DEPARTMENT OF BUILDING
UNIVERSITI TEKNOLOGI MARA
(PERAK)

CONSTRUCTION METHOD OF SOIL IMPROVEMENT FOR NEW SURAU OF TAMAN ANIKA, BATU 9, PORT DICKSON AND OTHER RELATED WORKS

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DEPARTMENT OF BUILDING

FACULTY OF ARCHITECTURE, PLANNING AND SURVEYING

UNIVERSITI TEKNOLOGI MARA

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DECEMBER 2019

It is recommended that the report of this practical training provided

by

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2017206616

entitled

Construction method of soil improvement for new surau of Taman Anika, Batu 9, Port Dickson.

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 Pejabat Daerah dan Tanah Port Dickson 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 BGN307 and accepted as a partial fulfillment of the requirements for obtaining the Diploma in Building.

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UiTM ID No : 2017206616

Date : 20 December 2019

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Other than that, I would also like to thank both of my parents for always gives me moral and financial supports for this report. Last but not least, I would like to expand my deepest gratitude to all those who have helped me regarding this report, directly or indirectly.

Thank you very much.

ABSTRACT

In the early times before the advancement in the geotechnical engineering, the only chance for the foundation engineers was to design the foundation matching to the sub soil conditions at the provided site. But nowadays, due to the improvements in geotechnical techniques and with the help of latest technology, it is possible for the engineers to modify the weak foundation soil to become more strength and reached less compressibility characteristics, most importantly suit the chosen site foundation. Thus, these geotechnical processes of improving the quality of the foundation soil to the desired quality are called as ground or soil improvements. Therefore, this report will discuss mainly about the construction method of soil improvements which is Prefabricated Vertical Drainage (PVD) that were applied to the construction project under Pejabat Daerah dan Tanah Port Dickson titled as "Work to Build New Surau of Taman Anika, Batu 9, Port Dickson". The objectives of this report are to identify the construction method of the soil improvement, the materials used, and machineries involved. Other than that, to illustrate the step by step of the soil improvements method which is Prefabricated Vertical Drainage (PVD), and lastly to determine the problems occurred and solutions taken to solve the difficulties during the soil improvement process at the site. As the conclusion, this report will tell that soil improving is very preferable option by the engineers nowadays. It is none other than because of the benefits which are increase the density and shear strength parameters, decrease the compressibility, permeability and the settlement, that will also make the soil more water resistant, durable and stable.

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CHAPTER 1.0

INTRODUCTION

The term 'soil' refers to the upper layer of the earth's crust usually to a depth of 1.2 metres, in which plants usually growth on them. It consists of weathered rock, organic matter, air spaces and water. Soil structure is the combination or aggregation of soil particles into larger compound units with pore spaces and channels between that allow the flow of air, water and penetration of roots.

The secondary units are characterised and classified on the basis of size, shape and degree of development. Soil texture is the relative proportion of the various soil particle size fractions in a soil such as sand, silt, and clay. Other than that, since soil is the upper layer of the earth's crust, it has a very big exposure to liquid or water. Therefore, every soil has its own moisture content to verify the strength of it. Soil wetness is classified according to the depth and duration of water logging in the soil profile which means the vertical cross-section of it. The wetness of a soil is identified ranging from 'very well drained' to 'very poorly drained'. A soil wetness limitation exists where the soil water regime adversely affects plant growth or imposes restriction on cultivations or grazing by livestock.

There are many different types of soil can be encountered on construction sites. The importance of the characteristics of soil, such as the size and nature of particles, its density and structural properties, lead to soil surveys are often required to inform design and construction decisions based on soil conditions. Usually, a soil survey will classify the soil according to a standard classification system, record the boundaries of soils on drawings, and provide assessments on how soils are likely to behave. Since soil is everywhere, all structures are also built on it. Selection of sites with the best soil is an important engineering decision in the building process. Soil maps are a great tool to help engineers determine the best location for their design. Soil maps are created by soil scientists and present information such as the slope of the land surface, soil biological, chemical, and physical properties and potential for water runoff, drainage, or storage. There are many important engineering decisions that go into developing safe buildings, bridges, and other structures. One of these is to determine the best soil to build on. A good soil for infrastructure has the following properties which are balanced chemistry and neutral pH, so that building materials are not corroded. Secondly, stability through wetting and drying cycles, so that expanding soil does not cause cracked foundations. Thirdly, strength under pressure, so

that the weight of the building does not cause it to sink into the ground and lastly, the ability to capture precipitation, so that runoff and erosion do not damage structures.

Strength and stability of soil are related to its physical properties. Soil with good structure is more stable. For example, clay textures are often more stable than sand structures because they have better structure. However, a mix of particle and pore sizes is best for engineering especially for growing crops. Therefore, when soil properties are not ideal for building, there are ways to change the landscape and practises to provide for better building sites. Hence, one of the techniques to modify the texture and condition of the soil is Soil Improvement Method. Soil or Ground Improvements Method is very preferable method used by engineers nowadays and the exposure is getting the clout in construction industry because of the good benefit and advantages.

Soil improvement techniques involve changing soil characteristics by a physical action, such as vibration (vibroflotation), dynamic compaction, stone columns, compaction piles, compaction grouting, and drainage techniques. The main goal of most soil improvement method used for reducing liquefaction hazards is to avoid large increases in pore water pressure during earthquake shaking. This can be achieved by densification of the soil and improvement of its drainage capacity.

There are many types of Soil Improvement Method, however, the aim of this report is to discover the construction method of Prefabricated Vertical Drainage (PVD) which has been applied to the project of constructing new surau of Taman Anika under Pejabat Daerah dan Tanah Port Dickson. The reason why the choose this method is because of the suitable advantages which is mainly to reduce the liquefaction risk due to the place of this project, located near the beach and sandy area.

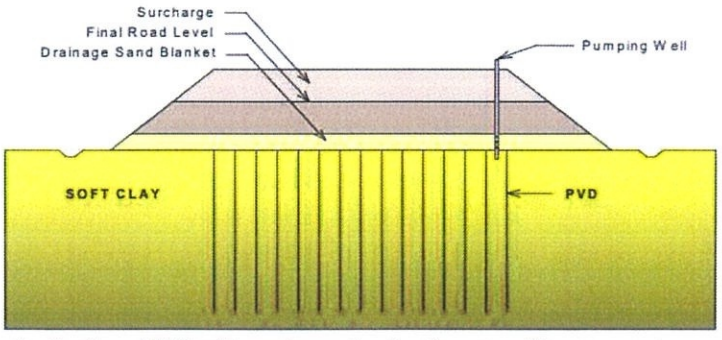


Figure 1.1 PVD Method

Source: http://geosystems.com

1.1 Objectives of the report

The function of the objectives is to set anything to achieve the aim of the report. For this report, it contained three aim to achieve. The first item will be explained the types of soil improvement which is Prefabricated Vertical Drainage (PVD). Next, to explain the process of the soil improvement used on the construction site. The last aim will be the explain about the difficulties and the solution taken by the staff throughout the construction time.

