



British Precast Drainage Association

Publications from the British Precast Drainage Association (BPDA):

BPDA was formed in 2017 from the integration of the Concrete Pipeline Systems Association (CPSA) and the Box Culvert Association (BCA).

Information published by both CPSA and BCA will be rebranded and replaced as BPDA in due course. New material will be branded BPDA.

All CPSA and BCA web traffic will be redirected to the new BPDA web site at www.precastdrainage.co.uk

The Real Scale of Plastic Pipes' Deformation? A US Case Study.

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 and progressive deflections, reaching alarming levels and leading to the pipe's failure. A study survey carried out in 2002 investigated levels of deformation in plastic pipe networks installed over a period stretching from 1987 to 1999 in a number of American states. The results were significantly alarming and showed what could be the real scale of excessive deformation in plastic pipeline systems at these states.

Study Results

The study survey looked at 39 High Density Polyethylene (HDPE) sewer pipelines in six American states. The diameters of the pipes ranged from 28 to 60 inches (711 to 1524mm). The inspectors included diameter measurements, distress documentation, alignment measurements, and still and video photography. The survey was carried out by an independent consultancy: Wiss, Janney, Elstner Associates Inc. The results were unexpectedly shocking:

- Twenty-seven pipes (69%) had deflections exceeding 5%.
- Twenty-four of the pipes (62%) had developed buckling, crackling, or bulging. Of the 27 pipes that exhibited deflections greater than 5%, 20 pipes also had cracking or buckling. Thus, No more than 36% of the pipes (seven pipes) with deflections greater than 5% had no cracking or buckling. These pipes had few deflections greater than 7.5%.
- Moreover, twenty-nine out of 39 pipes (74%) had joint separations greater than 1-inch and sixteen of the pipes (41%) had noticeable misalignment.

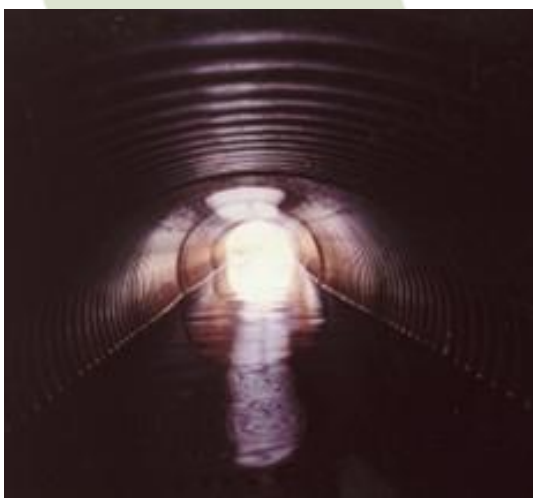
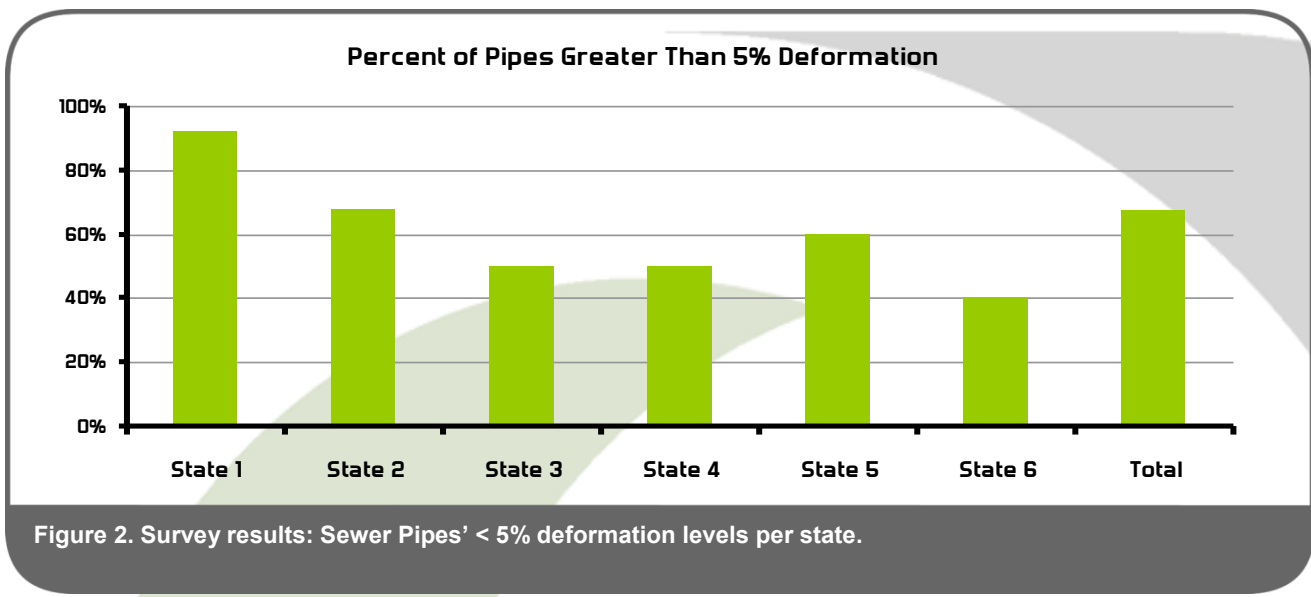


