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ABN 42 000 664 942

VIN162

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Supermain PVC-O

  

MOLECULAR ORIENTED FOR SUPERIOR STRENGTH & PERFORMANCE

Product Catalogue

Supermain PVC-O

MOLECULAR ORIENTED FOR SUPERIOR STRENGH & PERFORMANCE

product manual

Contents

Quality System
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Introduction

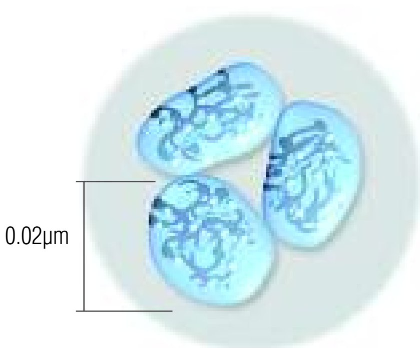
Vinidex Supermain Oriented PVC pressure pipe is the most technically advanced PVC pipe available. Supermain PVC-O is ideally suited for general water supply, rising mains and other pressure applications.

The benefits of PVC pressure pipes have been well established over their long service history. Molecular orientation further enhances the mechanical properties of PVC, allowing energy efficient production whilst conferring considerable performance advantages. These environmental and engineering advantages mean Supermain is the high-performance, cost-effective pipe material choice for pressure applications.

Manufacture

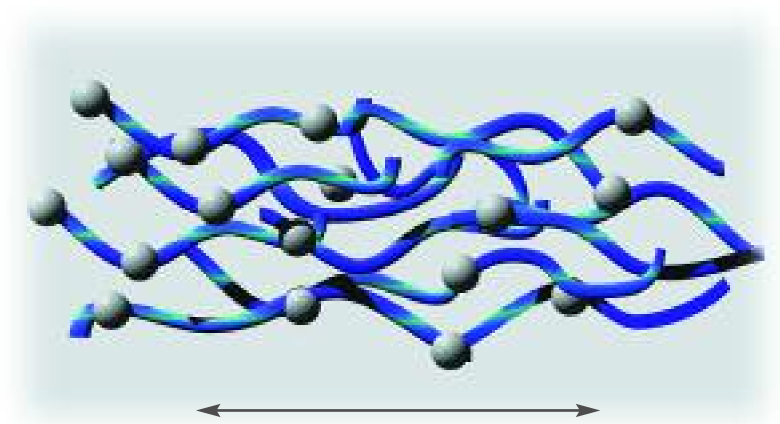
The manufacture of Supermain can best be considered as a two step process. Firstly, a small diameter thick walled pipe is extruded by conventional techniques. This feedstock pipe is then expanded under precise conditions of temperature and pressure to form the final pipe dimensions. Depending on the process, the expansion either takes place as part of a continuous process or in a separate mould.

It is during the expansion stage of the manufacturing process that molecular orientation takes place. The random long chain molecules of PVC become preferentially aligned in the expansion or hoop direction and a marked increase in strength is attained in this direction. For pipes, hoop strength is the primary factor determining resistance to internal pressure. The sketches below illustrate the general principle of orientation.



Clusters of PVC Molecules

Molecular Entanglements
Typical PVC Processing



Oriented PVC - Direction of Orientation

Benefits

- High flow capacity
- High impact strength
- High toughness
- Excellent damage tolerance
- Light weight
- Corrosion resistant
- No adverse effect on water quality
- Occupational Health & Safety risks are reduced
- Material and energy efficient – environmentally more sustainable

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Product Data

Standards for PVC-O Pipe

Supermain PVC-O pipes are manufactured in accordance with AS4441 (Int):2003 - Oriented PVC (PVC-O) pipes for pressure applications. This standard replicates the requirements of ISO/DIS 16422, Pipes and joints made of oriented unplasticized poly vinyl chloride (PVC-O) for water transport – Specifications, with some additional requirements for Australia.

Material Classification

AS4441 (Int) covers a range of PVC-O pipe materials, classified by their Minimum Required Strength or MRS value. Supermain pipes are classified as PVC-O 400 and PVC-O 500 materials. The material class is related to the MRS as shown in the table below.

