

IKT-LinerReport 2009



No leaks thanks to the inner foil:

The liner wall thickness is measured with precise callipers

Quantum leap in waterproofing

Pipe liners now average low fault rates. In particular in the area of impermeability, significant improvements have been achieved. Inner foils can make an important contribution.

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This sixth LinerReport of the IKT – Institut für Unterirdische Infrastruktur (Institute for Underground Infrastructure) is based on some 1,200 pipe liner samples that were taken at construction sites in 2009. They have inspected in the IKT testing laboratory for pipe liners. The individual results are summarised here in an overall overview.

Data basis

The results are shown of those rehabilitation companies from which the IKT has inspected at least 25 liner samples from five different construction sites. 15 companies fulfilled this criterion.

In 89% of the cases, the builders (or their engineering offices) contracted the IKT directly to perform the laboratory testing of liner samples, which were taken on site. Only 11% of the orders came from the rehabilitation companies themselves (see Tab. 1). The clients thus trusted foremost in the neutral and independent testing of the IKT.

Target/actual analysis

The properties modulus of elasticity, flexural strength, wall thickness and water impermeability of the pipe liner samples from the construction sites were tested. The actual values were compared with the target values from

the DIBt certifications or, in some cases, other specifications from the client. The target values for wall thicknesses are determined by the stress analysis or by the client.

For testing of water impermeability for needed felt liners, two different procedures are used: with or without cutting into the inner foil. The latter is selected for liners in whose DIBt certification the inner foil is defined as an integral and effective sealing element. This applied for the first time for a manufacturer at the end of 2008. For all other needed felt liners, the inner foil is cut into as before. GFRP liners are in general tested without an incision, as they do not have an inner foil that remains in the sewer.

Tab. 1: Rehabilitation companies and liner systems					
Rehabilitation companies	Liner systems	Liner type	Number of samples	IKT contracted by	
				Rehabilitation company %	Builder %
ARKIL INPIPE GmbH	Berolina liner	GFRP	136	20	80
Diringer & Scheidel Rohrsanierung GmbH	RS CityLiner	NF	25*	0	100
Diringer & Scheidel Rohrsanierung GmbH	Saertex-liner	GFRP	110	0	100
Erles Umweltservice GmbH	Impreg-liner	GFRP	49	33	67
Insituform Rohrsanierungstechniken GmbH	Insituform pipe liner	NF	113	0	100
Jeschke Umwelttechnik GmbH	Brandenburger pipe liner	GFRP	100	0	100
Kanaltechnik Geiger & Kunz GmbH & Co. KG	Berolina liner	GFRP	40	0	100
Karl Weiss GmbH & Co. KG	Brandenburger pipe liner	GFRP	32	0	100
Kleen + Huneke Umwelt & Kanaltechnik GmbH	Saertex-liner	GFRP	26	0	100
KS-Kanalsanierung GmbH	Brandenburger pipe liner	GFRP	51	4	96
Linertec GmbH	Euroliner	GFRP	50	46	54
Rainer Kiel Kanalsanierung GmbH	Saertex-liner	GFRP	38	29	71
Swietelsky-Faber GmbH Kanalsanierung	Berolina liner	GFRP	147	43	57
TKT Troisdorfer Kanalsanierungstechnik GbR	Brandenburger pipe liner	GFRP	96	0	100
U&W Umwelttechnik u. Wasserbau GmbH	Brandenburger pipe liner	GFRP	119	0	100
van der Velden Rioleringsbeheer B.V. (Netherlands)	Brandenburger pipe liner	GFRP	36	0	100
Total			1,168	11	89
GFRP: Glass fibre base material NF: Needled felt base material * from four construction sites					

An overview of the testing criteria

Modulus of elasticity (short-term bending modulus)

- Pipe liners must be withstand loads such as ground water, street traffic and ground pressure
- Modulus of elasticity is a property for load capacity
- if it is too low, the structural integrity may be compromised
- Testing methods: Three-point bending test according to DIN EN ISO 178 and DIN EN 13566-4

