UNIVERSITI TEKNIKAL MALAYSIA MELAKA

FACULTY OF ELECTRICAL ENGINEERING

BACHELOR OF INDUSTRIAL POWER (BEKP)

FINAL YEAR PROJECT (FYP2)

EXPERIMENTAL STUDY ON THE GROUND RESISTANCE REDUCTION BASED ON EARTH ELECTRODE

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EXPERIMENTAL STUDY ON THE GROUND RESISTANCE REDUCTION BASED ON EARTH ELECTRODE

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A report submitted in partial fulfillment of the requirements for the degree of Electrical Engineering (Industrial Power)

Faculty of Electrical Engineering

UNIVERSITI TEKNIKAL MALAYSIA MELAKA

2014

I declare that this report entitle "Experimental Study on The Ground Resistance Reduction Based on Earth Electrode" is the result of my own research except as cited in the references. The report has not been accepted for any degree and is not concurrently submitted in candidature of any other degree.

Signature : .....

Name : AHMAD TARMIZI B AZILY

Date : 18/06/14

" I hereby declare that I have read through this report entitle "Experimental Study on The Ground Resistance Reduction Based on Earth Electrode" and found that it has comply the partial fulfillment for awarding the degree of Bachelor of Electrical Engineering (Industrial Power)"

Signature : .....

Supervisor"sName : MISS ARFAH AHMAD

Date : 18/06/2014

ACKNOWLEGDEMENT

In the name of Allah S.W.T, the Creator of all mankind and the Most Gracious. Most Merciful. Firstly I would like to express my heartily thankfulness to my project supervisor, Ms Arfah Bt Ahmad for all the guidance and advices given along this project. Also did not forget to staff from FKE, UTeM that always help me in the management procedure. I will never forget your kindness.

My gratitude goes to my family, especially my sister Norida Salwa Bt Azily that always give me an ideas and solution relating to this project. To my lovely mother Noriah Bt Mastor, thanks for your spirit and always support me to achieve the goal of my project. Thank you very much for supporting me for the start till the end of this project.

Last but not least, my great appreciation dedicated to my entire friends that always give me a moral support to complete this project. I also would like to thank to Mohd Shafiq Bin Md Arshad as he always support and trust me that I was able to complete this project. May Allah bless all of you.

ABSTRACT

Grounding of electrical installation is primarily concern with ensuring safety. The main purpose of grounding is to channel the fault current straightly to earth. To produce a good grounding system, the value of earth resistance must be reduce as low as possible. In this project, a 3 meter length of copper, GI and pure steel rod will be installed in formatting 12 of grounding system. Six system for single installation and six for parallel installation. The aim of this study is to determine the effect on the resistance value when the soil condition is change and different type of rod is use. Furthermore, the Kyoritsu Digital Earth Tester will be used to measure the value of earth resistance. The diameters of rod are constant for each type of rod. Fall of Potential method will be used for this project to find the value of resistance. Single rod testing and parallel rod testing is performing in this project. From the result, it is expected that, the soil condition surrounding the rods are greatly influenced the value of earth resistance. The grounding system that use galvanized iron (GI) rod has the lower earth resistance compared to copper and steel.

ABSTRAK

Tujuan pembumian untuk setiap pemasangan sistem elektrik adalah untuk keselamatan. Kegunaan utama pembumian adalah untuk menyalurkan arus yang tidak dikehendaki terus ke dalam tanah, untuk menghasilkan sistem pembumian yang baik, nilai rintangan mestilah serendah yang mugkin. Dalam projek ini, panjang setiap rod adalah 3 meter antara rod tembaga,besi bergalvani (GI), dan besi tulen digunakan untuk menghasilkan dua belas sistem pembumian. Enam sistem untuk pemasangan tunggal dan enam untuk pemasangan secara selari. Tujuan kajian ini adalah untuk menentukan kesan ke atas nilai rintangan apabila keadaan tanah di sekeliling rod berubah dan jenis rod yang berbeza digunakan. *Kyoritsu Digital Earth Tester* akan digunakan untuk mengukur nilai rintangan bumi. Setiap jenis rod mempunyai diameter yang tetap. *Fall of potential method* akan digunakan dalam projek ini untuk menentukan nilai rintangan. Pengujian secara tunggal dan selari dlaksanakan dalm projek ini. Daripada keputusan yang diperolehi, dijangka bahawa keadaan tanah banyak mempengaruhi nilai rintangan bumi. Sistem pembumian yang menggunakan besi bergalvani (GI) rod mempunyai rintangan bumi yang lebih rendah berbanding dengan rod tembaga dan rod besi.