1.1.1 To identify the type of method used for soil improvement.

1.1.2 To analyse the procedure and installation method of soil improvement process.

1.1.3 To discover the problems occur and solutions taken at the construction site.

1.2 Background and Scope of study

The construction of new surau in Taman Anika, Batu 9 under Pejabat Daerah dan Tanah in Port Dickson was commenced at the end of the year 2018. This project was implemented through design and builds concept, where the appointed contractor was responsible for the design and construction of the project. It consists of 2 main buildings which are the surau building and the toilet building with other facilities such as wudhu' place. The site is surrounded by residential area, lot shops, and the beach which is approximately 200 metre from the site area. In surface, this report is focusing on the soil improvement works and the topic chosen is Prefabricated Vertical Drainage (PVD) installation. The reasons why this construction project decided to apply PVC method is because of the initial condition of the soil at the construction site. At the beginning, the soil condition is not in a good state and does not reach the requirement of a good strength soil. This is due to the excessive moisture content or called it as soft soil. The soil consists of silt and sand which logically explain why, because the construction site is very nearby the beach area. So, as a solution, the parties made a decision on the application of Prefabricated Vertical Drainage (PVD) and installation of Geotextile on the surface of the soil. It is informed that the soil improvement process for this project will take approximately about two months. The soil improvement operation includes ground treatment sequences such as survey works, site clearing along the route, stripping top soil, applying non-woven geotextile fabric and others. The location of our case study is on *Figure 1.2.*

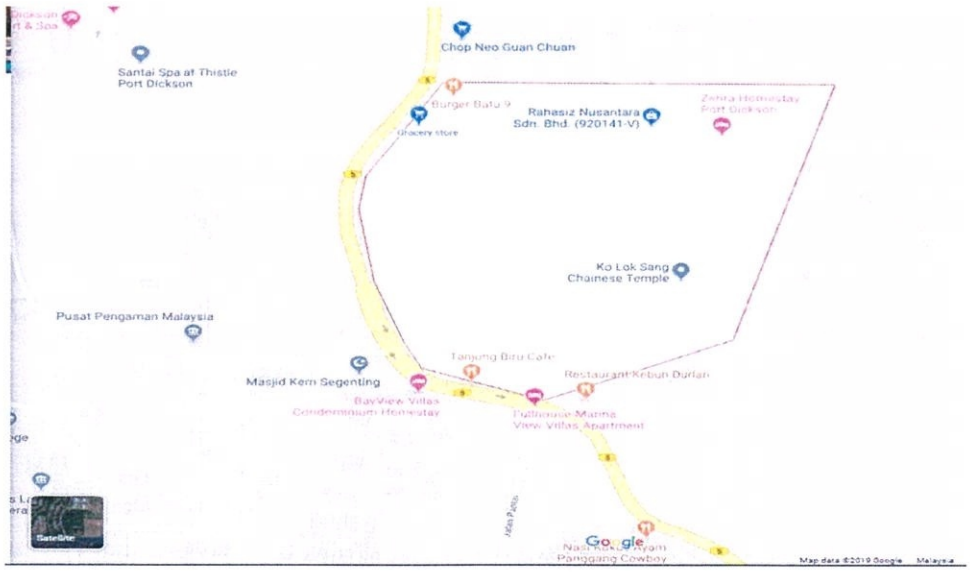


Figure 1.2 Site location

Source: Google maps

1.3 Research methods

Methods study is the process of subjecting work to systematic, critical scrutiny for make it more effective and more efficient. It is one of the keys to achieve productivity improvement. During the internship, there are three (3) method of study that has been used to collect the information from all the parties involved in the project. The method of study that has been used is observation, interviews and document reviews.

1.3.1 Primary Method

1. Observation

During the internship, there are a lot of things and knowledge that writer collects from the observation method. The most gained info by the writer is about soil improvement, Prefabricated Vertical Drainage (PVD) and the problems occur at the site during the soil improving process. During the internship, although only the substructure work is undergoing, the writer can still learn and collect the info and knowledge through documents and pictures as references. The first topic that has been observes is about soil improvement. The project chose Prefabricated Vertical Drainage (PVD) as the soil improvement method. It is because the initial type of soil at the construction site is marine soil (soft soil). Marine soil is the type of soil that has high water content and has the very soft texture. Furthermore, the foundation of this project is pad footing. So, in order to do pad footing, the soil needs to be high in stabilisation and good strength. Pad footing is commonly used in the construction industry due to the advantages. The cost is cheaper and time saving.

2. Interview

Interviews are the most effective for qualitative research. They help to explain, better understand, and explore research subjects such as opinions, behaviour, experiences, phenomenon and etc. Interview questions are usually open-ended questions so that it will be so much easier for the writer to collect the data.

Most of information gained was from the interview session. The topic of the interview mostly about soil improvement and the problems occur at the construction site. The location of the interview usually happens at the office. The person in-charge for being questioned is Encik Yusri bin Badaruddin the assistant engineer and Puan Suzilawati bin Sulaiman as the site supervisor. The interview usually takes about 15 minutes.

1.3.2 Secondary Method

1. Document Review

A document is a written, drawn, presented, or memorialized representation of thought. In the past, the word was usually used to denote a written proof, useful as evidence of a truth or fact. During the practical, document is very important and useful to collect information and gain knowledge. All the important information recorded into the paper is also consider as documents. However, during the practical session, the writer only gets the chance to read and understand a few documents due to private and confidential of the company. These are a few of the documents received from my consultant and supervisor as report references:

1. Monthly site progress report.
2. Company profile.
3. CCC form.
4. Minute meeting papers.
5. Drawing and plan.

CHAPTER 2.0

COMPANY BACKGROUND

2.1 Introduction of Company

Port Dickson District is the second smallest district among 7 other counties in Negeri Sembilan. It is located at the west of Negeri Sembilan bordering Seremban district. The area is also famous for its tourist areas which have a really beautiful scenery and long beaches. The area of Port Dickson County is estimated at 572.35 sq. km and the population is approximately at 117,397 people. The administrative area comprises of 5 districts managed by the 5 chiefs namely Jimah District, Port Dickson District, Si Rusa District, Pasir Panjang District, and Linggi District which covers 32 villages including the new one.

Pejabat Daerah dan Tanah is a district administrative centre under Pentadbiran Pejabat Setiausaha Kerajaan Negeri Sembilan, responsible for administering and controlling development, social construction, and property management throughout the Port Dickson area. It has four units operating to generate administration in the Port Dickson district. Pejabat Daerah dan Tanah consists of Management Services, Development Division, Building Management, and Land Administration.

