

GROUNDING ENHANCEMENT MATERIAL FROM
INDUSTRIAL BY-PRODUCT

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In (or with) the name of Allah, who is Beneficent and Merciful.

“...and say O’ my Lord increase me in knowledge...”

The Subline Quran (20:114)

To my beloved wife Norlaila Ramdan, daughter Laila Najwa,
my beloved mother Zaiton Ahmad, my father Muhammad Muhyiddin Hassan and
mother in-law Zainab Jasmin thank you for the support when I need it most.

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ABSTRACT

The purpose of this study is to investigate the use of additive material to improve the grounding performance. The material selection is based on industrial waste, where that can be obtain from Palm Oil Milling Factory and Coal-Fired Power Plant. The moisture content of these materials and their combination were studied and the effectiveness were highlighted. The ability of these materials to absorbed moisture can directly influence an effect reducing the grounding electrode resistance value. Grounding Enhancement Material (GEM) were developed and studied for their performance to improve soil resistivity. GEM was used as an additive material for ground resistance value reduction of a mock-up grid system. As a result, it was discovered that by using GEM the grounding resistance of the mock-up grid reduced. From three type of GEM developed during the study, Empty Fruit Bunch Ash based GEM provide better improvement to soil resistivity value and thus reducing the ground resistance value of the test scaled-down grounding system.

ABSTRAK

Kajian ini dilakukan bertujuan mengkaji penggunaan bahan penambah dalam meningkatkan keupayaan sistem pbumian. Pemilihan bahan adalah daripada sisa buangan yang diperolehi dari kilang pemprosesan kelapa sawit dan stesen janakuasa berasaskan arang batu. Kandungan kelembapan bagi bahan-bahan ini dan gabungannya dikaji dan keberkesanannya diutarakan. Kebolehan bahan-bahan ini menyerap kelembapan secara terus memberikan kesan bagi penurunan nilai rintangan elektrod bumi. Bahan penambahan pbumian (GEM) dibangunkan dan kebolehpayaan untuk memperbaiki rintangan tanah dikaji. GEM ini digunakan sebagai bahan penambah bagi pengurangan nilai rintangan sistem pbumian mini. Keputusan yang diperolehi dengan menggunakan GEM ini nilai rintangan sistem pbumian mini adalah berkurangan. Daripada tiga jenis GEM yang dibangunkan, GEM berasaskan Abu Tandan Kelapa Sawit memberikan pembaikan rintangan tanah dan seterusnya menurunkan nilai rintangan bagi sistem pbumian mini yang diuji.

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LIST OF SYMBOLS

ρ	-	Soil resistivity
R	-	Resistance
Ω	-	Ohm
A	-	Area
l	-	Length, meter (m)
a	-	Distances between electrode
π	-	3.142
A_{mm}^2	-	Area of conductor
I	-	RMS (Symmetrical Fault in kA
K_f	-	Constant of the material
t_c	-	Fault duration in sec
kA	-	Kilo Ampere
m_1	-	mass of container
m_2	-	mass of container with sample
m_3	-	mass of container with the dry sample
$^{\circ}\text{C}$	-	Degree Celsius

LIST OF ABBREVIATIONS

TNB	-	Tenaga Nasional Berhad
GEM	-	Ground Enhancement Material
FFB	-	Fresh fruits bunches
EFB	-	Empty fruits bunches
EFBA	-	Empty Fruit Bunch Ash
CO ₂	-	Carbon dioxide
SO ₂	-	Sulphur Dioxide
NO _x	-	Nitrogen Oxides

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CHAPTER 1

INTRODUCTION

Grounding of electrical installations is primarily concerned when safety aspect of equipment and users are concern. In electrical power networks the grounding system helps to maintain the voltage of any part of the network within a predetermined range with respect to earth under steady state and fault conditions. If it is design correctly, it should allow enough current to flow under fault conditions to operate the protective devices installed. The rise in potential experienced during the fault combined with the speed of fault clearance, should be such as to minimize both the risk of electrocution to individuals near the site of fault and damage to equipment. The widespread use of electrical appliances, both in the factory and the home, also introduces many situations where efficient grounding is of paramount importance, especially to prevent electric shock under fault conditions.

1.1 Grounding System

In terms grounding, earthing and bonding can be quite confusing. Earthing is a common term used outside the United State of America and is the connection of the equipment and facilities to Mother Earth. In the case of a lightning protection system the earthing terminals is the point where lightning current discharge to earth whereas bonding is a permanent joint of metallic parts to form an electrically conductive path that will ensure electrical continuity and the capacity to conduct safely any current likely to be imposed.

