The Electrical Resistivity of Various Field Soils: An Experimental Study

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Abstract:
The geophysical approach, traditionally used by geophysicists but increasingly adopted by civil engineers, is one of the most widely used research strategies today. One such geophysical instrument that provides a highly appealing approach for subsurface profile characterisation over a wide region is the Electrical Resistivity Method (ERM). Effective, efficient, and long-lasting in terms of cost, time, data coverage, and sustainability, ERM is a potentially useful alternative strategy in groundwater research. Several software programs have used ERM for locating underground water sources. For many years, excavating and test boring have been the mainstays of site inquiry in order to glean knowledge about the earth's layers.The depth at which a resistivity reading is taken depends on the distance between the test's two electrodes. Grounding system with aluminum rods to measure soil resistivity and ground resistance at 10 locations around K.S.R.M. College. Using geotechnical parameters and other relevant information, this research demonstrated that the ERM may be constructed as an alternative tool in soil identification.

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

I. Introduction

In order to learn more about the soil and rock that would be utilized in the building process, a geotechnical site investigation (SI) was conducted. There are often two phases: the first surface investigation, and the subsequent underground exploration. Soil samples and lab tests were often done during subterranean investigation, but physical mapping (like geological mapping) was always undertaken during surface exploration. Several methods, both conventional and nontraditional, were often used in the SI. Many geotechnical and other engineering challenges have benefited from the use of electrical resistivity soil monitoring to examine the near surface soil profile.

Since the resistivity of subsurface material is quickly altered by conductive or resistive fluid injection, direct current (DC) resistivity monitoring has been widely employed in geotechnical studies.

Construction of highway embankments, earth dams, geotechnical engineering, and other branches of civil engineering all need near-surface soil characterizations and soil strength calculations. Soil properties may be identified by measuring electric potential differences and electrical resistivity. in proportion to the soil's depth. Through layer-by-layer earth analysis, the multilayer earth structure model of soil electric properties will be able to carry out the required soil characterizations in geotechnical studies. In order to achieve the goals of the geotechnical inquiry, new approaches to constructing multilayer soil resistivity profiles are encouraged in this work.

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 resistivityof 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 commontypes. 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 groundto 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 haveto 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

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 plantgrowth; 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.

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 .

: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

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.

V. Results And Discussions

To study the electrical resistivity of soils:

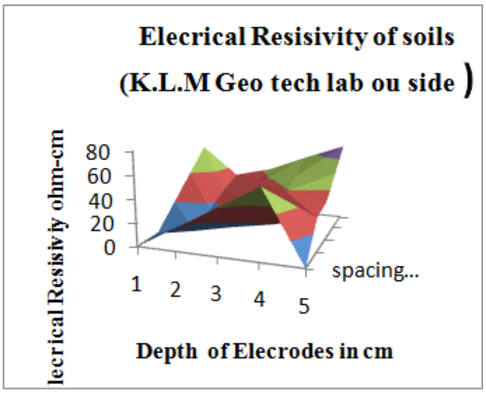
In these case i have to successfully done the electrical resistivity of different field soils by using electricalresistivity method. The soils electrical resistivity values mentioned below the objective

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:

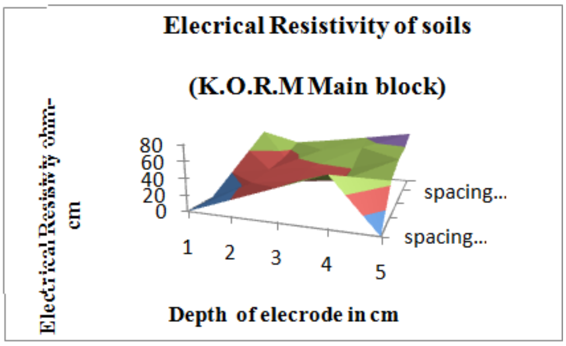
Depth of electrode in cm	Electrical Resistivity (ohm-cm) @equal spacing			
	0	20	40	60
0	6.432	13.86	20.112	29.62
20	16.324	28.421	39.163	33.121
40	26.121	36.492	45.762	50.362
60	33.492	42.003	56.132	69.132



