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

HDPE Pipes and Progressive Deformation: Case studies from Kentucky and Ohio, USA

Departments of Transport at the states of Kentucky and Ohio, USA, investigated around 1.4 km of HDPE pipeline systems laid in different locations in the two states in the late 1980s/ early 1990s. It was found that many of the pipes investigated would not pass a 5% deformation test and most of the sites inspected have pipe sections that would not pass a 10% deformation test. Both investigations referred to the problem associated with progression of deformation over time.

Kentucky DoT Inspection and Progressive Deformation

In 2005 The Kentucky Department of Transport (DoT) formed a task group to evaluate current specifications for use of HDPE pipes in Future DoT projects. Seven HDPE pipes sites were investigated. Long term performance was obtained from historical documentation and compared to the field measurements taken in July 2005. A detailed video inspection was performed on the selected pipelines at each of the sites considered. The total length of pipes inspected was 3,892 feet (around 1186 metres). The results were significant:

- At one site (Site 1) the inspection showed indications that several segments within a pipeline (last inspected in late 1991 with no deformations exceeding 5%) have experienced significant deflections exceeding 5%, with one location approaching 10%[1]. At another site (Site 2) average deformation was between 5 to 10%, with one pipe deflecting by 14%, that same pipe was inspected three years earlier and was found at the time to be deformed by 11%.

- The same pattern was observed in another site (Site 7) where an earlier 1991 inspection showed maximum deformation at some sections at 5.5 and 7.3%. The 2005 inspection showed that deformation at the outfall line has increased to 10 and 12%, raising numerous questions about the actual service life of these pipeline systems. Two other pipeline sites (Sites 3 and 4) experienced severe deflections with 10 to 13% for the first site and 50% (a collapsed storm pipeline) for the other. A third site (Site 5) showed several deformations reaching 10%.

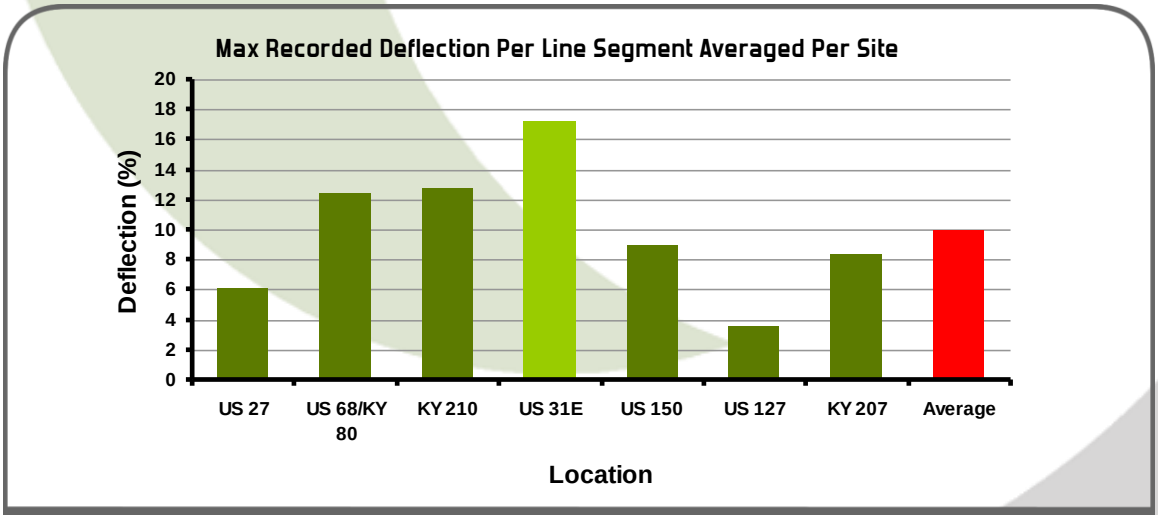

Figure 1. Maximum recorded deflection per line segment averaged per site inspected by Kentucky DoT.

[1] This is Asset Condition Grade 4 according to Ofwat's condition grading system.

- The final study report noted that the majority of pipes investigated at this project would not pass a 5% deformation requirement and most of the sites included have pipe sections that would not pass a 10% deformation test. It is noted in the complete report that several of the pipes have continued to deform since initial installation. It is also evident that the HDPE pipes are sensitive to construction installation and proper care is needed to ensure good performance. According to the report it is apparent that cracking and deflection had continued to occur in some of these sites since that 2005 inspection.