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UTeM - Universiti Teknikal Malaysia Melaka

EPR - Earth Potential Rise

EAF – Earth Additive Filler

GI – Galvanized Iron

CDEGS – Current Distribution, Electromagnetic Field Grounding and Soil Structure

DET – Digital Earth Tester

GPR- Ground Potential Rise

GPD - Ground Potential Difference

CHAPTER 1

INTRODUCTION

1.1 Project Background

Electric power system grounding is very important, particularly since large majority of faults are caused by poor grounding system or due to lightning strikes. The terms earthing and grounding have the same meaning. The purpose of grounding is to minimize potential transient overvoltage, in compliance with standard for personnel safety requirements also to assist within the rapid detection and isolation in the fault areas. Grounding connection is accomplished by driving ground electrode in several places in the earth. Earth electrode is often a metal plate, metal pipe or steel conductors electrically connected to the earth. The materials generally used for earth electrodes are made of copper, aluminum, mild steel and galvanized iron in order of preference. The factors that influence the earthing resistance of an electrode or group of electrodes includes are the composition of the soil, the temperature of the soil, the moisture content of the soil and the depth of the electrode [1].

Based on previous study by Megger researchers there is not much information has been collected on the effect on temperature, two facts lead to the logical conclusion that an increase temperature will decrease resistivity and decrease the moisture content in the soil [2]. Moreover, the depth of electrode also influence the ground resistance due to soil layer in which the upper layer of the soil have higher resistivity than lower layer. The soil types are mostly different in every part of the world and the resistivity also differ compare to other. The resistivity of soil is all depend on the type of soil. Thus, to install an electrical system and complete its circuit, a grounding system performance must be taken into

account, but in certain cases, due to geological condition, the soil resistivity is not good enough which is the resistance must be below 5Ω (depending on the type of electrical system). Single rod installation may not enough to decrease the resistivity. To overcome this problem, solutions that require by installed another rod that connected in parallel. But, these solution need extra area which is minimum space between each rod are 6 foot away.

The provision of good and effective electrical grounding system is necessary to protect personnel and equipment from the hazards of high potential rise due to the flow of high current to earth. Besides that, this system also becomes a major importance in the efforts to increase the reliability of the supply service, as it helps to provide stability of voltage conditions, preventing excessive voltage peaks during disturbances and also means to discharge lightning surges.

1.2 Motivation

The motivation for this project is to propose a new type of grounding electrode to replace the typical grounding electrode which is copper rod. The copper rod is very expensive in the market. This cause a lot of stealing case over the year that had been reported by the newspaper and television that cause the entire electrical system are unsafe. Electric shocks can paralyze the respiratory system or disrupt heart action, causing instant death. Based on the Department of Occupational Safety and Health (DOSH), three fatal cases were recorded to due to electrical shock taken from 2011 until 2013. The new type of grounding system is propose in this research by using the galvanized iron rod (GI) and steel rod.

1.3 Problem Statement

There are several important reason why a grounding system should be installed. But the most important reason is to protect people, another reason include protection of structures and equipment from unintentional contact with energized electrical lines the grounding must ensure maximum safety from electrical system faults and lightning.

In recent years, many report published in newspaper on the stealing of cable activities from substation telecommunication towers and power system network and the number of theft has increase over the year. From this activity, it affects the continuity of the system supply, disrupting service and the utilities company suffers great losses. Most of the grounding electrode is made of copper. Since the rise of copper price in the market, it attracted thieves to steal the grounding rod in the residential or commercial building. Moreover, it also bring huge problem to the utilities company such as Tenaga Nasional Berhad (TNB), Telekom and other.

To overcome this problem, the use of copper as a grounding is proposed to be replace by using galvanized iron or steel as an electrode. The performance and popularity of cooper are very well comparing to galvanized iron and steel. The prices of galvanized iron rod are much lower than cooper rod and provide an advantage in terms of installation cost for the ground system. Galvanized iron is chosen because of the electrical characteristic and reasonably low price. Since today, only a few testing had been conducted to test the effect on the value of resistance between type of electrode in use. Most of the testing was done by simulation only and that have a lot of limitations. This project will conduct by using single and parallel installation method with 3.0 meter length for each type of rod (copper, GI, steel).

1.4 Project objective

The aim of this study is to achieve the objective listed below:

1. To analyze the best type of rod between copper, galvanized iron (GI) and steel.
2. To investigate the effect of grounding resistance based on soil condition.
3. To analyze the best installation type for grounding system between single and parallel installation.

