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Tech Perspective – CIP Lateral Lining

Making It Stick

Contractors repairing sewer laterals with CIPP linings need to consider multiple factors that affect the quality of the lateral-to-main connection

By Larry Kiest, Jr.

Sewer laterals are steadily gaining attention as significant sources of clear water infiltration into sanitary sewer systems.

Studies have indicated that possibly as much as 70 percent of system infiltration can originate from faulty household service laterals. As vast amounts of data on this problem are collected, more and more sanitary sewer overflows (SSOs) are being attributed to lateral leakage.

This information comes to light as the U.S. EPA steps up efforts to reduce inflow and infiltration through initiatives such as the Capacity Management, Operation and Maintenance (CMOM) program.

Public Utility Operators understand the need for a verifiable non-leaking lateral pipe and the connection to the municipal main pipe. Cured-in-place pipe (CIPP) lining is a highly effective method for renewing lateral pipes. The continual challenge is making the seal between the lateral pipe and the municipal main pipe..

The creation of a verifiable, leak-free seal with CIPP lining depends on a variety of factors that include pipe materials, pipe wall contaminants (such as grease) and pipe surface preparation. All these factors must be considered from the design stage, through installation, to testing of the completed repair. If they are not addressed with verifiable results, then the rehabilitation may not meet its key objective of removing groundwater infiltration from the collection system.

Creating the seal

A common myth in the industry attributes adhesive (glue-like) qualities to the resins used in CIPP lining. Many believe the resin actually bonds to the host pipe, creating a leak-free seal. Extensive testing dispels this myth, showing that grease and other contaminants in the host pipe work against the formation of an adhesive seal.

The concern about adhesion increases when lateral linings must be sealed to a main pipe. In these cases, the level of adhesion directly affects the service life of lateral-to-main connections.

The industry needs methods for testing the connections between cured in-place lateral linings and the main sewer pipe. A recent research project looked at adhesion levels in thermo-set resins used in CIPP lining. Tests were performed on four types of resin: ISO polyester, vinylester, silicate and epoxy.

The tests involved various main sewer pipe materials, because a chemical bond with substantial adhesion will occur only if the main pipe and lateral lining materials are compatible. Five mainline pipe types were tested: Polyvinyl chloride (PVC), modified polyvinyl chloride (MPVC), polyethylene (PE), CIPP with polyurethane (PU) film, and CIPP with polyethylene (PE) film.

The testing procedures sought to replicate actual in-ground conditions. For example, the test used lard to simulate grease, which is universally present in sewers. In addition, the tests looked at the effect of roughening the main pipe surface to improve adhesion.

Test procedure

Tests were conducted on four sets of pipes that included different types of pipe material and CIPP lining resins. The first set served as a control – the inner surface was not modified, treated or changed in any manner.

The second set of each pipe type was prepared by roughing the inner surface with a robotic device so as to remove any glaze or slick finish that might inhibit adhesion, but without removing any polymer coatings. The third set had a layer of lard applied to the inner surface. The fourth set received robotic both roughening of the inner surface and application of lard.

To test the lining process, a one-piece resin-impregnated tubular main and lateral lining (CIPP) assembly was inserted and cured within each of the pipe sets. Each lining specimen was vacuum impregnated with the appropriate thermo-set resin.
The curing agents were consistent for each test specimen, as were the curing methods and exothermic temperatures.

Each lining specimen (resin-saturated fabric tube) was inserted into the host pipe by inversion and held against the pipe wall at 6 psi until full cure was achieved.
A destructive test was then performed on all samples to quantify adhesion between various main pipe materials and lateral linings.

The destructive test consisted of a sharp, wedged-shaped gauge, marked along its length to measure its width and identify the point of failure as it was driven between the pipe and lining.

Checking for adhesion

Four scenarios were tested with each of the thermo-set resins as listed below. The first scenario is a control sample or ordinary direct bury PVC pipe. The second scenario was direct bury pipe with the inner surface prepared by roughening the surface by use of a robotic cutter. The third was direct bury PVC pipe was fats, oils and grease (F.O.G.) applied to the pipe inner surface. The fourth scenario consisted of direct bury PVC pipe with grease applied to its inner surface and the pipe was prepared by jetting the pipe clean using hot water, detergent and robotically roughening the pipes inner surface.

