

Improving the Engineering Block Earthing System at Madonna University, Akpugo Campus in Enugu State, South Eastern Nigeria

¹Ezeakacha M.C., ²Tanko N.A., ³Igwe F.E., ⁴Ndukaba T. E., ⁵Isioufia D.I., ⁶Ezema E.E.

^{1,2,3,4,5,6}Department of Electrical/Electronic Engineering, Madonna University, Nigeria

Authors E-mails: ¹munachimsomicheal@gmail.com, ²tankonarai99@gmail.com, ³Faihemmanueligwe@gmail.com,
⁴Engrdctochi@gmail.com, ⁵davidikenna369@gmail.com, ⁶edwinezema@yahoo.com

Abstract - The maximum allowable earth resistance for a building varies depending on the application and regulations, but generally, a value below 10Ω is considered acceptable for most residential and commercial buildings. An earthing system stands to provide a lower resistance path to the earth mass for fault current or surge current emanating from lightning strike to be passed on to mass of earth thereby providing safety measures. This research paper reports on how earth resistance improvement was carried out at Engineering block of Madonna University, Akpugo Campus. The existing earthing system there prior to the improvement was 23.5Ω which is very high. To improve on this, the rod system of electrical earthing system was used to improve on it. After the completion and commissioning of the installation, the earth resistance continued to fluctuate as seen from the resistance - days plot but stabilized to 3.5Ω at last showing an improvement of 85.47%.

Keywords: Earthing, Systems, Earth Resistance, Safety, Lightning, Current Surge, Earthing System, Grounding Resistance, Electrical Safety, Earth Electrode, Fault Current Protection, Rod Earthing System, Lightning Protection.

I. INTRODUCTION

Proper earthing is needed to prevent unwanted current from passing through personnel, critical equipment and other nearby metallic objects. Soil resistivity directly affects the design of an earthing system. When designing an extensive earthing system, it is usual to locate the area of lowest soil resistivity in order to achieve the economical earthing installation. There are 5 types of earthing systems being used and they are; plate earthing, pipe earthing, rod earthing, wire earthing and waterman method. We made use of the rod earthing which involves the use of earth rods, earth mat, earth clamps, earth wire, bimetal line taps, charcoal, animal waste and water. Earthing is an important aspect of electrical system because it keeps people safe by preventing electric shocks, dissipating of short circuit current into the earth without

drying out the area, limits the potential gradient throughout the building to maintain the step and touch voltages within safe values, preventing damage to electrical appliances and devices by preventing excessive current from running through the circuit. It also prevents the risk of fire that could otherwise be caused by over current.

From a technical perspective, earthing has some excellent advantages, resulting in it becoming a mainstream practice in the electrical industry. The potential of the earth is zero volts and is known as the neutral of the electricity supply. This helps in keeping the balance. Earthing is a critical component of electrical installations, designed to protect personnel, equipment, and infrastructure from electrical faults by providing a low-resistance path for fault currents to dissipate safely into the ground. However, the efficiency of an earthing system is influenced by factors such as soil resistivity, electrode material degradation, seasonal variations, method of earthing and improper techniques. Over time, these factors contribute to earth resistance degradation, reducing the effectiveness of earthing systems and increasing the risk of electrical hazards.

This work focuses on constructing earthing improvement strategies to enhance electrical system reliability and safety.

II. MATERIALS AND METHOD

Key areas of improvement included the selection of effective earthing electrode materials, soil treatment techniques, electrode configurations, and maintenance strategies that can extend the lifespan and efficiency of the earthing system. The work explored advanced approaches such as deep-driven electrodes, chemical soil enhancement, and the use of composite earthing materials to mitigate resistance degradation. By implementing these solutions, the improvement aims to provide a safer electrical installation, reducing the likelihood of earthing failures and ensuring compliance with best practices.

