2019 IKT LinerReport

Figure 1: Three-point bending test: mechanical testing of modulus of elasticity and flexural strength

Seven Percent of Sewer Liner Samples do not Pass all Tests

In 2019, 93% of the sewer liner samples submitted for inclusion in the LinerReport achieved all the required material characteristics. But, seven percent of samples failed at least one of the four tests. So there remains a residual risk.

by Roland W. Waniek, Dieter Homann and Barbara Grunewald

This is the 16th Edition of IKT - Institute for Underground Infrastructure's annual LinerReport. It summarises the test results from a total of 2,353 sewer pipe liner samples examined by the institute during 2019. The IKT LinerReport has an international scope, with rehabilitation companies from seven countries participating.

The samples submitted are evaluated against four short term tests (see Infobox). Pass/fail for each individual sample is determined by comparing the test result with the expected value for the installed liner, which is either the manufacturer's declared value for the product or the value required by the client's specification.

Database for the 2019 IKT LinerReport

- Number of liner samples: 2,353
- of which: 2,072 were GRP liners and 281 needle felt liners
- Number of sewer liner systems included: 7
- Number of sewer rehabilitation companies: 23
- Minimum quantity of samples required: 25 liner samples of one type from five different construction sites per rehabilitation company
- Sample suppliers: 69% sewer network owners and 31% sewer rehabilitation companies
- Countries of origin: Belgium, Czech Republic, France, Germany, Great Britain, The Netherlands and Switzerland

2019 test results

In 2019, most of the sewer liner samples test results remained at a very high level, compared with recent years, if the four test criteria are considered individually (see Table 1). For the modulus of elasticity and flexural strength tests, average pass rates improved slightly compared to the previous year: by +0.4 percentage points (pp) to 97.9% and by 0.8 pp to 98.2% respectively. The average value for water tightness is almost at the same level as in 2018: dropping slightly by -0.3 pp to 98.6%. Whilst, for wall thickness the results improved by 3.4 pp (see Table 3).

Liners that passed all four test criteria

However, if it is assumed to be self-evident that a professionally installed sewer liner must meet its target values for all four test criteria (see also info box), a poorer picture of sewer liner quality emerges.

It is apparent that in 2019 only 93% of the samples, tested against all four criteria, passed all four test criteria at the same time. Some 7% of the installed sewer liners did not do this and thus do not meet all requirements

Infobox: Overview of testing criteria

Sewer liner samples are taken at installation sites and examined in the laboratory under the following four test criteria. The values determined from the tests are compared with the target values of the technical approvals for the product or the client's specifications. A test is passed when the target value is achieved.

Modulus of elasticity
(short-term flexural modulus)

- CIPP liners must be capable of bearing loads such as groundwater, road traffic, and soil pressure
- The modulus of elasticity is an indicator of load-bearing capability
- Stability may be endangered if the modulus of elasticity is too low
- Test method: three-point bending test in accordance with DIN EN ISO 178 and DIN EN ISO 11296-4

> Results: see Table 1

Wall thickness
(average composite thickness)

- Excessively low wall thickness can endanger stability
- Minimum values are specified in structural analysis calculation
- Wall thickness and modulus of elasticity jointly determine the stiffness of the liner
- Test method: with precision a caliper average composite thickness is measured in accordance with DIN EN ISO 11296-4

- > Results: see Table 1

Flexural strength
(Flexural stress at first break = short-termσ_{fb})

- This denotes the point at which the liner fails due to excessive high stress
- The liner may rupture before the permissible deformation is reached if flexural strength is too low
- Test method: Increase of load up to failure in the three-point bending in accordance with DIN EN ISO 178 and DIN EN ISO 11296-4

