Comparative study of tyre ash and palm kernel oil cake as backfilling agents for effective grounding

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Abstract. A simple method for analyzing electrical earthing system is presented. The idea behind this research is to furnish the general public particularly in Ghana to understand the effectiveness of using low resistive materials to provide low resistance values for their earthing frameworks to protect lives and guarantee hardware security. Right now, proficiency of materials accessible for free, to be specific, Palm Kernel Oil Cake (PKOC) and Tyre ash, as conductive inlay material for decreasing earth terminal resistance was assessed. Earth mat 20-cm length and 10cm breath were covered with each refilling material with their exhibition contrasted with reference to the earth mat additionally covered at a similar location with raw sand, specifically, sandy gravel at a specific area in Ghana. The outcomes show that tyre ash gives a steady earth resistance in both dry and wet climate conditions and improves it significantly as compared to PKOC. The main purpose of evaluating these two local materials as a backfilling agent is to reduce the earth resistivity which in this study was achieved successfully after 3 months of monitoring.

1. Introduction
Estimations of recently introduced earthing frameworks are required to affirm the plan estimation of earth resistance and the respectability of testing joints and so forth. Moreover, intermittent estimations for the duration of the life of the earthing framework are important to guarantee the framework and proceed with acceptable execution. Earthing is utilized in electrical frameworks to guarantee staff and hardware security. A better value in ground resistance is crucial to fulfill electrical security standards. The obstruction worth can differ from 10 ohms for lightning insurance to beneath 0.1ohm for some places for which defensive gadgets must work in an exceptionally brief timeframe because of enormous flaw flows included [1]. A successful establishing framework assumes a significant job in the protected activity of equipment in various household and the general prosperity of intensity frameworks. Earthing is fundamental and obligatory for protection of individuals and assists with forestalling electric stuns. It gives reference potential to legitimate utilization of intensity framework of hardware to improve the viable use of electrical energy [2]. The lightning strike is one of the cataclysmic events which happen now and then. The great sizes of flow and voltage at quick ascent periods can prompt the decimation of electrical properties and pose a genuine risk to the life of humans. If not, it can likewise harm a building...
and can burst into flames in those influenced regions. Accordingly, it is imperative to have a framework that can secure the structures and abstain from lightning stroke [3]-[4].

According to [1], the productivity of materials accessible for free, to be specific PKOC, tire ash, wood ash and powdered cocoa shell, as a supportive decorate for decreasing earth pole resistivity was assessed. A ground rod of 30cm by 40mm measurement was introduced for each refilling property and their exhibition contrasted and that of the main ground pole additionally introduced. The outcomes show that tire debris gives a steady earth rod obstruction in both harmattan and raining seasons which enhances it to about 16%. Another work by [2] established low resistance values using a blend of sawdust and charcoal and PKOC as a conductive refill material for decreasing earth electrode resistance. For each backfilling material, a ground rod of 120mm by 10mm was installed. An examination opening of 2ft and 4ft profound was burrowed for both soil varieties, sandy-gravel and loamy soils at the diverse destinations. The trials and study demonstrated obviously that, the PKOC and the blend of sawdust and charcoal provide an improved viable reduction in soil resistivity. The more profound of the earth electrode the lower the earth's resistivity.

In [5], this paper has introduced an intelligent way to deal with the structure of a necessary electrical establishing (earthing) framework. Key establishing standards have been clarified and different relevant establishing conditions have been accommodated to the reader to structure their establishing framework in a legitimate and precise way. Reference [6] proposed a framework in which adequacy of supplanting soil in the basic obstruction zone appeared by field experiments. This strategy involves the computation of earth pole opposition as an element of good ways from the pole. An explanatory recipe, inferred and approved utilizing test information to figure these protections, is likewise introduced.

