

PIPE TECH REVIEW

Pipe Technology NEWS from TEPPFA

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SEWER SPECIAL – PART TWO OF A TWO PART SERIES!

BRUSSELS. Recent developments in plastic sewer pipe technology



Roger Smith, TEPPFA President says: "Plastic sewer pipe systems are technically designed for performance and perfection. These light weight runners continue to set marathon track records!"



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► SEWER

Today, plastic sewer pipes can be found across the world. Compared to traditional materials, their performance is excellent and their contribution to public health and sanitation is significant. These sewer pipes may well be buried and thus out of sight, but their usefulness is certainly not out of mind.

In our September issue, we talk to industry experts about:

- Inspection Chambers
- Structured Wall Pipes
- Response to attacks from clay
- Jetting

► INSPECTION CHAMBERS

Plastic inspection chambers have been around for the last twenty years. It was inevitable that their popularity in Europe would prompt a move towards standardisation. But where to begin? Frans Alferink picks up the story to find common ground - for what can be usefully found underground!

All over Europe, the technical jury is out on the final agreement for the standardisation. If all goes well, by mid 2008, the European standard will be published. This process has taken many years and according to Frans Alferink, a member of the Dutch technical standards committee: "Once accepted, this standard will lead to the application of good quality chambers and therefore performance."



Frans Alferink

Vision

Alferink has a clear vision of the application of plastic pipes systems including plastics manholes and inspection chambers as well as plastics pipes.

"The function of a buried pipe system is that it maintains a system of smooth and tight holes in the ground for a long period of time." Says Alferink.

"The benefits of plastic inspection chambers are widely appreciated. In addition to their obvious handling, transport and long life advantages, plastic chambers are a lot more resistant to the corrosive gases and products caused by our waste products as they flow through the underground sewer network."

"And the wonderful characteristic of plastics is the absolute control in the

manufacturing process - enabling us to make products that will perform exactly as intended and for a long time."

Alferink acknowledges that the industry is well aware of some of the problems of non-plastic materials:

PIPES

- Leaking joints
- Deteriorating pipes caused by H₂S
- Cracked pipes

CHAMBERS

- Leaking pipe connections with non-plastic chambers
- Leaking chambers
- Deteriorating chambers caused by H₂S

Alferink points out that, "Suppliers of plastic pipe systems have to be alert not to enter the market with poor quality products, as this will jeopardise the good image and record of plastics pipe systems. It is therefore of prime importance to establish standards that ensure good products to be used in sewer systems."

According to Alferink, the essential properties of inspection chambers are **structural integrity, good operational performance, tightness and durability.**

Integrity

Plastic inspection chambers can withstand all chemicals that normally occur in sewers. Their durability is all the more relevant since unlike non-plastic chambers, they are not subject to chemical attack of biogenic "sulphuric acid" in the form of corrosion. Corrosion clearly has an adverse effect on flow properties and may affect the structural integrity. the diameter of the host pipe.

Furthermore, given that in most EU-countries there is a trend towards separation of sewer systems in to black (foul) water and rainwater, the concentration of chemicals in the sewer system may increase.

