DEPARTMENT OF BUILDING
UNIVERSITI TEKOLOGI MARA
(PERAK)

THE CONSTRUCTION OF TIE-BACK EARTH RETAINING STRUCTURES

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It is recommended that the report of this practical training provided

By

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entitled

THE CONSTRUCTION OF TIE-BACK EARTH RETAINING STRUCTURES

be accepted in partial fulfillment of requirement has for obtaining 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 stated herein, prepared during a practical training session that I underwent at AnchorSOL Wall Sdn. Bhd. for duration of 20 weeks starting from 23 August 2021 and ended on 7 January 2022. 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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Last but not least, I would like to express my endless gratitude and appreciations to those who have indirectly helping me with this report especially to my family and friends.

Thank you so much.

ABSTRACT

Tie back earth retaining structure is a very important thing to elaborate, therefore this report will discuss about tie back earth retaining structure efficiency for the building envelope based on code of practice retaining structure efficiency. This report was conducted for the retaining structure at Alam Impian and Puncak Alam, Selangor. The objective of this report is to compare the capacity of two site and how far it fulfills the requirements in the guideline. It will focus on tieback earth retaining structure conservation that provides a comfortable environment for its occupants. To illustrate the function of retaining wall envelope as an important aspect to focus on wall surface design achievement and then to evaluate how far the potential of the wall involvement that could fulfill the soil pressure. This report will also look at the retaining structure management based on the guideline by producing the use of effective and continuous method and to evaluate the quality of retaining structure usage that gives a better impact for the infrastructure in the future.

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CHAPTER 1

INTRODUCTION

Tieback retaining structure is an urban developed areas where commonly supported by diaphragm walls with internal braces or tieback anchors. To withstand lateral pressure of soil or hold back soil materials. There are still required the necessary civil works to serve the demands and to solve the environmental problems (Leshchinsky, D, 2009). Before that, the history of retaining structures method has been used for centuries by ancient Egypt who invented the wall for versatile reason, where they were used to harness the great power of the Nile River. At that times the Egyptians tired of flooding and soil erosion, they built Gabion style retaining walls from reeds to divert the flow of water from the Nile into reservoirs as well as fields for farming purpose(*The History of Retaining Walls*, n.d.). This type of wall could also be found in a few Mesopotamian Ziggurats as well. Ziggurats are heavy pyramid-type monuments made of clay (Bros & Inc, 2020).

This retaining Structures knowledge was used and brought to Ireland which was the first construction of a retaining wall that was over 5000 years ago. Newgrange Cairn, an ancient community in modern day Ireland explain the method used by Ireland to build the retaining wall between the stacks of rounded stones, layers of grass turf or mats were placed. This had the effect of reducing the pressure on the wall of rounded stones, effectively being one of the first instances of retention walls(Bros & Inc, 2020). While time goes by modern times have seen innovation in the materials used to build retaining walls, retaining wall applications have largely remained the same purpose to preventing soil erosion, creating space, and diverting water. In the 20th Century, retention walls were revolutionized the retention wall industry in many ways and began to change drastically. While the ancient times were simple using materials that are around the area like stone or some sort of imported wood. In addition, ancients use retaining walls for railways and ports as well. One of the biggest changes to the 20th century retaining wall industry is the widespread use of reinforced concrete. With the use of reinforced concrete, elements can be precast and more carefully engineered for their applications. Events like WWI accelerated the innovation of retaining walls across the world.

The 20th century witnessed steady advancements in the techniques and methods that would open the way for future growth in the 21st century. Earlier in the 20th century, gravity walls were frequently constructed from large masses of stone or concrete. These walls were simple and frequently failed in much less conditions. Taller retaining walls are increasingly being constructed as composite gravity walls in today's modern world. Composite gravity walls are simple barriers that resist driving forces by utilizing several materials. For example, provides composite walls that are tailored to each project rather than being one size fits all systems.

