Renewing Life of Large Diameter Pressure Pipelines with HDPE through Swagelining Technology

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ABSTRACT

Replacing utilities in urban areas presents challenges to all stake holders. Easement issues, street closures, traffic congestion, disturbing surface works and customer inconvenience are all areas of concern that communities must address. City administrators, engineers and residents are starting to demand more efficient and less disruptive methods of replacement to ease these concerns. As pipelines are coming to an end of their useful life, replacement methods such Swagelining are being selected to add value to all stake holders involved.

BACKGROUND

Over the past 20 years, many North American communities have begun implementing programs to replace failing gravity sewer and water distribution pipelines. A combination of construction methods, including trenchless technologies such as CIPP and pipe bursting have come to the forefront to replace these smaller diameter pipelines in a cost effective, efficient and environmentally friendly manner.

While much work is still to be done, the next major focus by communities is to address failing medium and large diameter water transmission and sewer force mains in the diameter range of 16-inches through 72-inches. These systems form the major artery of a community's pipeline network. Failure of large transmission mains poses a substantial risk to public safety; such a failure can result in an initial explosive force of between 20 and 200 tons of dynamite and the release of pressurized water with an initial velocity of 90 miles per hour. As we have unfortunately seen recently in the media, when these pipelines fail, the effect to a community can be catastrophic. The failure of a 36-inch transmission main is not equivalent to the failure to the segment of a 6-inch main servicing 10 customers. One single repair can cost well into the millions of dollars. Additional adverse effects include major sink holes, flooding, environmental damage, significant inconvenience of businesses, street closures on major roads and regrettably loss of life.

Just as the industry has seen various trenchless technologies come to the forefront to rehab smaller diameter pipelines, the Swagelining technology is emerging as a leading candidate to renew and replace mid to large diameter water transmission and sewer force mains. The principle of Swagelining was developed over 30 years ago by British Gas and United Utilities (then known as North West Water) to address the problem of failing pipeline systems that were buried and entangled with other utilities throughout urban and rural areas. It is currently considered by the pipeline industry as the benchmark in polymer lining technology due to its ability to deliver cost effective lining solutions in essentially every environment. With an extensive

list of successfully completed projects across the globe, the technology has been proven in many extreme projects spanning three decades onshore and subsea. Projects have been completed for water, sewer force main, mining, hydrocarbons, chemicals, bulk products and gas distribution.

DESCRIPTION

Specifying an HDPE pipe with an outside diameter larger in size than the inside of the host pipe, Swagelining reduces the HDPE pipe temporarily below the ID of the host pipe allowing it to be inserted (See Figure 1). While the towing load keeps the liner pipe under tension, it remains in its reduced size. The HDPE pipe remains fully elastic throughout the reduction and installation process. As the liner pipe is not permanently deformed by Swagelining, the release of the towing load after insertion is the catalyst for the liner to revert back towards its original size. As its original size is larger than that of the host pipe, the HDPE pipe expands until it is halted by the inside diameter of the host pipe. This produces a residual strain that is locked in the liner and maintains pressure against the inside of the host pipe, even in the absence of internal pressure from the product conveyed. A digital animation that illustrates this concept is available at www.swagelining.com.

