ASSESSMENT OF EARTHING RESISTANCE FOR EFFECTIVE GROUNDING

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Abstract

Electricity is an ever important discovery for mankind with major role to play in every sphere of our lives but with cases of mishaps such as fire outbreak, burns, and electrical shock and lack of its preventions, it becomes pertinent to assess the earthing resistance of locations where structures are situated. The soil resistivity of six different locations within Ilaro, a town in Yewa South LGA of Ogun State situated on Latitude: 6° 53' 20.44" N Longitude: 3° 00' 50.98" E was determined using fall of potential method by passing *an alternating current (I) through an outer electrode C placed 18m from the electrode under test and then measuring the voltage through an inner electrode P at chainage of 1.5m and continued till P was within 3m of the current probe. The results showed that the average resistances for the locations under consideration ranges between 3.51 – 77.08 ohms, However, the National Fire Protection Association (NFPA) and Institute of Electrical and Electronics Engineers (IEEE) have recommended a ground resistance value of 5.0 ohms or less which means out of the six considered locations, only two can be said to fall within this stipulation. Based on this, Ilaro town soil can be said to have high resistance and not suited for grounding without increasing the soil's conductivity*

***Keywords**: Conductivity, Earthing, Electrical shock, Ground, Resistance.*

Introduction

Safety, peace, healthy and prosperous living for the people necessitated the intertwining of their environmental, economic and social needs into 17 Sustainable Development Goals (SDGs). In ensuring the achievement of goal 7, which focuses on affordable and clean energy, attention should also be paid to the safety of the occupants of the buildings constructed on soils with a high resistivity as it pertains to its lightening protection system and the earthing because soils having high resistivity is known for their low conductivity and with dearth of free ions around the earthing electrode provided for the building, this becomes harmful to its functioning.

According to Jowett (2002), the earth resistance is the resistivity of the soil to electric current passing through its interconnected particles which implies that the earthing process and system should be as such as to be of high electrical conductivity which will invariably take care of the poor conductivity of the soil.

Arshad *et al*., (2020) in their work opined that though the earth can be a strong conductor, the resistance can be quite low in situations where there is a wider area for current to flow. Similarly, the significance of a low ground resistance value gives less voltage strains over the lagging of the line and the earth is a necessary component of a well-functioning electrical system because of its abundance and accessibility. Furtherance to that, the earth possesses electrical property that is used in on a daily basis not only in utilities but also industrial plants (Megger 2010, Adelakun 2018).

The loose material known as soil covers the Earth's land surfaces and aids in plant growth (King, 2009) and based on their coloration & geographic location, soils are known to conduct electrical current and assigned a grade (Prasad & Sharma, 2012). If soil is known to conduct electrical current, then it is appropriate to know its level of resistivity to the current that may be passing through it and according to Johnson (2006), soil resistivity is the opposition between two surfaces of a homogenous 1 m^3 of soil material with its resistance often expressed in Ω-m, or Ω-cm. The overall resistance and the amount of electrode needed to attain the desired values will directly depend on the soil resistivity value. It is obvious that less electrode is needed for effective earth resistance the lower the resistivity is and so knowing the resistivity value at the planning stage is helpful since it provides a solid estimate of how much electrode is going to be needed. The works of both Jakaila *et al*., (2015) and Unal *et al*., (2020) showed that though soils may have poor electrical conductivity, majority of the soils conduct electrical current.

Establishing a shared reference potential for the power supply system is the main objective of earthing electrical systems and suitable low resistance connection to earth is needed in order to achieve this goal in building and industrial yards to mention few.

The soil's resistivity varies greatly over the world and drastically within small areas. According to Salam et al. (2015), temperature, moisture content, the quantity of electrolytes (minerals and dissolved salts), and the kind of soil (sand, clay, peat, loam, etc.) all have an impact on soil resistivity. The resistance of the grounding system is directly influenced by the soil resistivity. A soil in a grounding system is deemed unsuitable for an efficient grounding system if its resistance is more than 5 Ω. Locating ore, clay, gravel, etc. underground requires evaluating the earth's resistivity.

