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IKT-LinerReport 2008

Tube liner quality:

Variegated trend

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Test engineer Tatjana Kijan preparing a three-point bending test

IKT-LinerReport 2008

Tube liner quality: Variegated trend

Tube liners improved on a broad front in 2007, whereas 2008 has brought both advances and retreats. Where are the potentials for improvement in individual liner systems?

By Dipl.-Ök. Roland W. Waniek and Dipl.-Ing. Dieter Homann

This fifth LinerReport by the independent and neutral IKT – Institute for Underground Infrastructure is based on the test results obtained from just on 1,400 on-site samples taken in Germany, the Netherlands and in Switzerland. The aim is that of providing clients with a comprehensive overview of the repair quality achieved on their sites.

Data-base

The IKT's liner data-base for 2008 has been evaluated for this purpose. The overall results obtained from repair and refurbishing contractors from whom IKT has received not less than twenty-five liner specimens from five different sites are shown. Twenty contractors fulfilled this requirement in 2008, four more than in the preceding year.

In 75% of cases, clients (or their engineering consultancies) commissioned IKT directly to perform laboratory testing of liner samples taken on site. Only 25% of orders originated from the contractors themselves (see Table 1).

Table 1: Installation contractors and liner systems

Installation contractor	Liner systems	Liner type	Number of samples	IKT test ordered by	
				Installation contractor %	Project client %
ARKIL INPIPE GmbH	Berolina Liner	GRP	60	3	97
Arpe AG (Switzerland)	Brandenburger Schlauchliner	GRP	31	0	100
Brandenburger Kanalsanierungs-GmbH	Brandenburger Schlauchliner	GRP	72	24	76
Diringer & Scheidel Rohrsanierung GmbH	Saertex-Liner	GRP	170	63	37
Erles Umweltservice GmbH	Impreg-Liner	GRP	33	0	100
Frisch & Faust Tiefbau GmbH	Brandenburger Schlauchliner	GRP	30	3	97
Insituform Rohrsanierungstechniken GmbH	Insituform Schlauchliner Impreg-Liner	NF GRP	235 30*	0	100
Jeschke Umwelttechnik GmbH	Brandenburger Schlauchliner	GRP	88	0	100
Karl Weiss GmbH & Co. KG	Brandenburger Schlauchliner	GRP	52	67	33
Kleen GmbH	Saertex-Liner	GRP	69	13	87
KMG Pipe Technologies GmbH	Impreg-Liner	GRP	29	0	100
KS-Kanalsanierung GmbH	Brandenburger Schlauchliner	GRP	33	15	85
Linertec GmbH	Euroliner	GRP	34	53	47
NordiTube GmbH	UniLiner	NF	48	100	0
Rainer Kiel Kanalsanierung GmbH	UniLiner	NF	30	27	73
Swietelsky-Faber GmbH Kanalsanierung	Berolina Liner	GRP	100	26	74
TKT Troisdorfer Kanalsanierungstechnik GbR	Brandenburger Schlauchliner	GRP	47	19	81
U&W Umwelttechnik u. Wasserbau GmbH	Brandenburger Schlauchliner	GRP	122	16	84
Umwelttechnik Jenni GmbH (Switzerland)	Berolina Liner	GRP	35	0	100
van der Velden Rioleringsbeheer B.V. (Netherlands)	Brandenburger Schlauchliner	GRP	48	94	6
Total			**1,396**	**25**	**75**

GRP: Glass-fiber support material
NF: Needle-felt support material
* From four sites

Target/Actual analysis

The IKT test body analyzes the mechanical characteristics data and water-tightness of the tube liners on the basis of liner samples. The actual data thus obtained for modulus of elasticity and flexural strength is then compared against target data from the DIBt approvals and/or against any other target specifications made by the client for individual projects, where this client desires this.

Target wall-thickness data is determined by means of static calculations or is specified by the client. Water-tightness is determined in accordance with the APS test and inspection code; the only possible result here is either "tight" or "not tight". The most recent result obtained by IKT is the definitive result in case of repeat tests.