Material Class	MRS (MPa)
400	40
500	50

Pipe Classes

Supermain pipes are classified in terms of their nominal working pressure at 20°C. Pressure classes are identified by their PN designation as shown in the table below.

Description			
Maximum working pressure at 20°C	PN 12.5	PN 16	PN 20
MPa	1.25	1.6	2.0
m head	127	163	204

Note: Other classes may be available for special projects. Contact Vinidex for further information.

Pipe Dimensions

Material Class			PVC-O 400		PVC-O 500		PVC-O 500	
Pressure Class (PN)			12.5		16		20	
Nominal Size	Mean Outside Diameter		Minimum Wall Thickness (e) and Nominal Internal Diameter (ID)					
DN	Min	Max	e	ID	e	ID	e	ID
100	121.7	122.1	3.0	115.4	3.0	115.4	3.8	113.7
150	177.1	177.7	4.4	167.9	4.4	167.9	5.5	165.5
200	231.9	232.6	5.7	220.0	5.7	220.0	-	-
225	258.9	259.7	6.4	245.5	6.4	245.5	-	-
250	285.8	286.7	7.0	271.2	7.0	271.2	-	-
300	344.9	346.0	8.5	327.2	8.5	327.2	-	-
375	425.7	427.0	10.5	403.8	-	-	-	-

All dimensions in mm.
Not all sizes/classes are available from all Vinidex locations. Contact Vinidex for further information.

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Lengths

Supermain pipes are supplied in standard 6m effective lengths.

Jointing

Supermain pipes are supplied with integral sockets for rubber ring jointing. The integral joints are capable of 1° deflection. Further deflection can be achieved using deflection couplings. Contact Vinidex for more information.

Solvent cements should not be used with Supermain pipes.

Fittings

A complete range of pipeline fittings is available for Supermain pipes to form a total pipeline system.

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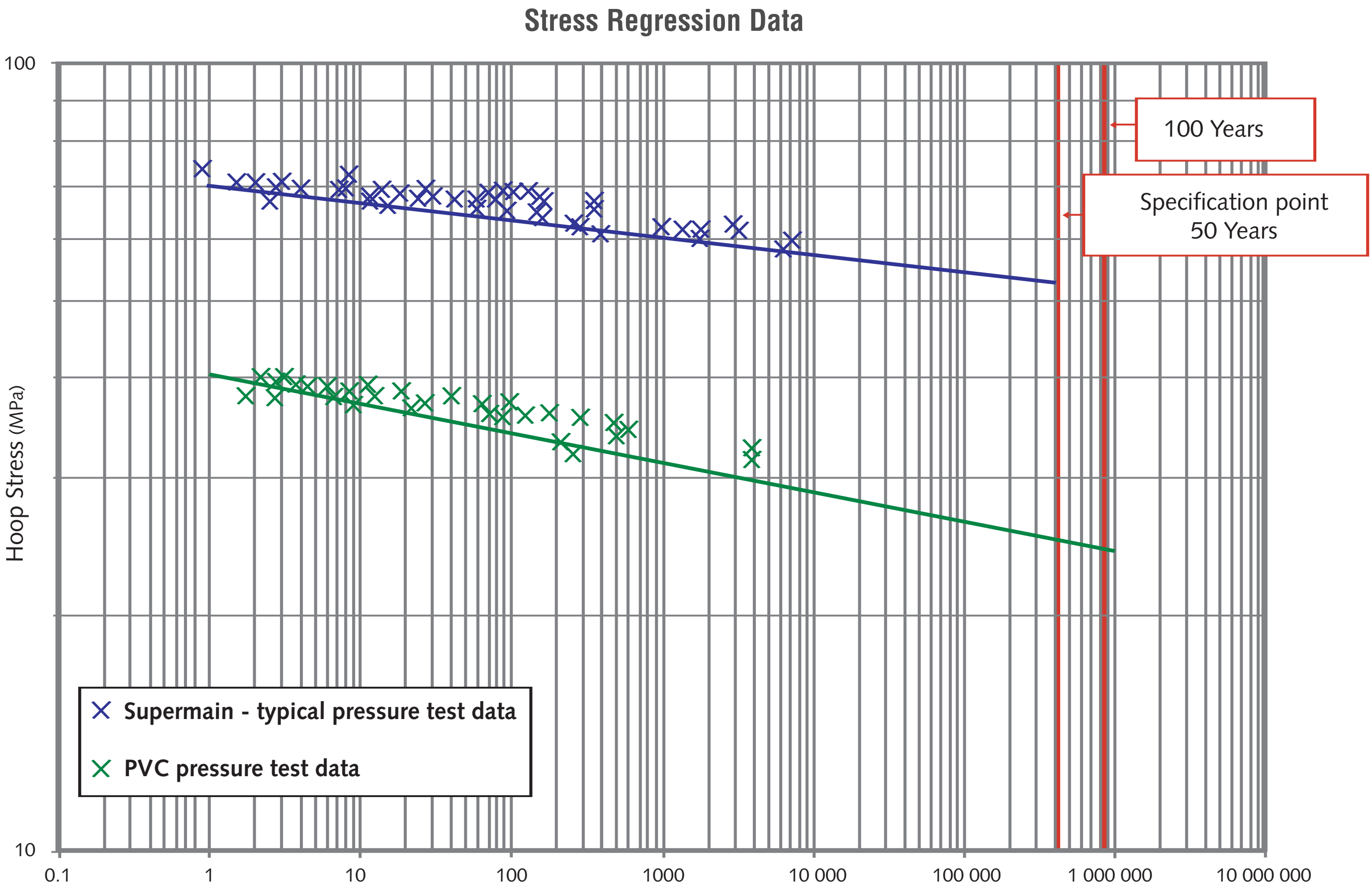
Performance