Location of Pejabat Daerah dan Tanah Port Dickson

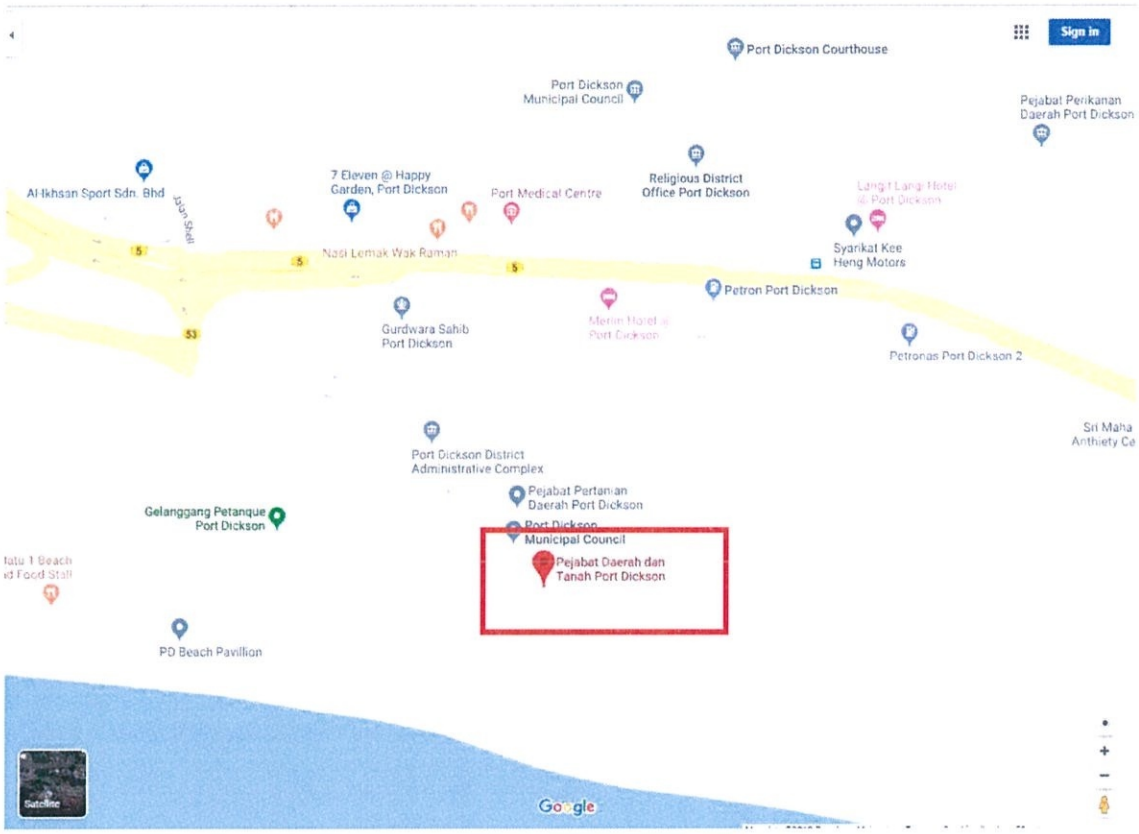


Figure 2.1 Location of Company

Source: Google maps

Port Dickson Map

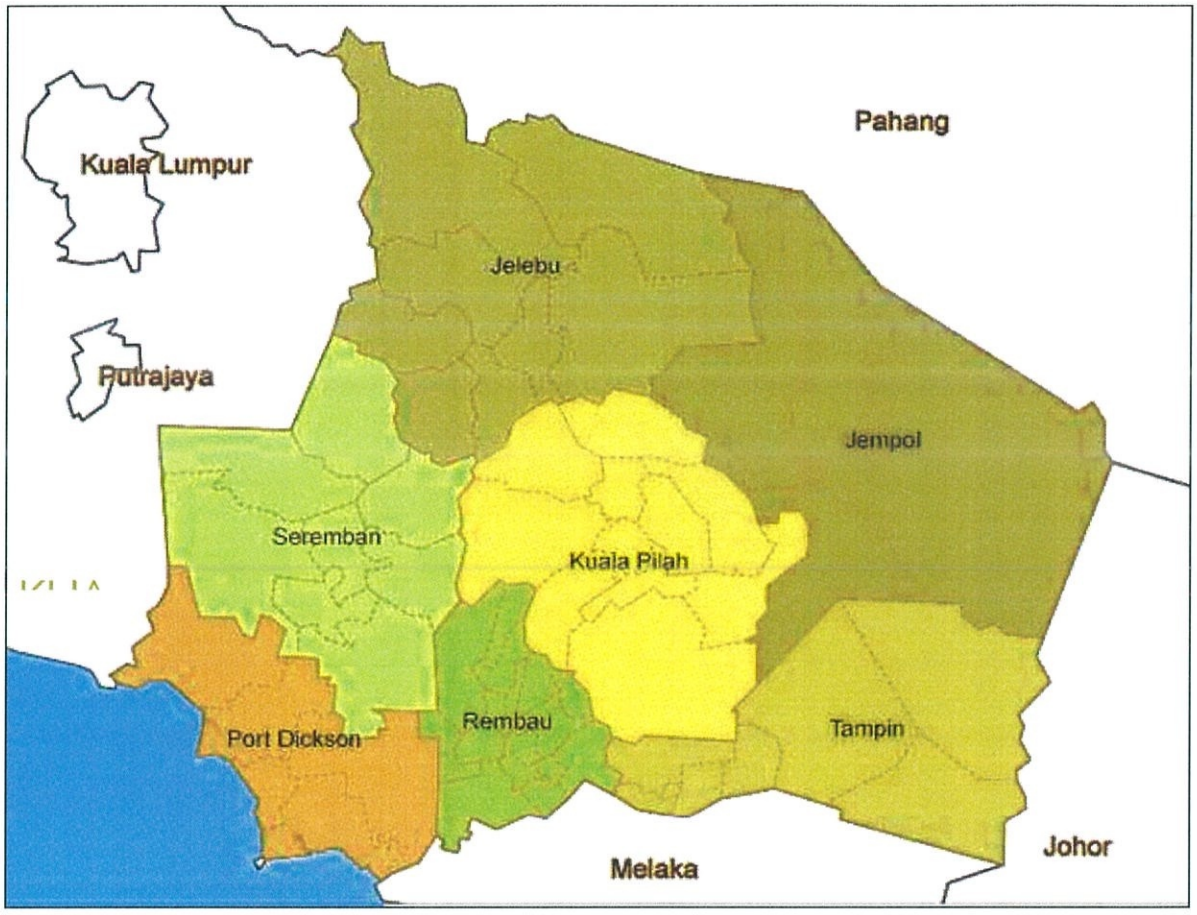


Figure 2.2 Location of Port Dickson

Source: provided by supervisor

2.1.1 Mission & Vision

1. Vision

   Make Port Dickson a thriving, competitive district, based on induction of travel and sustainable development to achieve Wawasan 2020.

2. Mission

   Manage and administering the Port Dickson district to generate land, physical, and social development to enhance the state's revenue sources.

2.1.2 Objectives of Pejabat Daerah dan Tanah Port Dickson

1. Ensure that office administration management is efficient in administration, finance, services and employment.
2. Provide a good quality of hospitality and service to the customers.
3. Promotes the unity of people and ensure harmony of the people in Port Dickson.
4. Ensure that all administrative affairs and control of the financial provisions entrusted used in the proper manner and in compliance with the provisions of law.