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

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

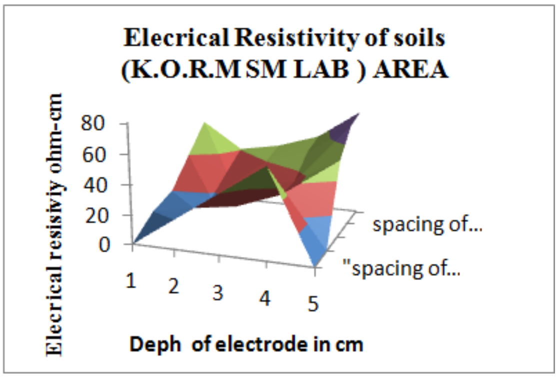
Depth of electrode in cm	Electrical Resistivity (ohm-cm) @equal spacing			
	0	20	40	60
0	25.62	32.46	39.00	44.02
20	28.92	36.42	40.13	56.12
40	34.32	49.02	56.12	59.01



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

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

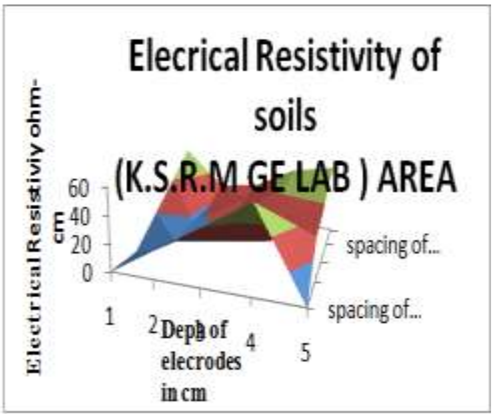
Depth of electrode in cm	Electrical Resistivity (ohm-cm) @equal spacing			
	0	20	40	60
0	13.26	18.96	23.12	34.16
20	17.43	26.190	35.63	52.32
40	29.34	39.96	48.94	69.73
60	40.06	45.43	54.63	74.65



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:

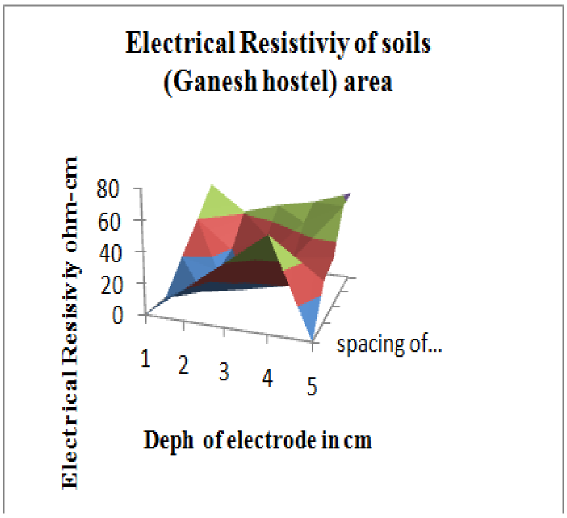
Depth of electrode in cm	Electrical Resistivity (ohm-cm) @equal spacing			
	0	20	40	60
0	13.42	18.30	23.00	30.96
20	17.45	23.48	33.34	36.48
40	19.05	30.08	44.66	49.42
60	29.42	32.63	48.96	53.68



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

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

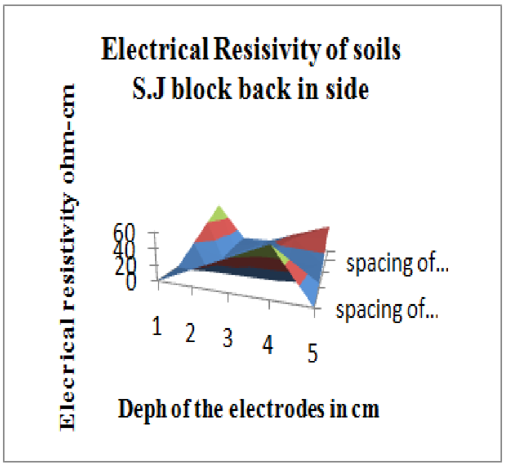
Depth of electrode in cm	Electrical Resistivity (ohm-cm) @equal spacing			
	0	20	40	60
0	8.42	13.46	19.38	26.32
20	13.03	18.63	28.46	32.00
40	19.62	32.48	45.32	58.96
60	41.32	48.63	53.42	61.8