Methodology

Six (6) different places in the Ilaro community (*Latitude: 6° 53' 20.44" N Longitude: 3° 00' 50.98" E.*) in Yewa South LGA of Ogun State Nigeria had their soil resistivity assessed using the "fall of potential" method. The technique involves the Earth Electrode (E) to be measured and two additional electrically independent test electrodes, which are typically referred to as P (Potential) and C (Current) and are linked to the earth resistance detector metre (Figure 1). It's worth noting that, the measurement of the electrode was not electrically dependent on the test electrodes.

The principal instrument for determining the earth's resistance is a digital earth resistance meter, which comes with a kit that also contains two T-shaped auxiliary ground electrodes, two 45m lengths of red and yellow lead wire, and 9m of green lead wire. The current location or coordinate of the gadget on Earth is found using the GPS, a navigational instrument. The GPS displays these coordinates in the North and East.

The test electrode is placed 18m away from the current probe (C) and 1.5m away from where the test set is linked to the ground electrode is where the potential probe (P2) was positioned. While an alternating current (I) is passed through the outer electrode C, the voltage is measured by means of an inner electrode P, placed transitional between them. Six different readings were taken per points due to variations in resistance per points. The earth resistance is computed as:

$R_g = V/I$

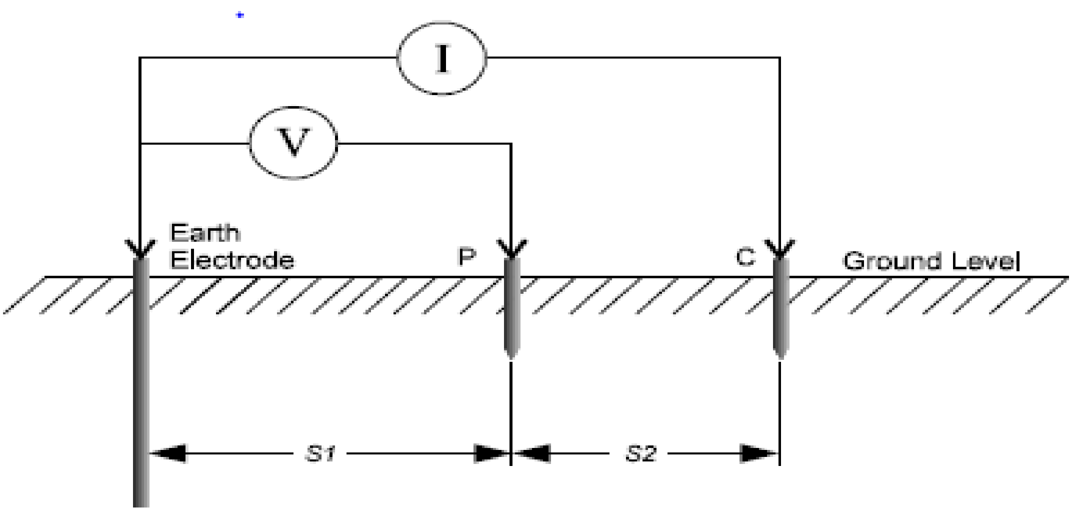

Figure 1: Connection Diagram

The potential probe (P2) was repositioned further by 1.5m away and the previous procedures were repeated until the potential probe (P2) is 3m or less from the active probe (C2).

Once all measurements have been completed, the data is plotted with the measured resistance on the vertical axis and the potential electrode's separation from the earth electrode on the horizontal axis. Each data set's curves should be flat, without any discernible peaks or troughs.

Results and discussions

C – the current probe; P – potential probe; E – Earth test probe

Figure 2 below shows at a glance the resistance per distance at each location considered. Careful study of the graph showed that the site conditions at A were what caused the graph's undulating and erratic appearance. It was seen that the resistance reading lowers when at B and then gradually increases until a point between 7.5m where the graph begins to run horizontally. Similar to how C demonstrates, the resistance reading decreases until it reaches 6m, at which point it starts to rise vertically upward. However, E demonstrates that the resistance value keeps fluctuating between high and low points, and F demonstrates the opposite, with a rapid increase in resistance at 6m before it quickly decreases at 10.5m swiftly.

