Special print from “3R International” | Edition 4-5/2004, pages 237-239, Vulkan Verlag

FRANK
Der Vorsprung.

Large-diameter, spirally wound pipes made from polyethylene open up interesting applications

Joachim Heß, FRANK GmbH
Mörfelden-Walldorf, Germany

Thomas Böhm, Basell Polyolefine GmbH
Frankfurt am Main, Germany

basell
Polyolefins

FRANK GmbH`s many years of practical experience with high-density polyethylene-based piping systems have continuously enabled the company to develop components and systems which fully conform with the demanding requirements of such diverse fields of application as waste-water disposal and plant engineering [1]. High-density wound polyethylene pipes, in particular, stand out in this field from other, “classical”, materials. The improved performance of new polyethylene materials has also made it possible to improve piping system properties and characteristics. This article describes two wound pipes installed in parallel which cross the River Neckar, in southern Germany, for a length of 190 m, at depths of up to 11m.

Large-diameter, spirally wound pipes made from poly-ethylene open up interesting new applications

Environmental awareness and material requirements are increasing ...

Current studies show, however, that leaks are occurring not only in damaged older pipes but even in newly installed sewers. This is often due to design errors, for example pipe joint defects caused by improper pipe and fitting material selections. Pipelines made from rigid materials also pose the additional risk of abrupt failure in the event of transient overload.

The resulting cracks and fragmentation often lead both to leaks and a loss of static load bearing capacity. This carries the risks of groundwater contamination with highly polluted wastewater or of sewerage infiltration. Since the number of combined drainage systems is decreasing and the trend is toward dedicated and therefore highly concentrated foul water sewers, the need for leakproof manholes and sewers is greater than ever today.

This inevitably gives rise to a demand for pipe materials and pipe jointing technologies that can ensure long-lasting integrity of pipe components and joints. Through practical experience over many years with pipe systems based on high-density polyethylene, FRANK GmbH has continuously developed components and systems that meet the stringent requirements of the various application areas, such as wastewater disposal and plant construction [1].

Spirally wound pipes made from high-density polyethylene have proved particularly effective here in comparison with more conventional materials. Because of the higher performance of new polyethylene materials, it has also been possible to improve the properties of pipe systems produced from them. Essentially these properties are long-term hydrostatic strength under internal pressure (creep strength), resistance to slow and rapid crack propagation and mechanical strength.

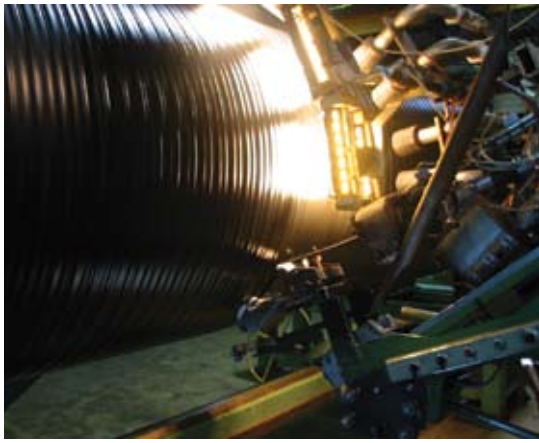

Fig. 1: Modern machine technology ensures high quality - production of spirally wound pipes at Frank & Krah GmbH

Large-diameter, spirally wound pipes made from PE 100

In view of the aforementioned benefits, there has been a trend in product development over a number of years toward profiled sewer pipe systems and associated components made from spirally wound polyethylene.

The special feature of this process is that it enables the production of lightweight products with very high dimensional stability, good chemical and mechanical resistance and a long service life (Fig.1). A feature of today's pipes from FRANK GmbH is the factory prefabricated, integrally wound and therefore uniformly bonded electrofusion socket.

The coextruded yellow inner layer of PE 100 ensures significantly better visibility for in-pipe camera inspection (Fig. 2 and 3).

The advantages described have been put to practical use in a wide variety of applications. For example, the large-diameter, spirally wound pipes in the profiled sewer pipe system have been used in various projects for industry, wastewater treatment, relining, road building and landfill site construction.

Underwater pipelines cross the Neckar at Mannheim

In 1903, the "Grabenstraße" riveted iron underwater pipeline, with an inside diameter of 1400 mm, was installed as a combined foul water/stormwater sewer serving Mannheim Old Town. Cleaning work in October 2002 to remove deposits from the pipe made it necessary to pump out the line. Work carried out over the previous decade to deepen the riverbed for shipping had had the effect of reducing the water load above the line. As a result, the underwater line floated and broke up. Renewal of the pipeline was therefore essential.

