`

Faculty of Electrical and Electronic Engineering Technology

UNIVERSITI TEKNIKAL MALAYSIA MELAKA

ASSESSMENT ON STRAY CURRENT FOR THIRD RAIL SYSTEM PERFORMANCE IN DC RAILWAY OPERATION

MHD AVID BIN MUSTAMIN

Bachelor of Electrical Engineering Technology (Industrial Power) with Honours

2021

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ASSESSMENT ON STRAY CURRENT FOR THIRD RAIL SYSTEM PERFORMANCE IN DC RAILWAY OPERATION

MHD AVID BIN MUSTAMIN

A project report submitted
in partial fulfillment of the requirements for the degree of
Bachelor of Electrical Engineering Technology (Industrial Power) with Honours

UNIVERSITI TEKNIKAL MALAYSIA MELAKA

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2021

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DECLARATION

I declare that this project report entitled "Assessment on Stray Current for Third Rail System Performance in DC Railway Operation" is the result of my own project except as cited in the references. The project report has not been accepted for any degree and is not concurrently submitted in candidature of any other degree.

Signature :

Student Name : MHD AVID BIN MUSTAMIN

Date : 13.01.2022

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APPROVAL

I hereby declare that I have checked this project report and in my opinion, this project report is adequate in terms of scope and quality for the award of the degree of Bachelor of Electrical Engineering Technology (Industrial Power) with Honours

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DEDICATION

To my beloved parents, family, lecturers and friends, I thank them for their lifelong love, support and sacrifice, and express my heartfelt gratitude and gratitude to them. From the day I learned to read and write to what I have achieved today, this sacrifice inspired me. I'm at a loss for words to appropriately convey my gratitude for their commitment, support, and belief in my abilities to achieve my goals.

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ABSTRACT

This project focuses on the DC electrification train system available in Malaysia and abroad. The problem of stray current or known as leakage current is always present and occurs in the performance of the Third rail system in DC operation. This project focuses on the evaluation of stray currents by modeling simple circuit earthing systems on railway systems. In evaluating the stray current on the DC electrification train system, this project uses Stray Current Monitoring System (SCMS) software used by the Malaysia's third railway system to obtain data to implement the effectiveness in assessing this problem and analyze the level of stray current, when the train moves away from the initial state. using the DC mode running rail insulation method. To reduce the problem of stray current the effectiveness of earthing systems was also evaluated in this project and comparisons were made between earthing systems. For the simulated modelling simple circuit earthing system, this project used Matlab/Simulink software. The result of this project is to obtain relevant data in the framework of the Performance of the Third Rail System in the DC Railway Operations system that is, the result of the data in assessment of the stray current when implementing the earthing scheme by taking the value of *ICollector(A), ILine(A), IEarth(A) and INeutral(A)* to show the appropriate earthing scheme used in the Malaysia's third rail system, and from this project show the Reverse diode earthing scheme is more effective in Malaysian third rail system. As hardware testing is not possible, this project focuses on data analysis performed by Matlab/simulink software as well as data obtained from Malaysia's third railway system to analyze stray current on DC electrification train system.

ABSTRAK

Projek ini memberi tumpuan kepada sistem kereta api elektrik DC yang terdapat di Malaysia dan di luar negara. Masalah arus sesat atau dikenali sebagai arus kebocoran selalu ada dan berlaku dalam prestasi sistem rel Ketiga dalam operasi DC. Projek ini memfokuskan pada penilaian arus sesat dengan memodelkan sistem pembumian pada sistem keretapi. Dalam melakukan penilaian arus sesat pada sistem kereta api elektrik, projek ini menggunakan perisian Sistem pemantauan arus sesat (SCMS) yang digunakan oleh pihak Sistem kereta api ketiga Malaysia bagi mendapatkan data untuk melaksanakan keberkesanan dalam penilaian masalah ini serta menganalisis tahap arus sesat, ketika kereta bergerak menjauh dari keadaan awal menggunakan kaedah penebat rel berjalan mod DC. Untuk mengurangkan masalah arus sesat yang berlaku keberkesanan sistem pembumian juga dinilai dalam projek ini dan membuat perbandingan antara sistem pembumian. Untuk sistem pembumian litar mudah pemodelan simulasi, projek ini akan menggunakan perisian Matlab/Simulink. Hasil dari projek ini adalah untuk mendapatkan data yang relevan dalam rangka Prestasi Sistem Rel Ketiga dalam sistem Operasi Keretapi DC iaitu data dalam penilaian keatas arus sesat ketika pelaksanaan sistem pembumian dengan mengambil kira nilai arus pengumpul, arus masuk, arus pembumian, serta arus neutral untuk menunjukkan skem pembumian yang sesuai digunakandidalam sistem kereta api ketiga Malaysia, dan daripada projek ini menujukkan bahawa skem pembumian diod terbalik adalah lebih berkesan digunakan. Oleh kerana ujian perkakasan tidak mungkin dilakukan, projek ini memfokuskan pada analisis data yang dilakukan oleh perisisan Matlab/simulink dan juga data yang diperolehi daripada pihak Sistem kereta api ketiga Malaysia untuk menganalisis arus sesat pada sistem kereta api elektrik DC.

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ACKNOWLEDGEMENTS

Alhamdulillah.

Finally, I was able to finish and submit my project on stray current evaluation for third rail system performance in DC railway operation on time. First so all, I'd want to express my gratitude to Allah S.W.T, who intends for us to accomplish this endeavour. I would be unable to do anything in my life without his instruction.

I'd also want to express my gratitude to my parents for their continued support of my education as well as for encouraging, advising, and leading me throughout my life. I'd want to take this time to thank Mr. Adlan Bin Ali, my supervisor, for his patient guidance, excitement, and encouragement. It was extremely appreciated that he was prepared to contribute so generously.

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LIST OF SYMBOLS

V_{rail}	-	Voltage rail
I_{stray}	-	Stray current
R_{r-e}	-	Rail-to-earth resistance
I_j	-	Equivalent current source
V_r	-	Rail potential
I_S	-	Stray current
V_{rt}	-	Rail potential at negative TSS
I_{earth}	-	Current flow at Earth
$I_{coleector}$	-	Stray current flow at collector
$I_{negative}$	-	Current flow at Running rail / negative
R_{Tr}	-	Resistance at line Third Rail
R_{Rr}	-	Running rail Resistance
R_{rg}	-	Resistance Rail-to-ground
R_{ng}	-	Resistance Neutral-to-ground
R_{cm}	-	Resistance Collector mat
R_{sg}	-	Resistance System ground
R_{Tn}	-	Resistance Load (Train)

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LIST OF ABBREVIATIONS

DC	-	Direct current
AC	-	Alternating current
EN	-	European standard
ISO	-	International Organization for standardized
LRT	-	Light Rapid Transit
MRT	-	Mass Rapid Transit
Hz	-	Frequency
V	-	Voltage
kV	-	Kilo volt
TPSS/TSS	-	Traction Power Supply Substation
PMU	-	Main Input Substation
BSS	-	Bulk Supply Station
TNB	-	Tenaga Nasional Berhad
Amp	-	Ampere
SCMS	-	Stray Current Monitoring System
VLD	-	Voltage Limiting Device

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CHAPTER 1

INTRODUCTION

1.1 Background

Railways electrification system are important and also critical component of transportation network, particularly in large metropolitan areas. The electrification rail system is divided into two types of supply, namely AC electrification and DC electrification system. Both systems can be operated in a third rail or fourth rail system. However, each system has its own shortcomings. For DC electrification on third rail systems, a common problem is with Stray current. The difference between these two traction techniques is that the positive polarity of the current is set to flow through the newly placed rail [1].

The third rail, and the negative polarity of the current (identified as a return path or return circuit) still uses either of the two running rails. Regrettably, the disturbing stray current problem has surfaced, casting a shadow over the performance of the third railway service of the London Underground, and it is believed that the problem should be solved. The return path, not the third track, is the source of the difficulty. As a result of employing the running track as the return channel for the traction source current, stray current from the DC railway is unavoidable[2],[5]. Because of the sleeper's poor insulation effectiveness, a portion of the return current will undoubtedly leak to the ground, creating an unwanted current return route. Because stray current can cause corrosion of neighbouring railway supports and third-party infrastructure, it is an issue that has to be actively handled.

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The current flowing in the running track may then leak to the ground, pass through the soil, and be connected to nearby bare or badly insulated buried metal structures, so supplying resistors, due to inadequate insulation between the return circuit and the earth. Current flowing along a low-resistance channel [4]. Corrosion and damage, as well as overheating, arcing, and fire, may occur if stray current escapes the metal structure; signal and communication systems with inadequate anti-interference capabilities are interfered, putting persons and equipment within and outside the railway or train in risk. The system's electricity comes from a variety of sources, including the third rail. Insulators are required to safeguard electric trains regardless of the power source. However, they frequently fail and/or malfunction, which has a detrimental impact on the transportation system's performance.

One of the difficult difficulties in the DC electric rail transportation system for third rail transit system is lowering rail voltage and stray current corrosion at the same time. Corrosion of metal parts near the railway is mostly caused by stray current. Selecting an adequate grounding strategy is a good method to decrease Stray current intensity while also ensuring crew safety. Metal items will corrode where the current exits the metal framework [5]. This project assess of stray current using running rail simulation method by SCMS. Next, design the simple circuit simulation modelling achievement of earthing system when applicable stray current. Finally, compare the earthing system effect when applicable stray current.

1.2 Problem Statement

In some railway networks, the third electrified railway is installed on electric railways to provide traction for trains. In order to isolate the third rail from the ground and prevent them from finding a short-circuit path to the negative circuit, an insulator is used.

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Insulators are usually covered by contaminants, which come from traction operations and other resources accumulated over time, and cause fire, smoke, leakage current, and even failure of the insulator. When an accident occurs in the tunnel, the problem becomes more serious. The failure of third rail system can cause a delay in one component of the transportation system and affect the entire railway. Passengers have lost trust in the safety of the subway system and the ability to reach their destinations on time. They are looking for other modes of transportation. Therefore, it is very important to study the causes of operation in the third rail transit system.

The project's main goal is to analyse issues and malfunctions with Malaysia's third rail transit system. As a result, the third rail system will always fail, and stray current will be reduced in the third rail system. Failures of this system include the following, as well as the early actions made to decrease stray current:

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i. The occurrence of a short circuit between rail to rail or between rail and earth, which could pose a danger to the system as well as to an individual nearby

ii. Earthing systems that are less effective or less suitable for railway systems, which can result in increased leakage current (Stray Current) issues and will endanger the system and an individual nearby

iii. The initial solution recommended in the literature to reduce the stray current is to increase the Resistance on the Insulation Rail to earth and reduce the potential of the Running rail by shortening the distance from one station to another.

1.3 Objective of Project

The major goal of this study is to develop an approach that is both methodical and effective to assess on stray current for third rail system performance in DC Railway operation Specifically, the objectives are as follows:

a) To assess of stray current using running rail insulation method by Stray Current Monitoring System (SCMS)

b) To design the simple circuit simulation modelling achievement of earthing system when applicable stray current using Matlab/simulink software

c) To compare the earthing system effect when applicable stray current using Result Data Matlab/simulink software

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1.4 Scope Project

The following is the project's scope:

a. The scope of project start by familiarize with the concept DC electrified of third rail system operation for railway system.

b. Then, concentrate on studying and comprehending the issue of stray current in the DC railways system, what causes it, and how to resolve it.

c. Study and understand the software will be used is MATLAB/simulink software to facilitate the assessment in this project.

d. Study and understand the schematic diagram related the stray current, the schematic diagram modelling achievement of earthing system when applicable stray current and make the comparison between earthing system.

1.5 Conclusion

The background, problem statement, objective, scope of project and organization of the report has been explain above. This chapter has also stated how to solve the problem and how the project is carried out.

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CHAPTER 2

LITERATURE REVIEW

2.1 Introduction

This chapter will go through the prior project that has been done on this topic in depth. It will include a study of the railway system, a discussion of the DC electrification third rail system, and a discussion of the DC electrification third rail system issue.

2.2 Railways system

Railways system is a transportation that has existed for therefore long in nearly each country. With this system, it will facilitate individuals in terms of transportation to at least one place to a different simply.Transit is look upon a sound public transportation and was born as a reliever to ease the pressure on town streets [1]. This rail system is additionally terribly helpful particularly these days, with the supply of different vehicles which will increase tie up in urban areas specially.

Train transportation is another name for railway transportation. It is a mode of transportation that uses a vehicle that moves on a track (rail or railroad). It is one of the most essential, widely utilized, and cost-effective modes of long- and short-distance travel, as well as freight transport. Because the system is based on metal (typically steel) rails and wheels, it has a lower frictional resistance, allowing the truck or carriage to carry more weight. A train is the name for this mechanism. Trains are typically propelled by locomotives using electric or diesel engines. A complicated signaling system is employed when there are several route networks. Railway transportation is also one of the most efficient modes of land transportation.. figure 2.0 shows the early evolution of train.

Railway transportation, which is used to move products and people, is also a driving factor of economic advancement. Passenger trains, subterranean (or above ground) urban subway trains, and freight trains are all adapting. Railway transportation comes with its own set of limitations and limits. The high expense of railway transportation is one of the most significant limitations.

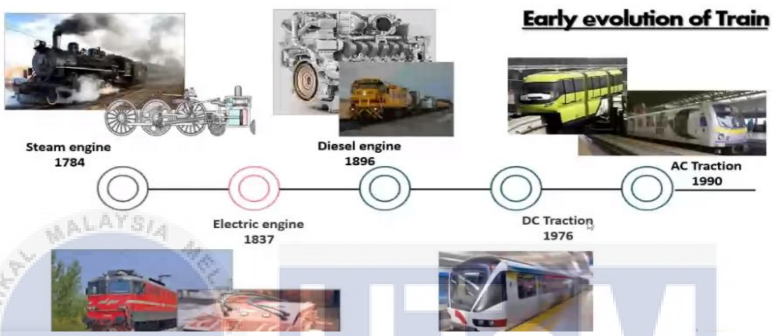

Figure 2.0 : Early evolution of train

In the railway system, there are four important components to create this railway system that is rolling stock, to move the train, truck network to support the movement of the train or in other words provide a way for the train to move, electrification system to provide the train with electricity to move either in AC or DC form. And finally, signal and communication, to facilitate the movement of the train to run smoothly.

