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Experimental Investigations of Electrical Resistivity of Different Field Soils

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Abstract: *The geophysical method which dominant by geophysicists become one of most popular method applied by engineers in civil engineering fields. Electrical Resistivity Method (ERM) is one of geophysical tool that offer very attractive technique for subsurface profile characterization in larger area. Applicable alternative technique in groundwater exploration such as ERM which complement with existing conventional method may produce comprehensive and convincing output thus effective in terms of cost, time, data coverage and sustainable. ERM has been applied by various applications in groundwater exploration. Over the years, conventional method such as excavation and test boring are the tools used to obtain information of earth layer especially during site investigation .Resistivity measurements are associated with varying depths relative to the spacing between two electrodes in the test. Soil resistivity and ground resistance at ten different sites nearby K.S.R.M College areas using grounding system with aluminium rods. This study was able to prove that the ERM can be established as an alternative tool in soil identification provided it was being verified other relevance information such using geotechnical properties.*

Keywords: *Electrical Resistively, Aluminium Rods, Geotechnical Properties Etc.*

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I. Introduction

Geotechnical site investigation (SI) was carried out to determine the properties of the geo materials (soil and rock) which importantly used in design and construction stage. Generally, it involves two stage involving surface and subsurface exploration. Physical mapping (e.g. geological mapping) was always conducted during the surface exploration while soil sampling and laboratory test was usually performed during the subsurface exploration. Several techniques were commonly used in the SI involving conventional and alternative approach. Soil monitoring using electrical resistivity has been widely applied to many geotechnical and other engineering problems to investigate near surface soil profile.

In particular, direct current (DC) resistivity monitoring has been actively used in geotechnical investigations, since the resistivity of subsurface material is easily affected by conductive or resistive fluid injection. Near surface soil characterizations and soil strength determinations are prerequisite in highway and road engineering including construction of highway embankments, earth dams, geotechnical engineering, and other divisions of civil engineering. The soil electrical resistivity and electric potential differences can be used for determining the specific soil characteristics. Corresponding to the depth of soil. The model of soil electric properties with multilayer earth structure will be able to perform specified soil characterizations through laver-by-layer earth analysis in geotechnical investigations. This study will encourage innovations in multilayer soil resistivity profile to scrutinize arrangement of specific characteristics of near surface soil such that the objectives of the geotechnical investigation can be realized.

II. Objective Of The Work

The main objectives of this project is 1.to study the existing status of soils. 2.to study the electrical resistivity of soils. 3.to know the behaviour of the soil ground water table, by using electrical resistivity method.

III. Materials

MATERIALS

- Digital multi meter
- Electric probes
- Aluminium rods
- Ground areas

Multimeter: Digital multimeters can be very helpful pieces of test equipment and when in the right hands can solve many electrical issues. A good multimeter that is equipped with a well designed wiring diagram, and handled by a trained professional can get to the root of just about any electrical problem. The two types of digital multimeters are the digital and the analog and the main difference is their display reading. An analog digital multimeter will use a needle to show results, while a digital multimeter will use a LCD or LED screen. In today's markets there is a very high demand for accuracy which makes a digital multimeter much more practical, although many people still use analog multimeters

Figure: 3.1 multimeter

Electric probes: A multimeter can use many different test probes to connect to the circuit or device under test. Crocodile clips, retractable hook clips, and pointed probes are the three most common types. Tweezer probes are used for closely spaced test points, as for instance surface-mount devices. The connectors are attached to flexible, well insulated leads terminated with connectors appropriate for the meter. Probes are connected to portable meters typically by shrouded or recessed banana jacks, while benchtop meters may use banana jacks or BNC connectors. 2 mm plugs and binding posts have also been used at times, but are less commonly used today. Indeed, safety ratings now require shrouded banana jacks.

Figure: 3.2 Electric probes

Aluminium rods: Aluminium rods are having good resistance power. These rods are used o inserting he ground to find the resistivity of soils a different depths

Figure:3.3 Aluminum rods

Ground areas: In this work done I have to choose ten different fields in K.S.R.M College Campus Areas I have to find the electrical resistivity of soils.

