THE FUTURE IS TRENCHLESS – REHABILITATION OF PRESSURE INFRASTRUCTURE WITH UV-CURED FIBERGLASS REINFORCED PIPE LINER

Katharina Helming, Business Development Manager, SAERTEX multiCom GmbH

ABSTRACT

There has been an expansion in the infrastructure of gravity and pressure pipes within municipalities and cities, driven by growth and demand. Maintaining these assets is crucial, especially in areas where the rate of population growth is rising. The task of replacing pipes is complicated due to accessibility and cities are motivated to minimise the impacts on the environment and community. Water authorities are focussed on mitigating water losses amidst these challenges.

While UV - CIPP is an established technology in non-pressurized wastewater applications, the demand for trenchless rehabilitation of pressure applications has grown. To meet demand, SAERTEX multiCom® has developed a UV-cured fiberglass-reinforced pipe liner, which is a close fit CIPP product for the trenchless rehabilitation of pipes in pressure applications such as sewer rising mains and potable water pipes.

This liner is pressure resistant, hygienic and fully structural and has been successfully appraised by WSAA and certified to AS/NZS 4020.

It has been successfully deployed in São Paulo, Brazil, where it addressed supply issues from a major leak in the potable water network from the 1930s. In a bustling urban area, 1.3km of SAERTEX-LINER® H_2O (DN450 - DN500) was installed. This paper focuses on the benefits and use of UV-CIPP from planning to execution of the project.

1.0 INTRODUCTION

Over the last decade the infrastructure for gravity and pressure pipes has increased according to growing demands. Due to their age, maintenance is a constant challenge to ensure functionality of the system. Digging is becoming increasingly complicated, because the pipes in need of rehabilitation are lying under streets, parks and buildings. The real-asset-loss is often not comparable to the costs of open construction methods. Additionally, cities and municipalities try to minimize the impacts on the environment, households and resources, for example the focus is often on the protection of tree roots as well as reducing smell, dirt and emissions [cf. Prof. Dr.-Ing. Stein & Partner GmbH, Instandhaltung von Kanalisationen, 2001, last access: 11/07/2024].

Aging potable water pipe infrastructure is a key concern as well for the water authority SABESP in São Paulo, Brazil. Their potable water network includes 93,200 kilometres of pipes [cf. SABESP, Sustainability Report, 2022, last access: 11/07/2023]. Besides a complete replacement of those pipes, there are methods available such as rehabilitation and repair to ensure functionality of the infrastructure [cf. DIN EN ISO 11295:2018-6, 2018]. The project focusses on potable water pipes from the late 1930s located in the city.

SAERTEX multiCom® is a German manufacturer of UV-cured fiberglass-reinforced (GRP) pipe liner, which is a close fit UV-CIPP product. These types of liners are used for

the trenchless rehabilitation of wastewater and supply pipes. SAERTEX-LINER® H_2O for the trenchless rehabilitation of potable water pipes have been used in this project to rehabilitate the aging pipes.

The project scope included 1.3 km of cast iron pipes in dimensions of 450 mm and 500 mm running operating pressures between 4.5 bar and 9.5 bar. As the infrastructure was built in the 1930s, the need for rehabilitation became evident with damages predominantly at the joints of the pipe. These vulnerable points in the system were causing significant leakages and endangering the overall integrity and functionality of the system.

2.0 PLANNING

The project in São Paulo began with assessing existing assets to determine if repairs, rehabilitation, or renewal were necessary due to operational safety threats, multiple leaks, or insufficient load-bearing capacity. The issues identified in this project in the city centre of São Paulo, Brazil were various leakages in the potable water network across pipes varying between DN 450 and DN 500. The cast iron pipes were built in the 1930s, while over the time this area of town changed in a very busy area. Detailed site analysis followed, considering the city center's dense urban environment, including a train station, factories, shops, and heavy foot and road traffic during the day. Due to these circumstances and surroundings the water authority deemed replacement of the pipe in an open construction method as impossible.

