A Review On Earthing

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ABSTRACT *The paper is carry out the review of the techniques and developments in Earthing System and suggest the different types of electrodes used in the earthing system.A good grounding system is the basic necessity to keep the safe operation of electrical operation without facing shock to the working personal.*

Keywords: *Earthing, resistance,resistivity,shock*

1.INTRODUCTION

The process of transferring the immediate discharge of the electrical energy directly to the earth by the help of the low resistance wire is known as the electrical earthing. The electrical earthing is done by connecting the non-current carrying part of the equipment or neutral of supply system to the ground.Theobjectiveoftheearthingharvestsa alternative corridorforthefaultcurrentto passthrough without dangerthepowerconsumer. Itmakes certain that all uncovered conductive elements do not get in touchwitha perilouspotential ofthe systems.The earthingsystemcultivatestokeepon thevoltageat anysegmentofapowersystemataspecifiedvalue so as to prevent over current or unwarranted voltage on the electrical device or apparatus [1], [3],[6]&[7].

Goodcharacteristic oftheelectrical earthingaptly include low permissible impedance to make sure that adequate current can pass through the protectingpieceofequipmentso thatitisolatesthe supply within 0.35 seconds for the secured safeguard purposes. Fault currentis characteristically higher than thefullloadcurrent ofthepowercircuitwhichliquefiesthefuseor trips the breakers. Consequently, the piece of equipment are isolated automatically from the powersupplymainstosafeandsoundthesystems [5],[4],[1]&[2].

2. FEATURES OF EARTHING

A good earthing systems will feature the following characteristics:

- Good electrical conductivity
- Conductors capable of withstanding high fault currents
- Long life – at least 40 years
- Low ground resistance and impedance

3. IMPORTANCE OF EARTHING

The earthing is essential because of the following reasons :

- The earthing protects the personnel from the shortcircuit current.
- The earthing provides the easiest path to the flow of shortcircuit current even after the failure of the insulation.
- The earthing protects the apparatus and personnel from the high voltage surges and lightning discharge.

Earthing can be done by electrically connecting the respective parts in the installation to some system of electrical conductors or electrodes placed near the soil or below the ground level.

The earthing mat or electrode under the ground level have flat iron riser through which all the non-current-carrying metallic parts of the equipment are connected.When the fault occurs the fault current from the equipment flows through the earthing system to the earth and thereby protect the equipment from the fault current. At the time of the fault, the earth mat conductors rise to the voltage which is equal to the resistance of the earth mat multiplied by a ground fault.The contacting assembly is called earthing. The metallic conductors connecting the parts of the installation with the earthing are called electrical connection. The earthing and the earthing connection together called the earthing system.

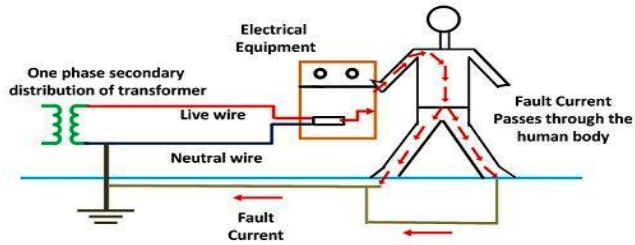

Fig 1 Electrical system without earthing

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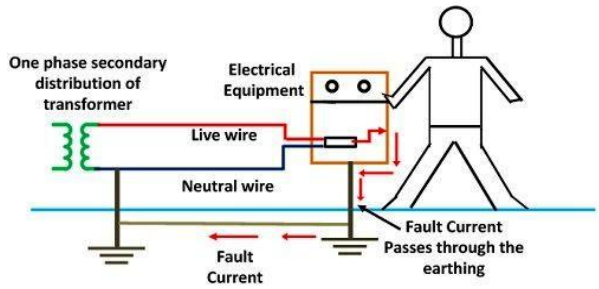

Fig 2Electrical system with earthing

4. TYPES OF ELECTRICAL EARTHING

The electrical equipment mainly consists of two non-current carrying parts. These parts are neutral of the system or frame of the electrical equipment. From the earthing of these two non-current carrying parts of the electrical system earthing can be classified into two types.(i)Neutral Earthing,(ii)Equipment Earthing.

