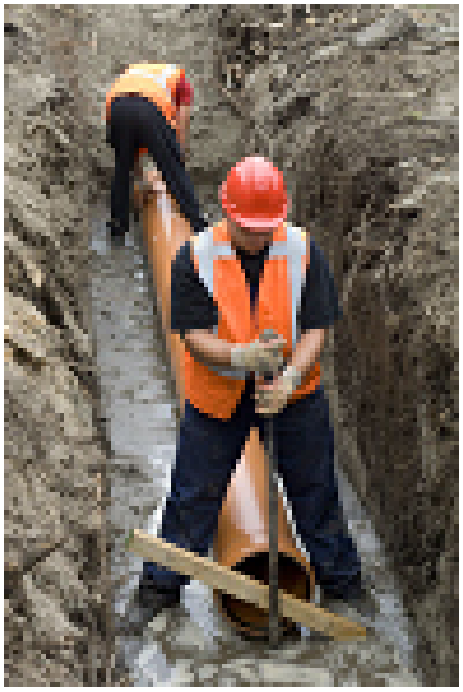
►BURIED PIPES

As the saying goes, what goes up comes down. The reverse also holds true for plastic sewer pipes – especially when they are being tested and studied by experts including a number of professors in this field…



In 1996, three experts in the underground infrastructure of buried pipes called Frans Alferink, Lars-Eric Janson and Jonathan Olliff embarked on what is now called the Buried Pipes Project. The aim of this four-year project was to disprove various misconceptions about the performance of such pipes. The result was all of that and a lot more. The knowledge acquired has contributed to our understanding of how plastic pipes behave under certain conditions.

But first the six misconceptions. They were both public and hypothetical:

MISCONCEPTIONS

Deflection increases with installation depth and with traffic load.

Pipe ring stiffness is the governing factor determining the performance.

Pipe looses stiffness with time, the load bearing capacity reduces.

To predict the structural performance an extensive design method is needed.

Flexible behaviour is a disadvantage.

Deflected pipe looses its discharge capacity and tightness.

Faced with these various challenges, the team quickly identified where they wanted to go and more importantly how? Frans Alferink explains: “The more we analysed these misconceptions, the more our experience and gut feeling told us they could not possibly be true. We knew that we had the best technical resources available but we first wanted to make sure that our aims would correspond to our expectations.”

PROJECT OBJECTIVES

Show the relative importance of the parameters.

Prove flexibility to be a strength instead of a disadvantage.

Develop a design approach in balance with achievable installation quality and actual behaviour.

Contribute to the development of the European standards with real field trials / test results.

Provide material to communicate the project results to the marketplace.

Sponsored by TEPPFA and PlasticsEurope, the team then consulted a wide range of industry experts from across the sector. These leading professors from across Europe were given the possibility to check their calculations for pipe installation. A steering committee was also set up to oversee and support the work in whatever shape and whatever form that was needed.

300 years of experience

“Steering Group members came from a mix of backgrounds,” says Alferink. “We had financial, technical and marketing specialists from all the pipe majors. This sounding board of 12 good minds and under the chairmanship of Ingemar Björklund had a collective experience of over 300 years.”

Frans Alferink

In July 1996 and with a budget of EUR 450,000 the project got underway. Full-scale trials with different materials, stiffnesses, soils and installation conditions were carried out in Haarle and Wons in the Netherlands. Tests carried out involved traffic load simulations, various depths, internal pressures and the effects over time. “We also supported this investigation with a complete series of laboratory tests.”

The conditions for the field trials can be seen opposite.

Furthermore, design exercises were undertaken by consulting with leading European experts to compare existing calculation methods with results from field measurements. Testing of these calculation methods had become paramount because experts – all part of a working group to develop a unified method – could no longer proceed. The theoretical arguments for one method or the other were exhausted and a reference to the real life situation was needed.

