4.2 ELECTRICAL RESISTIVITY METHOD

Applications of Electrical and Seismic Refraction methods:

- ✓ For groundwater prospecting, required for various Govt. water supply schemes.
- ✓ For soil exploration studies, required for Foundation design of various civil engineering structures.
- ✓ Bed rock investigation, required for dam & reservoir projects, etc.

Electrical Resistivity method:

Principle:

All the materials (whether soil or rock) will conduct or resist current. If they conduct current, it will be in various proportions, based on their composition and moisture content present. The conductivity of any rock / soil is the reciprocal of its resistivity. Knowing the resistivity values, different rock strata present in earth's crust is inferred and their aquifer characteristics are studied. Ohm's law is the basis for the principle of this method.

Equipment used:

1. Resistivity meter
2. Two current electrodes & two potential electrodes
3. Power pack
4. Cables, hammers, etc

Types / methods of Resistivity survey:

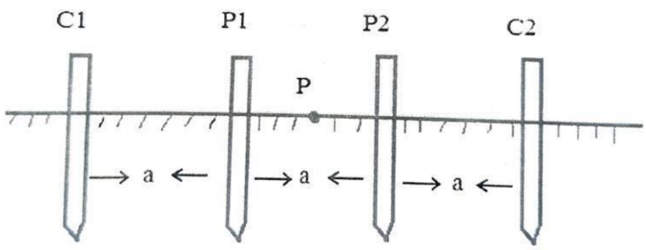
1. Wenner Electrode Array
2. Schlumberger Electrode Array

Procedure:

In both the methods, all the four electrodes are erected firmly into the ground and a known current (I) is sent into the ground through the two current electrodes (C1& C2) and the potential difference (V) between the two potential electrodes (P1 & P2) is measured.

In the case of Wenner configuration of electrodes, all the four electrodes are equally spaced where as in case of Schlumberger configuration, the potential electrodes are closely spaced and current electrodes are placed further apart.

Wenner Array:



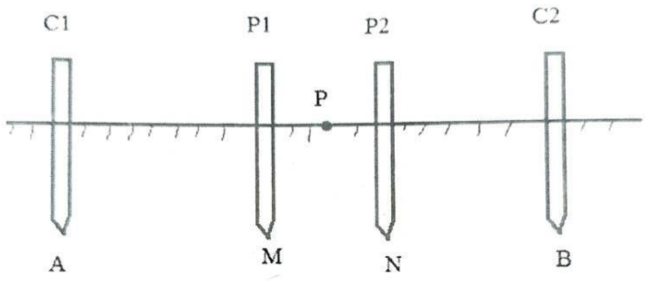
a = Electrode spacing

C1, C2 = Current electrodes

P1, P2 = potential electrodes

P = Point of exploration

Schlumberger Array:



Formula applied:

Wenner array:

$$\rho_a = 2\pi a (V / I) \text{ ohm m}$$

Where ρ_a = apparent resistivity in ohm m a = electrode spacing

V = potential difference between 2 potential electrodes in millivolts / volts

I = current sent in Ampere / milli amps

Schlumberger array:

$$\rho_a = \frac{\left[\left(\frac{AB}{2}\right)^2 - \left(\frac{MN}{2}\right)^2\right]}{MN} \times \left(\frac{V}{I}\right) \ ohm\ m$$

Where AB = spacing between current electrodes

MN = spacing between potential electrodes

All the four electrodes are moved laterally at a uniform spacing / span (in case of Wenner) and only the two current electrodes are shifted laterally (in case of Schlumberger), in order to increase the depth of exploration and at every shifting of electrodes, current is sent and potential difference between electrodes is measured. This process is repeated till the total depth of exploration is reached.

In case of Schlumberger, after reaching certain depth of exploration (say 50m), the potential electrodes are shifted to $1/5^{th}$ distance of current electrodes (say 10m) and the procedure is repeated.

The linear expansion of electrodes denotes the depth of exploration at the point of investigation. Then applying the relevant formula, the apparent resistivity values (ρ_a) are calculated.

Sedimentary strata	**Resistivity (in ohm m)**	**Hard rock terrain strain**	**Resistivity (in ohm m)**
Sand	8-15	Top soil	> weathered strata
Clay	Less than 5	Weathered strata	25-80
Sandy clay / clayey sand	5-8	Fractured rock	80-150
Kankar	25-40	Jointed rock	150-300

Sea water intrusion	Less than 1	Massive bed rock	> 300

Application civil engineering:

1. **For water supply schemes:**

   Depending upon the water table conditions of the study area and available favourable rock formations, the investigated location is recommended for open well or bore well or rejected, if unfavourable.

2. **For foundation studies in civil engineering:**

   The soil their nature type and depth to bed rock are inferred and based on the details of soil and rock types, foundation design is made for the civil engineering structures.