Tensile Strength

- The long term hydrostatic strength of PVC-O is up to twice that of ordinary PVC-U materials.
- Taking advantage of this superior strength allows the same pressure class of pipe to be manufactured with a larger bore.



Flow Capacity

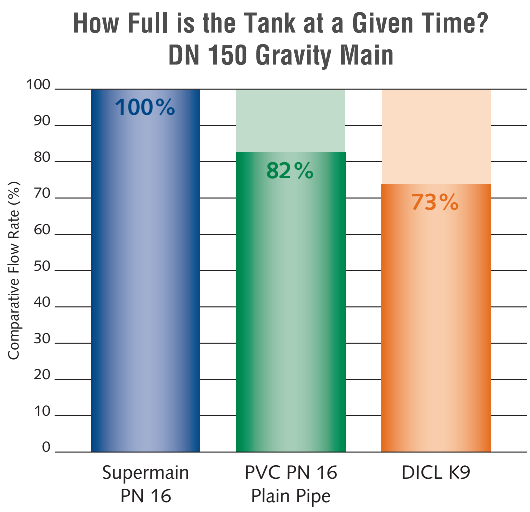
- Supermain pipes have excellent hydraulic performance. Their flow capacity exceeds that of any other commonly used pressure pipe in water and sewer applications.
- A comparison of the relative hydraulic capacity of Supermain, Series 2 PVC-U and DICL pipe is shown below[1].

For Gravity Flow Situations

Compare discharge for a constant hydraulic gradient (H/L) of 1m/100m.

Q (Litres/second)

	Supermain PN16	PVC PN 16	DICL K9	% increase over PVC	% increase over DICL
DN 100*	12	9.17	7.47	31	61
DN 150*	32.6	25	24.4	30	34
DN 200*	68.4	53.4	52.2	28	31

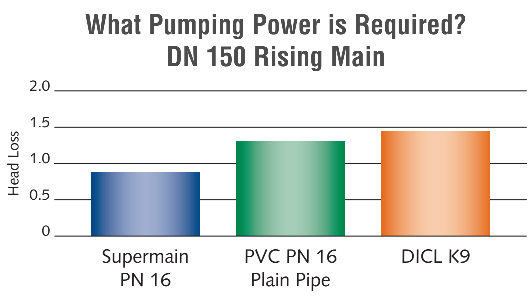


For Pumping Mains

Compare head loss for a given discharge (pumping costs related to friction losses).

