminary stages that component

configurations, material specifications and functional performance are decided. Quality control during construction consists largely of insuring conformance to these original designs and planning decisions.

3.2.5 PROGRESS REPORT

A progress report is simply what the name implies - a report, usually brief, explaining the progress you've made on a given project or set of projects. (J. Dubinsky, 2001) In this course, you'll write at least one progress report for your major research project.

Progress reports can take different forms, including brief verbal reports at your weekly or monthly staff meetings, periodic emails to your supervisor and covering all of your current projects, formal reports for clients marking various milestones in the project, and so on.

3.2.6 TEMPORARY WORKS

The duty of maintenance is not only to repair and maintain the slope. A professional maintenance person will keep the slope safe and reliably. The main task of maintenance is to make sure that the investments made will generate the best possible profit during the entire lifetime of the slope. Improving the availability, reliability, safety, and return on life cycle cost are the foundation of profitability and competitiveness. The better the Industry's competitiveness and the community's ability to provide services, the more the assets' efficiencies are optimised.

3.2.7 SITE CLEANING

Site clearance means removing all the buildings and facilities from a site. It might also include ground remediation where soil has been contaminated radiological or by other agents. Decommissioning is the process related to decontaminating and removing buildings or other structures; and clean up is concerned with ground remediation of contaminated land. Site clearance is, therefore, a combination of decommissioning and cleans up.

3.3 SEQUENCE OF INSTALLING SOIL NAILING

These are the sequence of work done for installation of soil nailing at slope area.

1. Site clearing.
2. Excavate and remove.
3. Construct rubble pitching.
4. Provide staging.
5. Install soil nail.
6. Spray slope.
7. Construct nail pad.
8. Pullout test.

3.3.1 SITE CLEARING

When the site is located in a wooded area, the first operation is to clear all timber, standing or fallen. If camouflage is necessary, trees or brush outside the designated cleared area should not be removed. Prior to the commencement of works, the setting out shall be carried out by the qualified surveyor to ensure the extent of which the site clearance works is required. The construction team shall identify the trees and structures to be preserved for retention and protection. Should it require be removing and demolishing.

Construction equipment operations are usually the most rapid and efficient means of clearing a site. Use of the equipment is limited only by unusually large trees and stumps–terrain which hinders their manoeuvrability and maintenance requirements. The construction equipment used includes bulldozers, winches, power saws, rippers, motor graders, and scrapers. In addition, hand tools are used in certain clearing operations. Brush may be disposed of by burning on the site.

Figure 3.3.1.1: Slope area has been cleared.

Photo credit: Redza Zamani (2011)

3.3.2 EXCAVATED AND REMOVE TOP SOIL

Excavate and remove all loose materials from slope and dispose off to the contractor own dump site. Removal of material from site is generally a fast process generally using wheelbarrow, hoe, shovel, and rake and loading contaminated material directly into lorry. The material is then taken off site generally for disposal. All loose material that is remove including trash, sticks, bushes, stone, rocks, and dirt.

Figure 3.3.2.1: Removal of loose materials from slope

Photo credit: Redza Zamani (2011)

3.3.3 CONSTRUCT RUBBLE PITCHING

After the slope has been cleared, rubble pitching will be put over the slope surface. The thickness of the rubble pitching is 300mm - 600mm thick and inclusively using 6" x 9" rocks and cement mortar to cover up the slope surface. Stone for pitching shall be granite and other clean, hard dense and durable rocks free from cracks. The sides of the stone should be roughly trimmed with a spalling hammer to obtain a reasonably close fit to and the interstice filled with clean coarse aggregate or gravel well rammed and wedged with spalls. This is to avoid from water from get inside the rubble pitching. The finished pitching will show an even surface to the lines and level.(**REFER APPENDEX B**)

Figure 3.3.3.1: Rubble pitching that has been done at slope area.

Photo credit: Redza Zamani (2011)

3.3.4 PROVIDE STAGING

Staging is most often used for creating a working platform for either building or maintaining structures. It is a temporary structure used to support people and material in the construction. It is usually a modular system of metal pipes or tubes, although it can be from other materials and will be use for soil nail and guniting works. It is most often used for creating a working platform for either building or maintaining structures, but because it is so adaptable. It can be used for a variety of purposes.

3.3.5 INSTALL SOIL NAIL

The size, length, spacing and inclination of soil nails should be designed to provide the required stabilising force to the reinforced soil mass. 100mm diameter, 6m length soil nail reinforced with 20mm diameter will be constructing on the slope surface.