The existing earth point was found to be located at the back of the Engineering building. The rectangular site for the earthing was taken at a distance of 8.9m from the building wall. After taking the earth reading of the existing earthing framework with kyoritsu earth resistance meter, the reading was recorded. Two straight lines of 7.2m intercepting each other at right angles in the middle were marked out. These lines were later subdivided into four equal distances of 1.8m giving each line five points thereby making a total of ten spots. These ten spots were all pegged. Two of the points coincided at the Centre of each line. Thus, in all we had nine points. A mark linking the holes were marked after which the excavation started. At each of the nine spots that were pegged, a hole of 1m was dug. Also, a link of 50cm was dug linking the nine holes. The procured nine 50cm copper earth rod were driven into each respective hole. A 70mm copper earth wire was now used in linking all the driven earth rods, each being held in place by copper clamp. The system formed a web of cross link copper array. With an AVO meter the continuity was confirmed. One end of the copper wire nearer to the existing earth point was bound to the existing copper wire with a bulldog clip. The two copper wires were bonded

together at the centre where they crossed and clamped to the centre earth rod. Animal waste from poultry and pig farm were poured on top of the copper wire filled with water. The holes were backfilled and rammed the following day after the water finished percolating and dried up.

III. RESULTS

On completion of the terminations, measurements were taken to assess its effectiveness. The new resistance value dropped to 10.5 Ω after 3 days under dry weather conditions, indicating an immediate improvement in the earthing system. The tests were conducted over a period of three days to ensure consistency in the readings. Subsequently, readings were taken for the next 27 days. These readings are plotted in the resistance – days graph shown in figure 1 below.

On the 30th of October, 2021, the final reading was taken which gave 3.5Ω. It is pertinent to note that there was intermittent rainfall from day 21 up until day 30. Within this time there was stability in the readings. Thus, the last reading gave an improved percentage resistance of 85.47%.

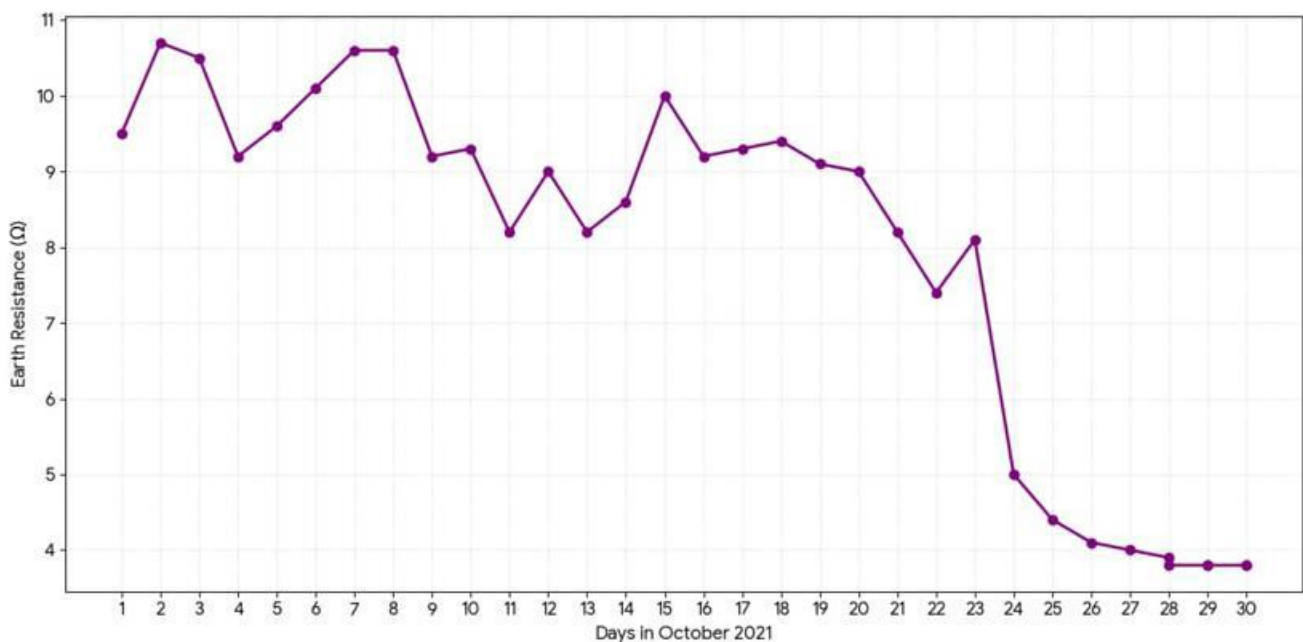


Figure 1: Earth resistance – days graph

IV. CONCLUSION

This study presented the design and implementation of an improved earthing system for the Engineering building block at Madonna University, Akpugo campus, aimed at enhancing electrical safety and system reliability. An assessment of the existing earthing arrangement revealed high earth resistance and inadequate fault current dissipation. The proposed

