

Maintenance Free, Eco-Friendly, Ready Capsule, Pipe-In-Cage (Pic) Type Earthing For Power Distribution System -An Effective Solution For DISCOM needs

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Abstract— The earthing of electrical installation is primarily concerned with safety; in particular, the prevention of electrical shock risk to life. As such, an earthing system must be designed, tested and maintained to satisfy this primary aim. It is irrefutable that, although good earthing is prime requirement to keep power system balanced and safe, but it is the most underrated and weakest link for the distribution utilities in India. The power distribution utilities are unable to maintain and monitor the quality standard of earthing due to many limitations. The crores of rupees have been spend by power utilities in form of the compensation to the affected lively beings. Although, the accident in private premises are not relevant to DISCOMs, but in many a cases it is related to improper and ineffective earthing and can't be neglected. This paper describes, what are the practical issues faced by the DISCOMs to maintain the earthing quality and how this issues can be resolved by innovative maintenance free, ready capsule, pipe-in-cage(PiC) type earthing design.

Keywords— EEM: Earth Conductivity Enhancement Material, PiC: Pipe in Cage, Safety, quality earthing for power utilities, issues in earthing.

I. INTRODUCTION

There are so many definitions on Earthing. Here the Earthing is defined in most simple words as- The process of transferring the immediate discharge of the electrical energy directly to the earth by providing the low resistance path. The electrical earthing is done by connecting the non-current carrying part of the equipment or neutral of supply system to the ground by providing very low ohmic value of earth resistance path.

The earth resistance value is highly dependent on following factors:

- (1) Soil Resistivity
- (2) Soil Condition
- (3) Physical Soil Composition
- (4) Location of Earth Pit
- (5) Moisture
- (6) Dissolved salts
- (7) Weather Condition
- (8) Obstructions at below the soil surface
- (9) Installation Procedure

Ideally a ground/earthing should be of zero ohms resistance. But practically it is not achievable and hence there is not one standard ground resistance threshold that is recognized by all agencies.

There are many practices followed by DISCOMs in earthing. Most of them are following conventional salt charcoal type earthing as an earth enhancement material. Some utilities have started using maintenance free or chemical type earthing system with either copper bonded roads or GI roads. As the effectiveness of earthing is highly dependent on workmanship which varies too much, the earthing is needed in almost every asset of utility such as pole, transformer, cables, switchgears, etc. The quantity of this earthings are so huge that, to monitor the each and every earthing by utility staff is a great challenge to the utilities.

II. ISSUES FACED BY UTILITIES IN EARTHING AS PER CONVENTIONAL PRACTISES

The quality, performance and life cycle of earthing is one of the major challenges in today's power system design. The good quality of earthing is much essential

to improve the power quality, safety and stability of the power system.

Apart from that, conventional salt-charcoal type earthing has many limitations like, short life span, need of recharging it at regular interval, etc. Also, the inclusion of the salt cause erosion of the coil which in turn increase the resistance of the earth pit over the period of time and reduces the life of the earthing. Many a times it happens that erosion is so high that the electrode/coil has been broken and separated apart which makes the earthing open circuited. Also, practically for the utility, it is very difficult to measure all the earthings at the regular interval of every year or so and take corrective action. This is one of the reasons of increasing cases of accidents in the field.

There are many reasons that contribute to poor installation procedures i.e.

- Contractor does not dig the required depth according to tech specification
- Layer type sand, coal and salt deposition around the electrode as per tech spec is not done
- Insufficient watering.

The actual method to do salt and charcoal type conventional earthing is shown as under.



The installation of salt-charcoal type earthing is not done properly. They just mix up and fill up the pit. Even they use lesser depth of pit and mixture.

III. PROBLEMS WITH CHEMICAL EARTHING/ MAINTENANCE FREE EARTHING SYSTEM AND EARTH ENHANCEMENT MATERIAL

Quality Earthing is the major problem for DISCOMS. DISCOMS are giving contracts for erecting of maintenance free, long life, eco-friendly earthing. Contractors generally provide the Earth Electrode and Earth Enhancement Material (EEM) separately for installation. These materials shall be tested properly as per the standards but it is not happening in DISCOMS under Govt sector. Sometimes the local contractor has to carry Earth Electrode, Earth Enhancement Material (EEM), water at remote t site. But, to save material cost, transportation cost and labor cost he carry less material

especially less EEM and do insufficient watering and dumping during refilling of earthing pit. Also due to difficulty of digging earth pit of required depth of 2 to 3 meters, they use Earthing Electrode of less length. Thus, use of poor quality and cheaper electrode and EEM, less use of EEM material and theft of labor work in absence of proper testing and supervision practice, resulting to poor quality of earthing and compromising with safety, especially in rural areas and scattered agricultural line. As in the utility there is a rare practice to inspect the earthing while erection and after erection, it is nearly impossible to check the length of electrode and other quality inspection related parameters.