H (m/100m)

	Supermain PN16	PVC PN 16	DICL K9
DN 100* Q=10L/s	0.72	1.17	1.72
DN 150* Q=30L/s	0.86	1.39	1.47
DN 200* Q=40L/s	0.39	0.59	0.61



[1] The information given in the flow comparisons and flow charts is based on the Colebrook-White formula with water at 20°C and the following roughness coefficients: For PVC-O and PVC-U, k=0.003, for DICL, k=0.03. For information on varying these parameters, see the Vinidex Water Supply Manual.

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Impact Strength

- Supermain exhibits extraordinary resistance to impact. Tests on Supermain show impact rupture energies up to 10 times that of standard PVC-U.
- Standard impact tests are carried out at 0°C because the mass required to test the pipe at 20°C is impracticable for normal test equipment. DN 375 pipes are tested using a 16kg ball dropped from a height of 2 metres above the sample.
- The unorthodox "field test" on pressurised pipe (left) illustrates the superior impact resistance of Supermain pipe.

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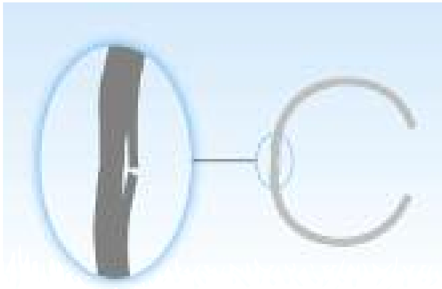
Toughness and Notch Sensitivity

PVC-U Pipe

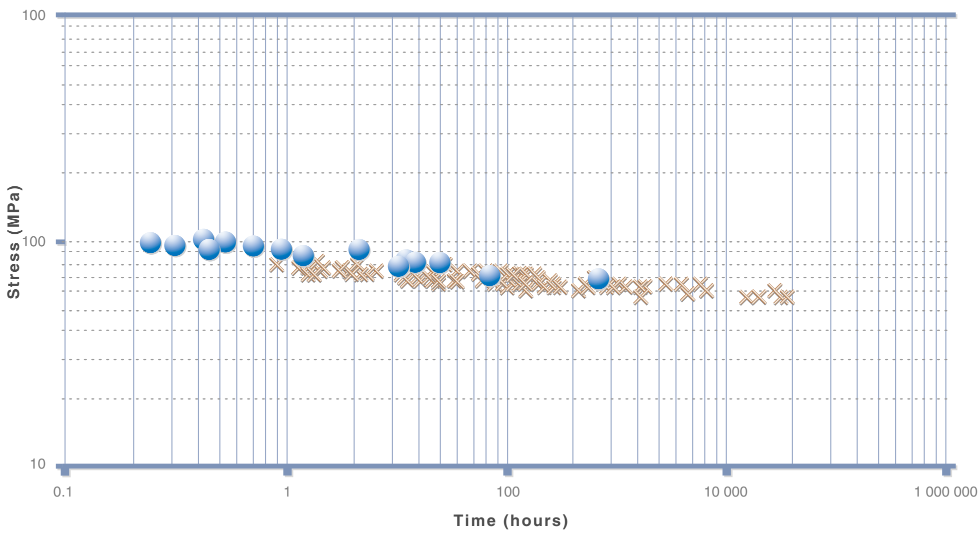


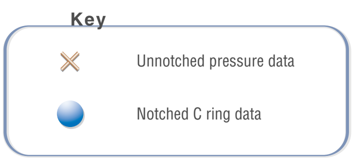
Supermain Pipe

- Toughness is a material's ability to resist brittle crack propagation.
- Marshall [2] (1989) investigated this property. He demonstrated the failure mode for Supermain was not radial through the wall section as it is with standard PVC-U pipe. The illustrations (left) depict the two failure modes.
- Marshall [2] also found that a notch in the pipe wall has the effect of only reducing the cross sectional area.

Notched and Unnotched Test

- The graph (right) shows that notched and un-notched test data follow the same relationship when the reduced wall thickness of notched specimens is taken into consideration.





