

# Withstanding the pressure: liners for pressure sewers put to the test

Pressure sewer pipes like gravity sewers that are getting on in years need to be renovated. But, which methods are suitable? What are their strengths and weaknesses? The recent IKT comparative product test on pressure sewer liners provides answers.

Pressure sewer pipes are critical and sensitive elements



Experimental setup of pressure sewer pipes in the IKT large 1:1 scale test facility

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Consequently, the neutral, independent and not for profit IKT Institute for Underground Infrastructure, in Germany, has been examining rehabilitation solutions in an extensive comparative product test. Over a three-year period an evaluation project was undertaken on behalf of six municipal network operators from Bottrop, Bremen, Burscheid, Iserlohn, Cologne and Voerde and two regional water associations, the Emschergenossenschaft and the Wupperverband.

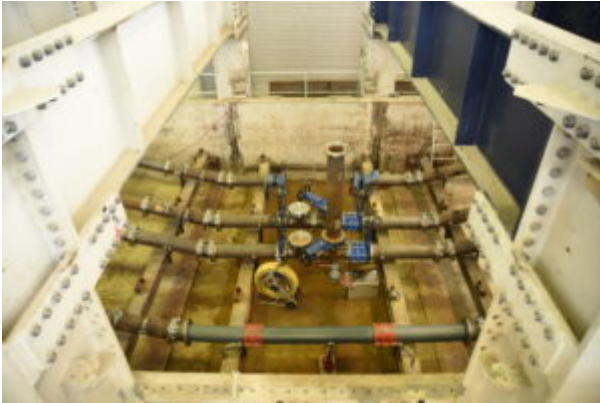
The project was supported by the district government of Münster and the State Office for Nature, Environment and Consumer Protection of North Rhine-Westphalia (LANUV). It was financed jointly by the NRW Ministry of the Environment and the eight network operators.

These organisations formed a steering group that determined the pressure sewer damage scenarios to be remedied, the testing programme and the evaluation of the results. IKT

developed the test concept, set up the test rigs in its large 1:1 scale test pit and carried out the testing.

## Six liners in the comparative product test

The steering committee selected the following lining technology



View of the built-in sewer pressure pipelines in the IKT large 1:1 scale test facility

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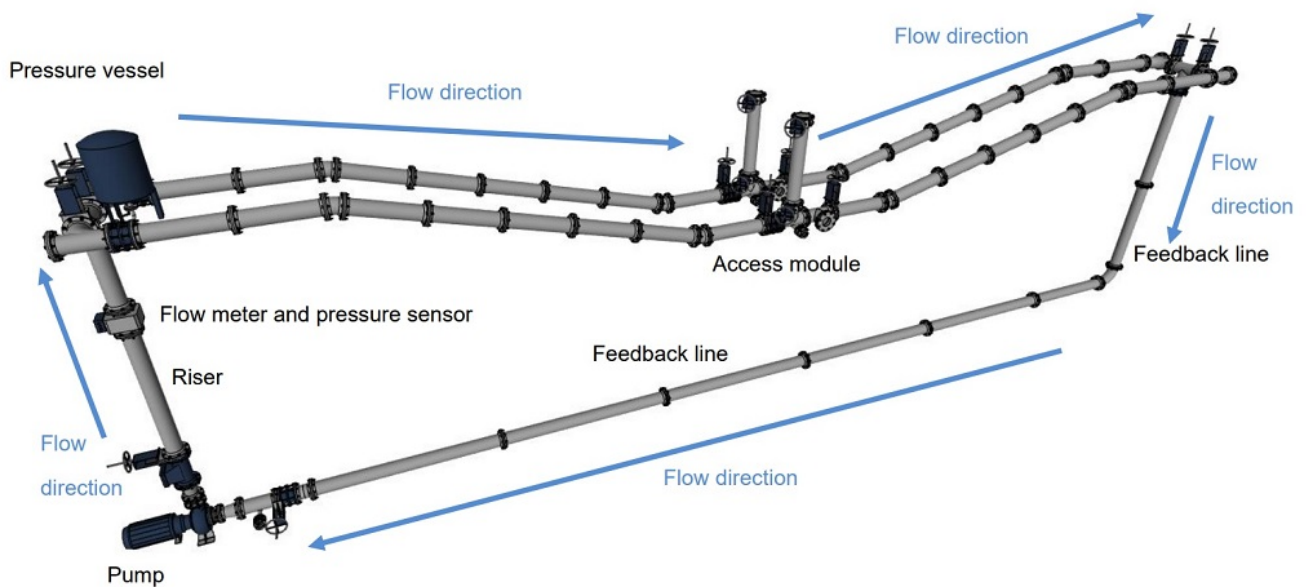
#### **Close-fit liner method:**

