



Annular Space Grouting of Slipline Products

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Traditional methods of using neat cement slurries, (Portland cement and water, cement with fly ash or cement with fly ash and bentonite), cement and aggregate mixes, sand or even pea gravel, have all been tried with little success and frequent failures. The lack of a safe, effective, and consistent grouting system which could be pumped under low pressure, thus reducing the concerns of deflection and collapse of the new liner pipe, has proven to be the Achilles' Heel of slipline products. Another challenge was locating materials and procedures which would eliminate floatation of the new pipe.

As recently as 1991, agencies in Southern California, through a Greenbook Task Force, have addressed the problems of annular space grouting by developing a new annular backfill grouting specification for slipline type products. The development of such specifications were included in the 1994 addition of the Greenbook.

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The Slipline Grouting Industry (SGI), continues to grow right along with the new slipline systems. When sliplining first appeared on the market, not enough emphasis or concern was placed on grouting techniques, performance and inspection standards.

As the SGI evolved, the first real materials given any notoriety were the oil well or casing cements. These systems typically were neat cement slurries, cement, fly ash and bentonite mixes, etc. The mixes developed to have low viscosity's, handle high temperatures and high pressure of injection.

Problems associated with these systems were illustrated in "Slip-lining Solutions," by Dennis Sullivan, Civil Engineering, Oct. '93. Sullivan reported a case study from the Los Angeles County Sanitation District which sliplined approximately 1733 lineal feet of 60-inch diameter, and 9235 lineal feet of 63 inch diameter Reinforced Concrete Pipe, (RCP). The article indicated that claims made of grouting runs of up to 850 lineal feet in single stage operations without damaging or floating the pipe were "difficult if not impossible". Materials tended to stack, segregate and "pressure" out after short runs. Additionally, the material mixes weigh in the range of 80 to 120 pounds per cubic foot (pcf). Even with a pipe full of water or sewerage, these systems will float the new segmental slipline pipe, which can cause joint separation and reduced flow rates. Recognizing the limitations, owners and engineers felt floatation was a fact of life, and the main focus went to completely grouting the annulus without damaging the pipe.

The article went on to outline a grouting procedure when using these types of oil well cement systems which would ensure success.

A CASE STUDY: The procedure which was agreed upon, after a initial trial and error period, was to "stage grout" when sliplining pipes. To ensure the new pipe would be grouted in place, without seeing high pressures, the pipe would be grouted into a cradle in the first stage, thus allowing the contractor to "pressure up" if need be to guarantee grouting the annular space. Even though this article pointed to this procedure as being successful, it is difficult at best to accomplish "stage grouting" of annular spaces when grouting from the surface. If the mix or slurry stacks, segregate and "pressure up" when grouting monolithically in short distances, one can expect the materials to do the same when trying to grout in two stages. These materials do not self level.

Sullivan's article also noted a brief update on the use of lower weight grouts - specifically, grouting systems and standards that Pacific International Grout Company of Bellingham, WA had incorporated. Since 1988, the company has successfully grouted all varieties of pipes using systems developed in conjunction with its main business of tunnel backfill grouting. The company has numerous U.S. patents on mix designs and density ranges for grouting horizontal, annular spaces in slipline pipes.

Grouting monolithically (in one step), generally from manhole-to-manhole, or insertion pit-to-manhole approach, can effectively handle runs to 800 lineal feet. Using materials in density ranges from 50 to 70 pcf, injection pressures stay consistently under 5 psi, while not deflecting, damaging or floating a pipe.

Due to problems that occurred on the LA Sanitation project (case

study) and just prior to releasing the Civil Engineering article in the fall of 1993, Pacific International Grout was asked to write up a short case study on grouting of Hobas pipe in Fairfax County, Virginia. Runs in excess of 800 lineal feet, were grouted monolithically and under the pipe manufacturers recommended grouting pressure of 18 psi. As indicated in the article, the runs were grouted continually over 5 hours, never exceeding 4.5 psi. Water was displaced from the annulus and floatation of the new pipeline did not occur. CH2M Hill's John Rawsthorne and County Engineer, Deepak Patel, PE, recorded these results.

The main difference between successful and failed projects is the ability to regulate densities with fluidifiers incorporated in the system. Typically these densities are lighter than a pipe full of water or sewage, but still can displace water in the annular space. No two pipe lines are alike. Recognizing this, adjustment in mix designs are made to accommodate issues such as:

- Size of the annular space
- Voids of the surrounding soil; absence or pressure of ground water
- The length of the run to be grouted
- The maximum external injection pressure of the new liner pipe
- Temperature of the sewer
- Control of fluid loss of the grout
- Weather conditions on a given day or climate in a given area

The real key for all agencies is having strong performance specifications in place and understanding what they have. Segmental slipline pipe products have been in the marketplace for quite some time. Almost any agency in the country has had a nightmare that has occurred not necessarily because of the pipe material they've selected and used, but because of a lack of understanding of grouting annular spaces. Engineers tend to rely on vendors or the pipe supplier to provide data for grouting specifications. The problem is not fully understanding the complexities and difficulties of the system selected and how difficult it is to grout small annular spaces without floating or damaging the new slipline product. The key is having standards which are achievable and understandable by the inspection people. The grouting contractor must be experienced

in using these systems, in live sewers, water lines or other trenchless conditions.

If in your standards you can specify and qualify through your submittal process, not only the material, but the grouting plan, and if you have a real knowledge and understanding of what has been put together, you can insure success when grouting these systems.

Throughout the country more agencies are focusing on how critical the annular space grouting portion of their specifications is. Truly, experience is the best teacher when it comes to looking at success and failures of annular space grouting projects. There is a sufficient track record or historical data of both successes and failures around the country that supports the need for a successful grouting system and for strong grouting standard specifications.

* If agencies use these specifications and take the time to demand each item is addressed, in detail through the submittal process, then successes with this portion of rehabilitation projects will occur. Annular space grouting is a critical component of any large diameter (18" on up) slipline project. There is no reason to have failures on annular space grouting portions of slipline projects, with the widespread knowledge of today's technology.