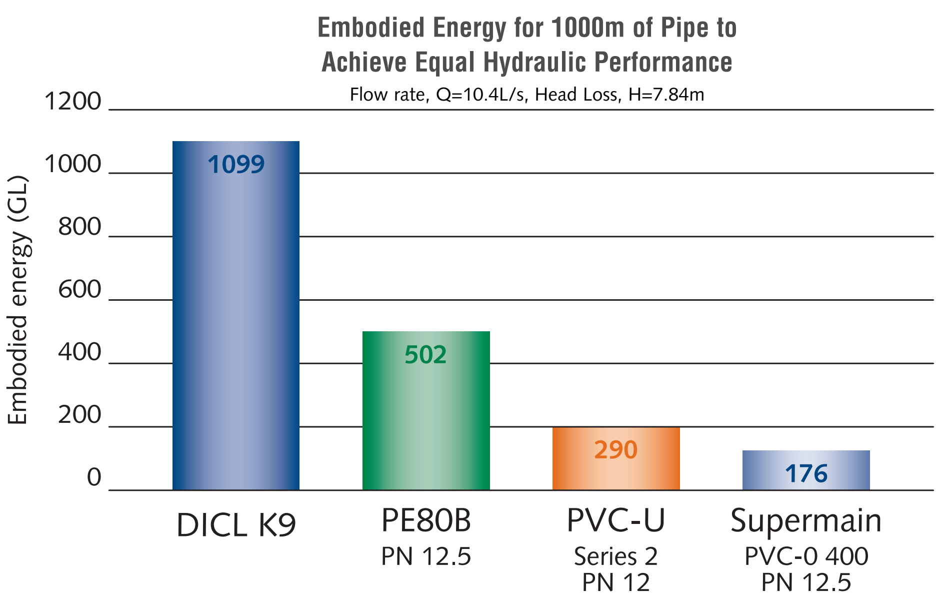
2 Marshall G P, "Report on Evaluation of Toughness Criteria for HSPVC" (Report prepared for Water Research, UK), 1989.

Embodied Energy

Embodied energy is defined as: "the quantity of energy required by all of the activities associated with a production process, including the relative proportions consumed in all activities upstream to the acquisition of natural resources and the share of energy used in making equipment and in other supporting functions i.e. direct energy plus indirect energy".

A recent study by CSIRO[3] demonstrated the considerable reduction in embodied energy for PVC-O pipes when compared with alternative pipe materials based on equal hydraulic performance.

The example below illustrates the benefit obtained by using Supermain pipes.



[3] M.D. Ambrose, G.D. Salomonsson and S. Burn, CSIRO, Australia, "Piping Systems – Embodied Energy Analysis".

Supermain Design and Installation

General

With some minor exceptions, the recommended procedures for design and installation of Supermain pipes are the same as for standard PVC-U pipes. These are covered by AS 2032 – "Installation of UPVC pipe systems". However, there are some aspects of design and installation for which either a different approach is required or a different response obtained from Supermain. These differences are highlighted below. For detailed information on the design and installation of all PVC pipes, including Supermain, refer to the Vinidex Water Supply Manual.

Temperature Considerations

Supermain pipes are de-rated for temperature according to the International practice for PVC based pipe materials as shown in the below table. Supermain pipes can be used for continuous service at temperatures up to 45°C[4]. Higher temperatures should be avoided as Supermain will experience 'reversion' of the oriented structure at elevated temperatures, and may undergo significant dimensional distortion above 50°C.

The operating temperature above refers to the average across the wall. Short term exposure on one surface to temperatures in excess of the maximum operating temperature, such as may occur during storage can be tolerated. If extreme conditions are encountered for extended periods during pipe storage, some ovality may develop in the pipe or socket. This is of no consequence in the performance of the product and for jointing, Supermain pipes are readily re-rounded in making the joint.

If prolonged storage is expected, consideration should be given to shading the pipe with a material such as shadecloth or hessian, which does not concentrate the heat, placed so as to not restrict the circulation of air in the pipes, which has a cooling effect.