→ Results: see Tab. 2

Wall thickness (mean composite thickness)

- The minimum value is determined in the stress analysis
- Wall thickness and modulus of elasticity together determine the stiffness of the liner
- Insufficient wall thickness can compromise structural integrity
- Testing methods: with precision callipers, the average composite thickness is measured according to DIN EN 13566-4

→ Results: see Tab. 4

Flexural strength (bending stress at failure = short-term σ_{fb})

- Indicates the point at which the liner fails due to stress
- If the flexural strength is too low, the liner can break before the permissible deformation has been achieved
- Testing methods: Load increase in the three-point bending test until failure; according to DIN EN ISO 178 and DIN EN 13566-4 (short-term flexural strength)

→ Results: see Tab. 3

Water impermeability

- Cut into inner foil as long as it is not an integral part of the liner; remove outer foil if there is one
- Apply red coloured water to the inside
- Apply 0.5 bar of underpressure
- Liner is leaky if water penetrates
- Duration of the test: 30 min

→ Results: see Tab. 5

Tab. 2: Test results, modulus of elasticity short-term bending modulus

Rehabilitation companies	2009		2008	Tendency
	Number of samples	Target value* achieved in % of the tests	Target value* achieved in % of the tests	
Erles Umweltservice GmbH	49	100.0 (100.0)	97.0	↑
Jeschke Umwelttechnik GmbH	100	100.0 (100.0)	100.0	↔
Kanaltechnik Geiger & Kunz GmbH & Co. KG	40	100.0 (100.0)	–	–
Karl Weiss GmbH & Co. KG	32	100.0 (100.0)	100.0	↔
KS-Kanalsanierung GmbH	51	100.0 (100.0)	100.0	↔
Linertec GmbH	49	100.0 (**)	100.0	↔
Swietelsky-Faber GmbH Kanalsanierung	147	100.0 (100.0)	100.0	↔
U&W Umwelttechnik u. Wasserbau GmbH	119	100.0 (100.0)	98.1	↑
van der Velden Rioleringsbeheer B.V. (Netherlands)	36	100.0 (100.0)	100.0	↔
Diringer & Scheidel Rohrsanierung GmbH with Saertex-Liner	110	98.2 (98.2)	98.8	↓
TKT Troisdorfer Kanalsanierungstechnik GbR	95	97.9 (97.9)	100.0	↓
Rainer Kiel Kanalsanierung GmbH	38	97.4 (97.4)	96.0	↑***
ARKIL INPIPE GmbH	136	97.1 (97.1)	98.3	↓
Mean value		96.4	96.8	↓
Kleen + Huneke Umwelt & Kanaltechnik GmbH	26	96.2 (96.2)	97.1	↓
Insituform Rohrsanierungstechniken GmbH with Insituform-Schlauchliner (NF)	113	80.5 (80.5)	86.3	↓
Diringer & Scheidel Rohrsanierung GmbH with RS CityLiner	25	60.0 (60.0)	–	–

* Target value according to client specifications (static or test data sheet) () Result for comparison with DIBt target value
** No DIBt certification – Not evaluated: not enough liner samples
*** Other liner system used in 2009 than in 2008

