DEPARTMENT OF BUILDING

FACULTY OF ARCHITECTURE, PLANNING AND SURVEYING

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It is recommended that the report of this practical training provided

by

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2017206638

entitled

Slope Stabilization

be accepted in partial fulfillment of the requirement for obtaining the Diploma In Building.

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STUDENT'S DECLARATION

I hereby declare that this report is my own work, except for extract and summaries for which the original references are stated herein, prepared during a practical training session that I underwent at JKR Kota Tinggi for a duration of 20 weeks starting from 5 August 2019 and ended on 20 December 2019. It is submitted as one of the prerequisite requirements of BGN310 and accepted as a partial fulfillment of the requirements for obtaining the Diploma in Building.

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ABSTRACT

Slope instability is a common phenomenon happening around the world. Every problem always have the solution. Slope stabilization is one of the solution to repair a damage slope. A few types of method can be used to stabilize the damaged slope such as rubble wall and stone pitching, soil nailing, gabion wall and rockfill and drainage. The purpose of this research is to investigate the method used, which is rubble wall and stone pitching, in stabilizing the damage slope located at Felda Air Tawar 3, Kota Tinggi, Johor. Various method were used to collect and obtain data during this practical training period. At the same time, advantages and disadvantages of the method used were also identified. The cause of the slope damage at Felda Air Tawar 3 is human modification of slope towards parts of the slope to make an access road towards houses down the slope. Necessary excavation and boring were done on the slope surface before constructing the rubble wall, stone pitching and drainage. The construction were on going for 62 days.

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CHAPTER 1.0

INTRODUCTION

1.1 Background and Scope of Study

Figure 1.1 : Rubble Wall and Stone Pitching

Slope instability and erosion of the soil by water and wind are major environmental hazards. Although the result of it are natural geomorphological processes, both affected by and have consequences for human daily activities, which could cause discomfort, often incurring economic and social damage. (Morgan 2003) Vegetation is one factor that works as to maintain the equilibrium in the landscape between the destructive forces of landscape instability and the constructive or regenerative forces of stability. (Morgan 2003) Besides the vegetation method, there are a few other methods that can be used for stabilizing the slope failure. Some of the methods are by constructing retaining wall on the fail slope which are rubble wall and stone pitching as shown in **Figure 1.1**, gabion wall as shown in **Figure 1.2**, rock fill and drainage and soil nailing.

Figure 1.2 : Gabion Wall at Jln Felda Tenggaroh

For scope of study, it was carried out at Felda Air Tawar 3 which is located at Kota Tinggi, Johor. For this construction, they use the method of rubble wall and stone pitching with the additional works of drainage construction. According to the situation at the site, the materials used in this for rubble wall are good quality stones with water absorption less than 5%, Portland cement, water, fine aggregate and mortar. As for stone pitching, granite stones, gravel or crushed stones, coarse aggregate and 1:2 cement and sand mortar. To make the rubble wall and stone pitching, the workers used excavator to excavate the unneeded soil from the slope and a loader to load the stone used in this method.

1.2 Objectives

a) To investigate the method of rubble wall, stone pitching and drainage construction.

b) To identify the advantages and disadvantages of using rubble wall and stone pitching method.

c) To identify the cause of slope damage.

1.3 Research Methods

To achieve the information and obtain data for this study, a few methods of research were used. The methods are as following :

1. Observation – Based on the observation at the site, the methods identified being used at the site was rubble wall and stonepitching. The observation took two days which were being carried out on two respective days. As for the first day of observation, the workers were still in the excavation part while for the second day of the observation was the workers already start with the installation of footing. On the same day, they were supposed to lay off concrete by 3 p.m in the evening. Pictures and videos were taken as data later.

2. Interviews – Interviews were carried out during the observation which involves the engineer, an employee and the workers. The interviews were considered as unstructured-interviews as the questions were not prepared beforehand. The interviews were recorded on a piece of paper.

3. Document reviews – A few documents reviewing were done to collect data for this report, such as reviewing construction drawing, JKR specification, company profile and pictures given by JKR Kota Tinggi and main contractor, PUSB.

CHAPTER 2.0

COMPANY BACKGROUND

2.1 Introduction of Company

Figure 2.1 : Jabatan Kerja Raya (JKR) official logo

JKR Kota Tinggi (JKRKT) is the branch of JKR JOHOR which the main office is located at Johor Bahru. JKR Kota Tinggi is located at Abdul Aziz road, Kota Tinggi.

Figure 2.2 : Bangunan Sultan Iskandar

Originally, this building was located in Bangunan Pejabat Penyelenggaraan Bangunan, Jalan, Elektrik dan Pelan which was located at Jalan Lombong, known as Jalan Tun Hababb now, opposite to Hospital Kota Tinggi before transferring to 5th floor of Bangunan Sultan Iskandar, Kota Tinggi as shown in **Figure 2.2**.

Figure 2.3 : JKR (D) Kota Tinggi

JKRKT finally moved to their own building as shown in **Figure 2.3**, right now permanently on January 2009. JKRKT used to have two offices which are at Kota Tinggi district and JKR KEJORA office. Then, when JKR KEJORA was dismissed at 1st March 1998, all the staff from the office were placed in JKRKT including the on-going projects that time.

JKRKT used to have several active department such as department of building, department of road, and department of water supply maintenance which were led by district engineer, assistant road technician, assistant building technician, assistant building maintenance technician and assistant education technician. Those representatives were also supported by administration department, workshop, store and a few other small branches in regards to handle and implemented the works of department of road and maintenance of government's building.

In addition, JKRKT were given the responsibilities to carry and handle a lot of maintenance project mainly as for outside and inside the state and other government bodies.

2.2 Company Profile

JKR Johor main office that is located at Johor Bahru were led by the Director of JKR Johor, Ir. Haji Mohamad Salleh Bin Abu Bakar. While for Kota Tinggi branches, it was led by Ir. Normansah Bin Bokhari, the District Engineer at JKR Kota Tinggi.

To give the absolute foremost to the citizen, JKRKT have their own vison and mission. The vision is to give the finest services towards the public and citizen with the world class services and utilities in the assets management sector, project management and the country's infrastructure development that based on creative and innovative individual also latest technology system.

As for the mission, JKR will always contribute in developing the countries more by helping customers to realization their policy information and deliver the services by the cooperation of as strategical partnership. At the same time, JKR standardizes the process and system to give a consistent services qualities for customers. JKR also serves an innovative and creative assets and projects management services and tightening the existing engineering competencies.

Next, for objectives, JKR provides government infrastructure for customers to fulfill the country's principle by focusing on delivering 100% of project based on schedules agreement with the 10% of variant. JKR also completed 100% of the project according to the cost with the variant of 10%.

2.3 Organization Chart

Organization chart of JKR Kota Tinggi employees as followed :