2.2 Organization Chart

2.2.1 Organization Chart of Pejabat Daerah dan Tanah Port Dickson

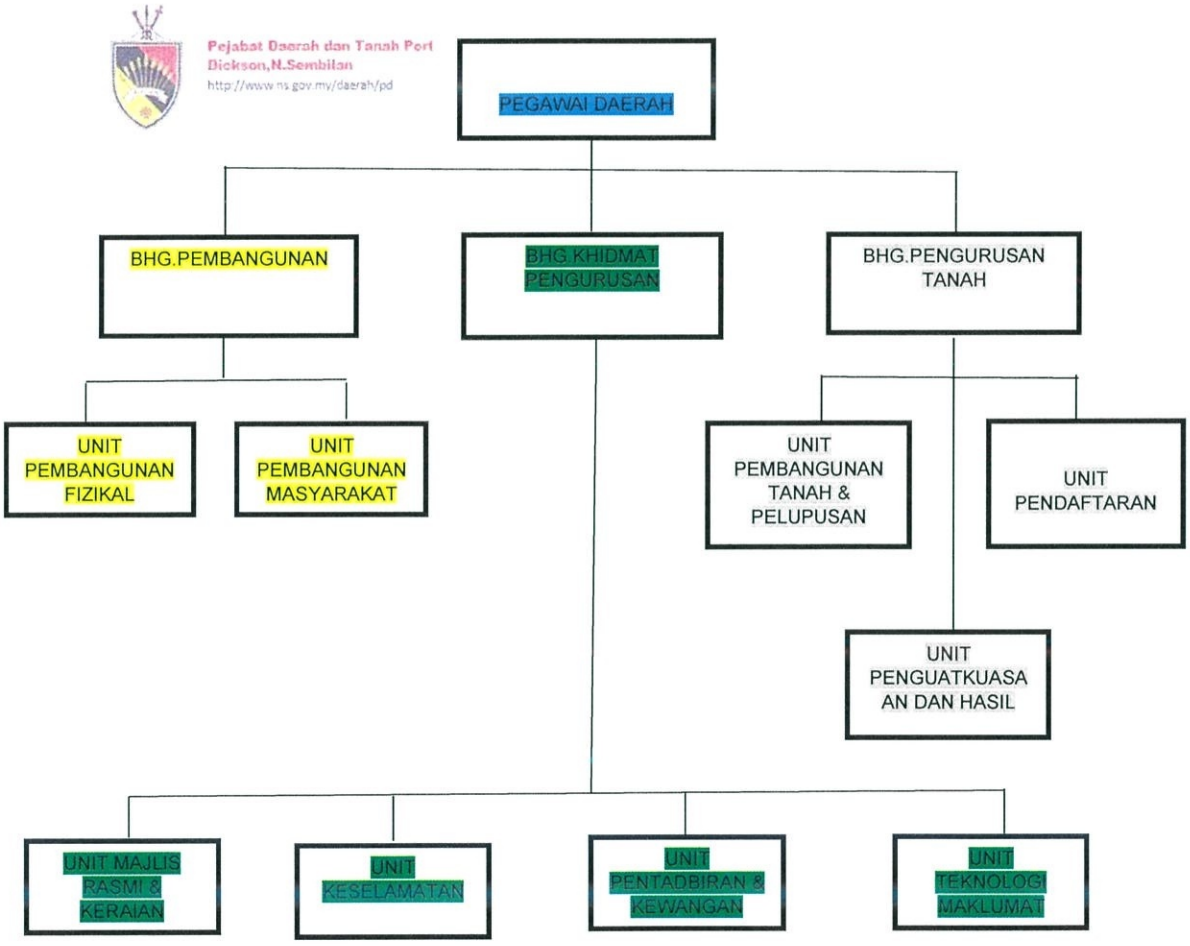


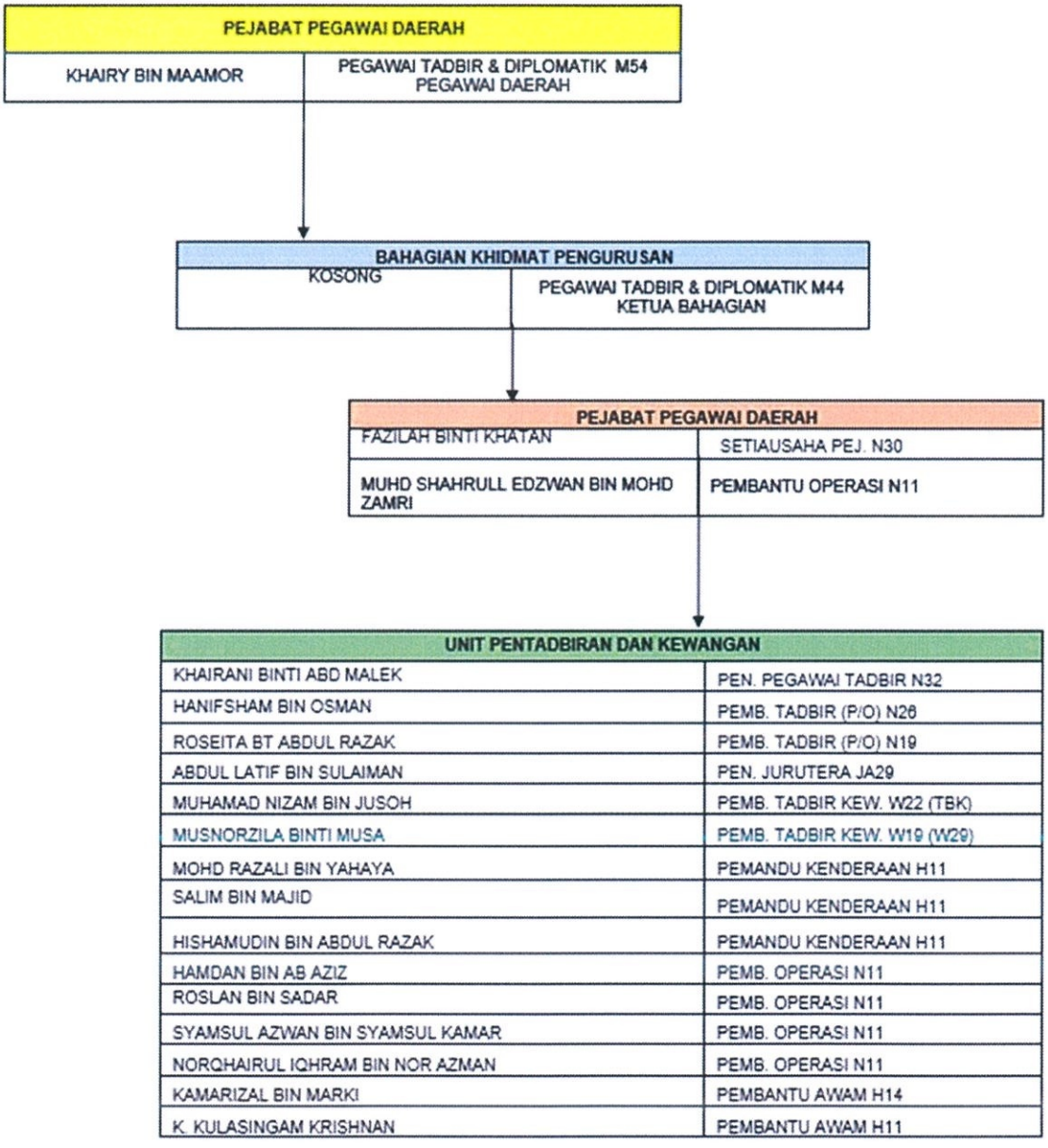
Chart 2.3 Organization Chart of Pejabat Daerah Port Dickson

Source: provided by supervisor

2.2.2 Organization Chart of Building and Management Department

CARTA ORGANISASI BAHAGIAN KHIDMAT PENGURUSAN

PEJABAT DAERAH DAN TANAH PORT DICKSON



PEJABAT PEGAWAI DAERAH	
KHAIRY BIN MAAMOR	PEGAWAI TADBIR & DIPLOMATIK M54 PEGAWAI DAERAH

BAHAGIAN KHIDMAT PENGURUSAN	
KOSONG	PEGAWAI TADBIR & DIPLOMATIK M44 KETUA BAHAGIAN

PEJABAT PEGAWAI DAERAH	
FAZILAH BINTI KHATAN	SETIAUSAHA PEJ. N30
MUHD SHAHRULL EDZWAN BIN MOHD ZAMRI	PEMBANTU OPERASI N11

UNIT PENTADBIRAN DAN KEWANGAN	
KHAIRANI BINTI ABD MALEK	PEN. PEGAWAI TADBIR N32
HANIFSHAM BIN OSMAN	PEMB. TADBIR (P/O) N26
ROSEITA BT ABDUL RAZAK	PEMB. TADBIR (P/O) N19
ABDUL LATIF BIN SULAIMAN	PEN. JURUTERA JA29
MUHAMAD NIZAM BIN JUSOH	PEMB. TADBIR KEW. W22 (TBK)
MUSNORZILA BINTI MUSA	PEMB. TADBIR KEW. W19 (W29)
MOHD RAZALI BIN YAHAYA	PEMANDU KENDERAAN H11
SALIM BIN MAJID	PEMANDU KENDERAAN H11
HISHAMUDIN BIN ABDUL RAZAK	PEMANDU KENDERAAN H11
HAMDAN BIN AB AZIZ	PEMB. OPERASI N11
ROSLAN BIN SADAR	PEMB. OPERASI N11
SYAMSUL AZWAN BIN SYAMSUL KAMAR	PEMB. OPERASI N11
NORQHAIRUL IQHRAM BIN NOR AZMAN	PEMB. OPERASI N11
KAMARIZAL BIN MARKI	PEMBANTU AWAM H14
K. KULASINGAM KRISHNAN	PEMBANTU AWAM H11

Chart 2.4 Organization Chart of department

Source: provided by supervisor

2.3 List of completed projects

This list of projects was taken started from 3 years past which is 2016, 2017 and 2018. All these projects do not include all the renovation application for house. This project list involved huge and small projects around Port Dickson. All information was given by Puan Suzilawati, the site supervisor of Pejabat Daerah dan Tanah Port Dickson.

