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ZERO-IMPACT REHABILITATION OF A WATER MAIN IN CONEGLIANO VENETO

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ABSTRACT: A minimized environmental impact, road disruption, and social hindrance are the main pros of NODIG technologies for the installation and rehabilitation of underground, buried pipelines. The job in Conegliano Veneto is a flagship project that allowed a 5 km (3 miles) long water supply network to retrieve the entire operation and supply water to the town and several other municipalities in Treviso. The rehabilitated portion of the network was made up of asbestos-cement pipes DN 500 with 400 l/s capacity and 8 bar pressure, partly laid across a historical center and a vineyard of great farming value as assigned to the production of prosecco grapes.
The project awarded by Piave Servizi was carried out using Primus Line technology, a semi-structural high-performance system based on a flexible liner from a structural composite material capable of withstanding very high operating pressure and with a pay life of 50 years. The liner, installed inside the existing pipe, needs no adherence to the existing walls because it takes up the flow pressure and the pressure surge or wave caused by the flowing fluid and vacuum events down the pipeline. The liner was pulled inside the host pipe through existing maintenance chambers, eventually excavating and digging out some 2 m long portions of the old pipe, minimizing site dimension, cement/asbestos waste, and working time.
Another salient feature of this system is the hydraulic bypass system constructed and designed to ensure non-stop water supply to the users, resistance to the operating pressure and capacity of the network, and avoid any trouble or repercussion on the latter. Two parallel lines were laid down side to side, each with a 5 km (m) structural liner portion DN 300 mm, capacity 200 l/s, and 8 bar pressure.

1. INTRODUCTION

Reducing a construction site's environmental and social impact is an increasingly central issue for most utility providers. This is even more true for sites within an urban location or any other context of particular natural and landscaping concern. The NODIG technology is widely approved for laying, rehabilitating, and upgrading buried, underground pipelines. An enlightening, critical case is the hydraulic rehabilitation of a water main portion carried out on behalf of Piave Servizi in Conegliano Veneto, Italian Province of Treviso. For this job, a considerable time and cost reduction was achieved whilst zeroing the impact of the work on territory in the heart of the Prosecco wine region traditionally highly concerned with environmental issues.

2. THE ANTECEDENT PIPE CONDITIONS

Over the years, Piave Servizi - the Company in charge of the water network in the eastern part of Veneto - has been carrying on an extensive improvement plan for the aqueducts in its territory, undertaking considerable investments. In this framework, Danphix was assigned the rehabilitation of a water main portion serving the town of Conegliano Veneto and seven more municipalities supplying water to some 100,000 users in total. It is a pipe portion stretching over approximately 5 km and made up of asbestos pipes diameter of 500 mm.
In this portion, the water pipes had been repeatedly and frequently repaired because of the leaks occurring at the joints between the various asbestos pipes because of A) corrosion; and B) worn-out rubber seals. To finally solve

the problem, Piave Servizi opted for the liner lining technique, installing a semi-structural liner serving as a brand-new pipe inside the (host) pipe.

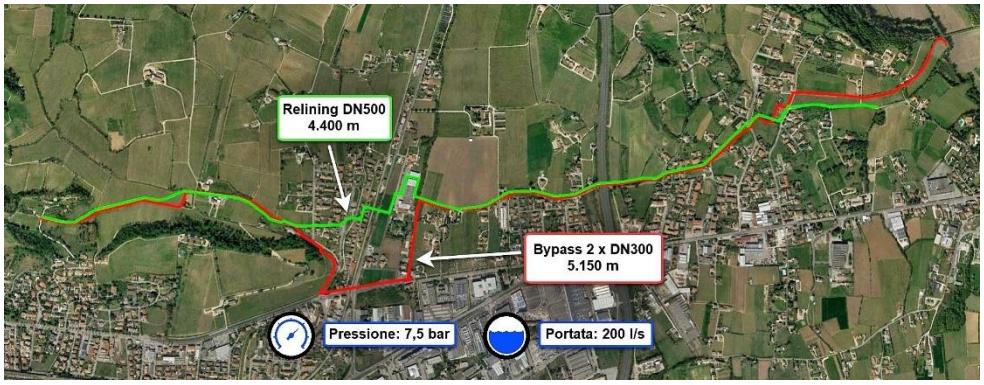

Figure 1. Host pipe and bypass route.

