

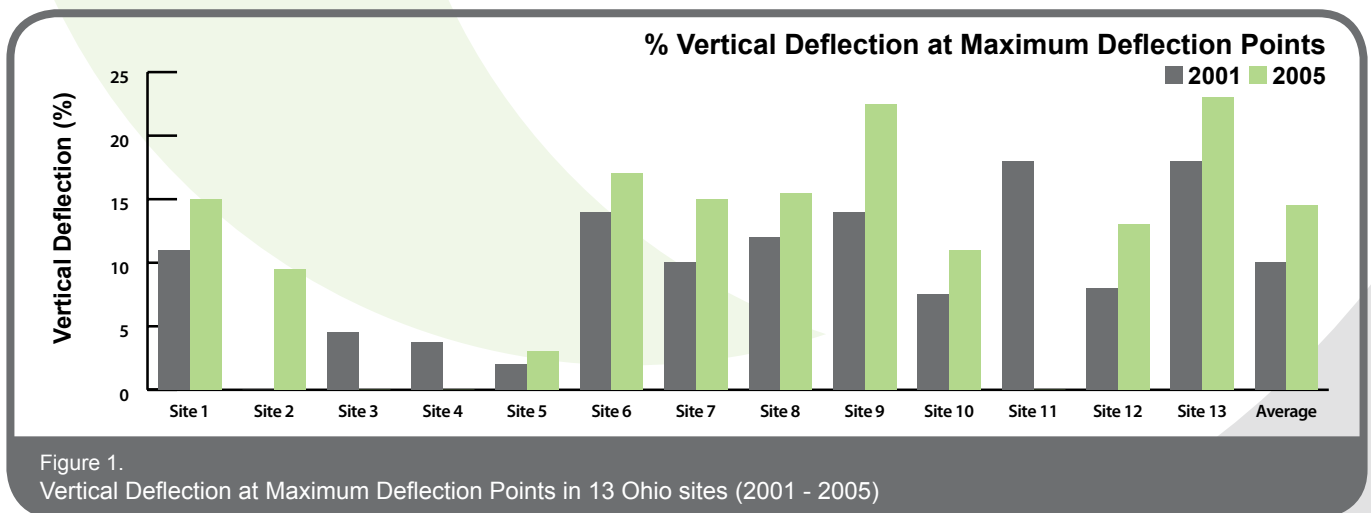
What do you know about plastic pipes' deformation?

Unlike concrete pipeline systems, plastic pipes use a different mechanism to deal with earth movements and dynamic/ static loads imposed on the pipeline. Plastic pipes usually deflect to redistribute these loads. Continuous pipe deformation can lead to permanent deflections and deformation levels (measured in %) may become progressive throughout the service life of the plastic pipe, reaching alarming levels and leading to the pipes' failure. This Factsheet offers a range of information on deformation of thermoplastic pipes. It also offers case studies may give an alarming indication of the possible scale of the problem.

- **Deformation/Deflection** is the change in a pipe's internal diameter that results when specific loads are applied to the pipe. Unlike other types of elastic polymeric materials (e.g. thermosetting plastics, elastomers, rubber) thermoplastics¹ are known to have a large deformation capacity (Farshad, 2006). Deformation is part of the mechanism thermoplastic pipes employ to redistribute the loads to the surrounding soil as these pipes have little inherent strength and depend mainly upon a properly installed soil embedment to achieve the required design strength (Mulhern, 2006). Other rigid types of pipes do not possess such a property and start to crack at 2%.



- **The equilibrium of a plastic pipeline structure** is based on how the entire structure deals with a number of loads. A change or imbalance to that equilibrium may lead to additional/ unaccounted-for loads affecting the elastic component of that system (pipes) leading to buckling, excessive deformation, and, consequently, failure. This is not the only reason why deformation develops, according to Farshad (2006) pipe systems may undergo certain deformation capacity and stiffness changes caused by aspects such as ageing and temperature.



1 A family of polymers that includes plastics such as Polyvinyl Chloride (PVC), Polyethylene (PE), and Polypropylene (PP).

- **Plastic pipes' deformation can be progressive:** a report by Kentucky Department of Transport, USA, demonstrates the case of a pipeline network installed in 1989/1990 with minor deflections (<5%) in its 24 inch pipe sections. The pipeline was inspected again in 2002 and was found to be deflected by 11%, and later in 2005 by 14%. Another investigation in Ohio showed similar levels as shown in Figure 1.
- Deformation of plastic pipes can also become permanent, as noted by prCEN/TS 15223: 2007.
- A TEPPFA study (see above) notes that most deformation incidents, around 80%, were caused by faults during installation. Other factors include cover depth, pipe stiffness, and pipe material.
- In a number of areas in the UK (including the Thames Valley) alarm is raised if deformation was found to be over 6% after 300 days (on-time for a sewer's adoption). One water company, United Utilities, decided to reduce the limit to 5% to account for deformation that may occur later in the product's service life. A number of Departments of Transport in American states and Canadian provinces have a 5% deflection limit. The 2005 AASHTO Bridge Committee in the United States recommends replacement of plastic pipes if deformation levels reaches 7.5%.

