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POOR EARTHING SYSTEM: A CASE STUDY OF AFIKPO AND ITS ENVIRON

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ABSTRACT

This paper presents the poor earthing situation in Afikpo with a view to ensuring a safe use of electric energy. In Afikpo town, there is total absence of a standard guiding the earthing procedure in buildings and other electrical installations. This paper therefore aims at providing information on the earthing system within Afikpo and its environs, to serve as a guide or a local standard. Survey was carried out in different areas of Afikpo town by way of experimental investigation using earth resistance tester to ascertain the various earth resistance properties of the areas. However the result from this research work revealed that less attention has been paid to preliminary test of the soil before earthing in most of the domestic installations thus resulting in various fault conditions in the installations. This research work provides required data on the resistance properties of various towns in Afikpoarea (Akanu Ibiam Federal Polytechnic Unwana, Unwana town, Enohia Itim town, Ozizza town, Ehugbo town, Ndibe town and Amasiri town) a metropolitan town in Ebonyi State, Nigeria. Responses from 151 questionnaires used to analyse this research work, show that there is very low awareness on the issue of earthing in Afikpo area. In view of this, a local earthing template was therefore developed from the study, to guide the practitioners in the area on appropriate earthing procedures. It is also believed to have enough information that will help in reducing the rampant cases of poor earthing practices with its attendant hazards. The paper finally recommends that landlords and tenants should be conscious of earthing in their buildings while government and professional bodies should ensure strict compliance with relevant earthing ethics in buildings.

Key Words: Afikpo Environs, Earth Resistance, Earth Electrode, Poor Earthing System.

INTRODUCTION

The environment under study is Afikpo area which comprises Akanu Ibiam Federal Polytechnic Unwana, Ehugbo town, Unwana town, Enohia Itim town, Ozizza town, Ndibe town, Amasiri town, etc. This research work takes a look at the necessary conditions that should be met before connecting the non-conducting part ofan electrical installation or facility to the general mass of the earth. The opinions of residents of these towns were also sought through questionnaires on earthing practice and inferences were drawn.

Earthing is achieved by creating a low resistance path for the flow of fault current using earth electrode as a first link. This reduces the degree of opposition to the flow of fault current. The assembly ofearth electrode and earth continuity conductor in a particular soil portion around an electrical installation in order to provide a low resistance path for fault current describes an earthing system (Rajput, 2011). The simplest and somewhat misleading idea of a good ground for an electrical system is a section of iron pipe driven into the earth with a wire conductor connected from the pipe to the electrical circuit. However, this may, or may not be a suitable low resistance path for electric current to protect personnel and equipment. The reason is that earth resistivity has an important bearing on electrode resistance as does the depth, size and shape of the electrode. In a simple way, electrodes are conducting elements used in conveying current to and from the medium under study, which is the earth in this case (Uppal and Garg, 2009).

Related Theories

Many important works have been done on earth resistance testing. According to Robert andWilliam (1987),a reliable equipment grounding system that connects all the metallic frames of electrical equipment together must be kept at a safe reference potential. They also stated that the most reliable and accurate method for determining the earth electrode resistance was identified as the "fall-of-potential" method, stressing that the resistance of a ground bed cannot be accurately measured unless it is isolated from other parallel ground paths. The current generated by a test instrument will be split among all the paths. As such, the meter reading on a test instrument will not represent the ground bed resistance accurately.

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Megger (2010), a registered trademark in the manufacturing of test instruments in her Getting Down to Earth, A Practical Guide to Earth Resistance Testing, made it clear that the resistivity of the earth depends much on the type of the soil; moisture content; availability of dissolved salts; variation in climatic conditions and the resultant effects on the temperature of the soil.

Owing to this fact,any reliable earth resistance test must consider the influence of these variables on the resistivity of the soil specimen under test.

Another important parameter in an effective and efficient earthing system is the earth electrode. The earth electrode is the means of making contact with the general mass of the earth. The Electrician Guide to the 16th Edition IEE Regulations opines that major considerations should be made to ensure that the electrode resistance is not so high that the voltage from the earthed metalwork to the earth exceeds 50V (IEE, 2001). In cases where Residual Current Devices are used, the product of the operating current of the Residual Current Devices in amperes and the electrode resistance in ohms should not exceed 50V for normal dry locations or25V for construction sites and agricultural premises. Based on the above fact, due consideration should be given to earth electrode resistance to ensure conformity to the above standard. Efforts should be made to ensure that earth resistance does not exceed 200 Ohms, for a proper earthing to be achieved in a domestic installation (Rao, 2009a).El-Tous and Alkhawaldeh (2014) posited that using chemical elements around the electrode of earthing systems reduces the earth resistance and as such improves the efficiency of the system.They however noted that the use of these elements cannot guarantee very high reduction in earth resistance accompanied by their expensive nature and unavailability at all times, hence their stand for the use of Dead Sea Water instead of the chemical elements to further reduce the earth resistance at minimum cost.