As mention earlier, there are several important reasons why grounding system should be installed. But the most important reason is to protect people. The secondary reasons include the protection of structures and equipment from unintentional contact with energized electrical lines. The grounding system must ensure maximum safety from the effect of electrical system faults and lightning.

A good grounding system should have periodic inspection and maintenance program to ensure its effectiveness. Continued or periodic maintenance is aided through adequate design, choice of materials (for the electrodes) and proper installation techniques to ensure that the grounding system resists deterioration or inadvertent destruction. The performance of such electrodes (considering the ground resistance of the electrode as an indicator) depends on the soil type, composition, conductivity, moisture content, soil temperature and etc.

1.2 Problem Statement

The quality and performance of grounding systems are the major concerns in today's power system design, due to the significant increase of short-circuit current levels associated with the need to provide the energy required by the phenomenal industrial growth. In Malaysia most of grounding system are using copper as a conductive material for above the ground, and metal electrode within the soils and the surrounding soils it self. However with the increasing price of copper and its vulnerability to theft, there is a concern to find an alternative material others than copper as a grounding conductor. Figure 1.1 and Figure 1.2 shows some cases theft incident happens in one of TNB's substation [1] (Appendix A).



Figure 1.1: Ground Fencing

Without those grounding the static charges and surge induced by lightning or other electrical internal and external phenomenon will cause damage to equipment. In the industrial, commercial and domestic sector. There are many cases reported involved the loss of equipment due to vandalism. The cost of loses can exceed million of ringgit if the equipment like power transformer damage by this incident.

In application of grounding system, earth low resistance is essential to meet the electrical safety standard. However in certain soil, it is difficult to obtain and maintain a satisfactory earth resistance values. To reduce the earth resistance, a

chemical treatment and other method are resort. Most of these additive materials are imported, and the cost of earth treatments will be high, hence it will increase the total cost for grounding system installation. Thus this project aims to analyze the performance of grounding system (made of aluminum) couple with the use of Oil Palm waste and Coal Fired Power Plant waste as additive material and comparison study between all the types with additive and without the proposed additive material will be studied.

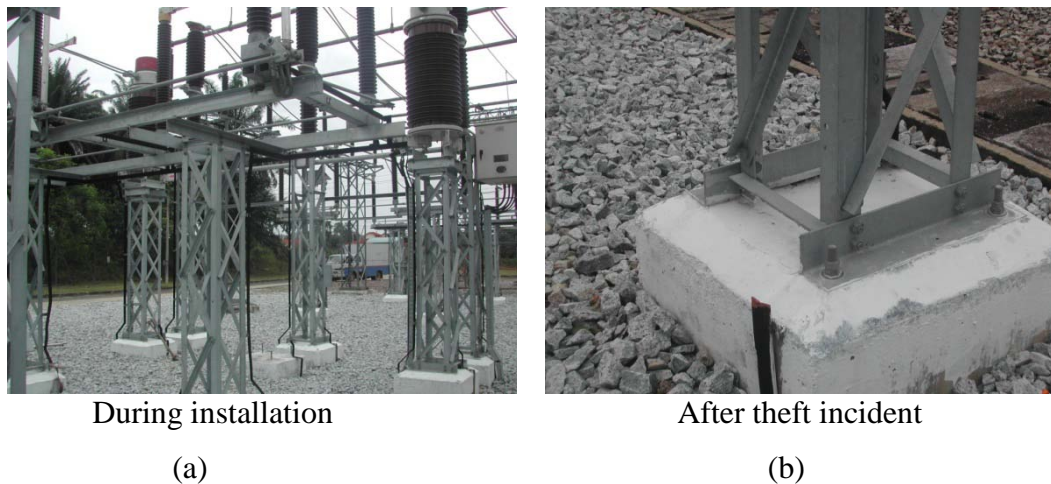


Figure 1.2: Equipment Grounding System

1.3 Objective

The main objective of this project, is to study the grounding performance that use formulated material derived from the industrial by-product. Second objective is a comparison study between formulate ground enhancement material (GEM) and without GEM, its effect on the grounding resistance value.

1.4 Scope of Project

These project will cover the works to obtain the main material to that be used as a grounding enhancement material (GEM) for this project. The ground enhancement material that will be use are from the industrial by-product which from Coal fired power plant and Palm Oil Milling Plant The test field area will have a grounding system consist of horizontal buried conductor to mock up the ground grid system. The conductor that will be used as ground electrode is 25mm x 3mm aluminum strip. The proposed material will be used as backfilled to enhance the grounding performance. The mock up grid performance will be monitor and compare.