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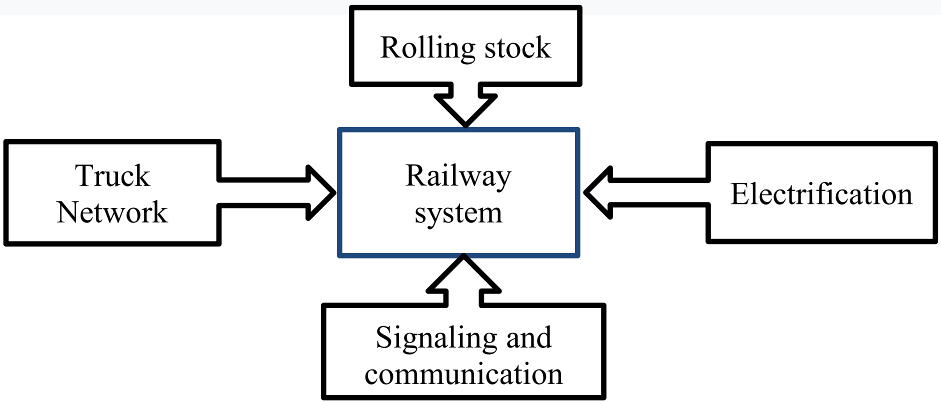

Figure 2.1 : Main components in Railway system

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2.2.1 DC Electrification System

Railway trains and trams are powered by an electrification system that eliminates the need for on-board prime movers or local fuel supplies. Electric locomotives (carrying passengers or cargo in separate carriages), electric multi-units (passenger cars with their own engines), or a mix of the two are used on electrified railways. Typically, electricity is generated in huge, reasonably efficient power plants, then transported to the railway network and delivered to trains. Although some electrified trains have their own power plants and transmission links, the majority purchase electricity from utility companies. In most cases, the railway is responsible for its own distribution lines, switches, and transformers.

In Malaysia system Railways using Standardized voltages from European (EN) and International Organization for standardization (ISO) for running the system. For DC Electrification system in Malaysia using 750VDC. This DC Electrification system is used in Malaysia Railways , such as LRT in Third Rail system. Table 2.0 show the Standardized voltages from European (EU) and International Organization for standardization (ISO)

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Electrification system	Voltage				
	Min. non-permanent	Min. permanent	Nominal	Max. permanent	Max. non-permanent
600 V DC	400 V	400 V	600 V	720 V	800 V
750 V DC	500 V	500 V	750 V	900 V	1,000 V
1,500 V DC	1,000 V	1,000 V	1,500 V	1,800 V	1,950 V
3 kV DC	2 kV	2 kV	3 kV	3.6 kV	3.9 kV
15 kV AC, 16.7 Hz	11 kV	12 kV	15 kV	17.25 kV	18 kV
25 kV AC, 50 Hz (EN 50163) and 60 Hz (IEC 60850)	17.5 kV	19 kV	25 kV	27.5 kV	29 kV

Table 2.0 show the Standardized voltages from European (EU) and International Organization for standardization (ISO)

Electricity travels along the track in (almost) continuous conductors to power mobile trains, usually in one of two forms: overhead lines, poles or towers suspended

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from the tracks, or suspended from the ceiling of structures or tunnels, or overhead lines, A sliding "pickup" contacts the third track, which is positioned on the track's horizontal plane. The return conductor is normally the running rails in both overhead wire and third-rail systems, though some systems employ a separate fourth rail for this function. The third rail system, in most circumstances, offers direct current (DC) for the supply. Within the DC voltage range of 600 to 750, the rails may supply positive polarity of the DC power offer, but the running rail delivers a negative path polarity [4].

However, increased system voltage is not considered safe when the third rail system poses a risk of electric shock. As a result, extremely high current is consumed, resulting in significant system power loss. Falling into the tracks is extremely dangerous when there is an electrical rail present. running track may leak to the ground, flow in the soil and be coupled to nearby. The train is powered by a collector shoe within the rails, which can occasionally be located near to the tracks and contains a high voltage that is extremely deadly if handled [2]. The current flowing through the bare or weakly insulated buried metal structures, thereby supplying resistors, is due to insufficient insulation between the return circuit and the ground. This is a road with very little resistance. Figure 2.2 show the Power Rail , is to supply power to the Train.

Figure 2.2: The Power Rail

2.2.2 How DC Electrification Supply in Railways system

The direct current supply system (DC) derives power directly from the primary lines at mains frequency without introducing unbalances, distortions, or the possibility of undesired flux on the contact lines. DC traction is used by half of all electric railways worldwide. DC traction is employed in most urban, suburban, and regional electric transportation networks. The energy needed to power the electrical drive systems comes from a three-phase medium or high voltage distribution network, which is then rectified to DC at the converter traction power substation (TPSS) via rectifier bridges .

In the DC electrification railway system, all energy supply comes from the Grid system with supply in Alternating current (AC) , that is, the energy supply from TNB is 275 KV, 50Hz on the primary winding transformer then will go out on the secondary winding of 250KV, 50 Hz on the Substation or known as the main input substation (PMU) owned by TNB. In the Railways system, it has been standardized that the energy supply on the Railway will not mix with the energy supply that is channeled to other consumption. This general incoming supply to DC Electrification system refer system in Malaysia Railways. Figure 2.3 show General incoming Supply to DC electrification system railways.

Then the 250KV, 50Hz supply will be sent to company railway Substation, which is called the Bulk Supply station (BSS) and then in the Step-down of 132 KV, 50 Hz. After that, it will be step-down again up to 33KV, 50Hz then it will be sent to the Traction Power Substation (TPSS), and it will be step-down again to 585 VAC, 50Hz.Then in this (TPSS) the one that will convert 585VAC, 50Hz will go through the Rectifier System and will be 750VDC. From the value of 750VDC will be sent to the Power Rail to provide Power Supply to the Railway DC electrification system.

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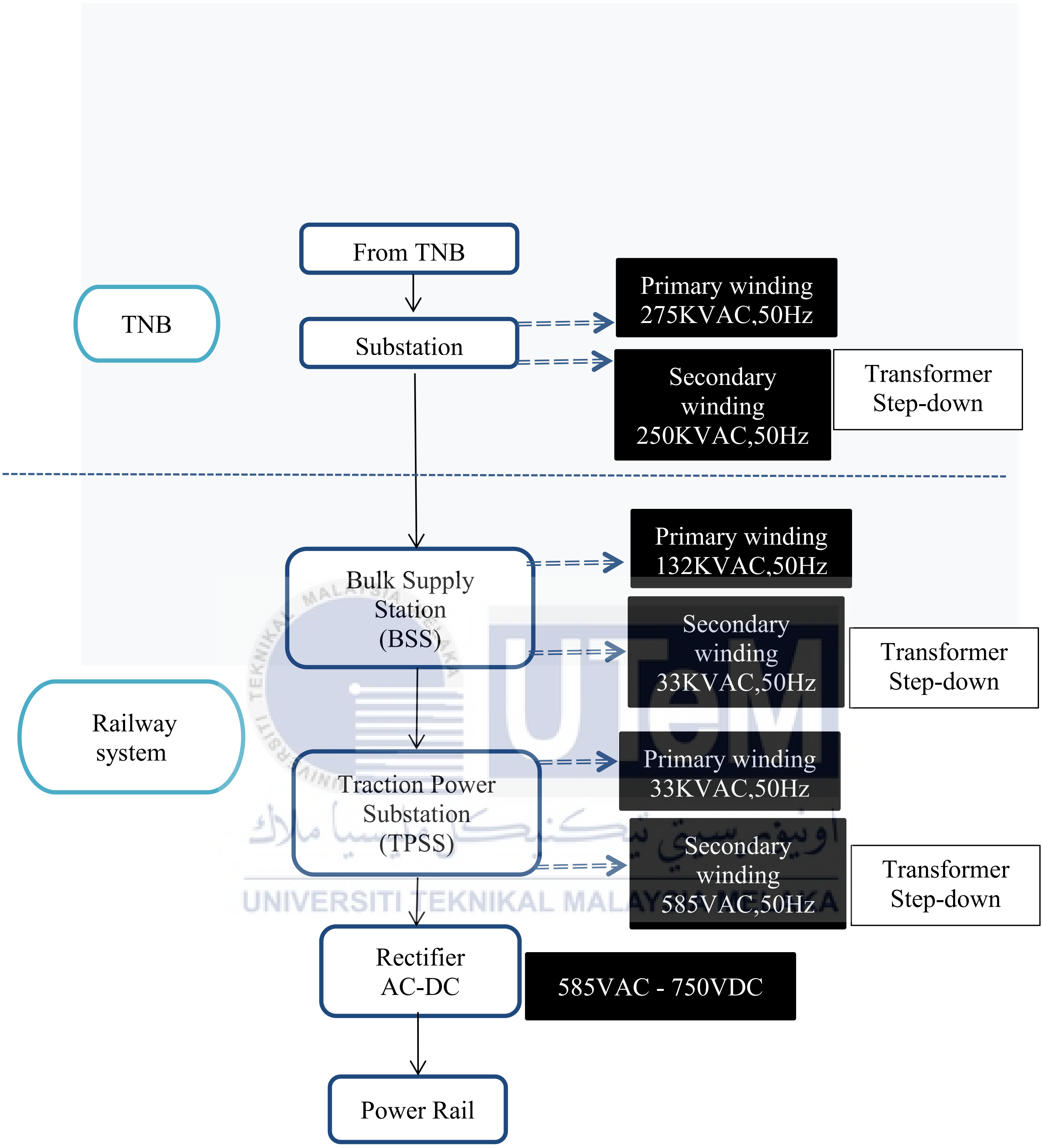

Figure 2.3 : General incoming Supply to DC electrification system railways.

2.3 General power system LRT System in Malaysia

When referring to the abbreviation of Malaysia LRT as "Fast," which conveys the same theme as the subway, Light Rapid Transit may be suitable. In summary, a light fast or light Metro is a rail transport system that has the physical qualities of a subway but has a capacity somewhat bigger than that of a light rail but smaller than that of a subway. In addition, the Malaysian light rail line has a route coverage of 46.4 kilometers, which is the second longest fully automated subway transport in the world (as of 2019) and the longest self-powered subway in Asia [5]

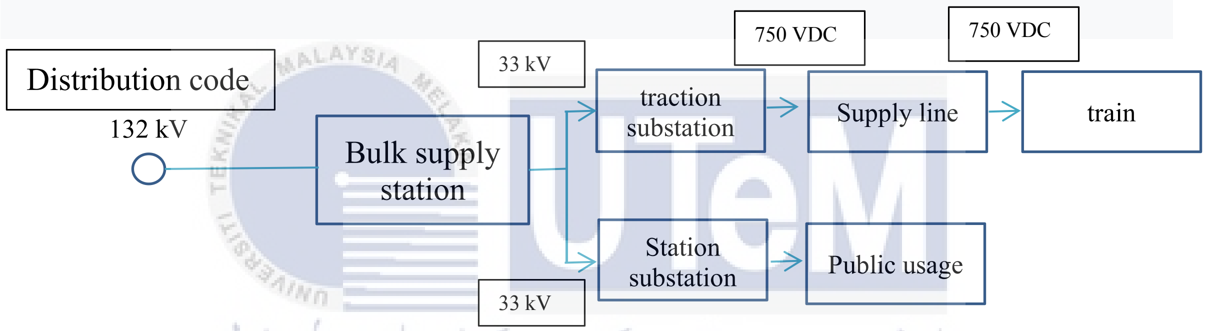

Figure 2.4: General diagram of LRT system in Malaysia power system

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Supply from distribution code which is 132 kV,50 Hz will be supplied to Bulk supply station, then in Bulk supply station will be step-down the supply to 33kV,50Hz using transformer. Next , will be supplied to traction substation. In traction substation the supply will be rectifier into DC voltage then just sent supply to the supply line.

2.4 General Operation of DC electrification in Third Rail

In this section we will describe how the operation from TPSS to the power Rail for Train operates and moves from one station to another. This operation starts from TPSS sending the power supply that has been step-down through the Transformer to 585VAC, 50Hz.

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Then the power will go into the Rectifier part (positive and negative). In a DC electrification system, all the components in the system will have two sets, namely the components for the positive power source and also the power source for the return path or Negative.

After that, the 585VAC, 50Hz power that the rectifier has will be 750VDC. Before the 750VDC power enters the Power Rail, it must be connected to the Isolator. In a DC system, Voltage does have a small value compared to an AC system, but DC has a fairly large and dangerous current of 6000 Amp DC, so it needs to be connected to the Isolators. Then from the Isolator it will be connected to the Feeder Breaker. Feeder Breaker serves as a power cut-off on the Power Rail. After that, the power source will connect to the Power Rail installed near the Track. Figure 2.5 show the operation

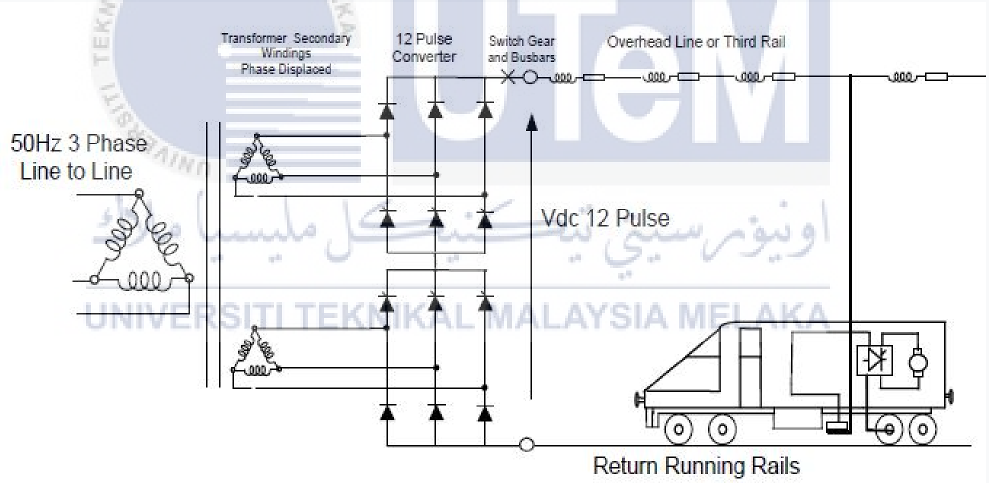

Figure 2.5: operation of DC electrification third Rail system

The power source that is channeled to the Power Rail will be collected by the train using a component called the Shoe collector. The shoe collector will link to the Power Rail to provide power to the motor system as well as other components in the Train.

2.5 Third Rail system

The third rail system uses continuous stiff conductors installed beside or between the tracks to provide power to the train. It's most commonly found in a large-scale transit or rapid transit system with its own alignment and is totally or nearly fully separated from the outside environment.In most situations, direct current is provided through the third rail system.

The third track system uses an extra track (known as a "conductor track") to provide electric propulsion to trains. The conductive rails are usually located outside the running rail at both ends of the sleeper, however in rare circumstances, the centre conductive rail is employed. At around 10-feet (3 meters) intervals, conductor rails are often supported on ceramic insulators or insulating brackets [6].

The rails are an American invention, and their use goes back to the first subway systems in the decennium. Because their voltage level is higher than one potential unit, several railway power-supply systems are prohibited to using overhead contact lines (kV), The third rails, on the other hand, provide electrical power to the railway car through a stiff conductor between or on the rails [7].