The capacity of a drill-and-grout soil nail is governed by the tensile capacity of the soil-nail reinforcement, the size of the soil nail, i.e., perimeter and length, the bond stress that can be mobilised at the soil-grout interface and at the grout reinforcement interface, and the resistance that can be provided by the soil-nail head or facing.

The bond strength between the soil-nail reinforcement and the cement grout depends on the mechanical interlocking between the cement grout, and the protrusions and depressions in the surface of the soil-nail reinforcement. This in turn is affected by the combined effect of adhesion, friction and bearing.

If high yield deformed steel bars with transverse ribs are used as soil-nail reinforcement, the bearing stress between the ribs and cement grout contributes most of the bond. The bond strength between cement grout and the soil depends primarily on the contact stress and the interface coefficient of friction between the cement grout and the soil.

Figure 3.3.5.1: Reinforcement bar on the slope surface
Photo credit: Redza Zamani (2011)

After that, 50mm diameter corrugated sheath. (Rate shall include drilling through soil and rock) will be drill through the slope. Detail of the soil nail as shown on **Appendix B.**

The correctness of the alignment of drillholes is important in the prevention of clashing of soil nails, in particular for closely-spaced or long soil nails, or soil nails with different inclination and bearing. It is common practice to check the correctness of the inclination and bearing of drillholes by using a protractor and compass on the drill rods. It is of paramount importance to control and check the initial inclination and bearing of drillholes. If accurate measurements of the inclination and bearing of the drillhole along its length are needed.

For drilling long soil nails, the drill rate should be suitably controlled to minimise the Eccentricity produced by the dip of the drill rods, which may otherwise cause misalignment of the drillhole or may unduly enlarge the diameter of the drillhole and cause the hole to collapse.

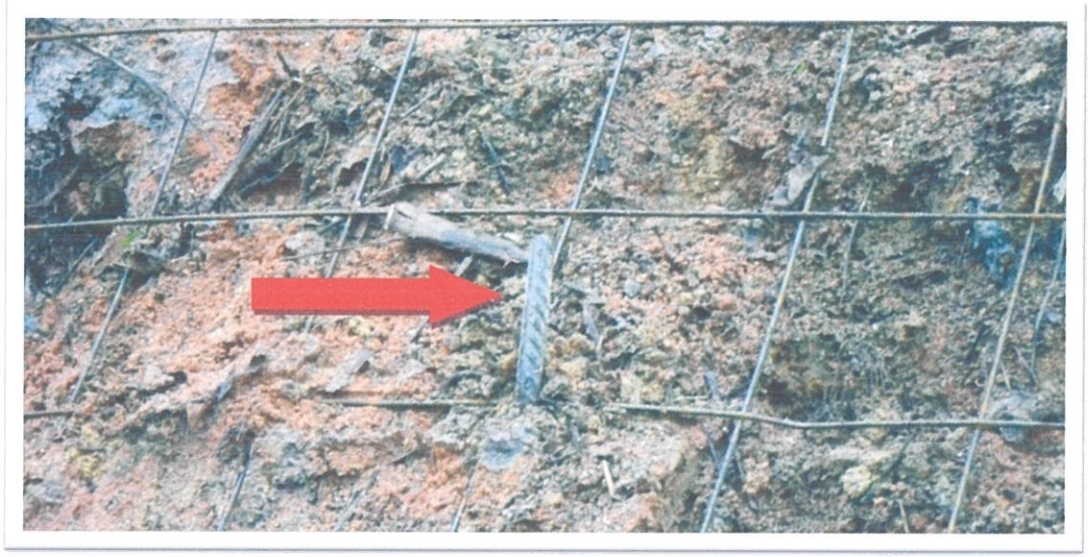

Figure 3.3.5.2: Soil nail has been drilled

Photo credit: Redza Zamani (2011)

3.3.6 SPRAY SLOPE

This works specification for guniting covers the technical requirements for gunite mix, machine and plant, surface preparation, method of operation, quality control and works acceptance criteria. Contractor shall apply gunite to the excavated slope surfaces at locations shown on **Appendix B** or at locations directed by the Engineer. Supply and spray 100mm thick gunite on slope including 75mm diameter PVC weepholes at 1.5m centers and one layer or BRC A6. To perform gunning on the panel form defined in section 5, place the panel form against the slope. So that it has the same grade as the actual slope, and place the open end down to prevent rebound from being trapped.

