NIRMA UNIVERSITY
Institute of Technology

Electric Safety, Earthing and Protective devices

Flow Of Presentation

- ✓ Electrical earthing
- ✓ Necessity of electrical earthing
- ✓ Protection against Electric Shock
- ✓ Components of Electrical Earthing
- ✓ Indian Standards for Earthing for Electrical Installation
- ✓ Touch and Step Potential
- ✓ Factors Affecting Resistence of Earthing Electrodes

What is Electrical Earthing?

- An electrical connection to the general mass of earth, the latter being a volume of soil/rock etc., whose dimensions are very large in comparison to the electrical system being considered.
- An electrical equipment or appliance is said to be earthed, if its outer frame and its other parts not carrying any current, are connected to the earth so as to attain as nearly zero potential as possible.

Necessity of Electrical Earthing

- To ensure that no part of equipments other than the live parts should assume a potential that is dangerously different from that of the surroundings.
- To provide a path to ground in fault conditions for quick isolation of equipment with operation of ground fault protection.
- To provide grounding of all conductive enclosures that may be touched by personnel, thereby eliminating shock hazards.
- To provide protection from large electrical disturbances (such as lightning) by creating a low resistive path to earth.

Effect of Electric Current through human body

- Effect of electric current through the vital parts of human body depend on the duration, magnitude and frequency of this current.
- Most dangerous consequence could be ventricular fibrillation, a condition resulting in immediate arrest of blood circulation.
- Currents at 50 Hz about 0.1 A can be lethal.
- Current depends on voltage applied and body resistance. Resistance is mainly offered by skin. Skin resistance increases with thickness and diminishes with moisture / perspiration.
- Except for skin; blood vessels, intravascular spaces etc. offer conduction system.

Tolerable current through human body

- Mostly all persons can safely withstand without ventricular fibrillation, the passage of current (I_b)(depends on weight of person) for duration ranging from 0.03 to 3.0 sec
- Energy absorbed by the body as per formula: $S_b = (I_b)^2 \times t_s$
- I_b = Current through body
- T_s = Time duration through which current flows

T_s	I_b (50 kg)	I_b (70 kg)
0.2 sec	259 mA	351 mA
0.5 sec	164 mA	222 mA
1.0 sec	116 mA	157 mA

Protection against Electric Shock

- All metallic parts of the electrical equipment are effectively earthed.
- Broken switches, plugs, etc., should be replaced immediately.
- Before replacing a broken switch, plug or blown fuse, always put off the main supply.
- Never insert bare wires in the holes of a socket, for taking a connection. Always use a proper plug.
- Use rubber- sole shoes while repairing/testing electrical equipments.
- Never touch two different terminals at the same time.
- Be careful that your body does not touch the wall or any other metallic frame having contact with earth.
- While working on an electric pole or tower, use safely – belt and a rubber padded ladder.
- It is preferable to work in the presence of an ‘assistant’, so that he can immediately disconnect the supply whenever needed.

