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PVC Technical Information

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Pipelines Integrity For a Cleaner Environment

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The resistance of elastomeric seal pipe joints to tree root penetration

It has generally been accepted that the ability of elastomeric seal pipe joints to resist tree root penetration is largely due to the interface or contact pressure exerted by the seal on the pipe. That is, if the contact pressure is high enough then the roots cannot get past the seal and into the pipe. For this reason, product standards such as those for unplasticised PVC (PVC-U)[1] and vitrified clay (VC)[2] have specified minimum interface pressures. In the case of PVC-U the Standard has specified a requirement for interface pressure for almost 30 years.

In recent years an extensive investigation has been undertaken by the CSIRO and Iplex Pipelines to determine what other factors might influence the ability of a pipe joint to resist tree roots and to re-establish what might be the minimum interface pressure necessary to create joints of high integrity. Part of this work was initiated because of the need to form a combined Australian – New Zealand Standard for PVC pipes for drain, waste and vent applications. Traditionally the two countries had different requirements for contact pressures and it seemed sensible to adopt only one. The New Zealand contact pressure specification was somewhat lower than the Australian but New Zealand PVC pipe joints had a history of good performance. The question was one of whether differences in climatic conditions or vegetation meant Australia had unique requirements. The test program and results have been described in a number of conference presentations and technical papers [3 -6].

The second part of the program was to compare the different pipe materials to see if tree root intrusion was influenced by factors such as pipe material or surface texture.

A number of practical tests were carried out at the Black Hill Flora Centre, Adelaide. The Flora Centre had previous experience with such trials and was able to supply and maintain the appropriate plant species. Initial trials used both rye-grass which has a fine, aggressive root system and melaleuca armillaris (bracelet honey myrtle) having a tap root system capable of entering small cracks and expanding them by secondary growth.

In all cases the plants were grown in a confined space so as to be sure the joints were ‘challenged’ by the root system. and the inside of the test pipe was filled with hydroponic solution to encourage the roots to penetrate the joint. The plants were maintained in a state where they had just enough water and nutrient to survive, but not so much that there was no incentive to seek more.

The test program and conclusions.

1. <u>Vertical assemblies.</u>

   Thirty six PVC assemblies in sizes DN100 and DN150 with either rye-grass or melaleuca were grown in triplicates with three styles of elastomeric seal.

   Despite the prolific growth, roots did not penetrate past any of the seals, even those having a contact width or interface pressure less than nominated in Australian Standard AS 1260- 1984.

2. Horizontal assemblies.

2.1. PVC Socket-mouth / spigot gap.

It had been suggested that the resistance to root intrusions might be related to the gap between the socket and spigot of elastomeric seal joints. A series of assemblies were again tested with both plant species but in a horizontal configuration and with increasing gaps between the mouth of the socket and spigot.

Even when the socket-mouth / spigot gap was increased from 0.2 to 3.7 mm no rye-grass or melaleuca roots penetrated the PVC pipe joints and it was concluded this was not a factor in the performance of the joints.

2.2. PVC joint with reduced interface pressure.

These pipes had sockets that had been machined to produce a range of interface pressures as low as 10% of the current specification. The joints were exposed to melaleuca roots for 3.5 years.

No root intrusions were observed in any of the commonly used PVC joints. Intrusions were however observed in some joints where the interface pressure had been reduced to 0.04 - 0.2 MPa compared to the minimum specified pressure of 0.4 MPa. An interface pressure of 0.38 MPa was even found to resist intrusions when the spigot had been grossly distorted by compressing between parallel plates by 7.5% of the original diameter.

2.3. Vitrified Clay (VC) pipes.

The VC pipes performed worst of all the pipes with 7 out of 8 rolling-ring joints being penetrated within 32 months when tested with melaleuca armillaris.

The experience with the second series of PVC joints illustrates the intrusion of the roots in the VC joints was not due to the open socket design. It was concluded that surface roughness and porosity of the pipe material were contributing factors to the poor performance.

2.4. Fibre reinforced concrete (FRC) pipes.

DN100 FRC pipes were selected as representative of concrete pipes. These were tested horizontally with melaleuca plants. Despite having a broad contact width and high interface pressure, 3 of the 8 joints showed tree root intrusions within 32 months.