Figure 3.3.6.1: Slope has been sprayed by gunite machine

Photo credit: Redza Zamani (2011)

3.3.7 CONSTRUCT NAIL PAD

After finishing spraying concrete all over the slope surface, nail pad will be constructing with 400mm x 400mm x 150mm thick concrete nail pad, inclusive reinforcement grade 20 concrete. Nail pad is use for covered the soil nail from rust and to strengthen the soil nail. **(REFER APPENDIX B)**.

Figure 3.3.7.1: Nail pad has been construct proper tabulation as per recommended based on its design by the structural engineer

Photo credit: Redza Zamani (2011)

3.3.8 PULLOUT TEST

The location of soil nail point for the pullout test shall be selected by the Engineer prior to commencement of testing work. The selected soil nail point steel bar for the pullout test are normally allowed to protrude at least 100mm beyond the slope surface for the convenience set up works of the testing.

The concrete pad to sit the 'Centre Hole' and the Hollow Cylinder Rams for pullout test shall be cast perpendicular to the test soil nail. The 'Centre Hole' Cylinder Ram for the pullout test shall that of DH 603 model capable of transferring 60 MT load. The effective area of the cylinder is 12.73 sq inch. The Hydraulic jack pressure gauge for the pullout test shall be calibrated and have enough pressure capacity to do the testing.

The dial gauge for the pullout test shall be approved and calibrated type with maximum travel of 50mm and accuracy of 0.01mm. The protruding threaded end of the soil nail shall be connecting to the Ram by an adapter (in the form of a extension bar). Loading sequence for the pullout test and the observation period shall be according to BS 8081:1989. The acceptance criteria for the pullout test shall be determined by the engineer at site.

Figure 3.3.8.1: Test in progress

Photo credit: Redza Zamani

Proof test loading sequence. (**REFER APPENDIX C**)

Method of calculation. (**REFER APPENDIX D**)

Pullout test result. (**REFER APPENDIX E**)

Pullout test data result. (**REFER APPENDIX F**)

CHAPTER 4

CONCLUSION AND RECOMMENDATION

4.1 CONCLUSION

Soil nailing has been used throughout the world as a means of more stable and better foundations to stabilize slope surface. After carry out study on the construction of soil nailing for slope stabilization, I had learn many things that were previously not revealed through theoretical study. Overall, I can achieve the objectives of the study and described briefly by several methods.

Sol nailing is a stabilization process used to build retaining walls or shoring systems when space ise limited. The process starts by installing threaded steel bars into slope or cuts made into the soil. Grouted bars are installed to create a stable mass of soil. Then a temporary or permanent facing is applied to retain and support the existing soil.

The face is typically made of guniting and reinforced with woven mesh over steel plates. Permanent walls are usually built with a cast-in-place face over the wall surface. Often, the permanent wall are made of decorative stone or other facing added on top of the guniting surface.

Engineers and other expert familiar with this type of construction must analyze the site and develop a site-specific nail placement design, including their correct depth, angle, and frequency. This ensures that the structure remain stable.

Soil nail walls should be constructed in ground where a 3 to 6.4 foot vertical slope can stand without support for up to two days during construction and is stable for the few hours it takes to drill and insert the nails. The depth of the cut layer depends on the soil's ability to stand unsupported while the nails are being inserted. Weathered rock, talus slope deposit, silt, clays with low plasticity that are not prone to creep, naturally cemented sands and gravels, heterogeneous and stratified soils, and some kinds of fine-to-medium homogeneous sand are suitable for soil nail construction. Soils not conductive to soil nail technology are soft plastic clays or saturated soils and coarse sand and gravels that are uncemented or lack capillary cohesion.

4.2 RECOMMENDATION

They are many factors that can be improved in installing soil nailing system:

1. Surface and subsurface drainages

   For most slope strengthening works, it is vitally critical to control the groundwater as it has significant impact on the safety factor. For efficient control of groundwater, horizontal subsoil drains are usually proposed at certain horizontal and vertical spacing to proactively lower the groundwater profile and depressurize excess pore pressure within the slope mass. If bedrock surface is encountered within the practical length (maximum 24m) of subsoil drain, it is always advisable to have the subsoil drain socket 0.5m into the bedrock to intercept perched water table over the bedrock. For rock mass where fracture and water seepage are observed, subsoil drains shall be installed at these locations.

2. Using high grade concrete

Consider that cast-in-place high grade reduce project start up time and start to finish time compared with low grade concrete. High grade concrete provides structural economy in many other ways too, including reduced material cost and improved cash flow. It can also maximize marketable space and increase return on investment.