The chosen liner is a UV-cured fiberglass-reinforced pipe liner, which is a close fit UV-CIPP product for the trenchless rehabilitation of potable water pipes. It is pressure resistant, hygienic and fully structural, which has been proven in multiple projects all over the world.

The project faced additional complexities due to COVID-19 regulations, which restricted the involvement of overseas project engineers and technicians from SAERTEX multiCom®. Only the Managing Director of the local sales office could attend the installation in person. Furthermore, regulations and laws around health measures at that time needed to be taken into account and impacted the realisation and timing of the project.

During planning, the consortium of installing companies, Sanit and Sanejets Engenharia, collaborated closely with liner supplier engineers to overcome these challenges and successfully execute the rehabilitation project.

2.1 TECHNICAL QUESTIONAIRE

To establish the viability of a project for pressure pipes using GRP liners, a technical questionnaire is completed by installers to capture all the general details of the project. This technical form serves as a first basis to check the general technical feasibility of the chosen product with the conditions of the project.
This technical form was finished by the installing companies in April 2020 and included the details and documentation for a first analysis of technical feasibility. Following checking the general data such as diameter, operating pressures and length, the project engineer calculated structural designs according to ASTM American standards and continued with meetings with all involved parties to advance the project planning.

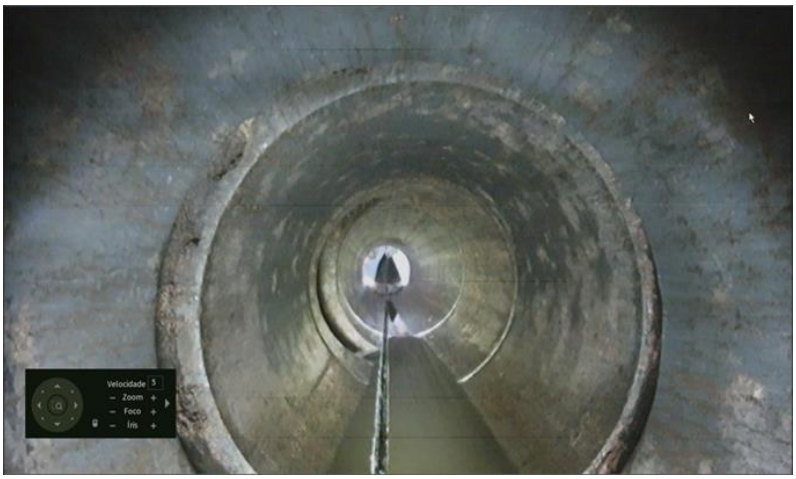
2.2 FIRST PLANNING

Project planning started with gathering data and documents concerning the network sections deemed for rehabilitation. This included original plans from 1936, as well as digital versions of the structure of the network. Over a number of years there have been multiple repairs to the pipes, some easy to identify and others harder to locate. In addition to the potable water pipes, the team observed various crossing infrastructure such as gas pipes, high voltage power and telephone conduits as well as tram lines and a bus station above ground that would need to be taken into account before works commenced.

Analysing all this data made it possible to identify the optimal positions of the excavation pits. In total the team established 15 pits to rehabilitate the 1.3 km of DN 450 and DN 500 in 14 sections. These excavation pits were opened temporarily first to clean the pipes and do a visual CCTV inspection. The inner diameter, wall thicknesses of the host pipe and lengths were checked again and compared with the initial documents provided about the assets. This was a crucial step in the planning to double check the feasibility of the project, as well as the planning data and structural designs to make any final updates if necessary. As a close fit CIPP product the liner strongly relies on the inner diameter of the host pipe, why Sanit and Sanejets Engenharia paid very close attention to ensure all measurement were accurate.

2.3 CCTV AND STATUS OF THE PIPES

After cleaning and CCTV inspection, it was found that the host pipe varied in wall thickness and lacked a consistent inner diameter due to its fragility. Despite its age, the pipe's condition was better than initially expected. However, all joints were leaking due to significant misalignments, caused by lead gaskets that had already failed a long time ago. Some misalignments were severe, complicating the project's planning and installation process. Picture 1 illustrates these misalignments at the pipe joints.