Components of Electrical earthing

- Components of Earthing system
- Earthmat (grid)
- Earth Electrodes
- Bonding

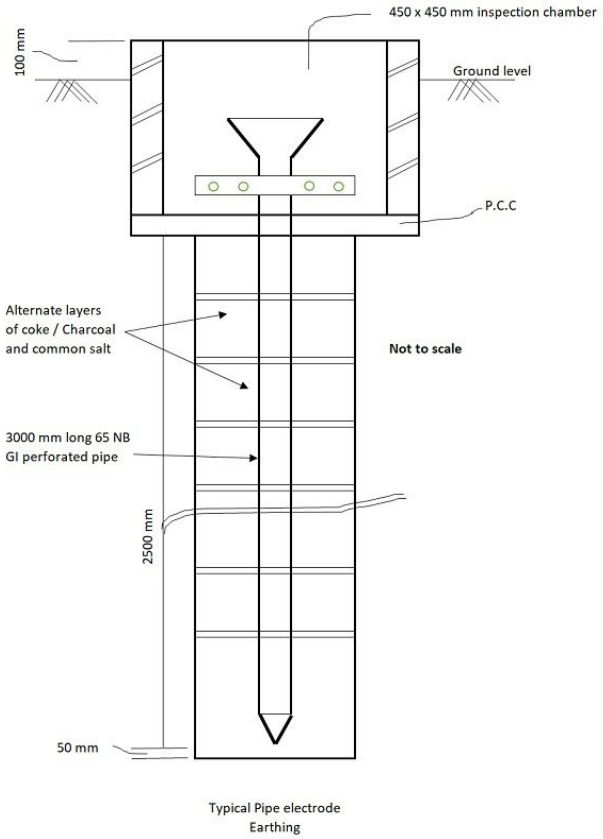
Electrical bonding

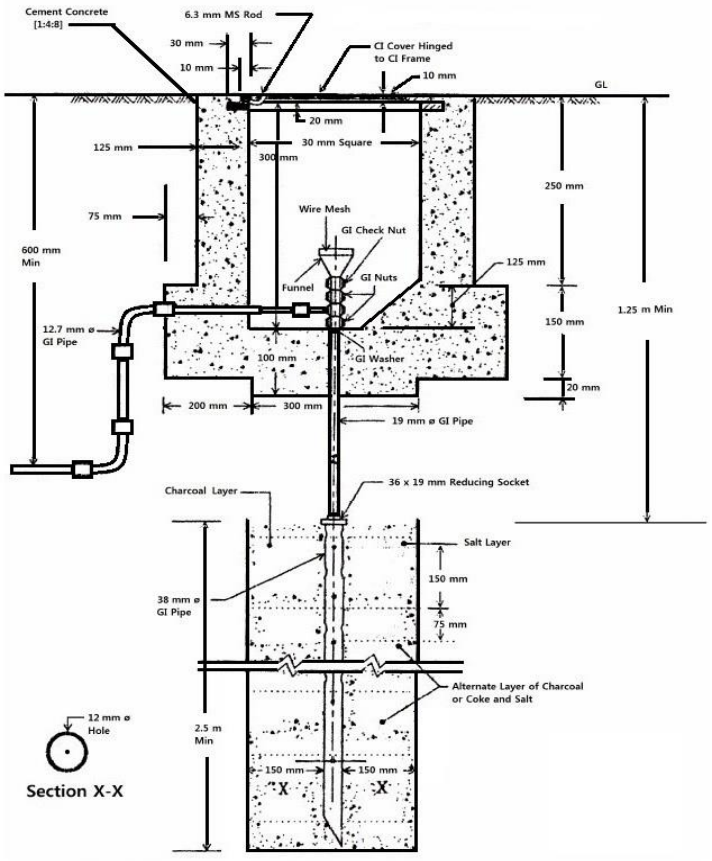
- Electrical bonding is an intentional practice of electrically connecting all exposed metallic items not designed to carry electricity in a room or building as protection from electric shock.
- If a failure of electrical insulation occurs, all bonded metal objects in the room will have substantially the same electrical potential, so that an occupant of the room cannot touch two objects with significantly different potentials.
- Even if the connection to a distant earth ground is lost, the occupant will be protected from dangerous potential differences.

Earth electrode

- Earth electrode is the component of the earthing system which is in direct contact with the ground and thus provides a means of releasing or collecting any earth leakage currents in the earth.
- The material should have good electrical conductivity and should not corrode in a wide range of soil conditions.
- Materials used include copper, copper bonded mild steel rod, galvanised steel, stainless steel and cast iron.