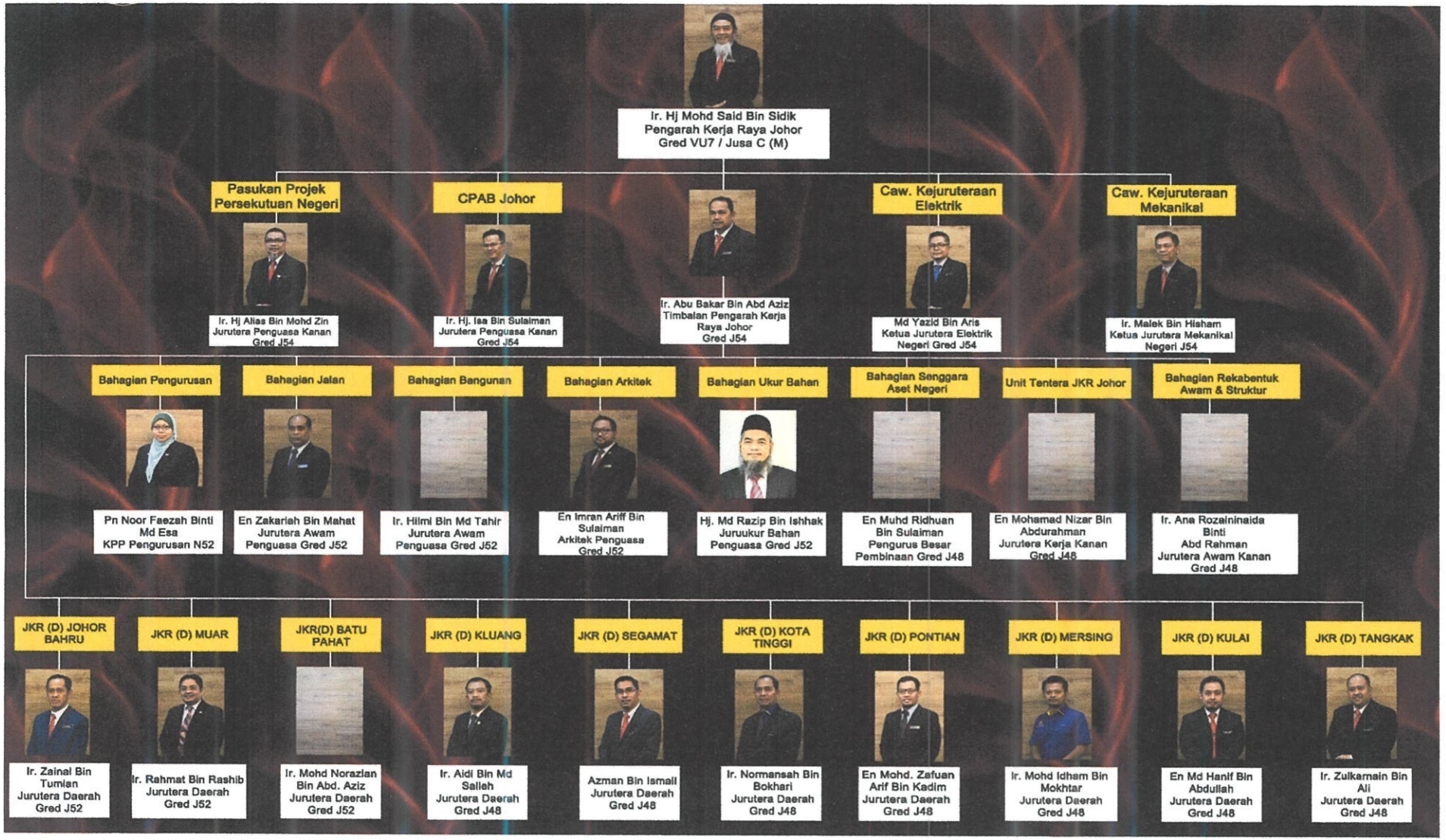

Figure 2.4 : Organization Chart of Jurutera Daerah

2.4 List of Projects

Following is the list of completed projects by JKR Kota Tinggi :

Table 2.1 : List of Completed Projects

NO.	NAME OF PROJECT	CONTRACTOR	DATE
1	Existing Bridge Replacement Works In FT003 / 86/90 And Other Related Works Over The Semanggot Kiri River, Mersing District, Johor.	Mekar Bina & Trading	10 Sept 2015 to 9 March 2017
2	Proposal To Build A Concrete Bridge To Replace The Existing Narrow Bridge At Endau-Penyabong Road, Mersing, Johor.	Sigma One Development Sdn. Bhd	13 Jan 2016 to 4 Apr 2017
3	Constructing a Mosque in Taman Megah Ria, Pasir Gudang, Johor.	Probuild Construction	19 Nov 2015 to 5 Apr 2017
6	Proposal to Replace the Bridge at Jln Layang-Layang (J06) Sec. 0.5 Kulaijaya, Johor.	Antena Bina Sdn. Bhd	7 Jan 2016 to 7 Dec 2016
7	Upgrading Works of Access Road at Kampung Tamok-Kemidak, Labis, Segamat, Johor.	Mohd. Nasir Enterprise	18 Aug 2015 to 14 Sept 2016

8	Upgrading Basic Facilities, Infrastructure and Utilities at Pulau Aur, Johor.	Achieve Think Sdn. Bhd	9 Nov 2015 to 8 May 2016

CHAPTER 3.0

SLOPE STABILIZATION

3.1 Introduction of Slope Stabilization

The project for this report was located at road FT1403 Section 0.00, Felda Air Tawar 3, Daerah Kota Tinggi, Johor. This project involves the use of the method rubble wall and stone pitching as the slope stabilization method. To be specific, this project was located just besides a residence house at Felda Air Tawar 3. The main contractor involved in this project was Pintas Utama Sdn. Bhd (PUSB) which was monitored by Jabatan Kerja Raya (JKR) Johor Cawangan Kota Tinggi. The organization chart of main contractor PUSB is attached in this report as shown in **Appendix I**.

This project was carried on for 62 days, which were from 29 July 2019 until 28 October 2019 attached in **Appendix I**. The cost of this project is RM 282,000. The purpose of this slope stabilization construction was to tend the failure happened at a location that can be dangerous and harmful for the villagers there as the slope was right beside a residence house. At the same time it could harm the children that are playing around the side of the road. Besides, there were a few other houses located around the area, a school and a mosque. This slope failure situation could affect the villagers especially those who are going to school and mosque as the site of the specifically small road were already unstable. Moreover, this could be dangerous for the school bus to be using the road with that kind of situation.

The activities that were carried out at the site were site investigation involving boring soil using rotary wash boring method. There were also site investigation on soil description to investigate the colour, strength, particle shape and composition, structures, soil types, weathering grade and any additional information. Site investigation was also including the sampling and JKR probe test. The most importantly, the main activities was the construction of rubble wall and stonepitching which were the method used for the slope stabilization. The site visit were carried out occasionally if there were any changes to be made on the construction and checking were to be made.

3.2 Rubble Wall and Stonepitching Construction Method

The construction of this slope stabilization is for the safety and comfort for the villagers as the condition of the slope soil were hazardous for quite sometimes. Without repairing the slope, villagers safety cannot be assure as it was located at the side of a road being used to go to school and mosque. This could not only harm the people using the road but also the family staying in the house down the slope. Despite being a small project, a few machineries and equipments were used for the construction such as compressor, rotary drill, excavator, backhoe and 6 m or 7 m drilling rig for wash boring. Rubble wall and stonepitching is one of the common method being used in Malaysia as one of the slope stabilization method.

3.2.1 Rotary wash boring in soils.

i. A standard drilling rig with the height of 6 m to 7 m was used to advance the hole and obtain samples. Boreholes were advanced by using the rotary wash boring method which a cutting tool was rotated by the drilling rig while drilling fluid were pumping down the drill rods to wash soil cuttings to ground level. The sides of the boreholes were supported either by casing or drilling mud consisting of water as the procedure carried on until a specified resistance was reached according to the Standard Penetration Test (SPT) attached in **Appendix II.**

ii. After the boring test, small disturbed samples were taken from the boreholes using the split spoon sampler and placed immediately in an air-tight plastic bag. Ground water samples were taken from borehole after removing mud and water added to assist the boring beforehand. As for the undisturbed sample, the borehole was cleaned out to the required depth and water maintained close to ground level. The piston sampler was lowered to the required depth and the inner rod with piston attached together was then connected to the mast of the drilling machine.

iii. The outer part of the sampler with sampling tube attached was pushed using the outer drilling rods with single steady movement into the soil being sampled while the piston remains stationary. The complete assembly was then pulled up to ground level as the piston remaining was locked in position. After that, the sampler was stripped down and cleanedand the ends was sealed with the non-shrinking micro-crystalline wax and rubber end caps. The maximum length that can be sampled was 0.8 m due to the space occupied by the piston while the empty spaces inside the tube were packed with saw-dust.

3.2.2 Mackintosh / JKR Probe Test

The Mackintosh or JKR probe consisted of a cased hardened steel cone. This cone was screwed on to a rod of 1.2 m length. More rods could still be connected to one another via a coupling for further used as the probe was driven deeper into the soil. The cone was driven into the ground by hammer falling freely along the guide road through a height of 300 mm onto an anvil. The total number of blows required for a penetration of 300 mm was then recorded.

3.2.3 Site Clearing Works

Figure 3.1 : Site clearing works (Source: Courtesy of JKRKT)

i. Site access road was constructed while also making use of the existing public road for the access to the site. All trees inside the area was uprooted by using the excavator as the condition of the existing ground was good as shown in **Figure 3.1**. Branches and stumps of the trees were transferred to the dumpsite later. Holes from the uprooted tree were cleansed out using backhoe and the workers.

Figure 3.2 : Plastic barriers placed along the road (Source: Courtesy of JKRKT)

ii. Plastic barrier were being put on site, along the road as shown in **Figure 3.2**.

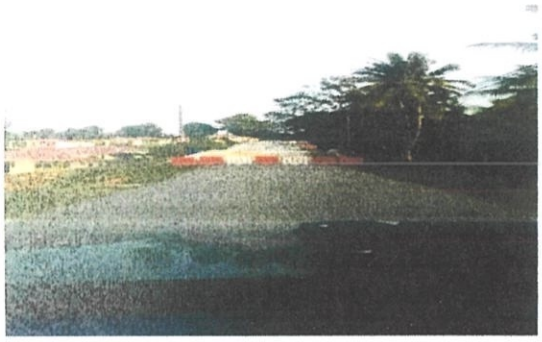

Figure 3.3 : Plastic barriers placed at the end of the road closure (Source: Courtesy of JKRKT)

While plastic barrier being put at the placed at the road closure were as shown in **Figure 3.3** before construction started. It was as the barrier so that the villagers did not use the road for the time the construction was still on going. However, the road was only close during the day and will open on the nighttime.

iii. The structures within ROW were demolished and removed by either dismantling by hand or by excavator. As for the existing sewer drainpipes or culvert were excavated and disposed. The equipment were either returned to the relevant authority or the owner, if required.

