LINING OF A LARGE DIAMETER STORMWATER PIPELINE USING ROTALOC TECHNOLOGY

David Dodemaide BE MIEAust
Interflow Pty Limited

ABSTRACT

This paper details the design and installation of a Rib Loc Rotaloc liner in a deteriorated large diameter stormwater pipeline in the exclusive Melbourne suburb of Glen Iris, in the District of Stonnington. Pipelines ranging from 900mm diameter to 1500mm diameter were lined.

This project at Stonnington was one of the world's largest applications so far of this unique Australian developed lining technology. It provided an example of how rehabilitation techniques previously only used for deteriorated sewers are now finding increasing application as Authorities realise the necessity to repair stormwater pipelines.

INTRODUCTION

The exclusive Melbourne suburb of Glen Iris, in the District of Stonnington is about 20 minutes South East of the Melbourne CBD. It is a heavily populated area, with major road and tram connections to Melbourne CBD – especially along High Street.

Located throughout the Stonnington district is a network of unreinforced concrete stormwater pipelines, some up to 100 years old. Used in their early days as combined storm/sewer pipelines, some of these had suffered abrasion and corrosion. Sections of the pipe wall were missing and partial collapses had occurred at some locations.

In late 2000, the City of Stonnington called tenders for the rehabilitation of one of these pipelines.

The aim was to renew their structural and hydraulic capacity. The project called for rehabilitation of over 500 metres of pipeline with its diameter varying from 900mm to 1500mm. Replacement was not feasible as sections were under more than 3 metres of cover, beneath houses and adjacent to major roads. A structural repair method that could be installed with minimum inconvenience to the community would be well regarded.

In April 2001, the project was awarded to prominent Australian pipeline rehabilitation contractor Interflow Pty Limited, who had proposed structural lining using the newly developed Rib Loc Rotaloc system.

DISCUSSION

Deteriorating large diameter pipelines present particular difficulties when structural rehabilitation is required. While there are several lining systems for smaller sizes that can economically provide 'as new' pipelines with minimum community disruption, these systems cannot be extended to provide the same benefits in pipelines over about 600mm diameter.

Traditional methods for large pipelines are slow, expensive and disruptive. Because of these difficulties, Water Authorities often shy away from the problem of repair until the risk of catastrophic failure becomes too great.

Methods of rehabilitation available were mostly developed for deteriorating sewer pipelines. While these typically have a greater need for renovation because of the abrasive and corrosive nature of sewerage, old stormwater pipelines pose similar problems as they age.

Interflow Pty Limited has developed considerable experience in rehabilitation of large diameter pipelines through their position as licensee for the Rib Loc range of spiral wound pipeline rehabilitation systems. Since 1992 Interflow has installed Rib Loc Expanda Pipe in over 300 kilometres of deteriorated sewers throughout Australia in sizes from 150mm to 750mm.

In larger sizes, a notable project was the installation of Rib Loc Ribsteel in a 1,800mm diameter sewer pipeline in Kemblawarra south of Sydney for Sydney Water in 1998. The pipeline was up to 10 metres deep, in water charged ground. Flow diversion was not needed and the Ribsteel structural liner was installed, without excavation, using existing manholes and with a minimum depth of flow of 300mm in the pipeline at all times.

Options Available to City of Stonnington

At Stonnington, the City required restoration of 4 sections of pipeline with a total length of some 500 metres, in diameters from 900mm to 1,500mm. Deterioration in the pipelines included missing inverts and obverts. The Project Specification prepared by Stonnington City Council was performance based, allowing consideration of a range of refurbishment methodology alternatives.

As there were no man-entry points along any of the pipelines, new pit installations were specified to provide access points for future routine maintenance activities and allow installation of new connections.

Some of the additional considerations included in the Specification were:

- Refurbishment should not significantly reduce the flow capacity of the pipelines
- Because of the importance of the location, Council needed a Contractor experienced in refurbishment of large diameter drains, and favoured a "no dig" solution
- Emphasis on the Contractors Safety Plan for carrying out the works because of the poor existing integrity of the pipelines.
- Tenderers needed to demonstrate understanding of the confined space requirements as well as experience in
    - traffic control
    - minimisation of customer disruption
    - minimisation of damage to the streetscape.

Council advertised for Expressions of Interest, which attracted a short list of 3 Contractors each offering a different rehabilitation methodology. The methodologies were:

- slip lining using pipe jacking techniques
- cured in place lining
- Rib Loc Rotaloc, proposed by Interflow

The Rotaloc option was ultimately chosen.

Reasons for this choice included:

- Quicker installation time – no heating and curing required, and pipeline did not have to be temporarily decommissioned
- Smaller on-site set-up – no large cranes, boilers etc
- Environmentally friendly – no digging required (other than that to install the new pits required in the Specification), no large volumes of water required for curing the liner
- Minimal man entry during installation
- A "tight fit" liner maximised flow capacity

Design of Liner

The Rib Loc Rotaloc liner offered by Interflow was designed as a structural liner capable of supporting all applied loads. Any remaining strength in the existing deteriorated pipeline was ignored.

Loads assumed to be acting on the Rib Loc Rotaloc liner were:

- Soil (full weight of soil above the pipeline, no reduction for trench effects),
- groundwater (assumed to be 0.5m below surface level)
- two lanes of highway loading, taken solely by the liner.

