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Sub-Station Earth Grid Design

Nikhil M Kushram*, Abhiranjan Singh, Sanket Patel
Department of Electrical Engineering, SIGMA Institute of Engineering, Vadodara, Gujarat, India

ABSTRACT

This project aims to present the design for earthing grid for a substation and calculation of its parameters. Successful operation of entire power system depends considerably upon efficient and satisfactory performance of substations. Hence substations in general, can be considered as the heart of the entire power system. In any substation, a well designed grounding plays an important role. Since absence of efficient grounding system can lead to malfunction and non-operation of control and protective devices, grounding system deserves considerable attention for all substations. Grounding system has to be safe as it is directly concerned with the safety of persons working within the substations. Main purpose of this project is to design safe and cost effective grounding system for HV/EHV substations situated at such locations where the soil type is not uniform in the whole substation area.

Keywords: Substation , Earthing , Grid Design

I. INTRODUCTION

The method used for earthing at different power stations is of immense importance. But this is often overlooked. his aspect is covered in most of the textbooks and reference books, but this is generally disregarded as too simple or not important. Such reference books are referred in the following paragraphs. This is very important for any engineer at a power station. The design for earthing must be designed in such a way that they can be easily maintained and also further improvements in the systems must also be considered, while designing earthing grid.

Earthing is necessary to provide protection to not only the people working in a power plant but also the equipments but also for proper functioning of the power system. The earthing method must be reliable and secure and also follow all the standard rules and regulations. This paper deals with earth grid design of AC substation of 50 Hz power frequency.

II. IMPORTANCE

Earth grid design is very essential in a power plant for the following reasons:

- Earth grid must provide a least resistance path for fault currents to protect both machinery and people.
- A low resistance earth grid related to remote earth avoids harmful ground potential rise, for earth faults with return paths for offsite generating source.
- A low resistance path must be given for voltage transients.
- Electrostatic buildup and discharge can cause sparks to burn flammable atmosphere. To avoid this equipotential bonding must be provided.

- A good earthing system will provide a reference for electrical circuits and reduces noise for electrical and communication systems.

III. EARTHING DESIGN FOR HV/EHV SUBSTATION

3.1 Earthing

"Earthing can be defined as the procedure for providing a least resistance path for fault currents to protect electrical equipments as well as human beings"

3.2 Types Of Earthing

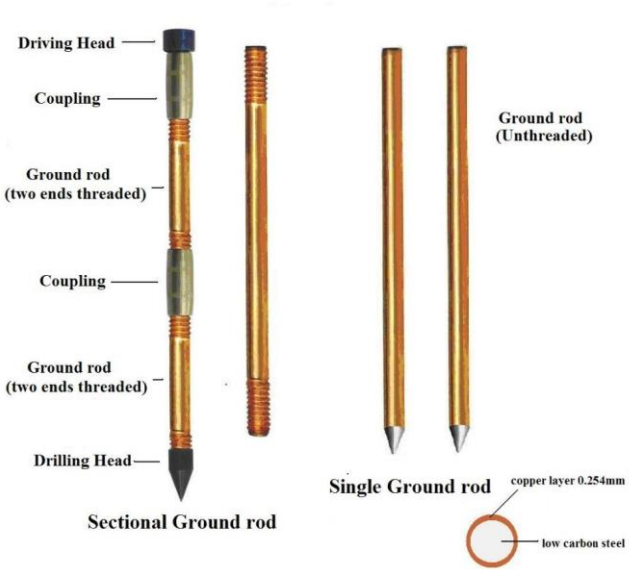
Earthing can be classified as :-

1) System earthing
   This type of earthing is generally associated with protection of equipments by stabilizing the voltage w.r.t ground
2) Equipment earthing
   This type of earthing deals with the protection of people from electrical shock by monitoring the potentials of no current carrying conductors at ground potential

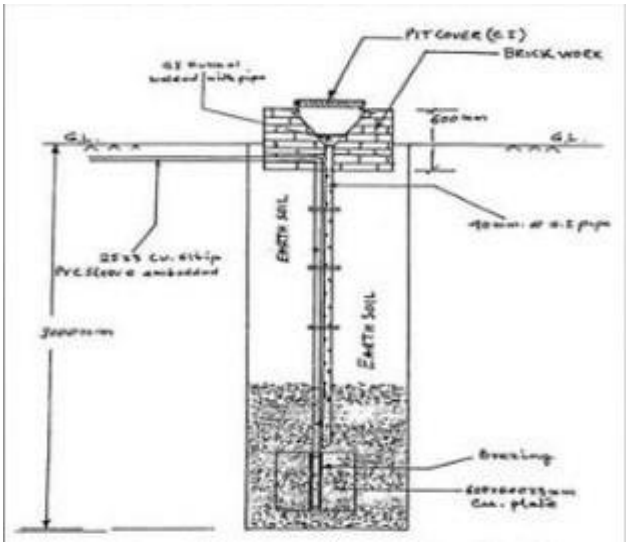
The above discussed types of earthing are generally interconnected and therefore fault in system ground raises potential of the safety ground and causes a big increase in the substation potential gradient. But when the two methods are separated, certain demerits like higher short circuit current, long distance to be covered to separate the two earths and low current flows are experienced. After studying the advantages and disadvantages of both the methods, we can choose the earthing method as per our requirement.