3. Using bakau piles

If timber piles are kept permanently wet or permanently dry, for example installed wholly below water level, they can have a long life. However, they are liable to decay in a zone of fluctuating water table. Bakau piles also use for preventing rock slide from happening during slope stabilization works.

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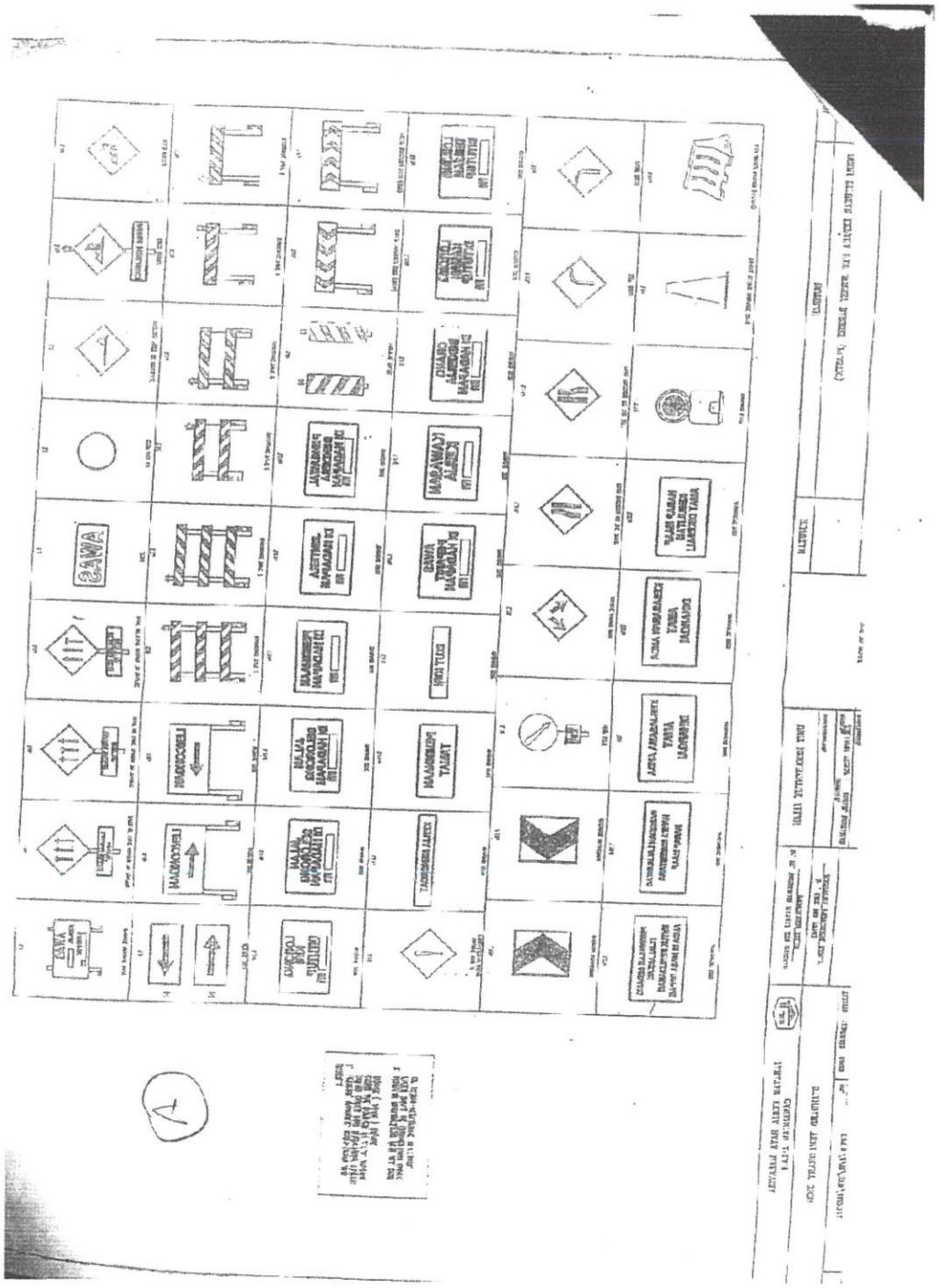
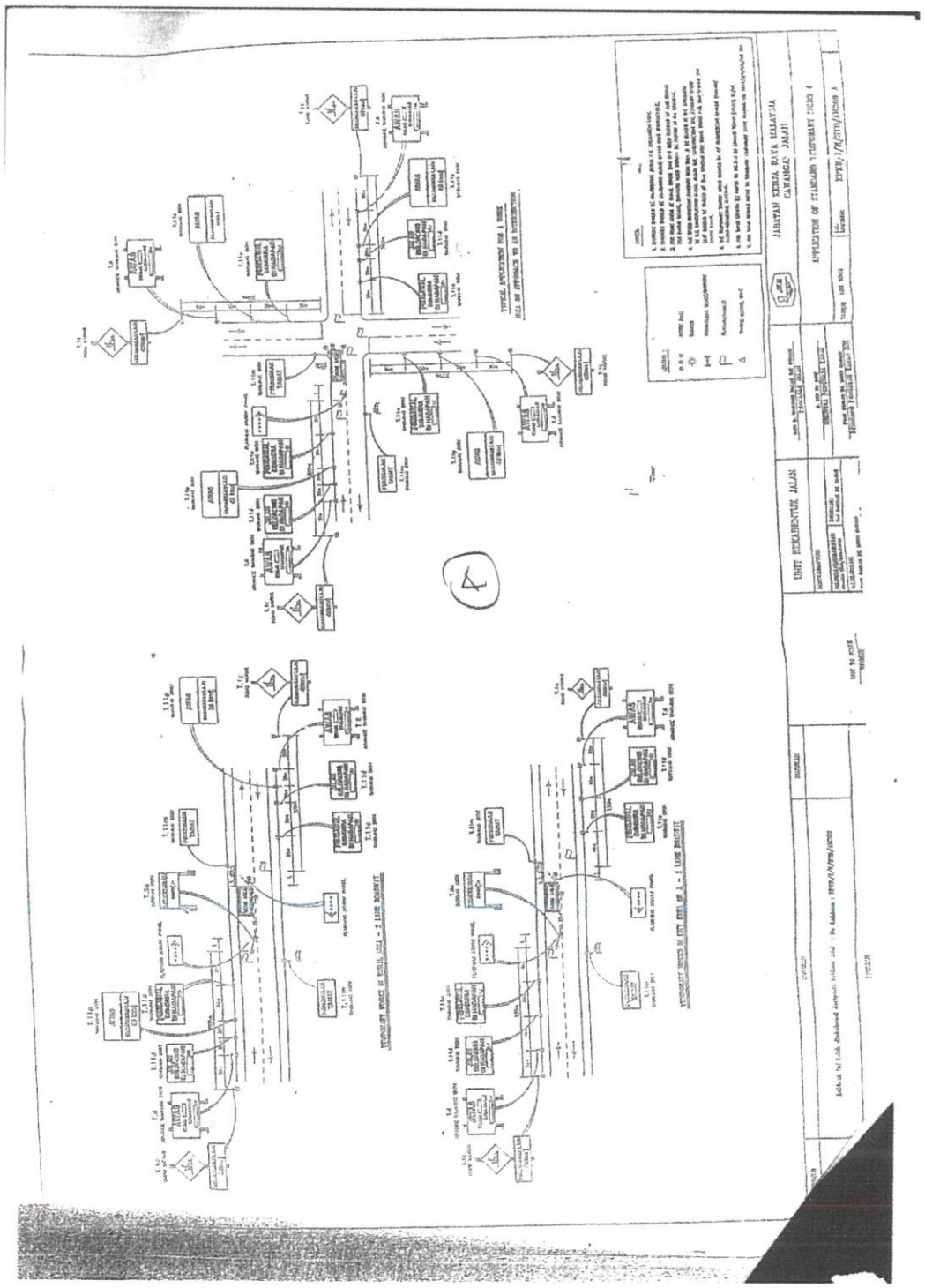
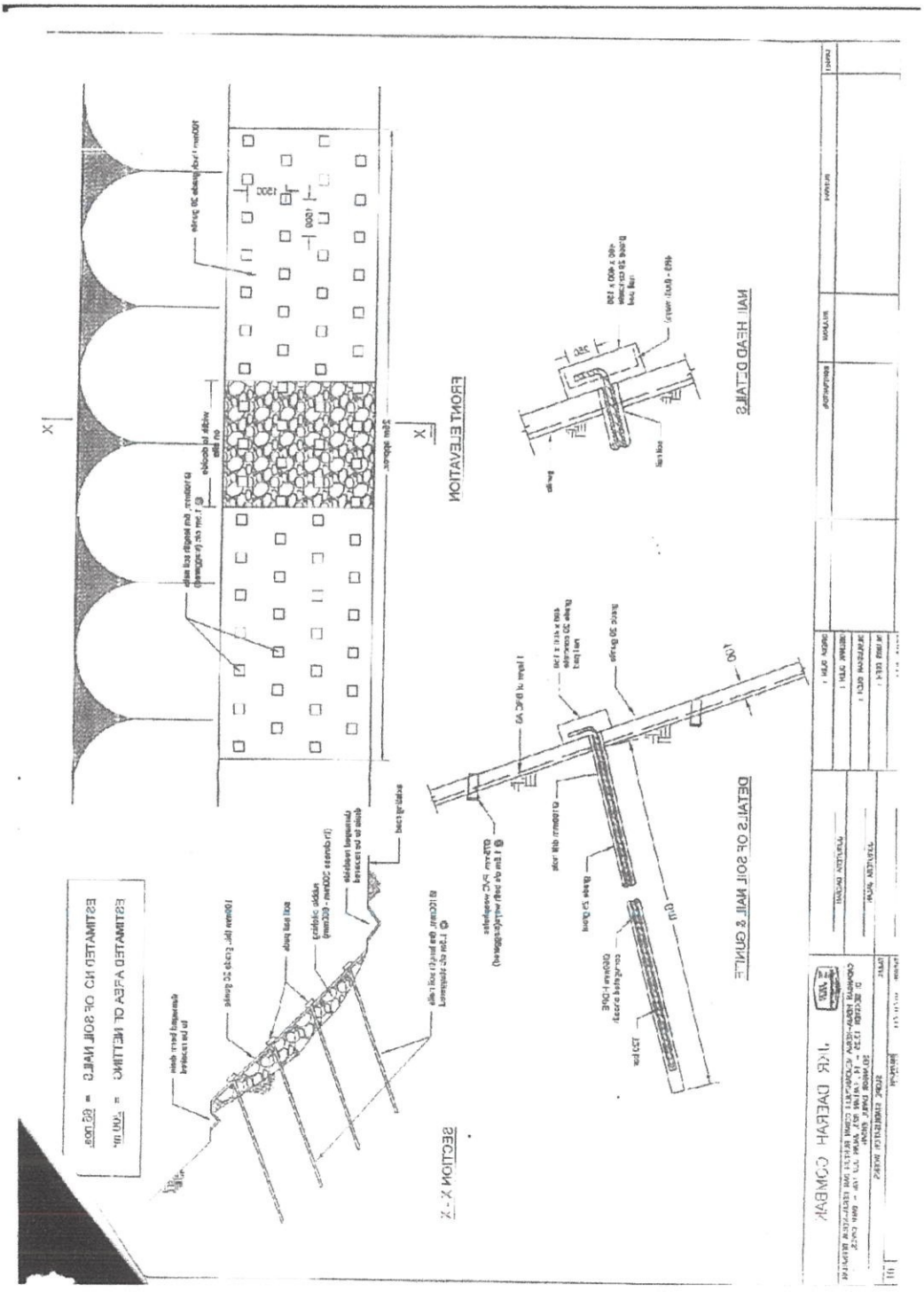
APPENDIX A