- Compact Pipe (Wavin GmbH)
- egeLiner (egeplast international GmbH)

#### **Cured in Place Pipe (CIPP) liner process:**

- Esders HPS Liner (Esders Pipeline Service GmbH)
- Nordiflow WPE (NordiTube Technologies SE)
- SaniPipe (AMEX Sanivar AG)
- Starliner Structure-S (Karl Weiss Technologies GmbH)

#### **Remediation task**



Schematic representation of the test setup in the IKT large 1:1 scale test facility

For each liner system, the test setup consisted of a DN200 steel pipe with damage patterns such as holes, leaky connections, point loads, transverse and longitudinal cracks, ovalisation and incrustations. This realistically depicted the damage that network operators find in their pipes.

## Class A liner systems

The central issue was whether the liners are suitable as Class A products. A Class A liner must be able to withstand internal and external stresses on its own, regardless of the condition of the host pipe. The stress testing programme conducted as part of the IKT comparative product test went well beyond the regular warranty period of five years in order to consider the entire useful life.

## Test program and evaluation scheme

The test programme consists of three phases:  
The first phase depicted the regu



Simulation of external water pressure: After flooding, part of the test setup is reflected in the water



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In the second phase, the degeneration of the host pipe was simulated over a prolonged period of time. For this purpose, some of the damage scenarios in the host old pipe were worsened in order to simulate progressive damage development and the resulting changes in external influences on the liner. Test pressures and flow rates remained the same as in

the first phase.

Finally, the third phase served to simulate additional, non-every day and extraordinary loads on the liner that may occur over the course of its useful life. These included high-pressure cleaning at 80 bar, abrasive substances, the rapid switching on and off of the pump or elevated groundwater levels, such as those that occur when pipes pass under rivers.

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Examination of the renovation results in the IKT large 1:1 scale test facility

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### **Watertightness criterion (weighting 45%)**

The main weak points found in the four CIPP liner processes were the end connections to the host pipe, there were leaks. In contrast, the PE flange and electrofusion sleeve connections of the close-fit liners were reliably watertight.

The close-fit systems Compact Pipe and egeLiner proved to be watertight after renovation. In contrast, the picture for the CIPP liner end connections was very different: Nordiflow and

SaniPipe each had to be reworked once to make them all watertight, whilst the Starline end connections had to be reworked twice in order to get them tight. The Esders HPS liner remained leaky even after the connections had been repaired twice and thus it failed on this criterion.

### **Stability criterion (weighting 25%)**

The stability



(lOptical inspection of rehabilitated sewage pressure lines in oathe IKT large 1:1 scale test facility

d-bearing in g capacity of the structure) was s

classified by the steering committee as a central “K0” (failure) criterion. It



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The SaniPipe liner failed this criterion as it collapsed under external pressure. The reason for this was insufficient fabrication of the liner, which took place without static proof. It was therefore not a Class A liner and consequently received the overall rating INADEQUATE, regardless of performance against all other criteria.

### **Operational performance criterion (weighting 15%)**

This examined to what extent the liners can withstand normal operating conditions such as pressure fluctuations, abrasion, static pressures and high-pressure cleaning.

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With high-pressure cleaning, the Compact Pipe and egeLiner close-fit products achieved a VERY GOOD rating. Nordiflow and Starline withstood this operational stress SATISFACTORILY. On the other hand, Esders and SaniPipe failed this criterion because holes and delaminations occurred. Chemical loads did not have a negative effect on any liner system.

### **Quality assurance criterion (weighting 15%)**

Although all the manufacturers provided an installation procedure manual, some of them have significant deficits in training, test certificates and external and internal monitoring. In addition, the installed Esders and SaniPipe liners each had a continuous longitudinal fold along the

length and SaniPipe had design defects, which led to a devaluation of the grade.