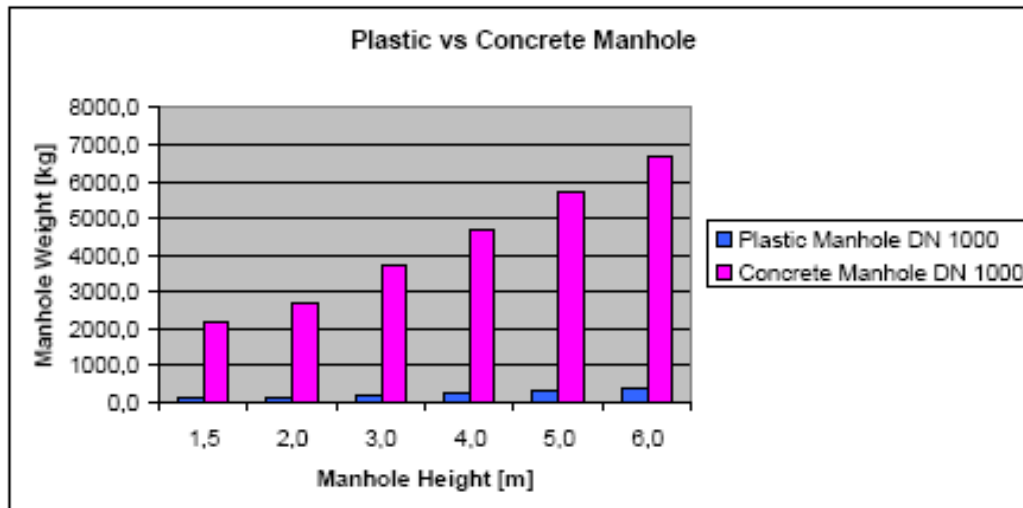
Lightweight is clearly a fundamental feature of plastic chambers. The benefits of easy transport, handling and installation without any special equipment are clearly worthwhile. As a general rule, the weight of a typical concrete manhole (inspection chamber diameter in excess of 600mm!) is 18 times that of a plastic manhole of the same height. See chart on following page.



Manhole deterioration



Manhole as sulphur factory



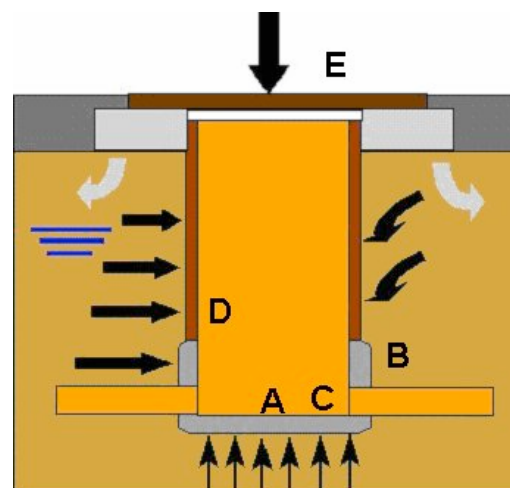
Performance

Whereas plastic chambers are lightweight, there can be no argument for focusing on lowest cost when it comes to buried products that establish such vital systems for society, as those of sewer. "These products must withstand traffic, soil and ground water loads: their functional performance should be excellent."

"Good design of flow profile is also important. Optimal flow profiles are a condition to be fulfilled in order to avoid high operational costs for the future. In Denmark, a test (DS2379) exists where the flow performance is tested. Especially so-called "multi-functional" chambers suffer from poor flow performance. However, the upcoming new European standard will not address the issue of flow, because except from Denmark, this issue is not considered as so important in other countries of Europe."

Alferink explains that the application windows of plastic chambers can be rather different. Some may be produced for low depth installation, whereas others may focus on deep burial in combination with high groundwater levels. The best way therefore is to classify the chambers according to their proven application

window. The upcoming European standard provides test methods and procedures to carry out this classification.



(Figure 1) Loads on buried chambers

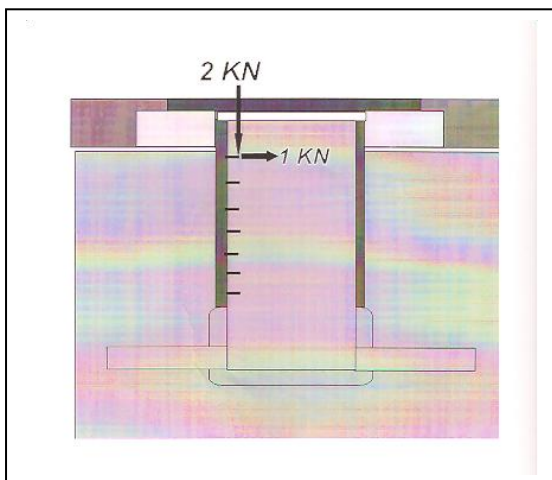
Load testing

An important function of the chamber is to maintain the hole in the ground. And in order to be able to do that, it needs to cope with the loads exerted upon the chamber.