The measurement of resistance for an earth electrode is very important and as such, should be done when the electrode is first installed and then at periodic intervals thereafter. This is meant to ensure that the resistance-to-ground does not increase over time (Rao, 2009b). Again, Rao (2009b) further advocated the use of ground resistance monitoring system which acts as an automated timed/continuousresistance to ground measurement, explaining that this dedicated system uses the induced frequency test method to continuously monitor the performance of critical grounding systems.Some models may also provide automated data reporting without interrupting the electrical services.

The domestic installations in Afikpoarea are faced with earthing challenges because the rural dwellers do not have access to the requisite testing before earthing. This is basically due to lack of the needed expertise on the part of the local artisans and the cost and availability of earth resistance measuring equipment. This study is geared towards giving builders and house owners an idea of how to get their buildings earthed in Afikpoarea; thereby answering the technical complaints that have always emanated from the artisans.

Theoretical results from researches reveal that some factors need to be considered for the purpose of long term efficient performance of earthing systems. These factors include:

1. Changes in the Size of Electrical Facility: A plant or other electrical facility can expand in size. Also, new plants continue to be built larger. Such changes create different needs in the earth electrode. This implies that what was formerly a suitably low earth resistance can become an obsolete standard.

2. Increase in the Use of Digital Technology:As facilities add more modern sensitive computer-controlled equipment, the problem of electrical noise is magnified. Noise that would not affect cruder, older equipment can cause daily problems with new equipment.

3. High Presence of Non-metallic Materials in the Earth: As more non-metallic pipes and conduits are installed underground, such installations become less dependable as effective, low-resistance ground connections.

METHODOLOGY

This study involved serious field work. The towns in question were physically visited and the earth resistance measurement was actually taken. In each town, two different spots were tested. One spot was usually the top of a hilly place and it is referred to, in this paper as 'High Spot'. The other is the base of a valley which is here referred to as 'Low Spot'. The essence of this was to see if the altitude of the soil has any effect on the resistance of the earth of a particular place. Therefore two readings were obtained from each town. Again, at each spot, four readings were taken to ensure repeatability. At the end, the average of the four readings was taken.

It is worthy of mention, that the instrument used was Megger Earth Resistance Tester. It is an analogue measuring instrument with three different values of multipliers to make readings easier.

The earth electrode used was a 4-feet copper electrode. This means that the measurements were done from a depth of 4 feet. This was considered more reliable than using the 2-feet electrode.
Figure 1 below is a schematic diagram of the actual connections made at the spots where the resistances were taken.
On the other hand, 200 hundred questionnaires were distributed to dwellers in Afikpo area and 151 completed ones were recovered from the respondents. The questionnaire of this study is in appendix A. These questionnaires were to ascertain among other things, how aware the dwellers of Afikpo town are, in issues relating to earthing. The details of the result of the study are shown in appendix B.

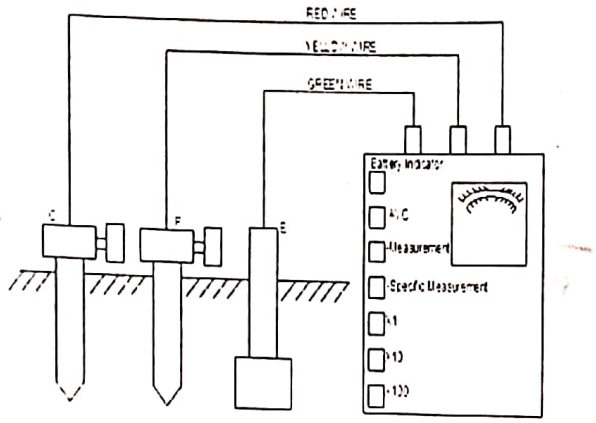

Figure 1: Schematic diagram of the earth resistance measurement

From figure 1, E is earth electrode; P is a steel pin while C is another steel pin. By specification, E, P and C are required to be separated from each other by between 5 metres to 10 metres. Measurement is taken by selecting a multiplier and pressing the 'Measurement' button.

Procedure

The procedure observed in carrying out the study at each study spot was as follows:

- The C electrode was driven into the earth and connected to the instrument.
- The P electrode was driven into the earth and connected to the instrument.
- The E electrode was driven into the earth and connected to the instrument.
- Each of the electrodes was 5 to 10 metres apart of the other.
- The connection of the probes was crosschecked to ensure accuracy.
- The battery indicator key was pressed to ensure that the instrument is working properly.
- The appropriate multiplier was selected for each soil composition.
- The measurement button was pressed to obtain a reading and it was taken four times while the average was recorded as shown in table 1.
- In the course of the experiments, questionnaires were also shared to dwellers of each locality for responses on issues relating to earthing.
- After some days, the questionnaires were collected back from the respondents.

