Polyethylene pipes already have an established position among all materials used to build pipelines. They are widely used to build water, gas and sewer systems (mainly pressure systems) and in industrial applications. Welded joints and high flexibility of PE pipes allow to use them also in new narrow-trench and trenchless technologies.

PE pipes are often used to restore old pipelines to full working order. Installation conditions in all those methods usually differ more or less from the theoretical model. Consequently, pipeline operation safety may be lower than expected due to potential point loads or deep outside scratches. In the worst case it may lead to a pipeline breakdown.

On the other hand new methods have proven to be so cost-effective, that many companies look for solutions which guarantee increased safety for the pipelines installed in that way. Such condition is fulfilled by Wavin TS\(^{DOQ}\) and SafeTech RC\(^n\), which thanks to special protective features are perfect solution for installation using tunneling, directional drilling (HDD), trenchless replacement of old pipelines using close-fit (e.g. swagelining) or loose-fit (e.g. sliplining) technologies.

**Construction of Wavin TS\(^{DOQ}\) and SafeTech RC\(^n\)**

Wavin TS\(^{DOQ}\) is a three-layer pipe, with all layers made of PE RC (resistant to crack). The three layers are integrated and cannot be separated mechanically. Consequently, the whole pipe is a solid construction with the same inner pressure resistance as a standard pipe made entirely of PE 100 grade polyethylene. Outer and inner layer thickness is identical and equals 25% of nominal wall thickness. Smaller diameter (for water and gas service pipes) are made as solid wall pipes.

Wavin SafeTech RC\(^n\) is a co-extruded two-layer pipe made of PE 100-RC (resistant to crack). About 90% of the nominal wall thickness is made of black PE-RC, remaining 10% - outer signal layer made of blue PE-RC.

**Jointing methods for Wavin TS\(^{DOQ}\) and SafeTech RC\(^n\)**

Wavin RC pipes are as easy to weld as PE 100 pipes. They can be comfortably jointed using butt fusion (fig. 3. and 5.) or electrofusion (fig. 4.) and by means of mechanical fittings. Fittings and equipment are exactly the same as those applied to joint PE 100. It should be stressed that pipe dimensions correspond with standard pipe dimensions and it is not necessary to peel off additional protective layer from the pipe ends to carry out jointing, as it happens with other pipes with protective layers of PP. Dimensions matching standard pipes mean that pipes are compatible to fittings by all major fitting manufacturers.
Research shows that Wavin multilayer pipes can be easily welded keeping long-term durability factor on a level higher than 0.8 and in case of electrofusion jointing more than 1.0 (fulfilled normative requirement). The tests have been carried out with fittings made by different producers (+GF+/Wavin, Friatec, Plasson).

**New PE pipes installation methods**

**Installation methods in urbanized areas**

Traditional installation method with sand bedding is more and more often replaced by new innovative technologies. Laying pipes in open trenches is very often unacceptable due to inconvenience to the public and traffic disturbance. Therefore new, fast trenchless rehabilitation and installation technologies such as burstlining or directional drilling (HDD) are gaining more and more popularity.

**Installation methods in the rural areas**

New trenchless or narrow-trench technologies, such as ploughing, milling or cutting are used depending on the soil and land development. Installing pipeline in open trench can proceed relatively easy. Moreover, soil can be used to refill the trench back in, which enables to avoid additional cost of building service road for trucks to carry soil from trenches and sand.

**Pipes applied in new installation technologies**

New installation methods are usually not only much faster and more cost-effective, but also less inconvenient to the public due to road works and more environmentally friendly. These new technologies are often called alternative or unconventional methods. However, pipes installed using new technologies are often exposed to different short- and long-term loads. What is more, these technologies require flexible materials. Steel, cast-iron, clay and concrete are heavy and can be moved only using a crane, so they are not suitable for alternative methods.

Pipes made of GFK, PP, PVC, PE are easier to install but have the same operation lifetime as traditional pipes. Due to recent advance

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Fig. 5. TS welding procedure

Fig. 6. HDD

Fig. 7. Burstlining

Fig. 8. Ploughing

Fig. 9. Installation without sand-bed in rural area
Inspections and renovations

in PE production technology and application of innovative resistant and durable material, these pipes meet enhanced requirements and can be applied in alternative methods without any limitations.

Classification of PE pipes (Table 1), suggested by Wavin in Germany, may help to take a decision which type of pipes should be used for a given installation technology.

PE pipes for all applications
Installation conditions have been divided into three groups: Low, Middle and High. This division helped to build classification of Wavin PE pressure systems and enables to choose the optimal product with at least 100 years of operation life for each of three groups. Wavin offers range of products including all three groups: PE 100 pressure pipes (LOW), two-layer pressure pipes Wavin SafeTech RC (MIDDLE) and three-layer pressure pipes Wavin TS (HIGH).