3. A TEMPORARY AQUEDUCT

This was a very demanding job in terms of the size of the pipe portion to rehabilitate, and the prep works needed to make the job possible. The first milestone of this challenging job was the installation of a bypass pipework replacing the old one to grant continuing water supply to the users throughout the works and, at the same time to avoid troubles to the overall operation of the remaining pipework. Building this bypass required accurate hydraulic engineering design to ensure the same 400 l/s capacity and 8 bar pressure as the original pipe. For this, Danphix and Piave Servizi technical services carried out preliminary engineering and research work to find the most viable and efficient solution. As a result, two parallel lines were laid side to side, each in DN 300 and the same kind of liner as the one to be used for rehabilitation. Therefore, each line was five km long, withstanding a flow capacity of 200 l/s and an 8 bar pressure. For this bypass, some 10 km of pipes had to be laid down on the ground, creating a temporary aqueduct, basically replicating the operation of the rehabilitated underground pipes.

Figure 2. Bypass route.

Figure 3. Bypass deployed in the protected area.

The design and development of the bypass path and the actual installation of the two interim pipelines was another step of the complex preparation work because no traffic disruption and disturbance to the nearby urban and farming activities were allowed. The pipelines extend across Conegliano's historical center and then stretch out under an open countryside prevalently occupied by numerous vineyards producing Glera grape, a late ripening variety for Prosecco. The bypass was to follow the same route.

Figure 4. Bypass liner deployed within the storm sewer pipe.

Figure 5. 1.150 m DN500 liner installation phase

An accurate territory analysis identified the optimal conditions to utilize all the infrastructural facilities already available on site. More specifically, the bypass pipes were buried across all urban sections and all most critical locations like roads and traffic arteries, crossings, and roundabouts. Wherever possible, they have been installed inside the existing sewer lines without compromising the overall hydraulic operation. The pipes were laid on the surface and inside the existing water irrigation channels in the farming areas. In the latter case, the pipes had to be safely anchored, taking all measures to prevent damages due to unforeseeable extreme flow increase in the event of storms and severe weather agents.

Figure 6. Bypass liner deployed in the water irrigation channel

Figure 7. Bypass liner deployed in the water irrigation channel

4. THE PRIMUS LINE SYSTEM

The bypass installation took about two and a half months of work. Immediately after its completion, a video inspection was done, followed by a pipeline cleaning, all before starting the actual relining operations. Relining was accomplished using the Primus Line system, which Piave Servizi selected based on the crucial and central importance of the old main to be rehabilitated. Primus Line is a lining technique specially designed for the trenchless rehabilitation of pressure pipes of any kind in the broadest range of situations. The most prominent benefit of this system is a remarkable installation time-saving. The Primus Line® system consists of the Kevlar® reinforced liner and specifically developed termination fittings and is available from DN 150 to DN 500. The composite liner consists of three different layers. The inner layer is made of a low-density polyethylene (PE) for potable water applications. The middle layer is made of a mixture of polyester and Kevlar® for low pressure applications available from DN 150 to DN 300 with maximum operating pressures of 25 bar and 12 bar respectively. For higher pressure applications, the middle layer is made of pure Kevlar® and is available from DN 150 to DN 500 with maximum operating pressures of 56 bar and 16 bar respectively. For special high pressure applications of up to 82 bar for a DN 150 or 32 bar for a DN 400, a second layer of the Kevlar® fabric can be added. The fabric accommodates both the operating pressure as well as the insertion forces during the installation process.

