Technologies and Methods for Rehabilitation of Gravity Sewer Pipelines

Gravity sewer pipelines are essential components of municipal infrastructure, and maintaining their integrity is crucial for efficient wastewater operation and environmental protection. Over time, these pipelines will deteriorate due to factors such as age, infiltration, corrosion, root intrusion, and other internal and external influences. This degradation can compromise the pipe's structural integrity and lead to defects that impact system operation, including backups and overflows. Numerous trenchless pipeline rehabilitation techniques have been developed to restore the structural integrity of aging pipelines, improve flow capacity, and extend the operational lifespan of the system. These methods can address localized defects or create a new continuous seamless pipe using the existing pipe as a form. These trenchless solutions minimize public disruption and are recognized as being more cost-effective than conventional dig-and-replace methods.

The NASSCO Pipeline Rehabilitation Committee has created a matrix summarizing prominent trenchless technologies used in gravity sewer pipeline rehabilitation. It includes information on the technical envelope, capabilities, limitations, and reference standards, along with guidance on design, materials, and installation. This article provides a summary of the matrix, which is available for download at NASSCO.org.

To determine which trenchless method to use for a specific project, several factors must be considered, including whether the final product can meet design objectives such as enhancing structural integrity, reducing infiltration and exfiltration, increasing flow capacity, or preventing corrosion. Consulting a trenchless expert is strongly recommended to select the most suitable methods for a specific project.

Cured-In-Place Pipe Lining

For over 50 years, cured-in-place pipe ("CIPP") lining has been a common trenchless rehabilitation technology for pipelines ranging in diameter from 2 inches to 120 inches. A CIPP liner is installed and cured insitu to repair localized damage with a trenchless sectional repair, manhole-to-manhole, or long segments, with capabilities for a single installation reaching up to half a mile in length. This method involves inserting a resin-saturated tube into the existing pipe and curing it in place under ambient conditions, by applying a heat source, or through a photoinitiated reaction by exposure to UV or LED light. The CIPP process creates a new, seamless structural pipe within the deteriorated host pipe, offering renewed structural integrity, increased durability, and protection against further deterioration. CIPP can be used to rehabilitate all types of pipe materials and shapes. The ease of installation and capability to

address host pipe defects, such as cracks, leaks, and corrosion, make CIPP an ideal trenchless solution for rehabilitating gravity sewer pipes.

Fold-and-Form Pipe Lining

Fold-and-form pipe lining ("FFPL") is made from a thermoplastic material, most commonly PVC, that is heated, folded, and coiled onto a reel for transport to the job site. Installation is performed through existing manholes or small access points, eliminating the need for excavation pits. This method is versatile, accommodating a variety of pipe shapes and sizes, and capable of navigating bends of up to 30 degrees. Once winched into the existing pipeline, the liner is typically heated using steam, causing it to revert to its original shape and form a new, close-fit, structurally independent pipe within the host pipe. Fold-and-form pipe is used to rehabilitate cylindrical pipelines, offering excellent corrosion and abrasion resistance.

Fiber Reinforced Polymer Lining (FRPL)

Fiber reinforced polymer lining ("FRPL") is applied using a wet-layup method, which is generally used to repair localized damage or sections of a deteriorated pipeline. The lining consists of a polymer, typically epoxy, and a reinforcing fabric such as glass or carbon fiber that is hand-applied and bonded to the host pipe. FRPL requires worker entry and is used for trenchless rehabilitation of larger-diameter pipelines, typically 30 inches and above. It offers excellent corrosion resistance, and due to the lining's high strength, it is applied in minimal thicknesses to restore structural integrity to the pipe, improve hydraulic capacity, and enhance flow efficiency.

Pipe Bursting

Pipe bursting is a trenchless method used to replace or upsize existing cylindrical pipelines. During this process, a bursting head is pulled through the old pipe, fracturing or splitting and displacing it as it moves forward. Simultaneously, a new pipe is pulled behind the bursting head, taking the place of the old one. This method is particularly effective when the existing pipeline is too deteriorated for other rehabilitation techniques. Pipe bursting is the only trenchless technology that can be used for upsizing pipelines to meet increased capacity demands.

Spray-In-Place Polymer (SIPP) Using Polymerics

Spray-in-place polymer (SIPP) is a trenchless method using a variety of polymeric formulations, including polyurethanes, epoxies, polyureas and hybrid formulations that are spincast or sprayed onto the interior surface of the pipeline. The capabilities of these polymers vary, including factors such as application thickness in a single coat, as well as set and cure times. Surface preparation is crucial for most SIPP systems, as they rely on adhesion to the host pipe and pinhole-free, monolithic coverage for optimal performance. SIPP systems offer a seamless, durable, and corrosion resistant barrier that rehabilitates deteriorated gravity sewer pipelines.

Spray-Applied Pipe Lining (SAPL) Using Cementitious or Geopolymer

Spray-applied pipe lining (SAPL) using cementitious or geopolymer formulation mortars is a trenchless method of pipeline rehabilitation that forms a new, structurally independent pipe within the existing pipe. The mortar is mixed on-site and delivered pneumatically into the pipeline, where it is applied using either centrifugal casting or shotcrete techniques. Installation is performed through manholes or access shafts, and with the right equipment, extended distances up to 6,000 feet can be lined.

Sliplining

Sliplining is a method that involves inserting a new, smaller-diameter pipe, known as the liner, into an existing, damaged or deteriorated pipeline and extend the system's overall lifespan. Liners are made from various materials such as HDPE, PVC, and FRP (fiberglass reinforced plastic), selected based on factors like pipe size, system requirements, and environmental conditions. The liner can be installed in continuous lengths or segmented sections, depending on project conditions. Typically, the annular space between the liner and the host pipe is grouted. Segmental sliplining can often be installed under live flow conditions.

Spiral Wound Linings

Spiral wound linings consist of continuous PVC strips or panels that are mechanically interlocked during installation. These strips are wound spirally into the host pipe and interlocked either manually or using specialized machinery, typically accessed through existing manholes. The interlocked strips are installed to closely fit the host pipe. When an annular gap is present, it is filled with grout. This method can allow liner construction to proceed without the need to divert or bypass flow, reducing disruption and restoring structural integrity.

Conclusion

Trenchless technologies have transformed how municipalities rehabilitate gravity sewer pipelines. Various methods exist to restore aging gravity sewer pipelines, each suited to specific conditions like material, size, shape, condition, and required capacity. Although no method fits all scenarios, trenchless solutions offer flexible, efficient, and cost-effective ways to extend pipeline lifespan without the need for extensive, time-consuming, and disruptive excavation. For tailored advice on projects, consult with trenchless technology consultants and technology representatives.