**Polypropylene Sewer Pipes – Pragma type**

    Corrugated double-layered pipes made of thermoplastic materials are distinguishable by their specific structure built of one smooth internal layer and one profiled external layer. Such structure allows for lower consumption of raw material per linear meter, and accordingly less weight as compared to the compact pipes made of the same materials, to achieve the same ring stiffness of the pipe. Briefly, a product of the same strength can be made using less material and more intelligent design of the pipe structure.

According to the basic manufacturing standard BDS EN 13476-3, the thermoplastic materials used for manufacturing plastic corrugated double-layered sewer pipes are:

* Polyethylene (PE) (elastic modulus ranging from 800 to 1000 MPa)
* **Polypropylene** (**PP**) (elastic modulus **ranging from 1500 to 1750 MPa**)
* Polyvinyl chloride (PVC) (elastic modulus ranging from 3000 to 3200 MPa)

Polypropylene (PP) is a material of the latest generation of thermoplastics used for manufacturing infrastructure piping systems. It is especially suitable for the manufacture of corrugated double-layered sewer pipes. Thanks to its elastic modulus, **Polypropylene (PP) appears to be the optimal thermoplastic material**, as compared to Polyethylene (PE) and Polyvinyl chloride (PVC). Polypropylene is neither too elastic like Polyethylene, nor too brittle like Polyvinyl chloride.

On one hand, Polypropylene corrugated pipes have the required product toughness, which ensures minimal cross ring deflection, on the other hand they have the required elasticity that guarantees their resistance to dynamic loads from traffic and to hard object impacts, even at temperatures below 0°C.

For socket type connections with elastomer sealing, the excessive residual stresses (creeping) that disappear within two years may lead to undesirable expansion of the socket and consequently to loss of water tightness. Practice has proven that Polypropylene corrugated pipes have less subsiding residual stresses (creeping) as compared to Polyethylene corrugated pipes, which makes them the better and more secure choice for piping system using socket type connections with elastomer sealing.

The measuring of creeping in double-layered corrugated pipes is regulated in the standard BDS EN 13476-3. Creeping is one of the major criteria that pipes should be tested for. Anyway, due to the test requirement for 1000 hours testing time, this test cannot be performed on a daily basis and cannot be used as indicator for quick check to make sure whether or not a certain manufactured pipe meets the standard requirements, although certainly it should be performed on a regular basis so that every manufacturer would be able to prove what are the creeping characteristics of the pipes it manufactures. The successful performance of the creeping test can only be guaranteed if the raw material used to manufacture the pipes has been certified for the manufacture of that specific type of pipe.

It is also interesting to note that the technology applied for the ribbed (corrugated) layer requires the use of vacuum immediately after the extrusion so that the external layer would adhere to the mold that shape the rib profile. When using polyethylene whose elastic modulus is lower, the ribs would have to be made higher than the ribs of polypropylene pipes. For the making of such higher ribs of the corrugated layer much greater vacuum is needed. This leads to the formation of residual stresses in the finished product, therefore the balance between the right toughness and the right elasticity in polyethylene corrugated pipes is more difficult to achieve as compared to the polypropylene corrugated pipes.

The most important production parameter of thermoplastic materials, is the so called melt flow index - MFI (measuring the liquefaction of thermoplastic materials). Based on the value of melt flow index, the manufacturer gets knowledge about the material and what settings to enter in the pipe making machines.

When the raw material is primary and intended for the manufacture of that specific type of products – the double-layered corrugated pipes, this would guarantee that the end product will meet the requirements of manufacturing standard – BDS EN 13476-3. When the raw material is a recyclate obtained from recycled products that have nothing in common with the corrugated pipes to be made of the desired plastic material, then such recyclate would not have homogenous liquefaction, therefore there could be no guarantee for the quality of end product, which in its turn would not have homogenous physical and mechanical properties and structure.

Polypropylene, being the most advanced material of the thermoplastic material group, is hardly available as uncertified low-quality granulate, therefore the possibility for abuses with polypropylene is much lower than with polyethylene or polyvinyl chloride.

A preventive measure to fight abuses with uncertified recycled granulate is to dye the external ribbed layer and the internal smooth layer of corrugated pipes intended for use in infrastructure sewage network in a color other than black because black is the most suitable color for concealing the non-homogenous components of uncertified recycled raw material.

To further guarantee the quality of raw material used for the production of plastic (polypropylene) pipes, the bodies responsible for supervising and controlling the implementation of infrastructure projects should require the relevant certificates of origin, and documentation for the intended use and quality of raw materials, as well as **test reports for each batch of pipes**.

In addition, the bodies responsible for supervising and controlling the implementation of projects for infrastructure sewage network should take **sample pieces** from the pipes of each diameter delivered to the site and submit them for **testing by the main criteria in accordance with the applicable manufacturing standard**.

According to standard BDS EN 13476-3 the main criteria for double-layered corrugated pipes made of thermoplastic materials are the following:

* Ring stiffness (SN)
* Ring elasticity
* Impact resistance

The testing of sample pieces from the pipes delivered to the site by those three main criteria may give a clear idea for the quality of pipes and possibly prevent installation works if the pipes fail to meet the requirements. This is how future spending for the cost of repairing bad quality and defective pipes can be avoided. Such tests will provide a clear picture on which manufacturer insists on quality and good reputation, staking on strict production control and top grade certified raw materials and which one is only interested in making profit to the expense of quality and reliability by neglecting production control and putting in low quality, recycled and uncertified raw materials.

Another important factor to ensure the good quality of installation and structure of the infrastructure sewage network is the choice of aggregate used for backfilling and the intensity of its compacting. Over the years the ballast consisting of crushed stone was proven to be the most suitable and effective to achieve maximum compacted backfilling by using minimal input of resources. Double-layered corrugated pipes made of polypropylene can be directly backfilled with ballast.

