CIPP Sectional/Point Repairs
Critical Factors – Finally Explained
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Abstract

A 1999 report from the American Society of Civil Engineers indicated at that time that the nation's 500,000 plus miles of sewer lines had an average age of 33 years. However, many cities today are maintaining and operating collection systems with sections that are nearly 100 years old. Significant proportions of these pipe segments have well exceeded their original design life and are failing at an alarming rate. To compound the problem, the line segments in question are not failing entirely from end to end, the failures and defects are occurring at specific points within the segment and with varying lengths. In the past, excavation or open-cut methods have been universally accepted as a means to address these problems. These traditional methods for rehabilitating or maintaining services have proven to be very costly, time consuming and disruptive. In addition, the true social costs and environmental impact of this type of repair method is not taken into full account and the effects are all too often realized during the construction and restoration phases of the project. This has resulted in an ever-increasing demand for proven methods of CIPP rehabilitation, which has the capability of restoring structural integrity for a particular "point" or "section" of varying lengths in a line segment without the need for traditional excavation or CIPP lining from manhole to manhole.

Trenchless methods provide many advantages as well as being a safe environmentally friendly sound approach for rehabilitating underground services such as:

1. It is less disruptive for, local residents, businesses and the general public.
2. There is no "ground-breaking" or surface disruption — parking lots, lawns, and streets are not disturbed.
3. Nothing is removed from the sewer that the general public can be exposed to. There are no excavation spoils to remove and dispose of.
4. There is no surface restoration required from settling that occurs long after the project has been completed.
5. They are generally completed from beginning to end in a fraction of the time needed for open-cut methods i.e. three hours compared to an entire workday plus an additional day for any restoration that may be required.
6. Rehabilitation can be completed in extreme weather conditions, hot or cold.
7. Workers have a much safer work environment with no open trenches and very little confined space entry.

Sectional repairs typically range from three to thirty feet in length with diameters ranging from six inches through forty-eight inches. There are three basic cured in-place sectional processes, which are specific to materials and trenchless installation methods used:

Method One: Liner/Bladder Assembly-Inversion Method.

Length of Repair~

Inversion type sectional repairs are not restricted by a particular length. Virtually any length repair can be made providing the launcher can accommodate the length of the tube to be inverted.

Vacuum impregnation~

The inversion process utilizes vacuum impregnation to ensure that all of the air is completely removed from the textile lining tube while drawing the resin in, fully saturating every fiber, thus producing a very dense and uniform cured-in-place pipe.

Translucent Inversion Bladder~

A translucent bladder allows the installer and inspector an opportunity to visually inspect and verify that the liner is completely vacuum impregnated. The installer can ensure that there is absolutely no resin deficiency present throughout the entire length of the repair. If resin deficiencies exist, the installer can then go back and properly saturate the portions affected.

Liner/Bladder Assembly~

The liner is contained within the inversion bladder. Inversion tabs are used to connect the leading end of the liner to the bladder. The inversion tabs are a frangible attachment allowing for the liner/bladder to invert anywhere in the pipeline.

Launching/Inflation Device~

The liner/bladder assembly is loaded into a flexible launching device. Sizing of the launching device is favorable for pipe repairs in diameters ranging from four through forty-two inches. The launching device is flexible for all sizes, allowing easy introduction of equipment into a standard manhole opening. The resin-saturated liner is contained within the launching device, completely protecting the liner from the time it is resin saturated until such time that it is properly positioned at the point of repair. Since the liner is loaded inside of the launching device and not wrapped around the exterior of the launching device, there is never a possibility of the liner being snagged, wrinkled or pulled off of the launcher during the process of pulling the liner into place.

Resin Loss~

Protecting the resin-saturated liner within the launching device is an integral part of any repair and ensures the resin is not wiped off or contaminated. The resin that provides a structural repair only contacts the pipe at the point of repair.