Figure: 3.4 Ground area

The most important electrical property of subsurface structure is due to the electrical resistivity changes, otherwise known as specific electrical resistance and apparent resistivity. When electrical current is passed into the ground, the magnitude and distribution of current lines in the subsurface are mostly dependent on effective electrical resistivity of the subsurface of the study area.

Electrical conduction in subsurface structures can be electronic or ionic due to electrolytes. However, groundwater available in pores, joints, fissures etc. is conductive because of the presence of aquifer and that gives rise to finite conductivity in subsurface formation. Thus the resistivity of a given geological formation is dependent on the nature and amount of water contained in it and hence resistivity method can effectively be used to study the groundwater conditions and subsurface structure of a given area.

IV. Methodology

4.1 To study the existing status of soil:

Soil is a mixture of organic matter, minerals, gases, liquids, and organisms that together support life. Earth's body of soil is the pedosphere, which has four important functions: it is a medium for plant growth; it is a means of water storage, supply and purification; it is a modifier of Earth's atmosphere; it is a habitat for organisms; all of which, in turn, modify the soil.

4.2 To study electrical resistivity of soils:

In this case i have collect the samples in different fields, like above study areas and then executed the Index properties of sols ,like liquid limit of soil, plastic limit of soil, index properties ,specific gravity of soils, and also free swell index test as per IS CODE recommendations .

4.3:To know the behaviour of soils &ground water table by using Electrical Resistivity method:

In this case i have to find the soil properties and behaviour of soil. especially the electrical resistivity of soils are successfully done.

Electrical Resistivity method:

The electrical resistivity method is by far the longest established geophysical tool for silting boreholes and wells in Africa. This technique involves two main survey methods which include: profiling and depth sounding. Unlike the depth sounding method, the resistivity profiling method is a comparatively slow process for detecting lateral 24 variations and has been overtaken by electromagnetic conductivity traversing. Even though there are methods available which combine both profiling and depth sounding, such surveys are complex and demand specialists equipment and interpretation. Hence, such methods are rendered inappropriate for small rural water supply projects (MacDonald et. al., 2002). However, in most parts of Africa, the vertical electrical depth sounding (VES) remains the most popularly used method.

Figure: 4.1 Electrical resistivity current flow between two the two current electrodes

V. Results And Discussions

5.1 Study the existing status of soils:

The soil has different in layers, which are arranged during the formation of soil. These layers called horizons, the sequence of layers is the soil profile. The layers of soil can easily be observed by their color and size of particles. The main layers of the soil are top soil, subsoil and the parent rock. Each layer has its own characteristics these features of the layer of soil play a very important role in determining the use of the soil. Soil that has developed three layers, is mature soil. It takes many years under a favorable condition for the soil to develop its three layers. At some places, the soil contains only two layers. Such soil is immature soil. I have to study the in detailed information about the selected locations.

5.2 To study the electrical resistivity of soils:

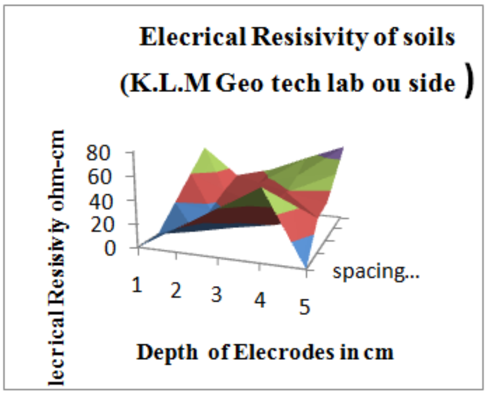
In these case i have to successfully done the electrical resistivity of different field soils by using electrical resistivity method. The soils electrical resistivity values mentioned below the objective