Overview of test and inspection criteria

Modulus of elasticity (short-term flexural modulus)
- Tube liners must be capable of withstanding loads such as those arising from groundwater, road traffic and soil pressure, for example
- The modulus of elasticity is an indicator of load-bearing capability
- If it is too low, stability may be endangered
- Test method: Three-point bending test as per DIN EN ISO 178 and DIN EN 13 566, Part 4

➔Results: see Table 2

Wall thickness (mean combined thickness)
- Minimum value is specified in the stress analysis calculation
- Wall thickness and modulus of elasticity jointly determine the stiffness of the liners
- Excessively low wall thickness can endanger stability
- Test method: Mean combined thickness is measured in accordance with DIN EN 13 566, Part 4, using a precision slide gauge

➔Results: see Table 4

Flexural strength (short-term σ_{fb})
- This indicates the point at which the liner fails due to excessively high stress
- If bending strength is too low, the liner may fracture before the permissible deformation is reached
- Test method: Increase of load up to failure in the three-point bending test; as per DIN EN ISO 178 and DIN EN 13 566, Part 4 (short-term flexural strength)

➔Results: see Table 3

Water tightness (in accordance with APS test and inspection code)
- Cut is made into inner film and the outer film (if any) is removed
- Water containing a red dye is applied internally
- A 0.5 bar (7.25 psi) partial vacuum is applied externally
- The liner is „not tight" if water penetrates through
- Test period: 30 min.

➔Results: see Table 5

Table 2: Test results for modulus of elasticity
Short-term flexural modulus

Installation contractor	2008			2007		Tendency
	No. of samples	Target* achieved in % of tests		Taget* achieved in % of tests		
Frisch & Faust Tiefbau GmbH	30	100.0	(100.0)	84.4	(57.1)	↑***
Insituform Rohrsanierungstechniken GmbH with Impreg-Liner (GRP)	30	100.0	(100.0)	–	–	–
Jeschke Umwelttechnik GmbH	88	100.0	(100.0)	98.7	(98.7)	↑
Karl Weiss GmbH & Co. KG	52	100.0	(100.0)	–	–	–
KS-Kanalsanierung GmbH	33	100.0	(100.0)	100.0	(97.1)	↔
Linertec GmbH	34	100.0	(**)	100.0	(**)	↔
NordiTube GmbH	48	100.0	(100.0)	100.0	(100.0)	↔
Swietelsky-Faber GmbH Kanalsanierung	99	100.0	(100.0)	100.0	(100.0)	↔
TKT Troisdorfer Kanalsanierungstechnik GbR	47	100.0	(100.0)	–	–	–
Umwelttechnik Jenni GmbH (Switzerland)	35	100.0	(100.0)	–	–	–
van der Velden Rioleringsbeheer B.V. (Netherlands)	48	100.0	(100.0)	100.0	(100.0)	↔
Diringer & Scheidel Rohrsanierung GmbH	169	98.8	(97.6)	97.2	(94.4)	↑
Brandenburger Kanalsanierungs-GmbH	72	98.6	(97.2)	98.5	(98.5)	↑
ARKIL INPIPE GmbH	60	98.3	(98.3)	100.0	(100.0)	↓
U&W Umwelttechnik u. Wasserbau GmbH	104	98.1	(98.1)	100.0	(100.0)	↓
Kleen GmbH	69	97.1	(97.1)	–	–	–
Erles Umweltservice GmbH	33	97.0	(97.0)	–	–	–
Arpe AG (Switzerland)	31	96.8	(96.8)	100.0	(96.0)	↓
Average		**96.8**		**94.1**		↑
KMG Pipe Technologies GmbH	29	96.6	(96.6)	96.8	(96.8)	↓***
Rainer Kiel Kanalsanierung GmbH	25	96.0	(100.0)	–	–	–
Insituform Rohrsanierungstechniken GmbH with Insituform-Schlauchliner (NF)	233	86.3	(86.3)	88.7	(88.7)	↓
FLEER-TECH GmbH		–	–	60.9	(60.9)	–
Rose Kanal- und Umwelttechnik		–	–	97.1	(97.1)	–

* Target data in accordance with client's information (stress analysis/sample traveller card)
** No DIBt approval
*** The liner system used in 2008 was different to that used in 2007
( ) Result of comparison against DIBt target
– Not evaluated, insufficient liner samples