## Overall result and conclusion

The IKT comparative product test “Renovation process for sewage pressure pipes – Class A liner” confirmed that it is possible to achieve good renovation results. However, there are major differences in the performance of the six rehabilitation technologies examined, which are reflected in the test results awarded. One of the six liners could not qualify as a Class A liner.

IKT - Institute for Underground Infrastructure

Overall Results: IKT-Comparative Product Test (IKT – Warentest) “Rehabilitation methods for wastewater pressure pipes - Class A liner”.



### Task:

Rehabilitation of an approx. 22 m long steel pipeline DN 200 with the following damage scenarios:  
Leaking joints (4x), pitting (2x - with condition deterioration), single hole 48 mm (2x), shear load (with condition deterioration), longitudinal cracks (with condition deterioration), 15°, leaky bend (2x - with condition deterioration), abrasion in the invert, axially displaced socket joint, single hole 8/48 mm (2x - with condition deterioration), ovalisation by 6 %, double overlapping hole 2x 48 mm (optional), transverse cracks with angulation (optional), incrustation (optional), maximum rehabilitable bend (optional).



System	Compact Pipe		egeLiner	Nordiflow W PE	Starline Structure-S	Esders HPS Liner	SaniPipe
Manufacturer	Wavin GmbH		egeplast international GmbH	NordiTube Technologies SE	Karl Weiss Technologies GmbH	Esders Pipeline Service GmbH	Amex Sanivar AG
Renovation company undertaking installation	Dringer & Scheidel Rohr-sanierung GmbH & Co. KG		Esders Pipeline Service GmbH	Esders Pipeline Service GmbH	Karl Weiss Technologies GmbH	Esders Pipeline Service GmbH	Amex Sanivar AG
IKT - Test Rating*	GOOD 1.8		GOOD 1.8	SATISFACTORY 2.6	SATISFACTORY 2.6	DEFICIENT 5.3	INADEQUATE 6.0 <sup>1</sup>
Statically independent class A liner? (knock-out criterion)	yes	yes	yes	yes	yes	yes	no
Watertightness <sup>2</sup> Devaluation due to rework after installation	45%	1.0 none	1.0 none	2.0 Tight only after 1x rework <sup>3</sup> (-1.0)	3.0 tight only after 2x rework <sup>3</sup> (-2.0)	6.0 Leaky even after 2x rework <sup>3</sup>	3.4 tight only after 1x rework <sup>3</sup> (-1.0)
Exfiltration watertightness	80%	1.0	1.0	1.0	1.0	5.0	2.8
Infiltration watertightness	20%	1.0	1.0	1.0	1.0	1.0	1.0
Stability	25%	3.0	3.0	3.2	2.0	5.4	6.0
Load bearing capacity of the structure	50%	2.0 Deformations in the bend	2.0 Deformations in the bend	4.0 Wrinkles in the bend, holes, air pockets	2.0 Wrinkles in the bend	5.0 Continuous longitudinal fold, wrinkles in the bend, holes, risk of failure	6.0 Continuous longitudinal fold, wrinkles in the bend, holes, risk of failure, system collapse
Static proof	30%	4.5	4.0	2.5	2.0	5.5	6.0
Material and geometry target/actual comparison	20%	3.0 2 Deviations	4.0 3 Deviations	2.0 1 Deviation	2.0 1 Deviations	6.0 6 Deviations	6.0 6 Deviations
Operational performance	15%	2.3	2.4	3.3	2.7	4.1	4.5
Overall visual impression after refurbishment, HP cleaning and end of testing	25%	1.0	1.0	3.4	2.7	5.0	4.7
Hydraulic performance loss after renovation in percent <sup>4</sup>	25%	3.0 - 0%	3.0 - 0%	4.0 - 0%	2.0 - 3%	3.0 - 5%	4.0 - 8%
Wrinkling / Obstacles	25%	1.0 none	1.0 none	3.0 > 6 mm in bend	3.0 > 6 mm in bend	5.0 > 6 mm in liner section & bend	5.0 > 6 mm in liner section & bend
Cross-section reduction of the host pipe DN 200: max. ball passage line / bend / connection	25%	4.3 160 / 155 / 160 mm	4.5 160 / 155 / 155 mm	3.0 180 / 170 / 155 mm	3.0 180 / 160 / 160 mm	3.3 170 / 170 / 160 mm	4.3 160 / 160 / 155 mm
Quality assurance Procedures manual, training, test certificate, monitoring, special anomalies	15%	1.5	1.5	2.5	2.5	4.5 Continuous longitudinal fold	5.5 Continuous longitudinal fold and execution defects
Additional information							
Not part of the grade							
Robustness: shard load, metal tip (double overlapping hole), incrustation, angular deflection, maximum bend							
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Wall structure	PE pipe SDR17 PN10 PE100		PE pipe SDR17 PN10 PE100-RC	Preliner + GRP-reinforced needle felt + inner foil	Preliner + laminate with glass fibres + fabric sleeve + inner foil	Outer foil + laminate with needle felt + fabric hose + inner foil	Outer film + felt fabric and polyester fibres with resin casting + inner film
Wall thickness	approx. 13.4 mm		approx. 13.5 mm	approx. 4.9 mm	approx. 6.3 mm	approx. 7.3 mm	approx. 7.7 mm
Installation procedure	Close-fit insertion method		Close-fit insertion method	Inversion method with preliner	Inversion method with preliner	Insertion/Inversion Process	Insertion/Inversion Process
Curing method and time	Steam (120 °C), approx. 2 h		Steam (130 °C), approx. 1.5 h	Steam (80 °C), approx. 3.5 h	Hot water (40 °C), approx. 19 h	Steam (100 °C), approx. 1.5 h	Steam (80 °C), approx. 22 h
Connection type	PE flange / electrofusion socket		PE flange / electrofusion socket	Amex liner end cuff	Kempe liner end sleeve	Amex liner end cuff	Amex liner end cuff
Total working time / days on site	14.5 h / 2 days		15.5 h / 3 days	15.5 h / 3 days	11.5 h / 2 days	11 h / 2 days	14.5 h / 4 days