Tab. 3: Test results, flexural strength Short-term σ_{fb}

Rehabilitation companies	2009		2008	Tendency
	Number of samples	Target value* achieved in % of the tests	Target value* achieved in % of the tests	
Diringer & Scheidel Rohrsanierung GmbH with Saertex-Liner	110	100.0 (100.0)	98.2	↑
Jeschke Umwelttechnik GmbH	100	100.0 (100.0)	100.0	↔
Karl Weiss GmbH & Co. KG	32	100.0 (100.0)	94.2	↑
Kleen + Huneke Umwelt & Kanaltechnik GmbH	26	100.0 (100.0)	97.1	↑
Linertec GmbH	49	100.0 (**)	100.0	↔
Swietelsky-Faber GmbH Kanalsanierung	147	100.0 (100.0)	96.0	↑
U&W Umwelttechnik u. Wasserbau GmbH	119	100.0 (100.0)	98.1	↑
van der Velden Rioleringsbeheer B.V. (Netherlands)	36	100.0 (100.0)	100.0	↔
Erles Umweltservice GmbH	49	98.0 (98.0)	100.0	↓
Mean value		96.3	92.9	↑
KS-Kanalsanierung GmbH	51	96.1 (96.1)	90.9	↑
Diringer & Scheidel Rohrsanierung GmbH with RS CityLiner	25	96.0 (96.0)	–	–
TKT Troisdorfer Kanalsanierungstechnik GbR	95	95.8 (97.9)	100.0	↓
Kanaltechnik Geiger & Kunz GmbH & Co. KG	40	95.0 (95.0)	–	–
Rainer Kiel Kanalsanierung GmbH	38	94.7 (100.0)	96.0	↓***
ARKIL INPIPE GmbH	136	94.1 (94.1)	98.3	↓
Insituform Rohrsanierungstechniken GmbH with Insituform-Schlauchliner (NF)	113	79.6 (81.4)	72.5	↑

* Target value according to client specifications (static or test data sheet) () Result for comparison with DIBt target value
** No DIBt certification – Not evaluated: not enough liner samples
*** Other liner system used in 2009 than in 2008

Tab. 4: Test results, wall thickness average composite thickness according to DIN EN 13566-4

Rehabilitation companies	2009		2008	Tendency
	Number of samples	Target value* achieved in % of the tests	Target value* achieved in % of the tests	
Jeschke Umwelttechnik GmbH	100	100.0	100.0	↔
Kleen + Huneke Umwelt & Kanaltechnik GmbH	26	100.0	100.0	↔
Linertec GmbH	49	100.0	100.0	↔
Insituform Rohr-sanierungstechniken GmbH with Insituform-Schlauchliner (NF)	90	98.9	99.6	↓
ARKIL INPIPE GmbH	116	97.4	96.4	↑
Diringer & Scheidel Rohr-sanierung GmbH with RS CityLiner	25	96.0	–	–
U&W Umwelttechnik u. Wasserbau GmbH	119	94.1	72.3	↑
Mean value		91.9	92.1	↓
Erles Umweltservice GmbH	49	91.8	54.5	↑
van der Velden Rioleringsbeheer B.V. (Netherlands)	35	91.4	97.9	↓
TKT Troisdorfer Kanalsanierungstechnik GbR	86	90.7	95.7	↓
KS-Kanalsanierung GmbH	46	89.1	81.8	↑
Swietelsky-Faber GmbH Kanalsanierung	137	89.1	94.8	↓
Diringer & Scheidel Rohr-sanierung GmbH with Saertex-Liner	105	87.6	96.0	↓
Rainer Kiel Kanalsanierung GmbH	38	86.8	92.0	↓**
Karl Weiss GmbH & Co. KG	32	68.8	83.3	↓
Kanaltechnik Geiger & Kunz GmbH & Co. KG	40	67.5	–	–