For almost all these loadings, test methods and requirements have been developed by a working group under CEN.

Aspect (referring to figure 1)	Description	Test	Method
A	Stability of flow profile	Vacuum test on base product. Vacuum relates to allowable groundwater depth with a minimum of 2 metre	EN14830
B	Tightness	Normal joint tightness requirements. Additional tightness under shear load	EN 1277 EN295-3
C	Impact resistance	Impact test	
D	Shaft stiffness	Minimum stiffness is 2 kPa	EN14982
E	Cover load test	Test load depending on type of road	EN14802

Steps and ladders could also be tested for how much weight they can withstand. "A downward vector of 2 KN and horizontal vector of 1 KN should be ideal for the fit purpose."



For the shaft the ring stiffness is the most important parameter to be considered as the shaft should not collapse under the load of ground and groundwater. In figure 2 the maximum allowable depth (H) is shown for chambers when buried in sand, clay and in very weak soils. The groundwater level is 0.5 meter below the surface.

For the calculation, use is made of the following buckling formula:

$$q_{crit} = 5.63 \sqrt{(E_t * S_N)}$$

q_{crit} = critical buckling pressure [kPa]

S_N = pipes ring stiffness [kPa]

E_t = tangent modulus (E_s) of soil [kPa]

For sand, a secant modulus of 1500 kPa is used and for clay a modulus of 500 KPa. These values are arbitrary and are actually depth dependant. However, for a conservative estimation, these values can be used.

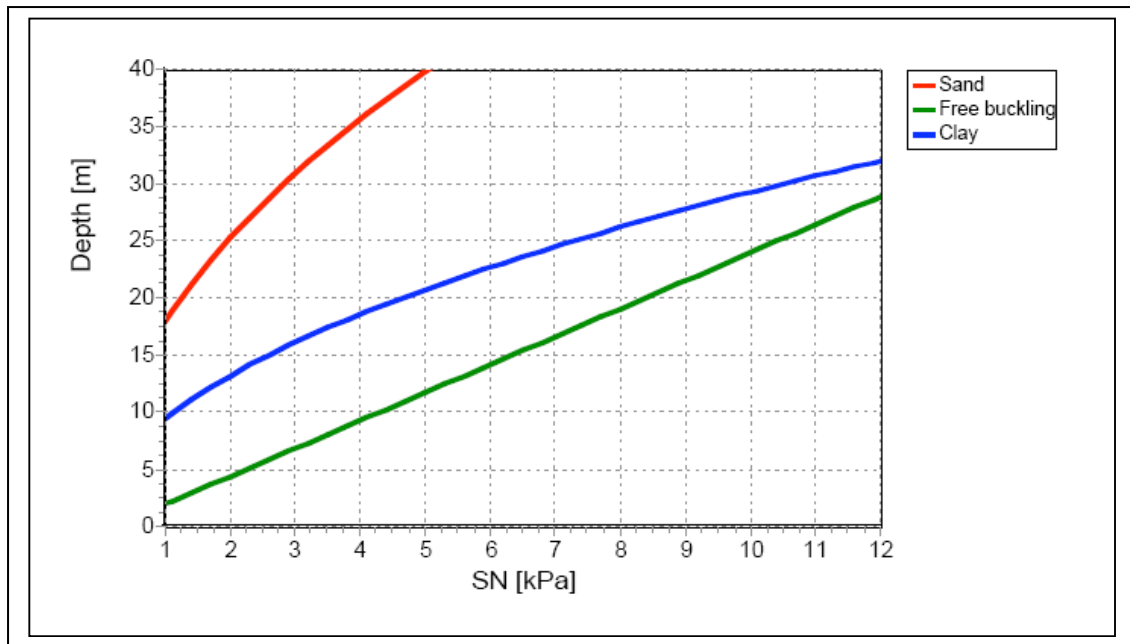


Figure 2) Allowable depth

What the above shows is that a ring stiffness of 1 KPa could also be used when installed in well-compacted sand. In clay it would also work.