Work done by [7] had proposed nearby conductive refills for decreasing ground opposition are researched. The outcomes show that the utilization of tyre ashes as refilling property brings earth resistivity down to 80% and above. It is likewise demonstrated that the best advantage in the soil resistivity enhancement is to restrain the refill to four earth rods. Finally, in [8] the paper presents and discusses the techniques in applying the palm cake and accounts on the outcome accomplished and show the sufficiency of the palm cake. Other significant characteristics considered are dampness property, pH (acidic) level, and its resistances. The Palm cake is a subordinate of palm piece nut after taking out the oil. Huge earth resistance decline is gained by techniques for displacing soil inside the 'Basic Resistance Area' of an earth rod with the palm cake.

In this paper, the backfilling materials used are Palm Kennel Oil Cake and Tyre Ash. This was done because the establishment of good and operational electrical earthing is indispensable to safeguard personnel and equipment from the dangers of the possible rise fault due to the progression of faulty current to the general mass of the earth.

2. Methodology
The motivation behind this analysis was to examine and gather information on the type of soil, the profundity of the mat and also the sort of the low backfilling material adds to the adequacy of effective grounding. The effective materials with very good resistivity accessible include, PKOC and tyre ash as a conductive inlay for the decrease of resistance over the earth terminal. The methodology adopted is grouped into the weaving and installation of earth mart, data acquisition using DET5/4R Digital Earth Resistance Tester for testing the earth resistance values weekly within the specified time frame. This basic critical resistance strategy was applied in the inlaying of earth mat which was woven as shown in Figure 1 with 35mm² copper wire. Earth mat of 20-cm length and 10-cm breath was introduced for each refilling material at a site. The span of the territory alluded to as basic resistance range has been seen as about 100% of the length of the ground mats. This basic territory opposition strategy was applied in the inlaying of the covered mats.
With the end goal of correlation, an earthing mat with tyre ash, earth mat with palm kernel oil cake and earth mat without refill, thus raw sand, as reference was likewise introduced at the site, all are introduced in various equal openings as shown in Figure 2, the length of the gap was 1.2m, breath was 0.60m and depth was 1m.

Earth resistance of each covered mat was estimated for a time of a quarter of a year utilizing the SEW 4236 ER Digital Earth Resistance Tester for testing the earth resistance values weekly within the specified time frame. With the end goal of correlation, an earth mat without a conductive inlay named reference covered mat was likewise introduced at the site. The four-point technique (Wenner method) was used in our investigation to measure the establishing resistance. Numerous kinds of upgrade material have been presented in the common soil. Subsequently, soil possessions are changed. The structural changes of the soil represent the variety in resistance esteems. The soil type used for this test is the sandy gravel. The discoveries exhibit that, the resistance of soil utilizing diverse improvement materials has contrast resistance. Henceforth, this method is appropriate in estimating the assortment of different soils and upgradable substances [9]-[10]. Figure 3 illustrates the measurement technique.
The terminal $P_1$-Es, $P_2$-S, $C_1$-E and $C_2$-H as shown in Figure 4 were used as the connection points of the testing leads. An appropriate testing type (4P) was selected. Four supporting spikes were introduced in the individual soils in an orderly fashion which was at equal interval from one another. The distance between each installed spike was three times greater than the buried earth mat. When the push button of the digital earth tester is pressed and locked, it creates a known current through the outer ground spikes and the voltage drop is measured between the two middle earth spikes. The instrument then analyzes the soil resistance automatically and displays the measured value on the screen and recorded. The test setup is as shown below;

![Figure 4. Connection Method and Testing Procedure](image)

### 3. Result and Discussion

The measured values are displayed in table 1 which shows the deliberate qualities for this period concerning their different low resistive materials (LRMs). Figure 5 depict a graphical results of the resistance values measured with respect to the raw sand and the LRM at their respective depths. The test readings of the earth mat resistance values were recorded on a weekly basis spanning a period of three months from 1st February 2019 to 2nd May 2019.