On the train, metal contact blocks known as "shoes" make touch with the conductive rails. Traction current returns to the power station through the running track. The Conductor rails are usually made of highly conductive steel, and wire bonding or other equipment must be used to electrically connect the rails to minimize the resistance in the circuit. Collectors transmit electricity from the third track to the train.

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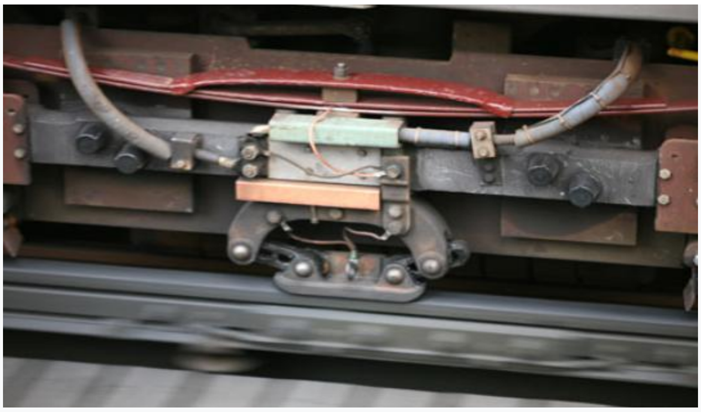

Figure 2.6: The shoe collector

The train moving the current collector, on the other hand, is subjected to tremendous loads and unfavourable environmental conditions such as heat, moisture, dust, and intense vibrations, making electrical current transmission problematic. Figure 2.6 shows the shoe collector. At level crossings and crossovers, the conductor rails must be halted, and ramps are built at the ends of the sections to ensure a seamless transition to the train shoes.

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2.5.1 Contact in Third Rail

A third rail is a means of supplying electric power to a train through a continuous rigid conductor installed beside or between the rails of a railway track. It is often utilized in a mass transport or rapid transit system that has alignment in its own Corridors and is completely or nearly completely isolated from the outside environment. Third rail systems, in most situations, provide (DC) direct current energy.

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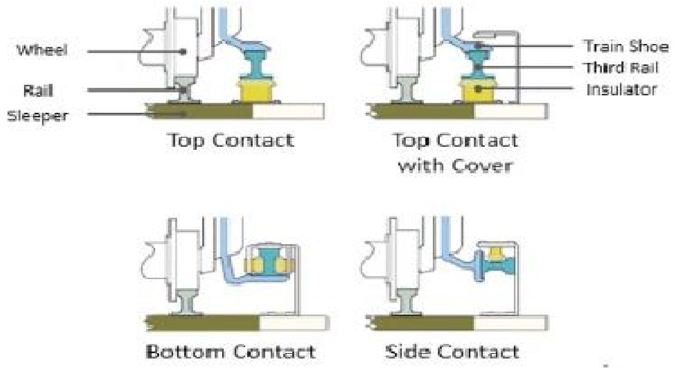

Figure 2.7: contact track in railways

2.6 Third Rail Characteristics

The third track, in technical terms, is a device that supplies traction current to a traction unit, such as a train. Shoes fixed on and situated on the beam capture the energy. Figure 2.8 schematically shows a third track system.

The third track can take many different forms, but they all serve to supply current to the running train. A sliding connection made up of springs, pistons, and shoe gears transmits the electricity to the train. Depending on the material of the third rail, the hoof gear is made of a different material.The third rail is usually situated between the running rails, although it can also be situated outside of them.

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The running track is frequently joined by wire bonding or other methods in order to reduce circuit resistance. The train will make contact with the rail at a different angle. Top connections were utilized in the beginning, while subsequent systems employed side or bottom connections. Both methods of contact protect the slide rail from dust and silt, as well as the truck driver. Depending on the type of rail, the contact shoe can be placed anywhere around the third rail.

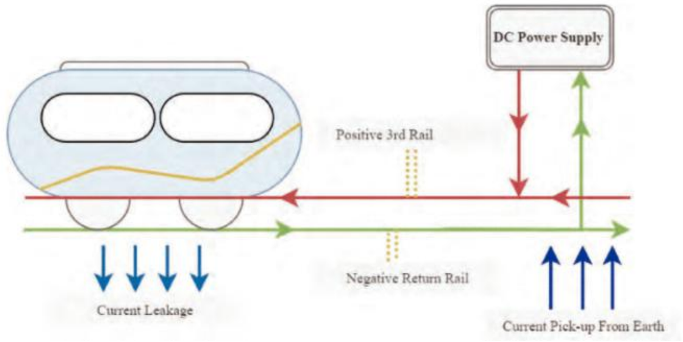

Figure 2.8: Schematically a third track system

Conductive rails are typically built of steel in the United States. To increase conductivity, composite rails (such as extruded aluminium with a steel surface) are sometimes utilized. Because of its longer service life, low resistance, and light weight, conductors in other regions of the world are typically built of extruded aluminium with stainless steel contact surfaces. This style of conductor is used on urban trains in several countries, including as Japan, South Korea, and Spain. Many overhead power lines have been built, but many new third-track systems have been developed around the world, especially in many sophisticated countries like China, Denmark, and Taiwan.

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2.6.1 Mechanism of the Third Rail

The third rail current can be collected in a variety of ways and designs. Although the top contact approach is the most basic and oldest, practitioners and experts on the third track have identified several flaws. The potential of naked electrical cables posing a serious safety hazard is quite high. It will collect leaves and other objects, rendering the train immobile. Effective corrective approaches to address these issues come at a significant price. Because the majority of the rail is properly covered and shielded from any environmental hazards, the bottom contact approach is commonly regarded as the finest approach to collect the third rail current. The third rail shoe serves as a power supply conductor.

2.7 Third Rail Arrangement

The third guide rail includes a sliding rail, an insulator, a protective plate, a protective plate bracket and a shoe contact. Figure 2.9 showing the location of the third rail and other related equipment.

2.7.1 Running Rails

The third rail is usually located outside the two slide rails, but on some systems it is installed between them: in other words, in most third rail systems, the conductor rail is located at the end of the sleeper outside the slide rail , But in some cases the system uses a central conductor rail.

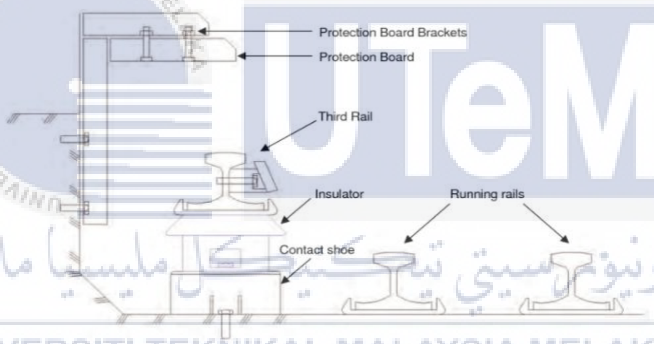

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Figure 2.9: The location of the third rail and other related equipment.

2.7.2 Insulators

Fiber reinforced plastic, metal end fittings, and silicone rubber are the three components that make up the insulator. They are typically constructed of non-conductive, quick-drying materials (such as porcelain, fibreglass, or composite materials) and put in each support bracket location. Rubber insulators are becoming more popular in transmission lines because they are less in weight, have a slimmer shape, are more resistant to deliberate damage, and produce less pollution than traditional insulators. However, the main problem with rubber insulators is that they degrade material properties due to aging.

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2.7.3 Protection Board

The protective plate covers the top of the third electrical rail of the railway and is fixed on the contact rail to prevent people from touching the rails. Fiberglass, plastic, and wood are commonly used in the construction of these boards.

2.7.4 Bracket Protection Board

The contact rail protection board is supported by the protection board bracket. Each bracket is carefully moved along the guide rail before being put on the board.

2.7.5 Shoe Collector

Although the third rail is often situated outside the running rail, it can also be found between the two running rails in rare situations. A sliding shoe is used to deliver power to the train, and it is in touch with the side and bottom of the third rail, with a protective cover on the top surface. The shoe collector will connect to the Power Rail to supply power to the train's motor system and other components. The show contacts a rail carrying electricity along side the track. Historically the conductor rail was mounted on the ground and the shoe contacted the rail from above.

2.8 Third Rail Challengers and issues

Environmental, mechanical, electrical, and operational issues might all contribute to the railway system's third collapse. Methods for preventing and resolving transmission insulator failures have been proposed by projecters [8]. When rust particles and carbon powder cause insulators to short-circuit, smoke, rupture, and damage wooden insulation, this is a common occurrence in tunnels. Contact is burning [8]. Was out that glass fibre insulators will likewise burn and ceramic insulators will melt in this situation.

Outside of the two slide rails, the third rail is generally found. Table 2.1 lists the inherent problem categories and relative causes of the third railway system.

Category	Causes
Environmental	Erosion, lightning, sunlight. And saltwater penetration
Mechanical	Cracks / fractures, mechanical stress, damage from impacts, and aging
Electrical	System voltage fluctuations, corrosion, distortion, and flash-overs / arcing
Operational	Dirt buildup, faulty product components, water infiltration, ice and snow accumulation, and vandalism are all problems that can occur.

Table 2.1 : Lists the inherent problem categories and relative causes of the third railway system.

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Because of the arc phenomena between the frame contacts and the collector shoes, all third track systems are prone to electrical corrosion. The conductor material will corrode if contact loss happens regularly at a specific location on the rail's surface. Engagement and disengagement at full power on a slope, inadequate dynamic responsiveness of the collector, discontinuity of the rail contact surface, and poor alignment between the third rail and the running rail are all possible causes of collector loss.

2.9 Advantages and disadvantages third rail system

Advantages	Disadvantages
➢ Third rail likes DC because it can carry 41% more than an AC system running at the same peak voltage [9], is more compact than overhead wire, and can be utilised in tunnels with lower diameters [9].	➢ Third rail system are limited to relatively low voltage and allows only a limited amount of air-conditioning on the train[9], [9]
➢ Electromagnetic interference has no effect on electrical components while using the third rail, and is more durable than an overhead wire, with a longer service life.	➢ Speeds are additionally limited to 160 km/h due to system technical restrictions (e.g., above this speed, reliable contact between the contact shoe and rail cannot be maintained) [9], and peak-time line capacity is limited to 60,000 people per hour per direction on lines electrified at 750 VDC. [9]
➢ Third rail has a reduced construction cost (since it uses existing rails to re-establish adequate electrical clearances) and is typically less expensive for surface line insulation difficulties. [9]	➢ The accumulation of ice and snow on the conductor rails poses a major threat since the collector shoes are unable to make contact with the rails, and the service is likely to be discontinued [9].
➢ Has the advantages of no phase-split along the overhead system thus the train can run smooth [7]	➢ As the return current must be carried by the running rails, which may also be required for autonomous signaling (due to the discrimination between these two currents) [7], there will be unavoidable power supply gaps at locations, and signaling costs will rise.
➢ Because it is fed on both sides by rectifiers from neighbouring substations, the system has a high level of dependability	➢ Stray current is also a possibility, while advances in technology are helping to manage and minimize this element.

Table 2.2: advantages and disadvantages Third Rail system

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2.10 Return Current System

With the exception of fourth rail systems, the railway generally employs the train wheels and running rails as the traction current return channel to the D.C. substation. The rails are not insulated from the sleepers, the structures to which they are linked. The earth return is more intricate than it looks at first because the current that flows out of the rails and returns at a different spot is referred to as stray current.

This part like a concept electric AC where the secondary on the winding transformer must be connected by the start winding and then grounded well, then the return path will be able to be created. why it is linked, because it has a significating relationship. There are many common earthing systems for connecting the negative at the substation to the running rails, which are described below [10]:

i. Floating Earth Systems (UK Standard)

ii. Floating System with Rail to earth detection and main tripping of the main circuit breakers, Singapore MRT.

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2.11 Stray Current

Corrosion of metal parts near the railway is mostly caused by stray current. When the return current flowing to the TPSS in the running rail finds a low-resistance path to its intended path, such as through bare or weakly insulated metal structures buried in dirt or concrete (for example, pipes, storage tanks, steel bars, cables)),It might leak into the ground or concrete and seep into the metal structure, causing interference [11].

The third track system is their corresponding component, often dealing with problems and challenges such as electrical corrosion and materials caused by dust accumulation. Corrosion of metal parts near the railway is mostly caused by stray current. One of the difficult difficulties is minimizing rail voltage and stray current corrosion at the same time. Cleaning insulators at regular intervals, frequent inspections, and preventative maintenance operations are all common ways to decrease corrosion [11]. Selecting an adequate grounding strategy is a good method to decrease corrosion intensity while also ensuring crew safety. Metal items will corrode where the current exits the metal structure. figure 2.10 show the schematic of operation of third rail system.

The magnitude of the leakage is determined by the voltage drop in the rail (which is determined by the current flowing in the rail and the rail's resistance) as well as the rail's resistance to the ground. The stray current is essentially determined by the conductance value per unit length of the slide rail. The inductance per unit length of the region where there is a danger of effective stray current is recommended in the of the standard EN 50122-2. The defined acceptable maximum of stray current is based on real-world experience with DC electrified trains, and it indicates that the danger of corrosion is minor after 25 years [11].

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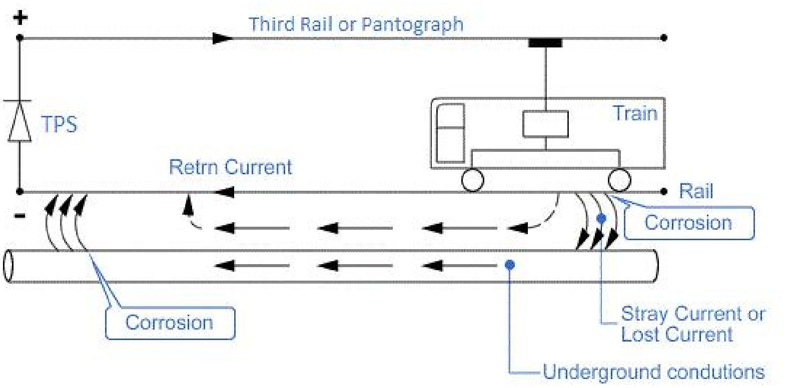

Figure 2.10 : show schematic of operation of third rail system

2.11.1 Corrosion

Flows stray from their original direction to parallel and alternate low-resistance pathways, such as metal structures buried in the ground. The underground pipeline may take stray current from the railway system far away from the traction substation, discharge it into the soil, and then return the current to the rail near the substation. The stray current in an electric train system exhibits unpredictable, dynamic, and bipolar features [12]. The flow direction is determined by the stray current source's immediate characteristics, which include the electric traction's real instantaneous load. The DC external power source leaves a certain metal structure, which causes electrolytic corrosion. Where the current exits the structure, corrosion develops [12]. Stray current corrosion is a kind of corrosion produced by railway systems. Figure 2.11 depicts stray current corrosion in a pipeline near a train.