Another problem is to supervise the proper use of EEM at the time of Earthing erection. Traditionally, to make earthing, a earth pit is dugged, earthing electrode is placed in that pit, EEM is fill up surrounding the electrode in the pit and watering is done to increase the conducting surface area of electrode. If the watering and filling of EEM is not done properly with sufficient quantity, cracks are developed in this fill up material which do not satisfy the objective of providing low resistance path for fault current to dissipate quickly. The earthing of electrical installations is primarily concerned with safety; in particular, the prevention of electrical shock risks to life. As such, an earthing system must be designed, tested and maintained to satisfy the primary aim of safety. These all are majorly problems related to the workmanship.

Utilities are not only facing issues related to the workmanship, but also with earth enhancement earthing of chemical earthing. In the lack of knowledge till the field staff, utility many a times publish a tender with specific proprietary name of chemical. This in turn limits the competition in the market and attract many maladies. Using the effective earth enhancement material itself is very big challenge. Generally, the earthing industries have marketed their earthing enhancement compound as the rare chemical which is invented by them and their monopoly. Infact, due to such marketing, the actual price of so called chemical earthing or maintenance free earthing vary too much in the industry. It is ranging from 1000 rupees to 1.5 lakh rupees per earthing. Due to such variations, it was needed that the composition of earth enhancement compound should be explored and finalize such that it should be cost-effective and have long life.

IV. DEVELOPMENT OF EARTH ENHANCEMENT MATERIAL

GPRD Project team has worked out to enhance the soil resistivity by preparing different combinations of material by procuring and mixing the material with bowl milling machine at IIT-Gn lab. After testing the characteristics of all possible material combination, the best material combination was derived. The same was prepared by procuring the material from the vendor and mixed in the concrete mixing machine. The earthing material of different combinations was prepared for proto

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installations and testing and also cured in the tray. The characteristics and testing results of different combinations of earth enhancement material were studied in detail and accordingly finalized superior conductive mixture made up of Conductive Cement, Graphite carbon powder, Sodium montmorillonite/ Sodium Bentonite Powder, Hydrous aluminum silicate etc. Most of the material is found out to be very cheap and is readily available in the market.

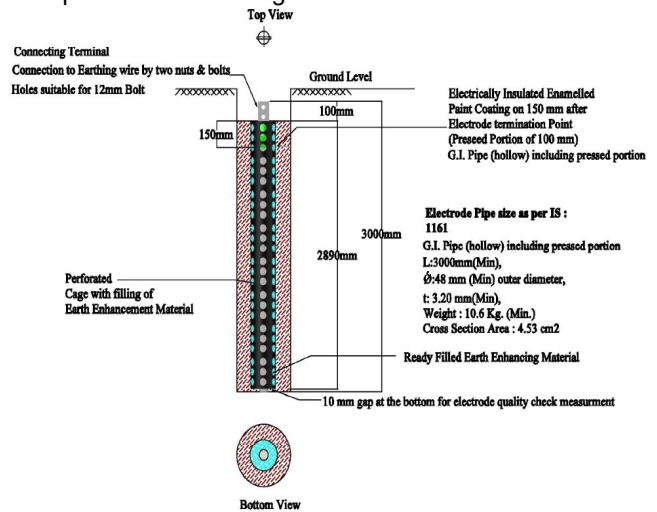
Some of the testing photographs are as below.



V. THE SOLUTION: MAINTENANCE FREE, ECO-FRIENDLY, READY CAPSULE, PIPE-IN-CAGE (PIC) TYPE EARTHING FOR DISTRIBUTION SYSTEM

An earthing system of present invention comprises a perforated hollow cage having number of holes on circumferential surface thereof and an earth electrode having an extended top portion and a bottom portion being extended through the perforated hollow cage. The earth electrode is longitudinally disposed within the perforated hollow cage to define an annular space which is filled with an earth enhancement compound (EEC). The earth enhancement compound is composed of, but not limited to, conductive cement, a graphite carbon powder, a sodium montmorillonite and kaolin. The extended top portion of the earth electrode is a continuous flatten stripe made by pressing through hydraulic press instead of welding, otherwise resistance may increase. Even after installation, the earth enhancement compound absorbs moisture from surroundings through the holes provided on the perforated cage and maintains a moisture level of the earth enhancement compounds due to its improved hygroscopic property and perforated cage design which increases the maintenance free life span of the earthing. Said earthing system is effective, convenient, less-time

consuming and cheaper in terms of installation, transportation and storage.



Maintenance Free, Ready Capsule, Pipe-in-Cage type earthing system.

VI. THE ADVANTAGES OF MAINTENANCE FREE, ECO-FRIENDLY, READY CAPSULE, PIPE-IN-CAGE (PIC) TYPE DESIGN

In this type of Earthing Electrode, the primary electrode, the surrounding earth enhancing material bonding with electrode, and the cage are in pre-fabricated single unit and ready to use form. So that on-field mal-practice in form of less digging of earth pit, less Earth enhancement filling, improper soil refilling, watering at site, can be overcome. This makes the quality check very convenient.

