EXPERIMENTAL STUDY ON THE GROUND RESISTANCE REDUCTION BASED ON EARTH ELECTRODE

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EXPERIMENTAL STUDY ON GROUND RESISTANCE REDUCTION BASED ON EARTH ELECTRODE

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

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2013

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

Signature : .....

Supervisor's Name : CIK ARFAH BT AHMAD

Date : 20 JUNE 2013

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

Signature : 

Student's name : Mohd Rizal Bin Ahmad Saroni

Date : 20 JUNE 2013

To my beloved mother and father

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ABSTRACT

Grounding of electrical installation is primarily concern with ensuring safety. The main usage 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. Otherwise, current may flow through to those who touch the damage electrical equipment instead of flowing through grounding system. In this project, a variety diameter of copper rod and GI pipe are installed to build six grounding system. Each system consist 3 rods with same type and diameter. The aim of this research is to find if there exist the different in the value of resistance for different diameter and different type of rod is used. In this research, the Kyoritsu Digital Earth Tester will be used to measure the value of earth resistance. The length of rod used is 1.5 meter. The Fall of Potential method will be used for this project to find the value of the resistance. Single rod testing and paralleled rod testing is performed in the project. From the result of the research, the value of earth resistance for the grounding system that has big diameter rod and small diameter rod was expected will almost same. The grounding system that use GI pipe, has lower earth resistance value than copper. The measured paralleled value resistance must near the calculation value that count using formula by the data from the single rod testing.

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 boleh. Jika tidak, arus mungkin mengalir kearah benda atau organisma hidup yang menyentuh peralatan elektrik yang rosak daripada mengalir kearah sistem pembumian. Didalam projek ini, pelbagai saiz diemeter rod tembaga dan paip GI digunakan untuk menghasilkan enam sistem pembumian. Setiap sistem mengandungi tiga batang rod dengan jenis dan diameter yang sama. Tujuan kajian ini adalah untuk mengenalpasti wujudnya perbezaan nilai rintangan jika rod berlainan diameter dan jenis digunakan untuk sistem pembumian. Didalam kajian ini, *Kyoritsu Digital Earth Tester* telah digunakan utukk mengukur nilai rintangan. Panjang setiap rod yang digunakan ialah 1.5 meter. Kaedah *Fall of Potential* digunakan untuk mengukur nilai rintangan. Ujian rod tunggal dan selari telah dilakukan dalam projek ini. Daripada keputusan kajian ini, nilai rintangan bagi sistem yang menggunakan rod berdiameter besar dan kecil adalah hampir sama. Bagi sistem pembumian yang menggunakan paip GI, ia menunjukkan nilai rintangan yang lebih rendah berbanding rod tembaga. Nilai rintangan diukur bagi kaedah selari adalah hampir sama dengan nilai yang dikira menggunakan formula.

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Ω	-	Ohm
A	-	Ampere
mA	-	Milliampere
KA	-	Kiloampere
Hz	-	Hertz
mm	-	Millimeter
Cm	-	Centimeter
m	-	Meter
ρ	-	Rho
R	-	Resistance
V	-	Voltage

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CHAPTER 1

INTRODUCTION

1.1 Project Background

Over the time, the matters of grounding of electrical system, circuit and equipment has become the subject that always been debates by electrical engineer and other electrician. It is about whether the systems were safer if they were grounded or if they were left ungrounded.

Electrical grounding basically means the involvement of earth in electrical system. Earth is a good conductor since all the current which make contact to the earth flow to the ground. The purpose of grounding is to reduce the risk of electrical shock from current leakage into uninsulated metal part of appliances, power tool or other electrical devices. A path through metal chassis and the earth moist dirt and rock is of less resistance than through the air or human being. A grounding rod is used to channel leakage current to the ground. The rod that commonly use are copper clad rod, aluminium clad rod, copper-coated aluminium rod, hot-dip galvanized rod and stainless steel rod. In a lightning protection design, failure any of the grounding components will significantly increases the risk of side flashing and structure fire during lightning event. Modern electronic equipment relies on an effective grounding system to provide a signal reference for low voltage digital signals. Utilities rely on effective grounding to prevent the flashover of insulators on transmission lines and to protect expensive equipment, such as transformers, capacitors, reclosers and lightning arrestors used on distribution systems. Majority agree that these are very important functions for all electrical equipment that has been design.

Every grounding system that has been installed, must be operated in good performance. In order to achieve good performance, the value of resistance must be below 5Ω (depending on the type of electrical system). To get a low reading of resistance, a good quality grounding rod should be installed to the ground. According to the property of the current, it will choose the lowest resistance path to flow to the ground. If the resistance is high enough, the leakage current may flow through to the person or other conductor that attach to it.