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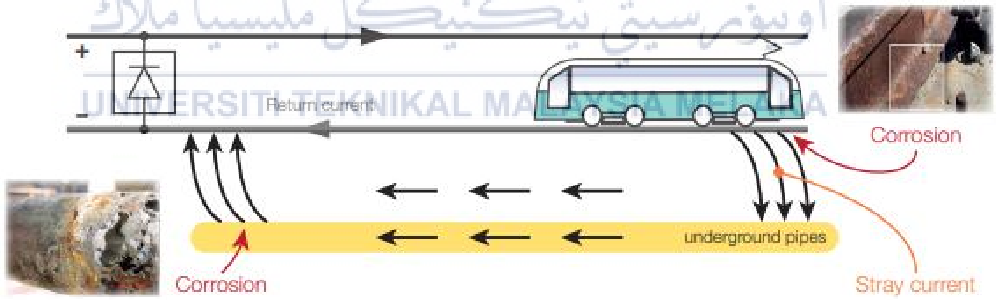

Figure 2.11: Depicts stray current corrosion in a pipeline near a train.

2.11.2 Does stray current corrosion affect the third rail system?

Corrosion produced by stray currents has been the focus of an increasing number of project papers. Not only is it significant from an economic standpoint, but the notion that stray currents may pose serious environmental dangers indirectly is also gaining popularity. Metal subsurface constructions that corrode can leak during shipment.

The metal structure is exposed to a negative voltage in the cathodic protection procedure. Similarly, if stray current travels down the metal channel and causes a negative potential on the structure, the structure will be protected against corrosion. Otherwise, corrosion will occur due to the positive rail voltage (in the anode region). As a result, corrosion is a possibility in the location where the current departs the metal structure. Figure 2.12 show scenario path of stray current flow.

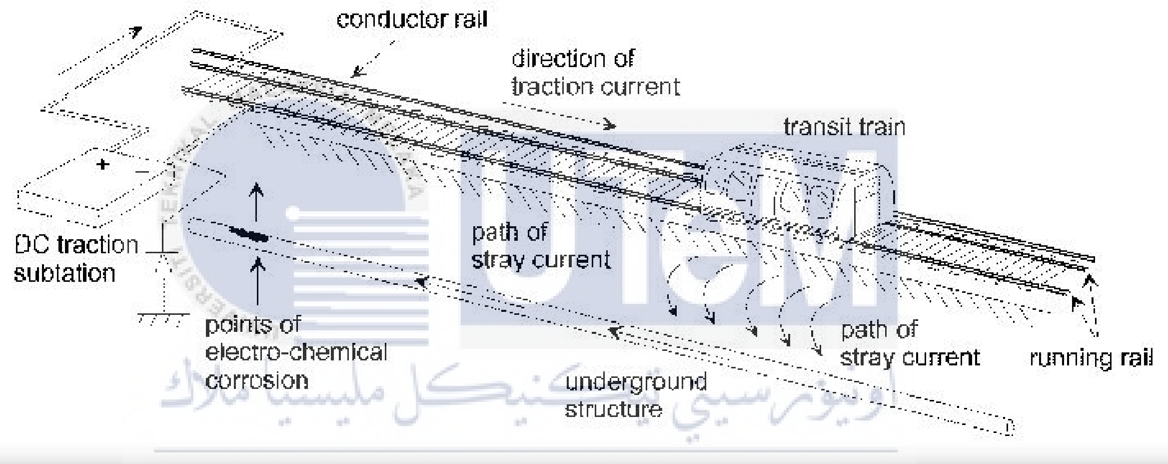

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Figure 2.12 : Scenario path of stray current flow.

Depending on the kind of ion source and the position of the metal structure, the distance between the anode and cathode regions can be as small as a few metres or as far as a few kilometres. Stray currents may damage a variety of structures, including railway bridges and tunnels, as well as structures near railways [12].

2.12 Analysis Stray Current using Rail Potential Monitoring Method

Analysis Stray Current using Rail Potential Monitoring basically specification for continuous monitoring is given in EN50122-2 as an informative (not normative) Annex (B),

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and upon this a number of commercial systems have been developed and marketed. The philosophy of these systems lies with the fact that direct measurement of stray currents is difficult; therefore they are based on measurements of the resistance of the return circuit to earth or the voltage against earth resulting from train operation .

These rail potential measurements are providing information to systems' operators and owners to restore their systems back into line with a reference condition. Thus, such endeavour do not measure the effects of stray current but they merely concentrate on its source. Figure 2.14 show Analysis Stray Current using Rail Potential Monitoring in Third Rail transit system. The reference condition should be able to account for elements that are semi-deterministic, but at the same time varying.

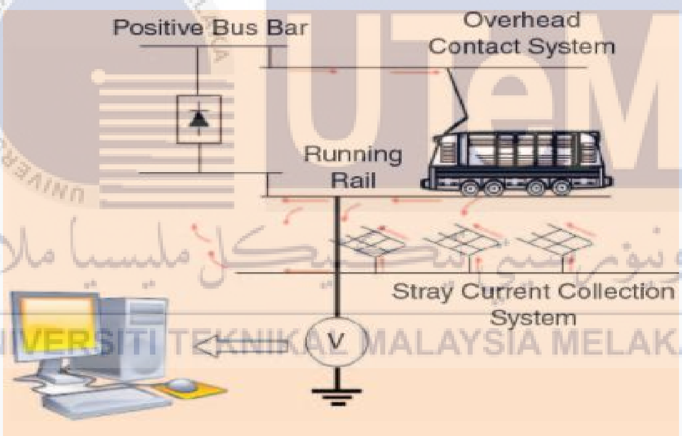

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Figure 2.13 : Analysis Stray Current using Rail Potential Monitoring

These elements include scheduled daily or seasonal traffic trends, occasional traffic peaks (e.g. a major sports event), weather/environmental conditions, rail insulation condition, faults, track pollution etc.[13]

2.12.1 Analysis Stray current modeling by using simulation method

Stray Current modelling by using simulation method is a simulation that has long been run for the purpose of analyzing data for parameters *V*rail and *I*stray. *I*stray is current that flow to the collector mat in the system. The software used in this analysis is mostly used by the Third Rail transit to analyze *V*rail and *I*stray and failures that occur in the system like multi-train network simulation. The multi-train network simulation includes the information on voltage, current and power of each traction substation (TSS), as well as voltage, current and power of each train on the rails. Most *I*stray out of the rail can be collected by the mat, so to reduce the amount of *I*stray into the earth. The secondary *I*stray (if flowing into the nearby metallic pipelines to the return substation) could cause electrolytic corrosion.

A high *V*rail, if violating standards (e.g., IEC 62128), could also be an electrical hazard. Apart from the rail-to-earth resistance (*R*r−e), the amount of *I*stray mainly depends on the status of moving vehicles that are accelerating, decelerating, or braking. Figure 2.14 show the schematic diagram for Stray current flow in third rail transit system

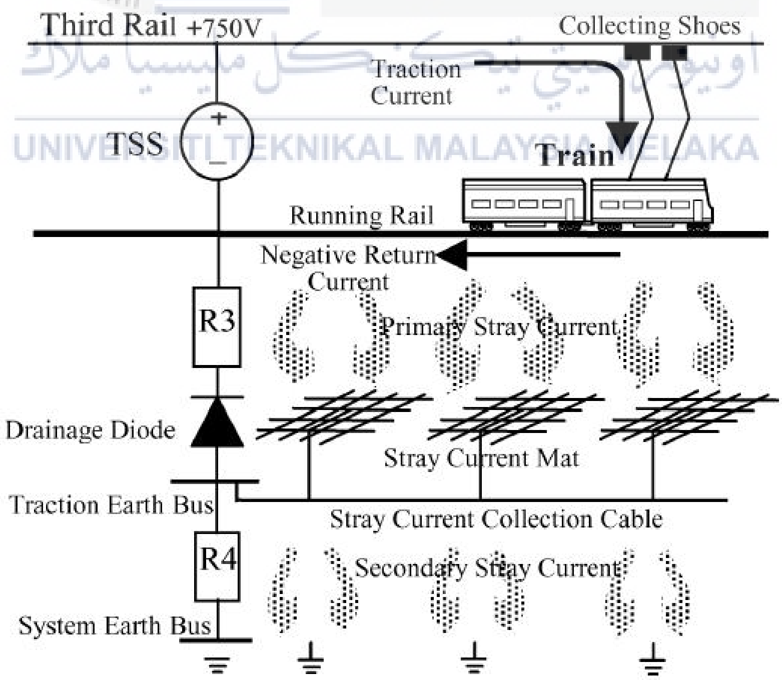

Figure 2.14 : Schematic diagram for Stray current flow in third rail transit system

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Several effective measures have been suggested for *I*stray control relating to the underground metallic structure corrosion [13] and [14]. Earthing and bonding effects have also been well presented [14]. As to the numerical simulation, the single-train and single-section model for *V*rail and *I*stray simulation have been developed [10] and [15]. The same authors have extended their work to the multi-train analysis using node equation matrices with their simulation results verified by the field measurements [15]. Figure 2.14 show analysis using node equation and figure 2.15 show result analysis.

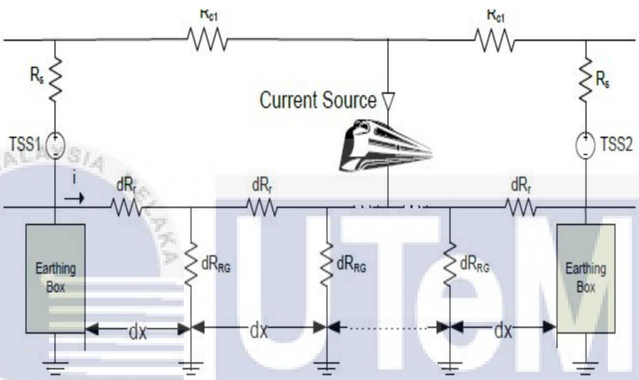

Fig 2.15 : analysis node equation

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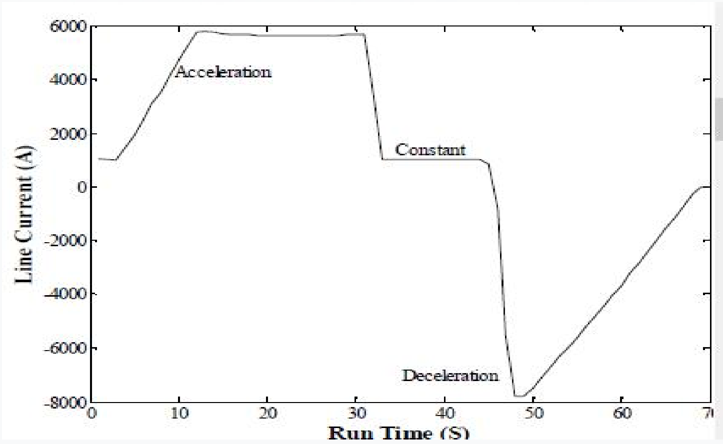

Fig 2.16 : Result analysis

2.12.2 Progress to Monitoring Stray Current when train move at LRT System

$[I_j]$ = equivalent current source

$[V_r]$ = Rail potential

$[I_S]$ = stray current

$[V_{rt}]$= rail potential at negative TSS

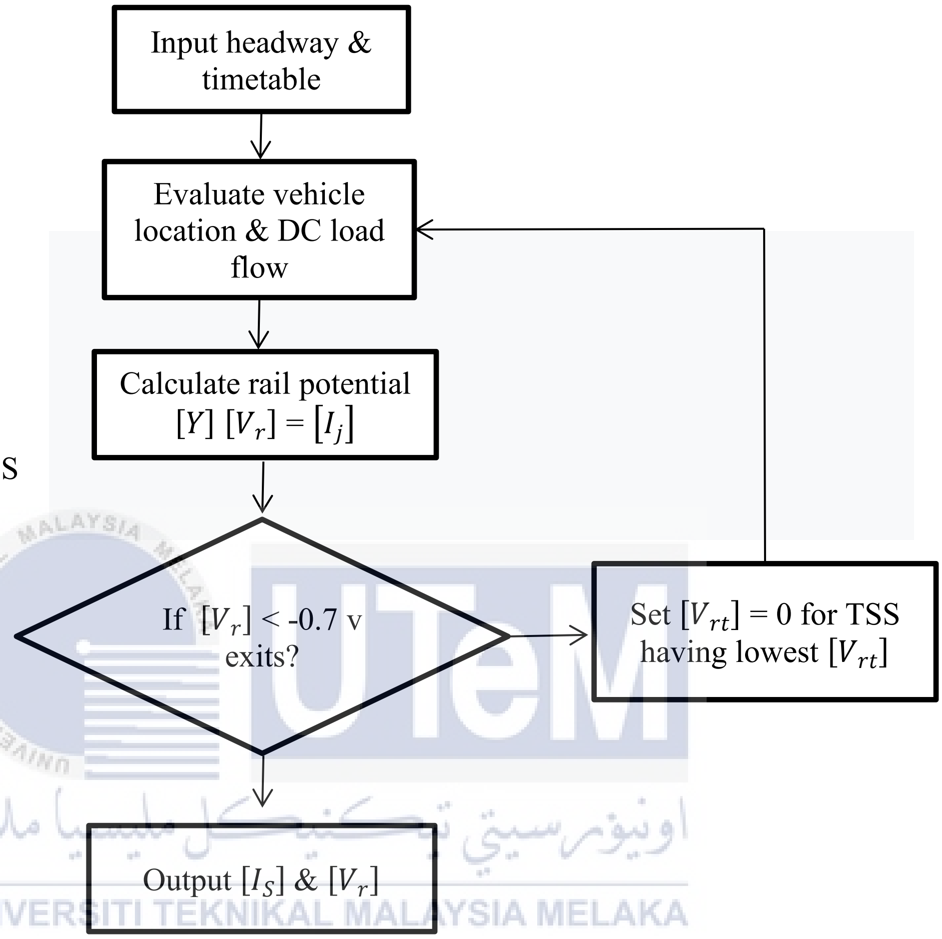

Figure 2.17 : Progress to Monitoring Stray Current

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2.13 Earthing Scheme

The optimal earthing scheme is chosen based on simulation studies that indicate how different earthing schemes might affect the quality of stray current in the third rail system.