- > Results: see Table 1

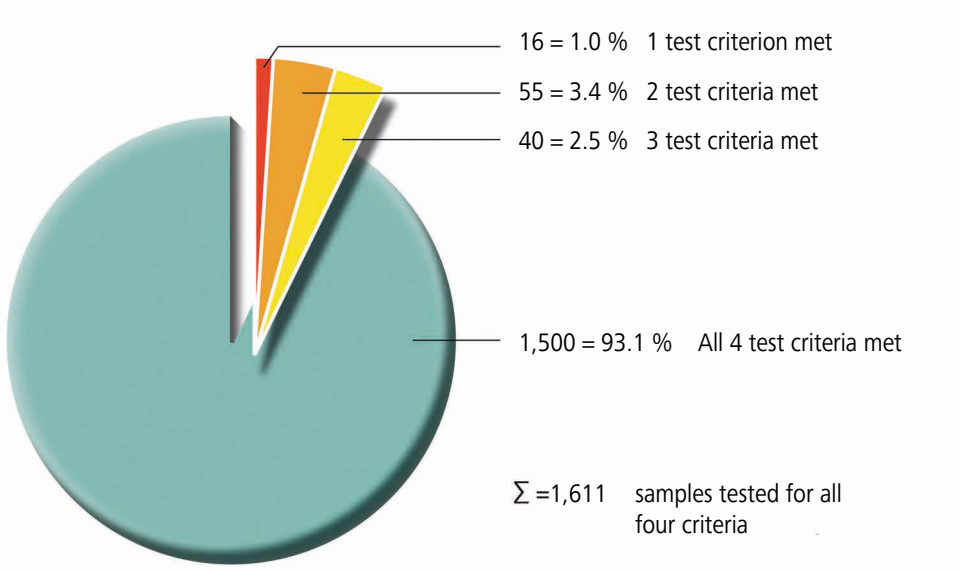
Water tightness

- The inner liner is cut if it is not an integral component of the liner
- Any outer film is removed if it is not an integral component of the liner
- Water containing a red dye is applied to the inner surface
- A 0.5 bar partial pressure is applied to the external surface
- The liner is "not tight" if water penetrated through
- Test duration: 30 min

- > Results: see Table 1

A detailed description of these tests can be found on the IKT website:
www.ikt.institute/cipp-liner/

Diagram 1: Percentage of individual liner samples that passed 1, 2, 3 or all 4 tests



and specifications. In other words, one in fourteen liners does not meet all test criteria and fails at least one criterion.

Diagram 1 shows that of the 1,611 samples (two thirds of all samples) for which all four nominal values are available:

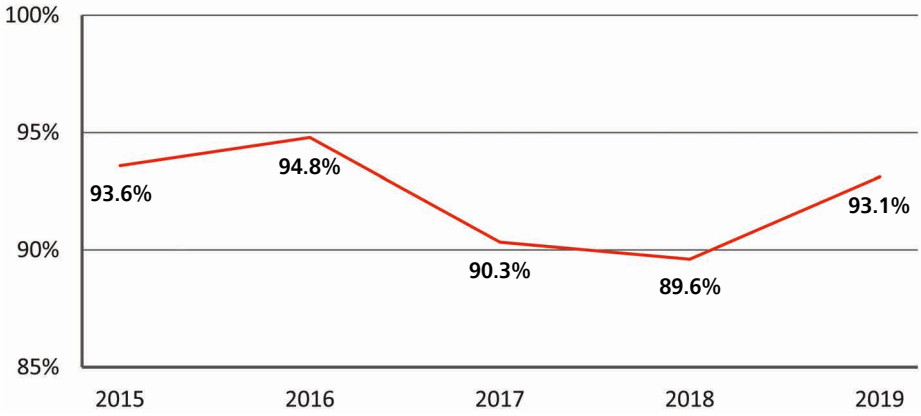
- 93.1% pass all four test criteria,
- 2.5% pass only three test criteria,
- 3.4% pass only two test criteria, and
- 1.0% pass only one test criterion.

For one third of the samples (742) the target value for at least one test criterion was not provided, or part of the testing programme was not commissioned.

Positive picture put into perspective

This puts into perspective the very positive picture apparent at first glance in Table 1, since seven percent of the liners do not achieve the required material characteristics across all four test criteria. In the previous two years, the situation was weaker: then only 90% passed all tests and so one in ten liners did not meet all the requirements (see Diagram 2).

Diagram 2: Graph showing % of samples that individually passed all four test criteria 2015 to 2019



This is a not inconsiderable rate for a rehabilitation procedure that claims to be the standard procedure for the rehabilitation of sewage pipes.