2016	2017	2018
Proposal to build and repair the badminton arena hall at Taman PD Utama, Batu 3, Port Dickson.	Proposal to build and upgrading drainage system of Kg. India, Bukit Pelanduk, Port Dickson. (March 2017)	Proposal to build new road at Kg. Cina, Bukit Pelanduk, Port Dickson. (February 2018)
Proposal to build community hall at Kg. Jimah Baru, Port Dickson.	Proposal to build and upgrading MPP hall (Dewan MPP) of Taman Ria, Batu 2, Port Dickson. (March 2017)	Proposal to build public facilities at Pantai Cahaya Negeri, Batu 5, Port Dickson. (April 2018)
Proposal to build new petanque court of SMK Yam Tuan Radin, Lukut, Port Dickson.	Proposal to build and repair Multipurpose Hall of Kg. Jimah Baru, Port Dickson. (July 2017)	Proposal to build new surau of Taman Anika, Batu 9, Port Dickson. (April 2018)

Table 2.5 List of completed projects

Ongoing projects: Proposal to build new road at Kg. Cina, Bukit Pelanduk, Port Dickson. (August, 2019)

CHAPTER 3.0

CASE STUDY
(CONSTRUCTION OF NEW SURAU AT TAMAN ANIKA BATU 9, PD)

3.1 Project Background

The construction of new surau in Taman Anika, Batu 9 under Pejabat Daerah dan Tanah in Port Dickson was commenced at the end of the year 2018. This project was implemented through design and builds concept, where the appointed contractor was responsible for the design and construction of the project. This project consists of two main buildings which are the surau and toilet block. The value of this project is around RM 500,000. This project is considered as a small project since the cost is still under million. The location of the site is very near to the beach which explains why the initial condition of the soil need to be improved. The texture of the initial soil is very loose and sandy or silt. The moisture content is very high which will definitely affect the strength of the soil itself. However, this report will focus more on soil improvement method which includes the application of non-geotextile fabric and Prefabricated Vertical Drainage (PVD) installed at the depth of 23 metres underground.

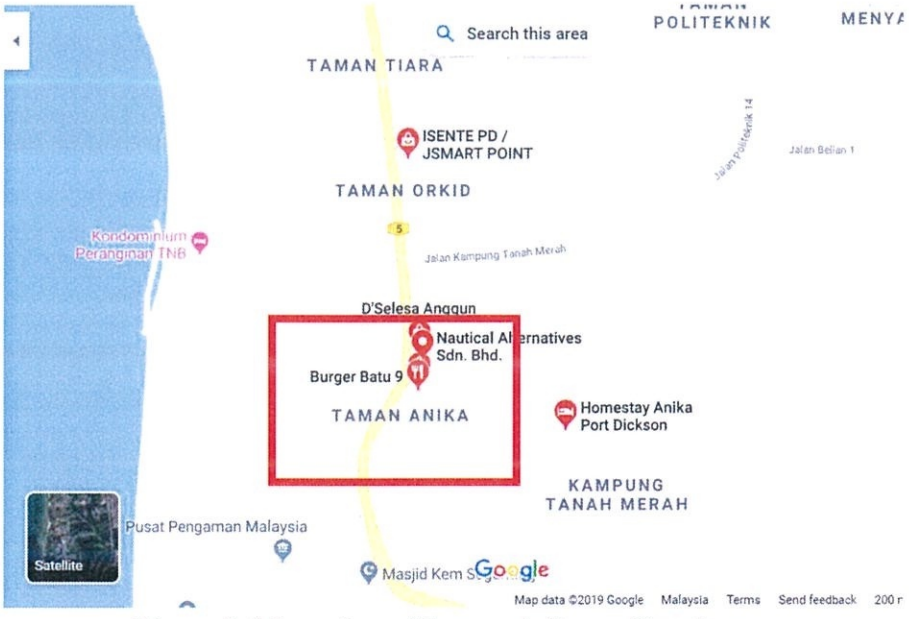


Figure 3.1 Location of Taman Anika on Google map

Source: Google maps

Figure 3.2 Current progress of the project (roofing)

Figure 3.3 Current progress of the project (door and window)

3.1.1 Soil Improvement Method

Soil improvement in its broadest sense is the alteration of any property of a soil to improve its engineering performance such as strength, reduced compressibility, reduced permeability, or improved ground water condition. It may be either a temporary process to permit the construction of a facility or may be a permanent measure to enhance the performance of the completed facility. In the dredging industry, soil improvement is typically implemented to prevent excessive settlement of reclaimed land when it is being used for construction purposes such as roads, airports, bridge and other foundations. Other than that, it is also to enhance the soil stiffness and density to prevent slip failure and increase the bearing capacity of the soil.

There are various types of soil improvement method such as surface compaction, drainage methods, vibration methods, precompression and consolidation, grouting and injection, chemical stabilisation, soil reinforcement, geotextile and geomembranes and other methods as well. However, this project chose the application of Prefabricated Vertical Drainage (PVD) and Geotextile as the improvement methods. PVD is characterised by its prefabricated material consisting of a plastic core covered by synthetic geotextile known as "filter jacket". Two main components of PVD serve the following functions such as core serves as a longitudinal flow path along the drain and filter jacket allows water to pass into the core while restricting intrusion of soil particle.

The reasons of Pejabat Daerah dan Tanah Port Dickson decide to choose PVD method was all because of the superior benefits as technically, it is the most economical ground improvement solution for soft soils with high clay and silty clay content. PVD is applied in areas with loose, compressible and water-saturated soils. These soils are characterised by a very weak soil skeleton and a large pore space, usually filled with water (pore water). When load such as building, road embankment, a hydraulic fill or a dike is placed on soft compressible soil, significant settlements may occur. These kinds of settlement can create serious problems. Any increase in load can also result in an increase of pore water pressure. In soil with low permeability, this water dissipates very slowly, gradually flowing from the stressed zone. Increased pore pressure may also cause soil instability and slip plane failures may result.

This vertical drainage system that has been applied to the site of Taman Anika Batu 9, are generally placed in a square or triangular pattern spaced about 1 to 3 metres in between for faster removal of excess pore water, thus decreasing the risk of slip plane failure. The consolidation of soft cohesive soils using vertical drains can reduce settlement time from years to months ensuring that bearing capacity is adequate and construction can commence rapidly.

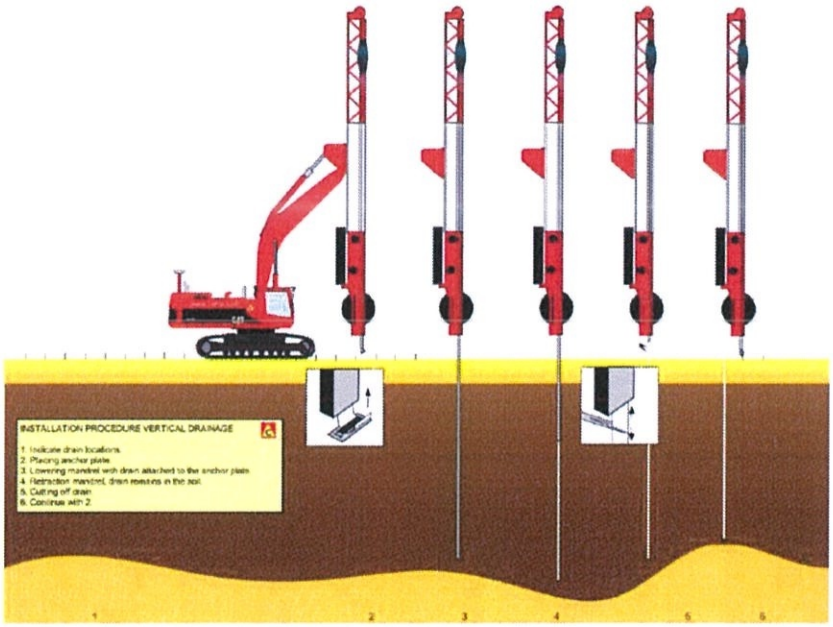


Figure 3.4 PVD Installation

Source: http://geosystem.geotech.edu.com

Hence, with the installation of Prefabricated Vertical Drainage (PVD) to the soil, it can accelerate the settlement of soft soil problems. Furthermore, with the combination of surcharge or vacuum consolidation pressure used by the contractor afterward was very intelligent idea to reduce the time consuming for this project.