Pipe Material		Maximum Allowable Pressure (MPa)		
Temperature	Re-Rating Factor	PN 12.5	PN 16	PN 20
20	1.00	1.25	1.60	2.00
25	0.94	1.18	1.50	1.88
30	0.87	1.09	1.39	1.74
35	0.79	0.99	1.26	1.58
40	0.70	0.88	1.12	1.40
45	0.64	0.80	1.02	1.28

[4] Water Authorities generally require temperatures of water supplies to be kept below 40°C to prevent growth of bacteria.

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Fatigue Design

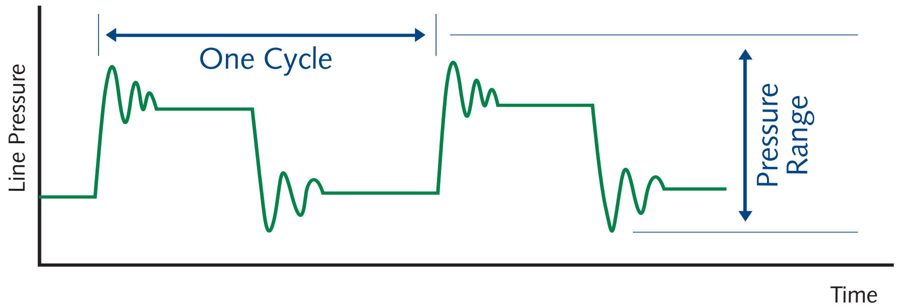
Where a pipeline is to be subjected to a large number of cyclic or repetitive loads, fatigue design must be considered. For Supermain pipes, de-rating may be required if the total number of cycles in the pipe lifetime exceeds 30 000.

The fatigue design procedure is fairly straightforward. Three important factors must be considered. These are the loading frequency or number of cycles per day, the cyclic pressure range and the required service life of the pipe. For a given number of cycles, a fatigue cycle factor is referenced from a table and used to calculate the maximum cyclic pressure range (MCPR) for a particular pipe material and pressure class.

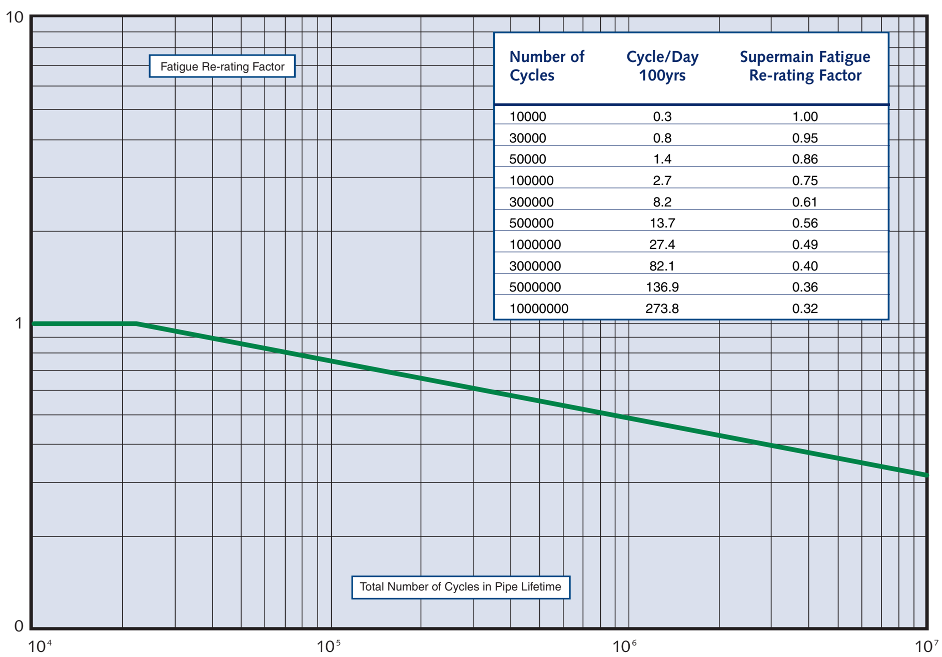
The pressure range is simply the maximum pressure minus the minimum pressure, including all transients, experienced by the system during normal operations as illustrated in the diagram below. The effect of accidental conditions such as power failure may be excluded. Note that for fatigue loading situations, the maximum pressure reached in the repetitive cycle should not exceed the static pressure rating of the pipe.