Figure 3.4 : Electric cable found beneath the ground

iv. During the construction, there were electric cables found that were laid underground near the slopes which the contractor were not awared beforehand as shown in **Figure 3.4**. As the manpower on duty notice it, the contractor directly contacted with TNB authorities for further action to be taken as the villagers needed another alternative electrical supply. As for the next day, the contractor and workers on site were informed that the electrical supply were supplied through generator provided for the mean time.

v. Other street furniture such as guardrails were dismantled and stored for re-use as required after the construction completed later. E.G.L. survey were carried out progressively with the clearing work, from ROW to ROW.

3.2.4 Construction of Footing for Rubble wall and Stonepitching

The purpose of stone masonry footing is to support the structural walls and transfer the load to the soil beneath the ground.

Figure 3.5 : Trench excavation for footing

i. Firstly, the ground were excavated to make a trench by using excavator as shown in **Figure 3.5** which took around a day while other materials like aggregates and granite stones had arrived to prepare for the next step.

Figure 3.6 : Hardcore with the thickness of 300mm being poured

ii. After the trench were dug and prepared, a layer of hardcore with the depth of 300 mm were poured as shown in **Figure 3.6**. After the hardcore have been laid, 50 mm thickness of lean concrete were laid before laying the plastic sheeting material of damp proof course (DPC) which works as to prevent rising damp and in some situations to prevent from any penetrating damp.

If the rubble masonry can easily absorbed water and moisture, the masonry could not last for a long time and might have damage in short period of time. Soon, spacer bars were put above the plastic sheeting of DPC as the spacer for concreting work later.

Figure 3.7 : BRC wire mesh steel

iii. Before concreting works, two layers of BRC wire mesh steel as shown in **Figure 3.7** with the size of A10 were installed as to tighten the concrete slab.

Figure 3.8 : Dowel bars being installed

iv. To lock the footing with the rubble wall, dowel bars were installed as shown in **Figure 3.8** with the size of T12 and spacing at 200 c/c from one another. Later on, grade JKR 30 concrete were poured with thickness of 300 mm. As this project were monitored by JKR, most of the materials specification were required to follow JKR specification especially for the concrete grade as standard grade 30 concrete were quite different compared to grade JKR 30 concrete.

3.2.5 Construction of Rubble Wall

Rubble masonry construction were made following the specification of JKR. The rubble masonry must be hard, durable and tough so the stones, which were roughly dressed and uniformly colored and of equal size were soaked before being used.

Figure 3.9 : Rubble wall works in process (Source: Courtesy of JKRKT)

i. Granite stones with the size of 225 mm to 300 mm were poured onto the footing. The masonry work then were carried out as far as possible at one uniform level throughout but as for the parts where the breaks are unavoidable the joint were made in good long steps to prevent cracks between the old and new works as shown in **Figure 3.9**.

ii. The granite stones were arranged to break joints as much as possible and long vertical lines were being avoided in face work. Simultaneously, 50 diameter UPVC weep holes were also installed at 1.5 m centers can be seen in the drawing in **Appendix II.** The purpose of putting the weep holes were to provide opening that allows any moisture that came from back of the wall through penetration and leakage. At the same time, the weep holes were also as ventilators to allow air to the back of the wall to prevent mildew, dry rot and damp in the future after the construction were completed.

iii. Spawls, which was the fragment broken off from the edge of the stones were being used when necessary as to avoid thick mortar beds for joints and must not exceed 20%. To hammer down the stones in position and embed it in the mortar, an equipment, wooden mallet were used. Lastly, the iron templates were used to compact the mortar in the masonry joints. Rubble masonry was constructed with 2.25 m height from the below ground level.

3.2.6 Construction of Stone Pitching

i. The stones used for the construction of stone pitching were granite stones which were free from cracks and of size 225 mm to 300 mm. Based on the construction drawing in **Appendix II,** geotextile separator were used to tighten the soil and increase the soil stabilization. Besides being used for the stone pitching, the geotextile were also being put surrounded crushed rock for 75 mm diameter weep holes installed beforehand in rubble wall.

ii. Before constructing the stonepitching, the slope were trimmed to an even surface as to make sure it was free from any unneeded loose debris and topsoil. To make sure the pitching were having even upper surface and can hold the granite stones properly, the soil were excavated more when necessary.

Figure 3.10 : Stone pitching works in progress

iii. The granite stones were then bedded into the slope surface as shown in **Figure 3.10**. Next, as it is a dry masonry wall, the stone pitching were built carefully and the stones were fitted together firmly.

Figure 3.11 : Stone pitching works in process (Source: Courtesy of JKRKT)

iv. The workers were making sure that the stones were perpendicular to the slope with the main point as the gradient is stable. A rough surface were left to retard any water flow in the drain and gullies. Other than planting grasses for strengthening the slope, this method used cement mortar instead although this method could impede drainage.

4 Drainage Works

Figure 3.12 : Drainage excavation

Figure 3.13 : Cascade drain construction in progress (Source: Courtesy of JKRKT)

i. After the construction of stone pitching was completed, the drainage work started. Point and space for the drain and sump were excavated as shown in **Figure 3.12** to the required depth to invert level as the drain were also excavated besides shoulder drain. The type of drains used were cascade drain as shown in **Figure 3.13** and interceptor or toe drain.

ii. After the excavation, the gradient were checked to ensure free flow of water later. As the gradient has been approved by Engineer (JKR), 50 mm thickness of lean concrete were laid along the drain. After laying the lean concrete, BRC A8 were installed on the lean concrete. Spacer bars were also used as to ensure the 50 mm thickness were achieved. For concreting works later, formwork for the drain walls were set up. Concrete used were of grade JKR 25. Concrete were cured for at least 2 days before dismantling the formwork.

Figure 3.14 : Installation of toe drain (Source: Courtesy of JKRKT)

iii. Next, prior to the interceptor drain installation as shown in **Figure 3.14**, the drain platform was compacted and tampered to ensure good ground preparation. As the shape of drains have been excavated, a reinforce mesh were placed and bended according to the shape of the drain. Then, a layer of concrete lining were applied. When concreting works were completed,the drain surface were troweled.

Figure 3.15 : Concrete slab as the cover for toe drain (Source: Courtesy of JKRKT)

iv. The intercepter/toe drain were covered by the concrete slab as shown in **Figure 3.15** as to prevent any debris from entering the drain.

v. The drain were later installed before backfilling the surrounding of drain to the finish profile with suitable materials and compacted.

Figure 3.16 : Backfilling soil onto covered drains (Source: Courtesy of JKRKT)

vi. Afterward, sumps were constructed which later works to facilitate the changes of level and flow within a drainage system. The sumps were covered by galvanized steel grating hinged as for safety and preventing from any big debris from entering the sumps. Last but not least, bedding was done consisting of grade 20 P concrete and backfilling of soil onto drains as shown in **Figure 3.16** after finishing the concrete slab installation for the drains. Completed works photos were attached in **Appendix III**.

3.3 Advantages and Disadvantages of Rubble Wall and Stone Pitching

Method might be a solution and way to fix thing but they also have the advantages and disadvantages. As for masonry method, there might be the used of brick or stone. For this topic, stones were used to build the rubble wall. As for the stone pitching, it is specific to be using stones. However, for rubble wall are not specified to be for slope stabilization but also for building. Here are some of the advantages and disadvantages shown in Table 3.1.

Table 3.1 : Advantages and Disadvantages of using Rubble Wall and Stone Pitching Method

