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Replacing Ground Rod Joining Cable from Copper to Galvanized Iron

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Abstract
Research on electrical grounding is well established over the past 180 years but recently due to the ever increasing price of copper, theft of copper from grounding systems has become common. The cost of a lack of integrity of electrical power systems due to the stolen copper from grounding systems can be massive. Therefore it is the objective of this research is to study if the 35mm^2 copper ground rod joining cable can be replaced with galvanized iron. Galvanized iron was chosen as a replacement because of its extensive used in civil engineering works which has resulted in its cheap price and easy availability. It also has sufficient electrical conductivity. The methodology of this work is to measure the ground resistance with a ground resistance meter; with copper and galvanized iron as the joining cable, over a period of eight months. The findings are that though the ground resistance using galvanized iron is higher, it is still cost effective to use more ground rods with galvanized iron joins rather than fewer ground rods with copper joints. Another unexpected finding is that beyond a certain number of joined ground rods, the reduction in ground resistance is not significant. A future work is to solve the remaining weak point in grounding systems which is the join between the joining cable and the ground rod.

Keywords: ground rod joining cable, ground electrode, Copper, galvanized iron (GI)

INTRODUCTION

Theft of grounding system copper is common in developing countries as well as developed countries [1,2]. And the consequence of such theft due to lack of integrity of the electrical systems is massive in terms of money and human lives. Grounding is basically the connection of metallic parts of switchgear which is not used in carrying current to the ground in electricity transmission, distribution and consumer devices. The ground rod was originally made of copper but due to the high cost of copper today, iron coated with copper has become the overwhelming standard. Other variants are aluminum, stainless steel coated with copper, mild steel, galvanized iron pipes in order of preference. Other than ground rods, options devised so far are copper plate or a fence like structure of copper [3]. Copper is preferred because of its higher conductivity and lower permeability. The lower permeability means it is less magnetic so it will not build up magnetic fields around it which disrupts the flow of current to the ground [4]. Copper is also one of the least corrosive metals. This is an important criterion because ground rods are planted in the corrosive environment of the ground.

The Local Electricity Authority (LEA) has set a rule in the Sarawak, Malaysia that for the entire grid, ground rods shall be joined to each other and to switchgear with 35mm^2 bare copper cables [5]. The 35mm^2 bare Cu cable is expensive and therefore very prone to theft. And when theft of this copper occurs, the integrity loss of the electrical system is a much bigger concern than the financial loss of the theft because operators cannot predict the missing ground connection since the ground rods and bare copper cable are normally buried under 300mm of soil. The second largest electric installation company in Sarawak (after the LEA), has requested Universiti Malaysia Sarawak (UNIMAS) to do a research in the feasibility of replacing the 35mm^2 bare copper joining cable to another cheaper materials.

The integrity of electrical systems of the grid assumes and depends on the fact that the grounding system is in place. The grounding serves to leak down surges of electricity as from a short circuit in the grid and lightning strikes. It is only a good grounding system that can safeguard humans and machines from a terribly damaging (up to three million volt per meter) lightning strike [6]. No human made device can survive such a lightning strike. If humans can handle the electric power of lightning, all of humanity's energy problems will vanish because of the huge power latent even in even one lightning strike [7]. And the best place to study this energy harnessing will be at the Twin Tower (TT), Kuala Lumpur (KL) because KL is the city with the highest rate of lightning strikes and Twin Tower is one of the highest points in the city. But such a study cannot be done so far because human made devices simply cannot handle the power of lightning strikes.

Another example of the danger of stolen grounding system is when humans are working on high voltage (HV) switchgears. These humans depend on the built-in grounding system leaking all the capacitive and inductive electricity stored, so they can service the switchgears. They will normally confidently work after switching the built-in ground switches located all over the HV substation as per Standard Operating Procedure (SOP). They then use a voltage detector to confirm the power is off before embarking on their work. It is still not in the SOP to consider that someone has stolen the ground rod joining cables. The consequence of this fact is that electrical workers can be killed while performing their job even if the switchgears are switch off because of the stored capacitance and inductance.

As an indication of how widespread the ground rod joining cable theft is, during a grounding training conducted by the chief engineer who built the grounding system of the TT, KL, a site visit was organized to a 132kV Sama Jaya substation in Kuching, Malaysia which is one of the largest substations around Kuching. The trainer was asking the LEA manager