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A Study of Kenaf, Straw Rice Ash and Palm Oil Residue Ashes as Additive Material to Earthing System Using Fall of Potential Method

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Abstract. Earthing systems acts as a significant part of the safety of the electric system. Under standard and failure situations, it should be necessary to be functioning efficiently in electrical system safety throughout all times. This project is to study the effect of Natural Enhancement Material (NEM) by using Fall of Potential Method to the earthing resistivity. The NEM material used is Kenaf, Straw Rice ash and Palm Oil Residue Ashes. The measurement took part for 60 days. The purpose of this project is to compare the effect of the NEM as the additive material to the earthing system between three situations, Reference as bare soil, Kenaf with Straw Rice Ash and Kenaf with Palm Oil Residue Ashes. With two NEM material has been conducted, the analysis shown which the better material combining can improve the earth resistivity.

1. Introduction

Earthing systems acts as a significant part of the safety of the electric system. Under standard and failure situations, it should be necessary to be functioning efficiently in electrical system safety throughout all times. Earthing system includes a wire or other conductor linking electrical appliances and ground cable systems. Good earth would generate a secure way back to convey the electric current to the ground under standard and failure situations, without affecting another facilities and beyond the constraints of operation and machinery. This is to encourage an individual to not be revealed at any danger of serious electrical impact that causing death in the facility region [1-3]. There are several ways to have a increase grounding system such as adding rod in parallel or deeper the long rod or having a soil treatment by adding other enhance or additive material to provide better grounding system.



For this project, the soil is performed to increase earthing system efficiency, with one earth conductor installed upwards in the land. Improvement of material used for land therapy can split into two materials, there are material for synthetic improvement (CEM) and material for natural improvement (NEM). The material of improvement could parasite in to the land to decrease the dielectric constant of the soil as components could assist to increase the capacity of the soil to absorb the moisture from the surrounding soil and maintain the moisture within its structure. Note that in this project only NEM is regarded with Kenaf, Paddy Straw Rice ash and Palm Oil Residue ashes has been addressed in the earthing systems installed [2-3]. This additive material would given the effect on grounding system to the soil resistivity whether it can be enhance or not.

Grounding system is very important for designing an electrical installation building. In National Electrical Code (NEC) [5] as mention grounding system as a connection from one of the current carrying conductors of an electrical power system or of an interior wiring system. In IEC Standard [6] for grounding system, the grounding is defined as the act of connecting exposed conductive sections of the equipment, systems or installation with the earth conductor or other grounding elements. The term grounding is synonymous with earthing or binding the circuit to the earth itself. It could also be defined as the act of connecting the circuit to a common reference point which is the Earth.

The structure of the soil, its moisture and temperature all influence the resistivity of the soil. Soil is generally stable and the soil resistivity may change at distinct depths of the soil. Moisture content shifts seasonally depending on the nature of the Earth's sub-layers and the depth of the continuous water table. Because soil and water are usually more flexible in deeper layers, it is suggested that the floor rods be positioned as deep as possible in the floor, if possible at the water table. Where there is a consistent temperature like below the frost line, floor rods must be mounted. It must be intended to resist worst possible circumstances in order for an earthing system to be efficient.

A good technique is generally recognized as the 3-point or fall-of-potential technique, and one which is commonly used. It utilizes a link to evaluate electrode and two test spikes to be forced into the earth before the experiment is performed [4]. One of spikes is the current spike that injects the test current and must be put as far from electrode under analysis as feasible. Other spike is the voltage spike is pushed into the earth between current spike and the electrode at a number of places, ideally in a straight line. A voltage measurement is performed at each place. Since the current transmitted by the device is identified, each of these readings of voltage can be transformed to a resistance value using Ohm's law. In reality, the tool itself performs this conversion. This technique is precise and any issues with the readings are easily evident as the graph of resistance will significantly differ from the predicted form. Only limitations are that the experiment takes a lot of time, a decent amount of space, and that the earth electrode being tested must be separated from all other circuits while the experiment is ongoing. These are somewhat important weaknesses.

Wan Ahmad et al. [3] study the effect of natural enhancement material which can be used to lowering earth resistance. This work employed 15 kg Bentonite, and 3 kg Kenaf in powder and fibre forms as the NEM for grounding systems at which they were either mixed or layered. The main purpose of the study is to compare the performance of the mixed grounding mixture of natural enhancement materials with a grounding reference system located near the ground guide. For the output of the four grounding systems to be compared, fall-of-potential method was used to test earth resistance. All in all, a powder-layered grounding system of bentonite and kenaf is proposed as an effective soil treatment grounding method. Therefore, it is suggested to further test different Bentonite and Kenaf mixes for an optimal ratio between these two NEMs for grounding purposes.