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

Installation contractor	2008			2007		Tendency
	No. of samples	Target* achieved in % of tests		Target* achieved in % of tests		
Erles Umweltservice GmbH	33	100.0	(100.0)	–	–	–
Frisch & Faust Tiefbau GmbH	30	100.0	(100.0)	77.9	(32.5)	↑***
Insituform Rohrsanierungstechniken GmbH mit Impreg-Liner (GRP)	30	100.0	(100.0)	–	–	–
Jeschke Umwelttechnik GmbH	88	100.0	(100.0)	100.0	(100.0)	↔
Linertec GmbH	34	100.0	(**)	100.0	(**)	↔
NordiTube GmbH	48	100.0	(100.0)	100.0	(100.0)	↔
TKT Troisdorfer Kanalsanierungstechnik GbR	47	100.0	(100.0)	–	–	–
van der Velden Rioleringsbeheer B.V. (Netherlands)	48	100.0	(100.0)	100.0	(100.0)	↔
ARKIL INPIPE GmbH	60	98.3	(96.7)	97.0	(97.0)	↑
Diringer & Scheidel Rohrsanierung GmbH	169	98.2	(98.8)	97.2	(87.3)	↑
U&W Umwelttechnik u. Wasserbau GmbH	104	98.1	(100.0)	100.0	(100.0)	↓
Kleen GmbH	69	97.1	(97.1)	–	–	–
KMG Pipe Technologies GmbH	29	96.6	(96.6)	87.1	(87.1)	↑***
Rainer Kiel Kanalsanierung GmbH	25	96.0	(96.0)	–	–	–
Swietelsky-Faber GmbH Kanalsanierung	99	96.0	(94.9)	95.9	(94.5)	↑
Karl Weiss GmbH & Co. KG	52	94.2	(96.2)	–	–	–
Arpe AG (Switzerland)	31	93.5	(96.8)	92.0	(92.0)	↑
Average		**92.9**		**92.5**		↑
KS-Kanalsanierung GmbH	33	90.9	(97.0)	97.1	(94.1)	↓
Brandenburger Kanalsanierungs-GmbH	72	90.3	(91.7)	100.0	(95.5)	↓
Umwelttechnik Jenni GmbH (Switzerland)	35	88.6	(97.1)	–	–	–
Insituform Rohrsanierungstechniken GmbH with Insituform-Schlauchliner (NF)	233	72.5	(83.3)	78.0	(78.0)	↓
FLEER-TECH GmbH		–		95.7	(95.7)	–
Rose Kanal- und Umwelttechnik		–		100.0	(100.0)	–

* Target data in accordance with client's information (stress analysis/sample traveller card)
** No DIBt approval
*** The liner system used in 2008 was different to that used in 2007
( ) Result of comparison against DIBt target
– Not evaluated, insufficient liner samples

Table 4: Test results for wall thickness

mean combined thickness in accordance with DIN EN 13 566, Part 4

Installation contractor	2008		2007	Tendency
	No. of samples	Target* achieved in % of tests	Target* achieved in % of tests	
Jeschke Umwelttechnik GmbH	86	100.0	98.7	↑
Kleen GmbH	69	100.0	–	–
Linertec GmbH	34	100.0	100.0	↔
Insituform Rohrsanierungstechniken GmbH with Insituform-Schlauchliner (NF)	225	99.6	97.1	↑
NordiTube GmbH	48	97.9	84.6	↑
van der Velden Rioleringsbeheer B.V. (Netherlands)	48	97.9	96.9	↑
ARKIL INPIPE GmbH	55	96.4	82.5	↑
Diringer & Scheidel Rohrsanierung GmbH	169	95.9	95.8	↑
TKT Troisdorfer Kanalsanierungstechnik GbR	47	95.7	–	–
Swietelsky-Faber GmbH Kanalsanierung	96	94.8	56.2	↑
Brandenburger Kanalsanierungs-GmbH	71	94.4	89.5	↑
Insituform Rohrsanierungstechniken GmbH with Impreg-Liner (GRP)	30	93.3	–	–
Average		**92.1**	**87.8**	↑
Rainer Kiel Kanalsanierung GmbH	25	92.0	–	–
Frisch & Faust Tiefbau GmbH	26	88.5	100.0	↓**
KMG Pipe Technologies GmbH	28	85.7	100.0	↓**
Karl Weiss GmbH & Co. KG	48	83.3	–	–
KS-Kanalsanierung GmbH	22	81.8	76.9	↑
Umwelttechnik Jenni GmbH (Switzerland)	30	76.7	–	–
U&W Umwelttechnik u. Wasserbau GmbH	101	72.3	74.0	↓
Arpe AG (Switzerland)	31	71.0	56.0	↑
Erles Umweltservice GmbH	33	54.5	–	–
FLEER-TECH GmbH		–	84.8	–
Rose Kanal- und Umwelttechnik		–	79.4	–

* Target data in accordance with client´s information (stress analysis/sample traveller card)
** The liner system used in 2008 was different to that used in 2007
– Not evaluated, insufficient liner samples

