Proceedings of the 17th Plastic Pipes Conference
PPXVII
September 22-24, 2014, Chicago, Illinois, USA

PVC – REVIEW OF AVAILABLE TECHNOLOGIES FOR TRENCHLESS PIPELINE APPLICATIONS

Nigel Jones
Australian Vinyls Pty Ltd Corp
Laverton North, Victoria,
Australia

ABSTRACT

PVC is clearly widely known as a material highly suited for trenched or open-cut pipe installations for a variety of uses. Less widely discussed is the fact that PVC offers the widest range of options for trenchless installations. While open-cut installations continue to be the standard method of construction for new projects where access is readily available, for projects in developed urban areas various trenchless technologies are making no dig options more economically viable and appealing. For rehabilitation of our cities aging pipelines, trenchless technologies make it possible to restore the structural integrity and fluid velocity of the pipeline whilst minimising the financial and social costs. In this paper, the options for and advantages of PVC in common trenchless installation techniques are reviewed.

INTRODUCTION

Common with other countries around the world, the use of trenchless pipeline installation technologies is expanding in Australia, with this trend is expected to continue. This has been confirmed in discussions held with water utilities and local governments, who continually seek the most cost effective ways to install and rehabilitate pipelines.

Where new pipelines are installed in open areas, open-cut or trenched installations will likely continue to be the most efficient and cost effective way of completing the installation for some time. However, for installations in densely populated urban areas, open-cut installations are disruptive, costly and increasingly impractical.

In many cities in the developed world, corrosion of water pipelines installed many years ago continues to become an increasing burden for water utilities and source of annoyance for end users affected by the frequent breaks in these pipelines[1]. Ever increasing maintenance costs and compensation payments to flooded end users add to this burden.
In Australia, it is becoming well accepted that replacing corroded pipe with another corrosion prone product does not represent progress. Thus the overwhelming majority of new and replacement water pipelines being installed in Australia are plastic, predominantly PVC. With the expected increase in trenchless installations in the future, it is critical for the plastic pipe industry to have a range of technologies available to cover the different challenges posed by trenchless pipeline installations.

The versatility of PVC, particularly its excellent balance between strength, stiffness and flexibility make it an ideal material to cover a wide range of installation situations, particularly when challenges exist. This paper looks at different trenchless PVC technologies used in Australia and discusses why PVC is well placed to continue its growth in this market.

PVC TRENCHLESS TECHNOLOGY

The PVC pipe industry has developed solutions for the common types of trenchless installations including Sliplining, Horizontal Directional Drilling (HDD), Pipe Bursting, Tight Fit Structural Liner, Jacking and Microtunnelling. Some of these technologies are well established and have been successfully used for many years. In more recent times, the development

of restraint joint systems such as Bulldog Restraint System, Certa-Lok and TerraBrute as well as Fusible PVC™ pipe has significantly widened the range of PVC options. To date, whilst New Zealand has successfully installed a number of Fusible PVC™ projects, none of these technologies have been installed in Australia, though this will hopefully change in the near future. Technologies that have been successfully used include jacking pipe, spiral winding profile, fold and form and segmental lining pipe.

In this paper, these four different PVC solutions are discussed.

1. **Jacking Pipe**
   Whilst Steel and Concrete are generally accepted as standard materials for jacking pipe, PVC is successfully finding use in smaller diameters. PVC's advantages over other materials include safety and ease of handling from lower weight pipes, ease of joining and faster installation. In good ground conditions, installation speeds of 30m (100') in 10 hours can be achieved. PVC jacking pipe is suitable for gravity and pressure sewer, as well as clean water systems.

   Pipe diameters from 150mm (6") up to 375mm (15") using PN12 (174 psi) PVC-U pipe have been successfully jacked, with pipeline lengths up to 300m (1000') installed using this technique. Installation depths of 6m (20') using jacking pressures up to 15 tonnes with a safety factor of 2.5 have been achieved. Maximum jacking pressures of 22 tonnes for 300mm (12") diameter and 32 tonnes for 375mm pipes are allowed by Australian water utilities. Larger diameter pipes should also be in theory possible to install. The pipes are joined using a flush solvent welded socket spigot join containing a rebated section, as can be seen in figures 1 – 4 below. Either PVC-U or PVC-M can be used for jacking pipe.



Figures 1 & 2: Images of PVC Jacking Pipe (Photos courtesy of GM Microtunnelling)

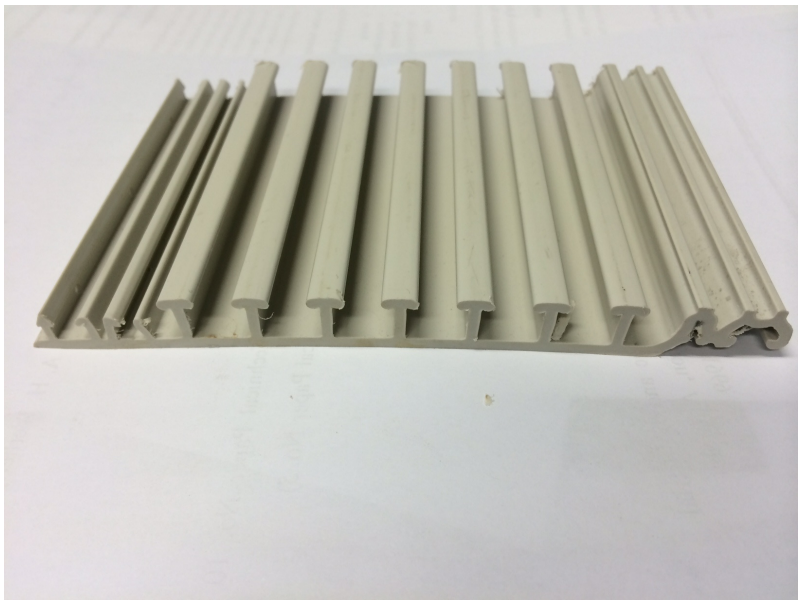

Figures 3 & 4: Ends of PVC Jacking Pipe (Photos courtesy of GM Microtunnelling)