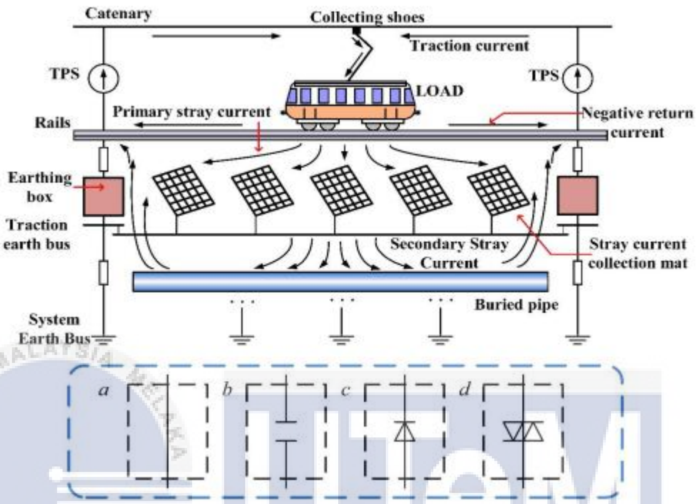

Figure 2.18 Stray Current Collection system along 4 earthing scheme

2.13.1 Solidly earthing schemes

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The DC negative circuit is earthed without any deliberate impedance in a firmly earthed scheme, and the ground resistance is maintained as low as feasible. The rail voltage is reduced by earthing the running rails at traction substations, therefore satisfying the life safety criteria. The fundamental goal of an earthing system is to offer a way to ensure that the power supply remains stable and that no one in the area of an earthed installation receives a severe electrical shock. As a result, an earthing system's apparent electrical resistance should be low enough. Many stray current problems have been seen near depots or maintenance depots , where local rules and practise require the use of solidly-earthed running rails with low earthing resistance as a form of employee protection [14]. Figure 2.18 show value current flow at traction is high and less stray current flow to collector mat.

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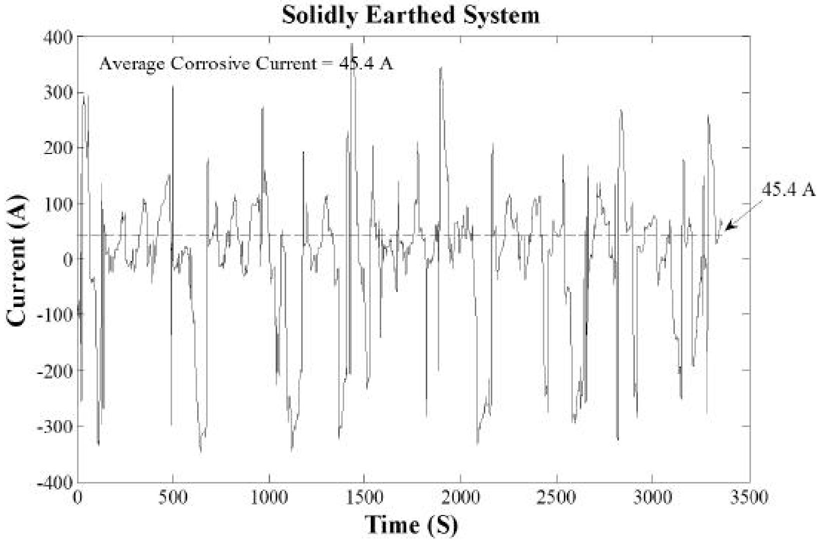

Figure 2.19 : Solidly earthing schemes

2.13.2 Undirectly earthing schemes

Because there is no deliberate connection to the ground in a floating running rail system, stray current is controlled by the high rail-to-earth insulation provided by rail fastenings. When compared to earthed schemes, the rail voltage variation caused by the floating return channel at traction substations often increases the operating rail potential. Increasing rail voltage over the amount specified in the applicable standards is hazardous to people and the general public. Furthermore, if a rail-to-earth connection is made, such as as a result of an earth fault, a relatively high rail voltage may be recorded. To limit the possibility of dangerous rail voltage, over-voltage protection is necessary [10]. Figure 2.19 show value current flow at traction is less and high value stray current flow to collector mat.

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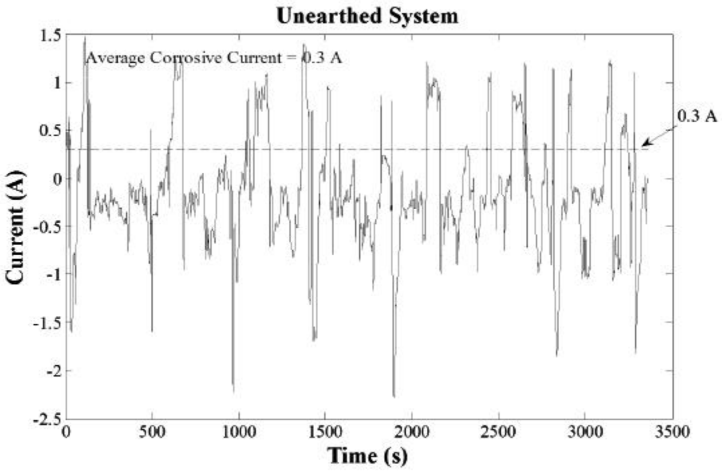

Figure 2.20 : Floating earthing schemes

2.13.3 Diode earthing scheme

Recent theoretical studies have shown that the diode grounding strategy may cause both high contact potential and stray current [15]. In the diode earthing scheme, the connection between the ground and the negative bus in the traction substation is achieved through diodes. When the voltage exceeds the threshold limit of the diode, the diode limits the rail voltage by short-circuiting the loop rail of the traction substation. Diodes also provide a low-resistance return path for short-circuit faults between live parts and the ground bus in the substation [15]. The stray current collecting pad is regularly located under the track and connected to the stray current collecting cable, which is connected to the negative bus of each substation through a diode. Since the diode device provides a path for the stray current, it can easily and conveniently monitor the size of the stray current, and can check the positive ground fault

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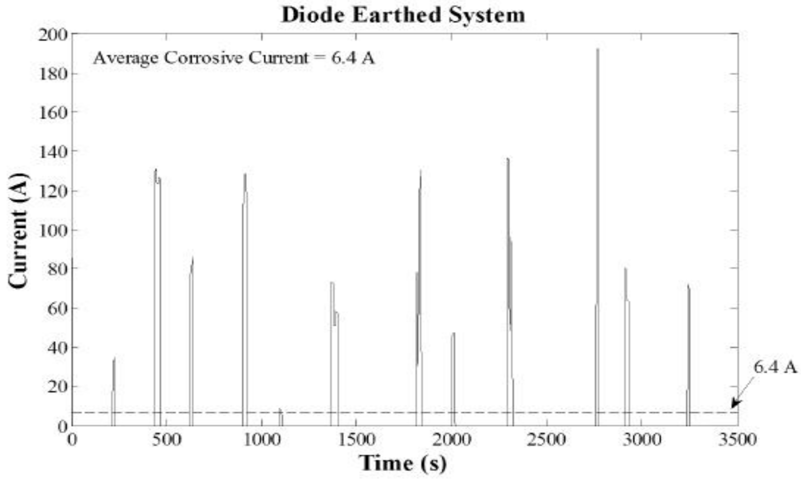

Figure 2.21 : Diode earthing schemes

Although the low-resistance path made by the diode is to be able to clear the fault faster, the diode earthing scheme will also cause the system leakage current to return to the substation, thereby aggravating the stray current corrosion. The diode earthing scheme only allows current to flow back from the ground and the collector pad to the negative bus of the substation, and prevents the traction current from the negative bus of the substation from flowing into the ground or the collector.

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2.14 Summary and Critical Review

This section describes the railway system of the third rail system that uses a DC Electrification system. The third rail system is commonly utilised in railway systems because it is more effective than the fourth rail system. However, the third rail system on the DC electrification system does not escape the shortcomings. Where, on the third rail system, the weakness that often occurs in this system is in the return path (negative) to TPSS. This condition, called stray current, where the current to return to the TPSS, leaks the track which can cause danger to the train system and also the workers. In addition, stray current also causes corrosion, where the leaking current flows to the nearest piping system which can cause harm to the system. Therefore, stray current cannot be eliminated but it can be reduced by using the existing earthing scheme, to control stray current from increasing.

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CHAPTER 3

METHODOLOGY

3.1 Introduction

This chapter comments on the overall progress of this project, starting from the introduction. Then, the methods that will be used will be described here.

The assessment on stray current for third rail system performance in DC railway operation basically divided into two parts which consist of project and software simulation. The whole project has three main objective which is to assess of stray current using Running rail simulation method by SCMS ,to design the simple circuit simulation modelling achievement of earthing system when applicable stray current using Matlab/simulink software, and do comparison of earthing system scheme method when applicable stray current using Matlab/simulink software.

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In this project in this project also which is the Bachelor Project (PSM), implemented solely as evidence based on existing studies through studies using simulation software and also data obtained from the Third rail transit Malaysia.

3.2 Progress of overall Project

Overall for This project is Discussions to decide on the selection of an appropriate title and project objectives are the main things carried out in this project.

Initially, all information and study on the core concept of a Third rail system on the world's railway system was gathered. Surveys on the issue of railways system which is stray current and performance of the system from the journals, articles, newspapers and internet were conducted. Then, find the issues about the Third Rail system in Railway performance , then find out method and basic theoretical to address the issues to be written in the literature review.

The method of data collection in this study is a variety of methods where the data obtained in this study from previous study data (article), journal, and data from the System third rail transit Malaysia itself as well as data results through circuit modeling using software. From the data obtained, this study can be implemented and can be data that can be inferred method and used to analyze in the study of stray current assessment on the third rail system. If Yes, will be proceed to next step which is data analysis, while , if No, will be go back through the data collection.

Then, the data is being analyze by using MatLab/simulink software and do a comparison of earthing system scheme method when applicable stray current. If the data analysis can classify the performance of each earthing scheme if there is a stray current on the Railway system through simulation and can be used to compare the appropriate earthing scheme used for the Third rail system in Malaysia, it will go through results and discussions. While if No, it will go back through the literature review to make sure the data analysis is true and make the comparison on the previous project. Figure 3.0 show the Flowchart of overall project.

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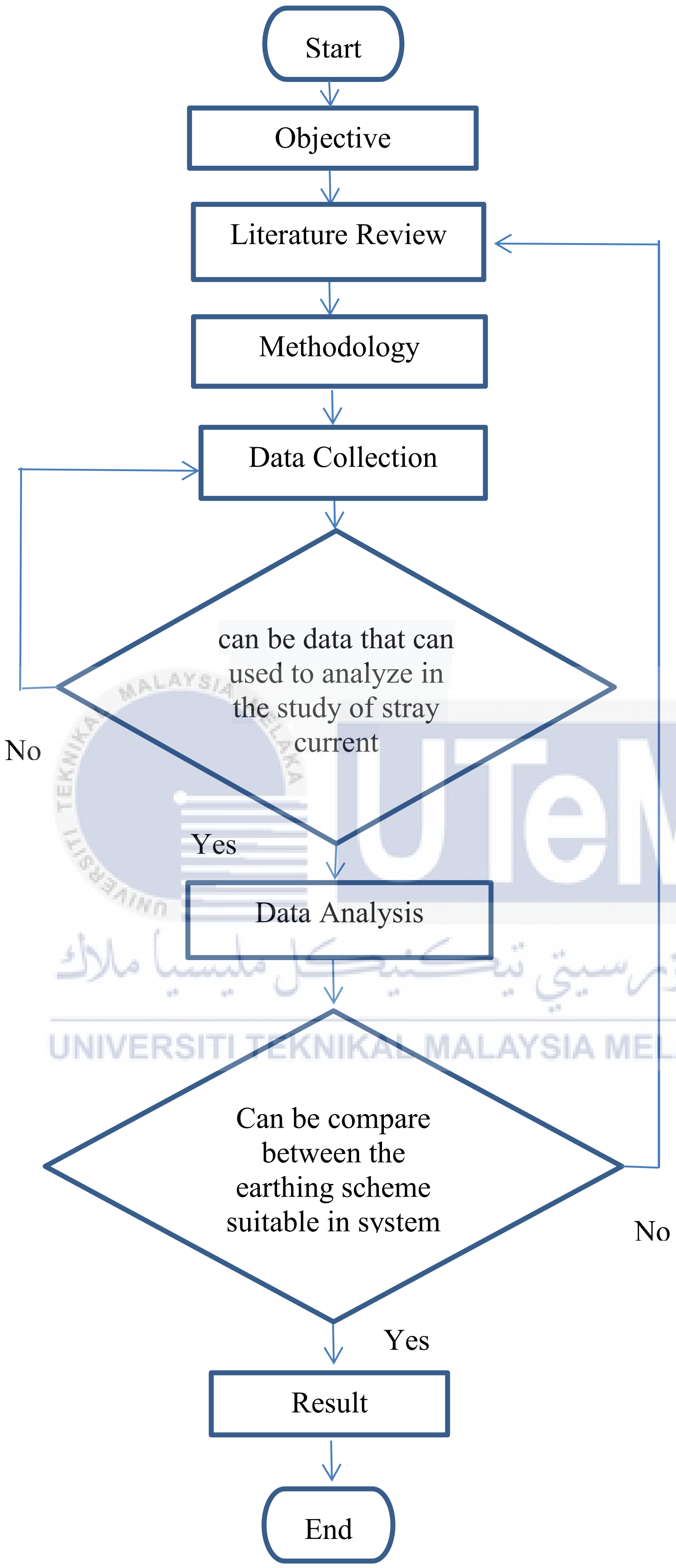

Figure 3.0 : Flowchart of Progress overall project

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3.3 Running Rail Insulation

In this project, to assess the stray current on the dc electrification third rail system operation, Running rail insulation / traction is used to evaluate the rate of current and voltage that flows out of the rail. The variation of the structure potential can be null and so compliant with the requirement of EN50122-2. Figure 3.3 show the Running rail insulation.

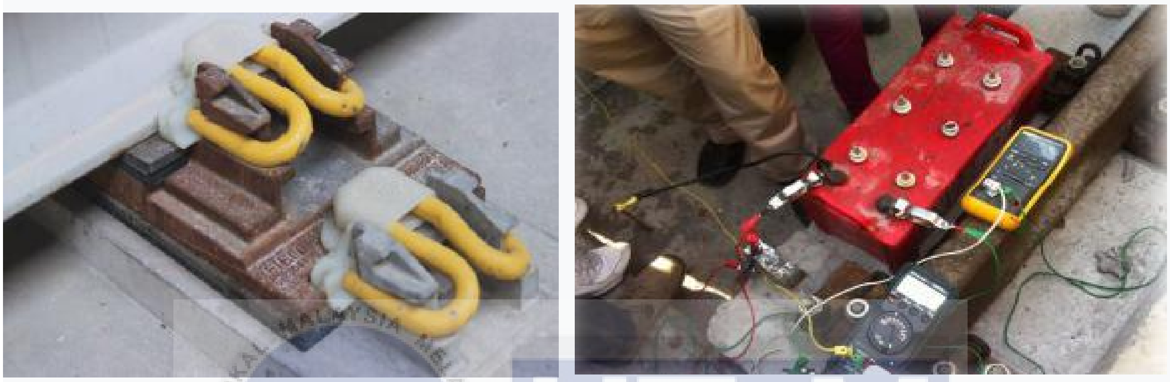

Figure 3.1: rail insulation

Train wheels and running rails are commonly used as the DC substation's traction current return channel (except for the fourth track system). Because current may flow out of the rail and return at other locations if the rail and sleeper are not insulated, the ground loop is significantly more difficult Stray current. In general Data collection , the LRT performs data collection some day depending on management's instruction regarding Stray Current . Then any repairs will be implemented or carried out during off duty operation at midnight.

