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Exploring the World of Trenchless Technology

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Abstract

This report, *North American No-Dig '99, Exploring the World of Trenchless Technology*, presents the thirty-nine papers prepared by experts in the field of trenchless technology and presented at the No-Dig '99 Conference and Exhibition in Orlando, Florida on May 23 – 26, 1999. These papers cover a broad range of subjects related to trenchless technology from new construction to rehabilitation of underground infrastructure. The papers are classified by subject matter corresponding to the twelve No-Dig '99 technical sessions.

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Sewage Force Main Rehabilitation using Cured-in-Place Pipe Technology

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Sewer Force Main Rehabilitation Using Cured-in-Place Pipe Technology

Introduction

The flat topography of Florida mandates the pumping of the vast majority of domestic sewerage to respective treatment facilities; while the application of force main rehabilitation using trenchless methods is yielding important developments in the field of cured-in-place pipe technology. This paper will present the case history of a 14,000 linear foot force main along State Road A-1-A in the City of Boca Raton and a 6,000 linear foot force main rehabilitation along State Road A-1-A in South Palm Beach, respectively.

Condition Assessment and Rehabilitation Selection

The pipeline in Boca Raton failed due to sulfide attack at the pipe crown in multiple areas along the 14,000 linear foot pipe run. Several collapses in the pipes, ranging from 6" through 16", occurring without advanced warning and at random locations served as an incentive for an urgently paced rehabilitation effort. Lack of access to both ductile iron and reinforced concrete restrained joint force main pipes buried adjacent to environmentally sensitive areas containing seagrapes and other protected species of plants near City park and beach access locations along State road A-1-A, made a trenchless solution extremely attractive. Cured-in-place pipe selection combined pressure pipe capacity, economy, multiple size and configuration adaptability with the advantage of minimum disruption. A competitive bid was structured, which called for the cured-in-place pipe method, including pre-qualification criteria mandating minimum experience with this type of technology in force main applications. Design considerations required a fully deteriorated 100-psi pressure rated liner with a 50-year life expectancy.

Three bids were received and the project was awarded to the successful bidder at a base bid of US $985,000. The open cut estimate for this project consisting of replacement of all pipes with extensive restoration, which would have been required, was in excess of US $2,000,000.

The force main in South Palm Beach was the victim of electrolysis in the soil resistivity less than 1000 ohm-cm within 50 yards of the Inter Coastal waterway. Segments of the cast iron pipeline had corroded "from the outside-in," causing random failures in easement areas, as well as directly under A-1-A. The mode of failure rendered internal video inspection useless in identifying zones of potential corrosion sites, since the entire hydraulic radius was in fine shape for most of the 6,000 linear foot reach of 8" ductile iron pipe. The Town manager and Council elected to "piggy back" the city of Boca Raton bid In an effort to expedite repairs to the line which was costing an estimated US $30,000 per month in random open cut emergency pipeline repairs along a busily traveled State road. This project was similar to the Boca Raton project in size to be rehabilitated, complexity, and degree of urgency. The completed contract cost of the Town of south Palm Beach contract was US $480,000.

System Design

The philosophy in design of force main rehabilitation using the cured-in-place method is extremely conservative, given the highly critical nature of system failures or defects. This is done by using only fully deteriorated design parameters, while

making extensive lining experience a requirement for pre-qualification.

The design parameters included fully deteriorated pressure host pipe criteria, internal pressures of 100 psi, a safety factor of 2, ovality of 5 percent, external hydrostatic pressure equal to depth of bury, with soil depths as high as 12 feet. Design wall thickness ranged from 9.0 mm, 8" force main liners to 15.0 mm, 16" force main liners. The minimum diameter reduction along with a superior flow coefficient meant there would be no compromise in system capacity. Epoxy Vinyl Ester resin was specified for its superior chemical resistance, creep resistance, and proven track record in force main applications.