Types of Earth Electrode





Rod Type earth electrode

Pipe type earth electrode

Rod and Pipe earth electrode

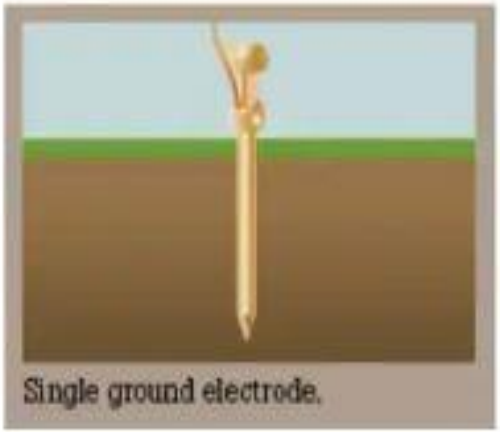
- Rod electrodes shall be at least 16mm in diameter of steel or 12.5mm in diameter of copper.
- Pipe electrodes shall be larger than 38mm in diameter of galvanized iron or steel and 100mm in internal diameter of CI or mild steel.
- The length of rod or pipe electrode not less than 2.5m, which shall be driven to a minimum depth of 2.5 m.
- If rock is encountered at depth less than 2.5m, it can be tilted by an angle of 35^0 to vertical.

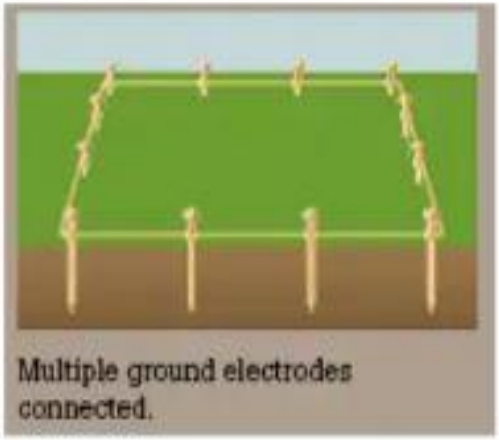
IS 3043 for Earthing of Electrical Installations

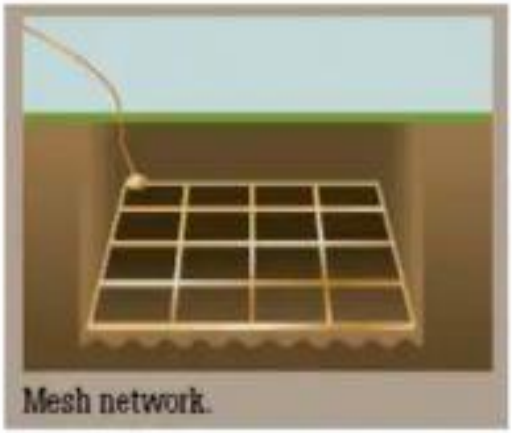
- Earth Grid: A system of grounding electrodes consisting of inter-connected connectors buried in the earth to provide a common ground for electrical devices and metallic structures.
- EarthMat: A grounding system formed by a grid of horizontally buried conductors and which serves to dissipate the earth fault current to earth and also as an equipotential bonding conductor system.
- Ground Potential Rise (GPR): The maximum electrical potential that a substation grounding grid may attain relative to a distant grounding point assumed to be at the potential of remote earth. This voltage, GPR, is equal to the maximum grid current times the grid resistance.

