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# Study the Effect of Void Ratio & Temperature over the Electrical Resistivity of Soil.

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**Abstract -** The Electric Resistivity (ER) is the instrument which is helpful to study the layers of soil which is below the earth surface without any disturbance to the soil on the surface. There are many methods such as soil boring, Auger boring and so on which are used to soil exploration and to study the properties of soil such as water content, Dry unit weight, cohesion factor and angle of internal friction and so on. But these methods are very uneconomical, destructive and time consuming as compere to Electrical Resistivity. That's why Now a days Electrical Resistivity method is largely used in all over the world to investigate the soil properties. In this study we confirm that there are various geotechnical parameters which shows the effect over electrical resistivity of soil such as void ratio and temperature.

From these study the relationship is established between void ratio and temperature factor with electrical resistivity of soil. After the results we get that as temperature increases the soil resistivity get decreased and if void ratio is increased, the electrical resistivity of soil get decreased. These relations are useful for future geotechnical investigation.

***Key Words***: Electrical Resistivity, Dry Sand, Compacted Clay soil, Void Ratio & Temperature.

## 1.INTRODUCTION

Electrical resistivity of soil, is the resistance offered by the soil which having High intermolecular forces and less Temperature is against the conduction of electricity through that soil. Electrical Resistivity is worked on the Principle of Ohm's Law, thai is:

$$V = I * R$$

Where, V = Potential Difference

I = Electric Current

R = Electric Resistivity

By using this principle the soil investigation is done through Electric Resistivity. The various geotechnical factors such Moisture content, Degree of saturation, Dry unit weight, Void ratio, Temperature and so on are having some what impact over them. This relation is directly proportional or indirectly proportion, is mainly studied in this paper.

For taking the the void ratio values four soil samples are selected, from that is Sandy soil as high void ratio and Compacted clay soil as less void ratio. Then the Electrical Resistivity test of that both soils conducted to investigate the relation between Void Ratio and Electrical Resistivity of soil.

In this study the two number of sites are selected as location-1 and location-2 for the conduction of electrical resistivity test of soil having different site condition that of river side site as less temperature soil and dry desert type site as high temperature soil. Then the Electrical Resistivity test of that both soils conducted to investigate the relation between Temperature and Electrical Resistivity of soil.

## 2. PROCEDURE

### 2.1 LAB TEST (VOID RATIO)

To conduct the electric resistivity test, a soil samples having different percentage of void ratio are selected such as clayey sand, Inorganic silt, Poorly graded sand and Coarse sand having void ratio of 0.17, 0.26, 0.30 and 0.35 respectively.

| Soil Sample | Void ratio |
|---|---|
| Clayey sand | 0.17 |
| Inorganic silts | 0.26 |
| Poorly graded sand | 0.30 |
| Coarse sand | 0.35 |

Table 1 : Soil with Void ratio

A Single Electrode electric resistivity is used in this method. At every time an electrode is inserted in that respective soil and the resistivity offered by soil at that particular void ratio is recorded. The values of void ratio are referred from the IS-chart.

### 2.2 FIELD TEST (TEMPERATURE)

Two sites are selected which are located at river side and another one is at dry desert site. The site along the river side is having the temperature of 10 to 25 ℃ and the Site that of at desert dry site having the temperature range of 25 to 40 ℃.

As per previous study and by references we got that the subsurface temperature upto depth of 300 feet the soil temperature does not vary rapidly. In these field method by using 48 Electrodes method for 180 meter profile length as of 36 meter (100 feet) only. Below fig.1 shows the electric resistivity instrument used over the site :

Fig.1 Electric Resistivity Instrument used over the Site.

The selected site should be plain terrain. So that the procedure of testing should be done freely without any obstruction.

