



PIPA

PLASTICS INDUSTRY
PIPE ASSOCIATION
OF AUSTRALIA LIMITED

POLYOLEFINS AND PVC GUIDELINES POP202

PVC, PP and PE
Pipe Installation on
Curved Alignments

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PVC, PP and PE Pressure Pipe Installation on Curved Alignments

The installation of buried pipeline systems often requires the pipeline follow a curved alignment. Typically, this could occur on a curved road where the pipeline needs to follow a similarly curved allocation in the footway or simply to facilitate localized deviations to allow the pipeline to negotiate a fixed obstacle such as a power pole or tree. In recent years many Australian water agencies have also changed their approach to sewer design allowing curving of sewers and as a result the scope of this document has been expanded over previous versions to include non-pressure applications and polypropylene (PP) pipe systems.

The purpose of this guideline is to provide general guidance regarding the installation of these pipe systems on curved alignments. The information contained in this document should be read in conjunction with the Australian Standards covering the installation of PVC and PE pipelines (AS/NZS2032 and 2033) and the manufacturer's installation guidelines for all pipe systems including PP. This document contains supplementary information to these references.

PIPA recommends the advice of the pipe manufacturer be obtained where bend radii is a critical feature of any installation as it may be possible to safely install specific products in specific installations with bend radii that differ from these general recommendations. There may also be water agency specific instructions relating to water and sewer infrastructure applications.

It is important to note that the force required to curve the pipe varies significantly with increasing diameter, increasing wall thickness and tighter bend radii. Similarly, the energy stored in a curved pipe also increases under the same circumstances. The installer must develop safe methods of curving and restraining pipes during installation.

PE PIPELINES

Coiled PE pipe or pipe strings formed by butt fusing multiple lengths of individual PE pipes may be cold bent in the field to form a curve. (Guidance on curving PE structured wall non-pressure pipe is provided later in this document).

AS/NZS 2033 is the Australian Standard for PE pipe installation and should be the primary reference document. This standard mentions both plain wall pipe and profile (or structured) wall non-pressure pipe.

One of the features of plain wall polyethylene pipe is that it can be readily curved during installation. The allowable radius of curvature is dependent upon the pipe diameter (DN), temperature of the pipe and SDR rating (wall thickness).

This general guide is based on published recommendations of the PE 100+ Association (<http://www.pe100plus.com/>). The minimum bend radii are recommended to avoid the risk of kinking, buckling and overstressing of the pipe at a temperature of 20°C. Installations at much lower temperatures, for example at or below 0°C may require significant increases in the minimum bend radius of the order of 50% and hence under these circumstances the installer is advised to seek the recommendations of the pipe manufacturer.

PE PIPE SDR	MIN BEND RADIUS (X DN)
9	12
11	15
13.6	21
17/17.6	25
21	35
26	45
33	65

Fittings or flange present in the curve See recommendations below

EXAMPLE

The minimum radius of bend for placing a 500mm, SDR 11 PE pipe is:

$$(500 \times 15) \text{ mm} = 7.5\text{m}$$

Where the required bend radii is less than the manufacturer's specified minimum radii formed bends shall be used to prevent undue stresses in the pipeline.

BUTT FUSION JOINTS

Where butt fusion joints will be installed as part of a curved pipeline all welding, including the full cooling cycle must be completed on straight pipe sections prior to curving. Pipelines including butt fusion joints can be curved to the minimum bend radii of plain pipe as defined in the table above.

ELECTROFUSION FITTINGS AND MECHANICAL JOINTS

Where electrofusion, flanged or other mechanical fittings are required on the curved section, it is advisable to seek the advice of the fitting manufacturer as in some cases different minimum radii will be required to avoid the creation of high localised stresses at the fitting. As a general guide the minimum bend radii for pipelines containing these fittings should be 100 times DN.

Electrofusion Fittings:

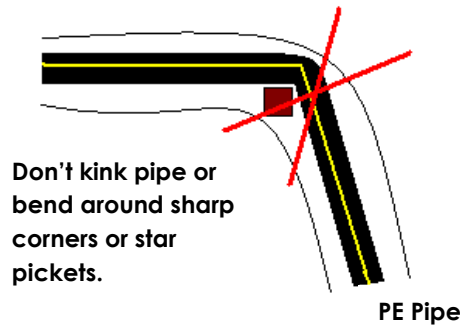
- All EF joints shall be welded with the pipeline straight (i.e. prior to any curving)
- The full welding and cooling cycle must be completed before bending the pipeline. Many fitting manufacturers also recommend an additional cooling period of the order of 4 times the recommended cooling cycle before the pipeline is curved.