RUBBLE WALL AND STONE PITCHING		
NO.	**ADVANTAGES**	**DISADVANTAGES**
1	**Durable and Strong** Stones are always known as the most durable and strong material since centuries. For example, back in centuries, the used of different kind of materials in construction were practical. They did not have bricks like nowadays so materials like stones were used and it was long lasting, sometimes until now. Other than that, stones are weather resistant. It could withstand any sort of climate. (Patel) Any buildings of stones masonry were still intact nowadays due to their high durability.	**Very Slow Execution** As days goes by, the specialized workmanship are difficult to find. Labours nowadays are mostly familiar with bricks as the source materials for construction. Moreover, these labours are mostly came from other countries. There are specialize on this field but very limited and require more credibility. As stones are not in uniform shapes which can easily stacked together like bricks shapes.
2	**Hard to Chip and Unbendable** Stones are very tight and hard to chip. This criteria could save them from spending money to repair. Due to the hardness, any impact of sudden shocks will not easily break them. Eventhough the stones are in random shapes and sizes, the bonding when using	**Difficult to Repair and Relocate** As stones are not in uniform shapes, if there is a slight dislocated stones at the stacks, it is difficult to relocate back. This is because once the stones have been stacked, bonding were used like mortar that makes it hard to repair back. Any foul have to be avoided to prevent

	proper materials can last for a long time. Other than that, it could withstand any weather without easily break out.	from having the rubble wall to be repair and relocate back.
3	**Long Lasting** Due to the durability of this materials, it could last for longer lifespan. Even nowadays people could still find a building from this materials standing proudly with hardly any sign to demolish. That is why older building tend to built by stones and masonry products as it is stronger than most of the materials used nowadays. This could say how far credible the workers or specialized workmanship and even te engineer back in the days.	**Time Consuming** Despite being a stronger materials for constructing building or retaining wall, it took a long time to finish the construction as the design stone masonry is far more complicated. As different type of masonry require different specialized, it took a proper planning of construction timeline as to have the adequate project planning. The construction require high accuracy as the arrangement are more complicated than bricks' arrangement as to prevent any collapse or requirement of relocate in the future.
4	**Aesthetic** One of the reason some may prefer the use of masonry in constructing building is that it offers the aesthetic value which appealing to anyone seeing the building. Compare to the normal design of bricks arrangement which appear a simple design, some may be choosing masonry as to experience the difference. It cannot be denied that masonry design will always catch the attention first when there were a bunch of buildings at a place. Although every building have their own uniqueness, masonry design will appeal to people's eyes. It can be imposing,	**Undefined Stability** In constructing masonry, it requires a strong foundation as the masonry walls are heavy especially if it is for a building. For example, in this report, the construction of rubble wall for the slope at Felda Air Tawar 3 having the footing as to anchor the rubble wall to avoid any slide down by the stone pitching in the future. To be conclude, despite the construction of the rubble wall is small, it still needs foundation as to avoid any cracking and easily damage walls in the future.

	grandiose, dignified, and impressive, but it can also be warm, welcoming and homely (DelPrete, 2015).	

3.4 The Cause of Slope Damage

Slope damage or also can be called slope failures, are major natural hazards occuring both globally and locally. (blisscoding 2017) It could happened from various reason. It is not limited to the high slopes but also the low slopes. When there are damages on the slope, it could be dangerous and hazardous towards the public. Each slope is different in terms of the geology, soil composition, vegetation and a myriad other factors. As they were differed in the factors, the cause of the failures were also different. Therefore, these are some of the causes of slope damage :

a) Steepness of Slope

Different slope have different steepness. However, steeper slopes have greater risks for instability. (blisscoding 2017) In addition, steep slope tend to have the natural tendency to move some of its materials downwards until the natural angle of repose were found. It may be natural tendency for some of the slope, but there are also because of human tendency in removing upper soil of the slopes that causing the soil to fail and move downwards the lower ground. Any form of slope modification, whether it be through natural means such as a stream undercutting the banks of a river or by workers removing a section of the slope's base to build roads, will impact the stability of a slope. (sinaiconstruction 2012) Despite being safe enough if it was located at an open spaces with no residential, there might be a condition where the slope failure to happen above residential area. This could be dangerous to the people living there.

b) Human Modifications

Humans nowadays working on the construction field tend to modify the stability of slopes in many way to suit their purposes of works. This activity may trigger the sudden mass movement of the soil in the slopes. As for example, the removal of slope's base, mining, the passage of heavy trucks, groundwater manipulation and more could cause slope failure and damage. The failure happened usually due to the multi-excavation which will lead to landslide. (Ayalew 2009) In China, landslides due to the excavation in various engineering activities are frequently reported on cut slopes. (Huang, Chan 2004). Unfortunately, in Malaysia, these activities were also being carried out massively.

Figure 3.17 : Access road

For example, the slope instability at Felda Air Tawar 3 were due to the human modifications too. As from the observation on site, the condition of the slope were slightly shaken and instable was because of the modifications made to the parts of the slope to make an access road towards two houses located down the slope as shown in **Figure 3.17**. It makes more unbearable as the access road made on the slope was by unprofessional person.

As modifications were made there without specialize workmanship and further investigation on the slope, the rest of the soil of the slope received the impact too which resulting to the unstable slope. Nowadays, people will see a lot of excavation being done on slopes. In order to build more buildings in becoming one of the developed countries, more slope were excavated. Other than that, some of the error made from this modification could cause life in the future if there were no engineered fill on the slopes. If the slopes were to be modified, it could have further engineered fill. Take Highland Tower tragedy as example, one of the main reason of the landslide and slope failure was because of the soil creep due to the non-engineered fill on the slopes which were affecting the strength of the slope. (Kazmi 2017) In this stated that human modification can be done only if further matter were taken seriously, not only changing the soil composition and textures.

c) **Soil Composition**

Figure 3.18 : Road above the slope

Soil composition becoming loose because of the frequent modifications. As different soil have different composition and durability, some of them might be loose and some might be tight. Different types of soil also have different characteristic when it comes to frictional resistance towards the erosion and cohesion between the grains. Loose composition soil will move downwards the ground in a form of smaller debris but it will slowly taken the soil from the slope. As the slope becoming loose, bigger debris will start moving downwards too. As example, from the site location at Felda Air Tawar 3, one of the cause was loose soil composition. As it was located right beside a residence house, when the condition get worse day by day, it could affect the house and the upper road as shown in **Figure 3.18**.

Next, usually bigger debris form from compacted particles from the slope. For example, lime stone slopes which can usually be seen on highway. This type of slope are very unpredictable to be failing as it move in bigger debris downwards the ground. This could be hazardous and dangerous to the highway users it could cause accident.

d) **Water and Drainage**

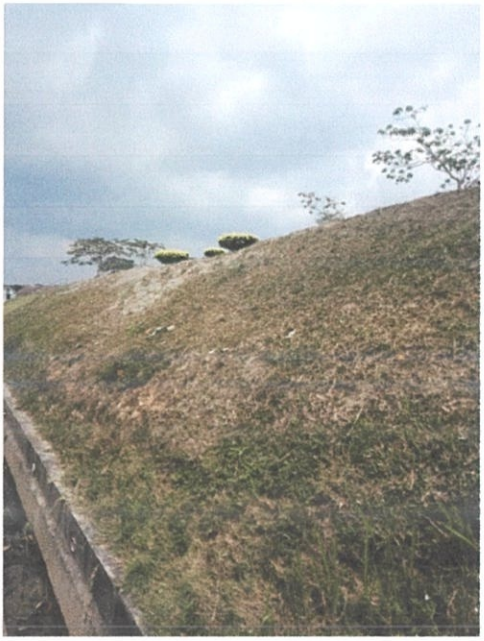

Figure 3.19 : Slope damage at SSTMI

Excessive water and inadequate drainage could cause big impact to the slope condition. For example, during this practical training, one of the location for slope stabilization works at Sekolah Sukan Tunku Mahkota Ismail, Bandar Penawar (SSTMI) were damaged because of the excessive water flow, specifically rainwater as shown in **Figure 3.19**. This is due to the improper drainage system which are making the water to overflow out of the shallow drain and went straight to the hockey field nearby. As the location was at sport school, the hockey field is one of the necessary facilities for the students there. Due to the damages from the water, the students and athletes could not do their training because of the damaged field. According to one of the school teachers, the condition could get worse when it was rainy season.

e) **Vegetation**

One of the other common causes of slope failure is the lack of vegetation. Vegetation in fact is known as the common anchor for slopes or soil. It works as to hold the soil composition so that they will not loose and easily move. It was specifically the plants' roots that were holding the soils as the resistance to the erosion. The lack of vegetation was also due to the constant excavation by human. As the vegetation is lacking, there will be no anchor for the slopes and the soil will easily moves downwards. Before doing any excavation works, the vegetation will be the first one to be removed out of the slopes. This is commonly seen at highways where the

plants that were holding the soils together were moving downwards. This could sometimes even cause discomfort to the highway users.

f) **Sudden Shocks**

Earthquake, blasting, volcanos and tornados are common phenomenon which could cause sudden shocks to the slopes. It could cracks the soil composition and cause sudden mass movement for the soils in slopes. All these shocks later causing the landslide to happen. According Keefer (1984), landslides caused by earthquakes are among the most destructive secondary hazards associated with strong seismicity which are often resulting in damage to infrastructure and loss of life. A huge earthquakes can cause fractures to the slopes which resulting in huge mass movement and later causing slope failure. It also happened due to ongoing slope deformation. This phenomenon applies to the rock type of slopes.

CHAPTER 4.0

CONCLUSION

This project took place at Felda Air Tawar 3, Kota Tinggi, constructing rubble wall and stone pitching as the method to stabilize the damaged slope. The damaged slope were happened to be located beside two villagers' houses. The process of this construction were on going for 62 days with various research methods being carried. Observation, interviews and documents previews were given by the assistent engineer in charge in monitoring the site. The procedures carried out were boring, site clearing works and excavation before proceeding with constructing the rubble wall, stone pitching and drainage system. Before constructing the masonry, the gradient of the slope were checked by engineer as to make sure the gradient are following the specifications. Rubble wall and stone pitching were constructed simultaneously in some parts of the design as drainage system were constructed seperately as to focus more on perfecting the masonry. As the materials used were granite stones for the rubble wall and stone pitching, it needs meticulous skill to arrange the stones. The bonding used to bind the stones were mortar.