Figure 2: Wall thickness measurement: requires particularly high precision

Table 1: Test results of the 2019 IKT LinerReport

		Water tightness		E-Modulus		Flexural strength		Wall thickness	
Rehabilitation Company	Liner system	No. of samples	watertight in % of tests	No. of samples	Target value met* in % of tests	No. of samples	Target value met* in % of tests	No. of samples	Target value met* in % of tests
Hamers Leidingtechniek B.V. (NL)	Alphaliner	76	100	76	100	76	100	76	100
Jeschke Umwelttechnik GmbH	Alphaliner	175		175		175		163	
Kanaltechnik Agricola GmbH	Brandenburger Liner	37		37		37		37	
Aarsleff Rohrsanierung GmbH	iMPREG-Liner	72	94.4	72	98.6	72	95.8	68	88.2
Aarsleff Rohrsanierung GmbH	PAA-G-LINER	94	98.9	94	98.9	94	97.9	89	100
Aarsleff Rohrsanierung GmbH	PAA SF Liner	175** 67	99.4 100	241	100	241	98.8	175	100
Arkil Inpipe GmbH	iMPREG-Liner	26***	80.8	26	100	26	96.2	20	90.0
Axeo TP (F)	Alphaliner	30***	100	30	86.7	30	100	30	100
Diringer & Scheidel Rohrsanierung GmbH & Co. KG	SAERTEX-Liner	50***	100	49	89.8	49	95.5	47	93.6
Geiger Kanaltechnik GmbH & Co.KG	Brandenburger Liner	38***	100	38	97.4	38	97.4	37	91.9
GMB Rioleringstechnieken B.V. (NL)	SAERTEX-Liner	232	99.6	231	97.4	231	97.4	231	99.1
Insituform Rioolrenovatietechnieken B.V. (NL)	Insituform Schlauchliner (NL)	36**	100	39	84.6	39	89.7	39	100
ISS Kanal Services AG (CH)	Alphaliner	59	96.6	59	100	59	100	59	98.3
Kann. d.i.s. Kanaltechnologie GmbH	SAERTEX-Liner	44	100	44	100	44	97.7	14	100
KATEC Kanaltechnik Müller und Wahl GmbH	Alphaliner	30	96.7	30	96.7	30	96.7	11	100
KTF GmbH	iMPREG-Liner	16	100	58	96.6	58	98.3	58	100
M.J. Oomen Leidingtechniek B.V. (NL)	SAERTEX-Liner	31	100	41	100	41	100	41	95.1
OnSite Central Ltd (UK)	iMPREG-Liner	27	100	24	95.8	24	87.5	19	68.4
Rainer Kiel Kanalsanierung GmbH	SAERTEX-Liner	71	98.6	71	100	71	100	50	100
Renotec N.V. (B)	Alphaliner	-	-	42	95.2	42	92.9	42	97.6
Renotec N.V. (B)	SAERTEX-Liner	19	100	132	96.2	132	98.5	129	100
Rohrsanierung Jensen GmbH & Co. KG	Alphaliner	37***	94.6	37	100	37	100	37	97.3
Swietelsky-Faber Kanalsanierung GmbH	Brandenburger Liner	145	100	159	93.1	159	96.2	121	93.4
Swietelsky-Faber Kanalsanierung GmbH	iMPREG-Liner	36	86.1	36	97.2	36	97.2	33	97.0
Swietelsky-Faber Kanalsanierung GmbH	SAERTEX-Liner	90	98.9	90	100	90	100	48	97.9
TKT GmbH & Co. KG	Alphaliner	144	99.3	144	100	144	100	-	-
TRASKO BVT, s.r.o. (CZ)	Alphaliner	50	96.0	50	96.0	50	98.0	50	90.0
Umwelttechnik und Wasserbau GmbH	Alphaliner	161	100	162	99.4	162	99.4	99	99.0
Umwelttechnik und Wasserbau GmbH	Brandenburger Liner	55	98.2	55	100	55	100	-	-
Mean value			**98.6**		**97.9**		**98.2**		**97.5**

* Target values determined according to a product approval (DIBt approval, KOMO certificate, QUIK guideline) or customer requirement (static calculation or as stated on sample submission form)
** without cutting the integrated foil
*** from 4 construction sites
- not evaluated, because too few liner samples with nominal value specifications