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3.4 Stray Current Monitoring System (SCMS)

Sécheron developed its stray current observation system (SCMS) employed by 'Light fast Transit' (LRT) to forestall corrosion caused by stray currents on instrumentality within the railway and non-railway installations. SCMS could be a straightforward, economical resolution to watch stray currents, eliminating the necessity for repetitive manual measuring and interference with the stray current assortment system. Figure 3.2 show the SCMS collect the data on the Third rail transit system.

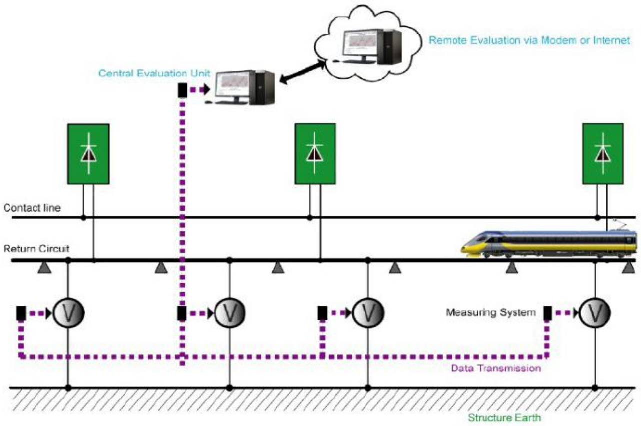

Figure 3.2 : SCMS collect the data

SCMS is compliant with the recommendations in the EN 50122-2 standards, continuously measuring the rail-to-earth potential in operating conditions. SCMS also offers central analysis, display, signaling, and logging capabilities.

3.4 .1 Stray Current Monitoring System (SCMS) collect Data from VLD

The VLD (Voltage Limiting Device) send Data to SCMS along the line Voltage between the return circuit and the earth structure through a high accuracy sensor and potential current flowing in the VLD through a high accuracy sensor.

Figure 3.3: The SCMS collect data from VLD

3.5 Earthing Scheme

The earthing scheme is utilized in this chapter to decrease stray current, which happens when current flows out of the rail and returns at other spots which is (stray current) by using existing earthing schemes such as solidly earthing, floating earthing scheme, diode earthing scheme.and reverse diode earthing scheme. Figure 3.4 show the schematic diagram used for create simple modelling circuit simulation. The Floating earthing scheme is one of the schemes used in the third rail transit system in Malaysia to the present day.

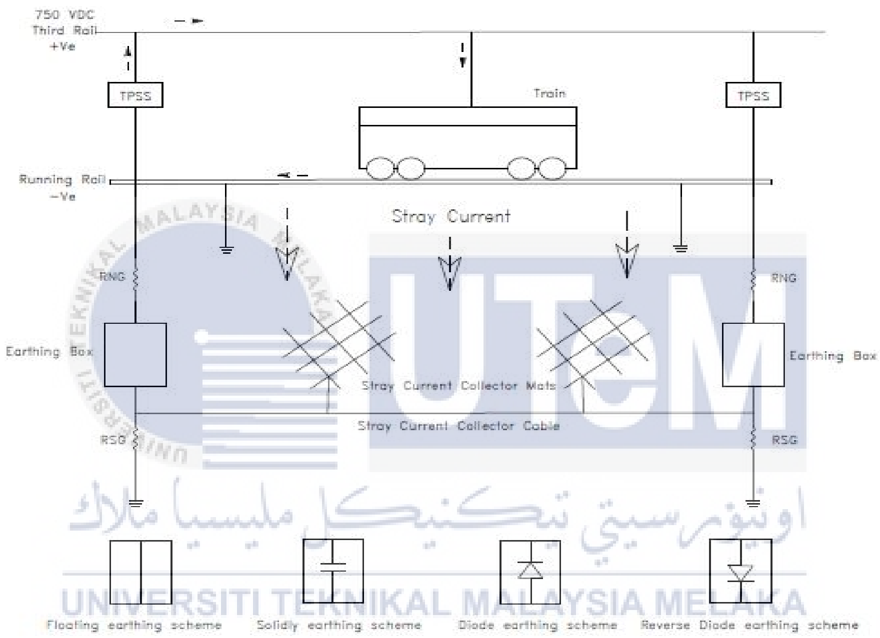

Figure 3.4 : Schematic diagram used for create simple modelling circuit simulation

The circuit simulation for these four earthing techniques is nearly identical, and the same resistor parameter values are used at each point. The earthing box, however, is what distinguishes the fourth circuit simulation earthing approach. using capacitor components, floating earthing schemes utilising direct connection to earth, diode earthing schemes using regular diode components, and reverse diode earthing schemes using reverse diode components. The polarity position of the diode is only adjusted for securely earthing schemes.

3.6 Software

In this chapter, the software will be used to analyse the earthing scheme when stray current is present, as well as to develop a basic Modeling Circuit simulation using Matlab/simulink. The schematic diagram was utilised in this study to develop a Simple Model Stray Current circuit simulation to be used in demonstrating the data in this investigation, whether the Stray current value is lowered or not. The information acquired from a Simple Model Stray Current circuit simulation may then be used to compare which earthing method is the best to utilise.

3.6.1 Matlab/simulink software

This software will be used to analyse the earthing scheme when stray current is present in the system, and the results will be used to compare the earthing schemes utilised in this project. This part will assess whether stray current is reduced or not in this study by creating a Simple Model Stray Current circuit simulation to be utilised in demonstrating the data in this study, as indicated in the project's chapter 2 literature review. The Current measuring component was used to obtain the reading of the value of the stray current in this simulated circuit. In the simulation, four types of current measurements will be taken which is $I_{Earth}(A)$, $I_{Stray\_current}(A)$, $I_{Collector}(A)$ and also $I_{Negative}(A)$

Figure 3.5 : Matlab/simulink software

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3.7 Conclusion

This section goes through the steps involved in creating this project in general. Then, utilising the running rail insulation approach, this part covers how to analyse stray current on the functioning of the Third DC electric rail system. Then, utilising the Stray Current Monitoring System (SCMS) data get from Third Rail Transit Malaysia (LRT). In addition, this section describes how to use earthing methods to reduce stray currents in DC electrification systems in third rail systems. Create four basic modelling circuit simulations for earthing schemes in this project: solid, floating, diode, and reverse diode. Then, using Matlab/Simulink Software, design a basic modelling circuit simulation to acquire a value for the Stray Current that exits the Rail and flows to the Collector Mats. Finally, using graph histogram, compare the value data received from each earthing technique to determine which earthing strategy is more successful in Third Rail train systems.

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CHAPTER 4

RESULTS & DISCUSSION

4.1 Introduction

In this chapter discussion about result in accordance with objectives previously stated. The result and discussion in this chapter begins with the collection of data and analysis results based on the methodological framework that has been described in chapter 3. Parameter that is Stray Current can be analyzed and evaluated by using running rail method which uses Stray Current Monitoring System (SCMS) to obtain the data required on the system third rail transit Malaysia. Meanwhile, to obtain data proof for grounding system performance when Stray Current occurs, the implementation of Simple Circuit simulation modeling design is implemented by using Simulink Software to obtain data. In view of the test work that could not be carried out on the part of the system third rail transit Malaysian due to the covid-19 pandemic issue. Then all data analysis required in this study is provided and assisted by system third rail transit Malaysia. All further information relating to the data obtained is for reference only for assessment stray current in this project , and all information obtained is declare confidential.

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4.2 Analysis based on Running Rail Insulation by using SCMS

As mentioned in The chapter 3, the approach was carried out using the implementation of the Running Rail simulation method. In obtaining the data required in this study, from the results of data obtained through SCMS showed parameter values on the stations run . In general Data collection , the system third rail transit Malaysia performs data collection every day. Then any repairs will be implemented or carried out during off duty operation at midnight. Data obtained from SCMS Third rail transit Malaysia which is LRT as described in the next section such as data for Monthly result data and also year result data.

4.2.1 Monthly Result Data by SCMS

Based on table 4.0, the data shows the values for $I_{Earth}(A)$, $I_{Stray\_current}(A)$, $I_{Collector}(A)$ and also $I_{Negative}(A)$ for all stations set by the LRT Malaysia. The units for all these parameters are in units (Ampere).

Station	$I_{Earth}(A)$	$I_{Stray\_current}(A)$	$I_{Collector}(A))$	$I_{Negative}(A)$
P69	8.51	9.68	1.17	226.83
P71	18.80	19.46	0.66	190.22
P72	16.51	20.61	4.09	171.18
P74	16.69	16.70	0.00	214.41
P75	8.86	13.28	4.42	100.25
P77	15.47	18.33	2.87	212.41
P79	15.45	18.67	3.22	194.76
P80	15.63	20.75	5.12	90.93
P81	8.40	11.24	2.85	90.16
P82 (D)	12.53	12.54	0.01	144.20

Table 4.0: value of parameter from SCMS LRT Malaysia

Where $I_{Stray\_current}(A)$ values can be calculated if $I_{Earth}(A)$ and $I_{Collector}(A)$ values can be collected are using additional equation between value of Current Earth with Current Collector:

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$$I_{Stray\_current}(A) = I_{Collector}(A) + I_{Earth}(A)$$

In addition, Table 1 also shows that the higher the current received on the 'Collector mat' $I_{Collector}(A)$, the higher the potential Stray current $I_{Stray\_current}(A)$ on the system. However, based on table 1 seen at station P82(D) has a $I_{Stray\_current}(A)$ of 12.54A, but the $I_{Collector}(A)$ only shows a value of 0.01A. This is because the Third rail transit Malaysia informed that the station for P82 (D) is a depot station. Depot station are mostly earthing systems using the Direct earthing method, where the the Current Leakage will be go through back to proper Virtual Earthing. Because the earthing is less the resistant.

Traction substation operation track grounding can reduce track voltage and meet life safety requirements. The main purpose of the grounding system is to provide a method to ensure the continuity of the power supply and to ensure that people near the grounding device will not receive dangerous electric shocks. It is worth noting that many stray current problems occur near repair stations or repair shops, and local standards and practices require the use of low ground resistance directly grounded running rails as a protection for workers [15].

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Safety is ensured by a complementary protection scheme performing a critical function [16]. With the parameter values shown in figure 1, it shows that, the issue of Stray Current on the system Third rail transit Malaysia , still has shortcomings and issues that can cause problems on system, such as the piping system in the Railway system and reduce the performance. Reducing rail voltage and stray current corrosion at the same time is one of the challenging problems in DC electrified rail transit systems [16].

4.2.2 Yearly result Data by SCMS

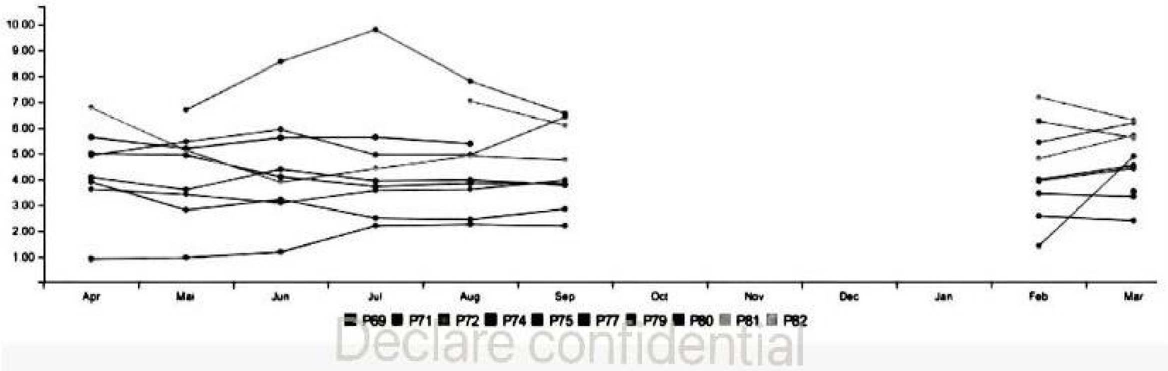

Figure 4.0: yearly result data collector for all station at third rail transit Malaysia

This section shows the annual summary result data collected from the third rail transit Malaysia using SCMS from 'sancheon'. based on figure 4.0, shows the evaluation of all stations almost every month implemented in year 2020. This data is also taken from the reading of data from the daily and monthly summaries. Based on figure 4.0 station P82, the line is blue, showing readings for two months only. This is because, Station P82 is the Depot, while the other Station is the Mainline in the Railway system.

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Moreover, based on Figure 4.0 shows the graph on in October, November, December and also January the graph does not show any reading. This is due to issues related to the pandemic. Then, based on figure 4.0 as well, it shows Station P80 showed a relatively high increase in July, and declined again in August. Reducing rail voltage and stray current corrosion at the same time is one of the challenging problems in DC electrified rail transit systems [16]. All further information relating to the data obtained is for reference only for assessment stray current in this project , and all information obtained is declare confidential.

4.3 Analysis Earthing system performance when Stray Current occurs, using the implementation of Simple Circuit simulation modeling design

This section explains to analyse the LRT Malaysia's Earthing system and create a basic circuit simulation model using Simulink software. This circuit is based on schematic designs from prior studies, which were covered in Chapter 2. The value of each parameter utilised in the circuit simulation is the value that is regarded suitable in this study, based on prior studies done through readings as well as (UK Standard), which is also used in Malaysia's railway system. Resistance Third Rail/Source (RTr), Running Rail Resistance (RRr), Resistance Rail-to-Ground (Rrg), Resistance Neutral-to-Ground (Rng), Resistance at Collector Mat (Rcm), Resistance System Ground (Rsg), and Resistance Train (RTn). Figure 4.1 show simple modelling circuit simulation.

