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Scope:

This test was an actual installation of Utility Structural Systems newest line of engineered backfills known as Poly-Ground®. In our opinion, Poly-Ground® has many benefits, such as worker safety and enhanced grounding, but perhaps one of the most significant benefits that can be noted is the lower impedance, which decreases line loss of the system. It also, in this particular case given this was a transmission line, provides a much more effective, safer, and faster path to ground for electrical discharges of all types.

Conditions and Installation:

Upon arrival I was able to make contact with the crew supervisor responsible for building and constructing the line. It had rained for several days and it rained throughout our entire installation. This particular line was a 161kv H-Frame, wood pole structure that was being refurbished. According to several reports from the crews this line has been installed in the early 1900's. The line was being fed to a substation about 1.5 miles away. The terrain was mainly hills and farmland. I met the crew at another substation to go over the details of the day. We traveled to the East substation and we were able to start talking about what to expect from this project. We traveled to the jobsite and began by doing a soils resistivity test in order to get a baseline reading for the area in which we were working. We used the "line traverse" method for calculating soil resistivity which is an industry standard for this type of testing. We used an AVO International DET 2/2 Digital Earth Tester for this particular test. The need for this type of testing is important due to the fact that you need a baseline of the soil properties to determine the real effectiveness of the Poly-Ground® in any given soil condition. The better the soil is, then, theoretically, the less Poly-Ground® is needed. Conversely, the worse the soil is, more Poly-Ground® is better for the system. Please see the results of the soils reading in the below table. (*Also see Appendix "A" to view a photo of the resistivity method being employed*).

POLY-SET®

Soil Reading Table

Line Traverse		Arkansas 3/22/2005			
Calculation of Resistivity			p = 2 x 3.14159 x a x R		
p = resistivity in ohm-meters				depth = a / 20	
a = test spike spacing in meters					
R = resistance measured in ohms					
a	a	depth of spike	ohms		Average Soil Resistivity to Depth "a" in
feet	meters	feet	reading	ohm - meter	ohm - centimeters
2	0.610	0.100	67.900	260.07	26007.24
3	0.914	0.150	0.000	0.00	0.00
4	1.219	0.200	31.400	240.54	24053.82
5	1.524	0.250	0.000	0.00	0.00
6	1.829	0.300	27.500	315.99	31599.37
7	2.134	0.350	0.000	0.00	0.00
8	2.438	0.400	16.500	252.79	25279.50
9	2.743	0.450	0.000	0.00	0.00
10	3.048	0.500	8.600	164.70	16469.97

The poor soil condition readings obtained in this test (*see above chart*) means the soil in this general area was not particularly favorable to lowering resistance values. The resistance in this area ranged from 260 ohm-meter at 2' deep to 164 ohm-meter at 10' deep. I can only assume this was a known fact given this location was chosen to test our product. Once the clearance was obtained on the line, removal of structure 443 on this line was begun. Prior to excavation and removal of the north side structure, we were able to disconnect the ground line from the static line resulting in the southern pole on that structure being isolated from the rest of the poles and the system in general. This was done so we could tell exactly what readings were existed prior to the installation. Using the "Fall of Potential" method, a reading of 336 ohms was observed. This seemed high at first, but after reviewing the soil resistivity reading and plugging in the known data, it could be calculated that a 5/8" copper clad ground rod would have read about 79.2 ohms. This number was calculated using IEEE formulas and standards, and was not verified in the field. Once the north structure was removed from the hole, we viewed the remnants of the copper ground wire currently in place and massive corrosion had taken place. Corrosion was so prevalent, that the ground wire was actually in 3 separate pieces. At the end of the pieces, the ground wire was corroded to the approximate size of a pencil-point. It can be assumed this particular ground wire was highly ineffective in it current condition. It would also explain the extremely high reading obtained from the south structure. The poles being installed as replacements for the wood poles were poles supplied by Thomas & Betts Manufacturing from the South Carolina plant.

Conditions and Installation (continued):

They were 2-piece Core 10, self-weathering steel poles with corro-coat (or similar product) applied from approximately 3’ above grade to 4’ above the butt of the pole. The 4’ section of the pole was not coated in any way and appeared to have a galvanized finish. (*See Appendix “B” for a photo of the poles prior to installation*). The pole identification plate listed them as LD3 class poles 65’ in height. These poles had a groundline diameter of about 15 ½” with a butt diameter of 18”. The hole was augured out to 26” in diameter to accommodate the new pole being installed. Once in place and plumb, the pole was then backfilled with 2 Poly-Ground® kits (PG-30W) and then finished off with a Poly-Set® kit (PS-250W). It was suggested by Utility Structural Systems, that the foundation be done this way as Poly-Ground® would not make a significant impact on the portion of the pole that was corro-coated because it could not make direct contact with that portion of the pole. We can presume the resistance numbers would have improved, but any improvement would have been negligible. Once set, this structure was not megged but the assumption could be made that the pole would have been relatively identical to the south structure. The south structure was removed in the same fashion and found to be in very close condition to the north structure. The ground wire on this pole was actually in 4 pieces. (*Please see Appendix “C” for a photo of the condition of the ground wire*). It was this structure that provided a reading of 336 ohms prior to removal, so it was decided that due to weather conditions, we leave the megger probes in place and meg this structure so to save some time in very inclement weather. It would also provide a direct correlation to what the readings were from what was existing to what reading was obtained showing the improvement from the new structure. The structure was backfilled in sections. The first reading obtained was after installing a single Poly-Ground® kit. That reading was 3.9 ohms. After the second Poly-Ground® kit was installed, a second reading of 4.19 ohms was taken. The reason for the increase is because the Poly-Ground® has an exothermic reaction (heat is generated) and heat is resistance. Once the foam cooled down the reading went back down to 3.87 ohms, showing virtually no gain resistance. The remainder of the structure was backfilled with Poly-Set®. Cross arms, X-braces and conductor/static installation completed the assembly of the structure and the job was deemed completed. (*See Appendix D for the finished structure*). I remained on site to answer questions from the crew, and staff. Poly-Ground® is similar in installation procedures to Poly-Set®, however, Poly-Ground® MUST be pre-mixed with a drill and the combined foam must also be drill mixed given its much higher viscosity. The installation went well and I again thank all that attended.

Conclusions:

We feel quite confident, as evidenced by the numbers, that Poly-Ground® had a significant, positive effect on the grounding of these types of poles. Furthermore, it indicates surface area is playing a key role in the grounding of structures when Poly-Ground® is used. The reason we conducted the test in this fashion was to prove that very theory.

Respectfully submitted:

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Utility Structural Systems

Appendix A Photos:

Line Traverse Method for Ground Resistance

Photo showing existing line

Appendix B Photos:

Photo showing poles prior to installation

Appendix C Photos:

Photos showing the condition of the ground wire that was excavated from the existing structure. The ground wire from the ground line down, was corroded into 4 pieces.

Appendix D Photos:

Photo showing Poly-Ground installed prior to Poly-Set backfilling

Photo showing finished structure