5. NEUTRAL EARTHING

In neutral earthing, the neutral of the system is directly connected to earth by the help of the GI wire. The neutral earthing is also called the system earthing. Such type of earthing is mostly provided to the system which has star winding. For example, the neutral earthing is provided in the generator, transformer, motor etc.

6. EQUIPMENT EARTHING

Such type of earthing is provided to the electrical equipment. The non-current carrying part of the equipment like their metallic frame is connected to the earth by the help of the conducting wire. If any fault occurs in the apparatus, the short-circuit current to pass the earth by the help of wire. Thus, protect the system from damage.

7. DIFFERENCE BETWEEN EARTHING, GROUNDING AND BONDING.

Earthing and Grounding is the same terms used for earthing. Grounding is the commonly word used for earthing in the North American standards like IEEE, NEC, ANSI and UL etc while, Earthing is used in European, Common wealth countries and Britain standards like IS and IEC etc.

The word Bonding used for jointing two wires (as well as conductors, pipes or appliances together. Bonding is known as connecting the metallic parts of different machines which is not considered to be carrying electric current during normal operation of the machines to bring them at the same level of electric potential.

8. DIFFERENT TERMS USED IN ELECTRICAL EARTHING

Earth: The proper connection between electrical installation systems via conductor to the buried plate in the earth is known as Earth.

Earthed: When an electrical device, appliance or wiring system connected to the earth through earth electrode, it is known as earthed device or simple “Earthed”.

Solidly Earthed: When an electric device, appliance or electrical installation is connected to the earth electrode without a fuse circuit breaker or resistance/Impedance, It is called “solidly earthed”.

Earth Electrode: When a conductor (or conductive plate) buried in the earth for electrical earthing system. It is known to be Earth Electrode. Earth electrodes are in different shapes like, conductive plate, conductive rod, metal water pipe or any other conductor with low resistance.

Earthing Lead: The conductor wire or conductive strip connected between Earth electrode and Electrical installation system and devices in called Earthing lead.

Earth Continuity Conductor: The conductor wire, which is connected among different electrical devices and appliances like, distribution board, different plugs and appliances etc. in other words, the wire between earthing lead and electrical device or appliance is called earth continuity conductor. It may be in the shape of metal pipe (fully or partial), or cable metallic sheath or flexible wire.

Sub Main Earthing Conductor: A wire connected between switch board and distribution board i.e. that conductor is related to sub main circuits.

Earth Resistance: This is the total resistance between earth electrode and earth in Ω (Ohms). Earth resistance is the algebraic sum of the resistances of earth continuity conductor, earthing lead, earth electrode and earth.

9. POINTS TO BE EARTHED

Earthing is not done anyhow. According to IE rules and IEE (Institute of Electrical Engineers) regulations,

- Earth pin of 3-pin lighting plug sockets and 4-pin power plug should be efficiently and permanently earthed.
- All metal casing or metallic coverings containing or protecting any electric supply line or apparatus such as GI pipes and conduits enclosing VIR or PVC cables, iron clad switches, iron clad distribution fuse boards etc should be earthed (connected to earth).
- The frame of every generator, stationary motors and metallic parts of all transformers used for controlling energy should be earthed by two separate and yet distinct connections with the earth.
- In a dc 3-wire system, the middle conductors should be earthed at the generating station.
- Stay wires that are for overhead lines should be connected to earth by connecting at least one strand to the earth wires.

10.SIZE OF EARTH CONTINUITY CONDUCTOR

The cross sectional area of the **Earth Continuity Conductor** should not be less than the half of the cross sectional area of the thickest wire used in the **electrical wiring installation**.