| Date       | Reference soil Resistance (Ω) | Palm kernel cake Resistance (Ω) | Tyre ash Resistance (Ω) |
|------------|-------------------------------|--------------------------------|-------------------------|
| 01/02/2019 | 168.02                        | 22.10                          | 12.08                   |
| 08/02/2019 | 163.19                        | 18.44                          | 7.08                    |
| 15/02/2019 | 159.80                        | 14.38                          | 4.33                    |
| 22/02/2019 | 156.09                        | 11.16                          | 3.95                    |
| 28/02/2019 | 158.92                        | 13.85                          | 3.68                    |
| 07/03/2019 | 158.08                        | 13.94                          | 3.70                    |
| 14/03/2019 | 159.22                        | 14.03                          | 3.69                    |
| 21/03/2019 | 154.02                        | 10.12                          | 3.70                    |
| 28/03/2019 | 155.20                        | 10.41                          | 3.61                    |
| 04/04/2019 | 157.54                        | 12.11                          | 3.66                    |
| 11/04/2019 | 158.02                        | 13.04                          | 3.65                    |
| 18/04/2019 | 153.41                        | 9.22                           | 3.41                    |
| 25/04/2019 | 153.66                        | 9.20                           | 2.99                    |
| 02/05/2019 | 152.70                        | 9.07                           | 3.77                    |
In the end, the tyre ash was seen to have given the least and steadiest resistive values in the course of the entire period of monitoring and measurements. The PKOC offered a huge decrease from 18th April through to the 2nd of May, 2019 when various heavy downpours were usual during such periods in Ghana. From the beginning of the monitoring through 14th of March, 2019 when the dry season set in, their protections turned out to be entirely flimsy, falling when there were light rains and taking off during no downpours. At some days as appeared in Figure 5 when they delivered resistances values ordinarily more prominent than that of the reference mat installed. It has been established in [1] with evidence that these materials appeared to have a high water-holding limit and are seen as successful in wet climate conditions and inadequate in exceptionally hot climate periods.

A top to bottom investigation additionally done in [11] demonstrates that soils have a pH scope of 5-7 in rainy areas where tyre ash is seen as inside this range. Right now, it is commonly not viewed as the predominant variable influencing consumption rates. The pH levels of the other inlaying material; palm kernel oil cake is close even though it is outside the pH scope. The reference earth (raw sand) provided high resistance values throughout the monitoring and measurement of the resistance values. An establishing framework with high ground resistance gives a risky way to the deficiency current, which builds the danger of hardware and equipment disappointment just as the probability of serious damage to person. Consequently, it fitting not to introduce an earth rod or mat in a crude ground for earthing purposes.

A comparable great investigation done by [1] in 2009 indicated that the tire ash supposedly had given the least and steadiest resistance values during the entire time period of monitoring against three (3) other refilling materials; PKOC, Powdered Cocoa Shell and Wood Ashes. The figures given exhibited the assortment of resistance with time. The perusing taken on a day was imparted as the degree of the resistance of the reference terminal taken around a similar time. The tire ash was found to have given the improvement in resistance values up to about 16% in the wet season with further enhancement of 8% in the dry season. This affirms our research report to be valid and substantial.

4. Conclusion
The usage of upgrade material is essential, particularly in areas with high level of soil resistance values, rough, and sand soil structure. These materials give huge effect on establishing framework improvement explicitly to bringing down the establishing resistance. Numerous investigations have been led to consider different sorts of improvement material on their properties, trademark, and conduct. Tyre ash and PKOC commonly used as low resistive materials during earthing systems particularly in Ghana can result in low resistive values both in wet and dry seasons.
It should be noted that estimation of the general earth resistance is significant and must be completed utilizing appropriate hardware and methods, in a reliable way without being unfavourably influenced by ecological variables. Results obtained from the test prove tyre ash to be an excellent backfill material for domestic earthing whiles PKOC could be an alternative material for the non-availability of the tyre ash.

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