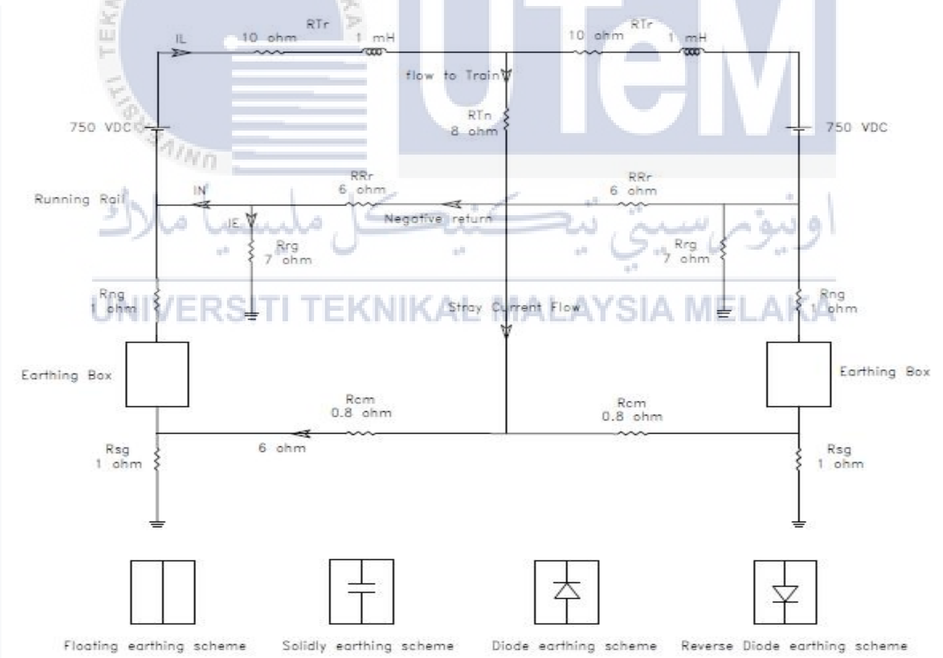

Figure 4.1: simple Modelling circuit simulation

The parameter for Resistor used in circuit is to obtain the value of the current passing through the resistor in the simulation run. In this analysis the current parameter for the $I_{Line}(A)$, $I_{Negative}(A)$, $I_{Collector}(A)$ and $I_{Earth}(A)$ to be taken readings, according to

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different earthing schemes carried out to evaluate the value of stray current whether reduced or not with each scheme carried out in the simulation as show in the figure 4.1. The $I_{Line}(A)$ is the represented current measured on the line system (third rail source). while $I_{Negative}(A)$ is the measured current flowing on the return path (running rail) on the third rail system. $I_{Collector}(A)$ is the stray current that flows to the collector mat and $I_{Earth}(A)$ is the current that flows to the earthing on the system along the traction (Running Rail). This section also, will show four type simple model circuit of earthing scheme which can be used in LRT System which is Diode Earthing simple model circuit, Solidly Earthing Simple model, Floating Earthing simple model circuit and also Reverse Diode Earthing Simple model..

4.3.1 Data for Direct/Floating Earthing simple model circuit

In this part, explain about result data obtained from simulation simple circuit design by using simulink software. Figure 4.2, shows the reading values for the current parameters namely $I_{Line}(A)$, $I_{Negative}(A)$, $I_{Collector}(A)$ and $I_{Earth}(A)$. Based on the data obtained in figure 4.2 through the simulation, shows the current readings when performing the simulation using Floating earthing scheme, where the result data shows the readings $I_{Line}(A)$ = 32.01 Amp, $I_{Negative}(A)$ = 9.825 Amp , $I_{Collector}(A)$ = 21.95 Amp and $I_{Earth}(A)$ = 3.201 Amp . In the situation when using (direct earthing scheme) in the earthing system on railways the current value$I_{Collector}(A)$ is higher than the reading that is 21.95 Amp, while $I_{Negative}(A)$ = 9.825. Here it can be seen that the Stray Current in the system shows a high reading that is almost twice the current that should flow back to the Substation (TPSS) but it flows according to other flows.

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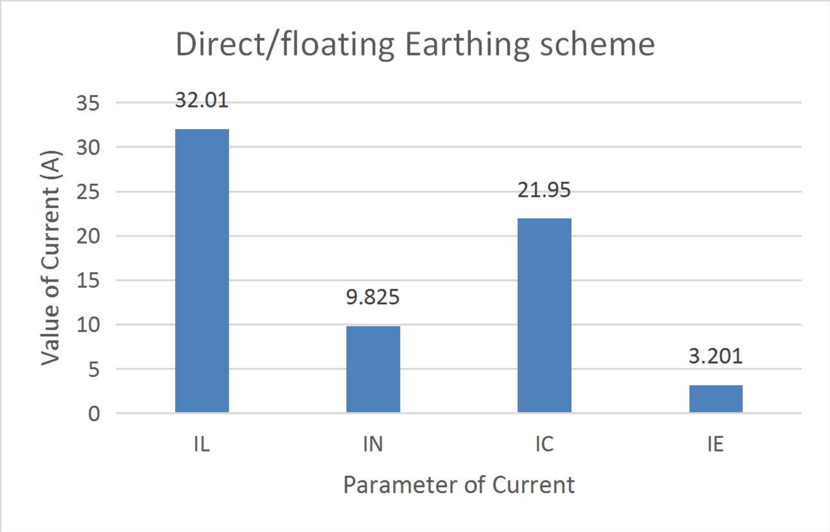

Figure 4.2 : Result Data for Floating Earthing Scheme

$I_{Line}(A)$	$I_{Negative}(A)$	$I_{Collector}(A)$	$I_{Earth}(A)$
32.01 Amp	9.825 Amp	21.95 Amp	3.201 Amp

Table 4.1 : Result Data for Floating Earthing Scheme

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This condition will endanger both the railway system and human lives. Many stray current problems have been seen at depots or repair depots, where local rules and practises mandate the use of directly-earthed running rails with low earthing resistance as an employee protection measure [17].

4.3.2 Data for Diode Earthing simple model circuit

In this part, explain the result data obtained through simulation using simulink when the earthing system uses Diode earthing scheme on the railways system. Where the result data shows at figure 2 the readings $I_{Line}(A)$ = 31.98 Amp, $I_{Negative}(A)$ = 9.994 Amp , $I_{Collector}(A)$ = 21.84 Amp and $I_{Earth}(A)$= 3.28 Amp as show at figure 2. Based on the data image, shows the current reading value $I_{Collector}(A)$ = 21.84 Amp is the leak stray current in the third rail system. Almost half of the current $I_{Line}(A)$ = 31.98 Amp should return to

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the system by flowing on the Running Rail which is Negative path, but it flows out by following another flow. While the current flowing at $I_{Negative}(A)$ only shows the value of 9.994 Ampere only.

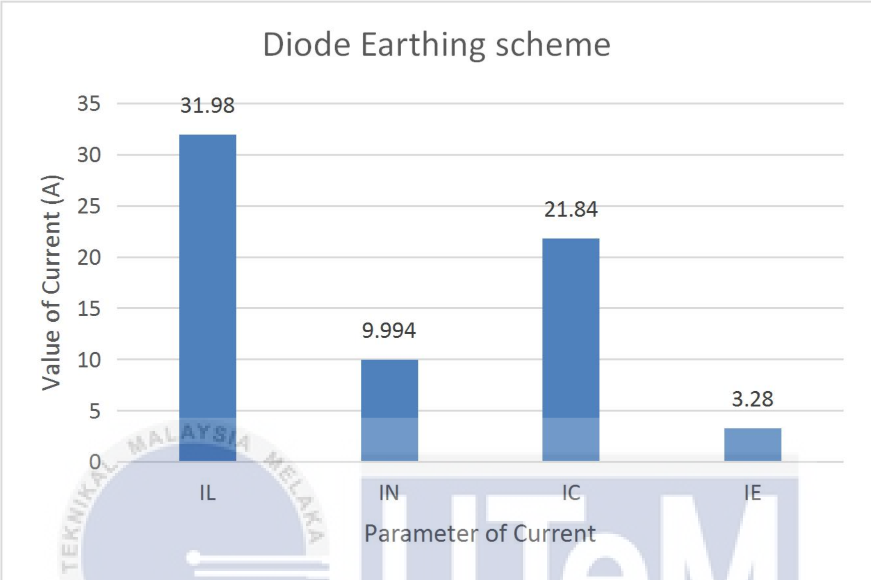

Figure 4.3 : Result Data for Diode Earthing Scheme

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$I_{Line}(A)$	$I_{Negative}(A)$	$I_{Collector}(A)$	$I_{Earth}(A)$
31.98 Amp	9.994 Amp	21.84 Amp	3.28 Amp

Table 4.2 : Result Data for Diode Earthing Scheme

This shows that with Diode earthing scheme used in the earthing system on the third rail system is still less effective used, because based on the result figure 4.3 shows the stray current shows a high value. With a high value of stray current it can give a risk to humans and also problems in the pipe system. Meanwhile, the leaking current flowing to the ground only shows the reading value $I_{Earth}(A)$= 3.28 Amp . With the grounding system along the traction is still not enough to provide protection in the performance in the Railway system.

4.3.3 Data for Solidly/undirect Earthing simple model circuit

Figure 4.4 shows the result of the current reading in the state of earthing system using Solidly earthing scheme, where the value $I_{Line}(A) = 28.79$, $I_{Negative}(A) = 28.77$. based on these two readings shows the current Positive flowing at $I_{Line}(A)$ shows a value that is close to the same as $I_{Negative}(A)$ which is the negative return path current.

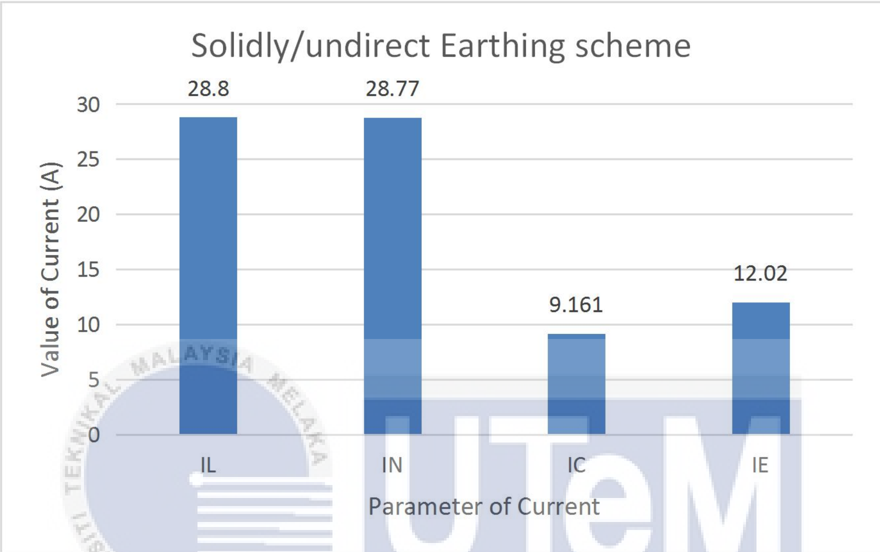

Figure 4.4 : Result Data for Solidly Earthing Scheme

$I_{Line}(A)$	$I_{Negative}(A)$	$I_{Collector}(A)$	$I_{Earth}(A)$
28.79 Amp	28.77 Amp	9.161 Amp	12.02 Amp

Table 4.3 : Result Data for Solidly Earthing Scheme

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While the current $I_{Collector}(A)$=9.161 where the stray current that flows out of the return path is slightly lower than the value $I_{Negative}(A) = 28.77$. Then $I_{Earth}(A)$= 12.02 leak current to ground along the traction. This indicates that in this scheme, the stray current flowing to $I_{Collector}(A)$ is reduced almost twice. Show that part of the current negative flows back according to the correct flow that is on the running rail. This can to some extent reduce the risk of danger in the system as well as problems in the piping area of the system in the railways system.

4.3.4 Data for Reverse Diode Earthing simple model circuit

In this part, explain the result data obtained through simulation using simulink when the earthing system uses Reverse Diode earthing scheme on the railways system. Where the result data shows at figure 2 the readings $I_{Line}(A)$ = 28.79 Amp, $I_{Negative}(A)$ = 28.69 Amp , $I_{Collector}(A)$ = 9.159 Amp and $I_{Earth}(A)$= 12.02 Amp as show at figure 2. Figure 2 also shows the result of the current reading in the state of earthing system using Reverse Diode earthing scheme, where the value $I_{Line}(A) = 28.79$, $I_{Negative}(A) = 28.69$. based on these two readings shows the current Positive flowing at $I_{Line}(A)$ shows a value that is close to the same as $I_{Negative}(A)$ which is the negative return path current.

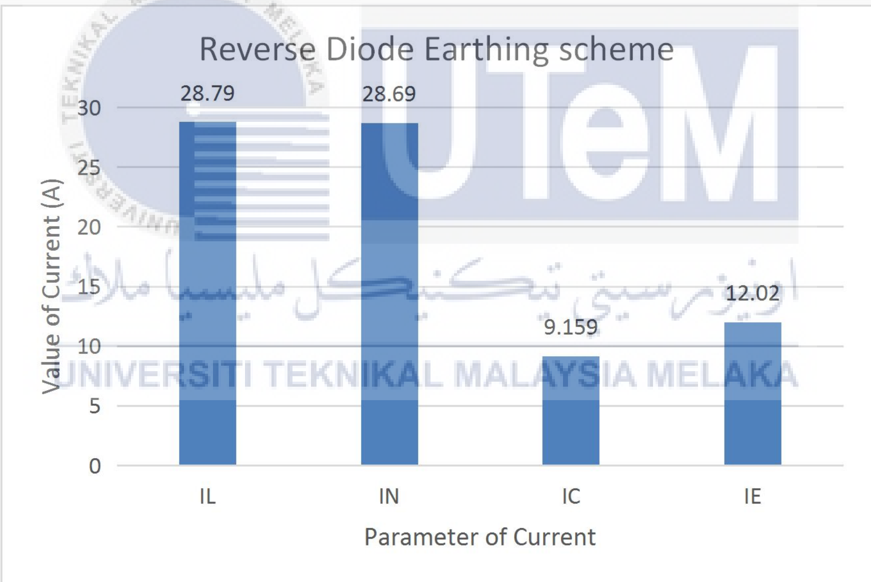

Figure 4.5 : Result Data for Reverse Diode Earthing Scheme

$I_{Line}(A)$	$I_{Negative}(A)$	$I_{Collector}(A)$	$I_{Earth}(A)$
28.79 Amp	28.69 Amp	9.159 Amp	12.02 Amp

Table 4.4 : Result Data for Reverse Diode Earthing Scheme

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While the current $I_{Collector}(A)$=9.159 where the stray current that flows out of the return path is slightly lower than the value $I_{Negative}(A) = 28.69$. Then $I_{Earth}(A)$= 12.02 leak current to ground along the traction. This indicates that in this scheme, the stray current flowing to $I_{Collector}(A)$ is reduced almost twice. Show that part of the current negative flows back according to the correct flow that is on the running rail. This can to some extent reduce the risk of danger in the system as well as problems in the piping area of the system in the railways system. Reversed diode may be a diode earthed theme with a diode placed in a very reversed direction. Reversing diode blocks the trail for the foremost unsafe a part of corrosive charge flowing from buried antimonial structures into the negative pole of DC provide system. Thereby lowers the corrosion injury effectively[36].

4.4 Comparison result Data Stray current value Between Earthing Scheme by Modelling Simple Circuit simulation.

In addition, this part will compare the earthing schemes employed in this study and determine whether earthing scheme is more effective for implementation in our country's Third Rail Transit system. Then, select the type of earthing scheme that is appropriate for usage in our country's DC Electrification train system. The results data for four types of Earthing schemes are shown in the figure 4.6 which is Floating/directly Earthing Scheme, Diode Earthing Scheme, Solidly/undirect Earthing Scheme, and Reverse Diode Earthing Scheme.