The electrodes are inserted properly and the connection of electrodes and acceptor should be done properly. so that the supply of electric current to the electrodes should not irregular, as shown in below figure.2 :

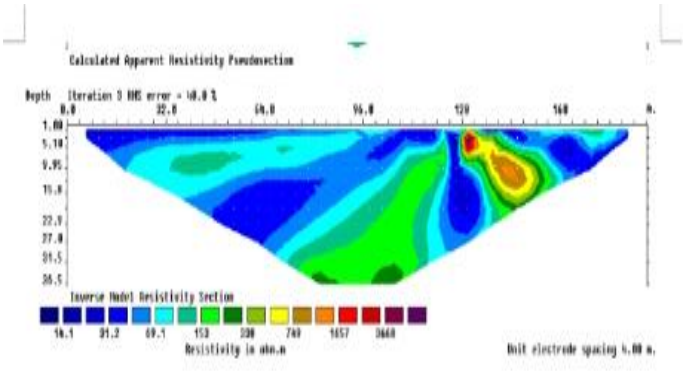
Fig.2 Connection of electrodes with acceptor.

The inputs are given to the electric resistivity so that the data can be used for the future field work of same site.

## 3. RESULTS

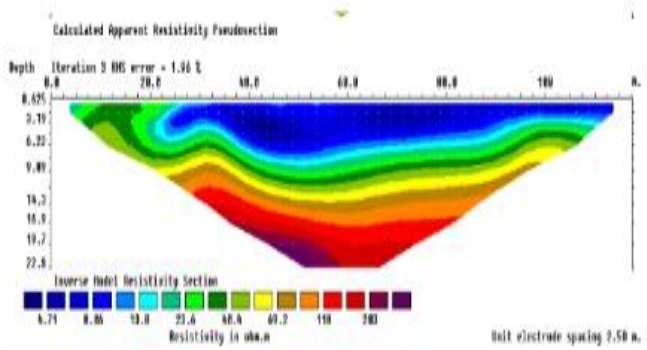
### 3.1 RESISTIVITY PSEUDO SECTION ( WET SOIL) :

Calculated apparent resistivity pseudo section at site 1, which is located at river site. The site having soil temperature of 10 to 25 degree Celsius.




### 3.2 RESISTIVITY PSEUDO SECTION ( DRY SOIL) :

Calculated apparent resistivity pseudo section at site 2, which is located at dry desert site. The site having soil temperature of 25 to 40 degree Celsius.




By using thesepseudo-section we get the subsurface section which gives the properties of soil and layers of soil presented below the ground surface.

### 4.1EFFECT OF VOID RATIO OVER THE ELECTRICAL RESISTIVITY OF SOIL

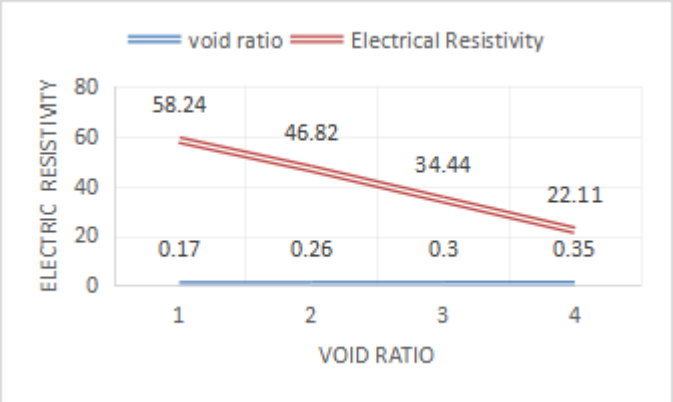
The volume of voids to the volume of total solid present in the soil sample is nothing but the Void Ratio. By using four different soil samples the Relation is established between void ratio of soil and the respective Electrical Resistivity of that soil.

Table 2. different types of soil with various void ratio and there respective Electrical Resistivity:

| Soil Sample | Void Ratio | Electrical Resistivity (ohm-meter) |
|---|---|---|
| Clayey soil | 0.17 | 58.24 |
| Inorganic silts | 0.26 | 46.82 |
| Poorly graded sand | 0.30 | 34.44 |
| Coarse sand | 0.35 | 22.11 |

After the study the table-2 given above, shows that as void ratio of soil increases, the value of ER gets decreased.