- In case of conventional earthing, maintenance of low ohmic values in dry seasons is not possible. It requires periodical maintenance and watering. (It needs maintenance and pouring of water at regular intervals.) While, the greatest advantage of this maintenance free earthing is that, the ohmic value remains almost constant despite seasonal changes and water conditions. Bentonite added as a chemical absorbs water and retains moisture around the earth pit. The presence of moisture maintains ionic solution around the earth electrode, thus effects in faster dissipation of fault current. No need to pour water at regular interval.
- The life of conventional earthing is comparatively very less due to corrosion of GI wire / Earthing Plate due to salt and water. Salt gets dissolved after few months and creates porosity in the land which causes reduction in the contact area and thus decreases the current dissipation area. The corrosive effect and porosity effect occurs in the conventional earthing system is eliminated in this maintenance free earthing. The PiC type maintenance free earthing systems last for 15-20 years depending on soil and surrounding conditions

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- Due to pre-fabricated, ready to use methodology, on-field wastage of Earth enhancement material can be saved.
- Installation procedure is effective, convenient, less time consuming and cheaper.
- Transportation and storing of single unit electrode, compare to separate component (i.e. electrode, Earth Enhancement compound, etc.) on field is convenient, cheaper and too easy to do.
- Quality check of material and whole design parameters according to standard is much easy.
- Here back fill compound filled between perforated cage & Main electrode, so one can easily check quality of Back fill compound in factory inspection test with soil box.

For safety concerns, Discoms are regularly giving orders for installation for Earthing. But many times due to one or other reason like lack of supervision in regular practice, theft in material and labor, no measurement of earth resistance value etc the effective earthing for long life, maintenance free quality earthing is not achieved. This reflects in more nos of accident cases. Here, PiC type earthing with specification as shown in the drawing may serve the purpose of quality earthing and safety issues for Discoms. Being a ready to use type PiC, theft of material, transportation and labor etc can be almost avoided in this maintenance free, ready capsule, Pipe-in-Cage type (PiC) type of earthing, Thus it is very effective in resolving various ongoing issues faced by utilities for providing effective earthing and yet be proved as cost-effective for long term.

VII. CONCLUSION

As per current practice followed by various utilities, Earthing in most of the Discoms are found inefficient.

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He is currently working as a Chief Engineer of GUVNL and Head of the GPRD Cell. He has over 30 years of experience in various utilities of Gujarat. Through his career he has contributed in many research and development related activities for performance improvement of DISCOMs. His area of interest is in Transformer designing, Underground system designing, GIS, Renewable Energies and energy auditing, Water and Energy conservation He was also key inventor in the development of SDT (Specially designed Transformer), PLMT (Plant Load management transformer), WDT (Watch Dog transformer) which is registered under Intellectual Property Rights.



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Shri D. R. Shah born in 1967 in Ahmedabad District of Gujarat. After passing B.E. (Electrical) with First Class-Distinction in 1988, He joined UGVCL (erstwhile GEB) in 1990. Later he passed MBA (Finance) through Sikkim Manipal University in 2006 and also completed (Advanced Certificate in Power Distribution Management (ACPDM) through IGNOU in 2007. He has wide experience of Transmission and Distribution power system and also monitoring of the different electricity schemes. He has performed best at “Area Load Dispatch Centre” (ALDC), Gandhinagar. He has very vast experience of testing of material like Transformer, Solar panel, conductor etc. Presently he is serving as a Deputy Engineer (R & D) in Gujarat Power Research and Development (GPRD) Cell (GUVNL), Gandhinagar since February, 2017 and engaged with many research program related with Research & Development of Energy Sector. His email id is dernd1@gprd.in.



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Hardik Sakariya, born in 1991 in Tapi District. After passing B.E. with distinction in 2012 with 21st rank in Gujarat Technological University in Electrical Engineering, he joined Electrical Research & Development Association [ERDA], Vadodara, Gujarat in 2012, where his work was related with Product Testing & Inspection, Condition monitoring, Fault Diagnostics, Calibration & Quality Management, Energy Audit, Quality Assurance of Testing lab as per ISO: 17025, Energy audit covering scope of HVAC. Later he joined PGVCL (erstwhile GEB) in 2015 where his work was related with Testing of various kind of Meters, CT PT unit, Daily wrapped meter inspection, GETCO Panel Meter and HT connection checking and Management of overall operation of all lab staff and maintaining lab standard, subsequently he joined Gujarat Power Research & Development Cell, GUVNL where he is keen-sighted the research works of Various Power quality and research related issues like harmonics, Voltage fluctuations issues, Voltage swag-swell Effects. He has played leading role in research project of “LoRA based Cost Effective Automatic Meter Reading on AG consumers” and Renewable Energy projects, Battery Energy Storage Systems (BESS), Improvement of safety by earthing systems.