Table 5: Test results for water-tightness

in accordance with APS test and inspection code

Installation contractor	2008		2007	Tendency
	No. of samples	Watertight in % of tests	Watertight in % of tests	
ARKIL INPIPE GmbH	60	100.0	97.8	↑
Diringer & Scheidel Rohrsanierung GmbH	169	100.0	100.0	↔
Erles Umweltservice GmbH	33	100.0	–	–
Jeschke Umwelttechnik GmbH	88	100.0	94.8	↑
Kleen GmbH	69	100.0	–	–
Linertec GmbH	34	100.0	97.4	↑
Swietelsky-Faber GmbH Kanalsanierung	100	100.0	100.0	↔
U&W Umwelttechnik u. Wasserbau GmbH	119	100.0	100.0	↔
van der Velden Rioleringsbeheer B.V. (Netherlands)	48	100.0	100.0	↔
Brandenburger Kanalsanierungs-GmbH	64	98.4	100.0	↓
NordiTube GmbH	48	97.9	96.2	↑
KS-Kanalsanierung GmbH	33	97.1	97.1	↔
Karl Weiss GmbH & Co. KG	52	96.2	–	–
TKT Troisdorfer Kanalsanierungstechnik GbR	47	95.7	–	–
Umwelttechnik Jenni GmbH (Switzerland)	35	94.3	–	–
Arpe AG (Switzerland)	31	93.5	100.0	↓
Insituform Rohrsanierungstechniken GmbH with Impreg-Liner (GRP)	30	93.3	–	–
Average		**92.6**	**93.8**	↓
Frisch & Faust Tiefbau GmbH	30	90.0	97.4	↓**
KMG Pipe Technologies GmbH	29	89.7	75.0	↑**
Insituform Rohrsanierungstechniken GmbH with Insituform-Schlauchliner (NF) a) in accordance with APS test and inspection code b) with reference to APS test and inspection code with lower test pressures and times in some cases*	 214 18	 68.7 94.4	 70.8 92.0	 ↓ ↑
Rainer Kiel Kanalsanierung GmbH	30	50.0	–	–
FLEER-TECH GmbH		–	86.1	–
Rose Kanal- und Umwelttechnik		–	100.0	–

– Not evaluated, insufficient liner samples
* At the request of one individual client
** The liner system used in 2008 was different to that used in 2007

Liner wall-thickness is measured using a precision slide caliper gauge

Tightness testing: water containing a red dye is applied to the inner side of the liner

Tightness testing: liner tight

Tightness testing: liner not tight

Table 6: Test results classified by liner types

		Water-tightness		Modulus of elasticity		Flexural strength		Wall thickness	
Liner type	Liner system	No. of samples	Watertight** in % of tests	No. of samples	Target* achieved in % of tests	No. of samples	Target* achieved in % of tests	No. of samples	Target* achieved in % of tests
GRP	Euroliner	34	100.0	34	100.0	34	100.0	34	100.0
	Saertex-Liner	238	100.0	238	98.3	238	97.9	238	97.1
	Berolina Liner	194	99.0	194	99.5	194	95.4	181	92.3
	Brandenburger Schlauchliner	512	97.9	505	99.2	505	96.6	480	87.7
	Impreg-Liner	92	94.6	92	97.8	92	98.9	91	76.9
NF	UniLiner	78	79.5	73	98.6	73	98.6	73	95.9
	Insituform Schlauchliner	214	68.7	233	86.3	233	72.5	225	99.6
Average			92.6		96.8		92.9		92.1

above average
below average
GRP: Glass-fiber support material
NF: Needle-felt support material
* Targets in accordance with client´s data (stress analysis/sample traveller card)
** In accordance with APS test and inspection code

Assessment against previous year

The result averages for modulus of elasticity, flexural strength and wall thickness in 2008 exhibited slight improvements compared to 2007. They rose on average by up to 4.3 percentage points (%P); only the flexural strength of needle-felt liners dropped, by 5%P (see Table 7).

A conspicuous feature is the significant upward trend in wall thickness, which has been the weak point of GRP liners, in particular, in previous years. The scores attained by the GRP liners are, it is true, still significantly below those of the NF liners, but the contractors are obviously addressing this problem, and have already achieved an improvement of 5%P.

The average quality level in terms of watertightness has regressed slightly (-1.2%P).