This approach involved a five-step process:

1. Consultation Field Trials and final definition of the trials
2. Calculation of pipe deflections using different methods
3. Establishing field tests and carrying out measurements
4. Continuing measurements at different intervals
5. Two day workshop (DEC1997) to evaluate results

Test data were comprehensive and included the following:

Soil

Grain size distribution
Grain shape
Proctor density
Menard test
Cone penetration test
Tri-axial test (clay)
Cone-pressiometer test
Impact cone test
Oedometer
(device used to test soil compression)

Pipe

Dimensions
Stiffness
Creep ratio
Deflections

- time dependency
- under internal pressure
- under traffic load
- under ground water

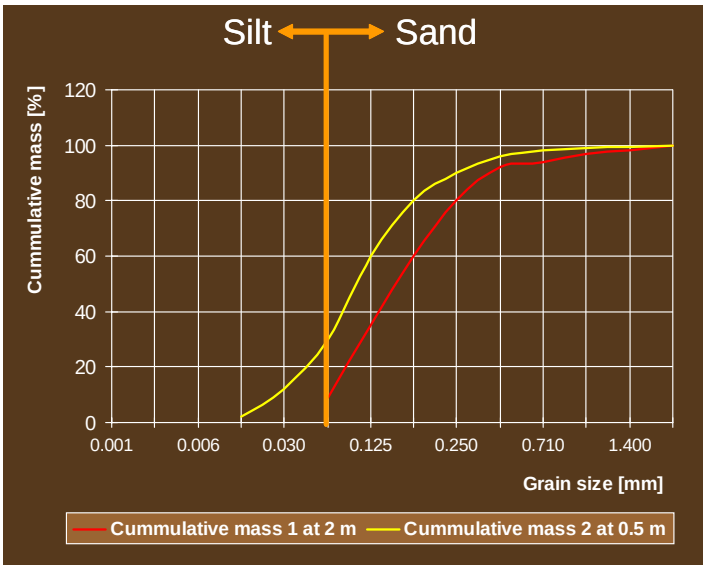
Strain under deformation

FIELD TRIALS: Installed Pipes

Material	Stiffness [kN/m^2]	Cover [m]	Installed Length [m]
Silty Sand, November 1996			
PVC	2 & 4	1.15	120
		1.85	60
PE	5	1.15	45
Steel	4	1.85	20
Silty clay, August 1997			
PE	5	1.15	60
		3.0	60

Three installation conditions were used: good, moderate and none.