The first documented construction of a geotextile-reinforced wall was taken place at United States in 1974 in the Siskiyou National Forest in Oregon. The wall material is install using a needle punched nonwoven geotextile and sandbags for facing to verify laboratory model tests. In 1975, a second geotextile-reinforced wall was built and monitored on a forest road in the Olympic National Forest near Shelton, Washington DC. Two different geotextiles were used to compare their strength and elongation characteristics. To ensure shoreline protection or sunlight protection, the wall facing was sprayed with an asphalt emulsion(Geotextile, 2021). The performances of these walls were encouraging which led to the construction of several other geosynthetic-reinforced walls in 1979 and 1994(Geotextile, 2021). There are various types of retaining structures which are used for numerous goals like gravity retaining wall call, crib retaining wall, gabion retaining wall, cantilever retaining wall, buttressed retaining wall, anchored retaining wall, piled retaining wall, mechanically stabilized (MSE) retaining wall and hybrid systems but for this report choose anchored retaining wall. The advantage of tieback retaining structure can be constructed from different materials such as concrete, stone and masonry units to produce a thick strong panel wall for retaining structure. It is economical for a height up to 3m or more that involve high ground and big projects. Besides that, tieback earth retaining wall gravity is massive because it requires significant gravity load to counter act soil pressure. Retaining walls grew increasingly variety, with an explosion of numerous forms of retaining walls to match the industry's growth of demand. As a result, the sector has become tremendously broad and innovative. However, the aim of this report is to discover the construction of retaining structure at a conjected area in Malaysia.

1.1 Objectives of Study

The objectives of the study are as follows:

1. To study the construction of tie back earth retaining structures
2. To identify the element that involve tie back earth retaining structures
3. To understand the problem of tie back earth retaining structures during the construction and solution to the problems.

1.2 Scope of Study

To understand the scope of construction of tie back earth retaining structures on site. The classification of retaining structures and how the wall useful to block soil or ground pressure.

1.3 Research Methods

The research methods are one of the ways to start the first page of elements and techniques used to gather data to generate more knowledge. Here are a few research methods use in this report:

1. Observation

   The construction methods and specification AnchorSOL Wall was supervise on site. The site visits were carried out with specific jobs for example, alignment of each panel walls and entire process backfill before and after install retaining structures. The observation can conclude that every single works carried out by the general worker and being supervised by professional and experience contractor. In addition, all the data related to retaining structures from supervise were recorded by writing on check list. To fulfill requirement based on the checklist. The picture was taken using camera phone brand vivo. This is because by having a picture it makes easier to recall especially when it come for construction method. The observation normally took around 3 hours based on construction site.

2. Interview

   The unstructured interviews have been done on site visits. Usually, spontaneous unstructured questions will be pointed to the workers at the construction site, especially during installations that require high expertise. For example, the installation of retaining structures. Unstructured interviews also will be conducted with the site supervisor regarding the structure found in the construction site and has been compare with structural drawings. By having unstructured interviews, the data will be record by writing short notes into notebook. After that, the semi structured also been carried out which is the question will be prepared before asking directly to the site supervisor and the data will be record by smartphone audio recorder. Some of the questions asked are about project background and method construction. It also will be conducted at office which will take 30 minutes. The semi-structured interview will be done from time to time.

3. Documents reviews

The type of documents that has been refer are architecture drawing and structural drawing. Another document is company profile that was used for describing company background and progress report also been referred include progress pictures that has been captured by site supervisors using camera from smartphone. This is because to find out the missing progress. Document review will be done in the office. All important information will be written briefly into a notebook meanwhile documents with diagrams such as architecture plan and structural plan will be capture by using smartphone camera brand vivo. It is intended for future use when the document is not available.

