



WATER SERVICES ASSOCIATION
of Australia

**HEPWORTH PIPES PTY LTD
PRODUCT APPRAISAL NO 98/8**

**HEPWORTH “SUPERSLEVE”
and “HEPSEAL”
VITRIFIED CLAY PIPE**

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Executive Summary

Hepworth Building Products International Ltd are importing their British-made Supersleve and Hepseal vitrified clay pipe systems into Australia. This report is an appraisal of the fitness for purpose of these systems for the sewerage gravity pipeline systems of WSAA members and associates.

The Supersleve system consists of socketless pipes jointed by polypropylene couplings and is manufactured in sizes DN 100 to 300. The Hepseal system uses socketed pipes and the imported range is DN 400 to DN 600, although a greater range is manufactured in the United Kingdom.

The Supersleve and Hepseal systems were appraised against published Australian and European Standards and found to comply. It was also found that the products were manufactured under Quality Assurance systems certified to international standards. It was concluded that these pipe systems were fit for purpose.

It is recommended that WSAA members and associates accept the Hepworth Supersleve and Hepseal vitrified clay pipe systems for their sewerage systems.

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1 The Company

Hepworth Building Products International Ltd is a British company manufacturing vitrified clay (VC) pipes, as well as concrete pipes, a range of plastic pipes and other building products. Annual sales revenue is approximately \$2 billion.

Hepworth's Australian operations are based in Brisbane with sales offices and distribution facilities in Sydney and Melbourne.

Hepworth have been importing vitrified clay sewer pipe into Australia from their Hazlehead, Yorkshire manufacturing plant since 1995. The imported products include:

“Supersleve” socketless pipes with polypropylene couplings, size range DN 100 to DN 300.

“Hepseal” socketed pipes. These are manufactured from DN 150 to DN 600 but Hepworth are importing the range from DN 400 to 600 to complement the Supersleve range.

2 The Product

Vitrified clay (VC) pipe has been used in sewerage systems since early times and was the predominant material until the introduction of PVC pipe. VC pipe is preferred in many applications principally because of its strength and chemical inertness, and because it does not require deflection testing as do plastic pipes.

The Hepworth pipe system differs from traditional Australian VC pipes in that:

It is manufactured to the European Standard EN 295 *Vitrified clay pipes and fittings and pipe joints for drains and sewers* rather than Australian Standard AS 1741-1991 *Vitrified clay pipes and fittings with flexible joints - Sewer quality*.

Use of special processes and finer clay enables a thinner wall pipe to achieve strength comparable with traditional Australian pipe.

The Supersleve system utilises polypropylene couplings for jointing rather than a socket and spigot. Plain ended pipes are jointed by injection moulded polypropylene sleeves, each sleeve containing two encapsulated elastomeric seals.

HepSeal pipes have sockets like traditional Australian pipe. However the inside of the socket and the outside of the spigot are coated with polyester to ensure a smooth reproducible joint. An "O" ring sits between two high points on the spigot. The joint is assembled by sliding the ring, not by rolling as with traditional Australian pipe.

The Supersleve systems are available in sizes from DN 100 to DN 300. Hepseal is manufactured from DN 150 to DN 600 but Hepworth are importing the range from DN 400 to 600 to complement the Supersleve range.

Standard pipe length for Supersleve is 1.6 m (DN 100), 1.75 m (DN 150), or 2.0 m (DN 225 and DN 300). Standard pipe length for Hepseal is 2.5 metres. Shorter pipes are available.

2.1 European Standard EN 295

Comparing European Standard to AS 1741 significant differences between the standards are:

- Dimensional requirements
- Interface compression in the elastomeric joint
- Permeability

The dimensional tolerancing limits in EN 295 are generally more broad than AS 1741 in the areas of pipe length, straightness, ovality, concentricity and end squareness. It is doubtful that the more strict dimensional tolerancing requirements in AS 1741 are strictly necessary for the pipe to be fit for purpose. In practice Hepworth pipe is manufactured to much tighter tolerances than either standard requires.