Fig. 2: Inspection-friendly light-colored interior surface - Profiled sewer pipes in storage

Fig. 3: Large-diameter, profiled sewer pipes (PKS) in lenghts up to 12 m - profiled sewer pipes with light-colored interior surface produced by Frank & Krah GmbH

Fig. 4: Easy handling cuts costs - General view of the Neckar underwater pipeline

The engineering company de la Motte & Partner Ingenieurgesellschaft mbH from Reinbek near Hamburg was commissioned to undertake a feasibility study, prepare a project plan and supervise pipeline construction and installation work while at the same time providing a cost guarantee for the overall project.

The pipeline construction and installation work was entrusted to a Neckar underwater pipeline consortium comprising the companies Diringer & Scheidel of Mannheim for pipeline and manhole construction and Bohlen & Doyen of Wiesmoor for hydraulic engineering work.

In consultation with the sewer operator, the Mannheim Municipal Sewerage Operations, a solution was worked out that took account of special local requirements [5]. In general terms, the points that had to be considered were the different river water levels (storm and dry weather flow), the need to prevent the pipeline from floating, the provision of a high flow rate to avoid deposits and the importance of a long service life.

The essential advantages of the PE 100 design over pipes made from other materials lay in the areas of weight, handling and expected cleaning requirements. Particularly challenging demands made on the material in this project included high stress due to external water pressure, the need to prevent the pipes from floating and the need to ensure their structural integrity while emptied for inspections.

Specifications, validations and objectives

During the planning process, as required by the operator, static load calculations were carried out according to the latest version of ATV A 127 (published by *Abwassertechnische Vereinigung* = German Wastewater Association) on the basis of the specified water levels and planned invert levels.

These calculations successfully validated the adequate ring stiffness of the pipes when filled to capacity and when emptied for inspection. In the project, profiled sewer pipes manufactured by FRANK GmbH were welded together on the river bank to form two parallel pipelines with diameters DN 800 and DN 1400.

The pipelines were prefitted into a steel box section profile and then sunk to the bottom of the Neckar as a complete component on August 12, 2003 (Fig. 4 and 5).

In addition, the following requirements could be met with spirally wound pipes made from PE 100:

- long-lasting leakproof welds between individual components
- constant production conditions
- reliable quality monitoring
- simple on-site assembly of components
- high cost effectiveness
- proof of long-term hydrostatic strength

To facilitate any maintenance and cleaning that might become necessary, each pipeline was provided with a manhole in the riverside area.

Once the box section profile had been successfully filled with underwater concrete to prevent the pipes from floating, the existing sewer reconnected and construction work completed, the client formally took over the underwater pipeline on November 6, 2003.

Fig. 5: Pipe floated into position after fast and efficient assembly - sinking the Neckar underwater pipeline

PE 100 – the ideal material for this project

The advantages of plastic pipes for transporting foul water had been known to the companies involved in the project for a number of years. The deciding factor in the choice of PE 100 for this project was the combination of cost effectiveness, light weight and the technical advantages offered by the PE 100 material.

Cost effectiveness of PE 100

Spirally wound pipes, pressure pipes and fittings made from PE 100 offer significant advantages in terms of handling and pipelaying because of their relatively low density (0.959 g/cm³). This has a positive impact on installation costs. Spirally wound pipes with a nominal diameter greater than DN 300 can be produced cost-effectively by a flexible production process.

Fig. 6: Strong, leak-proof pipe joint - welding together profiled sewerpipes produced by Frank & Krah GmbH

During the planning process, reference to successful experience in various previous projects was made and served to convince both the operator and the consortium carrying out the project.

Technical advantages of PE 100

The special advantages of PE 100 are good chemical resistance, high operational reliability, significantly better wear behavior than conventional pipe materials (by the Darmstadt method) and good weldability that ensures long-lasting integrity of the system. From an environmental viewpoint, PE 100 pipe‘s recyclability and low production energy requirements should be mentioned [2].

Validation of long-term hydrostatic strength

Because of their high performance, cost effectiveness and in-service reliability, pipe systems made from PE 80 and PE 100 have been used to successfully transport gas, drinking water, wastewater and groundwater-polluting media for several decades now.