1.5 Project Scope

To pursuit the objective of this project, there are several scope that have been specified. The scope of the projects are.

1. Location of the experiment will be conducted at an area around FKE, UTeM which have the same type of soil.
2. Apparatus that will be used is digital earth tester (DET).
3. Three types of rod will be analyzed, copper rod, galvanized iron and steel rod.
4. The ground electrode that will be used are vertical type single and parallel installation
5. The length of the ground electrode is 3m for single and parallel installation with the same diameter for each type of electrode.
6. Fall of potential method will be used to measure the resistance of the electrode.
7. The data will be recorded and compared to ensure which type of installation give a lower value of resistance.

1.6 Thesis Outline

Chapter 1 briefly review the summarize about project background and project scope. Project background basically describe about the purpose of grounding system followed by the problem statement which stated the problem that initiate in this project. The project objective and project scope also describe in this chapter to clarify the limitation of this project.

In chapter 2, describe about the basic theory on grounding rod, and type of rod will be used in this project. This chapter also discussed and summarize the related previous study that will be use as a reference in completed this project. Furthermore, the purpose of this chapter also to make sure that this project are not the same with other.

In chapter 3 of this report, consist of all methodology and procedure that need to be taken in completing this experiment. All the procedures are described in a flowchart. It is important to follow all the methodology and procedure that had been stated to make sure all the objective achieved and not exceed the scope of the project. Other than that, the installation process also included in this chapter.

Chapter 4 consists of the preliminary result in 15 day of measurement based on previous study. All the result was shown in the graph that had been plotted and discussed. It is expected that the length of the rod greatly influenced the value of grounding resistance.

In chapter 5, the final chapter will describe the analysis of the data for the 15 days. All type and efficiency of the rod were discussed and elaborate. This consist of recommendation that need to be taken for further study.

CHAPTER2

LITERATURE REVIEW

2.1 Introduction

The term "ground" is defined as a conducting connection where a circuit or equipment is connected to the earth. The connection is used to establish and maintain as closely as possible the potential of the earth on the circuit or equipment connected to it. A "ground" consists of a grounding conductor, a bonding connector, its grounding electrodes and the soil in contact with the electrode. Grounds have several protection applications. For natural phenomena such as lightning, grounds are used to discharge the system of current before personnel can be injured or system components damaged. For foreign potentials due to faults in electric power systems with ground returns, grounds help to ensure rapid operation of the protection relays by providing low resistance fault current paths. This provides for the removal of the foreign potential as quickly as possible. The ground should drain the foreign potential before personnel are injured and the power or communications system is damaged. Ideally, to maintain a reference potential for instrument safety, protect against static electricity, and limit the system to frame voltage for operator safety, a ground resistance should be zero ohms. In reality, this value cannot be obtained. Last but not least, low ground resistance is essential to meet National Electrical Code (NEC), Occupational Safety and Health Administration (OSHA) and other electrical safety standards [7]. To have a lower ground resistance, there are a few factor that need to be consider are type of soil, depth, spacing, size of the electrode and soil treatment before installation [2].

2.1.1 Copper Rod

Typically, grounding copper rod is made up from solid copper. For this specific experiment, the rod will be used are copper bonded type, which mean only the surface of the rod covered using copper. The inside material was made up from iron. It comes in many forms such as plates, strip, tubes, and wire. For example of bonded copper rod as shown in Figure 2.1.

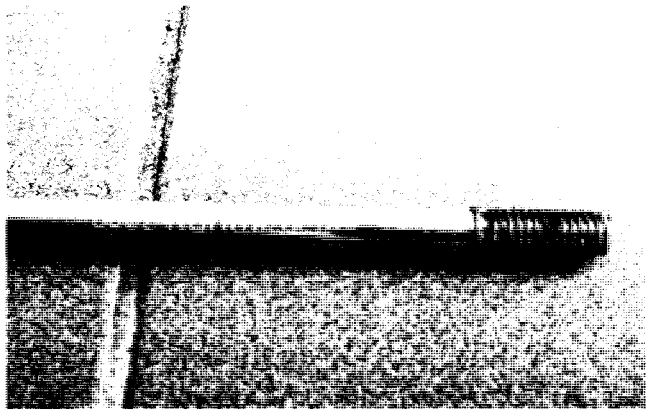

Figure 2.1: Copper rod

In this experiment, the length and also the diameter of the rod is the main characteristic that needs to be considered. The diameter has to be same for every type of rod.

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