Due to Encik Yusri Bin Badaruddin the assistant engineer of the project, vacuum consolidation is a process whereby vacuum pressure is applied to an area where PVD have already installed. The purpose is to potentially increase the drains' effectiveness. Generally, this technique requires the application of a surcharge loading to squeeze water out of the soft clay soils. Such loading must be equal to or in excess of the service loading to which the developed land will be subjected. In vacuum consolidation, the vacuum pressure applied contributes to the surcharge heights are reduced. An additional important advantage of the vacuum is the isotropic nature of the vacuum pressure and the correlated improvement of the stability under preloading, reducing considerably the risk of slope failure resulting from the surcharge.

However, during the site visit, it cannot be taken place every single day since they were facing problems throughout the whole procedure such as prolonged heavy rain that lead to soft soil and excessive moisture content.

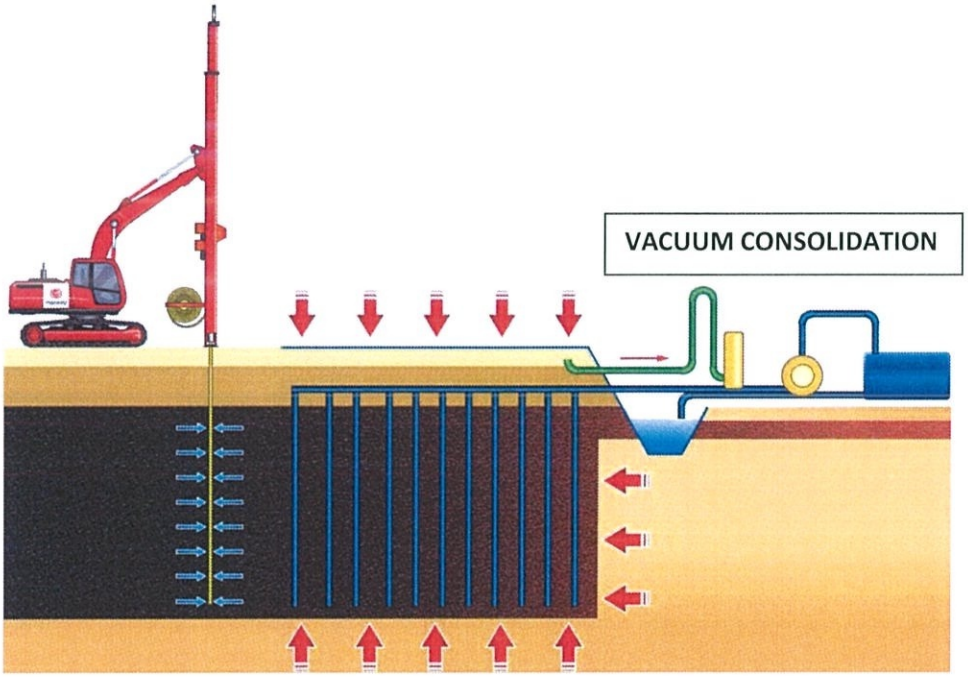


Figure 3.5 Vacuum Consolidation

Source: http://geosystem.geotech.edu.com

In construction of various structures on compressible, saturated soils like soft clay, excessive settlement is a common problem to deal with. The ground improvement technique using prefabricated vertical drains (PVD) is one of the most suitable methods to overcome this problem. The sole purpose of vertical drain system is to shorten the drainage path of the pore water from a low permeable layer to free water surface or to pre-installed drainage layer, thereby accelerating the rate of primary consolidation or the process of settlement. Application of ground improvement method using prefabricated vertical drains (PVD) coupled with surcharge or preloading and vacuum consolidation can significantly shorten the period of primary settlement.

3.2 Installation and Procedure of Soil Improvement

Prefabricated Vertical Drains (PVDs) are composed of a plastic core encased by a geotextile for the purpose of expediting consolidation of slow draining soils. They are typically coupled with surcharging to expedite preconstruction soil consolidation. Surcharging means to pre-load soft soils by applying a temporary load to the ground that exerts stress of usually equivalent or greater magnitude than the anticipated design stresses. The surcharge will increase pore water pressures initially, but with time the water will drain away and the soil voids will compress. These prefabricated wick drains are used to shorten pore water travel distance, reducing the preloading time. The intent is to accelerate primary settlement. Pore water will flow laterally to the nearest drain, as opposed to vertical flow to an underlying or overlying drainage layer. The drain flow is a result from the pressures generated in the pore water. Figure 3.6 below demonstrate vertical water flow without the use of prefabricated wick drains, and horizontal water flow with the use of wick drains. Procedure with further explanations are as below.

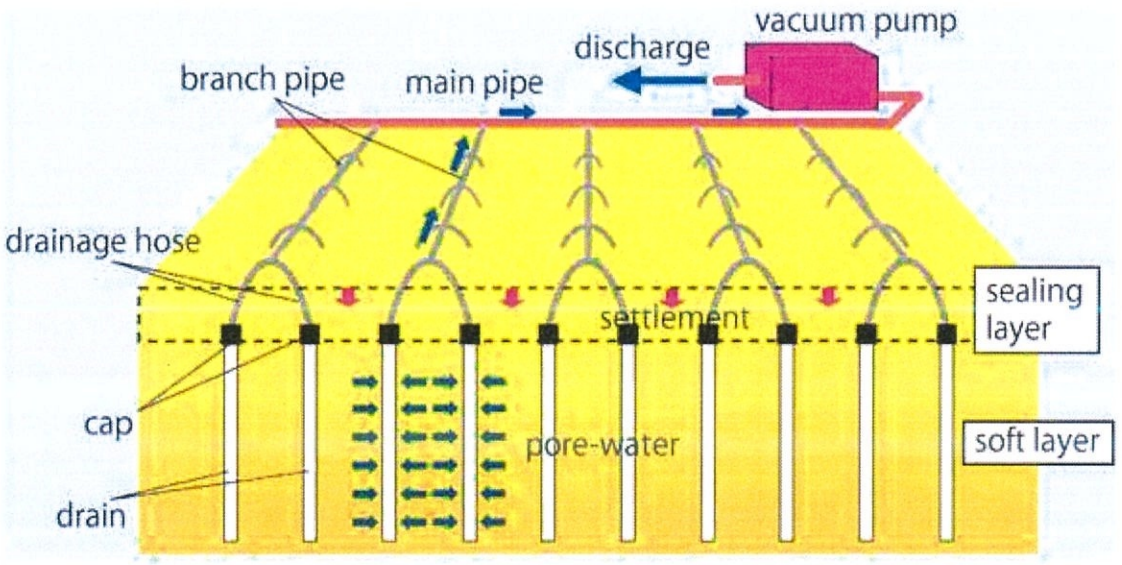


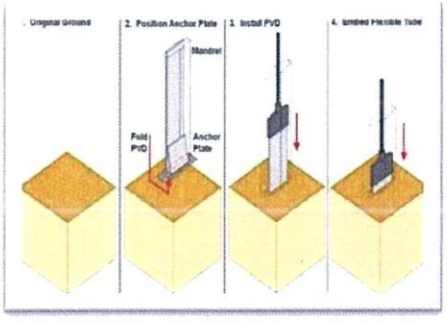
Figure 3.6 Cross-section of soil improvement (PVD)

Source: http://geosystem.geotech.edu.com

The Procedure of Soil Improvement method

Table 3.1 Procedure of PVD method

NO.	OPERATION	SEQUENTIAL DIAGRAM	PLANT AND EQUIPMENT
1.	Go through survey works to determine the required areas and volumes of land and materials needed during construction.		• Measuring tape • Total station • Staff
2.	Carry out site clearing or demolition works. Site clearing is the process of clearing away the vegetation and surface soil of the site.		• Excavator
3.	Stripping top soil or platform to remove any unwanted materials or debris in the soil		• Excavator
4.	Lays non-woven geotextile fabric on the stripped soil as a separation. Inserting well-designed geotextile to ensure that different particle layers are separated from each other.		