2. **Spiral Winding Profile**

The use of spiral winding uPVC profile for relining of sewer and drainage systems was pioneered in Australia by Rib Loc (now part of Sekisui) over two decades ago. They have successfully exported product using this technology to many parts of the world including the USA from their factory in Adelaide. Other similar competing systems are now also in use in Australia.

The advantages of PVC spiral winding profile include installing under ambient conditions without the need for heating, no joining of pipes, flexibility in final diameter and shape and light weight/material efficiency. Another potential advantage of this system is that there is a hollow opening at all times along the entire length of spiral wound pipe, so existing sewer flows can usually be accommodated during installation without the use of over pumping. Grouting can be used after installation to fill the void between the liner and original pipeline if required.

Spiral winding profiles typically range in widths from 100mm (4”) up to 300mm (12”), with stiffening ribs on the outside of the profile. They are produced from an impact modified rigid PVC formulation. Steel reinforcing can also be placed on the outside of the wound profile to further increase stiffness. Pipe diameters ranging from 150mm (6”) up to 5500mm (18’) have been achieved in circular and non-circular shapes and also curved sections as shown in figure 6.




Figures 5 & 6: Spiral winding profile and pipe (Photos courtesy of Sekisui Rib Loc)

3. **Fold and Form Pipe**
Fold and form PVC pipe was introduced into Australia by Kembla Watertech about 20 years ago and has successfully been used for relining gravity sewers from 150mm (6") up to 300mm (12") diameters. A special rigid PVC formulation is used to produce the pipe, which enhances the strength of the pipe during the forming process.

The advantages of fold and form mainly lie in the simplicity and speed of installation, with single joint free lengths of pipe fed from one access chamber to the next. After expansion and forming of the final pipe, the smoothest possible pipe is achieved. Flow calculations show that for a 150mm aged concrete pipe, flow rate improvements of over 40% are possible after relining with fold and form PVC pipe. Heat is required to initially soften the pipe to allow it be folded and installed. Pressurised steam is used for the expansion and forming process. Connections can be made to the pipe using a specially designed system.

Figure 7: Fold and Form PVC pipe during installation (Photo courtesy of Kembla Watertech)

4. **Segmental Sliplining Pipe**
In recent years, Iplex Pipelines New Zealand has developed a segmental sewer relining system called Restrain™. This system uses a threaded spigot and low profile threaded socket along with an elastomeric seal to join and seal the pipes. Pipe diameters range from 100mm (4") up to 300mm (12"), with lengths anywhere from 1m (3') to 6m (20') being used, depending on the circumstances of the installation. It is produced from standard PVC-U sewer pipe formulation.

Restrain™ sewer pipe can be installed by a variety of trenchless methods including sliplining, HDD, pipe bursting and microtunnelling. The advantages of Restrain™ include its ability to be used in tight and deep installations where access is restricted; it is easy to assemble requiring no special tools or training; it can be installed in either direction; it is produced in standard sizes allowing simple connections; it is produced with a minimum stiffness of 16,000N/m.m (SN16) to allow adequate resistance external loading. Grouting can be used where necessary to fill the annulus between the Restrain™ and the host pipe.


Figures 8 & 9: Segmental Sliplining pipe (Photos courtesy of Iplex Pipelines)

SUMMARY

The use of trenchless pipeline installation technology is expected to grow as the need to rehabilitate or replace existing sewer and water pipeline infrastructure increases in importance. Much of this infrastructure is located in densely urbanised areas where access to existing pipelines is often restricted. It is important when designing a trenchless installation project that engineers not only consider what installation method to use, but also the full range of pipe materials available to achieve the most cost effective and sustainable result for the client.

The properties and versatility of PVC allow it to be used for a wider range of solutions for trenchless installations than any other material. The advantages of PVC include strength, light weight, hydraulic capacity, crack resistant flexibility, corrosion resistance, chemical resistance including resistance to hydrocarbon permeation, maintainability and environmental performance.

This flexibility and versatility will see the use of PVC expand in this increasingly important sector for the plastic pipes industry. The range of physical properties attainable through formulating and variety of joining techniques allow PVC to have the widest range of options for trenchless pipeline installations of any pipe material.

ACKNOWLEDGMENTS

The author would like to acknowledge the assistance of the following organisations in preparing this paper:

GM Microtunnelling
Iplex Pipelines
Kembla Watertech
Plastics Industry Pipe Association of Australia Limited (PIPA)
Sekisui Rib Loc

REFERENCES

1. Petersen R.B., Melchers R.E. - Centre for Infrastructure Performance and Reliability, The University of Newcastle, Australia: Long-Term Corrosion Of Cast Iron Cement Lined Pipes, ACA 2012 Corrosion & Prevention conference