<sup>1</sup> Due to system collapse, the IKT test rating of “INADEQUATE 6.0” was awarded by the Steering Committee independently of the other sub-ratings.

<sup>2</sup> For the difference in the evaluation of exfiltration and infiltration watertightness, see chapter 4.2, page 31.

<sup>3</sup> Rework on liner end seals

<sup>4</sup> Does not serve as a dimensioning reference.

\*Note calculation based on unrounded values Evaluation key of the test results: Very good = 1.0 - 1.5, Good = 1.6 - 2.5, Satisfactory = 2.6 - 3.5, Sufficient = 3.6 - 4.5, Deficient = 4.6 - 5.5, Inadequate = 5.6 - 6.0

Table of results IKT comparative product test “Renovation of sewage pressure pipes”

## Passed:

- Compact Pipe (Wavin) GOOD (1.8)
- egeLiner (egeplast international) GOOD (1.8)
- Nordiflow W PE (NordiTube Technologies) SATISFACTORY

(2.6)

- Starline Structure-S (Karl Weiss Technologies) SATISFACTORY (2.6)

### Failed:

- Esders HPS Liner (Esders Pipeline Service) DEFICIENT (5.3)
- SaniPipe (Amex Sanivar) INADEQUATE (6.0)

Results at a glance and complete report (English)

The further deterioration of the condition of the host pipe over time was found to have no effect on the success of the rehabilitation. This applied in particular to signs of corrosion such as simulated pitting and point loads. Only in one case did the complete loss of the supporting host pipe lead to liner failure under external water pressure.

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30° bend in a pressure sewer pipeline

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The systems were able to withstand normal operating conditions such as pressure fluctuations, abrasion and static pressure without any problems. However, there are clear limits to high-pressure cleaning and holes and delamination can occur here. Chemical stresses did not affect the tightness of the liner.

All liner systems lead to hydraulic performance losses in the pressure sewer the highest up to 8% at the top. The internal diameter was reduced by more than 20% in some places in some liners. Wrinkles >6 mm could be seen on all the CIPP

liners. In contrast, the close-fit liners showed no creasing whatsoever, but there was clear ovalisation in the bends.