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Technical Report

Resistivity Tests on RESLO Ground Enhancement Compound

for

Lightning Protection International Pty Ltd

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1. Introduction

RESLO Ground Enhancement Compound is used in earthing systems to reduce the resistivity of the soil surrounding earth system electrodes, effectively reducing the resistance of the overall earth system.

The resistivity of typical soils varies between 10 Ω.m and 1000 Ω.m, with higher resistivities occurring with low moisture content and low temperatures. The resistivity of earth enhancement compounds also varies considerably with moisture content and temperature. Resistivity also varies as the compound goes through various chemical processes as it “sets”.

The purpose of this test is to measure the resistivity of a sample of RESLO ground enhancement compound. The electrical properties of the RESLO were measured using the equipment and methods described in this report, and following the recommendations of ASTM G57 - 06(2012) *Standard Test Method for Field Measurement of Soil Resistivity Using the Wenner Four-Electrode Method*.

This report was prepared using the data obtained from these tests.

2. Test Equipment

- 0-20V variable voltage DC power supply
- Volt meter
- Current meter
- 4 lengths ~1mm^2 wire
- 4 electrodes
- Non-conductive long rectangular container with constant cross section.

3. Theory

The resistivity of a material can be defined as the electrical resistance between opposite faces of a cube with 1 m sides, measured when a uniformly distributed current is flowing between the two faces.

For a material with resistivity ρ *[Ω.m]*, the resistance R between two faces of area A *[m^2]*, separated by a distance l *[m]*, is given by:

$$R = \frac{\rho l}{A}$$

If a resistance measurement is made of a known rectangular volume of material, this formula can be inverted to calculate the resistivity.

In order to measure the resistance, a test current can be injected via the ends of the test volume, and the voltage generated between two inner electrodes measured. This technique is known as the four wire resistance method, and is as per the method recommended for measurement of soil resistivity in standard ASTM G57 - 06(2012) *Standard Test Method for Field Measurement of Soil Resistivity Using the Wenner Four-Electrode Method*.

The resistivity can then be calculated as:

$$\rho = \frac{V.D.W}{I.l}$$

Where V = measured voltage [V]
D = depth of container [m]
W = width of container [m]
I = test current [A]
l = distance between voltage electrodes [m]
ρ = resistivity [Ω.m]

The voltage measuring electrodes should be at a known distance apart with sufficient separation from the current injection electrodes to avoid localised current density variations.

The maximum test current should be restricted to ensure that the compound being tested is not electrically heated, and the time of application of the test current should be limited to avoid electrolysis effects.

4. Test Configuration

Approximate internal dimensions of the polystyrene test container were 250mm long, 55mm wide and 40mm deep. These dimensions were measured with an accuracy of 1%.

The electrodes were fitted into the container such that they could not move when the earth enhancing compound was poured in. The two current electrodes were fitted at either end of the container. The two voltage sense electrodes were placed 150mm apart, centered between the current electrodes. The distance between the voltage sense electrodes was measured with an accuracy of 3%.

The Variable DC Power Supply was connected in series with the Current Meter and current electrodes. The Voltmeter was connected between the voltage electrodes.

The supply voltage was adjusted to ensure that the maximum test current remained below 1 Amp, and only turned on for brief periods while the voltage was measured.

Readings were taken of current and voltage and time noted. A number of readings were taken at different current levels. The accuracy of these readings was 1%.

The sample was kept undercover. The sample was subject to temperature fluctuations between 10°C and 25°C. Humidity was not recorded, but is known to be reasonably constant at approximately 45%.

Figure 1 - Test container filled with RESLO

5. Results

RESLO resistivity measurements:

Parameter	Value	Units	Comments
Width, W	0.055	m	Width of test container
Depth, D	0.04	m	Depth of test container
Length, L	0.15	m	Distance between voltage electrodes

Time	Test Current (mA)	Electrode Voltage (V)	Resistivity (Ω.m)	Comments
11:30am	25	0.179	0.11	RESLO poured into container
12:00pm	300	8.24	0.40	
12:00pm	150	3.72	0.36	
12:00pm	100	2.35	0.34	
12:00pm	50	0.98	0.29	
12:00pm	25	0.278	0.16	
12:00pm	10	0.134	0.20	
3:30pm	100	3.04	0.45	
9:30pm	300	10.42	0.51	Fully set
9:30pm	200	6.96	0.51	Fully set
9:30pm	100	3.6	0.53	Fully set
9:30pm	25	0.98	0.57	Fully set

Average	0.53	Average of fully set values only	

6. Conclusions

RESLO ground enhancement compound was found to have an electrical resistivity of 0.53 Ω.m after sufficient time had been allowed for the compound to set. This is between one and three orders of magnitude lower than the resistivity of typical soils, implying that when used as directed this compound will reduce soil resistivity.

The initial electrical resistivity was nearly 5 times lower, measuring only 0.11 Ω.m. The lower initial resistivity is due to the higher moisture content in the material when it is first poured.

It should be noted that test results can be influenced by variables that are outside of the control of the test procedure. Such variables include air temperature and air humidity. Differences in these variables at the time of testing will influence the actual resistivity figures measured and as such some variability in results can be expected if tests are to be repeated under different temperature and humidity conditions.