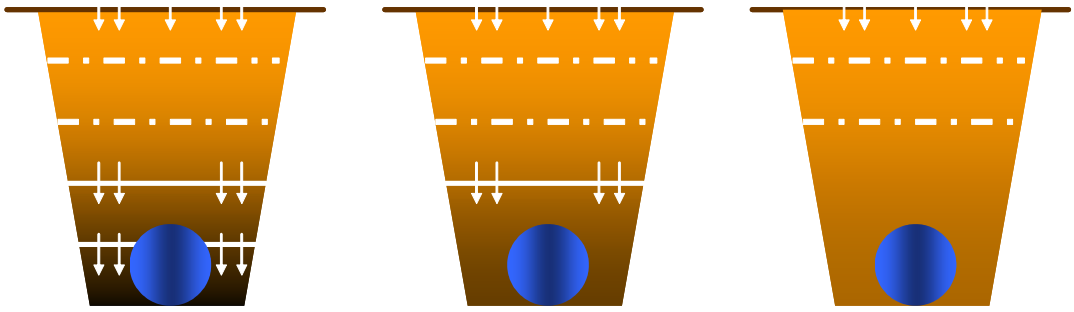
Natural variations in soil



Grain size distributions of sand taken at two different depths

Installation practices used in the project

Good **Moderate** **None**

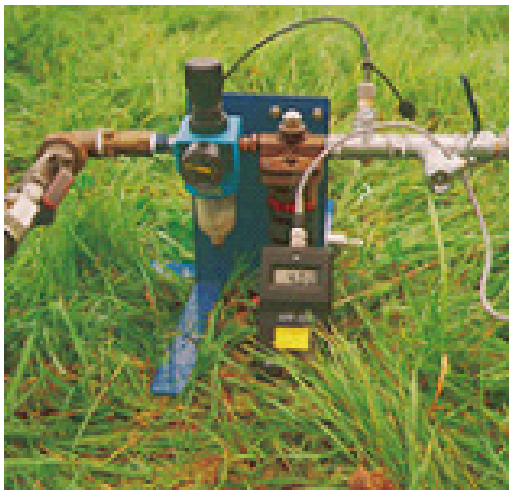


Results

Workshop findings were more or less as expected. "Installation of pipeline systems varies from meter to meter depending on many aspects such as workmanship, native soil variations, weather conditions and logistics in the field." Alferink explains. "Consequently, the installation variability results in variations in ring deflection along the pipeline for flexible pipes and in variations in bending moments along the pipeline for rigid and semi-rigid pipes."

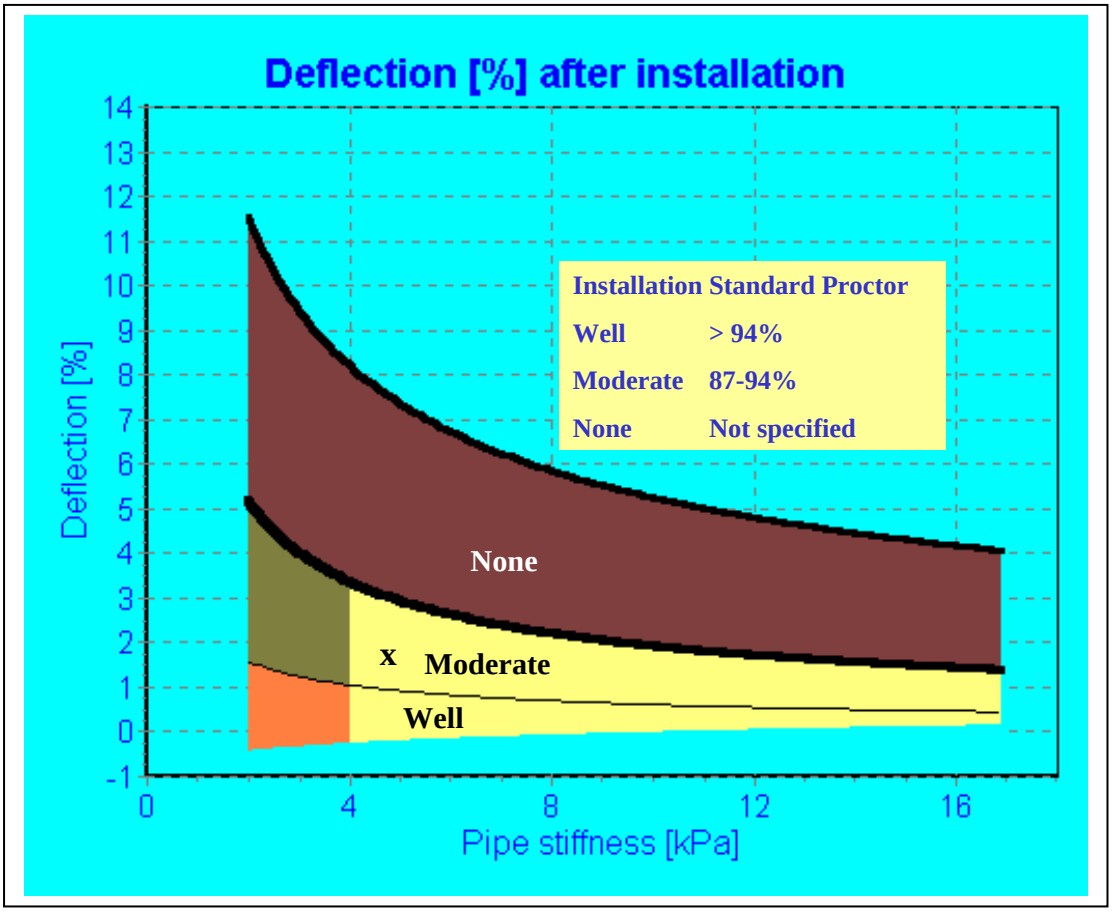
"In terms of Time dependency of the deflection, there was no difference between PVC and steel."