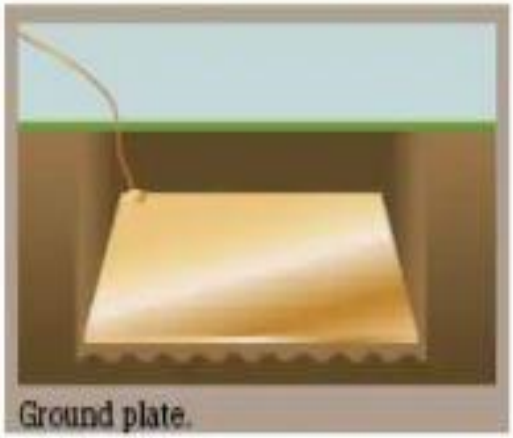
Different Earthing Types

- The below figure shows different earthing types



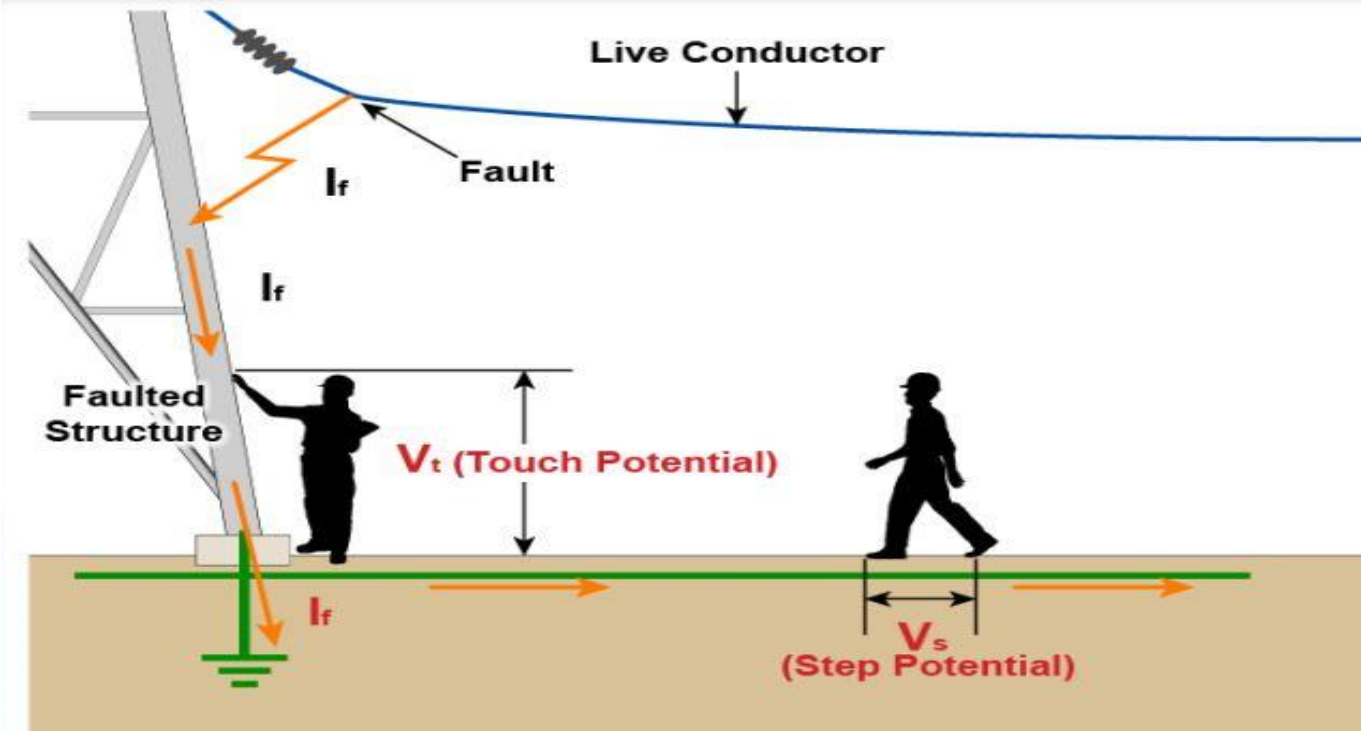






Touch and Step Potential

- Touch potential is the difference in voltage between the object touched and the ground point just below the person touching the object when ground currents are flowing.
- Step Potential is the difference in voltage between two feet, which are one meter apart along the earth when ground currents are flowing.



Factors affecting resistence of earthing electrodes

- The earthing resistance of an electrode is made up of:
- Resistance of the (metal) electrode
- Contact resistance between the electrode and the soil, and
- The most important factor influencing the resistance of earthing electrodes is the impedance of the medium in which the earth electrodes are situated, i.e. the soil.

Soil Properties

- Soil is a poor Conductor of Electricity.
- Soil becomes conductive due to salts and moisture added in it
- Soil under the surface of earth is non- homogenous, hence resistivity values in wide range between 1 ohm metre to 1,00,000 ohm metres depending on type, nature of soil & physical and chemical properties.
- Sandy soil drains faster, solid rock does not retain water and have high resistivity.
- Soil resistivity measurement is important for design of earthing system.
- Moisture in the soil is the most important element determining its conductivity / resistivity.