“However, in soft soils and ultimately in water-like soils, the shaft would buckle when the depth would be more than 2 metres. In the draft standard, a minimum stiffness of 2 KPa has been proposed. The reason for that is that the installation may well result in uneven loading, especially when clay or big lumps of soil are dumped around the shaft. Experience in Europe has shown that the stiffness of 2 KPa is a safe limit,” says Alferink.

Integrity

Structural integrity of the base of the chamber is also an important criterion. “There is no point in manufacturing flimsy structures that will yield to deformation and thus create flow problems.”

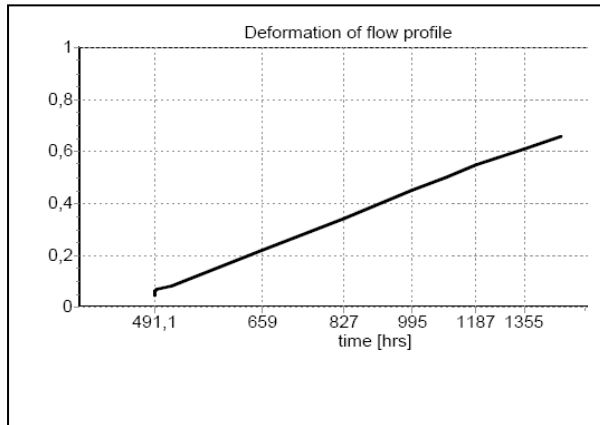


Impression of measuring spots, mid-point deformation and horizontal deformation

The stability of the flow profile can be tested using a vacuum test or an external water pressure test.

“In both cases a pressure difference is established over the load bearing part of the chamber. The deformation of the flow profile is measured during the test. Both the vertical deformation of the midpoint of the flow profile as well as the horizontal deformation is recorded during 1000 hours at ambient temperature.”

Alferink points out that by using a similar extrapolation technique as in ISO 9969, the 50 years deformation prediction is estimated. If the construction is not stable in the long term, then this test will certainly tackle that.



Deformation of flow profile (vertical axis plotted in mm)

Reality

Europe with its tapestry of cultures and customs is not the best of all possible worlds to reach agreement.

Alferink says it could be another year before the standard is eventually agreed and accepted. "But we are confident that the customer's best interests will be served through an optimal functioning sewer system!"

Zoran Davidovski who is closely following developments for the Civils Working Group of TEPPFA is reasonably optimistic that the 2008 deadline will be reached. "Following a certain amount of testing, outstanding differences are to be discussed imminently. The document can then be released for voting by end of 2007 and then depending on the procedure chosen, voting can last three to six months. The best case scenario is therefore mid 2008."

► STRUCTURED WALL PIPES

Brussels. Now that the European Standard for Structured Wall Sewer Pipes & Fittings has been approved, what next?

Zoran Davidovski from Pipelife has been following the progress of EN 13476. "It took about twenty years to develop this standard and would have taken another twenty had TEPPFA not taken the initiative. After two years of reasonable reduction without reduction of reason, we got there!"

Highlights are:

- Ring Stiffness of Pipes and Fittings and Available Classes
- Required Ring Flexibility of Pipes
- Dimensions and Tolerances
- Impact Strength, Resistance to Dynamic Loading
- Demonstration of Leak Tightness of the System
- Resistance to High Temperatures
- Recommendation for Sewer Pipe Cleaning, Jetting
- Demonstration of the Durability of the Used Thermoplastic Materials
- Chemical Resistance of the Used Thermoplastic Materials
- Additional Information: Recycling of Thermoplastic Pipes and Fittings



Zoran Davidovski

Plastic structured wall pipes and fittings have been used in Europe for over thirty years. As their name suggests, these pipes are differentiated by a pipe wall that has a structured external profile or are composed of different layers to give an improved performance and to meet the stringent requirements of a drainage and sewer system.