Further Evidence: Ohio DoT Investigation

Shortly after Kentucky's DoT investigation, eleven Ohio DoT HDPE pipeline sites were chosen for further testing and investigation. Data on installation (e.g. construction procedures, backfill methods, compaction methods, materials utilised) was not available in full, however these sites were the subject of an earlier investigation by Wiss, Janney, and Elstner Associates Inc. in 2001. In late 2005 a detailed manual and video inspection (using different deflection measurement equipments) was performed on 205 metres of HDPE pipeline at the 11 sites. Despite the short period, comparisons between the 2001 and 2005 investigation results were very worrying:

- In Site 1 manual deformation measurements taken in 2005 indicates that a 36inch (Approx DN900) drain pipe installed in 1992 continued to deform: from a maximum deformation in 2001 of 11.81% to a maximum of 15.63% in 2005. Approximately 23% of the vertical measurements taken in 2001 would not pass a 5% deformation test, this has increased to around 43% in 2005. At another site with 60% of vertical readings for a 48inch (Approx DN1200) 21 metre long drain pipe did not pass a 5% deflection test, indications showed that this percentage has increased to 87% in 2005. At the same site the greatest deformation taken moved from 14.84% in 2001 to 17% in 2005. The same pattern was also documented at sites 7, 8, 9, 10, 12, and 13. More worryingly, at site 8 deterioration was not restricted to excessively deformed pipe sections, at the site two thirds of vertical deformations exceeded 5% in 2001, in 2005 it was found that 71% of deformations were over 5%. Site 10 showed an even faster pace with 9% of readings exceeding 7% deformation in 2001, increasing to 45% of reading in 2005.

- The problems at these sites were not restricted to deformation, The pipes suffered from problems with cracking, cross drains inspected for this project showed that cracking has increased by four to seven times since the 2001 inspection. There were also other problems with bulging, sagging, and problems with joints and connections.

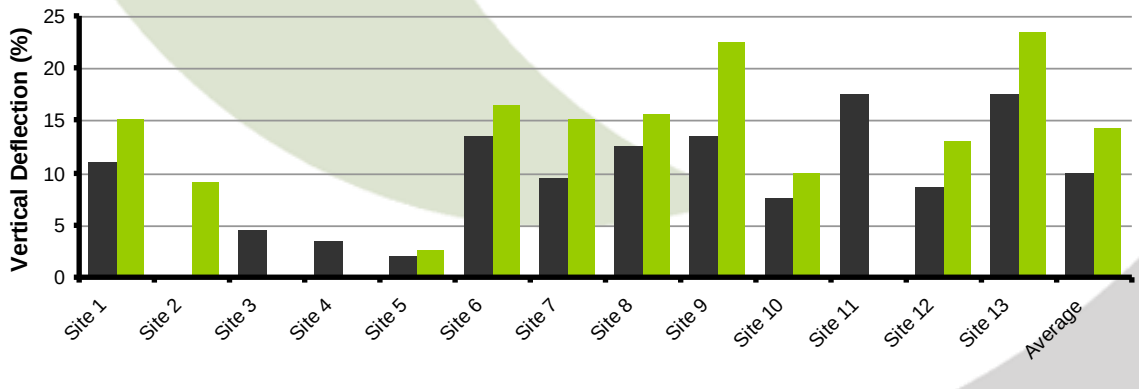

Figure 2. Vertical Deflection at Maximum Points in 13 Ohio Site in 2001 (in Grey) and 2005 (in Green).

- The majority of pipes investigated at this project would not pass a 5% deformation test and most of the sites have pipe sections that would not pass a 10% deformation test. The majority of pipes have continued to creep and deform since the 2001 inspection. There were indications that in at least two sites the problems of deformation may have been caused by faulty installation.

- The two studies clearly demonstrate the difficulty of achieving a problem-free installation of HDPE pipe as the pipe does not always perform in accordance with theory. Excessive deformation is a major problem, just one location in a pipeline can result in faults at joints, grade problems, poor hydraulic performance, or surface irregularities. The deterioration of deformed pipes can take place at a very fast pace, more worryingly progressive deformation can happen to pipelines with very low deformation levels (<5%) within an unexpectedly short period of time as shown in a number of examples at both projects. It was not possible to prove that all these deformation incidents were directly linked to faulty installation.

- It should also be noted that the two studies also show that progression of deformation is not the only problem; corrugation growth, crown and invert flattening, racking, sagging, and radial cracking are problems documented throughout the sites included.

- The scale of the phenomenon (deformation/ progression of deformation) is another important question which remains unanswered. With over 13,000 km of plastic sewer pipes installed in the UK in the last 11 years, there are legitimate concerns that the UK national sewer network may have been affected by the same scale. Hopefully, the water industry will seriously consider this matter and investigate more the type of plastic pipes available in the market and the risks associated with deformation.

- A detailed report on these two projects can be found at ACPA website: www.**concrete-pipe**.org