Utility Structural Systems

Corporate Sales Office
2201 N. Collins St., Suite 240
Arlington, Texas 76011

Voice 800.367.9273
Fax 817.277.3441

Houston Sales Office
9430 Telephone Rd.
Houston, Texas 77075

Voice 877.765.3738
Fax 281.890.6913

www.utilitystructural.com

POLY-GROUND

August 25, 2005

Scope:

This test was an actual installation of Poly-Ground, Utility Structural Systems' newest line of engineered backfills in the desert Southwest. We believe Poly-Ground® has various 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. With this test being on a transmission line, Poly-Ground® also provides a safer, more effective, and faster path to ground for electrical discharges of all types and will potentially greatly reduce the incidence of nuisance tripping.

Conditions and Installation:

We arrived at the Service Center the morning of August 1st and met with personnel from the standards engineering team. After conversing about the project, we went to the jobsite and met up with the construction crews.

I was advised to give preliminary instruction to the crew on Poly-Ground®. In addition to instructions, I gave everybody, an overview of what we were attempting to accomplish that morning. Prior to starting we discussed safe use, installation, precautions, and measuring the product's performance. The line being tested was a wood pole line being replaced/refurbished with LD 5 Class poles 65' in length intended to be an unguyed structure. As a precaution, I did calculations in our Houston office prior to my arrival to determine if the pole would be under enough strain to cause backfill failure. After looking at the numbers, I determined it would be safe to proceed with the installation. This hole was about 36" in diameter and 8'-6" in depth (the standard depth for this pole using the 10%+2' rule for pole embedment).

The soil in the vicinity was typical for the area with the exception of moisture. According to the utility's personnel, for several days there had been an unusual amount of rainfall in this area resulting in much more soil moisture than normal. There were several large holes with standing water in them, including the second pole that actually had water standing around the base of the pole due to normal runoff. I attempted to do a soils resistivity test, but for several reasons, it could not be performed. The first reason was the large amount of water present. The numbers would certainly be skewed reflecting the high soil moisture at the surface and would not reflect normal conditions. The second reason was due to the sandy nature of the soil. The probes used to measure the soils resistivity could not stand on their own. The probes are driven no deeper than 6" incrementally by ½" throughout the test but the sandy soil had no cohesive properties and could not adequately hold the probes in place. A soil reading could have been taken in another location, but it may not have accurately reflected the location we were doing the installation.

The pole being replaced was still connected to the rest of the line by the neutral and to be tested properly, it had to be disconnected so we would not be reading the system resistance instead of the individual pole. This particular pole had 4 ground wires connected to 4 previously installed individual ground rods. Using the "Fall-Of

Potential Method", we megged all 4 ground rods connected together and got a reading of 42 ohms (not a particularly good reading for 4 connected ground rods). Utility Structural Systems uses a DET 2/2 Auto Earth Tester manufactured by AVO International.

We prepared to install the new structure and went over the installation process once more. I explained we would be very deliberate in this method for testing/instructional purposes and it would take longer then normal. After stretching out the megger into the "Fall-Of-Potential Method", we focused on the actual installation and backfill of the pole. For this particular test method, the megger was not moved until completion to insure accuracy of the several readings to be taken. I calculated this void (with the dimensions of the pole and hole size and depth) would require about 45 ft^3 of backfill, no matter what material was used; i.e. crushed stone, dirt, concrete, or foam. Simply stated it would have taken 1.7 yards of any "native" backfill. I mention this to help the utility evaluate the associated costs between the different products, keeping in mind that Poly-Ground is the only one that will greatly reduce the ground resistance readings (even though, the other backfills can be considered "conductive", at least to some degree). Prior to the trip, we discussed the pole being installed and decided the best way to install this pole was to use Poly-Ground only on the portion of the steel pole not in contact with the protective urethane coating, sometimes referred to as "corro-coat". According to their personnel, it is standard practice to coat these poles from 1' above grade to 4' above the butt of the pole to help curtail the corrosion effects of the soil, be it either from moisture, or cathodic in nature. Note:Full length urethane coatings, while arguably effective in corrosion curtailment, brings up a far greater issue of pole grounding and safety if there are no other grounding methods on that structure (i.e. a ground rod or butt plate and assuming the utility is using the pole as the grounding electrode). If a ground rod is used as a primary ground, the ground rod must be driven outside the augured hole or into the ground below the point of excavation (driven into the soil prior to backfilling). If the ground rod is placed in the void and backfilled natively, which is not as uncommon as one might think, then contact with earth is highly questionable at best. However, tests have shown Poly-Ground can be used effectively in this method because of It's bonding nature.