Mechanical Fittings: In the case of mechanical fittings the same minimum bend radii as applied to plain pipe can be used for fittings up to and including DN63 where the fittings meet the requirements of AS/NZS 4129. Above DN63 or where the fitting does not meet the requirements of AS/NZS4129 the installer shall seek the advice of the manufacturer as there is a wide variation in capability across the

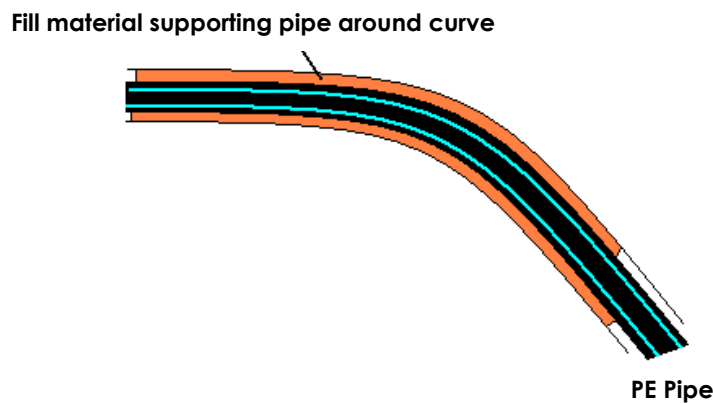
variety of mechanical fittings that are available.

CURVING PE PIPE

Curving shall always be gradual and the pipe must never be kinked or bent around a corner, sharp object or a star picket.



The pipe should be progressively supported with backfill material as the pipe is formed around the curve.



CONNECTIONS TO AN EXISTING CURVED PIPELINE

The information above covers the installation aspects for curving PE pipelines during the construction phase. Where connections are required to curved pipelines post installation or during their operational life some other aspects need to be considered as the pipeline is now fixed in position. Depending on the degree of pipeline curvature it may be necessary to incorporate additional fittings in the assembly to achieve a stress free joint. For example where a cut-in type connection is required on a pipeline that has been installed at or near to the limits of curvature it may be necessary to use sweep bends or electrofusion fittings with adjustable angles to achieve stress free joints. Installers should seek the advice of the manufacturer to ensure the appropriate fittings are used.

Electrofusion saddle welding can be carried out on existing curved pipelines where the radius of curvature is 100 times DN or greater. It is also recommended the installer seek the advice of the saddle manufacturer to ensure appropriate interface gaps can be maintained and the risk of distortion minimised.

PVC PIPELINES

Australian Standard AS/NZS2032 covers the installation of PVC pipe systems and should be the primary reference document.

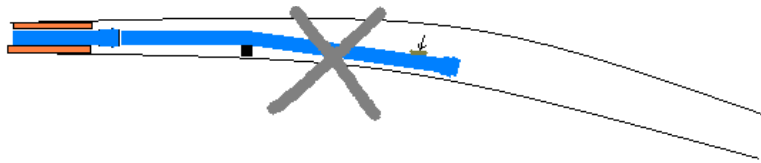
This guide is intended to assist in the installation of PVC-U, PVC-M and PVC-O pipes in applications where the pipe is to be curved.

INSTALLATION TIPS FOR ALL PVC PIPES

1. The pipe shall be curved evenly in the trench.

DO NOT BEND THE PIPE AROUND STAR PICKETS OR STAKES.

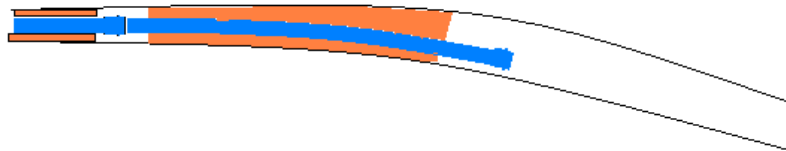
DO NOT BEND PIPE AROUND A POINT



2. With the pipe now curved it must be fixed in place by compacted soil.

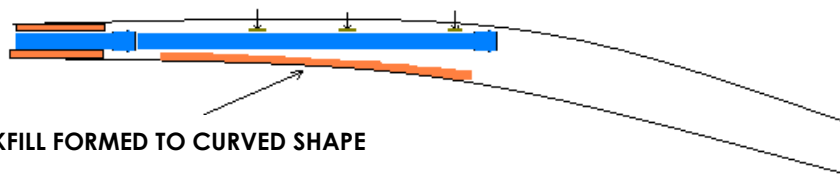
DO NOT USE STAR PICKETS, STAKES OR OTHER POINT LOAD DEVICES TO HOLD THE PIPE IN PLACE PERMANENTLY.