PE 100 pipes for the low load properties
Laying pipelines using traditional technology in open trenches is least demanding for the pipe system. Moreover, acceptable loads and requirements are clearly defined for installation with sand bedding. Much the same requirements have been met without any objections for many years for standard PE 80 pipes and PE 100 pipes installation. Standard PE 80 and PE 100 pipes must be laid with sand bedding and should not be used for alternative methods. If it is not sure that pipes will be installed carefully, it is more beneficial for the investor to use pipes with protective characteristics.

Pipes with protective characteristics made of PE 100 RC for middle load properties
If a pipe is laid in using trenchless technology, e.g. ploughing, ground cutting (milling) or relining, requirements are much higher. Using ploughing or ground cutting enables to avoid so called “black box” situation, where the first meter of the pipe must cover the whole route, and consequently this part runs unpredictable risk. Relining involves installing new pipeline inside the TV-inspected and calibration of old, existing pipeline.
This group comprises also installing pipelines using traditional method in the open trench. In this extremely interesting, cost-effective method pipe is simply laid down the trench in the ground, provided it can be thickened after filling in. It allows to avoid additional cost of sand and cost of transport and storage of soil.

For such middle requirements Wavin SafeTechRC® has been developed, which is a co-extruded two-layer pipe with protective characteristics made of innovative material PE 100 RC. RC stands for ‘Resistance to Crack’. Compared with a traditional PE 100 pipe, PE 100 RC is about ten times more resistant, and about four times more resistant to point loads. Therefore, it meets the requirement for the minimum 100 years service life.

**Pipes with protective characteristics made of PE 100 RC for the maximum requirements**

In methods such as ‘black box’, i.e. bursting or directional drilling pipes are exposed to short- and long-term loads, which may lead to notches and scratches on the surface and to point loads with tension on the inner pipe surface. Obviously, before these methods are applied, soil condition or the existing pipeline has to be checked. Depending on the method, bentonite, which later hardens and creates bedding, is applied. Change of direction, diameter and material should be taken into account.

Especially for that purpose Wavin made tree-layer, co-extruded pipe Wavin TS® and has launched at the turn of the century the first pressure pipe made of PE 100 RC, which has protective characteristics without PP protection or cross-linking. So far more than 7,7 million meters of Wavin TS with a 100-years operation life have been used in the whole Europe.

Wavin TS is applicable for any installation without restriction. Wavin together with plastic producers has drawn up a quality control system. Quality is closely monitored at every stage from plastic production to delivery to the building site. Wavin has a unique agreement with a raw material supplier, which goes beyond standard Type Test procedures. They makes sure that all plastic batches are checked for protective characteristics. FNCT test (Full Notch Creep Test) is carried out in an independent institute. Only after 3300 hours of testing it is possible to start production of a given batch. This timing corresponds to minimal value for a gas pipeline laid by means of bursting, according to the standard DVGW-GW 323.
Summary

Pipes with inner and outer protective layer produced by Wavin are a new, top quality on the market. They provide the maximum security when installed in adverse installation conditions. Due to extreme resistance of protective layers to slow crack growth these pipes are perfect solution for trenchless technologies, where pipe scratches of outside layer are inevitable.

Superior resistance to point loads enables to lay them directly in the ground without using sand bedding, which is an economic advantage. According to numerous tests, it is estimated that lifetime of Wavin TS laid in extremely difficult conditions exceeds 100 years. Wavin TS pipes can be jointed in a standard way, using standard welding machines and standard fittings. Moreover, their price is considerably lower than price of other comparable products (other pipes with protective layers) and only slightly higher than standard PE pipes. Therefore, we can expect significant growth in their application due to greater reliability of the pipeline and lower price of its construction.

The long-standing experience shows that applying pipes with increased protective characteristics and better resistance is always more beneficial for the end user.

Reliable materials with complete assurance of quality will definitely bring benefits in the form of failure-free operation and low maintenance cost of the pipeline. Moreover, using innovative installation technologies, which are alternative to traditional open trench methods with sand bedding, can significantly lower project cost both while building new systems and renovating the old pipeline systems.

Literature


Done by:
Civil Eng Ralf Glanert,
Product Manager PE Systems
Wavin GmbH Germany
M Sc Eng, MBA Anna Wróblewska
European Sales Manager Renovation
Wavin Poland
Nature lovers would go for Wavin

Trench-less technology

Compact Pipe
Close-fit liner for water, gas and sewer

Compact SlimLiner
Interactive close-fit liner for water

Neofit
Interactive close-fit liner for water

Wavin TS\textsuperscript{DOQ} & SafeTech RC\textsuperscript{R}
Extremely robust

WIR
For lining with discrete pipes

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