RESULTS

Table 1: Towns and their earth resistance readings

S/N	Locations	Readings(Ω)	
		High Spot	Low Spot
1	Federal PolytechnicUnwana	560	350
2	Unwana town	1010	350
3	Amasiri town	577	522
4	Ozizza town	363	920
5	Ehugbo town	960	560
6	Ndibe town	1100	1
7	Enohialtim town	1005	200

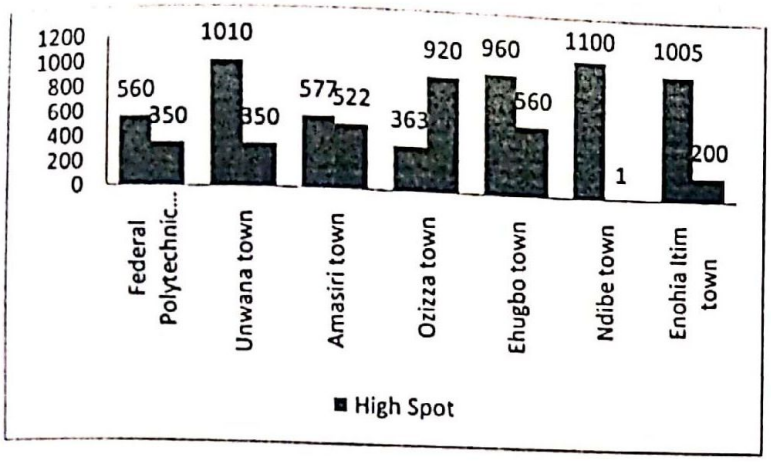

Figure 2: Bar chart of earth resistance values in Afikpoarea

Appendix B, shows details of the results gotten from the responses of the respondents to the questionnaires.

DISCUSSION

It should be recalled that (Rao, 2009a) advised that efforts should be made to ensure that earth resistance does not exceed 200Ω, for a proper earthing to be achieved in a domestic installation. However, looking at table 1 above, five out of the seven towns that were studied, recorded earth resistances of over 200Ω at both their high and low spots. These towns include Ehugbo town, Ozizza town, Amasiri town, Unwana town and Federal Polytechnic Unwana. Ndibe town recorded the highest resistance at the high spot (1100Ω) and the lowest resistance at the low spot (1Ω). It is worthy to state here, that the valley area that was tested at Ndibe town, had a water logging nature and a bed rock in the soil that could not allow the earth electrode to go up to half of its length into the soil. This is suspected to be the reason behind the very low reading of only 1Ω.

The low spot of Enohia Itim town was the only area that recorded the maximum acceptable 200Ω.Ozizza town rather sprang a surprise by giving a higher resistance reading at the low spot. It is 920Ω for the low spot and 363Ω for the high spot. To explain the likely cause of this scenario, recall what Meggar (2010) posited in her Getting Down to Earth, A Practical Guide to Earth Resistance Testing – that the resistivity of the earth depends much on the type of the soil; moisture content; availability of dissolved salts; variation in climatic conditions and the resultant effects on the temperature of the soil.

It is very possible that one or more of the above factors must have contributed to that result.

With reference to appendix B, 200 questionnaires were administered while 151 of them were recovered from the respondents. Out of the 151 respondents, 36 were landlords, representing 23.84%; 106 were tenants, representing 70.20% and 9 were electrical technicians or artisans, representing 5.96%.

Over 75% of the total respondents did not have even a fair knowledge of earthing; over 68% did not know if their buildings were earthed; over 82% experienced electric shock due to poor earthing system; more than 78% never knew if there was a regular check on the earthing system of their buildings; all the artisans stated that only between 1 and 20% of landlords they had worked for, had a fair knowledge of earthing and that there was no laid down chat on earthing practice in Afikpo.

As a result, this paper strongly advises that the table of earth resistances of the towns under study (as shown in table 1 above) should be used as a template for earthing system in Afikpo area. The target should be to reduce the earth resistance to 200Ω or less for the electrical installation of any building in question in the area.