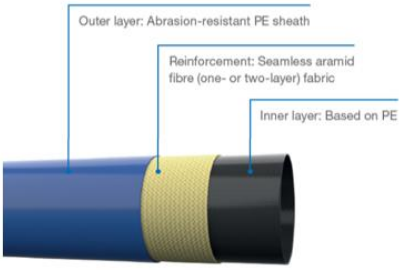

Figure 8. Schematic view of the Primus Liner

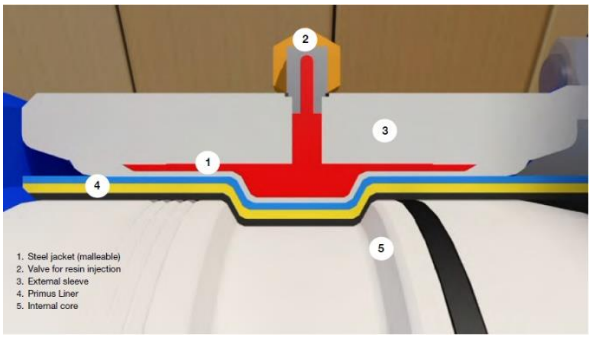

Figure 9. Medium and high pressure connector after injection of two-component resin

5. THE REHABILITATION WORK

The semi-structural lining system that is capable of accommodating the operating pressure independently from the host pipe requires the host pipe for ground and traffic loads only. The system can be installed regardless of the host pipe material and is suitable for asbestos cement, PVC, HDPE, steel, cast iron, ductile iron a.s.o. As a prerequisite for the longevity of the installation, a CCTV camera inspection is performed to assess the condition of the host pipe. Usually, a rope connection is created between the start and destination pit by means of a CCTV camera. The goal of the inspection process is to detect any obstacles that are protruding into the cross-section of the pipe which could damage the liner during the installation process. In a second step, a mechanical coarse cleaning process with metal scrapers and pull through rubber discs is performed. With HDPE, PVC, AC and cemented lined pipes, usally only lose debris is found in the host pipe. Hence, cleaning with pull through rubber discs will be sufficient. In case of cast and ductile iron pipes as well as steel pipes, severe incrustation may be expected. These can be loosened using scraper pigs and removed using rubber discs. With steel mains, protruding welding seams may be expected which can be removed with cutters. After a subsequent CCTV inspection and once a free inner diameter is available, the installation can commence.

The pre-folded liner is sent to the construction site on specific transport reels depending on the required sectional lengths. The liner is folded into U-shape at the factory to reduce the associated pulling forces during the insertion process. Thus, long installation sections can be realized and the stress on the material is minimized. A pulling head is mounted to the start of the liner and connected to a pulling winch. The liner can be installed with installation speeds of up to 400 m per hour.
The liner is inserted lose-fit with a pulling winch and does not adhere to the host pipe. Once the liner is in place, compressed air of 0.5 bar is applied to turn the liner into round shape (please refer to figure 11).

Figure 10. Liner status after pulling and before infalting.

Figure 11. Liner turned into round shape at 0.5 bar

The liner is inserted lose-fit with a pulling winch and does not adhere to the host pipe. Once the liner is in place, compressed air of 0.5 bar is applied to turn the liner into round shape (please refer to figure 11). The liner does not adhere to the host pipe and a small annular space will remain between the liner and the host pipe which does not have to be grouted. Once the liner has been turned into round shape the corresponding termination fittings are installed. After a leak test similar to local standards for HDPE pipes, disinfection, flushing and subsequent connection of the renovated section to the existing water main network, the rehabilitation is completed.

Figure 12. Liner installation phase

Figure 13. Liner installation phase

6. CONCLUSIONS

The rehabilitation of the water main in Conegliano Veneto shows the effectiveness of trenchless technologies, which are the best way to regenerate existing infrastructures in certain difficult conditions and reduce the overall impact at all levels. Moreover, this case evidences how leading-edge technologies walk hand in hand with the highly performant, skilled design competence of all players involved. In Conegliano's specific case, the union of technology and skills led to the full functional recovery of five km pipelines in just six months and with significant savings compared to any other traditional replacement method.

Figure 14. End connectors with an air realise valve spool piece.

Figure 15. End connectors with a branch connection spool piece.

All players' design work and technical know-how made it possible to utilize the existing infrastructure for both the bypass and the subsequent relining operations. Considerable savings were possible in site dimensions, traffic disruption, resident disturbance, and dangerous waste disposal (like asbestos cement) for a literally Zero Impact and sustainable job.