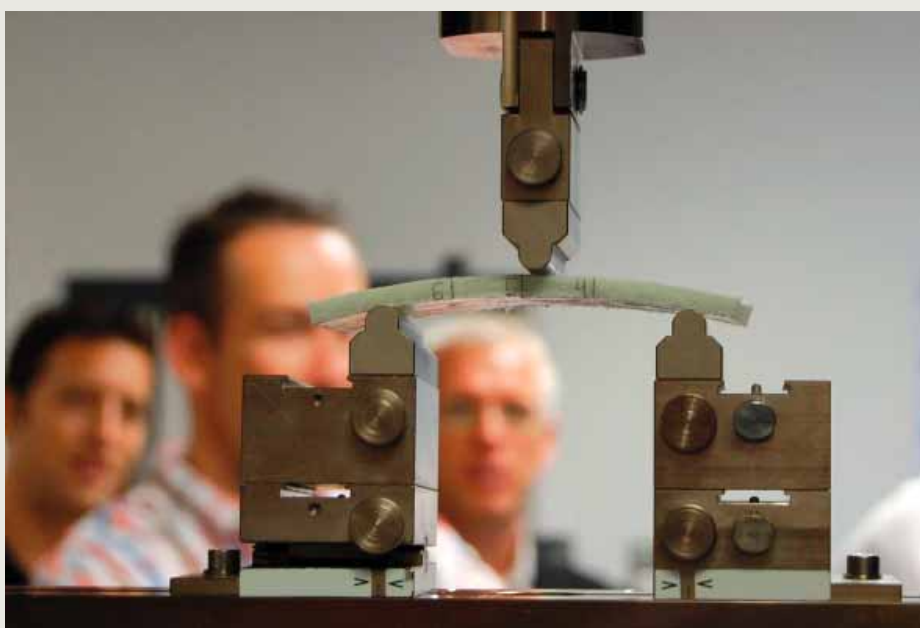
* Target value according to client specifications (static or test data sheet)
 ** Other liner system used in 2009 than in 2008
 – Not evaluated: not enough liner samples

Comparison with previous year

For the testing criterion modulus of elasticity in the year 2009 excellent results can be reported:

on average, 96.4% of the samples fulfilled the target values. The great majority of the rehabilitation companies were above the average, only three were below. The average in 2009

is barely below the value of the previous year (-0.4 percentage points, %P). While GFRP liners maintained their quality, the average for needed felt liners was -12.4 %P lower than 2008.



Pipe liner test in IKT

For the flexural strength, the average of the successfully passed tests improved significantly by +3.4 %P with respect to 2008. Most rehabilitation companies maintained their good results from the previous year and some were able to improve significantly (up to 7.1 %P). Only four companies did not achieve equivalent or improved results over the previous year. Both needed felt liners (3.8 %P) and GFRP liners (1.2 %P) improved.

Although the GFRP liners improved by +1.1 %P with respect to 2008 in terms of wall thickness, in 2009 their performance was again significantly worse than the needed felt liners. The latter was on average slightly worse, -0.4 %P, but nonetheless significantly better, +7 %P, than GFRP liners (needed felt: 98.3% vs. GFRP: 91.2%). With respect to the previous year, the level across all liners remained practically constant (-0.2 %P).

Tab. 5: Test results of water impermeability

Rehabilitation companies	2009		2008	Tendency
	Number of samples	waterproof in % of the tests	waterproof in % of the tests	
Jeschke Umwelttechnik GmbH	100	100.0	100.0	↔
Kanaltechnik Geiger & Kunz GmbH % Co. KG	38	100.0	–	–
Kleen + Huneke GmbH	26	100.0	100.0	↔
Rainer Kiel Kanalsanierung GmbH	38	100.0	50.0	↑**
van der Velden Rioleringsbeheer B.V. (Netherlands)	36	100.0	100.0	↔
KS-Kanalsanierung GmbH	50	98.0	97.1	↑
Linertec GmbH	50	98.0	100.0	↓
Erles Umweltservice GmbH	49	98.0	100.0	↓
Swietelsky-Faber GmbH Kanalsanierung	147	98.0	100.0	↓
Insituform Rohrsanierungstechniken GmbH with Insituform-Schlauchliner (NF) with integrated inner foil (no incision during testing)	91	97.8	68.7	↑
U&W Umwelttechnik u. Wasserbau GmbH	113	97.3	100.0	↓
Karl Weiss GmbH & Co. KG	32	96.9	96.2	↑
Mean value		96.8	92.6	↑
TKT Troisdorfer Kanalsanierungstechnik GbR	96	95.8	95.7	↑
ARKIL INPIPE GmbH	136	94.9	100.0	↓
Diringer & Scheidel Rohrsanierung GmbH with Saertex-Liner	109	93.6	100.0	↓
Diringer & Scheidel Rohrsanierung GmbH with RS CityLiner	25	76.0	–	–
Insituform Rohrsanierungstechniken GmbH with Insituform-Schlauchliner (NF) with incision of the integrated inner foil*	22	45.5	68.7	↓