5.3 To know the behaviour of soils &Ground water table by using Electrical Resistivity method:

The electrical Resistivity increases when the moisture content of soils increases. On the contrary, the electrical resistivity decreases when the moisture content of soils decreases

Location:1 K.L.M Geo tech lab out side:

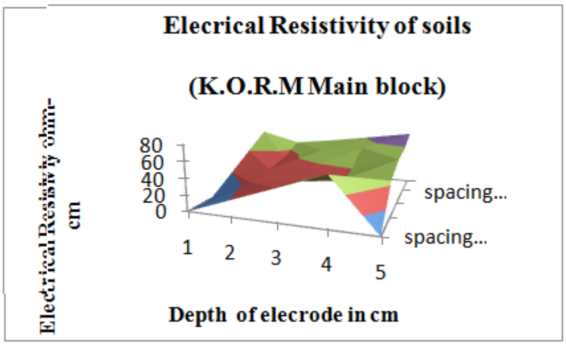
Depth of electrode in cm	Electrical Resistivity (ohm-cm) @equal spacing			
	0	20	40	60
0	6.432	13.86	20.112	29.62
20	16.324	28.421	39.163	33.121
40	26.121	36.492	45.762	50.362
60	33.492	42.003	56.132	69.132



The electrical resistivity of soils is depends on soils moisture content . if the soils are having very low moisture content on top surface of soils. So the electrical resistivity of soils are low.

Table 2. Location: K.O.R.M Main block inside:

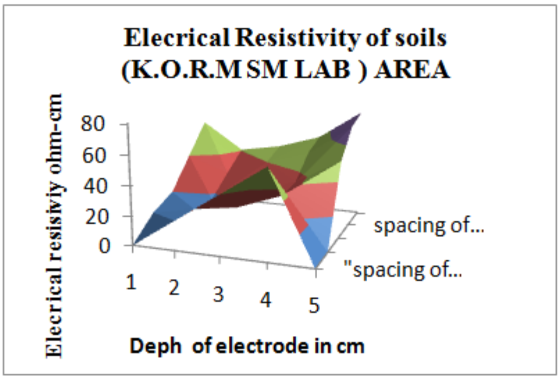
Depth of electrode in cm	Electrical Resistivity (ohm-cm) @equal spacing			
	0	20	40	60
0	25.62	32.46	39.00	44.02
20	28.92	36.42	40.13	56.12
40	34.32	49.02	56.12	59.01



In this area the electrical resistivity of surface soils are normal so the soils are having minimum moisture content.

Table 3 Location: K.O.R.M SM Lab:

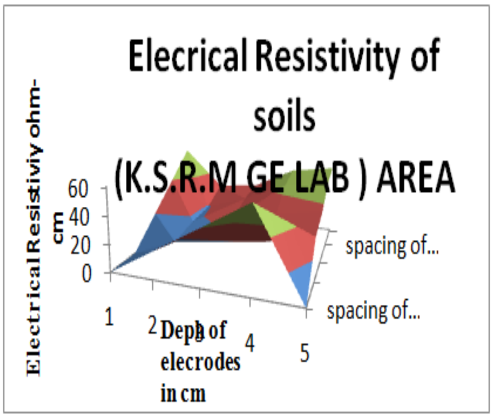
Depth of electrode in cm	Electrical Resistivity (ohm-cm) @equal spacing			
	0	20	40	60
0	13.26	18.96	23.12	34.16
20	17.43	26.190	35.63	52.32
40	29.34	39.96	48.94	69.73
60	40.06	45.43	54.63	74.65



In this area he resistivity of soils is high .so the soils having high moisture content. So the soils are saturated soils.