Moreover, through this research, a few advantages and disadvantages were identified such as the durability of stone masonry, the lifespan of masonry, strengtness of stones and the aesthetic value. Masonry walls are always seen as the aesthetic appeal of certain construction be it the building or retaining walls. Other than that, besides discovering that the cause of the slope damage at Felda Air Tawar 3 was due to human modifications, there are also a few other causes such as sudden shocks, improper drainage system, lack of vegetation and more. To be conclude, the slope damage could happen not only by nature but also by the hand of human themselves. Despite having a lot of damage happen, a lot of stabilization method can be carried out to ensure people's safety and to ensure the environment are free from any damages.

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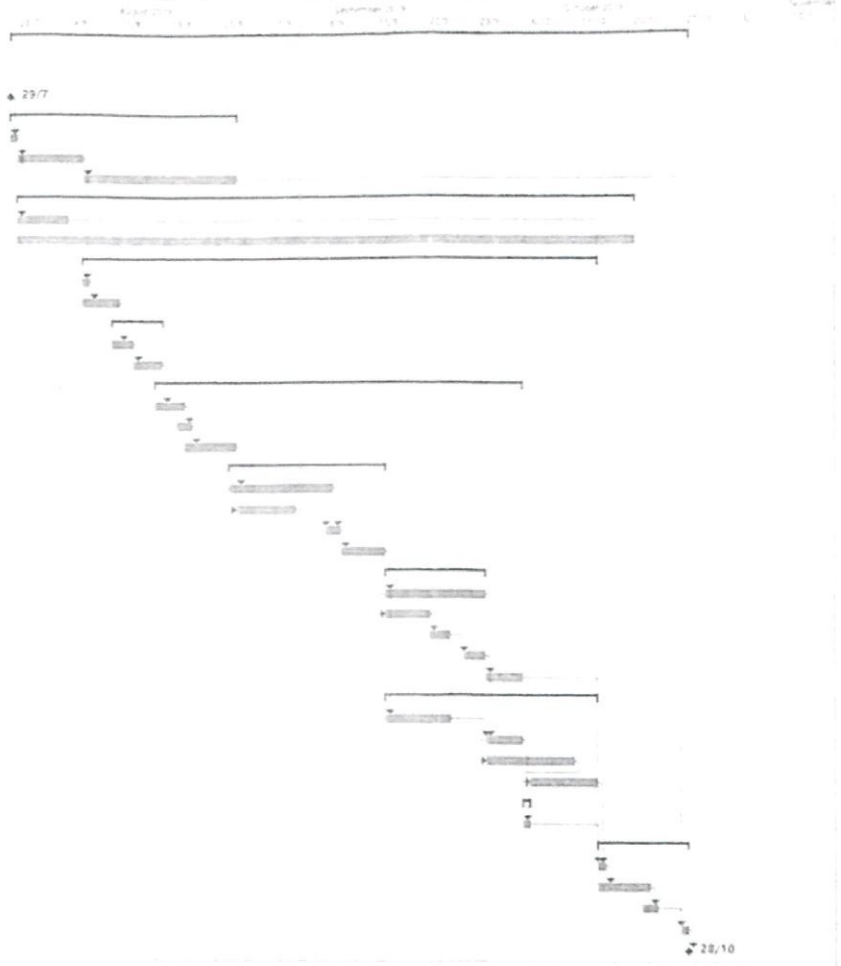
APPENDIX I

KERJA PEMBAIKAN CERUN MENGGUNAKAN KAEDAH RUBBLE WALL DAN STONEPITCHING
DI LALUAN FT1403 SEKSYEN 0.00, DAERAH KOTA TINGGI, JOHOR

	Task Name	Duration	Start	Finish
1	KERJA PEMBAIKAN CERUN MENGGUNAKAN KAEDAH RUBBLE WALL DAN STONEPITCHING DI LALUAN FT1403 SEKSYEN 0.00, DAERAH KOTA TINGGI, JOHOR	62 days	29/7/2019	28/10/2019
2	START	0 days	29/7/2019	29/7/2019
3	PRELIMINARIES	22 days	29/7/2019	28/8/2019
4	Received Work Order from S.O	1 day	29/7/2019	29/7/2019
5	Insurance	7 days	30/7/2019	7/8/2019
6	Performance Bond	14 days	8/8/2019	28/8/2019
7	TRAFFIC MANAGEMENT AND CONTROL	57 days	30/7/2019	21/10/2019
8	Temporary Road Furniture & Signage	5 days	30/7/2019	5/8/2019
9	Traffic Management Team	57 days	30/7/2019	21/10/2019
12	PHYSICAL WORK	47 days	8/8/2019	16/10/2019
13	Mobilization	1 day	8/8/2019	8/8/2019
14	Delivery Material on site	2 days	8/8/2019	12/8/2019
25	Earthworks	5 days	12/8/2019	18/8/2019
26	Site Clearance	3 days	12/8/2019	14/8/2019
27	Excavation	2 days	15/8/2019	18/8/2019
28	Slope Remedial and Mitigation Works	34 days	18/8/2019	6/10/2019
29	Geotextiles	4 days	19/8/2019	21/8/2019
30	Lean concrete	2 days	21/8/2019	22/8/2019
31	Concrete Base	5 days	22/8/2019	28/8/2019
32	Rubble Wall	13 days	28/8/2019	17/9/2019
33	Laying Block Stone with Concrete Mortar	8 days	28/8/2019	10/9/2019
34	PVC Weepholes	5 days	29/8/2019	5/9/2019
35	Sand Filling	2 days	10/9/2019	11/9/2019
36	Filling Works	4 days	12/9/2019	17/9/2019
37	Stone Pitching	10 days	18/9/2019	1/10/2019
38	Stone Pitching	10 days	18/9/2019	1/10/2019
39	Weephole	4 days	18/9/2019	23/9/2019
40	Wet Mortar	3 days	24/9/2019	26/9/2019
41	Dowel Bar	3 days	29/9/2019	1/10/2019
42	Turfing	3 days	2/10/2019	6/10/2019
43	Drainage Work	21 days	18/9/2019	16/10/2019
44	Toe Drain	7 days	19/9/2019	26/9/2019
45	Interceptor Drain	3 days	2/10/2019	6/10/2019
46	Cascade Drain with Handrail	8 days	7/10/2019	13/10/2019
47	RC Sump	7 days	8/10/2019	16/10/2019
48	Road Furniture	1 day	7/10/2019	7/10/2019
49	Signage	1 day	7/10/2019	7/10/2019
50	SUBMISSION DOCUMENTATION	7 days	17/10/2019	28/10/2019
51	Final Joint Measurement	1 day	17/10/2019	17/10/2019
52	As Built Drawing	5 days	17/10/2019	23/10/2019
53	Tidy Up and Clearing Work	2 days	23/10/2019	24/10/2019
54	Handing Over	1 day	28/10/2019	28/10/2019
55	FINISH	0 days	28/10/2019	28/10/2019



Work Program
FT1403 Sek. 0.00 Kota Tinggi Johor

Task | Summary | Inactive Milestone | Duration only | Start only | External Milestone | Critical Split
Split | Project Summary | Inactive Summary | Manual Summary Rollup | Finish only | Deadline | Progress
Milestone | Inactive Task | Manual Task | Manual Summary | External Tasks | Critical | Manual Progress

JABATAN KERJA RAYA MALAYSIA
CAWANGAN KEJURUTERAAN CERUN,
TINGKAT 12, BLOK F,
IBU PEJABAT JKR MALAYSIA,
JALAN SULTAN SALAHUDDIN,
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Kawat : MINTWORKS, KUALA LUMPUR
Fax :
Laman Web : http://www.jkr.gov.my

'CERUN YANG SELAMAT MENYELAMATKAN NYAWA'

SURAT PEMBERITAHUAN ARAHAN KERJA
(PREVENTIVE/CORRECTIVE)

Ruj. Tuan :
Ruj. Kami: (60) JKR/CKC/600-4/14/3(AK)01
Tarikh : 25 Julai 2019

PINTAS UTAMA SDN. BHD.
No.21, Jln. Sg. Burung W32/W
Bukit Rimau,
40460 Shah Alam
Selangor Darul Ehsan

Tuan,

PENYELENGGARAAN CERUN DI JALAN PERSEKUTUAN SEMENANJUNG MALAYSIA MELALUI KONTRAK JANGKAMASA PANJANG MULAI TAHUN 2017
- Surat Pemberitahuan Arahan Kerja Bagi Kerja Pembaikan cerun

Dengan segala hormatnya, saya merujuk kepada perkara di atas.