APPENDIX A



APPENDIX B



APPENDIX C

PROOF TEST LOADING SEQUENCE

Project: **MEMBAIKPULIH CERUN DAN KERJA - KERJA BERKAITAN DI ANTARA SEKSYEN 13.25 - 14.25 LALUAN B23, JALAN ULU YAM - SUNGAI TUA, DAERAH GOMBAK, SELANGOR**

	Minimum Period Of Observation		Reading Taken at Interval	LOAD		
	TIME	min	(Minutes)	LOAD (%)	LOAD (kN)	PRESS (PSI)
1st CYCLE		1	1	10	4.0	71
		1	1	25	10.0	177
		1	1	50	20.0	353
		1	1	75	30.0	530
		1	1	100	40.0	706
		1	1	125	50.0	883
		1	2	150	60.0	1060
		1	3	150	60.0	1060
		1	4	150	60.0	1060
		1	5	150	60.0	1060
		5	10	150	60.0	1060
		5	15	150	60.0	1060
		1	1	150	60.0	1060
		1	1	100	40.0	706
		1	1	50	20.0	353
		1	1	10	4.0	71
2 nd CYCLE		1	1	25	10.0	177
		1	1	50	20.0	353
		1	1	75	30.0	530
		1	1	100	40.0	706
		1	1	125	50.0	883
		1	1	150	60.0	1060
		1	2	150	60.0	1060
		1	3	150	60.0	1060
		1	4	150	60.0	1060
		1	5	150	60.0	1060
		5	10	150	60.0	1060
		5	15	150	60.0	1060
		1	1	100	40.0	706
		1	1	50	20.0	353
		1	1	10	4.0	71

with jack of ram area of 7.22 inches square

APPENDIX C

Table 18. Recommended load increments and minimum periods of observation for on-site acceptance tests