* At the request of the client

** Other liner system used 2009 than in 2008

– Not evaluated: not enough liner samples



Leakage test: Red coloured water is applied to the inner side of the liner





Leakage test: impermeable liner



Leakage test: leaky liner

Tab. 6: Test results by liner type

Liner system	Water impermeability		Young modulus		Flexural strength			Wall thickness	
	Number of samples	waterproof in % of the tests	Number of samples	Target value* achieved in % of the tests	Number of samples	Target value* achieved in % of the tests	Number of samples	Target value* achieved in % of the tests	
Euroliner	50	98.0	49	100.0	49	100.0	49	100.0	
Impreg-liner	49	98.0	49	100.0	49	98.0	49	91.8	
Brandenburger pipe liner	427	97.9	433	99.5	433	98.6	418	92.1	
Insituform pipe liner**	91	97.8	113	80.5	113	79.6	90	98.9	
Berolina liner	321	96.9	323	98.8	323	96.9	293	89.4	
Saertex-liner	173	96.0	174	97.7	174	98.8	169	89.3	
RS CityLiner	25	76.0	25	60.0	25	96.0	25	96.0	
Mean value		96.8		96.4		96.3		91.9	

 Above the average
 Below the average

* Target value according to client specifications (static or test data sheet)

** with integrated inner foil (no incision during testing)

Water impermeability significantly improved

The criterion water impermeability was in total +4.2 %P better in 2009 than in 2008. Here the difference between GFRP and needled felt is particularly interesting, as GFRP liners were on average -1.0 %P worse, while needled felt liners showed a particularly strong improvement of +21.5 %P. Needled felt liners (93.1 % passed) thus came much closer to the previously clearly superior GFRP results (97.3 %).

Inner foil meaningful

Notable is that the needled felt liners of the company Insituform improved by +30 %P with respect to 2008. Here the modified DIBt certification from September 2008 has an effect,

where the inner foil is an integral, sealing component of the liner and thus may no longer be cut into as a part of the test. This foil is typically less than 1.0 mm thick. The degree to which the laminate below is impermeable, which is significantly stronger and ensures the load capacity of the entire liner, cannot be determined without cutting into the foil. In the past, the laminate had proved to be leaky in some cases. For instance, also the needled felt liner Cityliner, with a success rate of 76%, showed significant weakness with respect to the impermeability of the laminate.

Conclusion

The IKT LinerReport 2009 is based on almost 1,200 liner samples from construction sites. The test results are overwhelmingly good and

demonstrate that in the pipe liner market, good product and services are offered. For the test criteria modulus of elasticity, flexural strength and water impermeability, for all liners, the failure rate was only roughly 3%. Only for wall thickness were higher failure rates recorded (8%). One particular result is notable for the testing of water impermeability. Here the new definition of the inner foil of a needled felt liner as a durable, seal-effective component had a very positive effect on the overall results.

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Tab. 7: Test results compared with the previous year

Liner type	waterproof in % of the tests			Young modulus Target value* achieved in % of the tests			Flexural strength Target value* achieved in % of the tests			Wall thickness Target value* achieved in % of the tests		
	2009	2008	+/-	2009	2008	+/-	2009	2008	+/-	2009	2008	+/-
Mean values - all samples	96.8	92.6	+4.2 ↑	96.4	96.8	-0.4 ↓	96.3	92.9	+3.4 ↑	91.9	92.1	-0.2 ↓
- GFRP	97.3	98.3	-1.0 ↓	99.0	99.0	±0.0 ↔	98.2	97.0	+1.2 ↑	91.2	90.1	+1.1 ↑
- NF	93.1	71.6	+21.5 ↑	76.8	89.2	-12.4 ↓	82.6	78.8	+3.8 ↑	98.3	98.7	-0.4 ↓

GFRP: Glass fibre base material
 NF: Needled felt base material

* Target value according to client specifications (static or test data sheet)