

Devils Lake City Embankmentsm - Creel Bay Reach Utility Abandonment Plan with Low-Shrink Grout

Final End User: City of Devils Lake
Construction Manager: U.S. Army Corps of Engineers
**Utility Abandonment
Phase 1 Contractor:** Park Construction Company
Phase 3 Contractor: United Crane & Excavating
Technology Support: Midwest Testing Labs, Inc.
Concrete/Grout Supplier: Strata Corporation, Inc.

Innovation Award



Prior to the construction of the new earthen levees required to protect the City of Devils Lake from the rapidly rising Devils Lake waters, all of the utility pipes running through the existing levee had to be located and filled with nonshrink grout. This construction requirement presented a huge challenge to Park Construction Company (Park). First, due to the large amounts of grout needed to fill the existing utility lines, and the limited capacity of the commercially available grout pumps, the set time of most commercial nonshrink grout was far too short. Second, in order to modify commercially available grout to meet the longer set times the grout producers had to charge in excess of \$2,000 per cubic yard for the mix alone. This figure did not include freight, mixing labor or delivery. Finally, due to the amounts of grout needed, mixing the grout in the grout pump's mixing tank was not an option. Park needed a nonshrink grout that could be mixed at the batch plant and delivered using standard concrete trucks. To solve this dilemma Park turned to its concrete supplier, Strata Corporation, for a value engineered solution.

Strata's mix design was an overwhelming success. Some of the utility lines Park had to fill and abandon were over 345' in length and up to 10" in diameter. This meant that it could take up to several hours to fill the lines with grout. The grout supplied by Strata was still extremely pumpable at the 3 hour point; and more importantly the grout contained within the utility line was still extremely fluid and easily moved by the commercial grout pump. In addition, the grout supplied by Strata was batched at the plant and could be delivered in a standard concrete truck. Moreover, the value engineered grout mix supplied by Strata offered a very substantial savings in material costs over a comparable modified bag grout mix that could have been supplied by the national non-shrink grout suppliers. And, the material that would have been supplied by the commercial grout suppliers could not have been mixed at the batch plant nor could it have been mixed in a standard concrete truck. Finally, in the area that matters most to the designers, performance, Strata's grout mix performed flawlessly and exceeded expectations. The U.S. Army Corps of Engineers had Park excavate an area that contained a portion of the utility that had been grouted to verify its performance and they could not have been more pleased with the results.

The task was to create a very fluid non-shrink cementitious grout that will stay fluid for 3-4 hours, and will be stable enough to pump through various size pipes up to 1000 feet. Then, the material had to be viscous enough not to experience any subsidence in the plastic state? This is a tremendous challenge.

The success of this value engineered solution is a model of how problems can be overcome through cooperative efforts between the owner, contractor, and supplier. Discussions started by identifying the constructability issues. With the help of the Corps of Engineers, we identified the desired material properties, and established laboratory tests to qualify these material properties. After identifying all the variables, a scientific method was created to address each variable. By utilizing various cementitious materials, combining them based on their properties, and applying chemical admixtures, we addressed each variable through a mix trial matrix. Once a target mix design was achieved, we turned to Midwest Testing Laboratory (MTL) to conduct qualifying test procedures. With the help of MTL the mix design was refined to the final product.

The grout mix contained the following materials:

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| 1. Cement | Strength development |
| 2. Pozzalons | Paste volume and robustness |
| 3. Bentonite | Expansion agent |
| 4. Hydration Stabilizer | Control set and temperature |
| 5. MRWR | Initial cementitious dispersion and mixing efficiencies |
| 6. HRWR | Reduce water content to reduce shrinkage |
| 7. Slump Retainer | Maintain fluidity (works in conjunction with HRWR) |
| 8. SRA | Shrinkage reducing admixture |
| 9. VMA | Viscosity Modifying Admixture |

This grout mix was used successfully on every following phase of the Devils Lake Levee project. It was pumped through pipes as narrow as 5/8" ID to 18" ID mainline as far as 1100 feet. Follow-up excavation inspections revealed full pipes with no subsidence or shrinkage.