The performance of the FRC joints was poor compared with PVC but not quite as bad as VC. It was concluded that whilst surface roughness, porosity and design play a part, the pH of the pipe material is also a factor. The solution in the FRC pipe was alkaline with a pH greater than 9. This was attributed to leaching from the alkaline concrete and restricted root growth compared to the VC pipes.

2.5. Spigoted vitrified clay pipes with plastics couplings and elastomeric seals. Rolling-ring VC joints have now been superseded by plain ended pipes joined with elastomeric seal couplings made from a polyolefin such as polypropylene.

There is evidence that these pipes also experience tree root intrusions and might not offer any long-term benefit compared to the rolling-ring joints that performed poorly in the tests.

Conclusions

- As a consequence of these accelerated root intrusion tests it was concluded that PVC elastomeric seal joints markedly outperformed FRC and VC pipe joints.

- The contact pressure requirements as originally specified in New Zealand [7] have been adopted in the combined Australian/New Zealand Standard [8].

- The results on the PVC joints imply the requirements for interface pressure, as nominated in AS/NZS1260:2002, are conservative for this product. [However, there is no proposal to reduce the requirements].

- The surface roughness and porosity of the VC and FRC pipes are considered to contribute towards the ease of root intrusion past the elastomeric seal joints used with these products.

- The FRC pipe joints appear to be better than the VC but are nowhere near as good as PVC.

Figure 1. Entrance to Black Hill Flora Centre.

Figure 2. Horizontal assemblies. One with 7.5% deflection applied to the spigot via 2 parallel steel plates.

Figure 3. Two horizontal assemblies with 7.5% deflection applied and ready for burial.

Figure 4. Horizontal assemblies with melaleuca seedlings.

Figure 5. Assemblies with established rye grass.

Figure 6. Rye grass roots binding all the soil together, including that below the assembly.

Figure 7. Assemblies with established melaleuca armillaris.

Figure 8. Melaleuca roots binding all the soil together.

Figure 9. Melaleuca roots surrounding the joint.

Figure 10. Cutting a PVC assembly with a bandsaw.

Figure 11. Melaleuca roots growing in the crevices at the socket of a PVC joint.

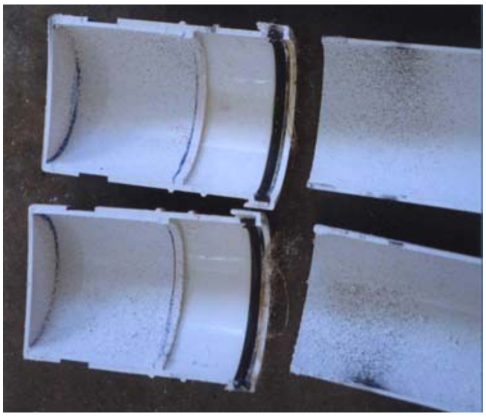

Figure 12. Dissected PVC assembly showing roots have not penetrated past the seal.

Figure 13. VC rolling ring joint with roots having entered past the seal.

Figure 14 VC pipes jointed with a plastics coupling showed a mass of root intrusions when dissected.

[1] Australian Standard AS 1260:1984 Unplasticized PVC (PVC-U) pipes and fittings for sewerage applications.
[2] Australian Standard AS 1741 Vitrified clay pipes and fittings with flexible joints – sewer quality.
[3] A. J. Whittle, J. P. Lu and L. S. Burn, Performance of elastomeric seal joints for PVC sewer pipes, Australian Plastics and Rubber Institute's 10 National Conf., Leura, Australia, 12 – 15 Oct., 1997.
[4] J. P. Lu, L. S. Burn and A. J. Whittle, Elastomeric joint comparison of PVC, VC and FRC pipes, Plastics Pipes X Conf., Gothenburg, Sweden, 14 – 17 Sept., 1998.
[5] J. P. Lu, L. S. Burn and A. J. Whittle, Elastomeric joint performance of PVC, VC and FRC pipes, Polym. Eng. Sci., 40, 10, 2217, 2000.
[6] P. A. Sadler, L. S. Burn and A. J. Whittle, Elastomeric pipe joint performance requirements for use in PVC sewer pipelines, Plastics Pipes XI Conf., Munich, Germany, 3 – 6 Sept., 2001.
[7] New Zealand Standard NZS 7649:1988, Unplasticized PVC sewer and drain pipe and fittings.
[8] Australian / New Zealand Standard AS/NZS 1260:1996, PVC pipes and fittings for drain, waste and vent applications.