The diagram also illustrates the definition of a cycle as a repetitive event. In some cases, the cycle pattern will be complex and it may be necessary to also consider the contribution of secondary cycles. For a more detailed discussion of fatigue design for plastics pipes, including examples and a full list of references, please refer to Vinidex Technical Notes VX-TN-4J and VX-TN-4H.

To select the appropriate pipe class for fatigue loading, the following procedure should be adopted:



Supermain Fatigue Design



Number of Cycles	Cycle/Day 100yrs	Supermain Fatigue Re-rating Factor
10000	0.3	1.00
30000	0.8	0.95
50000	1.4	0.86
100000	2.7	0.75
300000	8.2	0.61
500000	13.7	0.56
1000000	27.4	0.49
3000000	82.1	0.40
5000000	136.9	0.36
10000000	273.8	0.32

- Estimate the likely pressure range, ΔP, ie., the maximum pressure minus the minimum pressure.
- Estimate the frequency or the number of cycles per day, which are expected to occur.
- Determine the required service life and calculate the total number of cycles which will occur in the pipe lifetime.
- Using the table, determine the fatigue cycle factor to be applied.
- Calculate the maximum cyclic pressure range from the following equation:

$$MCPR = \frac{PN}{10} \times f$$

- Compare MCPR with ΔP, if MCPR is less than ΔP; try a higher pressure class in the equation.

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Chemical Resistance

PVC-O is expected to have the same inherent chemical resistance as PVC-U as the chemical nature of the two materials is identical. However, since the information presented in chemical resistance tables has been determined for standard PVC-U and the effect of chemical attack on the different molecular structure of PVC-O has not been extensively investigated, the use of Supermain pipes in chemical environments or for the transportation of chemicals is not recommended.

Lateral Loadings and Negative Pressures

The stiffness (lateral load for a given diametral deflection) is related to material modulus and the cube of the thickness. For PVC-O materials, the modulus is somewhat higher than that for standard PVC-U. However, the wall thickness is the overriding factor in determining the stiffness. Supermain pipes have a significantly lower stiffness than standard PVC-U pipes of the same pressure class. This is important in determining the response to lateral loading, due to soil and traffic, and negative pressures due to vacuum, ground water etc.

In general water supply works with buried pipes at normal covers, lateral stiffness will not be a limiting design factor and will not require special consideration. For abnormal conditions, design should be conducted in accordance with AS/NZS 2566. Vinidex recommends the following values be used for the ring bending modulus for Supermain pipes:

Short Term Ring Bending Modulus at 20°C E_b	**4000 MPa**
Long Term Ring Bending Modulus at 20°C E_{bL}	**1800 MPa**

Buckling may result if the pipe is subjected to internal vacuum, as a result of water hammer or siphonage. Other special cases include pump suction lines (with or without submersion) and concrete encasement.

Example: For a Supermain pipe buried with 1m cover height in sandy-clay native soil with sand used as the embedment material, the following supported buckling pressures are calculated in accordance with AS/NZS 2566.1 using an effective combined soil modulus, E', of 6.3MPa.

	Supported Critical Buckling Pressure, P_b (kPa) Short Term Loading at 20°C		
	PVC-O 400 PN 12.5	**PVC-O 500 PN 16**	**PVC-O 500 PN 20**
Supermain	590	590	740

Clearly, in this example, Supermain pipe has an adequate factor of safety for a full vacuum. It should be noted that to obtain support from the soil, the embedment material must be properly placed and compacted, and stable against long term washout or leaching.

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For the case where a pipe has no lateral support from the soil, the unsupported critical buckling pressure must be considered. This may occur in above ground lines, or where an underground line emerges into a pit (unsupported length greater than 5 diameters). Buried pipes having cover less than two diameters or 500 mm should also be considered unsupported.