N. H. Halim et al. [2] Study of paddy husk ashes to be used as an additive to improve grounding system performance. Paddy husk is one of Malaysia's largest farm waste and is used as a fertilizer, brick building, and other things. This research found that copper electrode is better than galvanized steel electrode in terms of service life or life span of such electrode material. Therefore, copper electrode is the best option for grounding system material in terms of long-life materials used in construction. Galvanized steel and paddy husk are not acceptable for use as an additive material and grounding electrode. The explanation why this research has demonstrated a high resistance to the soil,

which is not suitable for use as grounding material, is galvanized steel and paddy chuck ash. The galvanized steel electrode shows the highest soil strength and no galvanized steel is approved as the base of the industrial sector by the authority.

2. Experimental

2.1. Fall of Potential Method

In the case of grounding systems with small hemispheric electrodes separated by long distances, the classic fall-of-potential method is applicable specifically for homogenic soil. The proposed method would allow us to analyse the effect of the current electrode size and location over any distance chosen for the current electrode to obtain the appropriate measuring point of the potential probe. The essential aspect of this approach is to determine the proper or appropriate position of the potential electrode to obtain the correct ground electrode resistance. The soil electrode is called a hemisphere and the current electrode as a point source in the design of this process. This determined the 62% standard for very small hemispheric electrodes separated by a large distance in a homogeneous soil [2-3,7-8].

2.2. Gronding System Preparation

The land around the main campus of Universiti Malaysia Perlis (UniMAP) is a hilly terrain area. It would lead to strong resistance on the field. In irregular conditions or abnormal conditions, fault can be occur because of the the condition of distribute current in the soil. Soil resistance is directly related to moisture content and temperature, which is why soil resistivity in hilly areas is high compared to organic soils which are typically a good conductors because it maintain the higher levels of moisture. The site selection take place at field in front of School of Electrical System Engineering where this place chosen because it has the largest area for doing earth resistant measurement. Three groudng system were installed which are Reference, Kenaf fiber and Straw rice paddy ash and Kenaf fiber with Palm Oil Residue Ashes. The measurement took place from 10 January 2020 until 9 Mac 2020.

The first step is determining the space between the probe and mark the digging point. Then the digging process executed for 6 holes based on figure 1. The hole is set to standard by using the PVC pipe (11.3cm diameter and 150cm depth). After the hole making process is done, the additive (Kenaf, straw rice ashes and palm oil residue ashes) and the soil is put into the pit by layer. The volume of material used for the first process is 80 % of Kenaf and 20% of straw rice ash. And the second hole is also 70% of Kenaf and 30% of Palm Oil Residue Ashes.



Figure 1. Digging process



Figure 2. Pit filled with mixture of Kenaf, Straw Rice Ashes and Soil

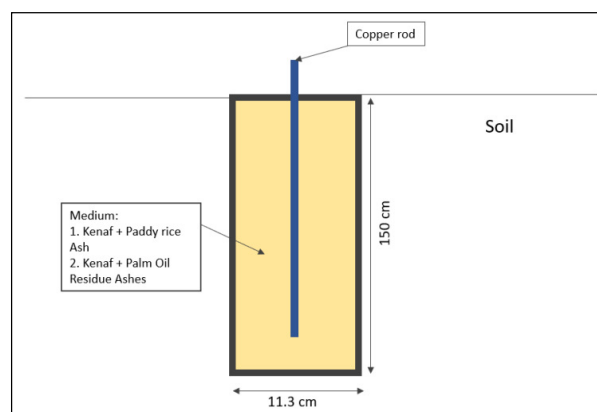


Figure 3. Copper rod with medium NEM

2.3. Earth Resistance Measurement

The Kyoritsu Model 4105A Digital Earth Tester produces a known current between the outer stake or called additional earth stake and the earth's electrode when testing the decrease in voltage potential between the inner earth stake and the earth's electrode. The auxiliary earth spikes P and C are installed into the soil. They must in a straight line at a range between 5m to 10m from the earth equipment under test. A green wire connected to the earth equipment under test, a yellow wire connected to the auxiliary earth spike P and a red wire connected to the auxiliary earth spike C from terminals E, P, and C of the equipment. The important note is to make sure that to install the auxiliary earth spikes in the humid part of the soil.