PVC structured wall pipes were introduced in the 1970's. Their lightweight, compared to traditional materials, toughness and excellent resistance to chemicals make them particularly suitable for sewer applications. More recently, structured wall pipes and fittings made from Polypropylene (PP) and Polyethylene (PE) have been introduced.

Zoran notes that a fair amount of testing has been included in the standard. "Quality options were also considered. These pipes are required to operate in Mediterranean as well as Scandinavian environments. Testing had to reflect this divergence."

"Some fundamental testing for ring stiffness and flexibility is clearly

welcomed. The European industry would be clearly concerned if sub standard imports from outside of Europe flooded our markets.

"Testing for leak tightness is also a critical parameter. Joints have to be tested under extreme conditions including joint angular and diametric deflection ranging from negative to positive. For underground drainage and sewer pipe systems this is a fundamental characteristic."

"We also considered flushing and were thus able to bring the standard completely up to date with recommendations for high volume low pressure jetting with the correct size of bore nozzles."

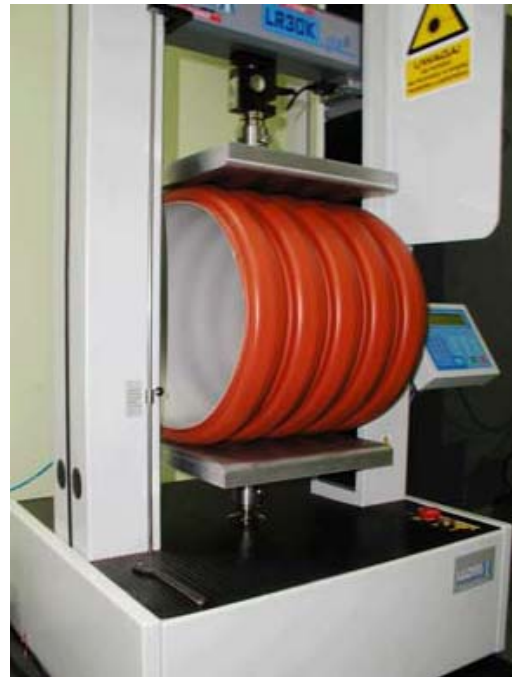
Level playing field

Even with about 40 basic types of structured wall pipe systems on the market, Zoran is satisfied that customers will be reassured by the EN marking. "This performance based standard will also assist Central Eastern European markets which tend to look to EN for guidance. We now have a level playing field and whereas publishing the standard will not lead immediately to enormous sales growth of plastic pipes, it should provide basic reassurance about where the products are coming from and how they will perform underground."

The Standard was published by CEN in April this year and this will be followed in the UK, for example, by BS EN 13476 and in France by Afnor EN 13476.



Leak tightness test



Compression testing machine for ring stiffness

The issue of the variety of types of pipe structure has been solved by enabling member countries to develop their own national foreword text to the Standard. Each Member State will offer a Third Party Certification scheme for their products.

"The growing market share of plastic pipe systems in Europe is partly the result of continuous innovation, resulting in more effective and efficient concepts. These concepts, like structured wall pipes, can only be successful when serving the basic customer need: **quality**. Standards have now been set and we are confident that performance will endure."

TEPPFA has issued a document for guidance on the standard entitled:

Structured Wall Piping Systems according to EN13476

This is available on request from tiem.meijering@teppfa.org

► FOR THE RECORD...

Brussels. Some rather inconsistent information is told about the nature of non-plastic pipes and the nature of plastic pipe systems. Tiem Meijering, technical manager of TEPFPA has a few convincing arguments of his own that he would like to share...

Some experts estimate that plastics conversion for pipe systems is running at about 6.5% per annum. For instance, Central Eastern Europe is converting rapidly to the benefits of modern plastic pipe technology.