Table 4. Location: K.S.R.M Civil block:

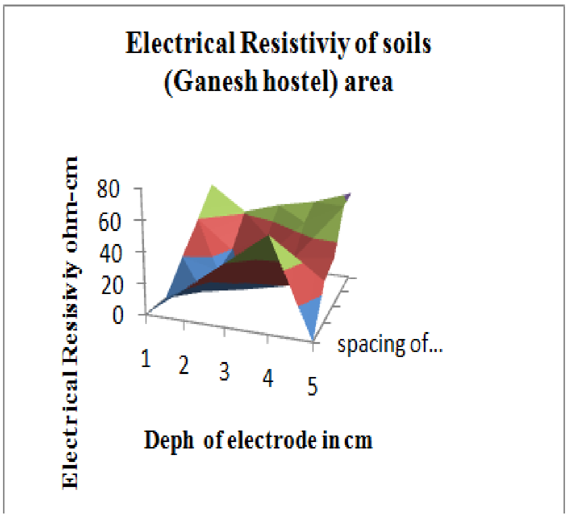
Depth of electrode in cm	Electrical Resistivity (ohm-cm) @equal spacing			
	0	20	40	60
0	13.42	18.30	23.00	30.96
20	17.45	23.48	33.34	36.48
40	19.05	30.08	44.66	49.42
60	29.42	32.63	48.96	53.68



In this area the electrical resistivity of soils is low so the he soils are un saturated ,and also moisture content of soils are very less.

Table 5. Location: K.S.R M Boys hostel:.

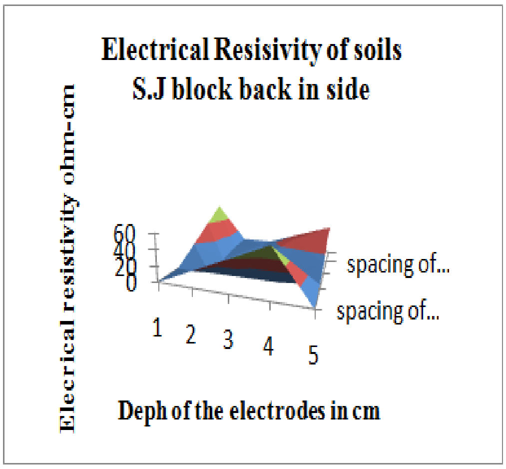
Depth of electrode in cm	Electrical Resistivity (ohm-cm) @equal spacing			
	0	20	40	60
0	8.42	13.46	19.38	26.32
20	13.03	18.63	28.46	32.00
40	19.62	32.48	45.32	58.96
60	41.32	48.63	53.42	61.8



In this area the electrical resistivity of soils very low, the basic principle is if the resistivity of soils very low the soils not having moisture content .

Table 6 .Location: K.S.R.M S.J BLOCK INSIDE:

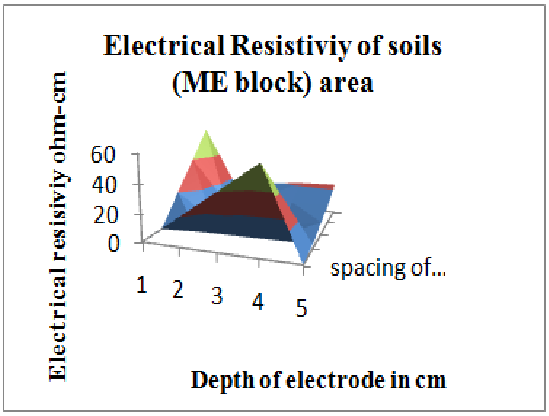
Depth of electrode in cm	Electrical Resistivity (ohm-cm) @equal spacing			
	0	20	40	60
0	0.56	0.99	1.46	5.98
20	2.34	3.89	7.06	12.45
40	6.42	14.62	28.42	32.07
60	6.56	7.00	23.426	38.48



In this area soils are having maximum resistivity .so the soils are having maximum moisture content.