1.2 Problem Statement

Ever since electricity was discovered, grounding is an essential part for all electrical system from the small system to the big electrical system. Grounding is compulsory for any system that used electricity so that the unwanted electricity can be flow to the ground. Grounding can protect electrical devices from failure and human from electrical shock. The lower grounding resistance, the better is the grounding system. Thus, if the diameter of the rod is large, the lower the resistivity of the rod.

Through this research, there will be a result on the effect of resistance value if different diameter of grounding rod is used. Beside that, this study also discusses type of grounding rod (whether copper or GI pipe) that serve as a good conductor. GI pipe is choosen because today it become a trend for many contractor to choose GI pipe than copper rod due to the cheaper price. Since today, only a few testing been conducted to test the effect on the value for resistance if different size of diameter of rod. Many of the testing is just a simulation in lab or other place that has limitation. This research will use parallel installation method which the rod is buried in parallel with different diameter to proved which size of diameter has the lowest resistance value. If the small rod diameter has a same performance as big diameter rod, the small diameter rod can be widely used to cut cost.

1.3 Project Objective

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

1) To study the existence on the different of resistance value for different diameter of grounding rod.
2) To compare the value of resistance on the paralleled and single rod test for different type of rod.To determine the grounding rod that has lowest resistivity based on diameter and type of rod (copper or GI pipe)
3) To determine the grounding rod that has lowest resistivity based on diameter and type of rod (copper or GI pipe)

1.4 Project Scope

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

1) This project only focus on the existence of different value of resistance if the different diameter of copper clad and GI pipe is used.
2) This project only focus to find the lowest resistivity of grounding rod whether copper clad rod or GI pipe.
3) Digital Earth Tester is used to measure the value of earth resistance and using the fall of potential method to measure the value of the grounding resistance.
4) The experiment will be conduct at the same place, same weather and same depth to avoid bias when measurement is taken.
5) The rod will be buried based on parallel installation only.
6) The performance of each type rod will be analyzed using the statistical method.
7) The value of resistance will be taken by each single rod and parallel connection.

1.5 Thesis Outline

Chapter 1 briefly summarizes the project background and problem statements as well as elaborate the objectives and scope of the project. All of these are really important to initiate any project because it help to set any parameter in the research field that we done. It also make us more understand about the research that we done.

In chapter 2, describe about literature review that used as reference in completing this project. Firstly, this chapter explain about the important of grounding system in every electrical system. After that, this chapter show about the related research that has been done by others researchers to make sure the research is not same.

Chapter 3 will show all methodology and procedures that has been use to complete this project. Methodology is the important part in this research has been shown in detail in this part. Usually, methodology defines the planning process and flow that is essential to produce a proper planning project. It is important that this project follow all the methodology that has been set to make sure it is achieving the objectives and do not exceed the scope that has been set.

Chapter 4 will show the detail of every results of this project. All data are recorded in table and graph are plotted from data obtain. It will also describe about the performance of every grounding system in 15 days.

In chapter 5, the final chapter will describe the analysis of the data for the 15 days. It will discussed about the performance of all grounding system that has been installed. The different value of the resistance of each electrode and grounding system is justified. Lastly it elaborates about the conclusion and recommendation on this project. This will determine wether the objectives has been achieved or not.

CHAPTER 2

LITERATURE REVIEW

2.1 Introduction

To get the lower value of resistance, the electrode should has big surface area that touch to the soil or a number of rod is buried in parallel. There is some consideration when installing the grounding system. That is total area of plate, maximum current that can be handled, properties of the soil and the depth of installation. Two type of electrode that commonly used are conventional copper rod and electrode that primarily used for other purposed like underground piping [2].

The factors that can effect the value of resistance of electrodes are type of soil, shape, spacing, number, size of electrode and the treatment on the soil before installation.

2.2 Investigation Into the Performance of Large Scale Earthing rods.

Research by D.Guo, D.Lathi and N.Harid from Cardiff university UK in 2010 investigate the of large scale earth electrode and the result it gain was use to compare with analytic and simulation techniques. Rapid growth in computer technology has led to the development of very powerful computation tool for earthing system. However, there is only a few literature is available on validation of these calculation techniques. The other experiment also has been done in laboratory using scaled model but the shortfail is related to the boundary condition which are not satisfactory for scaling up to full operating system. Thus, the

experiment is conducted at the lower water reservoir of a hydro pumped-storage power station on North Wales. The full scale test at operational electrical installation have non-uniform structures with both lateral and vertical variations and the non-homogenity presents difficulties in establishing accurate model for comparison [1].