Pipeline Location, Bypass and Host Pipe Preparation

The control parameters for rate of installation in sewage force main rehabilitation is the rate at which segments of the line can be located, bypassed, cleaned, and prepared. Prior to fabrication and wet out of the CIPP liners, a thorough survey of the defective pipeline is required. To allow for cleaning and televising, the force main was located at planned excavation points, which would later serve as "access pits." Typically, the force main tended not to follow line and grade as exhibited in as built engineering drawings which were over 20 years old. Using non-destructive sounding methods and pot holing; the pipeline was located, access pits were excavated, and bypass/entry points positioned with minimal open cut effort.

Once the pipeline was exposed at the access points, an adequate sized bypass was put in service. A major concern was the integrity of the bypass and its ability to conduct the flows necessary to maintain system capacity. Bypass pipes ranged from 8" through 12" in diameter. The bypass was strung and laid in advance of schedule four-hour shutdowns of adjacent pump stations, during which time each line segment bypass was put into service. Fusion welded HDPE bypass pipe was utilized, while victaulic grooved restrained joints, vic-grooved fittings and valves were implemented. The system adequately provided joint restraint with zero leakage in stretches commonly in the 3,000 linear foot range. Once the bypass was satisfactorily operational, cured-in-place pressure pipe lining was conducted.

Prior to lining the respective force main pipes, several types of line preparation were required. In most of the 6", 8", and 12" pipes; internal detuberculation of ductile iron using a chain flail was performed. All lines were hydraulically flushed and debris was removed using a high-pressure jet cleaning apparatus. Another common preparation in some of the ductile and concrete pipes consisted of rebuilding the host pipe in the vicinity of the access pit at the liner entry position.

CIPP Installation

Liner segments ranging in length from 200 linear feet to 1,800 linear feet were installed, using methods described in ASTM F 1743. Once isolated, the line to be rehabilitated was flooded with water to minimize friction between the host pipe and liner. The liner was then pulled in place, after which time the inversion process could commence. Just prior to inversion, the liner tube was pulled through an end template. This would allow the spigpot liner end to be formed and to be pressure fitting adaptable. Once the liner was fully inverted, the heater truck was positioned and the tube cured out. Upon completion of the curing/cooling cycle, the ends are reinstated and attached to the closure spool pieces.

The CIPP liner tube closure was constructed in a manner as to disallow the interaction of sewage and host pipe material to be lined once the installation is completed. Once back in service, the liner/host pipe interface is not subject to interaction with pressurized effluent. This is accomplished by connecting liner spigot to liner spigot with a pressure rated closure system. This can also be accomplished through implementation of a pressure rated end seal system.

In places where sections of the host pipe had to be replaced adjacent to pipes which are relined; C-900 PVC pipe, epoxy vinyl ester lined mechanical joint fittings, and megalug joint restraints were utilized to construct the closure assembly. In some instances, uncommon connections needed to be accommodated such as C-900 PVC to pit cast iron, or C-900 to PCCP. These connections were accommodated by utilizing combinations of harnessed mechanical couplings, megalugs, and starclamps. All connections were then proven by hydrostatic testing in accordance with AWWA C 600-87, section 4. Access pits were left open for the test duration to insure against leakage in the closure sections while test gages were observed to maintain specified test pressures and duration. AWWA C-600, pressure testing criteria was utilized in favor of those listed in ASTM F 1216, since the AWWA procedures are more stringent and used more widely in donation force main construction. Third party testing of plate samples cured on jobsite was conducted to prove out flexural modulus, flexural strength, and tensile properties utilized in tube design. In addition, lining through a PVC spool piece (restrained model) allowed the verification of wall thickness design.

The lines, once tested, are buried using crushed stone backfill and conventional compaction methods. Restoration on the project was only a fraction of what would be anticipated in a full blown open cut construction project.

Conclusion

Both cured-in-place pipe projects came in under budget and were completed on time. The Boca Raton Force Main Rehabilitation along A-1-A was awarded the Dow Chemical Fabricator Excellence Award for advancing the field of composite resin technology. To date, six projects totaling in excess of 30,000 linear feet have been put in service using methods presented herein.

Reference Documents:

ASTM F1743, American Society for Testing & Materials, Philadelphia, 1998.

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