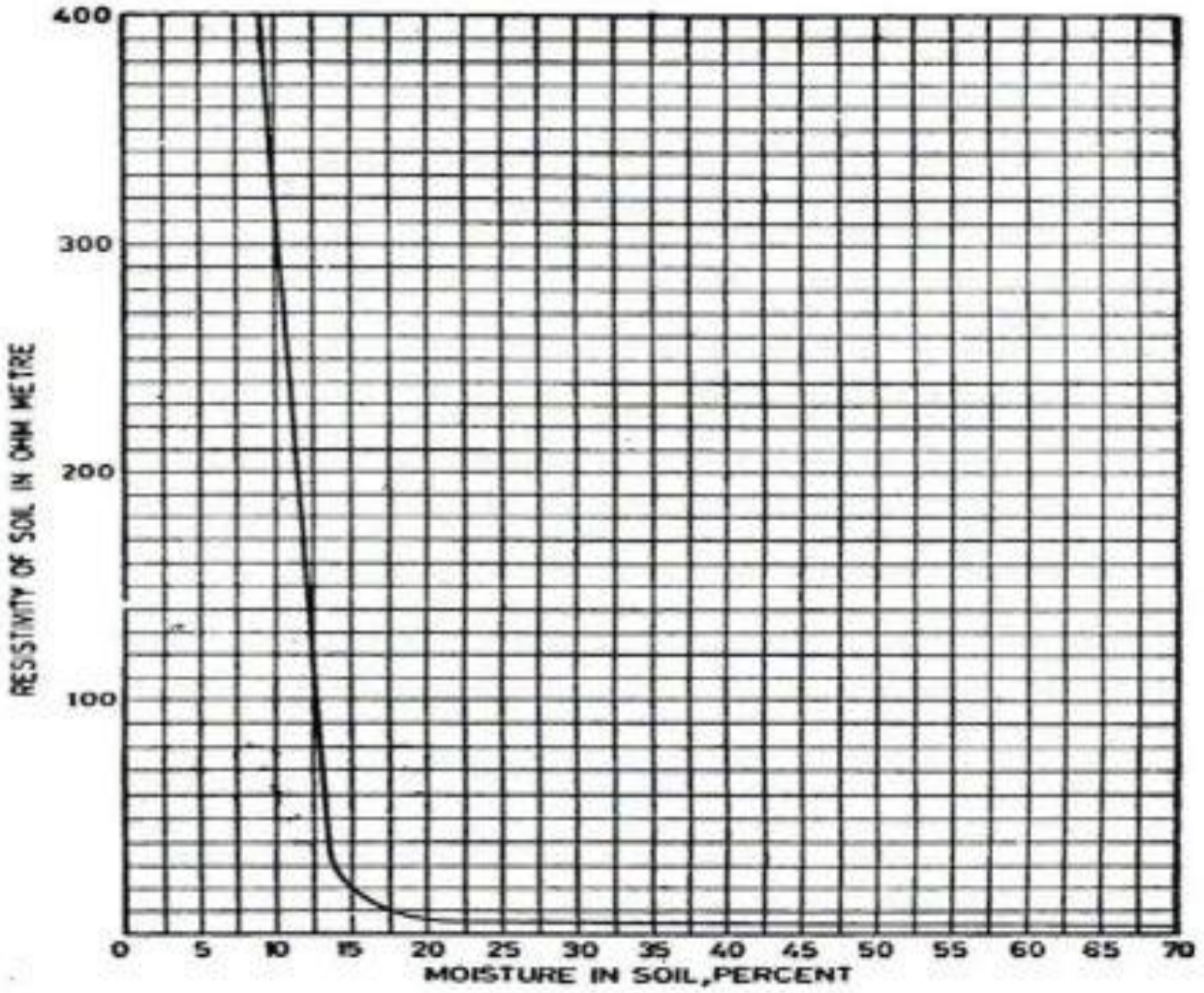
Soil Resistivity

- The below figure shows different soil resistivity

Type	Resistivity (Ohm metre)
Sea water	0.1 - 1
Garden soil/alluvial clay	5 - 50
clay	5 - 100
Clay, sand and gravel	40 - 250
Porous chalk	30 - 100
Quartzite/crystalline limestone	300+
Rock	1,000 - 10,000
Gneiss/igneous rock	2,000+
Dry concrete	2,000 - 10,000
Wet concrete	30 - 100
Ice	10,000 - 100,000