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

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

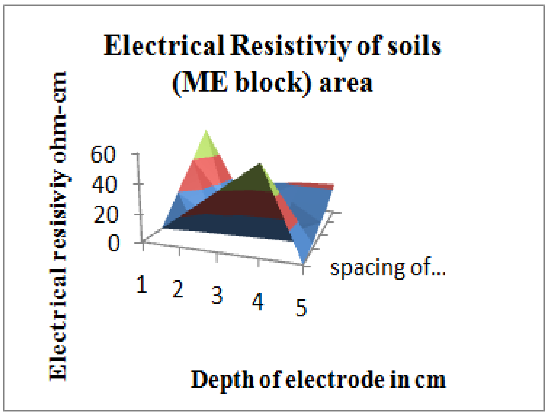
Depth of electrode in cm	Electrical Resistivity (ohm-cm) @equal spacing			
	0	20	40	60
0	0.56	0.99	1.46	5.98
20	2.34	3.89	7.06	12.45
40	6.42	14.62	28.42	32.07
60	6.56	7.00	23.426	38.48



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:

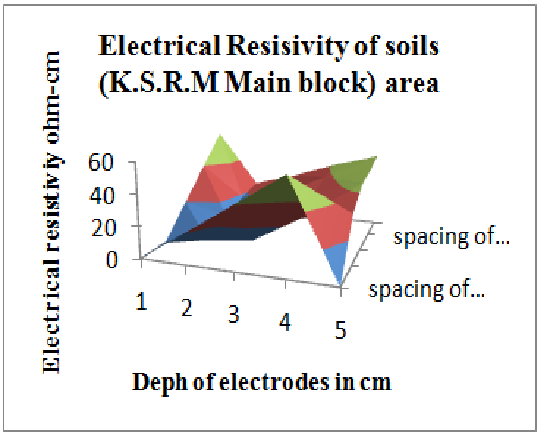
Depth of electrode in cm	Electrical Resistivity (ohm-cm) @equal spacing			
	0	20	40	60
0	1.45	1.98	2.56	2.98
20	2.42	2.89	3.46	8.94
40	8.96	12.36	12.98	13.86
60	13.42	18.62	21.42	22.39



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:

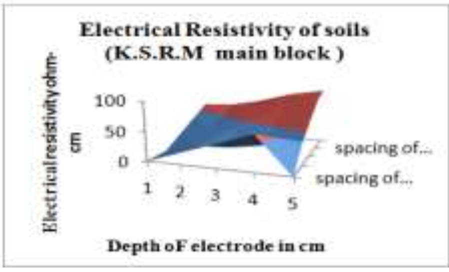
Depth of electrode in cm	Electrical Resistivity (ohm-cm) @equal spacing			
	0	20	40	60
0	5.43	8.94	26.48	32.45
20	13.45	28.42	34.63	43.82
40	18.64	23.42	38.68	46.03
60	22.42	30.92	41.32	49.83



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 :

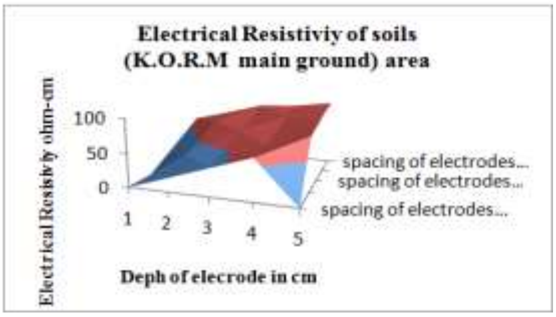
Depth of electrode in cm	Electrical Resistivity (ohm-cm) @equal spacing			
	0	20	40	60
0	16.89	19.38	28.46	39.63
20	34.31	46.48	53.42	64.64
40	48.92	64.38	76.01	87.46
60	62.34	73.46	89.46	112.42



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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