Table 2: Test results in 2019 according to liner system

Liner system	Carrier material	Water tightness		E-Modulus		Flexural strength		Wall thickness	
		No. of samples	watertight in % of tests	No. of samples	Target value met* in % of tests	No. of samples	Target value met* in % of tests	No. of samples	Target value met* in % of tests
PAA SF Liner	NF	175** 67	99.4 100	241	100	241	98.8	175	100
SAERTEX-Liner	GRP	487	99.4	609	98.2	609	98.5	513	99.0
Alphaliner	GRP	812	99.0	854	98.2	854	99.1	618	98.1
PAA-G-LINER	GRP	94	98.9	94	98.9	94	97.9	89	100
Insituform Schlauchliner (NL)	NF	36**	100	39	84.6	39	89.7	39	100
Brandenburg Liner	GRP	275	99.6	289	95.8	289	97.6	197	94.4
iMPREG-Liner	GRP	177	92.1	216	97.7	216	95.8	198	91.4
Mean value		98.6		97.9		98.2		97.5	

greater than or equal to mean value
below mean value

* Target values determined according to a product approval (DIBt approval, KOMO certificate, QUIK guideline) or customer requirement (static calculation or as stated on sample submission form)
** without cutting the integrated foil
GRP: Glass fibre carrier material
NF: Needle felt carrier material

Table. 3: Test results in 2019 compared to the previous year

Liner type	Water tightness watertight in % of tests			E-Modulus Target value* met in % of tests			Flexural strength Target value* met in % of tests			Wall thickness Target value* met in % of tests		
	2019	2018	+/–	2019	2018	+/–	2019	2018	+/–	2019	2018	+/–
Average values												
of all samples	98.6	98.9	- 0.3 ↓	97.9	97.5	+ 0.4 ↑	98.2	97.4	+ 0.8 ↑	97.5	94.1	+ 3.4 ↑
• GRP	98.5	98.8	- 0.3 ↓	97.9	98.0	- 0.1 ↓	98.3	97.0	+ 1.3 ↑	97.2	93.0	+ 4.2 ↑
• NF	99.6	100.0	- 0.4 ↓	97.9	96.5	+ 1.4 ↑	97.5	97.6	- 0.1 ↓	100	97.4	+ 2.6 ↑

GRP: Glass fibre carrier material
NF: Needle felt carrier material
* Target values determined according to a product approval (DIBt approval, KOMO certificate, QUIK guideline) or customer requirement (static calculation or as stated on sample submission form)

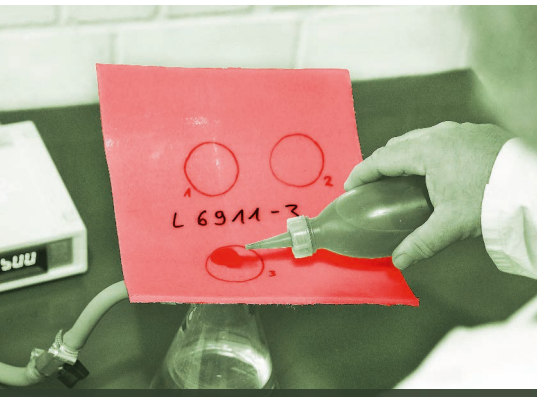


Figure 3: Tight or not?
Water tightness test in the IKT laboratory

A notable improvement in wall thickness

The improvement in the wall thickness results is remarkable: this test was passed by 97.5% of all samples tested, which is 3.4 percentage points (pp) more than in the previous year. Without exception, all samples made of needle felt carrier material (NF) have passed this test. NF liner performance improved by +2.6 pp to 100%. Liners made of glass fibre reinforced plastics (GRP) increased by +4.2 pp, with an average result of 97.2% passing, but remaining almost 3 pp below the NF result.

In the last three years there has been an intensive technical discussion about the wall thickness of sewer liners. Advocates of higher minimum thickness requirements were opposed by those who believe that wall thicknesses of three millimetres and less can also be tolerated. The test results of the IKT-LinerReport 2019 show that rehabilitation companies have successfully made efforts to comply with required wall thicknesses. This should have a positive effect in ensuring the long term performance of installed sewer liners.

The 100% Club

In 2019, once again, some rehabilitation companies managed to pass all four test criteria with all their sewer liner samples 100%. This year it is 3 of the 23 rehabilitation companies in the survey that fully meet the quality requirements. In the previous year there were five out of 25 companies that achieved 100%.