The test samples were cut into a cross-section of one-inch by 12-inch strips. Adhesion was then rated on a scale from zero to ten. Ratings of zero were assigned to test samples where the cured lining simply fell away from the main pipe. Ratings of ten were applied where the wedge test destroyed either the host pipe or liner material.
Here are the key test observations:

N*OTE: This research program tested immediate levels of adhesion and did not test long term levels of adhesion.*

Test results

Polyester/ Vinyl-ester Resins

1. The polyester and vinylester resins (the most commonly used resin for CIPP) did not adhere to the direct bury PVC pipe, the CIPP PU film, the CIPP PE film, the MPVC pipe and the PE pipe. *CONTROL SAMPLES.*

2. The polyester and vinylester resins produced a high level of adhesion to the PVC direct bury pipe and fair levels of adhesion to the PU Coated CIPP only when the pipe surface was properly prepared by roughing the inner surface. There was no adhesion to the PE pipe, the CIPP with PE film or the MPVC pipe in accordance with this test. *PREPARED PIPE*
3. The polyester and vinylester resins did not adhere to any of the control pipes tested when lard was applied to the pipes inner surface. There was no adhesion to the PE pipe, the CIPP with PE film or the MPVC pipe in accordance with this test. *GREASE IN PIPE*

4. The polyester and vinylester resins produced high levels of adhesion to the PVC direct bury pipe and fair levels of adhesion to the PU Coated CIPP with grease in the pipe, only when the pipe surface was properly prepared by cleaning with hot water/detergent and roughing the inner surface. There was no adhesion to the PE pipe, the CIPP with PE film or the MPVC pipe in accordance with this test. *PREPARED PIPE WITH GREASE IN PIPE*

Epoxy/ Silicate Resins

1. The epoxy/ silicate resins produced a fair to high level of adhesion to the PVC direct bury pipe and a medium to fair level of adhesion to the PU Coated CIPP. There was no adhesion to the PE pipe, the CIPP with PE film or the MPVC pipe in accordance with this test. *CONTROL SAMPLES.*

2. The epoxy/ silicate resins produced a high level of adhesion to the PVC direct bury pipe and fair levels of adhesion to the PU Coated CIPP only when the pipe surface was properly prepared by roughing the inner surface. There was no adhesion to the PE pipe, the CIPP with PE film or the MPVC pipe in accordance with this test. *PREPARED PIPE*

3. The epoxy/ silicate resins produced a medium to low level of adhesion to the PVC direct bury pipe and a low to poor level of adhesion to the PU Coated CIPP when lard was applied to the pipes inner surface. There was no adhesion to the PE pipe, the CIPP PE film or the MPVC pipe in accordance with this test. *GREASE IN PIPE*

4. The epoxy/ silicate resins produced a high level of adhesion to the PVC direct bury pipe and fair levels of adhesion to the PU Coated CIPP with grease in the pipe, only when the pipe surface was properly prepared by cleaning with hot water/detergent and roughing the inner surface. There was no adhesion to the PE pipe, the CIPP PE film or the MPVC pipe in accordance with this test.

What is the significance of these tests?

The tests prove that grease has a negative affect on adhesion levels and that short term levels of adhesion are enhanced by proper preparation of the pipes inner surface but only on a select type of pipe. That certain pipe surfaces resist adhesion regardless of the resin used or the method of preparation to the pipes inner surface. Furthermore, in the real world of pipe renewal, hot water, detergent and roughening the inner surface of the sewer pipe to be lined is not a standard practice and simply does not occur. The actual method of pipe preparation is the cleaning of the pipe using a jetter with only cold water.

Test methods to verify levels of adhesion in a remote pipelining application are not practical and such test are not performed. That in order to achieve a non-leaking connection between the main pipe and the lateral pipe, adhesion can not be the determining factor. Test methods that may be proven begin with common engineering practices which include a cylinder shaped liner, flexural strengths and liner wall thickness. These test methods are determining factors that calculate if the liner will buckle due to external pressures.

Test methods to verify a connection to be non-leaking can be accomplished by air testing, vacuum testing, hydrostatic exfiltration testing and dye water flood testing. Pipe sealing may be accomplished by using compression gasket technology. Gasket sealing technology does not require *a bond and adhesion is not a factor in the design.*

Similar technology is available for providing a verifiable non-leaking connection between a mainline and a lateral. Hydrophilic compression seals are being incorporated with cylinder shaped main liner to create a seal with the main pipe, providing a verifiable non-leaking connection with all pipe types.

CONCLUSION

A common myth in the industry attributes adhesive (glue-like) qualities to the resins used in CIPP lining. Many believe the resin in the liner actually bonds to the host pipe, creating a leak-free seal. Extensive testing dispels this myth.

The most effective solution incorporates common engineering practices and proven sealing technology. This creates a verifiable non-leaking connection in the presence of grease and with a variety of pipe types, regardless of the level of adhesion that may occurs between the liner and the main pipe.

All factors must be considered from the design stage, through the installation period to the testing of the end-product. If, these key issues are not addressed with verifiable results, then the rehabilitation methods being utilized will most likely, provide fruitless results and the removal of ground water infiltration will remain unresolved.

Larry Kiest, Jr., is president of LMK Enterprises, a cured-in-place pipe lining technology provider based on Ottawa, Ill. This article is based on a seminar to be given at Education Day (Feb. 15) at the 2006 Pumper & Cleaner Environmental Expo International in Nashville, Tenn.