The experiment is set up at the lower reservoir of Dinorwig power station that has long 1.8km and 400m wide. The operating regime of the power station is such that the water level varies over a range of about 15 meter and the water level at any given time can be ascertained accurately from station recording. To enabled the test electrodes to be immersed in the lake at fixed position, a pontoon anchored at positions along its length was constructed from the shore. Here, the 5m*5m test earth grid is immersed at controlled depth below water surface. Figure 2.1 shows the experiment arrangement.

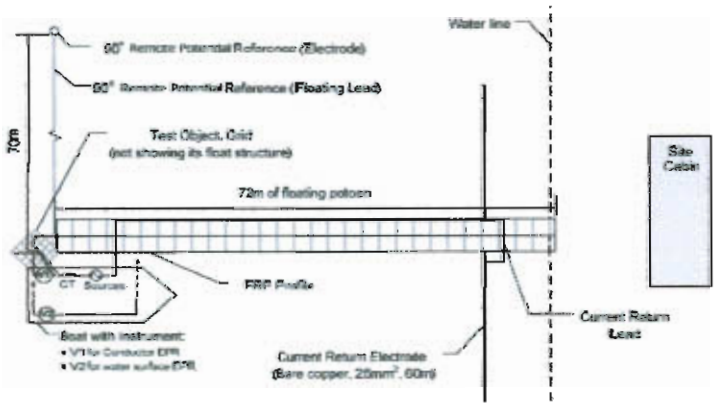

Figure 2.1: Experiment Arrangement[1]

A floating potential reference electrode was placed 70m away from the test electrode in a perpendicular direction to the current carrying test lead. The current return electrode, a 60m long copper conductor with 25mm2 cross-section, was immersed in the lake at the shore-end of the pontoon system.

The test earth grid measures 5m×5m and has 25 equal meshes. The grid conductors consist of aluminium strips, each of dimension 5m×50mm×6mm. The resistance of the grid was measured as 10.46Ω using a Megger DET2/2 composite earth tester. Using equation 2.1, the resistance was calculated to be 11.45Ω, assuming a uniform 'soil' model with a resistivity value of 115.33Ωm;9.5% higher than the measured value.

$$R_g = \rho\left[\frac{1}{L_T} + \frac{1}{\sqrt{20A}}\left(1 + \frac{1}{1+h\sqrt{20/A}}\right)\right] \quad (2.1)$$

where,

R= Resistance

P= Rho

L=Length

A= Current

h= Height

The grid was energized with low frequency (20Hz) a cover the range 2.5mA to 600mA and the measured earth resistance as a function of injected current is shown in Figure 2.2. From Figure 2.2, it can be seen that there is a small increase in resistance with current which and this represents an opposite trend compared with the rod electrode where a fall of about 10% in measured earth resistance was observed over a similar current range.

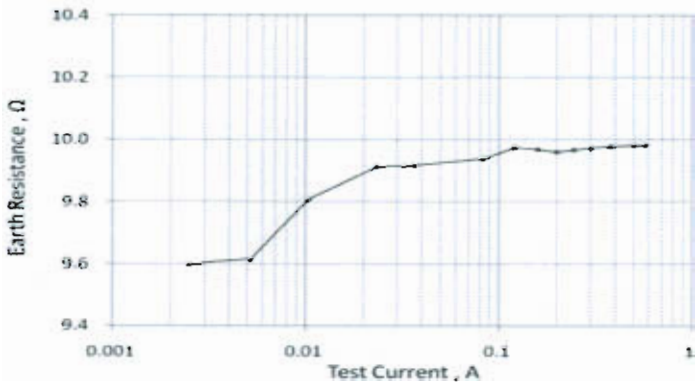

Figure 2.2: Current versus Resistance [1]

As a conclusion, the measured value of earth resistance and impedence have almost same value with the analytical one. However, the value of current dependence is just adopted by practical testing instrument, which may be due to the nonlinearity in the soil condition.

2.3 The Resistance of Earth Electrode

The report has been done by the associates member of the British Electrical And Allied Industries Research Association. This paper explain briefly the most important aspect of the resistance of electrode used for earthing electrical installation and apparatus. There is some considered and recommendation from panel committee of British Standard Specification for earth plate that seemed desirable, that is

- Area of earth plate
- Maximum current to be handled
- Nature of soil in which plate is sunk
- Depth of earth plate