2. Bersama-sama ini dimajukan rujukan Arahan Kerja berikut untuk tindakan tuan selanjutnya:

(Borang Arahan Kerja Disertakan)

Bil	Rujukan Arahan Kerja	Perihal Kerja	Nilai Kerja (RM)
1.	JKR/CKC/S27/2019/151	Kerja Pembaikan Cerun Menggunakan Kaedah Rubble Wall Dan Stonepitching Di Laluan FT1403 Seksyen 0.00, Daerah Kota Tinggi, Johor.	282,000.00
Jumlah Kos Keseluruhan			**282,000.00**

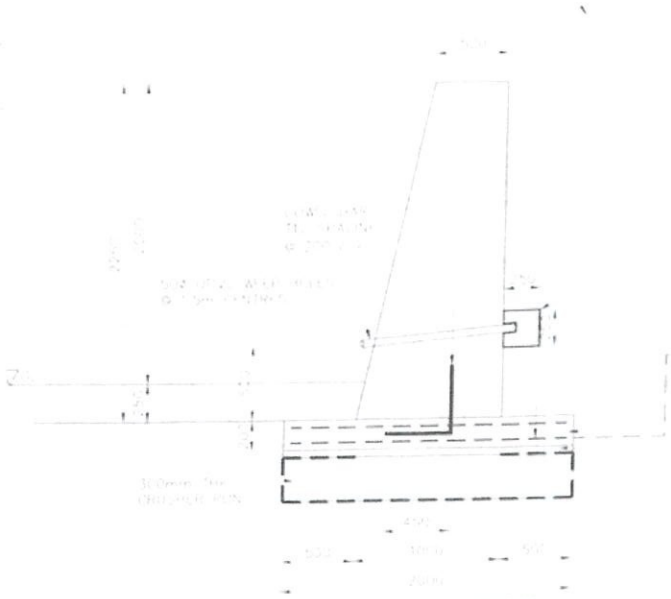
3. Kerja ini hendaklah dimulakan pada **29/7/2019** dan disiapkan sepenuhi **28/10/2019** iaitu **3** bulan dari tarikh mula kerja. Sekiranya tuan gagal memulakan atau menyiapkan kerja pada tarikh yang ditetapkan tindakan yang sewajarnya akan diambil berdasarkan syarat-syarat dalam Perjanjian Kontrak

4. Sila kemukakan Pelan Kualiti Projek (Project Quality Plan) dalam tempoh empat belas (14) hari dari tarikh surat ini yang mengandungi :

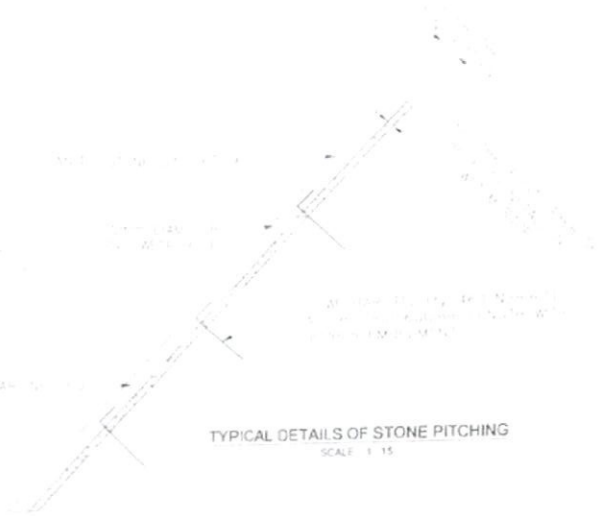
a. Carta Organisasi Dan Tanggungjawab Kontraktor;
~~b. Pelan Penyenggaraan Peralatan~~
c. Program Kerja dan Method Statement;
d. Pelan Pemeriksaan dan Pengujian (Inspection and Testing Plan);
e. Lukisan Pembinaan ; dan
f. Pelan Pengurusan Trafik (Traffic Management Plan) dan pematuhan terhadap OSHA (Occupational Safety Health Act) serta penempatan SSO/SSS di tapak projek
~~g. Risk Management Plan (Untuk Kos Kerja Melebihi RM500,000.00)~~

APPENDIX II

FT1403 : SEKSYEN 0.0



DETAIL OF 2.25 m (H) RUBBLE WALL
SCALE 1:15



TYPICAL DETAILS OF STONE PITCHING
SCALE 1:15

CONSTRUCTION DRAWING

JABATAN KERJA RAYA MALAYSIA

DETAIL OF RUBBLE WALL AND STONE PITCHING

The sides of the boreholes are usually supported either by casing or by drilling mud consisting of water/bentonite mixture. Advancing of hole is achieved by dislodging of soil below the rod by the cutting bit and transport of these cutting to the surface by drilling fluid.

Boring in soil is continued either until a specified resistance is reached according to the Standard Penetration Test (SPT) or a specified depth.

Records of groundwater level are made by measuring depth to water at beginning and end of each day's work.

Standard Penetration Test (SPT)

The Standard Penetration Test (SPT) used in the field to obtain rapid empirical results which can be used estimate shear strength and bearing capacity. The SPT is carried out in borehole at basically 1.5m intervals or as indicated by the Employer.

The SPT consists of driving a split spoon sampler to obtain a disturbed sample of the soil penetrated.

The important details of the SPT equipment areas follow:

EQUIPMENT	DESCRIPTION
Rod	AW type
Hammer	65kg with 0.76m fall and trip mechanism

The penetration test itself is carried out in two stages as follows:

- Seating drive: number of blows for first 150mm penetration. If 50 blows are required before 150mm penetration is reached, then record penetration and terminate seating drive.

- Test drive: number of blows for 300mm penetration after seating drive. If 50 blows are required before 300mm penetration is reached, then record penetration for 50 blows and terminated test drive.

APPENDIX III

PROJEK PENYELENGGARAAN CERUN DI JALAN PERSEKUTUAN DAN JALAN NEGERI SEMENANJUNG MALAYSIA MELALUI KONTRAK JANGKAMASA PANJANG:
KERJA PEMBAIKAN CERUN MENGGUNAKAN KAEDAH "RUBBLE WALL DAN STONE PITCHING" DI LALUAN FT1403 SEKSYEN 0.00, DAERAH KOTA TINGGI, JOHOR

GAMBAR SEBELUM

Site condition before start work

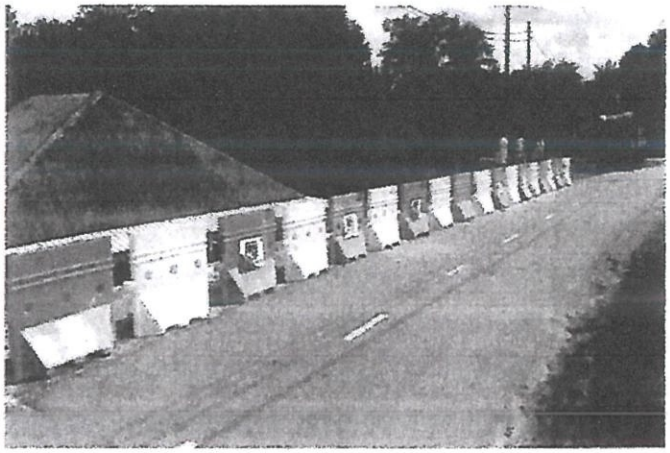
Site condition before start work

Site condition before start work

Site condition before start work

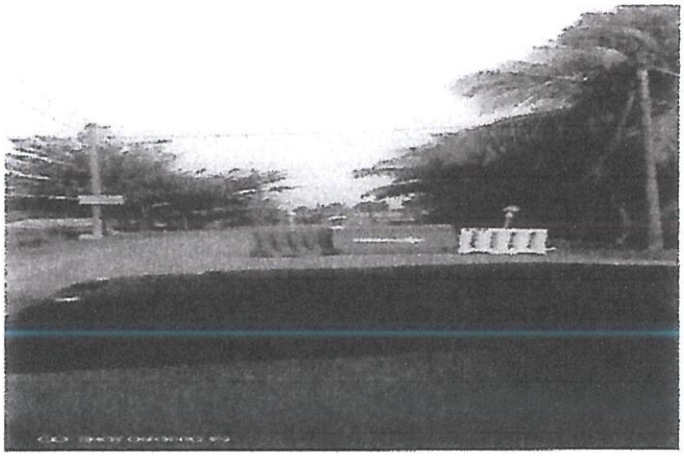
PROJEK PENYELENGGARAAN CERUN DI JALAN PERSEKUTUAN DAN JALAN NEGERI SEMENANJUNG MALAYSIA MELALUI KONTRAK JANGKAMASA PANJANG:
KERJA PEMBAIKAN CERUN MENGGUNAKAN KAEDAH "RUBBLE WALL DAN STONE PITCHING" DI LALUAN FT1403 SEKSYEN 0.00, DAERAH KOTA TINGGI, JOHOR