All Earthing schemes show the value of the Stray current flowing out of the Rail and flowing to the collector mat which is $I_{Collector}(A)$. from value $I_{Collector}(A)$ in this project will show how many value of Stray Current flow to the collector mat in the system. For the first Earthing scheme which is Floating Earthing Scheme shows the reading value of the stray current is 21.9A. For Diode earthing Scheme shows the stray current reading is

21.8A, whereas Solidly Earthing Scheme shows the reading is 9.161A . And then the reading value Reverse Diode earthing Scheme is 9.159 A.

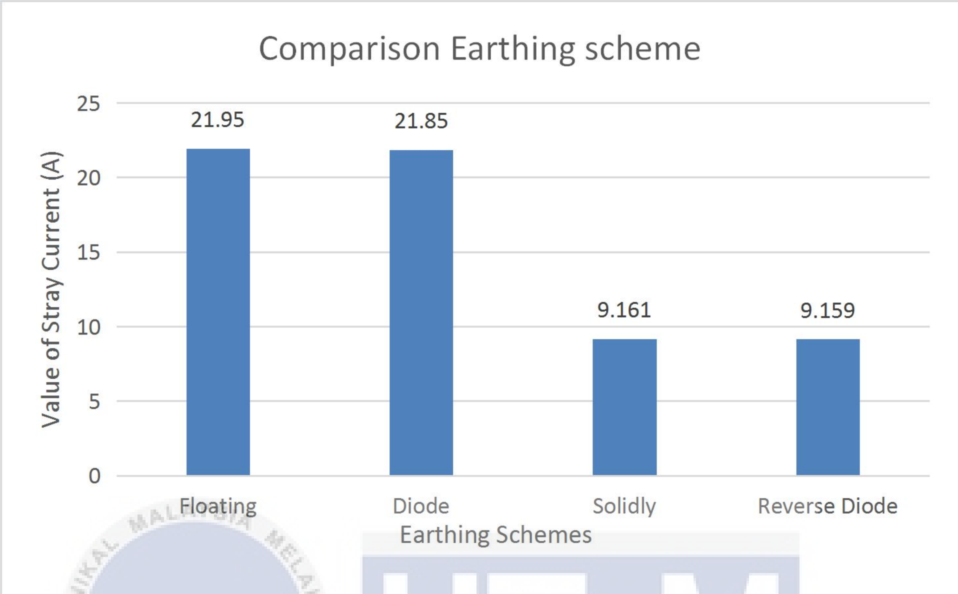

Figure 4.6 : Comparison Result Data value stray current of Earthing Scheme

From the results conducted in this Project, shows the current value reading for Stray Current which shows the highest reading is Floating Earthing Scheme, next the reading value Diode earthing Scheme. The lowest reading value of stray current is Solidly Earthing Scheme and then Reverse Diode earthing Scheme. This prove that Solidly Earthing Scheme and Reverse Diode earthing Scheme is a more effective earthing scheme in dealing with the issue of stray current in this third rail transit system. By showing a low reading value on $I_{Collector}(A)$. The less of value on the collector mat, the less the value of stray current on the system.

4.5 Summary

In this section, describe the Results and analysis conducted throughout this study. In Assess Stray Current issues by implementing Running Rail insulation method using Stray Current Monitoring System (SCMS) on system third rail Malaysia to obtain data. With the use of (SCMS) the parameter values required in this study can be presented among which are the parameter values for $I_{Line}(A)$, $I_{Negative}(A)$, $I_{Collector}(A)$ and $I_{Earth}(A)$. All data obtained from (SCMS) were transferred into printed data readings to facilitate data readability. This analysis is carried out by embracing several stations and depots in the system third rail Malaysia by using codes such as P69, P71,P72,P74,P75,P77,P79,P80,P81 and also P82. The uses of this code is done due to some parts and information in the system, this system third rail Malaysia is confidential information to be known by the public.

Based on the data obtained, the LRT informed that the data for stray current is not necessarily to record every day. It all depends on the management on the maintenance part as well. Next, to prove that a more effective earthing system is used to reduce the stray current that occurs, a simple modeling simulation circuit is designed by referring to schematic diagrams from previous project using simulink software. The value of each parameter used in the circuit simulation is the value that is considered appropriate in this study, taken from previous studies that have been conducted through readings. So based on the results obtained, it shows that the Reverse diode earthing scheme is more effective in the Malaysian LRT system, because through the simulation simulink circuit the value of the current flowing on the collector mat is considered as a result in this study either with the use of different earthing schemes is the current stray current decreased or not and the reading value at $I_{Collector}(A)$ indicates a low reading compared to other earthing schemes.

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CHAPTER 5

CONCLUSION AND RECOMMENDETION

5.1 Conclusion of Project

In this chapter, discuss the results of studies carried out throughout the implementation of this project. In this project, to able assessment of Stray Current using Running rail simulation method by Stray Current Monitoring System (SCMS). Data needed in achieving the first objective Stray current assessment on the third rail system can be achieved with the help of the Third rail transit Malaysia in terms of data sharing required in this project, as show at Figure 5.0 shows data obtained from third rail transit Malaysia from the evaluation of stray current in the system.

Station	$I_{Earth}(A)$	$I_{Stray\_current}(A)$	$I_{Collector}(A))$	$I_{Negative}(A)$
P69	8.51	9.68	1.17	226.83
P71	18.80	19.46	0.66	190.22
P72	16.51	20.61	4.09	171.18
P74	16.69	16.70	0.00	214.41
P75	8.86	13.28	4.42	100.25
P77	15.47	18.33	2.87	212.41
P79	15.45	18.67	3.22	194.76
P80	15.63	20.75	5.12	90.93
P81	8.40	11.24	2.85	90.16
P82 (D)	12.53	12.54	0.01	144.20

Figure 5.0 Data from Third rail transit Malaysia

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The data obtained from the Third rail transit Malaysia was carried out by performing an analysis on the third rail transit Malaysia system by using the Running rail insulation method to obtain parameter data such as Voltage rail and also parameters for (I) Current. And based on the The data for yearly obtained show there is one station that shows a higher reading than another station that is P80, where the data shows the value of $I_{Stray\_current}(A)$ at P80 which is 20.75 Ampere and followed by P72 which is 20.61 Ampere, then the lowest value at P69 which is 9.68 Ampere. The data obtained will be re-table again in implementing this project.

In addition, this project also able to design the simple circuit simulation Modelling achievement of earthing system when applicable Stray Current using Matlab/Simulink software. By using Matlab/simulink software the simple circuit simulation modelling can be create with reference to the readings from Chapter 2, for the aim of establishing that stray current is decreased by utilising an earthing method. The parameter values used in this simulation are solely those that are deemed suitable by the simulation's authors EN50122-2. Because some factors, such as factors in obtaining the actual value of the system, such as the value of resistance on the running rail (track), collector mats, and so on, as well as the age factor of components in the Third rail transit system itself, the possibility that each reading component cannot show the exact value, and so on, it is very difficult to use the actual value of the system. The designing the simple circuit simulation modelling achievement of earthing system show at Figure 4.1

Furthermore, in this project also, it can be proved as described in chapter 4 that, by implementing different earthing schemes in the third rail transit system can show the change in stray current value that occurs in the third rail transit system that often occurs in DC electrification Third rail system. And then, can able to compare the earthing system

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effect when applicable Stray Current using Matlab/simulink software. From the data obtained through simulation using Matlab/ simulink software can show two earthing schemes that show the potential in reducing stray current in the Third rail transit Malaysia system, namely Solidly earthing scheme and Reverse Diode earthing Scheme. Because based on the value obtained is very low compared to other earthing schemes. As show Figure 5.1 result data comparison between earthing scheme.

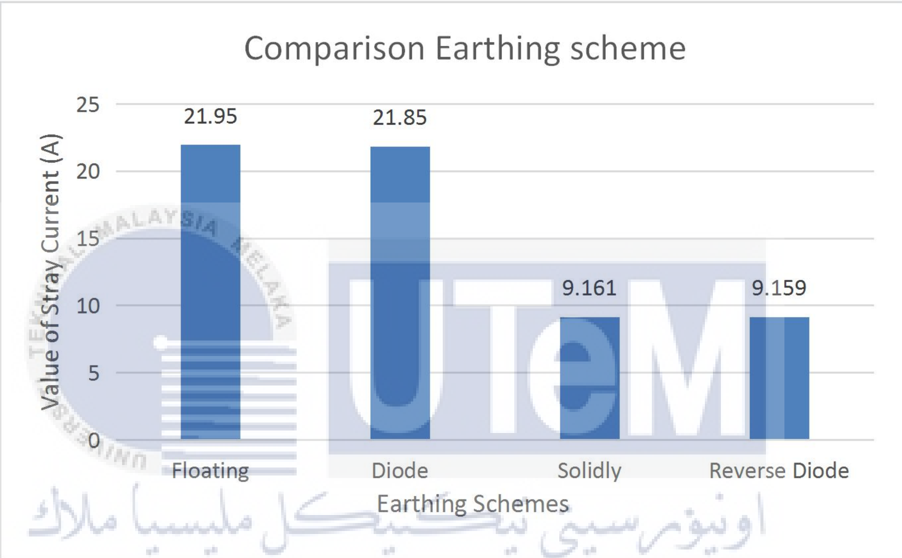

Figure 5.1 : Comparison Result value of stray current between earthing scheme.

It is supported that Reversed diode is a diode earthed scheme with a diode placed in a reversed direction. Reversed diode may be a diode earthed theme with a diode placed in a very reversed direction. Reversing diode blocks the trail for the foremost unsafe a part of corrosive charge flowing from buried structures into the negative pole of DC provide system. Thereby lowers the corrosion injury effectively [16]. Based on the project carried out shows the issue of stray current that often occurs in the third rail system is still lacking project carried out because based on data obtained from the third rail transit Malaysia shows the reading value for stray current still shows a fairly high reading value.

5.2 Recommendation

The implementation of stray current evaluation utilising running rail simulation technique by using SCMS is carried out in this project project by getting readings from the Third Rail Transit Malaysia, which are data for just one year. Perhaps in a continued project, additional information about the stray current that frequently happens on Third Rail Transit Malaysia can be gained by evaluating the readings taken over a period of two to three years or more for data that is more significant for the future of this project.

Furthermore, the approach used to reduce the Stray Current based on the measurements taken. By implementing the earthing scheme can also be implemented by introducing a more effective earthing scheme to reduce stray current such as using the Thyristor earthing scheme for example. In addition, There are many other methods that can be used to reduce stray current on the Third Rail system and improve safety, such as increasing resistance on the running rail by shortening the upper and lower rails using curtain methods which is improving insulation at the source of the Stray current and increasing the distance between structure and the interfering structure such as distance between substations to other substations to reduce stray current on the Third Rail system.

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APPENDICES

APPENDICES A

BDP 1 GANTT CHART

N0	Detail / Week	1	2	3	4	5	6	7	MID SEMESTER BREAK WEEK 8	9	10	11	12	13	14
1	Selection and confirmation of Project Title	■	■												
2	Preliminary Research Work on Related Topics		■	■	■	■									
3	Submission of Proposal 1 (progress week 6)						■								
4	Chapter 2 Research							■		■	■				
5	Chapter 3 Research method will be used									■	■	■	■		
6	Submission of Interim Draft Report 2												■	■	
7	Submission of Interim Final Report														■

BDP 2 GANTT CHART

N0	Detail / Week	1	2	3	4	5	6	7	MID SEMESTER BREAK WEEK 8	9	10	11	12	13	14	16
1	Continue on Chapter 3 design Circuit Modeling	■	■	■												
2	Research Work on Related Circuit and Software			■	■	■										
3	Submission of Logbook and Progress Report 1						■									
4	Chapter 4/5 Result and Discussion							■		■	■	■				
5	Submission of Logbook and Progress Report 2												■			
6	Submit Report to Panels													■		
7	BDP Presentation														■	
8	Submit Final Softcopy Format															■

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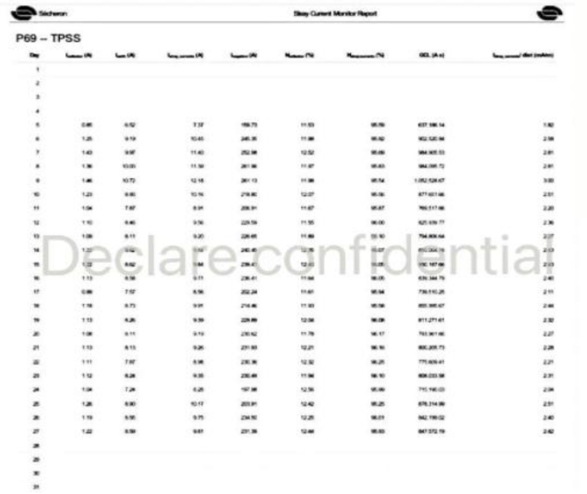
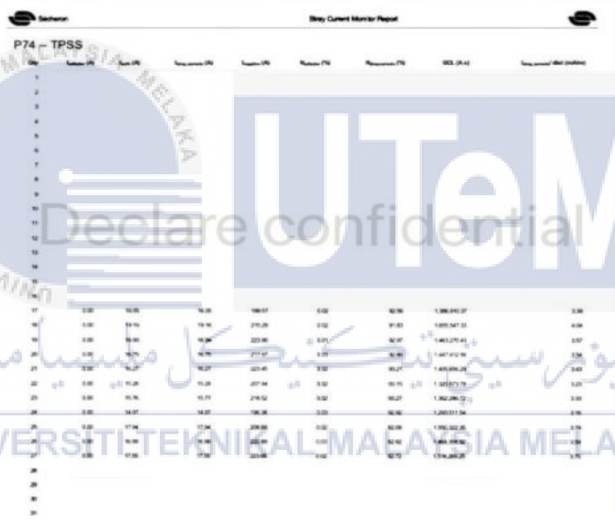
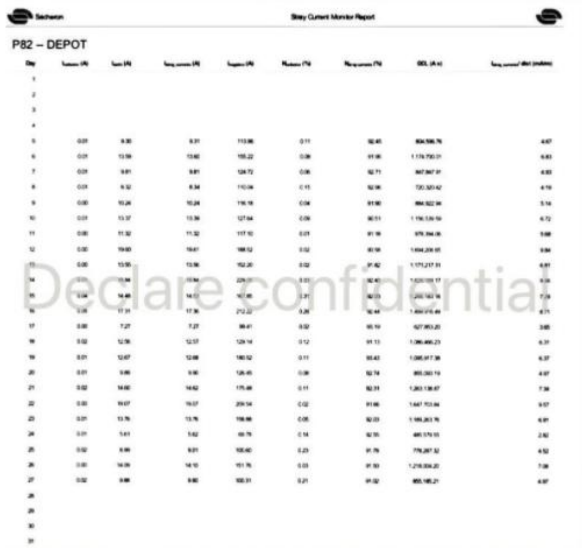
APPENDICES B

DATA DAILY SUMMARY STATION (P69 , P74 & P82)







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