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The Nebraska Study in a Nutshell

The Nebraska Grout Study now is several years old, and information from it has been widely circulated. There have been articles written and lectures given, and the study has been cussed and discussed around the industry. What does it mean to the grouting industry? How does it change grouting practices? What are the solutions to the problems found? This article will attempt to answer these questions, and hopefully show the best path forward with what we know today.

First, we need to look at the major findings of the study:

Positives Findings:

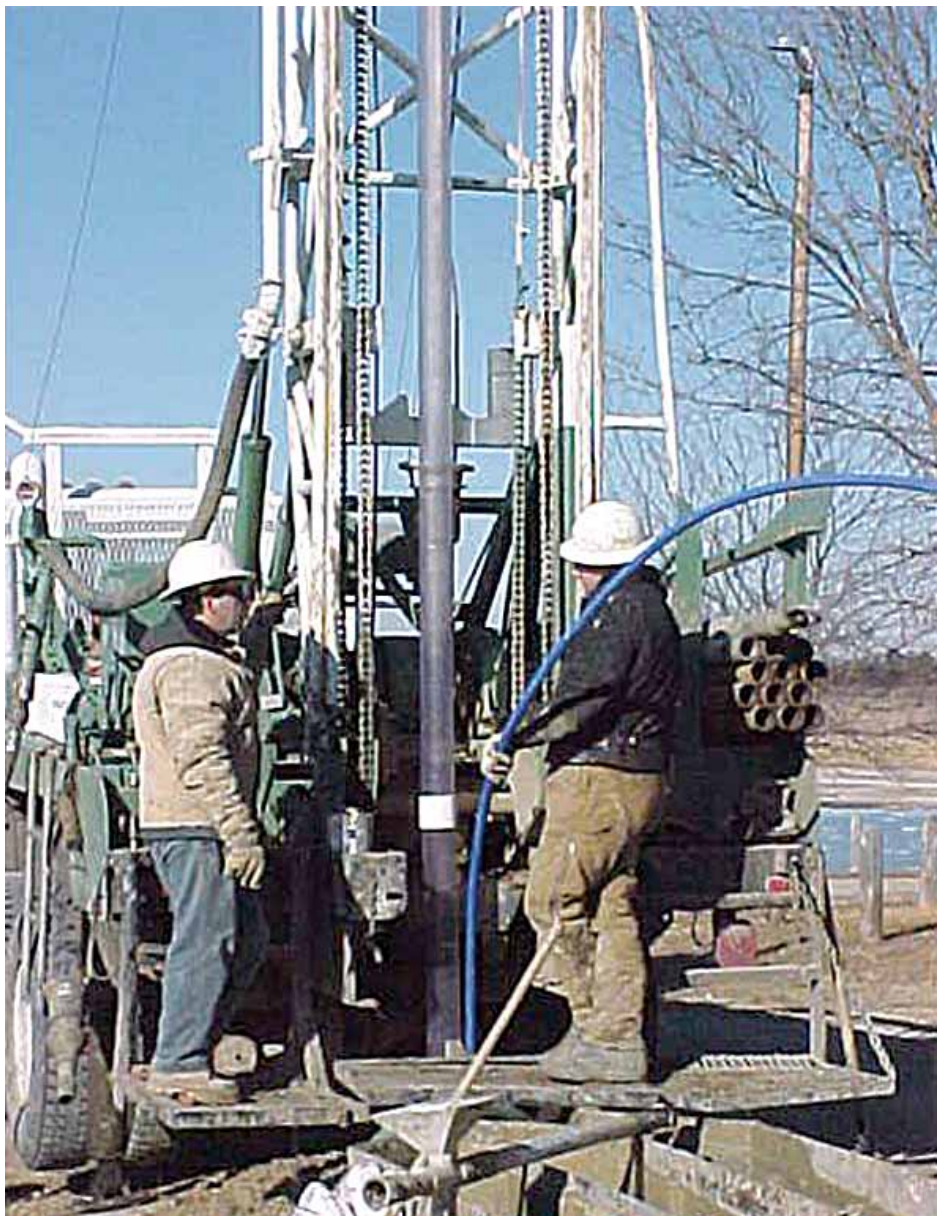
- Bentonite chips performed very well – both above and below the water table.
- Bentonite slurry grouts performed well below the water table.
- Sand cement slurries performed better than the other cement-based slurries.
- There is a place for most of the grouts tested in the study.

Negative Findings:

- Bentonite slurries, including <20 percent, 20 percent and >20 percent, did not perform well in the unsaturated zone; the grout columns showed considerable desiccation in that area.
- Cement slurry grouts cracked both above and below the water table.
- The study showed that there is no perfect grout; a grout that will work in every application was not found.