CONCLUSION

By the foregoing observations therefore, the safe professional advice that can be given to members of these towns is that they need to treat their soil very well during earthing. This is more serious for those whose buildings are located at high spots. The aim of this treatment is to reduce the resistance of the earth at that spot to less than or equal to 200Ω. El-Tous and Alkhawaldeh (2014) suggested the use of chemical compounds (e.g. aqueous methacrylamide, sodium acrylate, etc.) around the electrode of earthing systems. However, they noted that the use of these elements cannot guarantee very high reduction in earth resistance

in addition to their expensive nature and unavailability at all times. They later suggested the use of Dead Sea Water instead of the chemical elements to further reduce the earth resistance at minimum cost.Others suggested the use of salt.For instance, Okyere and Eduful (2006) suggested the use of two or more earth electrode buried at different locations and connected in parallel; addition of salts such as magnesium sulphate, sodium chloride, copper sulphate, etc. and use of soil of lower resistivity as an earth electrode backfill.Moreover, the advice is that whatever method that is employed, there should be a regular check on the resistivity of the area in use to ensure that it is treated when necessary to avoid an undesirable increase in the earth resistance.

RECOMMENDATIONS

i. Appropriate regulatory body such as COREN should periodically organize an enlightenment campaign for artisans, craftsmen and technicians to ensure due compliance with normal earthing standards;
ii. There should be periodic testing of already existing electrical installations to ensure that variation in the resistivity of the earth does not adversely affect the effectiveness of the earthing system.
iii. Certifying bodies should put-up a frame work that will ensure that intending artisans, technicians, etc. are made to be owners of relevant earth testing kits before certification.
iv. Regulatory body such as COREN is encouraged to ensure pretesting of completed domestic installation before they are put to use.

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Appendices

Appendix A

QUESTIONNAIRE TO FIND OUT THE POOR EARTHING SITUATION IN AFIKPO AREA

Dear Respondent,

We are trying to carry out a practical investigation on the topic, **'The Poor Earthing System: A Case Study of Afikpo and Its Environs'**. The investigation is a purely professional academic research work. We want to seek your opinion through this questionnaire, to know if the thought that drove us to the above topic is right. Your response can help in redirecting us and the local dwellers on the recent acceptable earthing technique for Afikpo area.

Finally, accept our assurance that any personal information you give here shall be treated as confidential.

Thank you.

Etu, I. A. and K. E. Jack

What category do you belong?

[A] Landlord
[B] Tenant
[C] Electrical Technician or Artisan

1. **What is your locality in Afikpo?**
   [A] Akanulbiam Federal Polytechnic Unwana
   [B] Unwana town
   [C] Enohialtim town
   [D] Ozizza town
   [E] Ehugbo town
   [F] Ndibe town
   [H] Amasiri town
2. **How long have you resided in the locality?**
   [A] 1-5years
   [B] 6-10years
   [C] 11-15years
   [D] 16 and above
3. **Do you know what earthing means?**
   [A] Yes
   [B] No
4. **Is your building earthed?**
   [A] Yes
   [B] No
   [C] No idea
5. **Do you experience any kind of electricity shock on the walls of the buliding or the body of your appliances?**
   [A] Yes
   [B] No
6. **Is there any regular check on the earthing installations?**
   [A] Yes
   [B] No
   [C] No idea
7. **Was the earthing system treated with any other material apart from domestic salt?**
   [A] Yes
   [B] No
   [C] No idea
8. **As an Electrical Technician or Artisan, rate by percentage how many landlords you have worked for that know and appreciate proper earthing practice.**
   [A] 1-20%
   [B] 21- 40%
   [C] 41- 60%
   [D] 61% and above
9. **As an Electrical Technician or Artisan, have you come across any laid down chat on earthing practice in afikpo area?**
   [A] Yes
   [B] No

Appendix B

Number of questionnaires administered: 200

Number of questionnaires recovered: 151

Question 1 result

Number of landlords	36	23.84%
Number of tenants	106	70.20%
Number of Electrical Technicians or Artisans	9	5.96%
Total	151	100

Question 2 result

Akanulbiam Federal Polytechnic Unwana	5	3.31%
Unwana town	21	13.91%
Enohialtim town	13	8.61%
Ozizza town	17	11.26%
Ehugbo town	57	37.75%
Ndibe town	18	11.92%
Amasiri town	20	13.25%
Total	151	100

Question 3 result

1 – 5 years	32	21.19%
6 – 10 years	59	39.07%
11 – 15 years	45	29.80%
16 years and above	15	9.93%
Total	151	100

Question 4 result

Yes	37	24.50%
No	114	75.50%
Total	151	100

Question 5 result

Yes	33	21.85%
No	14	9.27%
No idea	104	68.87%
Total	151	100

Question 6 result

Yes	124	82.12%
No	27	17.88%
Total	151	100

Question 7 result

Yes	6	3.97%
No	27	17.88%
No idea	118	78.15%
Total	151	100

Question 8 result

Yes	10	6.62%
No	20	13.25%
No idea	121	80.13%
Total	151	100

Question 9 result

1 – 20%	9	100%
21 – 40%	0	0%
41 – 60%	0	0%
61% and above	0	0%
Total	9	100

Question 10 result

Yes	0	0%
No	9	100%
Total	9	100