CHAPTER 2

COMPANY BACKGROUND

AnchorSOL Wall Sdn. Bhd. is the name of a company that had 23 years of established for the development of state infrastructure in 1999 until now. The company involved new technology in the soil industry to solve the problem of soil pressure more efficiently and can last longer. The work concept in Geotechnical construction. Geotechnical construction is the specialist branch of civil engineering concerned with the performance of earth materials and the application of soil and rock mechanics retaining structures includes earth filled dams and retaining walls. AnchorSOL Wall Sdn. Bhd. is a group of professionals and experience in problem solving and inspection of geotechnical related production in Malaysia. Every design and performance works done by AnchorSOL is take full responsibility in supervise and material wall supplier to keep the quality of retaining structures for the good reputation results on each construction site. The Managing Director is Dr. Ir. Lai Yip Poon and Director is Ir. Tham Yoke Wah. The operational area is taken place at Plaza Jelutong, Persiaran Gerbang Utama, Shah Alam, Selangor. Company status is Sendirian Berhad (Sdn. Bhd). AnchorSOL Wall system successfully built a vast variety of projects throught Malaysia in the past 20 years comprising of mega infrastructure work projects such as Expressways, Overpasses, Bridge Abutments, Sea Walls and Hill Slope Stabilizations as well as mixed commercial and Residential Development. The Anchorsol wall is a reinforced soil wall or mechanically stabilized earth (MSE) wall system consisting of aesthetically pleasing Precast concrete facing panel, reinforcing element, Anchor block and granular reinforced fill. The AnchorSOL vision is become a World-Class Service Provider and Centre of Excellence in the areas of Asset Management, Project Management and Engineering for National Infrastructure Development Experienced in Creative and Innovative Human Capital as well as Latest Technology. That means, AnchorSOL will make their company equivalent to an international company. Besides, AnchorSOL mission are to assist their customers realizing policy objectives and deliver services through partnership cooperation strategy, standardisation of processes and their system to provide consistent outcomes, to provide asset management services and an effective and innovative project.

2.1 Completed Projects

AnchorSOL Wall has monitored many governments and non- government projects that have been completed under main contractors as shown in Table 2.1.

Table 2.1: Completed projects

Project's Name	Contrator's Grade	Price (RM)	Duration	Started	Finished
Project Phase 2- Earthwork, Retaining Structure and Escp.	Grade 2	150,000.00	3Year	1/7/2017	1/7/2020
Cadangan Pembangunan Perumahan Bercampur Dan Perniagaan.	Grade 2	100,500.00	2Year	1/4/2019	1/12/2021
Membina Jalan Sambungan Kota Warisan.	Grade 2	300,000.00	2Year	1/5/2018	1/5/2021
Kerja Menaik Taraf Jalan Persekutuan FR5	Grade 2	103,390.00	2Year	1/2/2018	1/2/2021

2.2 Ongoing Projects

AnchorSOL Wall Sdn. Bhd. has monitoring ongoing government and non-government projects under main contractors as shown in Table 2.2.

Table 2.2: Ongoing projects

Project's Name	Contrator's Grade	Price (RM)	Duration	Started	Estimated to finish
Cadangan Kerja Tanah, Tembok Penahanan & Perparitan Untuk Fasa 2	Grade 2	290,000.00	3Year	1/4/2021	1/4/2024
Construction & Completion of Earthworks, Retaining Wall, Persiran Tun Fatimah at Alam Impian.	Grade 2	240,500.00	3Year	1/1/2021	1/1/2024
Cadangan Mempertingkatkan Persimpangan Bertingkat Di Lebuhraya Sultan Iskandar (Lebuhraya Mahameru).	Grade 2	208,000.00	3Year	1/12/2020	1/12/2023
Cadangan Jalan Dan Saliran Untuk Pembangunan Perindustrian	Grade 2	278,000.00	3Year	1/1/2021	1/12/2024

2.3 Organization Charts

At AnchorSOL Wall Sdn. Bhd., the departments were responsible for overall construction that involve with area of professional specializations in Figure 2.3. The Managing Director was responsible in managing staff administration, in terms of the Service Scheme, benefits in and after the service as well as discipline. Furthermore, he planned and carried out works, panel wall, and all machines under the jurisdiction of the Department. In addition, he took a responsible in planning and implementing maintenance works of construction.