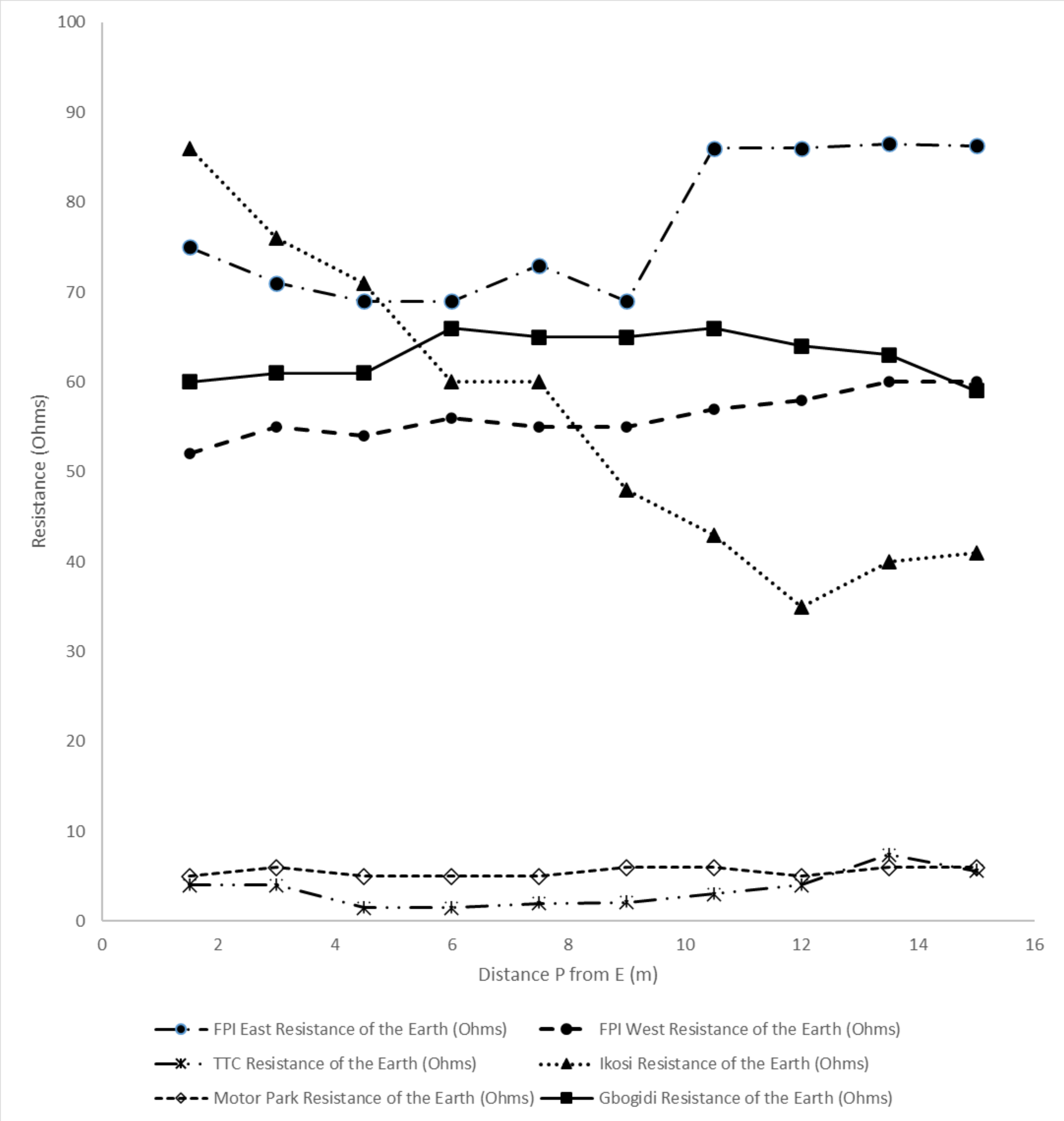

Figure 2: Graph of resistance in ohms-metre

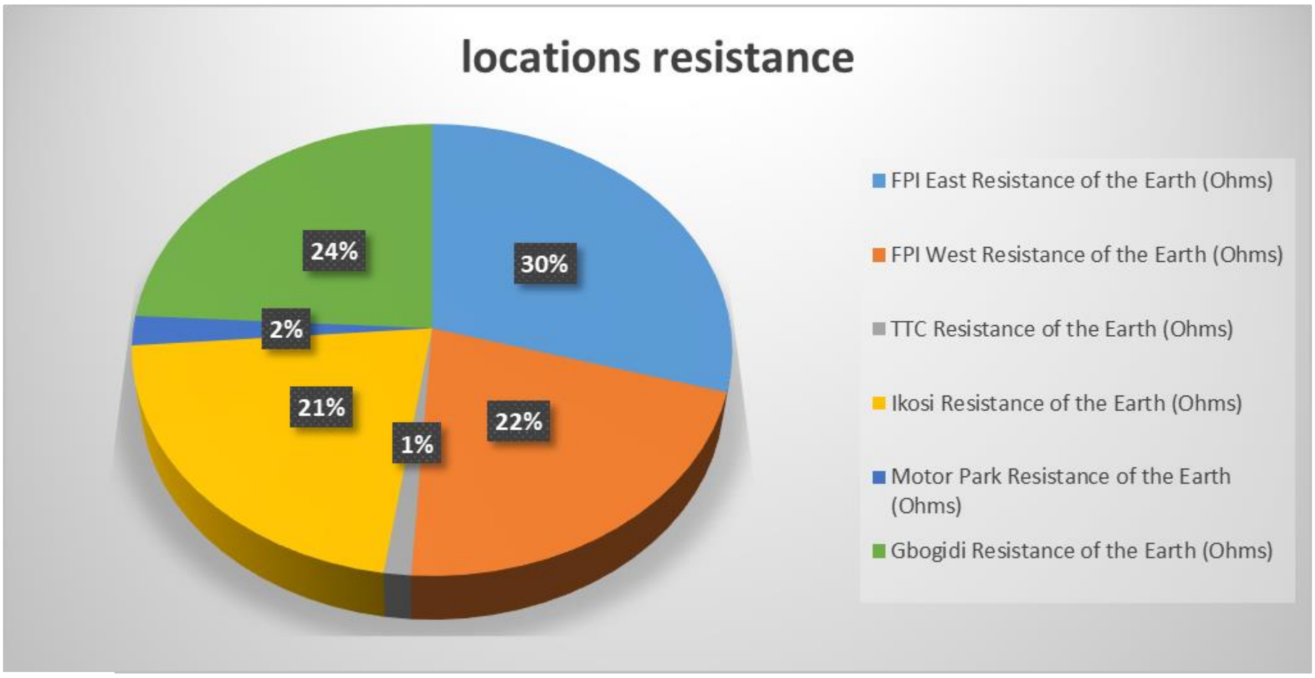

Figure 3: locations resistance for the six locations

According to the pie chart in Figure 3, the resistance at Ilaro Garage (along Papa road) and Teachers Training College is minimal, therefore adding soil additives to the area before connecting it to an electrical installation won't be necessary in most cases. This complies with the optimal 3 - 5ohm standard. Other locations with high resistance readings, such as Gbogidi Quarters, Ikosi CDA, F.P.I west campus, and F.P.I east campus, demonstrated the need to increase soil resistance by employing soil additives to bring the resistance down to the desired level.

Conclusions

The research's findings can be applied to gain a general understanding of the resistance of a portion of the Ilaro community. However, these findings are subject to change in light of a number of variables, including the soil's moisture content at the time of testing, the depth of the test electrode, its diameter, and its mineral content at the time of testing, to name a few. The results of readings taken at each of the six places show that the resistance of the land and town of Ilaro is higher than the typical 3-5 ohms needed for good grounding.

The research's findings lead us to the conclusion that Ilaro town's soil has a high resistance and is not suited for successful grounding without increasing the soil's conductivity.

It is crucial to note that the earth resistance measurement technique utilized in this study uses electrodes that are inserted very little, typically 4 feet, to estimate the deeper layers. It is possible to make improvements to areas with high resistivity to enable lower resistance to the flow of earth current, which in turn makes the ground suitable for the earthing system.

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