2.2 Thin walled pipes

Hepworth pipes have considerably thinner walls than Australian VC pipes. Because they are produced from clay with finer particles, and because of more refined control of the firing process, they are able to achieve comparable crushing strength and beam strength in a thinner walled pipe. This gives considerable reduction in handling and shipping weights and makes pipelaying easier and safer.

2.3 Diameter range

Supersleve pipes are supplied in AS 1741 preferred sizes.

Hepseal pipes are supplied in DN 400, 450, 500 and 600. The equivalent diameter series allowed by AS 1741 is DN 350, 375, 400, 450, 525 and 600, where 350 and 400 are non-preferred. The DN 500 Hepseal is not a standard size according to AS 1741, and DN 400 is non-preferred.

This is not seen as a serious problem although it will be a complication for designers.

3 Appraisal Criteria

Following consultation with the WSAA Product Appraisal network the following criteria were established for appraising the Supersleve and Hepseal pipe systems:

1. Evaluation of Quality Assurance
2. Compliance with EN 295
3. Compliance with root penetration resistance requirements of AS 1741
4. Compliance with permeability requirements of AS 1741
5. Structural strength
6. Assessment of creep performance of joint confining system (Supersleve only)
7. Seal elastomer compliance with AS 1646 (or equivalent)
8. Elastomer type in joints
9. Jointing materials assessed for suitability when exposed to trade wastes and/or aggressive soil conditions
10. Availability of converters to other pipe systems
11. Securing pipe ends during pressure testing
12. Report on installation experiences of agencies who have used these systems
13. Available training systems
14. Fittings
15. Systems for connecting to access chamber internal drop pipes
16. Use of sleeved joints in lieu of sockets (Supersleve only)

4 Product appraisal

4.1 Quality Assurance

Hepworth have supplied Certificate of Registration as a Registered Firm by the British Standards Institution (BSI) - No FM 01415. This certifies that Hepworth operate a quality management system which complies with the requirements of BS EN ISO 9001:1994. This satisfies the Quality Assurance requirements of the Australian Water Agencies Quality Assurance Network (AWAQAN).

4.2 Compliance with EN 295.

Hepworth have supplied BSI KiteMark Schedules KM 14092 (Pipes and fittings) and KM 20171 (Couplings). These certify that the products comply with BS EN 295. This satisfies the Product Certification requirements of AWAQAN.

Hepworth have also obtained Australian WaterMark Licence (Interim) No W 257 for Supersleve from Quality Assurance Services.

4.3 Compliance with root penetration resistance requirements of AS 1741.

AS 1741 specifies (Clause 6.3.1) minimum initial (24 hour) contact pressure of 0.55 MPa in the elastomer, and a minimum contact width of 7 mm. This is considered necessary for the joint to resist tree root penetration. There is no equivalent requirement in EN 295.

With traditional Australian socketed pipes, production variation in pipe barrel diameter and (especially) socket inside diameter causes variation in the ring compression. With the Supersleve pipes, on the other hand, the pipe barrel is extruded to a greater accuracy and the socket is injection moulded. Likewise with Hepseal, the polyester is moulded onto the pipe and then machined to a tolerance. The consistency of the joint compression is therefore more assured. Furthermore, the smoother nature of the pipe will give a better pipe-rubber interface which should itself resist tree roots better.

The CSIRO is currently performing tests in South Australia on tree root penetration of various types of sewer joints. The results of these tests should give the water industry a better appreciation of the parameters that affect root penetration resistance of joints. Previous testing of V.C. pipe indicated that high ring compression is effective in preventing tree root entry.

4.3.1 Supersleve

Hepworth has supplied test results for Supersleve couplings from DN 100 to DN 300 for extremes of tolerancing. These show compliance with AS 1741 even for the worst combination of tolerances. The highest contact pressure was 1.4 MPa for a DN 100 coupling and the lowest 0.65 MPa for a DN 300 with the widest possible gap. For the mid-range of production the contact pressure is considerably in excess of requirements. Contact width is greater than 8 mm in all cases.