Case Studies

There are some indications that the deformation problem may be bigger and more significant than many would expect. A number of investigations and case studies in the last few years have highlighted the scale of the problem, and the case studies (demonstrated below) indicate that deformation may be affecting a huge proportion of plastic pipes:

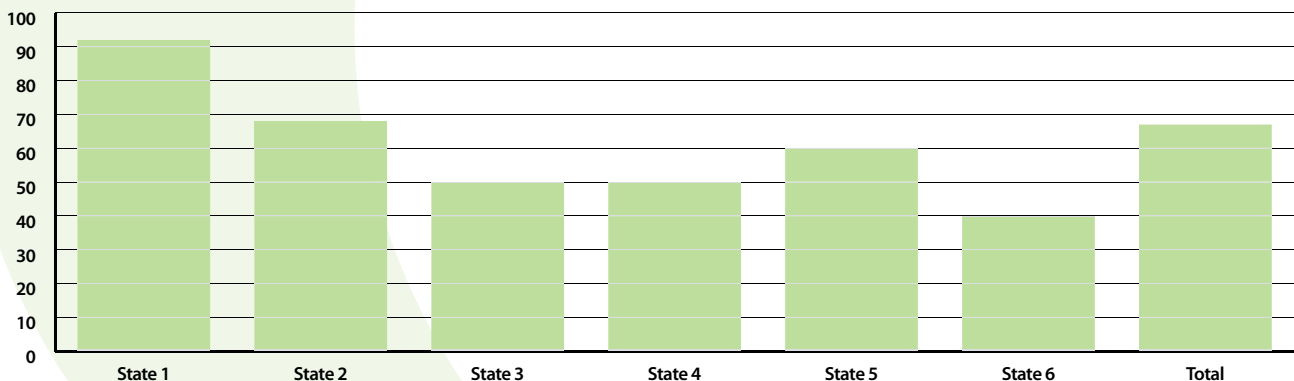


Figure 2.
Sewer pipes' deformation levels (over 5%) per State.

- **Condition grading study in six US States:** A study survey was carried out in 2002 to investigate levels of deformation in plastic pipe networks installed since 1987 in six American states. The results were significantly alarming and showed what could be the real scale of the problem in these states as 69% of the pipes inspected had deflections exceeding 5%.
- **Kentucky and Ohio Departments of Transport investigations:** These two investigations looked at over 1.18 km of HDPE pipeline systems. It was found that the majority of pipes investigated would not pass a 5% deflection test and most of the sites inspected have pipe sections that would not pass a 10% deformation test.

- **Texas University at Arlington research:** The structural performance of 22 HDPE pipelines throughout the State of Texas was investigated. 38% of the pipelines inspected had excessive deformation (over 5%). The average deformation value for all pipes was found to be 6.8%. The study clearly indicated that the structural health and integrity of the installed HDPE pipelines tested are generally below structurally acceptable levels of serviceability.

With over 13,000 km of plastic sewer pipes installed in the UK over the last 11 years, there are fears that the UK national sewer network may have been affected by the same scale. To date there are no studies specifically identifying the exact number or proportion of deformed plastic pipelines within the UK sewer network. Hopefully, the water industry will seriously consider this matter and investigate more about different types of plastic pipes in the market and the risks associated with deformation.

References

- Abolmaali, A; Motahari, A (2007) Evaluation of HDPE Pipelines Structural Performance on Texas DoT and Municipal Projects. The Initiative on the Underground Structural Health Monitoring and Equipment Development. University of Texas at Arlington. Arlington, Texas 76019 - December 2007.
- Anon (2006) Sewers for Adoption; A design and construction guide for developers. 6th Ed. Wrc, Swindon, UK. March, 2006.
- CEN (2007) prCEN/TS 15223: Plastics piping systems - Validated design parameters of buried thermoplastics piping systems. Rue de Stassart, 36 B-1050 Brussels, May 2007.
- Farshad, M. (2006) Plastic Pipe Systems: Failure Investigation and Diagnosis. First Edition 2006. Elsevier Ltd. ISBN-13: 978-1-85-617496-1.
- Mulhern, G (2006) Protecting Yourself as a Gravity Pipe Municipal Engineer. Institution of Municipal Engineering of Southern Africa (IMESA) Conference 2006.
- Nelson, T; Krauss, P (2002) Condition Investigations of HDPE Pipe In-Service in the United States (Six States) for the American Concrete Pipes Association. Wiss, Janney, Elstner Associates, Inc. report. Irving, Texas - 2002.
- Pipeline & Drainage Consultants (2006) Evaluation of HDPE Pipe Performance on Kentucky DOT and Ohio DOT Construction Projects. Resource # 03-248 (08/06) 3M .ACPA, 2006.
- TEPPFA (1999) Design of Buried Thermoplastic Pipes. Project held for TEPPFA and APME. Brussels, 1999.

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Buchan Concrete Solutions

Tel: 01606 843 500
Web: www.buchanconcrete.com

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Web: www.fpmccann.co.uk

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Web: www.ennstone.com

Milton Precast

Tel: 01795 425 191
Web: www.miltonprecast.com

Concrete Pipelines Systems Association: 60 Charles Street, Leicester. LE1 1FB.
Tel: 0116 253 6161 | Fax: 0116 251 4568 | Email: mail@concretepipes.co.uk | Web: www.concretepipes.co.uk