By using the values given in the above table no. 2, the graph is plotted as x-axis as void ratio and y-axis as Electrical resistivity (ohm-meter).




Graph 1. Relation of Void Ratio with Electric Resistivity of soil.

After the analytical study of the graphs of void ratio with electrical resistivity, we get that the Electric Resistivity of soil decreases with increase in void ratio of soil.

As values of Void Ratio of soil increases as 0.17, 0.26, 0.30 and 0.35, then the values of Electrical Resistivity get decreases as 58.24, 46.82, 34.44 and 22.11 ohm-meter respectively.

### 4.2 EFFECT OF TEMPERATURE OVER THE ELECTRICAL RESISTIVITY OF SOIL

In case of metal and water, as temperature increases the electric conductivity also get increased. Same conditions are seen in case of soil. As depth increases below the ground surface, the temperature of soil gets increased slowly.

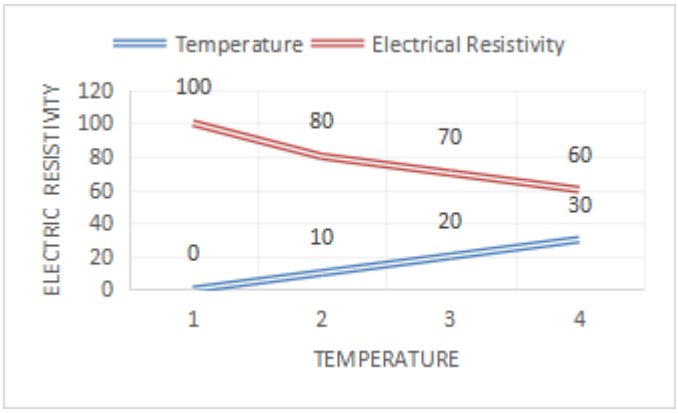
To determine the correlation of soil resistivity with Temperature of soil, resistivity tests were conducted at two different sites having various temperature values ranges From 10 to 40 degree Celsius.

Table 3. Soil with various Temperature values and respective ER values.

| Temperature (degree Celsius) | Electrical Resistivity (ohm-meter) |
|---|---|
| 10 | 80 |
| 20 | 70 |
| 30 | 60 |

After study the table-3 , we get that the Temperature of soil decreases, the Electrical Resistivity of soil gets increases.

By using the above table Graphical representation having Temperature ( degree Celsius ) as x-axis and Electrical Resistivity ( ohm-m) as y-axis is plotted as shown below:




Graph 2. Relation of Temperature of soil with Electric Resistivity.

As Temperature value of soil increases as 10, 20 and 30 degree Celsius, the respective Electric resistivity values get decreased as 80, 70 and 60 ohm-m. This shows that the relation between ER and Temperature of soil is Inversely proportional.

## 5. CONCLUSIONS

- After the total study of Electrical Resistivity of soil with different geotechnical factors such as void ratio and temperature of soil, we get the effects of that particular factors over the electrical resistivity of soil.
- These field study is very effective in case of another site that having same conditions in future. These effects were considerable in future soil investigation.
- With the increase Void Ratio of soil as 0.17, 0.26, 0.30 and 0.35, the soil shows the variation in electrical resistivity as decreasing the values as 58.24 ohm-m, 46.82 ohm-m, 34.44 ohm-m and 22.11Ohm-m. Inversely proportional relation is established

between the void ratio of soil and electric resistivity of soil.

- As Temperature of soil increases as 10, 20 and 30 degree Celsius, the respective Electric resistivity values get decreased as 80, 70 and 60 ohm-m. This shows that the Inversely proportional relation established between Temperature of soil and electrical resistivity of soil.

- These study also gives shows that the temperature below the ground surface is widely varied after 100 to 120 meter depth, upto that a slight changes are occur In the temperature.

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