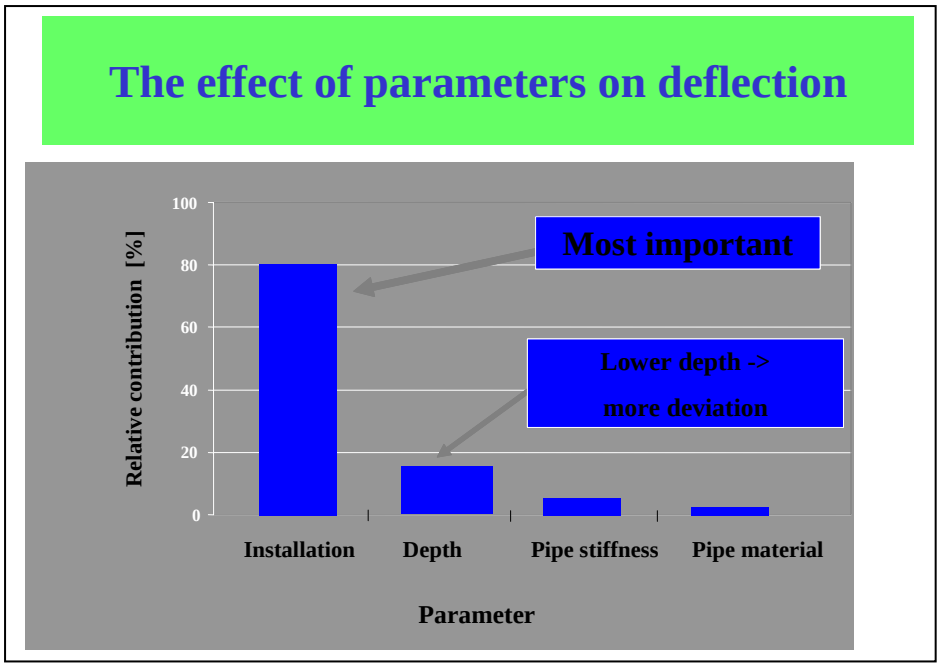
"With over 20 well-documented data sets, we were able to gain an excellent insight into what is happening for the various installation conditions. A comparison of the various calculation methods with the measured data, showed that none of the methods were accurate over the whole range of the installation window of pipes."



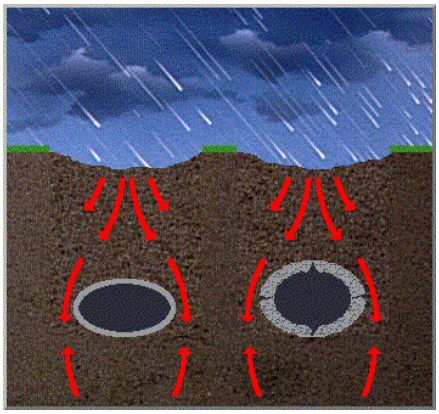
pressure testing device

Alferink also says that the industry now has a design tool that can be applied to the majority of pipe installations. What is also important to him and installers is that ring deflection of flexible pipes is controlled by the settlement of the soil. "After settlement, traffic and other loads do not affect pipe deflection."



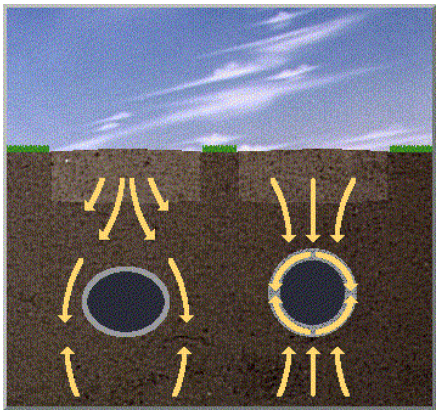


"Moreover it was shown that there is no need for sophisticated design methods. A simple design graph gives more reliable results then the result of an extensive calculation". Alferink says: "Referring to my colleagues Jonathan Olliff and Prof. Lars-Eric Janson: "Thermoplastics pipes are very forgiving. Even if something goes wrong during installation, then this will not result in failure because of the high strainability of thermoplastics"



"Deflection is safety! When pipes are relatively more rigid than the soil, the traffic and other loads have to be resisted by the pipe."