Evaluation of the grouts used in the study was accomplished by the use of clear PVC casing, video cameras and dye penetration into the grout columns. The Nebraska Study is the most comprehensive and scientific study conducted to date. The industry has learned from it, and will continue to learn from it.

Now let's take a closer look at the findings and analyze them. Why did chip bentonite grout columns do so well in the study? The answer is that there were more solids in the chip grout columns than in the columns made from bentonite slurries. Percent solids in the chip columns were in the 70-percent range. They were mainly made up of high-swelling sodium bentonite that tends to hold onto the water in the column. Bentonite tablets, although not tested in the study, would perform as well or better than chips because they are made up of higher-purity bentonite. Granular bentonite also would work well, as long as it could be placed in a dry borehole and hydrated as it was placed in the borehole. The study definitely showed that the secret to successful grouting is in the solids content of the grout column – the higher, the better.



The industry learned much from the Nebraska Grout Study.

When we consider the bentonite slurries used in the study, the solids contents were relatively low, ranging from 15 percent to 30 percent, which made water content 70 percent to 85 percent of the slurry. That is a large amount of water to have in a grout column. When we take that into consideration, it makes sense that these columns would tend to shrink and crack when they are in a dry, unsaturated environment. The fact that desiccation did occur was not a surprise to grout manufacturers and many end-users of the grout. The surprise was the extent of the desiccation in a dry, harsh environment. Another surprise shown by the study was that these desiccated grout columns would not rehydrate once they came in contact with water again; it was widely thought that they would. However, the conclusion from the study was that although high-solids grout columns made up of chips would rehydrate, those bentonite slurries with solids contents of 15 percent to 30 percent would not rehydrate sufficiently.

Another part of the study – geothermal heat pump installations – gave us an answer for minimizing the desiccation in grout slurries. In this ground source heat pump market, special grouts are used. These specially formulated grouts are enhanced with large quantities of fine silica sand to increase conductivity. The Nebraska Study showed in one particularly harsh environment (135 ft. of unsaturated zone), that the addition of 200 pounds of silica sand to one bag of geothermal grout not only raised the conductivity for the heat loops, but also raised the resistance of the grout column to desiccation. Subsequent private testing has shown this to be true, and also has shown that the addition of 200 pounds of silica sand does not affect the permeability of the grout column. It makes sense that the addition of sand would result in less shrinking and cracking because the solids contents are being raised to 65 percent solids or more. The result is more solids and less water to be lost from the grout. The bentonite grout encapsulates the sand, keeps it moist, and also fills the voids between the sand particles, lowering permeability and reducing shrinkage.

For many years, it was believed that high-solids slurry grouts needed to contain only active solids that would hydrate when coming in contact with water. The ground source heat pump market and the Nebraska Study have shown us that this is not the case. Inactive solids mixed in bentonite grout slurries do very well in allowing the grout to have very high solids and remain pumpable, as well as helping to reduce shrinking and cracking in the unsaturated zone.

Research continues on bentonite grouts, particularly bentonite slurries. Improvements in this area definitely are needed. However, these slurries with silica sand additions help address the problem of desiccation where pumpable grouts are needed. They certainly are a viable grouting option, and are easy to use, as well as readily available in the market today. We urge all contractors who need a pumpable bentonite grout to add silica sand when placing them in unsaturated zones.

The problem of shrinking and cracking of cement slurries continues to be a problem as well. The study showed that using sand cement helped reduce this problem, but does not totally solve the problem.

The use of cement slurries also is a problem because cement does not tend to bond to PVC casing, and will shrink away from the casing, leaving a micro-annulus, which is a conduit for contamination of the well.

Research and development has been and continues to be conducted to address these problems with cement grouts. Various additives and formulations have been used to reduce shrinking and cracking, along with the bonding problems. Some of these formulations have helped, and are being used, while others are cost-prohibitive. However, the research goes on, and hopefully answers will be found.

The Nebraska Study has been especially successful in promoting a fresh look at grouting practices. Yes, grouting will cost a little more than it did, but even with the increased costs, grouting costs only are a fraction of the cost of the investment in a well. With better grouting products and practices, we also can take pride in the fact that we are taking extra steps to protect our water resource.

To summarize the main points mentioned in the discussion above:

- If a dry sealant can be used for a grouting application, bentonite chips or bentonite tablets make a very effective grout seal.
- If a pumpable bentonite grout is required or desired, *please* use silica sand in the mix to raise the solids content in the unsaturated zones.
- If a cement grout is specified or required, please check for products that contain additives for reducing shrinking and cracking.

Please contact me through *National Driller* for comments or questions on this topic. ND

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