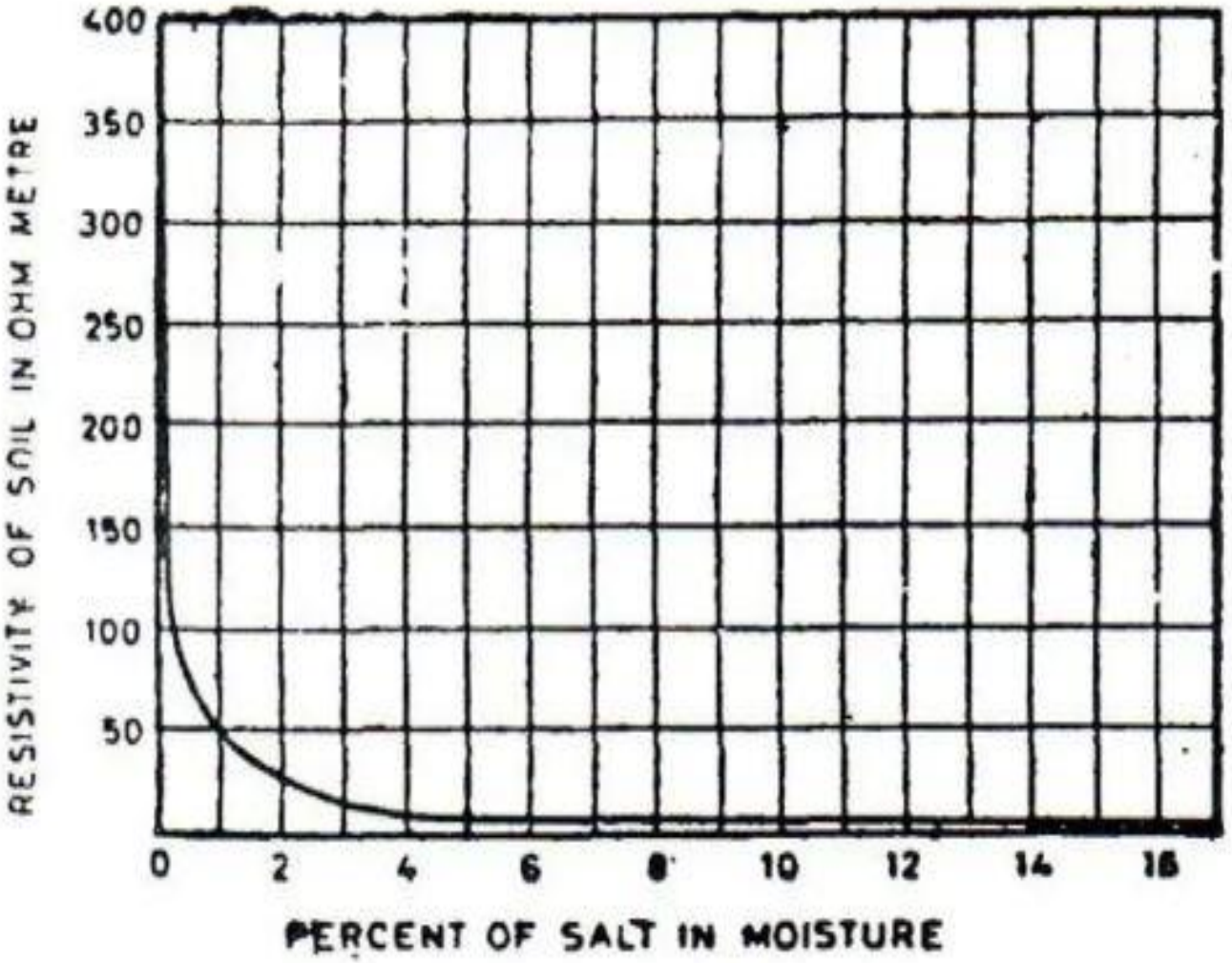
Effect of moisture on Soil Resistivity

- The below figure shows effect of moisture on soil resistivity



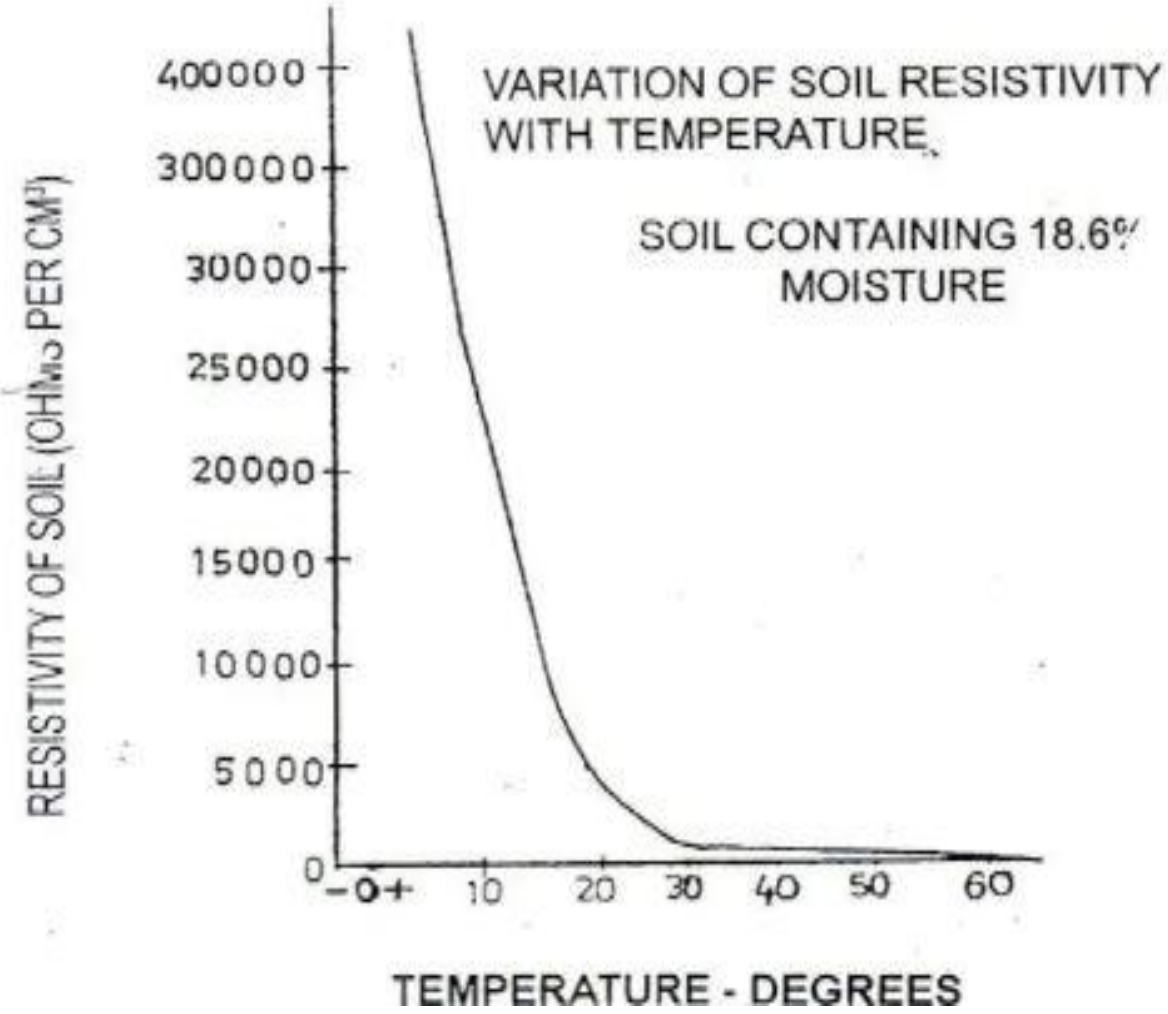
Effect of salt on Soil Resistivity

- The below figure shows effect of salt on soil resistivity



Effect of temperature on Soil Resistivity

- The below figure shows effect of temperature on soil resistivity



Thank You