4.3.2 Hepseal

For Hepseal, Hepworth has provided a theoretical analysis to predict ring compression and contact width for DN 400, 450, 500 and 600 pipe. Actual measurements of compression force performed on a DN 450 joint confirmed good agreement between theoretical and actual. Results for all diameters for both maximum and minimum tolerance conditions showed compliance with AS 1741 with the highest contact pressure being 1.00 MPa for a DN 400 coupling and the lowest 0.60 MPa for a DN 600. Contact width is greater than 7.1 mm in all cases.

4.4 Compliance with permeability requirements of AS 1741.

Vitrified clay is not an impervious material. Due to its porosity, ground water will pass through the pipe to some extent. This causes higher volumes to be pumped and treated, and greater likelihood of overflows and spills downstream. AS 1741 sets an upper limit of permeability of 0.25 ml/hour/mm diameter/metre of pipe when subjected to an external head of 6 metres. The EN 295 requirement is expressed differently and is not directly comparable, but it has been estimated that it allows approximately 4 times as much infiltration as AS 1741.

Test results performed at the NATA-certified laboratory of Austral Pipes Pty Ltd have been supplied by Hepworth. Tests on 20 samples of Supersleve pipes by the AS 1741 method with diameters DN 100 to DN 150 give permeability varying between 0.003 and 0.184 ml/hour/mm diameter/metre. All pipes tested well below the AS acceptable level, and most samples were lower by a factor of 4 or more.

Glazing was traditionally used to reduce infiltration through VC pipe. This practice is no longer permitted by AS 1741, because advances in clay pipe technology allow the target permeability to be achieved without glazing. EN 295 does permit glazing, but Hepworth does not glaze pipes.

4.5 Structural strength.

Structural strength of VC pipes is categorised by ring crushing strength, measured in kN/m. and by beam or bending moment strength, measured in kN.m. Although both AS 1741 and EN 295 require testing pipes in saturated wet condition, the test methods differ so measured strengths are not directly comparable.

AS 1741 allows two classes of pipe, Class 3 and Class 4 with different crushing strengths for each diameter, whereas EN-295 nominates three crushing strengths for each nominal diameter. Generally there is overlap between the requirements of the two Standards.

In addition to Kitemark testing, Hepworth has supplied test results to the AS 1741 method on DN 100 and DN 150 Supersleve pipes performed by the NATA-certificated laboratory of Austral Pipes Australia Pty Ltd. Results show the Supersleve pipes having crushing strengths well in excess of the AS 1741 Class 4 requirements. One can conclude that the European test methods are more conservative than the AS 1741 and the Supersleve pipes and the Hepseal pipes will exceed the requirements of AS 1741 Class 4.

It is not essential that pipes achieve AS 1741 crushing strengths. Pipelines must be designed to resist structural failure under service conditions. This can be done in accordance with AS 4060 *Loads on buried vitrified clay pipe*. For each installation the designer must perform computations based on the tested strength of the pipe.

Beam or bending moment strength is also not directly comparable. The numbers for beam strength in EN 295 numerically exceed those in AS 1741. Again, Hepworth have supplied test results on beam strength to the AS 1741 method on DN 100 and DN 150 Supersleve pipes performed by Austral Pipes Australia Pty Ltd. Results are that the Supersleve pipes having beam strengths well in excess of the AS 1741 Class 4 requirements

4.6 Assessment of creep performance of joint confining system.

Creep in the polypropylene couplings of Supersleve under stress from the seal will tend to reduce the compression in the seal over time in addition to relaxation from the elastomer itself. While no figures have been provided, the Supersleve coupling contains ribbing to reduce the stresses. Polypropylene is less prone to creep than, for instance, polyethylene. Creep is not seen as significantly reducing the life of the pipeline.

4.7 Seal elastomer compliance with AS 1646 (or equivalent).

Elastomeric seals provide flexibility to cope with ground movement but must ensure that the pipeline is leak free. For Supersleve pipes the seals are supplied fitted into the polypropylene coupling.

EN 295 requires seals to comply with International Standards ISO/DIS 4633-1986 *Rubber Seals - Joint rings for water supply, drainage and sewerage* and ISO 3302-1990 *Rubber: Dimensional tolerances of solid moulded and extruded products*. Conformity of the Hepworth seals to these standards was assessed as part of the KiteMark certification process.