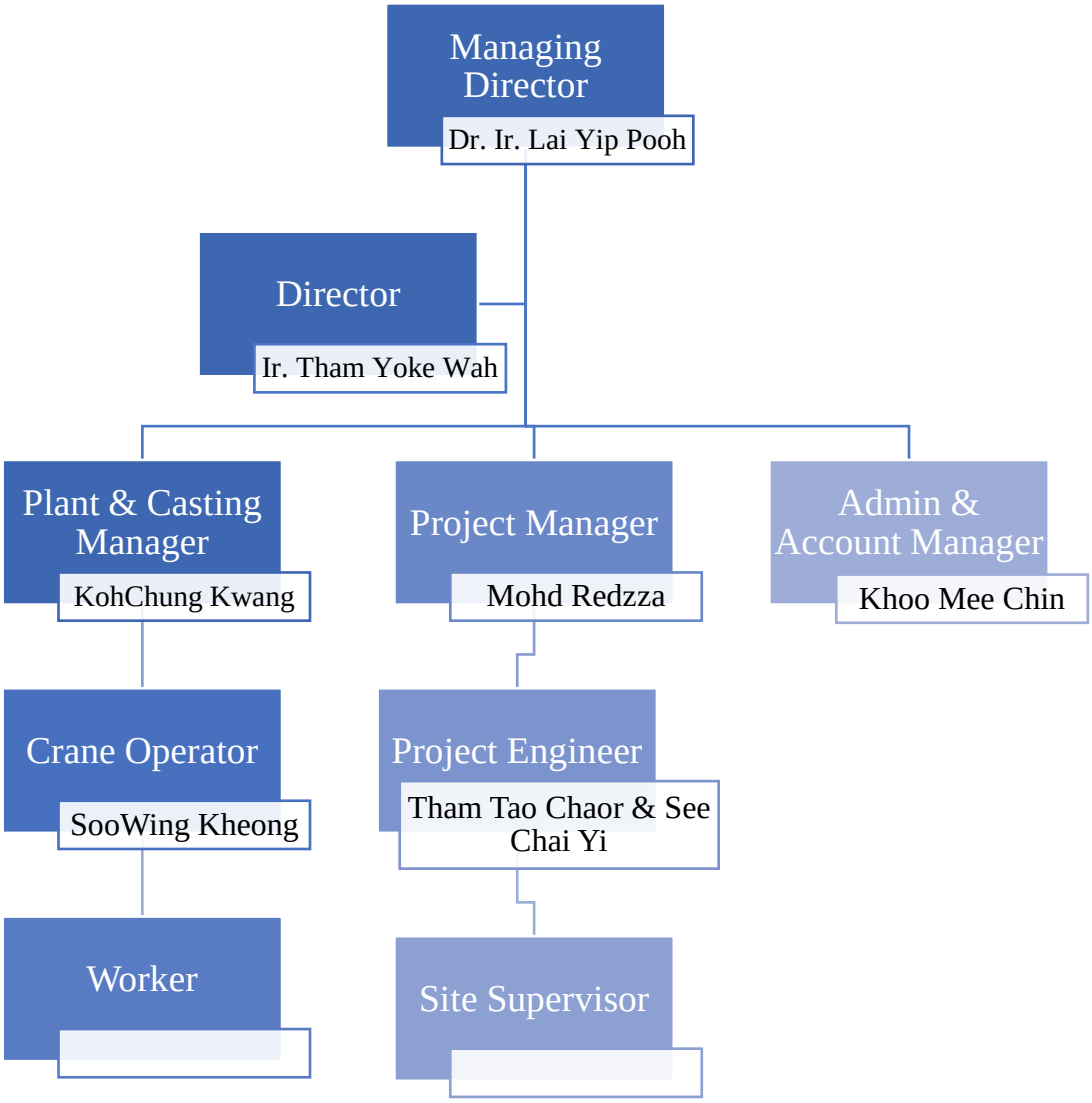


Figure 2.3: AnchorSol Organization Chart

CHAPTER 3

CASE STUDY

The case study is a process or record of research into the development of a tie back earth retaining structures situation over a period was carried out one of the location constructions shown as below.

3.1 Construction of tie back earth retaining structures

At the construction site plays the role of a construction project to avoid high costs and the safety of workers. Here I will explain the flow of installation tie back retaining structures on site as shown as below:

1. Do investigation or research the ground level and strength.
   This job done by the main contractor or clients. The sample of the soil need to take a laboratory test by the expertise in soil development before beginning the operation work. It took a few days to come up with a result. If the result shown a good scale of soil strength no need to put a levelling pad under the panel wall as shown as below:

Figure 3.1.1: Levelling pad

2. Survey and setting out.

   This job done by the main contractor or clients. To make a drawing plan based on the site construction need an accurate measure on real site. The person in charge does a surveying to relocate the length and position of the retaining structures as shown as below:

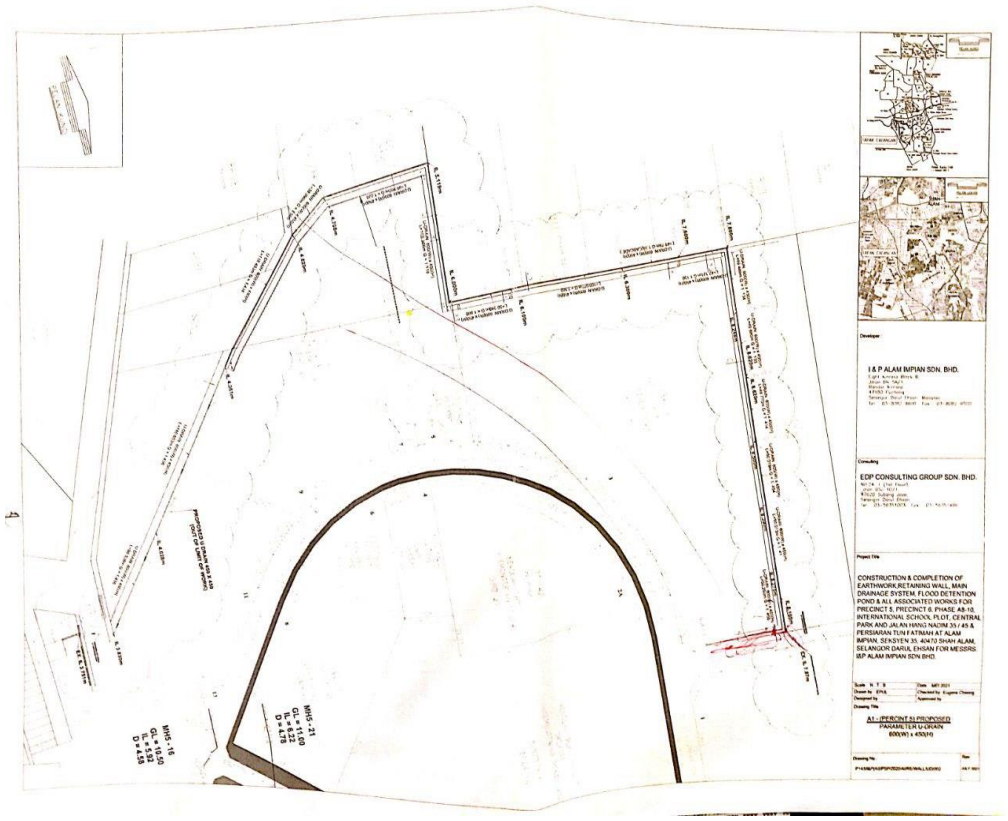


Figure 3.1.2: Setting Out

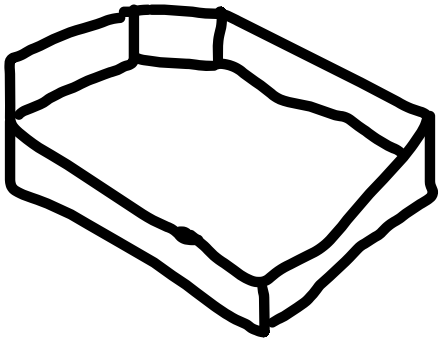
3. Excavation large scale work.

   This job done by the main contractor or AnchorSOL subcontractor. The ground level needs to remove any waste material or bad material soil and replace with a better material. To improve the strength of the ground platform before installation panel wall. The excavation process needs a big amount of power men to start the ground level. The excavate work done by a modern machines like backhoe loaders, excavators, and common dump trucks. Easy and faster to install the retaining wall in matter of seconds. Here some picture of real situation:

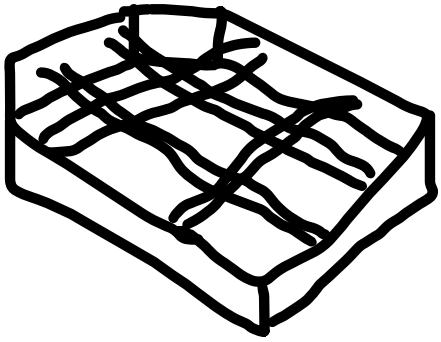
Figure 3.1.3: Excavation

4. Supplier

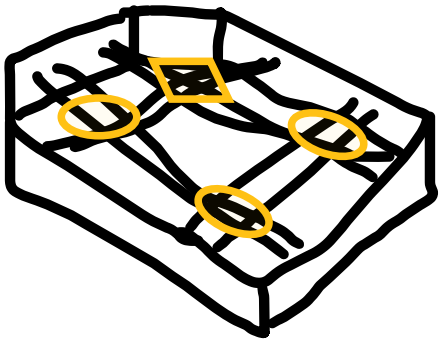
   This job done by the AnchorSOL subcontractor. The process to make a panel wall is made in factory and can be precast on the site The preparation of material to make a panel wall is make a former site using a wood or anything that can be former a shape.



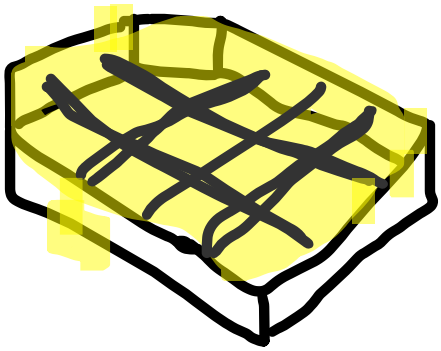
   Later, insert the reinforcement bar inside the former and line up according to the blueprint. The material use for reinforcement bar is High tensile and the minimum strength is not less than 500N/mm2.



After that, insert Omega Connector (Yellow) between reinforcement bar with 50mm x 6mm flat mild steel bar. The overall dimension of the omega connector is not less than 200mm in height and 150mm in width at the base.



Afterward, pour the fresh concrete (Yellow) inside the former into rigid steel within 2 hours from time of mixing. Wait 2 hour to dry to get the tolerance of 75+/- 25mm determined according to BS 1377.



5. Installation Panel Wall

This job done by the AnchorSOL subcontractor. The installation happens after the excavation done earlier at the same time the ground level is in good condition.