Visual Placement~

Inverted sectional liners allow for a camera to be placed in front of the tube and launcher as it is inverted in-place. This allows for exact visual placement as the liner is projected from the open end of the launching device. The liner is never pulled through the damaged pipe section, but positioned at the beginning of the damaged pipe section minimizing the danger of further damaging the defect area. Air pressure is then applied causing the liner/bladder assembly to invert rolling its way through the damaged pipe section.

Resin Migration~

By the action of the inversion bladder and air pressure the liner is turned inside out or “inverted” forcing the resin against the old pipe wall. In the design phase, excess resin is utilized to ensure complete rehabilitation and full migration occurs through any defects or open joints. The excess resin is pressed into every existing pipe defect, sealing and mechanically locking the liner into the pipe as it is held in-place under pressure by the inversion bladder.

Removal~

The bladder is re-inverted being peeled away from the cured liner as it is drawn back into the launching device. With a camera positioned at the end of the liner, a mechanical lock test is performed utilizing the frangible tabs attached to the end of the lining tube located around the entire circumference of the textile tube. The tensile strength of each tab is rated between sixty and eighty pounds. Multiply this by the number of tabs (this varies with the diameter of the liner with a minimum of six) and you will get the total tensile strength of the mechanical lock for a particular test. The pull required to break the tabs must exceed the total tensile strength of the tabs ensuring the finished product is permanently locked into place. The equipment being removed from the pipe completes the repair.

Method Two: Packer Wrapping Method

Length of Repair~

The length of this type of repair is generally restricted by the length of the plug that can be utilized to wrap the textile tube. Typically, the distance for this repair does not exceed thirty-feet.

Saturation~

Saturation for this method is achieved by placing the flat sheet on the ground or a workbench. Without the ability to vacuum impregnate, the epoxy or resin is physically worked into the fabric by hand until the entire sheet is covered. Full saturation becomes very difficult achieve and even more difficult to verify without the full evacuation of air from the fabric. Without complete impregnation, the liner is subject to portions having dry spots leaving the textile tube partially resin deficient, thus critically affecting the end product.

Packer Wrap~

The saturated tube is then wrapped tightly around a standard sewer plug overlapping the ends to produce the full circle tube.

Resin Loss~

Resin loss will occur when the resin-saturated textile tube is not contained and protected during the process by which the plug and tube are towed into the line prior to final placement. The bottom of the tube is drug down the pipe in full contact resulting in significant epoxy/resin loss greatly affecting the end product.

Visual Placement~

Visual placement is achieved by placing the camera at the furthest point of one end or the other of the plug and liner assembly. One of the issues with this type of placement occurs when the plug and liner are pulled through the entire defect section increasing the probability of further damaging the very section that is intended for repair. If the pipe is adversely affected and further damage occurs during this phase it is impossible for the installer to know it until such time the liner has been cured, the plug removed and a visual inspection can be made. If the plug itself has caused a collapse or even a partial collapse, the liner will have permanently locked in any broken pipe fragments or pieces causing a severe reduction in the diameter and a point of blockage. In the event of this happening, it is likely a traditional excavation will have to be made at this point.

Resin Migration~

Resin migration can occur with this process with the exception of any portion that has experienced resin loss due to an uncontained liner as already explained.

Removal~

Simply relieving the air pressure, deflating the apparatus and pulling it back to the manhole completes the removal of the plug, deflating the apparatus.

The packer method is not contained and significant resin loss occurs when the packer/liner comes in contact with the manhole and as it is drug through the bottom of the mainline segment until such time that it reaches the point of repair. When resin is wiped off in the pipe this means the resin that was designed to be in the tube and cured at a specific location is no longer in the tube at that location. In this situation, the engineering design calculations based on the physical properties the composite pipe have been changed and may no longer meet the intended specification.