Table 7: Test results compared to results for previous year

Liner type	Watertight** in % of tests			Modulus of elasticity Targets achieved in % of tests			Flexural strength* Targets achieved in % of tests			Wall thickness* Targets achieved in % of tests		
	2008	2007	+/–	2008	2007	+/–	2008	2007	+/–	2008	2007	+/–
Averages												
• of all samples	92.6	93.8	-1.2 ↓	96.8	94.1	+2.7 ↑	92.9	92.5	+0.4 ↑	92.1	87.8	+4.3 ↑
• GRP	98.3	98.5	-0.2 ↓	99.0	97.4	+1.6 ↑	97.0	96.0	+1.0 ↑	90.1	85.1	+5.0 ↑
• NF	71.6	77.4	-5.8 ↓	89.2	86.0	+3.2 ↑	78.8	84.1	-5.3 ↓	98.7	94.2	+4.5 ↑

GRP: Glass-fiber support material
NF: Needle-felt support material
* Targets in accordance with client´s data (stress analysis/sample traveller card)
** In accordance with APS test and inspection code

A considerable improvement of 5%P was registered here in the preceding year, and a good 7%P in the case of the needle-felt liners. In 2008, on the other hand, GRP liners remained practically at the level of the previous year, at -0.2%P, while needle-felt liners fell back by -5.8%P.

Can liners still get better?

On an overall view, the IKT-LinerReport 2008 indicates a pleasing quality level on the tube liner market. The test results for modulus of elasticity stand out, in particular, with an average of just on 97%; the three other criteria of flexural strength, wall thickness and water-tightness also indicate a comparatively good state of affairs, however, with an average of just on 93% tests passed.
So have we already reached the end of the road? Will it be possible at all to improve on these averages, which have steadily become better and better in recent years?

Analysis of the results for individual support materials shows where there are, nonetheless, still potentials for improvement:

- GRP liners pass laboratory tests for water-tightness, modulus of elasticity and flexural strength in 97 to 99% of cases, whereas the needle-felt liners pass only in 72%, 89% and 79% of cases, respectively.
- This picture is precisely reversed in the case of wall thickness; here, needle-felt liners score significantly better, at 99%, than GRP liners, at 90%.

It is thus apparent that scarcely any further great improvements are to be anticipated from GRP liners in water-tightness, modulus of elasticity and flexural strength, whereas needle-felt liners still have adequate room for improvement in these three sectors. And, as we have seen, the situation is precisely reversed in the case of wall-thickness.
The quality of installation of both GRP and needle-felt liners must still improve further, if it is to satisfy the demands of quite justifiably critical clients. The manufacturers will therefore need to convince the market, by means of genuine technical innovations, in the next few years.
The extent to which the reduction of requirements or additional functions for existing liner components will actually be able to achieve this will be shown by future quality checks and guarantee acceptance procedures.

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neutral
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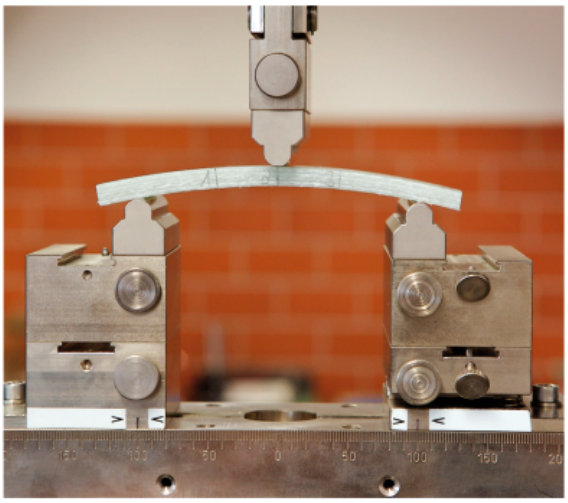
Testing tube liner



To

IKT – Institute for Underground Infrastructure
Exterbruch 1
45886 Gelsenkirchen
Germany

by fax: +49 209 17806-88

Please send us an offer for testing of tube liner samples

Name of project site: _____

Expected number of specimen: _____

Expected period of project site: _____

Standard tests

- Water tightness as per APS code ☐
- Three-point bending test as per DIN EN 13566-4 and ISO 178) (incl. modulus of elasticity, flexural strength, wall thickness) ☐
- 24h creep tendency with ref. to DIN EN ISO 899, part 2 ☐

Additional tests

- Residual styrene content as per DIN 53394, Part 2 (GC) ☐
- IR spectroscopy for characterization of reactive resin specimens ☐
- Calcining method as per DIN EN ISO 1172 ☐
- Determination of density with reference to DIN EN ISO 1183, part 1 ☐
- DSC analysis as per DIN 53765 ☐

Client: _____

Contact: _____

Adress: _____

_____

Telephone and fax: _____

e-mail: _____

We have further questions! Please call back: ☐