The companies in the "100% Club" of 2019 are:
- Hamers Leidingtechniek B.V. (NL) with Alphaliner
- Jeschke Umwelttechnik GmbH (D) with Alphaliner
- Kanaltechnik Agricola GmbH (D) with Brandenburger Liner

Diagram 3 shows the years in which these companies previously got a "100% Club" membership, highlighting their recent performance.

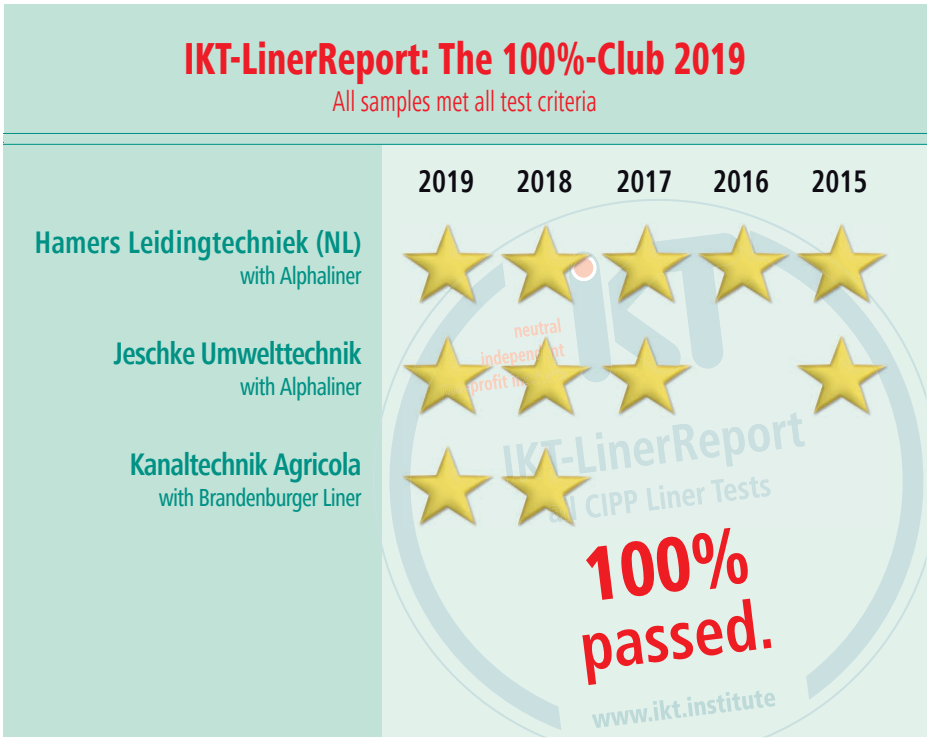


Diagram 3: Rehabilitation companies in the 2019 100% Club

Conclusions

2019 was predominantly a good year for sewer liner quality, not only in Germany, but also in a number of European countries participating in this report. It is encouraging that, on average, better or equally good results were achieved compared with the previous year for almost all test criteria.

However, it cannot be overlooked that only very few rehabilitation companies manage to provide a very high performance throughout. These are the three companies in the "100% Club" that have passed all four test criteria for each of their samples. With a total of 23 rehabilitation companies whose sewer liner samples are included in the 2019 IKT LinerReport, there is undoubtedly still some room for improvement in quality.

The same applies to the proportion of sewer liner samples that meet all four test criteria at the same time. At 93%, this is not so impressive because it means that every 14th liner does not fully meet the quality requirements. However, the four test criteria with their target values are there for a good reason: only if all four are fulfilled can clients assume that they have received a professionally installed liner, with good prospects of a long service life in the sewer. The rehabilitation companies as well as the liner producers have to make the same demands on themselves. Because only in combination can they achieve high sewer liner quality at installation sites and thus permanently consolidate the position of the sewer liner as the leading sewer rehabilitation method.

And in the future, in their own interest, clients should pay more attention to ensuring that they state the required target values for all four test criteria in their sample submission forms. So far, this is only the case in two thirds of the samples, with one third lacking information on the target values for some tests. It is therefore not possible to fully assess the performance of all the samples submitted for the IKT LinerReport.

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