The project illustrated that depth of cover is not relevant and also that traffic load has no significant effect. "Deflection and its variation depends more on the installation quality than on the pipe stiffness."



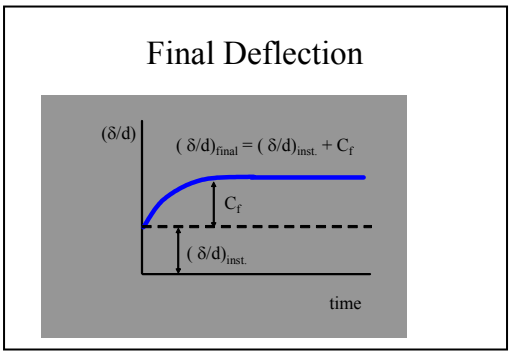
Alferink concludes that deflection is therefore not an issue. Recommended maximum values according to ISO TR 7073 are 8% initial and 12.5% final. "Our pipes deflected up to 10% which corresponds to only a 2.5% reduction in discharge capacity.

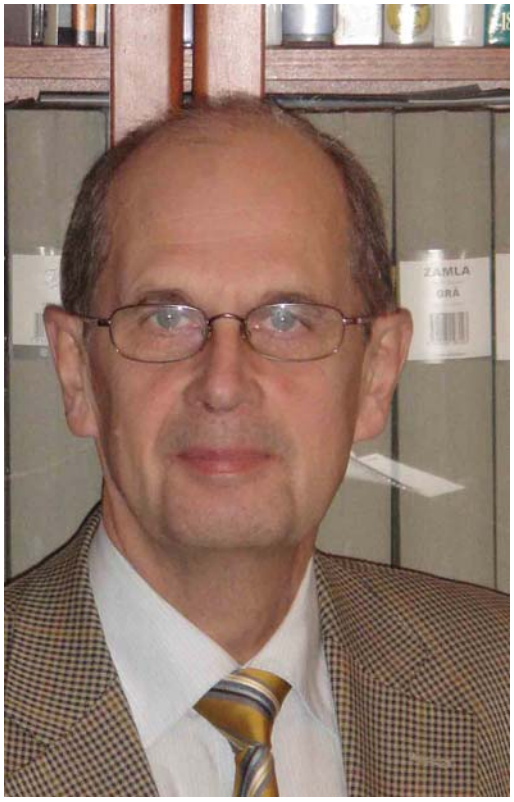
The Buried Pipes project has clearly demonstrated the benefits of flexible pipe systems and the correct way to design and install PVC and PE sewer pipes. The results contributed to the standardisation work of design methods in TC164/165.

Scientific confirmation

Ingemar Björklund, chairman of the project is convinced that the project absolutely confirmed the calculation methods used to install pipes. “By using accurate test methods, we have proved how plastic pipes should be installed and what kind of checks should be used. Tests showed that the scatter of ovality is small in normal installations. However, an installation with a pipe stiffness of less than 4 kN/m2 will require accurate installation – with good support for compaction. Increased stiffness from 4 – 8 kN/m2 provides an ideal situation.”

Despite the importance of these results, little has changed on the ground and under the ground! Scientific confirmation does not mean that principle is immediately put into practice.





Ingemar Björklund

Tony Calton from the TEPPFA Working Group that deals with the Civils sector believes that more communication is necessary.

“Calculations are still based on national methods and the European standard (EN 1295) has not been shaped by the scientific conclusions.”

But all is not lost. Campaigns are being developed in various European countries to raise the level of perception. “The pitch is very much towards technical stakeholders and we shall eventually see a more European approach.”

“Communication activities have until now centred on public affaires. However, in the field of press and pr, we are developing some creative ideas. Reflections may have more impact than deflections…”