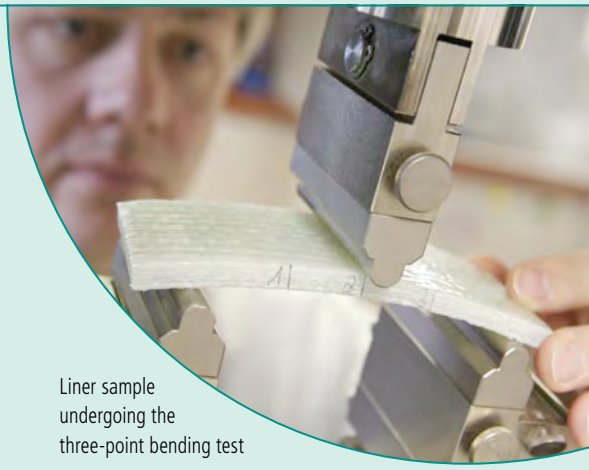
Tube liner quality in 2007: An improvement over last year



Liner sample undergoing the three-point bending test

A pleasing trend: This year's IKT LinerReport is pleased to announce higher on-site quality levels. Test results have, on average, improved. The ongoing quality debate is starting to produce results.

The cured-in-place liner market has, for some time, been experiencing an intensive debate on quality. A good twenty-five years after the introduction of this renewal technology in Germany, discussion is livelier than ever. This is not surprising, when one remembers that tube lining has become established as the leading renovation method for waste-water conduits.

The CIPP technology competes directly with pipe replacement and has now managed to capture a highly respectable market share (around 20% of the overall market, and some 80% of the renovation market). This success story has been made possible, among other factors, by the fact that it provides customers with properties and service-lives equivalent to those of new pipes, but in most cases at lower cost.

Quality the guarantee of cost-efficiency

In the field of quality-assurance, however, CIPP liners have a built-in system disadvantage compared to factory-manufactured pipes: they are produced on-site, i.e., generally under significantly more difficult production conditions than those found in a pipe mill.

The end products are therefore submitted to strict quality testing. Random samples are taken from the cured liners and examined in the test laboratory. The reason for this: if the properties and characteristics promised are not achieved in a renewal project, achievement of the expected service-life, and thus the overall cost-effectiveness of the renewal project, becomes dubious.

Transparency

There is no doubt that the annual IKT Liner-Report, which is here presented for the fourth time, makes a significant contribution to the heated debate on quality. Its aim is to achieve clarity and transparency and to provide project clients with an objective overview of the tube liner qualities actually achieved.

The extensive liner data-base operated by the independent and neutral IKT Testing Center is evaluated for this purpose. This generates a

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	89	0	100
Arpe AG (Switzerland)	Brandenburger Liner	GRP	25	0	100
Brandenburger Kanalsanierungs-GmbH	Brandenburger Liner	GRP	67	10	90
Diringer & Scheidel Rohrsanierung GmbH	Saertex-Liner	GRP	71	82	18
FLEER-TECH GmbH	CityLiner	NF	46	0	100
Frisch & Faust Tiefbau GmbH	Saertex-Liner	GRP	77	0	100
Insituform Rohrsanierungs-techniken GmbH	Insituform Schlauchliner	NF	182	0	100
Jeschke Umwelttechnik GmbH	Brandenburger Liner	GRP	77	1	99
KMG Pipe Technologies GmbH	KM Inliner	NF	31	19	81
KS Kanalsanierung Friedrich e.K.	Brandenburger Liner	GRP	34	38	62
Linertec GmbH	Euroliner	GRP	39	36	64
NordiTube GmbH	UniLiner	NF	26	100	0
Rose Kanal- und Umwelttechnik	Brandenburger Liner	GRP	34	91	9
Swietelsky-Faber GmbH Kanalsanierung	Berolina Liner	GRP	73	7	93
U&W Umwelttechnik u. Wasserbau GmbH	Brandenburger Liner	GRP	73	74	26
Van der Velden Riolerings-beheer B.V. (Netherlands)	Brandenburger Liner	GRP	32	100	0
Total			**976**	**25**	**75**

GRP: Glass-fiber support material | NF: Needle-felt support material

comprehensive overall picture of tube liner quality as actually achieved on project sites.

Data-base

The IKT LinerReport 2007 covers the January to December, 2007, inspection period and is based on a total of just on 1,000 on-site samples. This year, the input results have, for the first time, been obtained not only in Germany, but also from other European countries, with the application of identical test and inspection standards in all cases.

In order to avoid statistical outliers, only installation contractors for whom not less than twenty-five liner samples from five different project sites are available are included in the survey. A total of sixteen installation contractors (see Table 1) fulfilled this minimum requirement for this year's reporting period, five more than in the previous year. In the case of repeat tests, the final result obtained applies, provided the relevant tests were also performed at IKT.