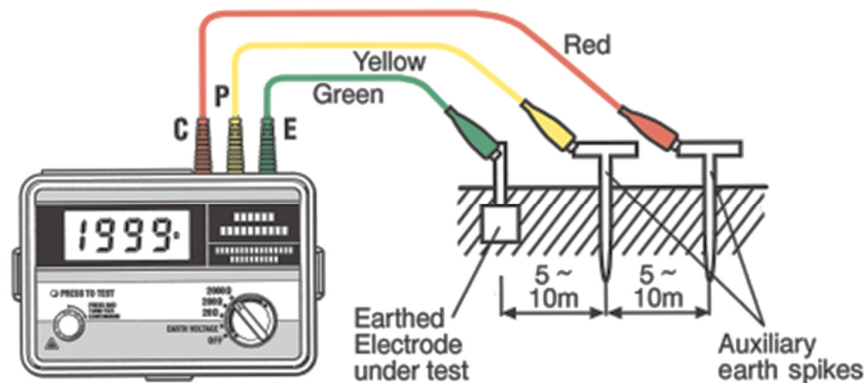


Figure 4. The connection for 3-point method by using Kyoritsu Model 4105A Digital Earth Tester.

3. Results and Discussions

The measurement was taken between 10 January 2020 until 9 Mac 2020, for 60 days and the result were plotted in the figure 5. Throughout the experiment for 60 days, it show the Reference as the main soil for grounding system showed the highest resistance compared to the soil with include with additive. This followed by the soil with kenaf and palm oil residue ashes and the lowest is kenaf with straw rice ashes. Based on it, the grounding system with natural enhancement material NEM can reducing the earth resistance and can be used as additive to the grouding system.

As shown in the graph, the NEM have effect to the earth resistance compare than the reference as bare soil. The grounding with NEM can lower the grouding resistance due to the its capacity. For example Kenaf is a good water absorber as it contain cellulose, lignin and other components. in study, Kenaf fibre can be used as material can absorb oils and liquids. USDA has acknowledged the Kenaf plant is the most promising paper making non-wood alternative [8].

Kenaf and straw rice ashes has a good combining material as it can reduce more highly compare than other material. It showed a better performance in grounding resistivity as it might due to different sizes of particles between the materials. As a result, the average soil resistivity for the NEM Kenaf and straw rice paddy ash is around 165 Ω -m. For Kenaf and palm oil residue ashes, it slightly reduce very low of grounding resistivity as it shown it the graph. The average measurement for this mix material is 182 Ω -m. This material only can make a little reduce to the soil resistivity because of it characteristic of material.

From day 1, starting measurement for soil (reference), Kenaf with Palm Oild residue ash and Kenaf with straw rice ash is 178 Ω -m , 176 Ω -m and 156 Ω -m. Then both of material has shown an effect of increasing and sometime decrease the result for several day. The highest measurement take is on day 59, which it resulting 201 Ω -m, 190 Ω -m and 170 Ω -m on each material. It due to the hot climate in UniMAP which will effect to the wet soil moisture. Average temperature in early season at Perlis is around 35-36°C.

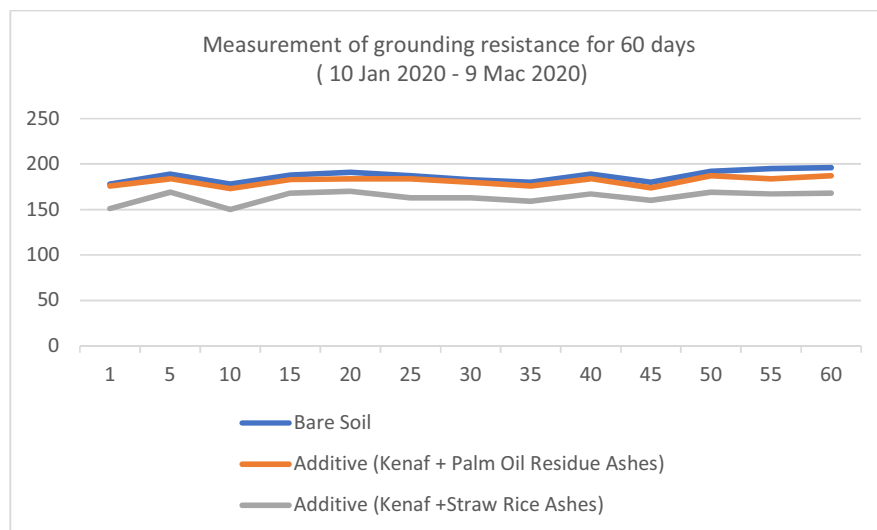


Figure 5. Result measurement of grounding resistance in 60 days.

4. Conclusions

Based on the results obtained, it shows that the presence of 25% waste tire dust in the total filler mixture with palm slag in PS 30/WTD 10 was improved the wear rate and moderated the hardness of the friction composite. Besides that, the large particle size of filler was also influence the hardness and wear behaviour of the composite.

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