CURVED PIPE HELD IN PLACE WITH BACKFILL



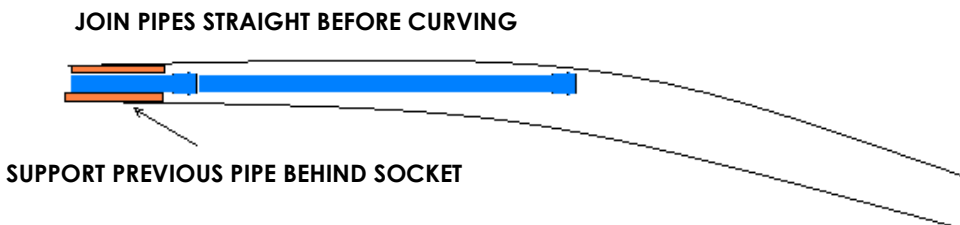
3. Bending of pipes is achieved after each joint is made, by laterally loading the pipe. The techniques used to load the pipe to achieve the curve will vary dependent on pipe size, class and type as clearly the forces required to induce bending vary over a very large range.

APPLY LATERAL LOAD USING BLOCKS TO SPREAD LOAD



RUBBER RING JOINTED PVC PIPES

The pipes must be joined straight and then laid to the curve. Modern PVC rubber ring joints have limited deflection allowance and this aspect varies across different manufacturers hence it is recommended installers seek the advice of the pipe manufacturer prior to joining. Additional trench width may be required to allow the pipe to be joined straight. Support the pipe behind the socket.

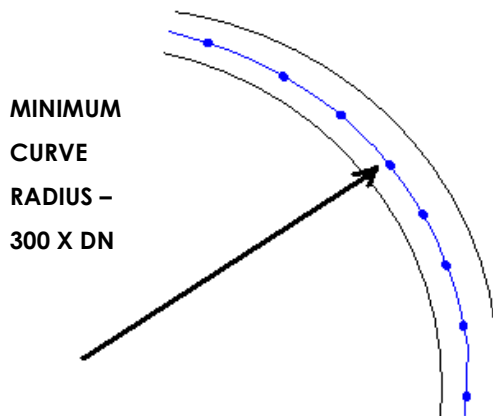


SOLVENT WELDED PVC PIPES

1. The joints must be assembled straight and allowed to fully cure before being curved. Cure times vary but typically a minimum of 24 hours is required for pressure pipe joints.
2. Solvent welded pipe can be curved continuously as the joints can accommodate bending moments across the joint - this is the most significant difference between rubber ring and solvent systems in terms of curved installation.

PVC PRESSURE PIPES – MINIMUM CURVE RADIUS

The minimum recommended curve radius for all PVC pressure pipes is 300 x DN if tapping is to be carried out on the curved pipe (see section below for tapping of curved pressure pipe). This is a limit applied to simplify the requirements for PVC pipe generally. **Tighter bend radii can be used where tapping is not required – individual manufacturers should be consulted where tighter bend radii are required.**



The minimum allowable radius of curvature for a range of common pipe sizes where tapping is permitted is given in the table below:

PIPE DN	MINIMUM ALLOWABLE CURVE RADIUS (m)
100	30
150	45
200	60
225	67
250	75
300	90
375	112

TAPPING OF CURVED PVC PRESSURE PIPE

Curved pipe can be tapped provided the minimum curve radius is no less than 300 x DN of the pipe. Tappings should be placed on the top of the pipe as this is a neutral axis when considering the stresses applied to the pipe by curving.

Recommended tapping saddles fully encircle the pipe and incorporate physical "stops" that prevent the saddle being overtightened.



Coated Ductile Iron saddle, dry tapping using hole saw in a brace and bit to cut the hole.



Gunmetal saddle

PVC NON-PRESSURE PIPES – MINIMUM CURVE RADIUS

The minimum bend radius for PVC non-pressure pipes is 150 x DN (taken from AS/NZS2032).

POLYPROPYLENE (PP) AND POLYETHYLENE (PE) STRUCTURED WALL NON-PRESSURE PIPELINES

PP and PE non-pressure structured wall pipes manufactured in Australia are rubber ring jointed and at the time of publication of this document no specific work had been undertaken on the curving of these systems. Hence it is recommended **PP and PE structured wall pipes should not be bent**. Only the allowable deflection at the rubber ring joints should be used to install these pipe systems on a curved alignment. The allowable joint deflection is nominated by the pipe manufacturer and hence the installer should seek the advice of the pipe manufacturer prior to joining.



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Disclaimer

In formulating this guideline PIPA has relied upon the advice of its members and, where appropriate, independent testing.

Notwithstanding, users of the guidelines are advised to seek their own independent advice and, where appropriate, to conduct their own testing and assessment of matters contained in the guidelines, and to not rely solely on the guidelines in relation to any matter that may risk loss or damage.

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