GAMBAR TRAFFIC AND MANAGEMENT CONTROL

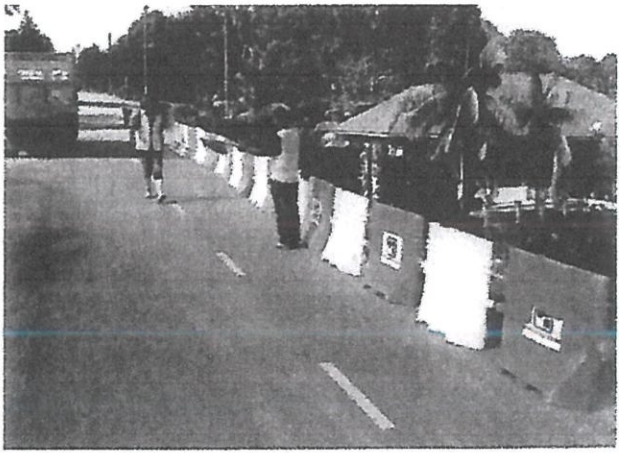


Plastic barrier and signage installation

Plastic barrier and signage installation



Plastic barrier and signage installation



Plastic barrier and signage installation

GAMBAR SEMASA

Site condition before start work

Site condition at excavation in progress

Base slab in progress

Base slab in progress

PROJEK PENYELENGGARAAN CERUN DI JALAN PERSEKUTUAN DAN JALAN NEGERI SEMENANJUNG MALAYSIA MELALUI KONTRAK JANGKAMASA PANJANG:
KERJA PEMBAIKAN CERUN MENGGUNAKAN KAEDAH "RUBBLE WALL DAN STONE PITCHING" DI LALUAN FT1403 SEKSYEN 0.00, DAERAH KOTA TINGGI, JOHOR

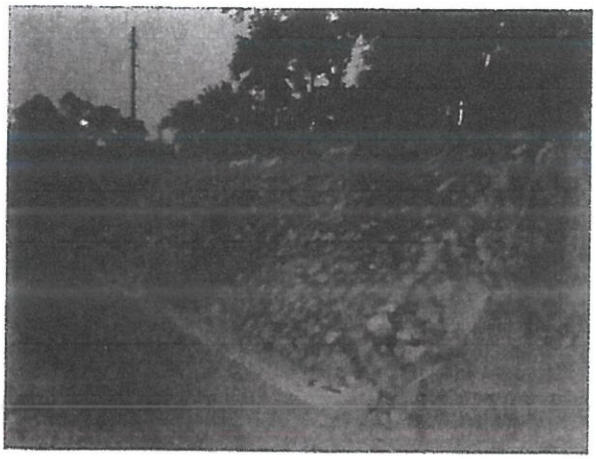
Crusher run backfill ongoing progress

Crusher run backfill ongoing progress

Stone Pitching works in progress

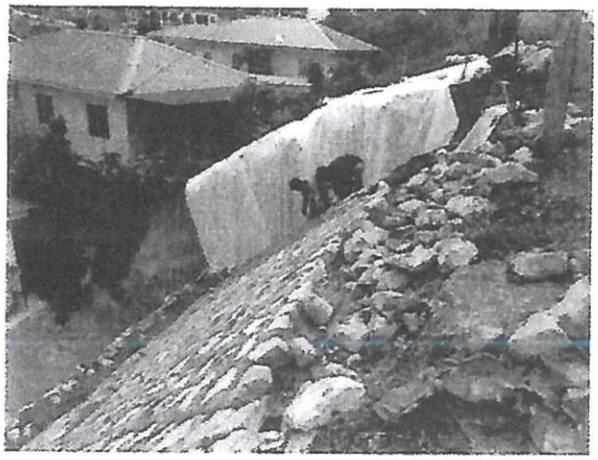
Stone Pitching works in progress

PROJEK PENYELENGGARAAN CERUN DI JALAN PERSEKUTUAN DAN JALAN NEGERI SEMENANJUNG MALAYSIA MELALUI KONTRAK JANGKAMASA PANJANG:
KERJA PEMBAIKAN CERUN MENGGUNAKAN KAEDAH "RUBBLE WALL DAN STONE PITCHING" DI LALUAN FT1403 SEKSYEN 0.00, DAERAH KOTA TINGGI, JOHOR



Stone Pitching works in progress

Stone Pitching works in progress



Stone Pitching works in progress

Stone Pitching works in progress

PROJEK PENYELENGGARAAN CERUN DI JALAN PERSEKUTUAN DAN JALAN NEGERI SEMENANJUNG MALAYSIA MELALUI KONTRAK JANGKAMASA PANJANG:
KERJA PEMBAIKAN CERUN MENGGUNAKAN KAEDAH "RUBBLE WALL DAN STONE PITCHING" DI LALUAN FT1403 SEKSYEN 0.00, DAERAH KOTA TINGGI, JOHOR

Stone Pitching works in progress

Stone Pitching works in progress

Stone Pitching works in progress

Stone Pitching works in progress

PROJEK PENYELENGGARAAN CERUN DI JALAN PERSEKUTUAN DAN JALAN NEGERI SEMENANJUNG MALAYSIA MELALUI KONTRAK JANGKAMASA PANJANG:
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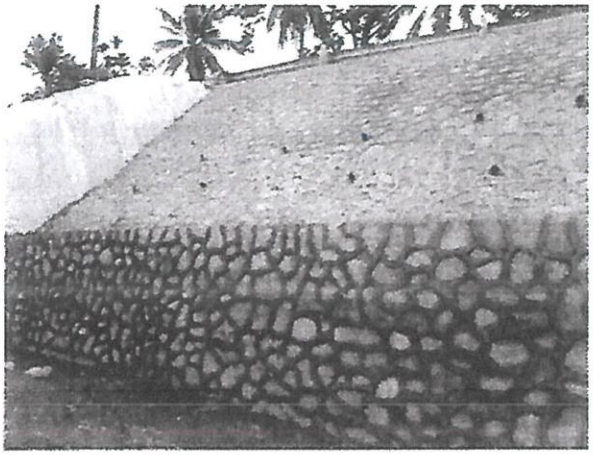
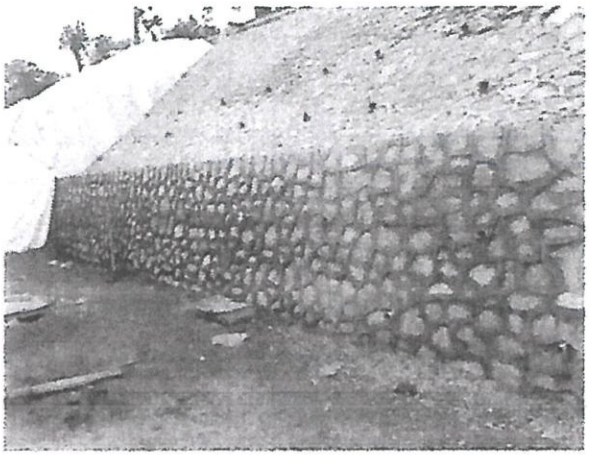


Rubble wall works in progress



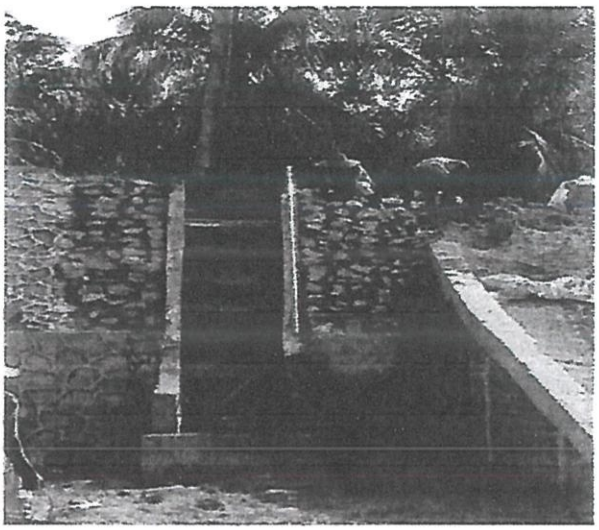
Rubble wall works in progress

Stone Pitching works in progress

Stone Pitching works in progress

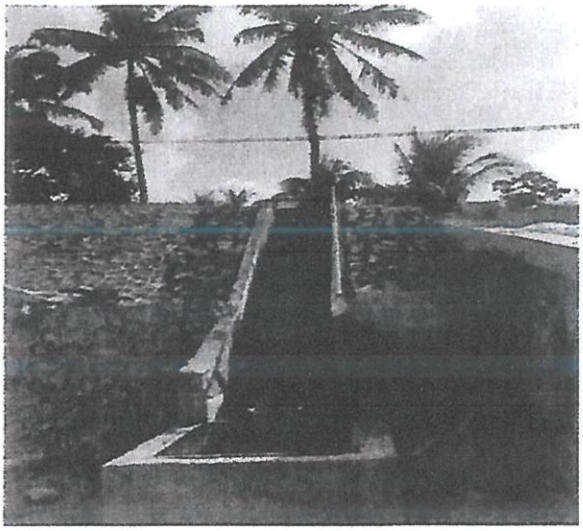
PROJEK PENYELENGGARAAN CERUN DI JALAN PERSEKUTUAN DAN JALAN NEGERI SEMENANJUNG MALAYSIA MELALUI KONTRAK JANGKAMASA PANJANG:
KERJA PEMBAIKAN CERUN MENGGUNAKAN KAEDAH "RUBBLE WALL DAN STONE PITCHING" DI LALUAN FT1403 SEKSYEN 0.00, DAERAH KOTA TINGGI, JOHOR