Generally, the size of the bare copper wire used as earth continuity conductor is 3SWG. But keep in mind that, don't use less than 14SWG as earth wire. Copper strip is also can be used as earth continuity conductor instead of bare copper wire but don't go for it until manufacture recommend it.

11.METHODS OF EARTHING

Earthing can be done in many ways. The various methods employed in earthing (in house wiring or factory and other connected electrical equipment and machines) are discussed as follows:

Plate Earthing:

In plate earthing system, a plate made up of either copper with dimensions 60cm x 60cm x 3.18mm (i.e. 2ft x 2ft x 1/8 in) or galvanized iron (GI) of dimensions 60cm x 60cm x 6.35 mm (2ft x 2ft x ¼ in) is buried vertical in the earth (earth pit) which should not be less than 3m (10ft) from the ground level.

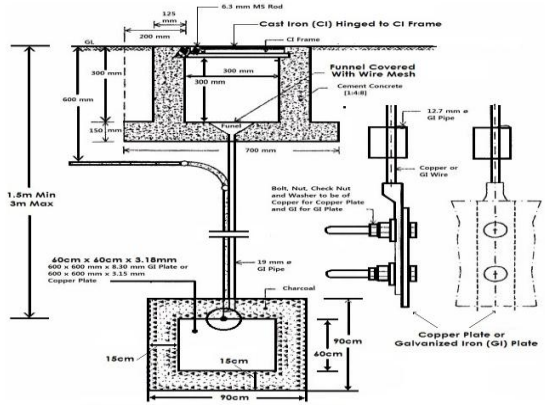

Fig3 Plate earthing

Pipe Earthing:

A galvanized steel and a perforated pipe of approved length and diameter is placed vertically in a wet soil in this kind of system of earthing. It is the most common system of earthing. The size of pipe to use depends on the magnitude of current and the type of soil. The dimension of the pipe is usually 40mm (1.5in) in diameter and 2.75m (9ft) in length for ordinary soil or greater for dry and rocky soil. The moisture of the soil will determine the length of the pipe to be buried but usually it should be 4.75m

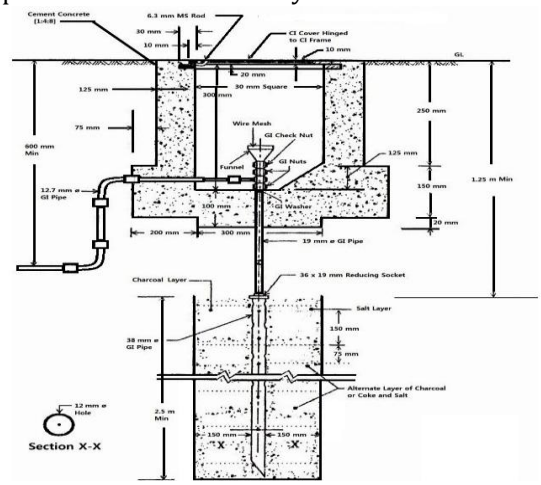

Fig 4 Pipe earthing

Rod Earthing

It is the same method as pipe earthing. A copper rod of 12.5mm (1/2 inch) diameter or 16mm (0.6in) diameter of galvanized steel or hollow section 25mm (1inch) of GI pipe of length above 2.5m (8.2 ft) are buried upright in the earth manually or with the help of a pneumatic hammer. The length of embedded electrodes in the soil reduces earth resistance to a desired value. Copper Rod Electrode Earthing System

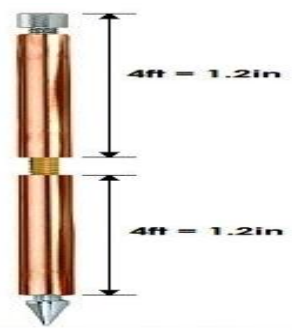

Fig 5 Rod earthing

Earthing through the Waterman

In this method of earthing, the waterman (Galvanized GI) pipes are used for earthing purpose. Make sure to check the resistance of GI pipes and use earthing clamps to minimize the resistance for proper earthing connection.