solution employed multiple copper-clad earth rods, interconnected with 70mm copper wire, and installed at optimized depths and spacing based on soil conditions. Design targets followed IEEE Std 80 and IEC 60364 recommendations, with an earth resistance requirement of less than 10Ω for institutional installations. Measurements conducted after installation showed a substantial reduction in earth resistance, achieving values within acceptable safety

limits. The improved earthing system provides an effective low-impedance path for fault and lightning currents, reducing touch and step potentials within the facility, and demonstrating the importance of standards-compliant earthing design for personnel safety, equipment protection, and long-term electrical system reliability performance. An improved percentage resistance of 85.47% with an earth resistance of 3.5Ω was gotten after the improvement. The work also shows the effectiveness of the rod system of earthing.

REFERENCES

- [1] Ashley, Kenneth L. (1984). Axis electrical component: Importance of earth mat in substation. www.greenmatch.co.uk retrieved 1984-06-20.
- [2] Anila Devi Y. V. Jaya Prakash (1999) Axis electrical component: earth clamps” retrieved 1999- 06-20.
- [3] Bakshi, U. A.; Godse, A. P. (2020). Axis electrical component: What are earth rods? *Electrical Circuits Design Technical Publication*. p 812.ISBN 978-81-8431-284-3.
- [4] Duffie, John A. and Beckman, Williams A. (2009) Axis electrical component: earth rods - function and advantages, *John & wiley and sons, NY* Vol. 12:234-240.
- [5] Edvard Csanyi (2017). Electrical engineering portal.” The Electrical Engineering Society. p. 183. ISBN 978-1566771931.
- [6] Manahar, L. (2020). Grounding resistance meter – en.m.wikipedia.org” Electrical circuits. *Technical Publications*. p 812.ISBN 968-81-8531-234-3.
- [7] Npiplani. D. January (2021). 4 types of earthing systems in India. India: my publisher www.intertech.com.co
- [8] Ofem, S. et al. (2021). world of electrical engineering on April 28,2021 – why salt and charcoal are added in earthing pit.
- [9] Patrick R. Jefferson (2020). “Electrical.” Electrical circuits. *Technical Publications*”. p.812.ISBN 968-81-8531-234-3.
- [10] Richu K. & Sansen, W. (2021). What is substation earthing with calculations. *Technical Publications*. p .812.ISBN 978-81-8431-284-3.
- [11] Saul. N. Jingnesh (2019). Methods of earth resistance testing (part-2)– electricalnotes.wordpress.com
- [12] Theraja, B. L., & Theraja, A. K. (2008). Test-book of Electrical Technology- Ground (electricity)”.
- [13] Vincent H. Jiguparmar (2011). Energy and Power: Earthing in the electrical network – purpose, methods and measurement. electrical-engineering-portal.com. *Lighting Research and technology* 2010; in press.
- [14] Venus Martin, K. (1986). Bi-metal line taps – split bolt connector. Lecture notes – ECEN4517 –Department of Electrical Engineering – *University of Colorado, Boulder*.

Citation of this Article:

Ezeakacha M.C., Tanko N.A., Igwe F.E., Ndukaba T. E., Isioufia D.I., & Ezema E.E.. (2026). Improving the Engineering Block Earthing System at Madonna University, Akpugo Campus in Enugu State, South Eastern Nigeria. *International Research Journal of Innovations in Engineering and Technology - IRJIET*, 10(6), 161-163. Article DOI <https://doi.org/10.47001/IRJIET/2026.106018>