Stone Pitching works in progress



Stone Pitching works in progress

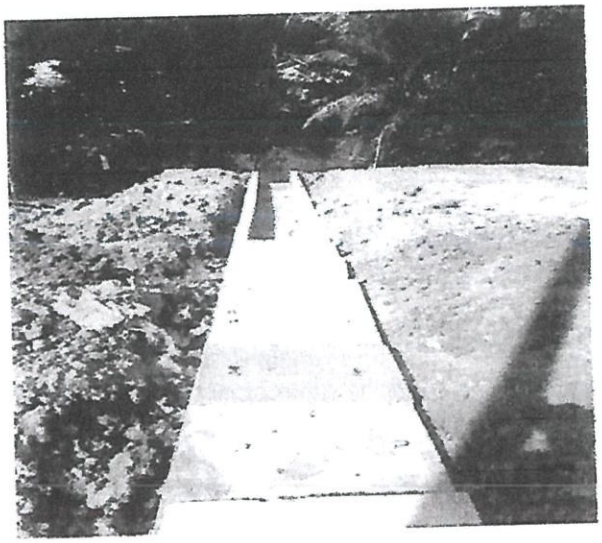
Stone Pitching works in progress



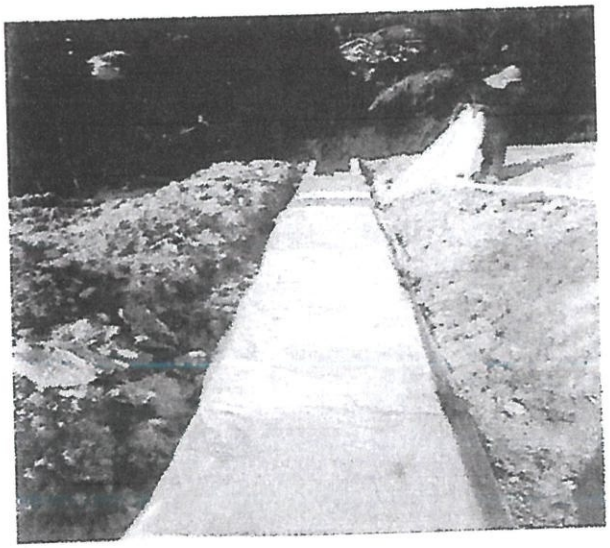
Stone Pitching works in progress

PROJEK PENYELENGGARAAN CERUN DI JALAN PERSEKUTUAN DAN JALAN NEGERI SEMENANJUNG MALAYSIA MELALUI KONTRAK JANGKAMASA PANJANG:
KERJA PEMBAIKAN CERUN MENGGUNAKAN KAEDAH "RUBBLE WALL DAN STONE PITCHING" DI LALUAN FT1403 SEKSYEN 0.00, DAERAH KOTA TINGGI, JOHOR

Toe drain works in progress, geotextile installation



Drainage, geotextile installation



Geotextile installation works in progress

Backfilling works for toe drain

PROJEK PENYELENGGARAAN CERUN DI JALAN PERSEKUTUAN DAN JALAN NEGERI SEMENANJUNG MALAYSIA MELALUI KONTRAK JANGKAMASA PANJANG:
KERJA PEMBAIKAN CERUN MENGGUNAKAN KAEDAH "RUBBLE WALL DAN STONE PITCHING" DI LALUAN FT1403 SEKSYEN 0.00, DAERAH KOTA TINGGI, JOHOR

Toe drainage works completed

Toe drainage works completed

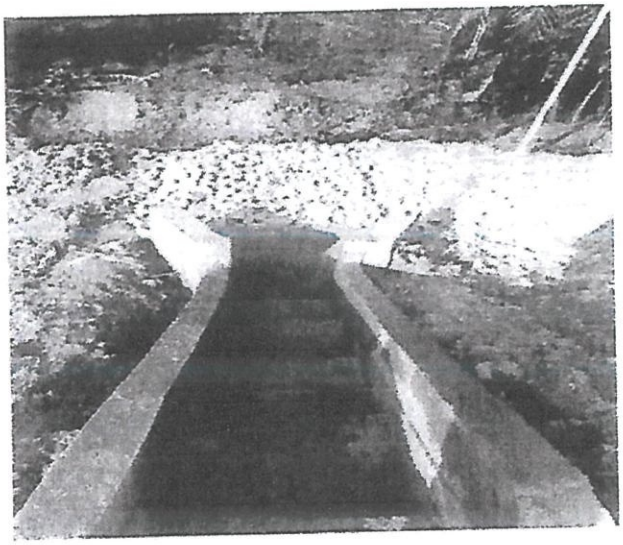
Gabion mattress installation

Gabion mattress installation

PROJEK PENYELENGGARAAN CERUN DI JALAN PERSEKUTUAN DAN JALAN NEGERI SEMENANJUNG MALAYSIA MELALUI KONTRAK JANGKAMASA PANJANG:
KERJA PEMBAIKAN CERUN MENGGUNAKAN KAEDAH "RUBBLE WALL DAN STONE PITCHING" DI LALUAN FT1403 SEKSYEN 0.00, DAERAH KOTA TINGGI, JOHOR

Cascade Drain and wingwall works in progress

Cascade Drain and wingwall works in progress



Cascade Drain, gabion mattress and wingwall works in progress

Backfilling works in progress

PROJEK PENYELENGGARAAN CERUN DI JALAN PERSEKUTUAN DAN JALAN NEGERI SEMENANJUNG MALAYSIA MELALUI KONTRAK JANGKAMASA PANJANG:
KERJA PEMBAIKAN CERUN MENGGUNAKAN KAEDAH "RUBBLE WALL DAN STONE PITCHING" DI LALUAN FT1403 SEKSYEN 0.00, DAERAH KOTA TINGGI, JOHOR

Housekeeping works in progress

Base slab under progress

Base slab under progress

Rubble wall finishing and touch up works in progress

PROJEK PENYELENGGARAAN CERUN DI JALAN PERSEKUTUAN DAN JALAN NEGERI SEMENANJUNG MALAYSIA MELALUI KONTRAK JANGKAMASA PANJANG:
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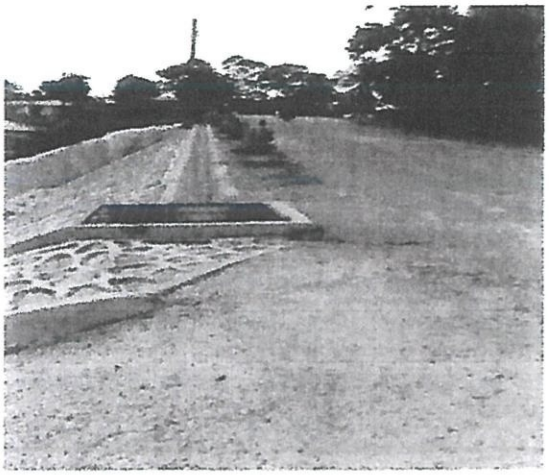
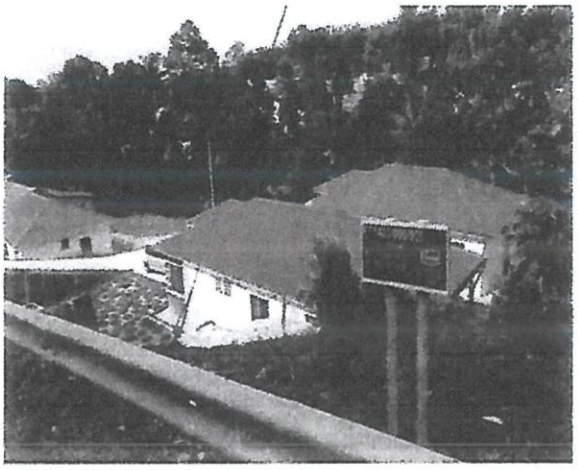
GAMBAR SELEPAS



Stone Pitching and Rubble Wall 100% complete



Signage installation

Stone Pitching and Rubble Wall 100% complete