5.	Sand is lay on top of the non-woven geotextile fabric to perform as a drainage layer.		• Roller compactor • Backhoe
6.	Prefabricated Vertical Drainage (PVD) works installed at a depth of 23 metres below ground to shorten the drainage path of the pore water from a low permeable layer to free water surface or to pre-installed drainage layer.	  	• Modified excavator
7.	Lays high strength woven geotextile fabric.		• Excavator

8.	Surcharge material is then loaded on top of the drainage layer for approximately 7 months to allow pore water pressure to flow upward through the PVD and will discharge to the nearest drain.		• Roller compactor • excavator
9.	Surcharge is removed to allow the construction proceed to the next step after soil improvement is done completely. Next, the installation of vacuum consolidation.	 	• Excavator • Roller compactor

Vacuum Consolidation

Vacuum consolidation is a process whereby vacuum pressure is applied to an area where PVDs have already been installed. The purpose is to potentially increase the drains' effectiveness. Generally, this technique requires the application of a surcharge loading to squeeze water out of the soft clay soils. Such loading must be equal to or in excess of the service loading to which the developed land will be subjected. In vacuum consolidation, the vacuum pressure applied contributes to the surcharge loading, and therefore actual surcharge heights are reduced. An additional important advantage of the vacuum is the isotropic nature of the vacuum pressure and the correlated improvement of the stability under preloading, reducing considerably the risk of slope failure resulting from the surcharge.

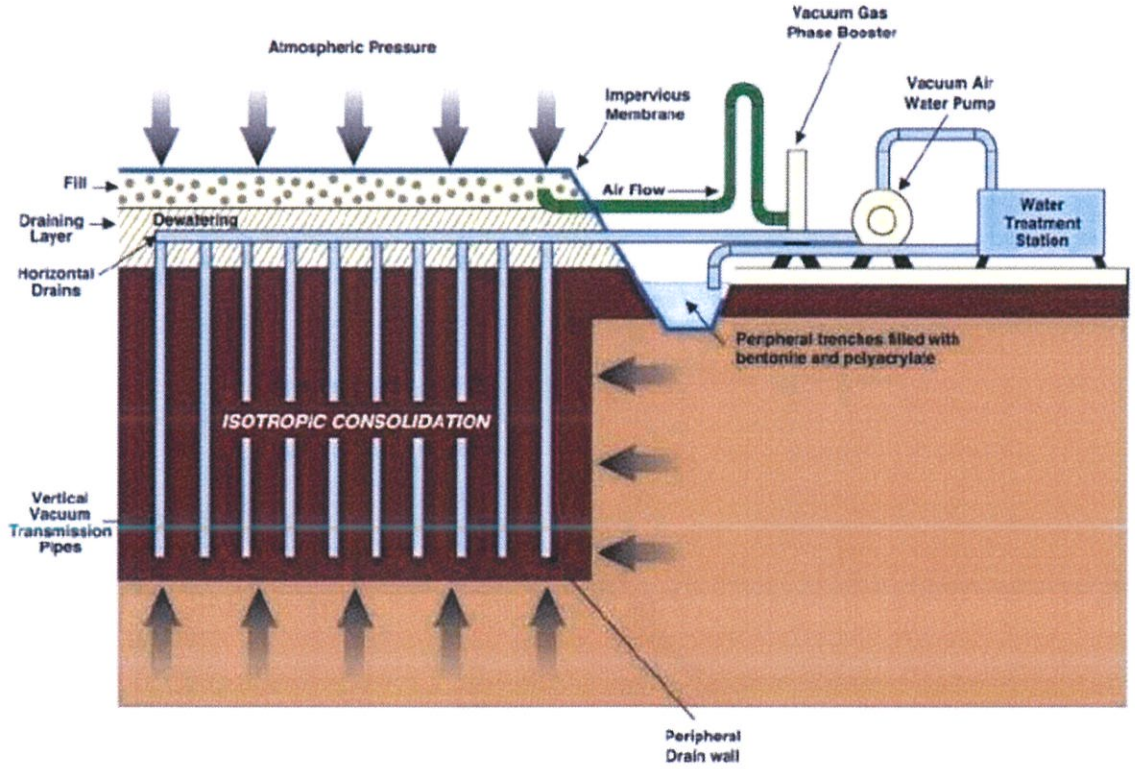


Figure 3.7 Vacuum consolidation

Source: http://geosystem.geotech.edu.com

Geotextile Installation

Geotextiles have many applications including filtration and drainage. Specific types of geotextiles can be used for embankment stabilisation and improving the bearing capacity of soft soil foundations on marine projects. Attention must be given to the composition of the geotextile for specific situations. Using a suitable geotextile can increase safety against underground failure and reduce the settlement of the subsoil foundation.

Figure 3.8 Geotextile fabric membrane

Source: Google image

Main component of PVD

Size used in construction : 100mm x 4mm

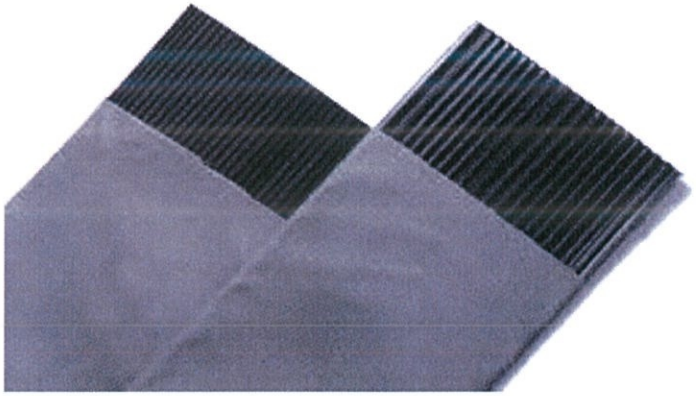


Figure 3.9 PVD material

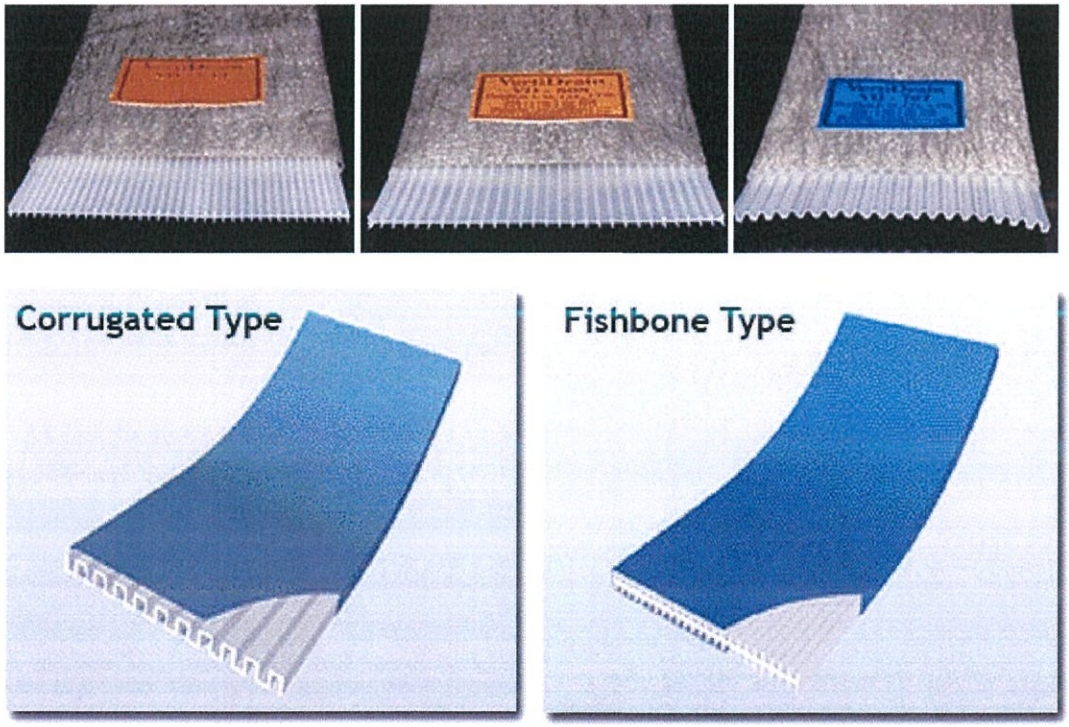


Figure 3.10 Cross-section of PVD material

Source: Google image

3.3 Problems and Solutions

Every construction project must have facing some problems, either they are minor or major problems. Different aspect of challenges faced in the present era by the construction industry are mentioned. These aspects have direct and indirect effect on the construction activity.