Temporary anchorages load increment (% T_w)		Permanent anchorages load increment (% T_w)		Minimum period of observation
1st load cycle*	2nd load cycle	1st load cycle*	2nd load cycle	
%	%	%	%	min
10	10	10	10	1
50	50	50	50	1
100	100	100	100	1
125	125	150	150	15
100	100	100	100	1
50	50	50	50	1
10	10	10	10	1

* For this load cycle, there is no pause other than that necessary for the recording of displacement data.

Each stage loading in the first cycle should be held only for the time necessary to record the displacement.

Each stage loading in the second cycle should be held for at least 1 min and the displacement recorded at the

APPENDIX D

SLOPE ENGINEERING & TESTING (001883299-A)
BLOCK A-107 MAYANG COURT APT, SS25/41
47301 PETALING JAYA, SELANGOR.
H/P:
TEL/FAX:

METHOD OF CALCULATION

THE PRESSURE VALUE OF A HYDRAULIC JACK AT A SPECIFIC LOAD WITH A HYDRAULIC JACK RAM AREA OF 7.22 INCHES SQUARE ARE CALCULATED AS BELOW

$$\frac{\text{LOAD (Pound)}}{\text{AREA (Square Inches)}} = \text{PRESSURE (PSI)}$$

1 kN = 224.81 lb

Example : PRESSURE for 4.00 kN of LOAD

$$\frac{224.81 \times 4.00}{7.22} = 70.64 \text{ PSI}$$

APPENDIX E

PUL OUT TEST RESULT DATA

SLOPE ENGINEERING & TESTING (001883299-A)

Project: **MEMBAIKPULIH CERUN DAN KERJA - KERJA BERKAITAN DI ANTARA SEKSYEN 13.25 - 14.25 LALUAN B23, JALAN ULU YAM - SUNGAI TUA, DAERAH GOMBAK, SELANGOR**

Date of Test : 5th of January 2012
Rock Bolt No : **SN 69**
Type of Test : Proof Test
Working Load : 40 kN
Test Load : 60 kN

DG 1 Ref : 263121
DG 2 Ref : 263122
DG 3 Ref : 263123
DG 4 Ref : 263124
Pressure Gauge Ref : 3070
Load cell Ref : 09092674

Bar size/length : Y 20 / 6 m
Type Of Jack : DH 302 / 30 ton
Ram Area : 7.22 in square
Tested By : Tan Say Hong

	Minimum Period Of Observation	Reading Taken at Interval	LOAD			DIAL GAUGE READING (mm)			Nail Movement
			LOAD	LOAD	PRESS	DG	DG	DG	(DG1+DG2+
TIME	min	(Minutes)	(%)	(kN)	(PSI)	1	2	3	DG3)/3
11:00am	1	1	10	4	71	0.00	0.00	0.00	0.000
	1	1	25	10	177	0.30	0.29	0.22	0.270
	1	1	50	20	353	1.01	0.95	0.88	0.947
	1	1	75	30	530	1.64	1.50	1.45	1.530
	1	1	100	40	706	2.28	2.07	2.00	2.117
	1	1	125	50	883	2.85	2.57	2.52	2.647
	1	1	150	60	1060	3.45	3.13	3.04	3.207
	1	2	150	60	1060	3.50	3.20	3.09	3.263
	1	3	150	60	1060	3.55	3.25	3.14	3.313
	1	4	150	60	1060	3.55	3.26	3.15	3.320
	1	5	150	60	1060	3.58	3.29	3.16	3.343
	5	10	150	60	1060	3.61	3.31	3.24	3.387
	5	15	150	60	1060	3.62	3.34	3.25	3.403
	1	1	100	40	706	3.03	2.89	2.74	2.887
	1	1	50	20	353	1.76	1.81	1.67	1.747
	1	1	10	4	71	0.40	0.47	0.41	0.427
	1	1	25	10	177	0.66	0.71	0.65	0.673
	1	1	50	20	353	1.36	1.35	1.27	1.327
	1	1	75	30	530	2.05	1.97	1.90	1.973
	1	1	100	40	706	2.63	2.46	2.40	2.497
	1	1	125	50	883	3.17	2.96	2.90	3.010
	1	1	150	60	1060	3.63	3.37	3.30	3.433
	1	2	150	60	1060	3.67	3.41	3.35	3.477
	1	3	150	60	1060	3.68	3.43	3.36	3.490
	1	4	150	60	1060	3.69	3.44	3.37	3.500
	1	5	150	60	1060	3.70	3.45	3.38	3.510
	5	10	150	60	1060	3.72	3.46	3.40	3.527
	5	15	150	60	1060	3.74	3.50	3.43	3.557
	1	1	100	40	706	3.16	3.07	3.00	3.077
	1	1	50	20	353	2.02	2.08	1.95	2.017
	1	1	10	4	71	0.55	0.61	0.65	0.603