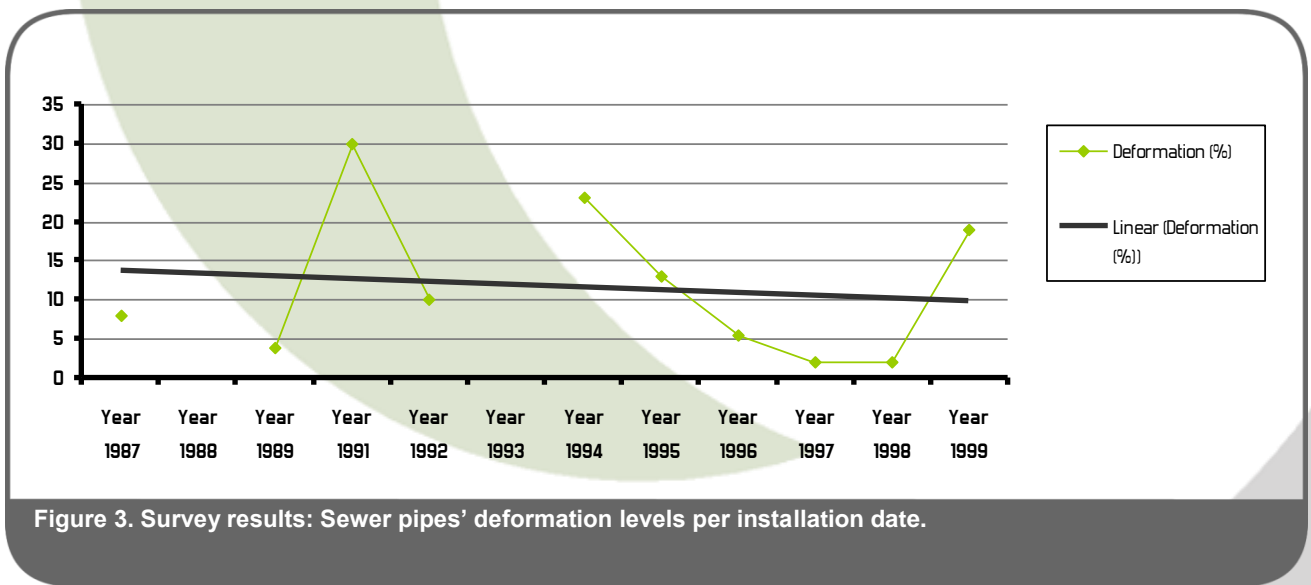
Figure 1. Two Cases of plastic pipe deformation from the survey carried out in six American States. Report by Wiss, Janney, Elstner Associates (2002)



Deformation Results Analysed

These results make grim reading for plastic pipes and what might be the true scale of problems such as deformation and cracking. Looking further into the samples developed, it is possible to identify a number of links between deformation scale/frequency and a range of factors (including age, size/diameter, and location):

- **Pipe Age:** The pipelines considered in the survey were installed between 1987 and 1999. It is still possible to detect a pattern that shows a link between increase/progression of pipe deflection and date of installation of pipe. The trend line is not strong enough due to the small sample considered in the study and the fact that other stronger factors, contributing to deformation, may have prevailed.



However, it should be noted that progressive deformation is a known phenomenon with documented case studies, notably the Kentucky and Ohio DoT survey investigations in 2003/2004 supported by ACPA. This corresponds with Farshad (2006) claims that plastic pipe systems may undergo certain deformation capacity and stiffness changes caused by aspects such as ageing and temperature.