4.8 Elastomer type for joints

Supersleve and Heseal offer the following options for jointing elastomer type:

SBR (styrene butadiene rubber) - standard.

EPDM (ethylene propylene diene monomer) rubber - recommended by Hepworth for applications where seal may be exposed to high temperature industrial effluent.

NBR (Nitrile rubber) - recommended by Hepworth for applications where seal may be exposed to industrial effluent containing hydrocarbons.

Natural rubber is not available. Most Australian water agencies currently use natural rubber for sewer pipe jointing. Exceptions to this include the Melbourne retail water companies and the Power and Water Authority (NT) all of which specify synthetic elastomers. Cases are known of microbiological degradation of natural rubber pipe joints in sewers. Information from overseas is that synthetic elastomers are preferred to natural rubber.

4.9 Jointing materials assessed for suitability when exposed to trade wastes and/or aggressive soil conditions

4.9.1 Chemical exposure charts published by the Clay Pipe Development Association, UK, indicate that polypropylene is resistant to most chemicals. Certain chemicals are injurious to polypropylene but the polypropylene is less susceptible than the seals in most cases. For a particular pipeline, the risk of exposure to such chemicals for sufficient period and concentration to cause damage must be minimal.

4.9.2 Likewise the chemical exposure charts indicate that polyester in the Heseal joint is resistant to most chemicals. Certain chemicals are injurious to polyester but the polyester is less susceptible than the seals in most cases. For a particular pipeline, the risk of exposure to such chemicals for sufficient period and concentration to cause damage must be minimal. Chemical degradation of the polyester will not necessarily be catastrophic to the pipeline but may reduce the sealing performance.

4.10 Availability of converters to other pipe systems.

AS 1741 ensured that all vitrified clay pipe manufactured in Australia is compatible. This is because the then three manufacturers standardised their products in the 1980's.

European Standard EN 295 on the other hand offers the manufacturers seven alternative dimensional systems for each nominal diameter (designated systems A to G). These systems are not compatible with each other, although converters are available in some instances. They are also not compatible with AS 1741 pipes.

Systems A, B, C and D relate to sizes governed by socket dimensions. Heseal pipes are System D. Systems E, F and G relate to sizes governed by barrel outside diameter. Hepworth Supersleve pipes are System E. A competitive product, Naylor Densleeve pipe is System G.

The incompatibility of the various systems is a disadvantage of these products compared to AS 1741 especially for future maintenance. Hepworth can supply adaptors to PVC pipe. Alternatively connection to other types of pipes can be made using elastomeric couplings with stainless steel worm drives. Hepworth supply such a coupling, known as "Flex Seal" and other makes are available.

AS/NZS 4327:1995 *Metal-banded flexible couplings for low-pressure applications* specifies requirements for the couplings.

4.11 Securing pipe ends during pressure testing.

Where sleeved pipes are used for vertical risers e.g. inspection shafts, the ends must be secured for exfiltration testing of pipelines. A pressure of 28 kPa applied to a DN 150 plug exerts an outward force equivalent to 50 kg. Socketed VC pipes use a metal clip to restrain the plug whereas PVC pipes use a screwed cap.

Weighting down the end fitting e.g. with sandbags is one option. Hepworth is working on an alternative solution.

4.12 Report on installation experiences of agencies who have used these systems.

Supersleve has been used by a number of water businesses. Heseal has not been used in Australia to date although it is widely used in Europe.

Brisbane Water has used Supersleve extensively. Any problems have been attributed to pipelaying errors.

Sydney Water has accepted use of Supersleve but use to date has not been high.

City West Water have a number of installations completed using Supersleve. In most cases results have been very satisfactory. However there have been some failures reported during pressure testing. Failures were attributed to cracked pipes, and in one instance a Hepworth 45 junction was out of round to an extent that the coupling would not seal.

Supersleve has been used by South East Water. Reports indicate that the lighter weight pipe is an advantage to the pipelayers compared to Australian made VC pipe.