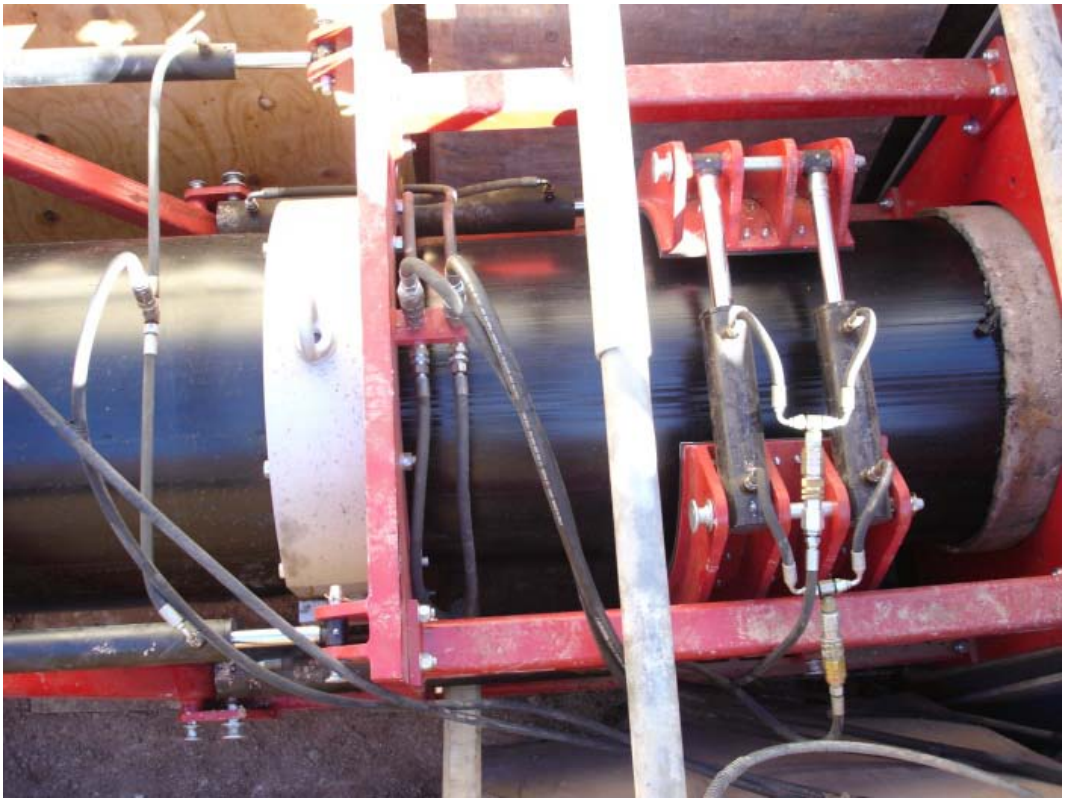

Figure 1: Swagelining Process

The effectively natural ‘tight’ or ‘compression fit’ produced by Swagelining is accepted as exchanging an existing failing pipeline with a composite pipe in its place. The HDPE provides the very long term corrosion protection barrier for the corroding pipe while the structural strength required to maintain pipeline operating pressure is delivered through the existing pipe. In circumstances where the host pipe

can no longer provide pressure retaining capability, Swagelining can insert a structural HDPE for almost any size of pipeline diameter.

Replacing large diameter pipelines incurs unique engineering and construction challenges, and therefore may limit the number of feasible construction methods. As large diameter mains can be located in high profile areas, attaining easements for relocation is often not an option. Maintaining the existing pipeline alignment, through the use of Swagelining, eliminates the need for utility relocates and easement concerns. In rural and environmentally sensitive areas, following the existing utility path reduces environmental concerns and permitting. In addition to following the existing utility path, one of Swagelining technologies key attributes is the resulting 'compressive tight' fit of the HDPE (See Figure 2), as described above. This allows for the maximum bore path as all annular space is eliminated, and rules out the need for grouting. The 'compressive fit' is also important to maintain the HDPE against vacuum collapse or in the absence of pressurized fluid.

On the job site, typical production ranges from 1,000 to 5,000 feet in a single continuous pull. This is critical to speed installation when many projects are undertaken during dry weather periods, with limited shut down. The long pull distances also contribute to minimizing excavations, including reducing the number of required connection points. As the installed HDPE represents one long continuous fused pipeline, the reduction in connection points also reduces the potential for leakage to occur in the future.

Figure 2: Compressive Tight Fit

HISTORY

Over the years, the Swagelining technology has been selected to renew numerous medium and large diameter water transmission and sewer force main projects throughout the US. This work includes some recent high profile work in Texas and Colorado, as described in the case studies below. These projects demonstrate the

unique engineering and construction challenges that ultimately lead to selection of the Swagelining technology. While many construction methods were considered during the pre-design phase, the Swagelining technology was recognized as being the most advantageous long term solution.

With over three decades of history, the Swagelining technology has combined engineering, research and development, advanced HDPE materials and connectors to deliver long term solutions to renew the life of medium and large diameter water transmission and sewer force mains.

Case Studies:

Two recent Swagelining projects highlight the unique engineering and construction requirements that ultimately lead to the selection of the technology.

(1) An existing 30-inch water transmission main, traveling through the heart of a major Texas community, and installed in 1927, required renewal. The design engineering team needed to select a construction method to renew the existing main. The transmission main was located in a tight utility corridor and passed through major intersections. As the pipeline is a major artery of the city's pipeline network, the transmission main moves water from a pump station to feed the north end of the city. Even of more importance than maintaining the existing utility path, was maintaining the existing flow and capacity of the pipeline. A resulting 'compressive tight' fit of the HDPE provides the same or better flow rate due to the C-factor of the new smooth walled pipe material. The HDPE also provided a long term design life, in excess of 100 years. An additional requirement of the project was to complete the work within a short dry weather period. With installation distances over 1,800 feet in continuous pull lengths, the project was completed well under the allotted time.

Figure 3: Texas Swagelining Installation

(2) A 24-inch raw water inverted siphon pipeline in Colorado, transporting mountain runoff to a reservoir, is a necessity of life for nearby town residents. The engineering design challenges included the location of the pipeline in an environmentally sensitive area, starting from Salt Lick Gulch on the north side of I-70, and then

traveling through the inverted siphon located under I-70, a major freeway. As the inverted siphon consisted of bends that could not be accessed, it was vital that the installation be completed in one continuous pull. The siphon could also only be renewed during a limited period of time during the summer dry season. The selected Swagelining technology eliminated costly and environmentally damaging excavations as the raw water main was successfully renewed in one continuous pull, as planned. The small footprint of the excavations also eliminated timely and costly permits. In addition, the 'tight' fitting HDPE will provide a long term design life to ensure continuing water supply of the siphon to the reservoir.

Figure 4: Colorado Swagelining Installation