- **Pipe Diameter:** The link between deformation and pipe diameter was stronger. However, this does not necessarily mean that diameter is the main factor associated with deflections as the sample was considerably small and one pipe diameter category (54 inch or DN 1375) was eliminated as there was only one pipe with such size.

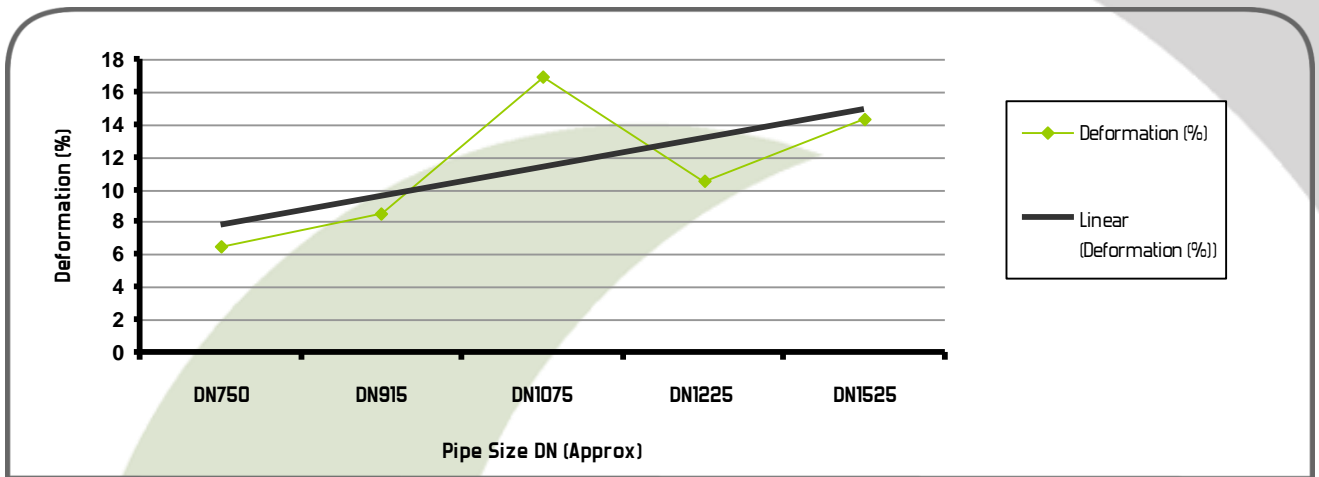


Figure 4. Survey Results: Sewer pipes' deformation levels per size (internal diameter).

- **Bedding/ Geography:** There were no clear findings on the impact of installation, bedding, or geography as the data presented did not cover this area. However the results show different levels from one state to another, as shown in Figure 1, suggesting that bedding and installation practices in these different states may be one of the most important aspects associated with deformation. This notion will be supported by overwhelming evidence, notably from research conducted by The European Plastic Pipes and Fittings Association (TEPPFA).
- The data offered in the report did not refer to cover depths, therefore it was not possible to detect results that would suggest a possible link between pipes' cover depth and deformation levels. It was not also possible to link levels of damage and deformation to the loads expected on pipes, as known pipes installed beneath roads and highways receive more live loads.



Figure 5. Cases of plastic pipe bulges and cracks from the survey (2002)

It is clear that the factors mentioned above may all contribute to deformation. As noted above, it was not possible to investigate claims made earlier by The European Plastic Pipes and Fittings Association (TEPPFA) that poor installation is the main factor causing 80% of deformation incidents. However, with 69% of the pipelines affected with what can be considered by many as excessive deformation¹ (>5%), and with more than 30% of these deformed pipes affected by a deformation rate exceeding 15%, it is clear that installation cannot always be the only factor to blame for deformation problems.

Another alarming finding is the significant level of cracks, bulges, and buckling in the pipes: out of 39 pipelines inspected, 24 pipes had problems with cracking, bulging and buckling. Ultimate collapse scenarios have been linked with cracks as well as deformation in different studies in the past, however this study did not investigate these possible links.

These findings do not only raise fears about the integrity of plastic pipes in the USA, but it also raises alarm over more than 13,000 km of plastic sewer pipeline systems installed across this country in the last 10 years.

For more information on the study, please use the following link:
<http://www.concrete-pipe.org/research.htm>

For further information please contact your usual supplier

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¹ The definition of excessive deformation will differ from one country to another and from one UK water company to another. See CPSA Factsheet on deformation.