A table comparing the unsupported collapse pressures of Supermain pipe with PVC-U is given below. This comparison is made using the short-term modulus at 20°C and would be applicable to a negative pressure associated with water hammer. Water hammer can normally be readily controlled with air valves and other devices to prevent negative surges, but under some circumstances this is not possible. Under these conditions, it can be seen that, despite having a much lower collapse pressure, the Supermain pipe can still support a full vacuum with a safety factor of 1.5. Designers should also evaluate resistance to buckling for applications with significant long term negative pressures eg. the presence of groundwater.

Pipe Type	Unsupported Critical Buckling Pressure, P_C (kPa) Short Term Loading as 20°C
PVC-U ≤ DN150 PN16	2930
PVC-U > DN150 PN16	2100
Supermain PVC-O 500 PN16	160

Jointing to Ductile Iron Fittings

Supermain pipes may be jointed to ductile iron push fit and compression gasketed fittings. As with standard PVC-U, factory witness marks are not applicable when jointing to ductile iron fittings, and the spigots should be fully inserted to the stop. It is advisable before jointing to mark a witness line on the spigot at the appropriate length for the particular fitting so that full insertion can be observed.

The depth of sockets on pipes and fittings must be sufficient to accommodate the axial movements due to the combined effect of a number of factors, such as thermal contraction and Poisson[5] contraction which occurs when a pipe is pressurised. The Poisson effect is more significant for PVC-O pipes because of their higher operating stress. Vinidex Superlink Ductile Iron Fittings have socket lengths adequate for all situations and are recommended for use with Supermain pipe. Fittings sockets from other suppliers may be shorter and there may be risk of pull out depending on operating parameters. If necessary, short lengths or special anchorage may be used to compensate for short-socket fittings.

[5] Change of dimensions in directions perpendicular to the direction of stress. Pipes contract in length when pressurised.

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Service Connections

Service connections to Supermain pipes are made using a suitable tapping band complying with AS/NZS 4793 (Int) – Mechanical tapping bands for waterworks purposes and the following considerations:

- Holes should be drilled using a hole saw.
- Tapping bands having full circle support, an "O" or "V" seal, and positive stop against over-tightening are recommended for PVC-O pipes.

Suitable products are available through Vinidex. Tapping saddles, which employ U-bolt fastenings, are not suitable for Supermain pipes. Tapping clamps with full face flat gaskets have no diameter control and the high force required to seal may crush the pipe. Plastic and reinforced plastic units should be used only with specific recommendation from the supplier that they have been tested for use with PVC-O.

Vinidex does not recommend direct tapping of any PVC pipes, including Supermain.

Installation

Installation techniques for Supermain pipes are similar to that used for standard PVC-U pipes. The lower wall thickness and stiffness of PVC-O pipes compared to PVC-U pipes makes it essential that recommended practices for installation are adhered to and the pipe is fully supported.

Quality non cohesive material should be used for pipe bedding, side support and overlay. The pipe side support material should be placed evenly on both sides of the pipeline to two thirds the height of the pipe diameter and compacted by hand tamping. Side fill material should be worked under the sides of the pipe to eliminate all voids and provide maximum pipe haunching. The pipe overlay material should be levelled and compacted in layers to a minimum height of 150mm above the crown of the pipe or as specified.

The field testing procedures specified in AS2032 and the Vinidex Water Supply Manual should also be followed for Supermain pipelines except that the field test pressure should not exceed 1.25 times the pressure rating of the pipe.

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Ordering Informaion

Product Code	Size	Description	PN	Length	Weight (kg)
17220	100	Supermain RRJ	12.5	6	11
17221	100	Supermain RRJ	16	6	11
TBA	100	Supermain RRJ	20	6	14
17225	150	Supermain RRJ	12.5	6	23
17226	150	Supermain RRJ	16	6	23
TBA	150	Supermain RRJ	20	6	29
17230	200	Supermain RRJ	12.5	6	39
17231	200	Supermain RRJ	16	6	39
17240	225	Supermain RRJ	12.5	6	49
17241	225	Supermain RRJ	16	6	49
17450	250	Supermain RRJ	12.5	6	59
17455	250	Supermain RRJ	16	6	59
17460	300	Supermain RRJ	12.5	6	86
17464	300	Supermain RRJ	16	6	86
17479	375	Supermain RRJ	12.5	6	131