The arguments for plastic pipes continue to remain relevant and worth considering if only to reflect on why plastic pipes continue to prove so successful.

DURABILITY

When properly installed, the physical and chemical stability of all plastics materials for piping systems show such a high level that all these materials can last much more than 100 years.

DIVERSITY

The variety of plastic pipe products is the result of market demands. The versatility of plastics is such that they are able to serve the market with different solutions. Most of the available plastics piping solutions are tailor made for different applications (e.g. sewer, road drainage, rainwater etc.) with different sets of preferences and requirements - which are basically determined by the wishes and demands of the users.



Tiem Meijering

All these piping systems have to fulfil the performance and quality requirements of the relevant EN standards that are generally decided by designers, specifiers, producers and users as being relevant for these particular applications.

HYDRAULICS

All commercially available plastic piping systems are well documented regarding their exact internal diameter and flow capacity. The smooth surface of the inner wall of plastic pipes guarantees a better flow than for non plastic pipes. Studies have shown that even when the maximum deflection of plastic pipes is reached, no significant reduction in flow capacity will occur.

STRENGTH/STIFFNESS

The TEPFPA Buried Pipes project showed that the flexible behaviour of plastics pipes (from SN2 - 16) results in a pipe deflection that is mainly determined by the settlement of the ground during and after installation.

Plastic pipes simply follow the ground settlement, which is normally finished within one month to two years after installation, depending of the soil compaction during installation.

From that moment on, no further deflection or deformation in the pipes will occur.

Studies have demonstrated that excavated pipes that have served up to 40-50 years operation still show physical and mechanical properties of the same level as newly produced pipes of today. So during its life, the initial pipe quality does not change at all. The **E modulus remains unchanged** which means that the resistance against external loadings remains the same during the whole lifetime of the pipes.

INSTALLATION STATICS

Static design calculations should demonstrate the ability of a pipe system to fulfil the required functioning. This means, operating without problems during the whole lifetime. In a recent TEPPFA study for Sustainable Municipal Pipes (SMP), it was demonstrated that rigid pipe systems show ~41 leaking failures per km and flexible pipes ~6 leaking failures per km. The evaluated effects on the environment are about 2 times higher for rigid pipes compared to flexible pipes.

As clearly demonstrated in the TEPPFA Buried Pipes project, it is mainly the quality of installation for both pipe systems, rigid and flexible, that determines the final performance during its lifetime. A design graph shows the predicted deflections after installation and after completed ground settlement.

INSTALLATION LENGTH

Because of the low weight per meter, plastic pipes can be used at greater

lengths. These greater lengths up to 10-12 meters can also be used efficiently in the trench where the flexibility of the pipes can easily accommodate the unavoidable unevenness of the trench bottom without causing problems.

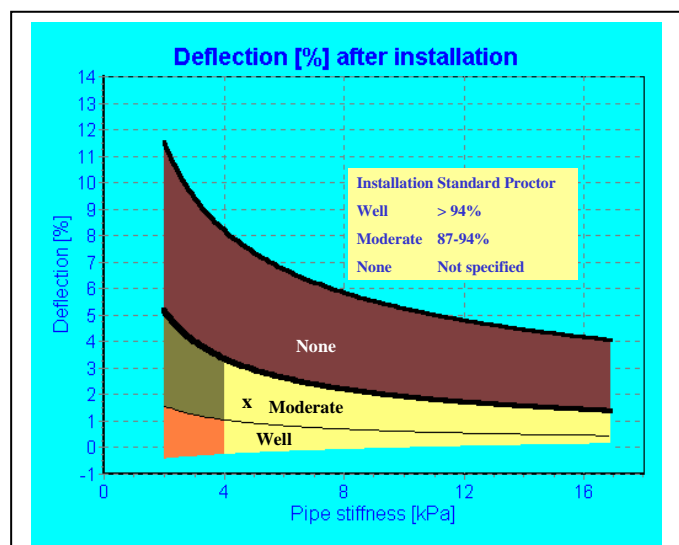
TEMPERATURE

Once properly installed in the ground, plastics sewer and drainage pipes show very minor thermal expansion (caused by soil friction but this process will anchor the buried pipes to such an extent).