Table 7 .Location: K.S.R.M Mechanical block:

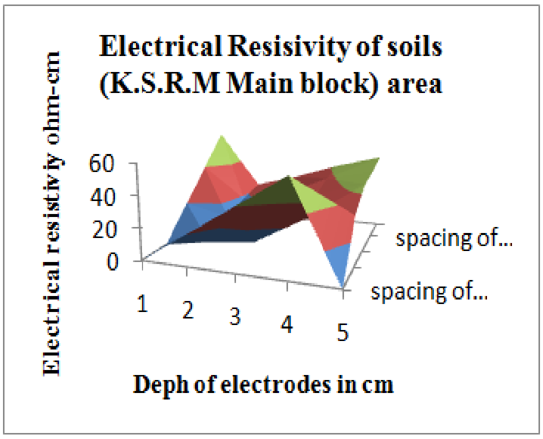
Depth of electrode in cm	Electrical Resistivity (ohm-cm) @equal spacing			
	0	20	40	60
0	1.45	1.98	2.56	2.98
20	2.42	2.89	3.46	8.94
40	8.96	12.36	12.98	13.86
60	13.42	18.62	21.42	22.39



In this area the electrical resistivity of soils are high. moisture content of soils are very high.

Table 8 .Location: K.S.R.M Main block:

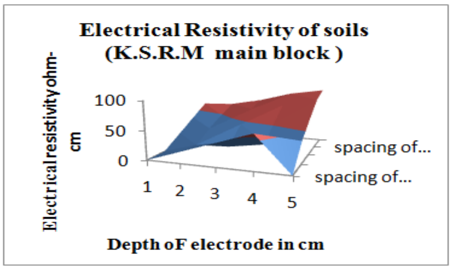
Depth of electrode in cm	Electrical Resistivity (ohm-cm) @equal spacing			
	0	20	40	60
0	5.43	8.94	26.48	32.45
20	13.45	28.42	34.63	43.82
40	18.64	23.42	38.68	46.03
60	22.42	30.92	41.32	49.83



In this area the electrical resistivity of soils are minimum. so the moisture content of soils are very less.

Table 9 .Location: K.S.R.M Main Ground :

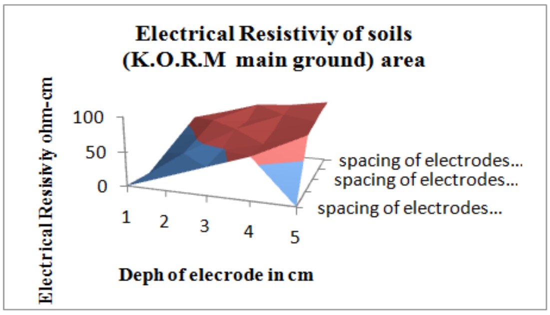
Depth of electrode in cm	Electrical Resistivity (ohm-cm) @equal spacing			
	0	20	40	60
0	16.89	19.38	28.46	39.63
20	34.31	46.48	53.42	64.64
40	48.92	64.38	76.01	87.46
60	62.34	73.46	89.46	112.42



In this area the electrical resistivity of soils is very low so the he soils are un saturated ,and also moisture content of soils are very less.

Table 10 .Location: K.O.R.M Main Ground :

Depth of electrode in cm	Electrical Resistivity (ohm-cm) @equal spacing			
	0	20	40	60
0	38.93	48.44	62.89	79.99
20	52.73	68.43	71.02	87.63
40	68.42	70.21	84.73	95.43
60	73.96	89.79	92.43	99.86



In this area the electrical resistivity of soils is very high. so the he soils are saturated and also moisture content of soils are very high.

VI. Conclusion

- Electrical Resistivity method was successfully performed for field soil identification. Electrical Resistivity value was relatively influenced by the variation of basic geotechnical properties.
- It is workable to measure electrical resistivity of field soil by the multi meter.
- Electrical resistivity of three kinds of soils and saturation has a good. Electrical resistivity of soils increases with the increase of soils saturation.
- Under the condition of the same density and saturation, electrical resistivity of sand is far larger than that of loess and clay due to the effect of mineral composition, particle arrangement, content of clay particle and internal impurities.
- if the depth and spacing of the electrodes increases the resistivity of soils are also increases.
- The electrical resistivity values are largely influenced by the variations of basic physical properties of soils.

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