During the installation, Poly-Ground was applied in increments due to the large void to fill and kit sizes being used. The maximum single kit size for Poly-Ground is 4 cubic feet but the largest Poly-Set kit will yield 10 ft^3. The Poly-Ground is a two component system with an "A" component and "B" component and each kit is pre-measured by ratio. The "A" component MUST be premixed prior to be combined with the "B" (this is clearly marked on the containers). The reason for this is the materials that make up Poly-Ground "A" can settle out over time. Once premixed, the "B" component is poured into the "A" component and mixed according to the temperature chart on each pail making sure to move the supplied mixing apparatus up and down in the pail to insure adequate mixing. The process MUST be done with a ½" drill that is either electric, gas driven, or battery operated and has enough power to adequately mix several kits throughout the day. Once mixed, the process of expansion cannot be stopped. The material is then poured into the void, making sure to scrape all Poly-Ground materials from inside the bucket using the supplied wooden paddle. The paddle is NOT to be used to mix the product. It will not do the job adequately. The PG30W kit supplied to the utility for this test, proved to fill about 1' of depth for each kit poured. Although this might seem extreme, the void size was rather large, and costs can be significantly reduced by using smaller auger sizes. During the Poly-Ground/Poly-Set reaction, an exothermic reaction takes place that generates heat and heat is resistance electrically speaking. We waited 10 minutes for the heat to dissipate in order to get a somewhat accurate reading without the heat influencing the numbers. We used the same method for each Poly-Ground kit poured. Below is a chart illustrating the megger readings after each Poly-Ground kit was poured and a 10 minute waiting period to allow the heat to dissipate. Once proven, the 10 minute waiting period is not necessary because no readings would be taken in the field unless specified.

46kv Primary, 13.8kv Secondary Steel Pole Measuring

Pour Number	Depth of Poly-Ground	Megger Reading
Pour #1	12"' Depth	90.6 ohms
Pour #2	24"' Depth	58.8 ohms
Pour #3	36" Depth	43 ohms
Pour #4	48" Depth	33.6 ohms
Pour #5	58" Depth	28.7 ohms

Ground resistance readings on the particular structure were measured with the boom of the augur truck attached, but I made sure the truck was isolated from the structure. We also measure the structure once the auger truck was disconnected from the structure. The numbers obtained were identical so it proved the boom isolated the truck from the structure. Once all of the Poly-Ground was poured we filled the remaining void with Poly-Set, which is our non-conductive backfill foam. Our prior calculations on the amount of foam needed to fill the void around this pole were exactly correct for the practical application. As you can see, we significantly reduced the resistance on this particular structure by 32% just by changing the backfill. Poly-Ground has more advantages than just it's conductive nature, such as being a solid backfill. This should be taken into consideration when evaluating the costs incurred with Poly-Ground. Pound for pound, it is a more expensive backfill, but when ALL factors involved are considered, Poly-Ground makes more sense than any other backfill available today.

Once this pole was finished, we moved one structure to the south which had two newly installed ground rods attached. Once disconnected from the system neutral, we were able to meg the structure and obtained a reading of 27 ohms. This was an unusually low reading for this structure but after evaluating the environment it was clearly explained. This particular structure had a drainage valley leading to it that contained quite a bit of rain runoff leading right to the base of the pole. As previously mentioned, it actually had standing water around potions of the base of the pole which would artificially lower the resistance readings. We do not feel this was representative of the normal conditions under which this structure operates.

We agreed to move back two structures to the north and meg that structure. This structure, according the utility's personnel, had one ground rod, and one grounding butt plate tied together. Once disconnected from the system neutral, we megged the two tied together and obtained a reading of 49.2 ohms. This was more in line with the initial structures readings. We agreed to separate the two grounding electrodes to measure them individually. What we saw was rather interesting, the ground rod, when megged by itself, was 42 ohms. Not any better then the 4 rods on the initial structure. We then megged the butt plate by itself and received a reading 177 ohms. This would indicate that the butt is highly ineffective for some reason. It was actually hurting the reading overall. I remained on site to answer questions from the crew, and staff.

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:

Jason Davenport

Jason Davenport
Account Executive
Utility Structural Systems

Appendix B Photos:

Poly-Ground Being Mixed On-Site

Poly-Ground Being Poured Into Hole

Appendix C Photos:

Photo After Initial Pour

Finished Poly-Ground Portion

Appendix D Photos:

Photo Showing Poly-Set Being Hand Mixed

Photo Showing Poly-Set Being Poured Into Hole

Appendix E Photos:

Photo Showing Finished Structure with Megger Wires attached

Additional Photo of Finished Structure