Laboratory quantities of individual systems made from HD-PE by former Hoechst in Frankfurt have been subjected to continuous shelf life tests since as early as 1956. These systems up to today have shown a service life of nearly 50 years. ISO 9080 (previously ISO/TR 9080) describes extrapolation methods according to which

scientifically founded predictions on the long-term hydrostatic strength of thermoplastic pipe materials can be made. The method uses Arrhenius law and calculates service life expectancy at lower temperatures based on service life studies of pipe samples exposed to elevated temperatures under internal pressure. The relevant extrapolation factors are specified in ISO 9080. The method shows an expected calculatory life time of 80 to 100 years. The minimum required hydrostatic strength curve for PE 100 in DIN 8075 follows the same law. Needless to say that any such predictions provide only an indication of the possible life time, and the actual service time of individual systems can be significantly affected by a number of local conditions and circumstances including above all the quality and conditions of the manufacturing process.

Hostalen GM 5010 T3 black (PE 80) and *Hostalen CRP* 100 black (PE 100) are two HD-PE materials that belong to the third-generation, multimodal HD-PE pipe materials are manufactured in a multi-stage polymerization plant by Basell Polyolefine GmbH at their production site in Frankfurt am Main [3]. Both these materials have been approved by the Deutsches Institut für Bautechnik or DIBt (German Institute for Building Technology) based in Berlin.

Weldability guarantees long-lasting leakproof systems

Guide values on the welding parameters (lining up the joint faces against the heated tool, heating up the joint faces to welding temperature, heated-tool removal, welding pressure build-up and cooling time under welding pressure) for these multimodal materials are given in the latest version of DVS 2207* for pipes and sheets made from HD-PE [4] (Fig. 6).

** Published by the Deutsche Verband für Schweißtechnik = German Association for Welding Technology*

Summary

Large-diameter, spirally wound pipes produced from multimodal PE 100 materials by FRANK GmbH permit rapid, cost-effective installation of long-lasting leakproof, high-load-bearing sewers, manholes and pipeline systems.

The integration of electrofusion sockets into the pipes also offers unsurpassed handling advantages in pipe welding. The light-colored, smooth, abrasion-resistant and inspection-friendly interior pipe surface ensures long-term troublefree operation of pipeline systems.

References

[1] Frank, T.: Profilierte Kanalrohre aus thermoplastischen Kunststoffen für Nennweiten bis DN 2000 (Profiled sewer pipes made from thermoplastics for nominal diameters up to DN 2000); plastic pipes Munich, Munich, 2001

[2] Fiedler, M.: Praxisbericht: Erfahrungen mit PE-HD-Vollwandrohren (Practical report: Experiences with PE-HD solid-wall pipes), 3. Göttinger Abwassertage 2003 (3rd Göttingen Waste-water Conference 2003)

[3] Schulte, U.: 100 Jahre Lebensdauer – Langzeitfestigkeit von Druckrohren aus bimodalem PE-HD nach ISO/TR 9080 (100 years service life – long-term hydrostatic strength of pressure pipes made from bimodal PE-HD as determined by ISO/TR 9080). – In: Reprint from the journals Kunststoffe and Kunststoffe plast europe; Carl Hanser Verlag, Munich, 1997

[4] Brömstrup, H.: Rohrsysteme aus PE 100 (Pipe systems made from PE 100), Vulkan Verlag, Essen – 1998, page 34 et seq.

[5] de la Motte, P.W., Ohldrich, H.-J.: Sauberkeit wurde ihm zum Verhängnis (Cleaning finished it off for good). – In: bi UmweltBau No.1, Feb. 2004, Norddeutscher Wirtschaftsverlag GmbH, pages 44–48

Photo sources:

Figure 1: Modern machine technology ensures high quality - production of spirally wound pipes at Frank & Krah GmbH

Figure 2: Inspection-friendly light-colored interior surface - Profiled sewer pipes in storage

Figure 3: Large-diameter, profiled sewer pipes (PKS) in lenghts up to 12 m - profiled sewer pipes with light-colored interior surface produced by Frank & Krah GmbH

Figure 4: Easy handling cuts costs - General view of the Neckar underwater pipeline

Figure 5: Pipe floated into position after fast and efficient assembly - sinking the Neckar underwater pipeline

Figure 6: Strong, leak-proof pipe joint - welding together profiled sewerpipes produced by Frank & Krah GmbH

FRANK
Der Vorsprung.

basell
Polyolefins

CONTACTS

Joachim Heß
FRANK GmbH

Starkenburgstraße 1
D-64546 Mörfelden-Walldorf

Tel.: 0 61 05 / 9 26-0
Fax: 0 61 05 / 2 82-50

E-mail: info@frank-gmbh.de
www.frank-gmbh.de

Thomas Böhm
Basell Polyolefine GmbH

Industriepark Höchst, C 657
D-65926 Frankfurt am Main

Tel.: 0 69 / 3 05-2 65 14
Fax: 0 69 / 3 05-8 46 62

E-mail: thomas.boehm@basell.com
www.basell.com