Picture 1. CCTV inspection shows various misalignments of the individual pipe sections

The team discovered repair collars used for short-term leakage fixes and disused lateral pipes intruding into the host pipe. Furthermore, at one point in the section a diameter change of DN 450 to DN 500 was revealed. To address this, an excavation pit was strategically placed at the transition point for lining in both directions. The change in dimension was then completed while reconnecting the pipes with an appropriate piece in between.

2.4 IN THE MEANTIME

Becoming a certified SAERTEX-LINER® installer for pressure applications is mandatory prior to any jobsite installations. The training program, attended by the installing companies in Germany in 2019, covered both theoretical knowledge and practical skills. Participants gained in-depth insights into the liner construction and properties, alongside mastering installation procedures for efficient handling of diverse scenarios with high quality standards.

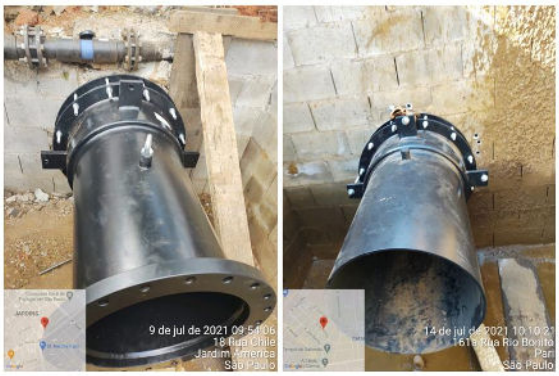
After gathering necessary information, the company proceeded to order the required liners, focusing on project timelines. Refresher training sessions in Brazil further bolstered expertise for upcoming installations. Despite pandemic logistics challenges, careful coordination ensured efficient liner production and shipping. In parallel, attention was devoted to installation planning. The team strategically addressed potential challenges such as bends and long sections, devising effective strategies and resource allocation to ensure smooth, high-standard installations.

3.0 INSTALLATION

When it was time to commence the project with the installation of the first liner, there was still a significant challenge to tackle – the ongoing pandemic. As there were strict travel restrictions, the installing team had to carry out the installations independently, without on-site assistance from overseas project engineers. The only option for support and guidance at the time were via online meetings. Additionally, due to general restrictions the team was only allowed to work one day per week. Another consideration was the location of the jobsite in a busy area in downtown São Paulo. To minimise disruptions and ensure a smooth installation process, nearly all works were conducted at night. This had the advantage of less traffic and pedestrians around the jobsite as well as lower temperatures which made the installation less risky. Additionally, the nighttime installations provided the benefits of no UV Light from the sun, as the resin being used reacts and hardens in contact with UV light. All in all, this allowed the team to work with less time pressure and instead focus on precision and quality.

The installation of SAERTEX-LINER® H_2O itself does not differ to other installation methods of UV-cured fiberglass-reinforced pipe liner, but there are specific additional installation steps needed to ensure full connection to the network, withstanding of operational pressures and safe work practices during the installation.

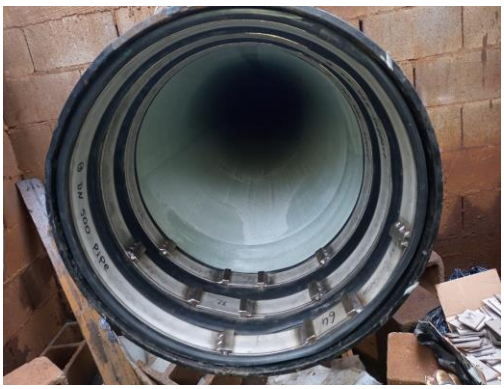
Generally, everything starts with creating the excavation pits for the rehabilitation. As the team had already created the temporary pits for cleaning and CCTV inspections, these could also be used for the installation of the liner. In general, it is necessary to cut out a piece of the host pipe to gain access to the network. Additionally, a new piece of pipe must be mounted on the host pipe as a preparation of the ends of the liner. Various methods can be employed to achieve this such as welding on a new piece of pipe, connect it with a coupling or utilising a product called CIP JOINT from the company NovaSiria®. This step is necessary to ensure a proper end connection of the liner with the existing network to ensure a leak tight system after installation. For this project a CIP JOINT of NovaSiria® was the preferred solution for the end connection which is shown in Picture 2. This is a combination of a coupling and a new piece of pipe either with or without flange, which will be slipped over the host pipe and secured with the coupling.