These are the common challenges faced in construction industry:

1. Lack of Productivity
2. Lack of Skilled Labour
3. Difference of Generations
4. Challenges with adoption of technology
5. Project Performance Challenges
6. Issues with Sustainability
7. Complexity of the Project
8. Lack of Communication
9. Unreliable Contractors
10. Game of Blaming

However, Pejabat Daerah dan Tanah Port Dickson managed to handle some problems that they had to face during the process of soil improvement. Every actions and decisions were taken carefully as they don't want to involved any damages and loss in the project. All are under controlled and managed to overcome.

3.3.1 Problems occur in construction site at Taman Anika, Batu 9, Port Dickson

- **Weather**

  The weather is the most common factor affecting the construction industry. Port Dickson, well-known with the beach shows the highest percentage of raining everyday throughout the duration of the project. This kind of news can be very harmful not only to the workers but also to the machineries as well. The workers must stop the construction operation immediately as written in company regulations. The operating machineries will be affected as well since the soil is getting wet and the movement of the machineries are very limited. Hence, the continuous raining affects the duration of the construction project.

- **Machineries**

  The workers most likely seldom to follow the rules and regulation regarding machineries regulations. The workers operate the machineries without following the right procedure and steps, for example parked the machineries at the wrong place and lead to unstable position of the machine. The site engineer told me that there were already two cases happened to be horrible incidents regarding the fall down of an excavator due to the unstable position of the machine.

- **Manpower**

  The workers always having problem with time management. Some of the workers come late at the site without giving any concrete reasons. On top of that, the workers do not follow the safety and health regulations as they do not alert with their safety during the construction which may lead to diseases, injuries, as well as fatal. For example, the workers do not wear a proper basic Personnel Protective Equipment (PPE) like dust mask and face shield as their protection.

3.3.2 Solutions to the problems at construction site of Taman Anika, Batu 9, Port Dickson

- **Weather**

  This problem is beyond the limit of human's ability. The only way to solve this problem is that the operation at the construction site must be postponed and stop immediately until the bad weather is under controlled. Other than that, all machineries must be stored at the right place so that it will not expose to excessive sunlight and moisture (liquid). The next action will be, all the soil must be covered with any plastic material to avoid soil settlement. Lastly, the application of water vacuum to remove the liquid from the soil.

- **Machineries**

  The company or employer must be alert and more responsible. They need to park and place the machineries at the right place to avoid any dangers or damaged. Other than that, the use of equipment with an extra safety requirement is really necessary. Besides, a proper work and procedure during soil levelling is recommended to avoid the instability of machineries and plant as well as to ensure the safety of the employees.

- **Manpower**

  The employer of the company needs to be very responsible towards the workers. Salary deduction and advise will be given to the workers who do not give enough commitment so that they will learn the lesson. Next, the employer also needs to take a good care of their workers to avoid injuries and other harmful incidents. A complete safety equipment provided by the company to make sure all the workers wear them and obey the rules of safety is also a good idea and innovation.

CHAPTER 4.0

CONCLUSION

As a conclusion, construction of soil improvement must be done to examine the suitability of the initial soil at the site. Generally, knows that soil improvement purpose is to prevent excessive settlement, slip failure, increase the bearing capacity of the soil and most importantly improve the soil conditions overall. A variety of soil improvement has been developed through all these while in construction industry. However, a suitable technique must be decided according to the necessity of the soil structure and economy. Hence, Pejabat Daerah dan Tanah Port Dickson chose Prefabricated Vertical Drainage (PVD) method.

Hence, since the initial condition of the soil at the site which is Taman Anika was slightly poor consists of soft clay and silt, all construction parties involved agreed to apply soil improvement method for the betterment. All were good throughout the process of soil improvement although there might be some problems as listed on the report that Pejabat Daerah dan Tanah Port Dickson need to deal with, they managed to overcome and all were under controlled. The illustrations of the soil before and after the application of PVD are as below.

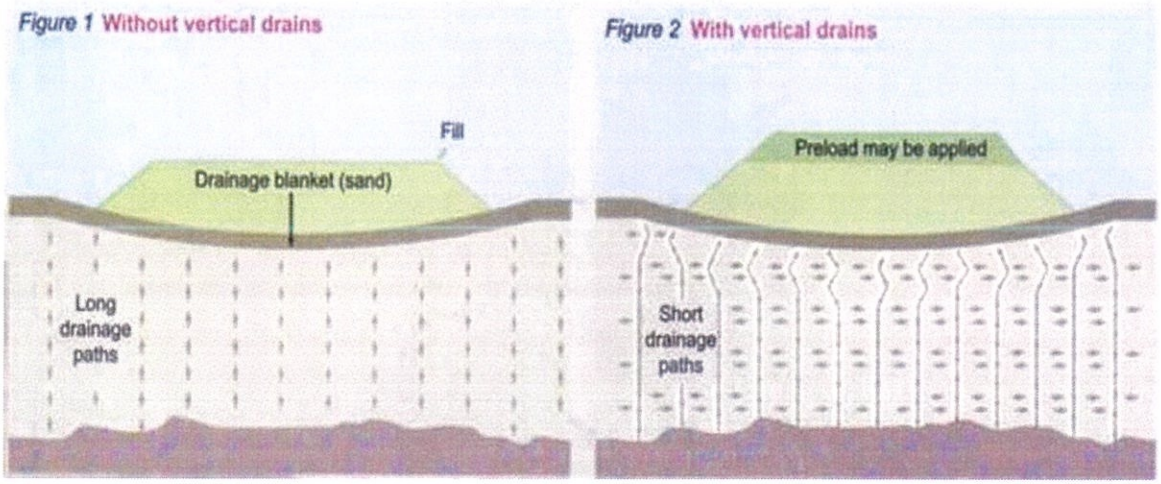


Figure 4.1 Cross section of soil with and without PVD method

REFERENCES

Books:

Ameratunga, J. De Bok, C. Boyle and Tranberg, B. (2007). *Planning for the Future – Ground Improvement Trials at the Port of Brisbane,* Terra et Aqua, Number 108, September.

Chu.J. Vraksin., S. Klotz, U and Menge. P, (2009) *State of the Art Report: Construction Processes 17th International Conference on Soil Mechanics & Geotechnical Engineering,* Alexandria, Egypt.

Montulet, A. Halleux, L. and Nguyen Van Ngoc (2013) *Subsoil Improvement Works at Dyiz, Haiphong, Vietnam.* Terra et Aqua, Number 133, December.

Spelt, J. (2007). *Technote: Vertical drainage installed from pontoons in Bremerhaven storage depot* Terra et Aqua, Number 106, March.

Van Mieghem, J. Aerts, F. Thues, Vandycke S. (2012) *Building on Soft Soils* Number 75, June.

Chan, R. (2006). *Foundation Design and Construction Geo* Publication No.1 China.

Website:

http://www.penta-ocean.co.jp/english/business/civil/softground.html (20 September 2019)

http://ceor.princeton.edu Soil Dynamics and Geotechnical Earthquake Engineering, Princeton University (16 August 2019)

http://geosystems.gatech.edu/Research/gpr.html Georgia Institute of Technology, Liquefaction research. (17 September 2019)

https://theconstructor.org/geotechnical The Constructor Civil Engineering Home

(4 November 2019)