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Faculty of Electrical and Electronic Engineering Technology

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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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

Faculty of Electrical and Electronic Engineering Technology

UNIVERSITI TEKNIKAL MALAYSIA MELAKA

2021

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UNIVERSITI TEKNIKAL MALAYSIA MELAKA

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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

Signature : 

Supervisor Name : Adlan bin Ali

Date : 13.01.2022

Signature :

Co-Supervisor :

Name (if any)

Date :

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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.

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.

Then, I'd want to express my deepest appreciation to my friends, who have been offering me advice and assisting me in a variety of ways to guarantee that I never give up our lives. It would be tough for me to accomplish this assignment on time if they did not cooperate. Thank you very much.

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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:

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.

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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

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.