North American Pipe Corporation

TECHNICAL BULLETIN

Deflection Testing of Buried PVC Pipe

Purpose of Deflection Testing

PVC pipe is classified as a flexible conduit as it will deflect at least 2% without any signs of rupture or cracking. It is because of this flexibility that PVC pipe can be installed at burial depths in excess of 50 feet.

A flexible buried pipe will vertically deflect when placed under a load which is then partially transferred to and supported by the strength of the embedment material on each side of the pipe. As a result, the ability of PVC pipe to withstand soil and surface loads without exceeding maximum deflection limits is directly related to the quality of the installation and compaction of the embedment material around the pipe.

Post-installation deflection testing of buried PVC pipe is performed to ensure that proper construction practices and embedment materials have been used to provide adequate support to the pipeline. After 30 days post-installation, a properly sized go, no-go mandrel is pulled through the buried pipeline to check the long-term vertical ring deflection before final acceptance. Locations with excessive deflection will prevent the mandrel from advancing and should be repaired by re-bedding. It is important that the inside of the pipeline be cleaned thoroughly before deflection testing. Debris or sediment in the pipe can impede the passing of the mandrel and provide a false indication of excessive deflection.

Deflection Percentage Limits

Pipe Product Family	Long-Term Vertical Deflection Limit	Source
AWWA C900	7.5%	AWWA C605
ASTM D3034	7.5%	ASTM D3034
ASTM F679	7.5%	ASTM F679
ASTM D1785 ASTM D2241 ASTM D2729 ASTM D2949 ASTM F758	Limit Not Specified in Industry Standards. 7.5% Recommended	

Deflection Percentage Limits

PVC pipe can withstand vertical ring deflection values of 30% the original base inside diameter before suffering reverse curvature failure. The PVC pipe industry suggests a conservative safety factor of 4:1 be applied which yields a threshold limit of 7.5%. Various industry product standards recommend this same value. Some utility owners and engineering firms choose to use an even more restrictive value of 5% deflection, yielding a 6:1 safety factor.

Pipe ovality due to vertical ring deflection slightly reduces the flow area and hydraulic radius, resulting in reductions of flow in both pressure and non-pressure applications. The choice of the specified maximum deflection value must balance the reduction in flow area against what are reasonably achievable installation conditions.

Pipe Ovality Due to Vertical Ring Deflection

Vertical Ring Deflection	Change in Internal Flow Area Due to Elliptical Shape	Change in Flow Rate Due to Elliptical Shape
5%	-0.66%	-1.10%
7.5%	-1.17%	-1.94%

Mandrel Sizing

The appendices of ASTM D3034 and ASTM F679 provide the methodology to properly size these mandrels. These calculations use a statistical formula that considers the dimensions of the pipe including allowable manufacturing tolerances as well as an out-of-round tolerance to determine a “base inside diameter” for the pipe.

The published dimensions of nominal outside diameter and minimum wall thickness cannot be used to properly calculate mandrel dimensions alone. Attempting to do so will result in an oversized mandrel and may result in false test results when the mandrel is used.

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*Mandrel Diameter = (100% – Deflection Percentage Limit) * Base Inside Diameter*

Base Inside Diameter = Average Inside Diameter – Tolerance Package

*Average Inside Diameter = Average Outside Diameter – 2 * 1.06 * Minimum Wall Thickness*

$$\text{Tolerance Package} = \sqrt{(\text{Outside Diameter Tolerance})^2 + 2(0.06 * \text{Minimum Wall Thickness})^2 + (\text{Roundness Tolerance})^2}$$

Using this methodology, sizing tables for ASTM D3034 and ASTM F679 gravity sewer pipe are shown below. Please contact our technical support team for assistance in mandrel sizing of other products, especially Certa-Lok®. (Some Certa-Lok products have a thickened spigot that will affect these calculations.)

References

- ASTM D3034. *Standard Specification for PSM Poly(Vinyl Chloride) (PVC) Sewer Pipe and Fittings*. May 2016.
- ASTM F679. *Standard Specification for Poly(Vinyl Chloride) (PVC) Large-Diameter Sewer Pipe and Fittings*. March 2015.
- Uni-Bell PVC Pipe Association. *Handbook of PVC Pipe Design and Construction*. 5th Ed. Chapters 7, 9 & 13.
- Uni-Bell PVC Pipe Association. UNI-TR-1. *Deflection: The Pipe/Soil Mechanism*.

Mandrel Sizing

Product Family	Nom. Size	Class	Avg. Inside Diameter (in)	Base Inside Diameter (in)	7.5%Deflection Mandrel (in)	5% Deflection Mandrel (in)
					SF = 4	SF = 6
ASTM D3034	4	SDR 35	3.961	3.909	3.616	3.713
		SDR 26	3.872	3.819	3.533	3.628
		SDR 23.5	3.838	3.785	3.501	3.595
	6	SDR 35	5.893	5.742	5.312	5.455
		SDR 26	5.764	5.612	5.191	5.332
		SDR 23.5	5.713	5.561	5.144	5.283
	8	SDR 35	7.891	7.665	7.090	7.282
		SDR 26	7.715	7.488	6.927	7.114
	10	SDR 35	9.864	9.563	8.845	9.084
		SDR 26	9.644	9.341	8.641	8.874
	12	SDR 35	11.737	11.360	10.508	10.792
		SDR 26	11.480	11.103	10.270	10.548
	15	SDR 35	14.374	13.897	12.854	13.202
		SDR 26	14.053	13.575	12.557	12.897
ASTM F679	18	PS 46	17.643	17.054	15.775	16.201
		PS 115	17.278	16.688	15.436	15.854
	21	PS 46	20.800	20.098	18.591	19.093
		PS 115	20.370	19.666	18.191	18.683
	24	PS 46	23.402	22.587	20.893	21.458
		PS 115	22.918	22.102	20.444	20.997
	27	PS 46	26.374	25.445	23.537	24.173
		PS 115	25.829	24.899	23.031	23.654
	30	PS 46	30.192	29.150	26.964	27.693
		PS 115	29.566	28.523	26.384	27.097
	36	PS 46	36.135	34.869	32.253	33.125
		PS 115	35.389	34.120	31.561	32.414