The jointing systems accommodate the possible movements due to temperature variations. According to the relevant product standards, these joints are tested to fulfil the required temperature variations as defined in EN476.

BACKFILLING

A good backfilling of the trench is important for all types of pipes, rigid or flexible. For rigid pipes, poor backfilling can easily be followed by pipe failures in the ground settlement phase after installation, due to the incapability of rigid pipes to deform. Flexible pipes also need good backfilling to avoid point loading and to avoid excessive deflections during the ground settlement phase.



Sewer pipes fulfilling the performance requirements of the relevant EN standards, have been shown to be tight under deflections up to 15%. The TEPPFA Buried Pipes study has shown that under normal good installation conditions, pipe deflections do not exceed 6-8% for the used stiffness classes.

The measurement of the deflection of the installed sewer pipes is an efficient and cheap method to verify the quality of the installation. It has nothing to do with the quality of the pipe.

HIGH-PRESSURE FLUSHING

A recent TEPPFA study has shown that the most effective way of cleaning sewers is by using medium water pressure levels and high water volumes.

TEPPFA considers it as inadvisable to advocate jetting pressures higher than are needed to flush or remove blockages – especially from rigid pipes. (see also article JETTING)

ENVIRONMENT

When the environment is taken as an argument for materials, the total aspect must be taken into account. As mentioned above, the SMP project showed that rigid pipes in operation show leakages that effect the environment either by infiltration or exfiltration by 41 defects per kilometre where flexible pipes only show 6 per kilometre. The calculated relative effect on the environment is for rigid pipes two times higher than for flexible pipes. (more info about CO2 can be found in the GUA study – see Bibliography)

QUALITY

Tiem Meijering is convinced that his technical arguments far outweigh those levelled against plastic pipe systems. "It is a measure of confidence in our technology and industry that we are continuously developing exciting products. Plastics provide a sustainable world in which expectations and standards are very high. This is why TEPPFA promotes quality marks based on third party certification to illustrate the continuity of this quality level in the pipe, its installation and its performance."

► JETTING

Brussels. TEPPFA has produced a brochure to advise maintenance contractors and the market on the subject of jetting. Tony Calton from Marley was involved with creating guidelines that have been successfully taken up by industry.

"All types of gravity drain and sewer systems require a regular cleaning regime to ensure top performance. Plastic sewer pipes are no exception although their maintenance requires only minimal attention."

"From a European perspective, we noted that this process in one or two member countries involved low volumes of water at high pressure. Usually this blast would be produced through small bore nozzles (typically 1 mm) and this treatment could cause damage to all kinds of pipe systems both rigid and flexible."

Gentle more effective

"Independent testing carried out by Loughborough University and the Danish Technological Institute (DTI) have identified that high volume at low pressure is a lot more effective way to achieve removal of obstructions and thorough cleansing of accumulated sediments from pipes as well as for routine maintenance."

"These more gentle yet more effective methods use larger bore (typically 2.8mm) nozzles."

In the UK, the Water Research Centre has already published best practice guidelines for such maintenance. "Most water companies and contractors have followed the advice."



Tony Calton

"Moreover, a new European standard for the management and control of these cleaning operations is currently being finalised: prEN 14654-1:2004 *Management and Control of Operations in Drains and Sewers – Part 1: Sewer Cleaning.*"

"We are confident that the plastic pipe industry in Europe has responded responsibly to this matter. Our technology and the good offices of TEPPFA have ensured that best practice will be served."

	BLOCKAGE REMOVAL	
	GREASE	SOLIDS
Solid and Structured Wall Plastic Pressure required...	70 bar	70-110 bar
Clay Pressure required...	70-105 bar	Required pressure levels may also damage pipeline.
Concrete Pressure required...	105 bar	Replacement would be recommended (see NOTE)

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