If stranded conductor is used as earth wire, then clean the end of the strands of the wire and make sure it is in the straight and parallel position which is possible then to connect tightly to the waterman pipe.

Strip or Wire Earthing:

In this method of earthing, strip electrodes of cross-section not less than 25mm x 1.6mm (1in x 0.06in) is buried in a horizontal trenches of a minimum depth of 0.5m. If copper with a cross-section of 25mm x 4mm (1in x 0.15in) is used and a dimension of 3.0mm^2 if it's a galvanized iron or steel.

If at all round conductors are used, their cross-section area should not be too small, say less than 6.0mm^2 if it's a galvanized iron or steel. The length of the conductor buried in the ground would give a sufficient earth resistance and this length should not be less than 15m.

12.GENERAL METHOD OF EARTHING / PROPER GROUNDING INSTALLATION (STEP BY STEP)

The usual method of earthing of electric equipments, devices and appliances are as follow:

- First of all, dig a 5x5ft (1.5×1.5m) pit about 20-30ft (6-9 meters) in the ground. (Note that, depth and width depends on the nature and structure of the ground)
- Bury an appropriate (usually 2' x 2' x 1/8" (600x600x300 mm) copper plate in that pit in vertical position.
- Tight earth lead through nut bolts from two different places on earth plate.
- Use two earth leads with each earth plate (in case of two earth plates) and tight them.
- To protect the joints from corrosion, put grease around it.
- Collect all the wires in a metallic pipe from the earth electrode(s). Make sure the pipe is 1ft (30cm) above the surface of the ground.
- To maintain the moisture condition around the earth plate, put a 1ft (30cm) layer of powdered charcoal (powdered wood coal) and lime mixture around the earth plate of around the earth plate.
- Use thimble and nut bolts to connect tightly wires to the bed plates of machines. Each machine should be earthed from two different places. The minimum distance between two earth electrodes should be 10 ft (3m).
- Earth continuity conductor which is connected to the body and metallic parts of all installation should be tightly connected to earth lead.
- At last (but not least), test the overall earthing system through earth tester. If everything is going about the planning, then fill the pit with soil. The maximum allowable resistance for earthing is 1Ω. If it is more than 1 ohm, then increase the size (not length) of earth lead and earth continuity conductors. Keep the external ends of the pipes open and put the water time to time to maintain the moisture condition around the earth electrode which is important for the better earthing system.

13.APPLICATIONS

ThemajoritycontemporaryresidencesinIndiahave an earthingscheme.The mutualneutraland earth takes place between the adjacent transformer substationandtheserviceconnectionthroughcut out. Afterthis,theneutralcoresareusedintheentirethe concealedhousewiring. Olderurbanandsuburban homesin the Indiancity tend to have three wire suppliesstemswiththeearthdistributethroughthe leadsheathofthe undergroundleadandpapercable. Someadultresidence,particularlythoseputtogether before the discovery of residual current circuit breakersandwiredhomeregionnetworks, employin residential service activities. This is no longer recommendedpracticedue tolackofrenovations. Laboratoryquarters,medicinalservices,production place,refurbishworkshopsand othersurroundings where there is a better than before jeopardy of insulationfailurefrequentlyemployanITearthing agreementsuppliedfrom anisolationtransformer.To alleviatethetwofaultquestionwithITsystemsthe isolationtransformersshouldonlycontributealight loadseveryandorshould beshelteredwith particular monitoringgearusuallyonly healthcheckITsystems are done with such switch gear because of the expenditure.

14.CONCLUSIONS

Earthing systems form the first lineof defense in every type of electrical systems. The system may be a generator/transformer/housing installation/generating station/etc. So it is strictly advised to know the basic concepts of grounding as far as electrical engg. is concerned.In this the basic idea of earthing is discussed .Also the Results if one is adopting earthing and one is not.

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