Method Three: Pull In & Inflate (Outer-Coated Tubes)

Length of Repair~

The length of this type of repair is not generally restricted. However, a specifying engineer must consider the stress that is put on the leading end of a liner that is pulled into place. As an example: If one is installing a liner that is twelve inches in diameter with a considerable length, a considerable amount of stress occurs at the front end of the liner as it stretches to compensate for the weight of the liner and resin. Pulling this weight can stretch and damage the liner and coating prior to curing. At this time, the effects of this damage and how it relates to the structural and physical properties of the finished product are still being done.

Visual Placement~

Visual placement is achieved by placing the camera at the furthest point of one end or the other of the liner and bladder. As is the case with the Packer Wrapping Method, one of the issues with this type of placement occurs when the liner is pulled through the entire defect section increasing the probability of further damage to the very section that is intended for repair. If the pipe is adversely affected and further damage occurs during this phase it is impossible for the installer to know until such time the liner has been cured, the bladder removed and a visual inspection can be made. If the plug itself has caused a collapse or even a partial collapse, the liner will have permanently locked in any broken pipe fragments or pieces causing a severe reduction in the diameter. In the event of this happening, it is likely a traditional excavation will have to be made at this point.

Resin Migration~

Due to the coating being on the outside of the liner to contain the resin through the entire process, no resin migration can occur. One of the significant dangers of this process is the lack of a mechanical lock upon completion. If any thermal contraction or shrinkage occurs the cured liner will eventually slide down the pipe. The liner will usually quit sliding at the point of an offset joint or a service connection that is not factory manufactured. In either case, the probability of a sewer blockage is evident.

Removal~

The bladder is re-inverted being peeled away from the cured liner as it is drawn back into the launching device. The equipment being removed from the pipe completes the repair.

In conclusion, one must consider that not only are the materials and the product itself critical factors but the installation procedures are even more critical when providing an end-product that meets the quality control standards and design parameters that ensures a long lasting repair. Some of the critical differences are as follows:

- Traditional Excavation is not very cost effective; it is disruptive for homeowners, businesses and local traffic. The environmental issues need to be looked at as well. Excavation is very messy above ground and also requires removing from the ground any excavated soil and/or pipe sections that have been contaminated with raw sewage. The spoils then need to be removed and dumped. In addition to this, the excavated hole then needs to be backfilled and restored. Final restoration must be delayed to compensate for any settling that may occur.
- The packer method uses a flat sheet and is impregnated by rubbing the epoxy on the liner. Consider carefully that the resin being cured is the key ingredient. There are many types of textile tubes available such as felt, fiberglass and carbon fibers but none can argue the structural properties of the textile fibers without the resin or epoxy.
- Curing procedures are typically at ambient temperatures where cure times can be completely controlled using a polyester or vinylester resin. The use of epoxy is not recommended due to time versus temperature in controlling the cure. Epoxy resins will either cure very fast not allowing ample insertion time, or they will require as long as 12 hours to cure. Temperatures less than forty-degrees typically result in the liner not curing at all.
- The inversion process allows repair lengths of one hundred feet or more while the packer method is limited by the length of the plug which is generally about eight-feet in length.
- The inversion process contains the liner throughout the process protecting it from resin loss and contamination. The packer method completely exposes the liner resulting in resin loss and contamination.
- Once cured, the bladder is re-inverted breaking the frangible attachment while performing a mechanical lock test. The bladder and launching device is then removed from the pipe, leaving a new, smooth, structural water-tight pipe within a pipe. The packer method is simply deflated and pulled out. The bottom of the liner is typically soft due to resin loss that occurs from dragging the packer/liner through the pipe during the installation process.

When the differences in sectional repairs are closely analyzed, it becomes obvious that the installation process directly affects the quality of the end product. Unlike full-length liners, a sectional repair may be any distance from the manhole, prohibiting any in-field physical property testing. Therefore, laboratory-testing results can only be relevant in the design of a CIPP sectional repair when proper installation techniques are utilized. Owners and specifying engineers need to understand the methods chosen and the subtle differences in the installation procedures and how that can adversely affect the quality of the repair.