mpa British Precast Drainage Association

# What do you know about plastic pipe 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 that 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 polymetric materials (e.g. thermosetting plastics, elastomers, rubber) thermoplastics 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.

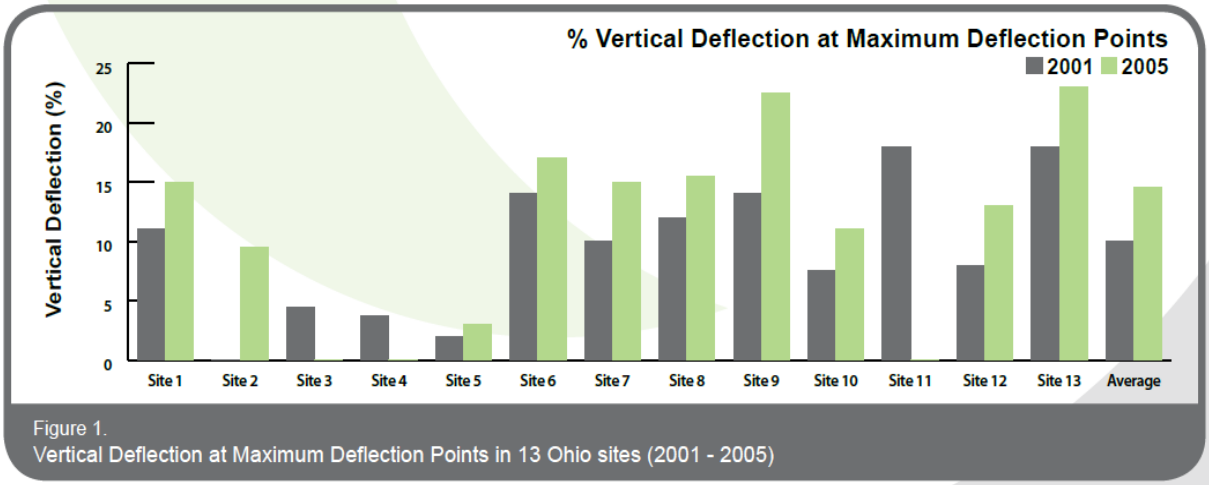


Figure 1.
Vertical Deflection at Maximum Deflection Points in 13 Ohio sites (2001 - 2005)

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

**Plastic pipe 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 is found to be over 6% after 300 days (on-time for a sewer's adoption). One water company, United Utilities, decided to reduce its 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:

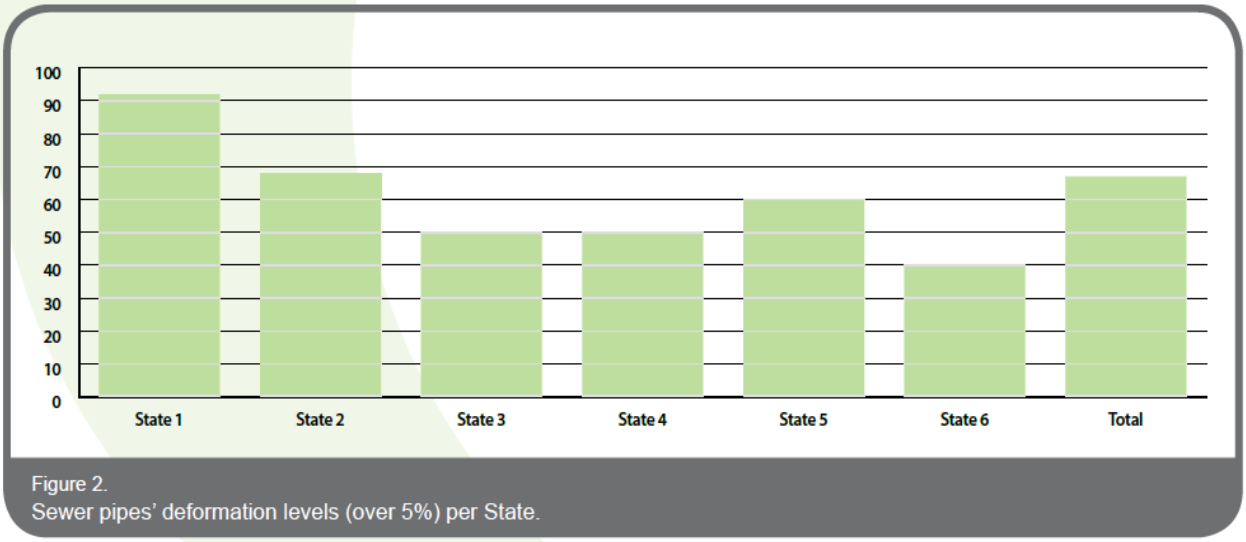


Figure 2.
Sewer pipes' deformation levels (over 5%) per State.

**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.

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