The liner was designed as a flexible pipe in accordance with the WRc Sewer Rehabilitation Manual for Type 2 structural design. Type 2 design assumes that there is no bond between the liner, the grout (if present) or the deteriorated pipe. The design method used is contained in Australian Standard AS2566.1 "Buried Flexible Pipes, Part 1: Structural Design."

This contrasts with Type 1 design, which treats the liner, the grout and the deteriorated host pipe as being a composite section. The strength of the bonds between these 3 elements is critical to the structural performance of the rehabilitation. Extensive testing must be done to confirm the that the grout has bonded to the deteriorated host pipe for its entire circumference and along its entire length.

For Type 2 design, as at Stonnington, the flexible liner is regarded as being supported by the surrounding soil environment. This is in accordance with standard flexible pipe design theory. For liners, support is actually provided by the deteriorated host pipe, the grout used to fill the voids, and the surrounding soil. A soil modulus is entered in design equations to account for this support. A larger value of soil modulus can be entered if voids external to the liner are filled with cementitious grout, as it is assumed that this provides more support for the liner. The strength of the grout is ignored and it is *not* assumed that the grout bonds the liner to the deteriorated host pipe.

In accordance with the design method given in AS2566.1, the design criteria for the liner were:

- deflection (designed to be <6%)
- wall strain (<2%)
- resistance to buckling (factor of safety >2.5)

The Project

Carrying out the project involved the following stages:

- Construction of new pits (as required by the Specification)
- Cleaning
- Installation of the Rotaloc liner
- Cutting and sealing of lateral connections
- Sealing the ends of the liner at access chambers
- Grout encasement of the liner
- Final CCTV survey of rehabilitated pipeline

The Project Specification required 6 new pits to be constructed. This work was done by a subcontracted specialist pit builder. Pits with dimensions of around 1.5m x 1.2m were excavated and cut into the existing pipeline, then the pit walls built up to around 1m below the surface. They were then safely barricaded.

The pit necks and covers were later installed in a second stage, after the lining operation.

The pipelines were cleaned using an eduction operation that directly sucked out large volumes of debris. With no bonding required between the liner and the host pipe and no concerns about debris mixing with resin, the purpose of cleaning was to remove obstructions and loose material from the pipe wall.

Man access was a concern because of the poor condition of pipe. A special internal protective cage was constructed to provide protection for the operator working within the deteriorated pipe. At the same time as cleaning, any protruding connections were also trimmed back.

Lining equipment comprised one truck that housed the generator and the hydraulics to power the winding machine and accessories. Two Rotaloc winding machines – one machine for the 1200mm and 1500mm diameter pipelines and one for the 900mm diameter section. These machines were inserted directly into the pipelines through the newly constructed pits. Had these access points been smaller, it would have been necessary to dismantle the machine and reassemble it at the base of the pit.

Profile was fed to the winding machine from spools located above ground. Each spool contained around 2000 metres of profile. Design requirements meant that large cross section 91-37 profile was used for the 1200mm and 1500mm diameter pipelines while smaller 91-21 profile was used for the 900mm size. The actual diameter of the pipe varied due to original construction tolerances and its advanced state of deterioration.

Liner winding progress varied depending on the condition of the host pipe. The best production rate achieved by the Interflow crew was to line some 50 metres of 1200 diameter pipeline in just over 2.5 hours from commencement of winding. The longest installed liner length between access points was 123 metres.

One section of pipeline curved 45º through a length of 9 metres. The Rotaloc liner was installed in one piece through this bend, without the need for fabrication. The diameter was gradually reduced over a distance of about 1.5 metres at the entrance to the bend. The strain capability of the PVC profile allowed sufficient deflection of the liner during installation through the bend. The diameter was then increased to match the host pipe diameter at the bend exit.
Lateral connections were made as winding progressed. Locations were marked on the liner with spray paint, then cut the same day, allowing services to be immediately restored. The lateral connections were subsequently sealed by injecting an expanding plastic foam up into the liner T-Ribs, then rendering with cement mortar. The liner at the pits was sealed the same way.

In one section, a 600mm diameter water main crossed the top of the existing stormwater pipeline, causing a 200mm obstruction. The Water Authority did not wish the water main to be relocated, so the decision was made to install the liner under the main. The Interflow crew reduced the liner diameter under the main then restored it to the existing diameter over a length of around 5m. The versatility of the Rotaloc machine, which allowed the installed diameter to be varied by 200mm, simplified the situation and allowed work to continue uninterrupted.

Flow diversion was not necessary. The drain at this stage accommodates local drainage in the area however on completion of this project a cross connection will be constructed from a MW main drain to the newly renovated drain, to provide an overflow relief.

The design of these particular liners required voids in the host pipe to be filled with grout to provide support for the liner. Grouting was done after installation of the liner, usually in 3 lifts. The cementitious grout developed for this purpose generally travelled up to 30 metres along the outside of the liner.

CONCLUSION

Authorities often shy away from the problem of renewing large diameter stormwater drains and sewers because of a lack of viable rehabilitation options. On this project, Interflow demonstrated a cost effective solution that restored the structural integrity and hydraulic capacity of the original pipelines. Work was completed without the inconvenience normally caused in densely populated areas by previously available reconstruction methods.

The project demonstrated the effectiveness of this technology for lining badly deteriorated pipelines with bends and offsets, as well as pipelines with long lengths between access points.