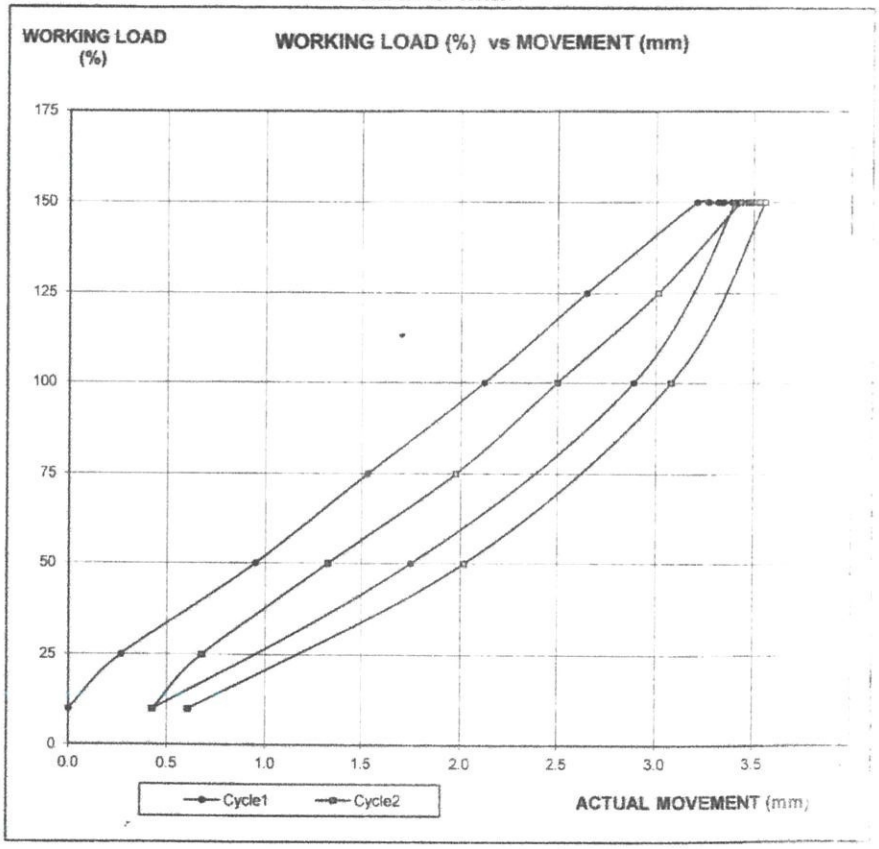
SLOPE ENGINEERING & TESTING 001883299-A

APPENDIX E

SLOPE ENGINEERING & TESTING (001883299-A)

Project: **MEMBAIKPULIH CERUN DAN KERJA - KERJA BERKAITAN DI ANTARA SEKSYEN 13.25 - 14.25 LALUAN B23, JALAN ULU YAM - SUNGAI TUA, DAERAH GOMBAK, SELANGOR**

Date of Test	: 5th of January 2012	DG 1 Ref : 263121	Bar size/length : Y 20 / 6
Rock Bolt No	: **SN 69**	DG 2 Ref : 263122	Type Of Jack : DH 302 / 3[illegible]
Type of Test	: Proof Test	DG 3 Ref : 263123	Ram Area : 7.22 [illegible]
Working Load	: 40 kN	DG 4 Ref : 263124	Tested By : Tan Say Hong
Test Load	: 60 kN	Pressure Gauge Ref : 3070	
		Load cell Ref : 09092674	



After the 2 cycle test, the nail came out 0.603 mm only.