Picture 5. CIP JOINTS

The next step is for gliding foil to be pulled through the rehabilitation section to ensure a smooth and protected path for pulling in the liner. The calibration of the liner is then done by closing the ends of the liner with packers and generating air pressure on the liner. This pressure will be increased until the liner is in a suitable position to the host pipe. Before inserting the UV-light chain into the trench, the lamps must be checked for functionality. The UV light chain is then inserted into the liner and pulled from the excavation pit to the starting point of the curing. The curing of the liner starts when the UV light is turned on and is pulled backwards through the liner at a prescribed speed. A visual inspection and check of the technical parameters are monitored via the UV truck and are continuously documented during the curing stage. This protocol has a crucial role in ensuring that the installation is executed in accordance with the installation manual. It makes it also possible to check the installation afterwards and in addition to all the other documentation, is a vital aspect to ensure the quality assurance for the product.

After the installation of the liner, it is necessary to install liner end seals for full connection to the network and to prevent groundwater from penetrating the cut edges of the composite material. These liner end seals consist of an EPDM rubber band including steel bands. The cured liner is cut back approximately 10 cm from the end of the pipe to fit the rubber on the cutting edge of the liner. Following this step, the steel bands are installed on the rubber to fixate the system. The installed seal is shown in Picture 3. Given the scale of the project with its large section, the installations often extended into the early morning hours with the final step being the installation of the end seal.



Picture 3. Installed Liner End Seal

4.0 FINAL WORKS

The final stage of the project included a CCTV inspection to visually assess the liner's condition. Additionally, a pressure tests was conducted to assess the integrity, stability

and leak tightness of the installed liner. This pressure test was done section by section to provide an additional layer of documentation and quality assurance for the entire system. As there are different standards worldwide this pressure testing might differ in the duration, pressure and air-free tests, but generally it follows the same method to maintain the same inner pressure for a specific period of time. For this project the pressure test was done with water and a set test pressure of 14 bar. All sections successfully passed the testing, so that cleaning and disinfection of the pipe could go ahead. The project concluded with the liner reconnected to the network system and excavation pits closed.

5.0 CONCLUSION

Despite facing challenging circumstances from the global pandemic, including affections on shipping times, strict hygiene measures and working time restrictions, the project was finished successfully and efficiently to ensure the potable water supply in an important area of São Paulo. Once the liners arrived in Brazil, the whole project, with its 14 sections of rehabilitated pipe, was completed in four months.

The innovative and practical advantages of SAERTEX-LINER® H_2O are highlighted through the success of this installation. There are many benefits, especially in areas where open trench methods are not economically practical or technically feasible. The possibilities of trenchless technology have remarkably advantages for several project scopes, as lining with GRP pipes need less space for the rehabilitation and causes only a minimal disruption to traffic and the surrounding area. Additionally, benefits are seen economically and environmentally as there is minimal movements of earth work required allowing for preservation of tree roots and plants [cf. RSV Rohrsanierungsverband e.V., Information Nr. 11, 2011]. The installed linings become fully structural pipes capable of bearing all internal and external loads independently once cured. Their high mechanical properties allow for thin wall thicknesses, minimizing reductions in the inner diameter and preserving crucial flow capacity.

In conclusion, UV-cured fiberglass-reinforced lining for pressure applications offers numerous advantages, making it the preferred choice for São Paulo's water authority. Its capability to swiftly restore infrastructure ensures a dependable potable water supply, crucial for the city's residents.

6.0 REFERENCES

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