3.3 Types of Earthing Electrode

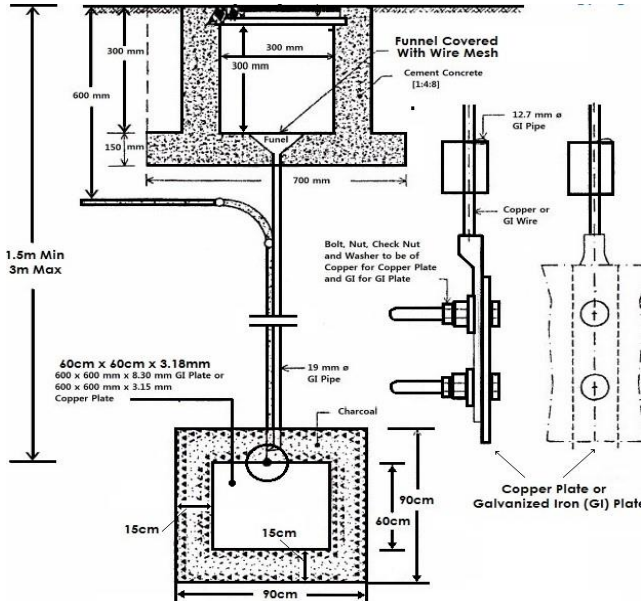
I) Rod electrode



II) Pipe electrode



III) Plate electrode



3.4 Permissible values of earth resistance

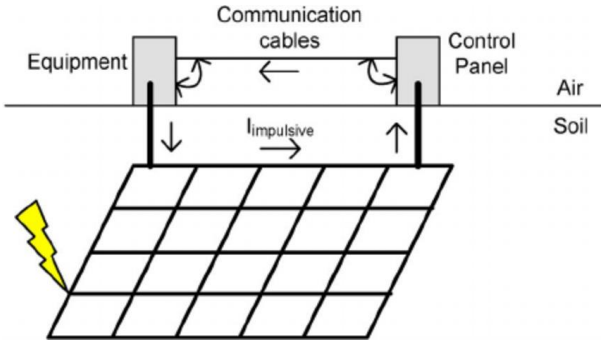
The permissible values of earth resistance for different types of power plants and substations are given as following, in the below table.

Sr. no	Particulars	Earth resistance
1	Power stations	0.5 ohms
2	EHT substations	1.0 ohms
3	33kV substations	2.0 ohms
4	d/t centers	5.0 ohms
5	Tower foot resistance	10.0 ohms

3.5 Earth Grid Design

Main aim is to have less earthing resistance. Substation contains many individual earthings through electrodes having high resistances. But on linking this individual electrodes inside the earth , the surface area increases and a large number of parallel paths are created. Eventually the earth resistance of this interconnected combined earth resistance will be less than that of the individual earth resistances.

The interconnection is made through flat/rod conductor which is known as earth mat/grid. It keeps the surface of substation equipments as near as absolute earthing potential as possible. To achieve our main goal, the earthing grid must be designed keeping in mind various factors like step potential, touch potential and transfer potential.



3.5.1 Factors effecting mat design

- Maximum fault current
- Duration of fault
- Earth resistance
- Resistivity of surface material
- Shock duration
- Material of earth mat conductor
- Earthing mat geometry

3.5.2 Design Parameters

- Size of earth grid conductor
- Safe step and touch potential
- Mesh potential
- Grid configuration for safe operation
- Number of electrodes required

The main properties of earthing grid are:

1) Earthing resistance
2) Earth surface potential distribution
3) Current carrying ability

The most common earth surface potential distribution have horizontal earth electrodes whose surface potential can easily be controlled. The most unfavourable are the vertical electrodes, having the least surface potential distribution. But the vertical electrodes have low earthing resistance with stable values, independent of seasons. The horizontal and vertical electrodes are also used together in a combination to achieve lower values of earthing resistances. Results prove that the earth grid is

considered to be safe for a 400 kV substation if the soil resistivity ranges between 100-350 ohms.

IV. FUTURE SCOPE

- Mathematical modeling and simulation.
- Programming and designing by using MATLAB.
- Recommendations to minimize problems in existing substation.
- Focus on the study to reduce problems in the earthing process.

V. CONCLUSION

This paper discusses the designing process of a 400 kV substation earthing grid system. The results are achieved by computational methods. For the conductors of earthing mild steel is used. The structural approach to design a substation earth grid system is followed.

The various conductors used in the earth grid system are mentioned in this paper. The harmful effect of touch and step potential for human beings are discussed in this paper. During the fault conditions, special care is given to ground potential rise(GPR).

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