The 1st action to install the retaining structures is insert the bottom panel wall (B2) and followed by original panel wall (F4) arrange alternately based on drawing plan. (**B2**) the meaning of the first letter represents as Bottom and the number represent as size of the panel wall. AnchorSOL has various sizes and shapes of panels wall according to the suitability and demand of the client.

Figure 3.1.5.1: Panel types

The 2nd action is fill behind the panel wall with selected granular backfill material as determined by BS 1377 as follow:

Table 3.1.5: Sieve size

Sieve Size	Percent Passing
125 mm	100%
90 mm	85%-100%
10 mm	25%-100%
600 µm	10%-65%
63 µm	0-10%

Figure 3.1.5.2: Backfill material

The 3rd action is installing the tie back using a steel bar behind the wall between the join of deadman block and omega connector. The purpose of the deadman block is to support the wall from inside the ground. Therefore, the wall can hold the movement and last longer. The steel bar plays a big role in each level of the panel walls. If the clients wanted a big tie back earth retaining structures, the suitable steel bar diameter for the bottom is 16mm plus the higher the panel wall, the bigger diameter add up to make a strong and lasting retaining structures. In addition, retaining structures especially for the biggest one will separate into two phases. For example, phase one around 6m heigh and backfill the top area for some space and continue behind the top area until finish. This reason is to avoid the to much pressure on the retaining wall. Here are some pictures:

Figure 3.1.5.3: Installation panel wall

The 4th action is compaction the backfill material using the road roller or backhoe loaders to compact behind from tie back retaining structures components and use small machineries compactor to cover area close to panel wall to avoid the destruction of alignments panel walls.

Figure 3.1.5.4: Compaction

3.2 Element that involve tie back earth retaining structures

The element that involved tieback a retaining structure is vertical stem. The vertical stem in retaining wall resists earth pressure from backfield side and bends like cantilever. The thickness of this slab is larger at the base of stem, and it decreases gradually upwards due to reduction of soil pressure in conjunction with decrease in depth.

Figure 3.2.1: Retaining wall

Next element is granular backfill material. Only selected material can be used to support retaining structures and demolish any bad material that cause pressure to the ground level.

Figure 3.2.2: Granular

Next element is steel bar. Steel bars play a huge role to support the panel wall where it come with lot of length and size by project. The big number of steel bar the stronger retaining structures to help panel wall last longer.

Figure 3.2.3: Steel bar

3.3 Problem and solution of tie back earth retaining structures during the construction and solution to the problems

1st problem encountered is the number of cracked damages on the panel walls which can result in permanent defects and cannot withstand the ground surface. The solution for this problem been solve by replace the cracked one with the new panel walls.

2nd problem faced is limited production and delivery of goods due through the movement of trucks in and out of highway which can slow down the construction activities and delay on schedules. The solution for this problem been solve by precast on site to reduce the cost of delivery and quick to install.

3rd problem is worker safety rate. The environment on site construction is a dangerous place and to be extra careful but a few workers does not wear the safety head covering. The solution for this problem is workers who violate and do not comply with rules while on the construction site get fined and not allowed to enter the site.

CHAPTER 4

CONCLUSION

Overall, the construction tie back earth retaining structures are used to prevent the retained material from assuming its naturel slope. Piles retaining walls may be classified according to how they produce stability as reinforced earth, gravity wall, cantilever wall and anchored wall. At present, the reinforced earth structure is the most used particularly for road work. The retaining structures provided the best protection of the soil bed against does simulated rain. Not only did the retaining wall strength, but stability and drainage were evident throughout the tests since the water filtered through the soil bed instead of creating pools of water on the surface. There was no evidence of collapse or formation all rivers. Besides that, while there was something settling, it did provide quite a bit of protection. Some of the settling may have been due to insufficient backing of the soil bed. This makes the environmentally friendly option a poor choice for real life applications. However, the small gaps between cans helped with the drainage making it reasonably good retaining structures. In the future, the retaining structures can be a good upgrade for highway traffic jam and flyover.

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