Yarra Valley Water has used Supersleve and found it an excellent product.. Subsequently the pipe laying contractor wrote an endorsement of the Supersleve system.

4.13 Available training systems.

Although pipeline training and accreditation courses have been developed for PVC pipe (Plastek), ductile iron pipe (Century Plus) and Hobas pipe (Hostek) there is no equivalent for vitrified clay pipe. This has been largely due to upheavals and uncertainty in the vitrified clay pipe industry in recent years.

With the sleeve jointing system, some training requirements arise additional to those with conventional VC pipes such as:

- Correct application of the lubricant.

- Avoiding tearing of the seals especially where jointing pipes have been cut.

- Sleeves must not to be stored in sunlight for excessive periods.

The water industry needs to demand from suppliers development of a training and accreditation course for VC pipe installation. This applies both to the Hepworth products and other vitrified clay systems currently in general usage.

4.14 Fittings

Fittings are included in the KiteMark certification.

Hepworth manufacture fittings to suit structures used in the United Kingdom. The common fittings used are available e.g. short pipes, 45° and 90° junctions, bends, PVC adaptors, saddles (for retro-fit of connections) and tapers. Hepworth's range of bends is 15°, 30°, 45° and 90°.

The non-availability of 60° and 75° bends will create some difficulties with some property branch configurations. Use of 45° bends in place of 75° will increase concreting requirements and reduce flexibility with small risers.

4.15 Systems for connecting to access chamber internal drop pipes.

Internal drop pipe connections are favoured by some water companies whereas others use external drops. Connections for external drops present no problem. However internal drops require a socketed coupling and no suitable VC fitting is available from Hepworth.

Hepworth has responded to this issue by developing a coupling for internal drops utilising a Hepworth VC - to - PVC polypropylene Supersleve coupling and hydrophilic rubber seal. Two beads of rubber are used. One bead is "Corkjoint" HR which has an expansion of 8 times when wet, but initially does not respond to moisture for 7 days. The other is "Leakmaster" which initially responds after 2 days and expands to double its volume. The Leakmaster is to ensure an early seal and allows the structure to pass the initial vacuum test.

Because of the confinement by the concrete, the expanding rubber seal develops compression against the concrete and coupling surfaces, creating an effective seal. Hepworth supply Supersleve couplings with hydrophilic rubber attached. Inside the access chamber a PVC adaptor and PVC drop pipe components are used. Hepworth proposes to assemble the sealing couplings at their Nunawading, Vic depot.

Hepworth have tested this sealing system and the testing was witnessed by WITS. WITS' evaluation of the sealing method is that it is satisfactory, but it may be that in some cases an early vacuum test will fail. This will not necessarily indicate an unsatisfactory connection, and repeating the vacuum test at a later date should obtain a satisfactory result. Care will be required to ensure the rubber components are kept dry before installation and not exposed to sunlight. Installation instructions should be provided by Hepworth.

4.16 Use of sleeved joints in lieu of sockets

Sleeved joints have recently been introduced in Australia. A sleeved coupling called "Unisleve" was developed jointly by Austral and PGH for use with Australian-made AS 1741 pipe. Many pipelayers prefer the new jointing system, although others have preferred jointing socket and spigot pipes.

Unlike the traditional rolling ring, the couplings require a lubricant to assemble the joint. Hepworth supplies a soap-based lubricant and have provided a Material Safety Data Sheet for the lubricant supplied. The material is non-hazardous and water soluble.

5 Conclusions

This appraisal finds that the Hepworth Supersleve and Heseal vitrified clay pipe systems:

Are manufactured under a Quality Assurance system certified to ISO 9001 by the British Standards Institution.

Comply with EN 295.

Comply with AS 1741 with regard to permeability and joint seal compression,

Are fit for purpose for sewerage gravity pipeline systems.

6 Recommendation

It is recommended that WSAA members and associates accept the Hepworth Supersleve and Heseal vitrified clay pipe systems for their sewerage systems.

Appendices

Attachments:

Quality Certification Certificate

KiteMark Certificates

Hepworth Product Literature