After backfilling and compacting elastic pipes will deflect, their cross section (ring) will deform, as a result the load of the earth above the pipe will be redistributed by transferring some of it to the backfill that is by the sides of the pipe. This way the load exercised on the pipe will be lower, hence the pipe use and operation will be facilitated in the long run.

The allowable deflection from the point of view of water tightness of the socket type connection with elastomer sealing is:

* 6% for polypropylene pipes
* 3% for fiberglass pipes

In practice this means that a **polypropylene corrugated pipe** of standard stiffness **SN8** is **comparable** to **fiberglass pipe SN10** provided the conditions of installation are the same. Naturally, when the deflection requirements for the pipes are even stricter than 6%, polypropylene corrugated pipes with higher stiffness class – SN10, SN12 и SN16 will be considered.

Rigid pipes such as concrete or ceramic glass, do not deflect in practice. Since they are tougher than the backfill, the backfill will get more compacted in the area beside the pipe than above its crown causing additional loading on the pipe.

In the instance of unexpected overload, the elastic **double-layered corrugated polypropylene pipes** of good qualitycan endure **30% extreme deflection**, without destroying their structural integrity. By deforming their cross sectional profile (ring) these pipes transfer the load to the soil. Rigid pipes, on the contrary, will carry all the weight of a possible unexpected overload, which may cause cracking followed by destruction of their structural integrity. When the overload is no longer present, corrugated polypropylene pipes will restore their initial shape and the sewerage system will resume its normal operation. If a crack appears in rigid pipes, practically the effects will be irreversible. Of course it should be borne in mind that a corrugated pipe of bad quality, which is made of uncertified recyclate, would most probably fail under such overload and will either deform irreversibly or directly collapse. That is why it is important to test sample pieces of the corrugated pipes that are delivered to the site and to demand certificates for the raw materials used for their production.

The main purpose of use of sewer pipes is to lead away wastewater for as long as possible and for as little cost of maintenance as possible. The main criteria to consider here are hydraulic roughness, abrasion resistance, chemical resistance, and resistance to high temperatures.

The values of absolute hydraulic roughness according to **Colebrook-White** are:

* **polypropylene** pipes – **0.015 mm**
* fiberglass pipes – 0.016 mm
* ceramic glass pipes – 0.035 mm
* concrete (reinforced concrete) pipes – 1.00 mm

Double-layered corrugated polypropylene pipes have time and again proven their abrasion resistance, by multiple successful testing according to the **Darmstadt – Kirschmer** method.

Wearing off the internal layer thickness of the pipe wall:

* **polypropylene** pipes **0.1 mm** - after **130 000** test cycles
* fiberglass pipes 0.2 mm - after 100 000 test cycles
* ceramic glass pipes 0.1 mm - after 100 000 test cycles

   Chemical resistance of the different types of pipes intended for infrastructure sewage network:

* **polypropylene** corrugatedpipes **pH=2** ÷ **pH=12**
* fiberglass pipes pH=1 ÷ pH=10
* ceramic glass pipes pH=0 ÷ pH=14.

Practically polypropylene pipes have almost identical chemical resistance as fiberglass and ceramic glass pipes. Considering also the fact that the normal pH values of wastewater from urban areas range between **pH=6.5** ÷ **pH=7.5**, it becomes clear that polypropylene double-layered corrugated pipes can completely resist the chemical effects produced by urban wastewater and by quite diverse variety of industrial wastewater.

The endurance of sewer pipes to high temperatures is very important for those sections of the urban sewerage system, which are situated close to enterprises discharging hot wastewater of high temperature, as well as for the site sewage network of such enterprises. Another important thing to consider is that pipes, which are situated close to residential buildings or public catering facilities should be resistant to the high temperatures of wastewater.

Polypropylene corrugated pipes can endure:

* permanent wastewater flow of **50°C** temperature
* brief supercritical flow for one up to two hours at temperature **95°C**

     Fiberglass pipes can endure:

* permanent wastewater flow of **40°C** temperature
* by special order pipes enduring **80°C** temperature can be produced

From the modern methods of cleaning deposits stuck on the sewer pipes, jetting is widely used by operators of sewage networks. Two are the basic methods applied in practice – the one employs high pressure (340 bar) and small amount of water, the other works with low pressure (120 bar) and greater amount of water.

It should be borne in mind that the cleaning of fat deposits on the walls of sewer pipes requires the application of the following pressures for injecting the cleaning jet depending on the material of which the pipe is made:

* plastic pipes (including double-layered **corrugated polypropylene pipes**) – 70 bar
* ceramic glass pipes – from 70 to 105 bar
* concrete pipes – 105 bar

The cleaning of hard deposits from the walls of sewer pipes requires the application of the following pressures for injecting the cleaning jet depending on the material of which the pipe is made:

* plastic pipes (including double-layered corrugated polypropylene pipes) – from **70 to 110** bar
* ceramic glass pipes –  **much more than** the recommended maximum pressure of **130 bar**
* concrete pipes – **much more than** the recommended maximum pressure of **130 bar**

In case hard deposits occurred as a result of still curing concrete, which was thrown out into the sewer pipeline in the course of construction works, the required cleaning pressure for ceramic glass and concrete pipes may exceed by many times the recommended maximum pressure of 130 bar because the curing concrete can stick as a lump to the walls of ceramic glass or concrete pipes. Such sticking to the walls of polypropylene pipes is practically impossible to occur, therefore the cleaning of such deposits require times lower pressures of the cleaning jet.

To **summarize,** the advantages provided by the material, the physical-chemical and hydraulic properties render double-layered corrugated polypropylene pipes profitable and reliable to be used in state-of-the-art projects for infrastructure sewerage networks.