Target/Actual analysis

The site samples submitted are examined at the IKT test center for two crucial properties of tube liners: stability and water-tightness. For the former, the following mechanical and geometrical characteristics data are determined, in detail:

- Modulus of elasticity (short-term flexural modulus)
- Flexural strength (short-term σ_{fb})
- Wall thickness

The data determined is compared in the context of a Target/Actual analysis against the specified minimum values. The sample is considered to pass the test provided these values are equal to or better than the target. The results are shown in aggregated form in Tables 2 to 4.

The target values for modulus of elasticity and flexural strength are based on:

a) the characteristics data from the National Technical Approval by the Deutsches Institut für Bautechnik (German Institute for Construction Technology, a government body, German abbreviation: DIBt), where the liner system has successfully passed the approval procedure or
b) site-specific minimum specifications set by the client for his specific renewal project; this data may deviate from that of the DIBt approval.

Wall thickness and water-tightness

Target values for wall thickness are defined, or are specified by the client, on the basis of stress analysis calculations. The property of water-tightness is nowadays determined in accordance with the APS test and inspection code. The result is stated either as „Tight" or „Not tight" (see Table 5 for results).

Contractual agreements

Target mechanical data and the water-tightness requirement are generally an integral component of the contractual agreement between the client and the installation contractor. More and more contracts nowadays provide precisely specified sanction mechanisms, in the form, for example, of repair or reworking obligations, or of price reductions, in case of failure to achieve target data. Great importance therefore attaches to laboratory inspection and testing of tube liners.

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})

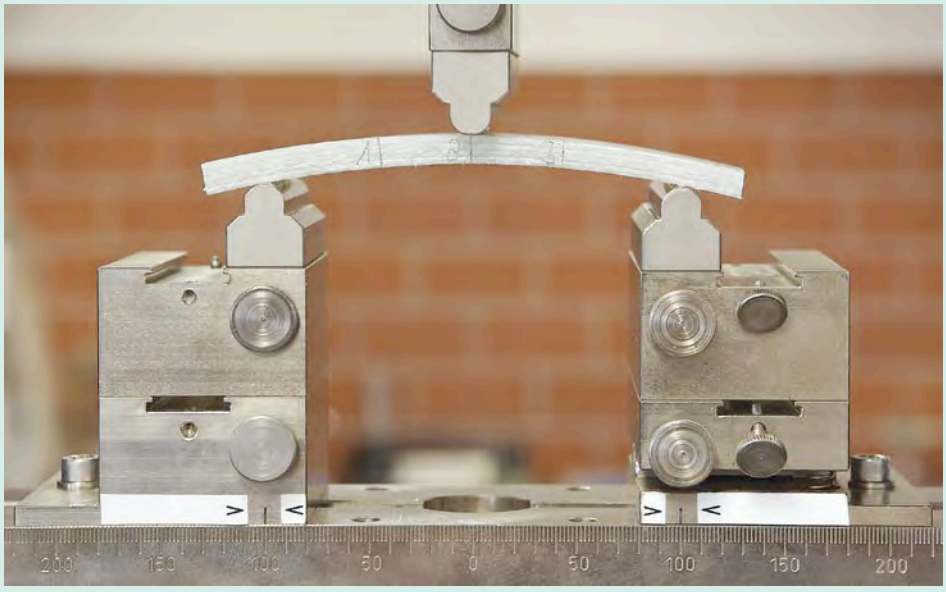
- This indicates the point at which the liner fails due to excessively high stress
- If bending strength is too low, the liner may fracture before the permissible deformation is reached
- Test method: Increase of load up to failure in the three-point bending test; as per DIN EN ISO 178 and DIN EN 13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



Liner sample undergoing the three-point bending test

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

Installation contractor	2007			2006	Tendency
	No. of samples	Target* achieved in % of tests		Target* achieved in % of tests	
ARKIL INPIPE GmbH	66	100.0	(100.0)	99.5	↑
Arpe AG (Switzerland)	25	100.0	(96.0)	–	–
KS Kanal Sanierung Friedrich e. K.	34	100.0	(97.1)	98.8	↑
Linertec GmbH	39	100.0	(**)	100.0	↔
NordiTube GmbH	26	100.0	(100.0)	-	–
Swietelsky-Faber GmbH Kanalsanierung	73	100.0	(100.0)	89.5	↑
U&W Umwelttechnik u. Wasserbau GmbH	73	100.0	(100.0)	–	–
Van der Velden Rioleringsbeheer B.V. (NL)	32	100.0	(100.0)	–	–
Jeschke Umwelttechnik GmbH	77	98.7	(98.7)	–	–
Brandenburger Kanalsanierungs-GmbH	67	98.5	(98.5)	100.0	↓
Diringer & Scheidel Rohrsanierung GmbH	71	97.2	(94.4)	93.9	↑
Rose Kanal- und Umwelttechnik	34	97.1	(97.1)	–	–
KMG Pipe Technologies GmbH	31	96.8	(96.8)	–	–
Average		**94.1**		**89.9**	↑
Insituform Rohrsanierungstechniken GmbH	168	88.7	(88.7)	84.2	↑
Frisch & Faust Tiefbau GmbH	77	84.4	(57.1)	88.3	↓
FLEER-TECH GmbH	46	60.9	(60.9)	63.4	↓

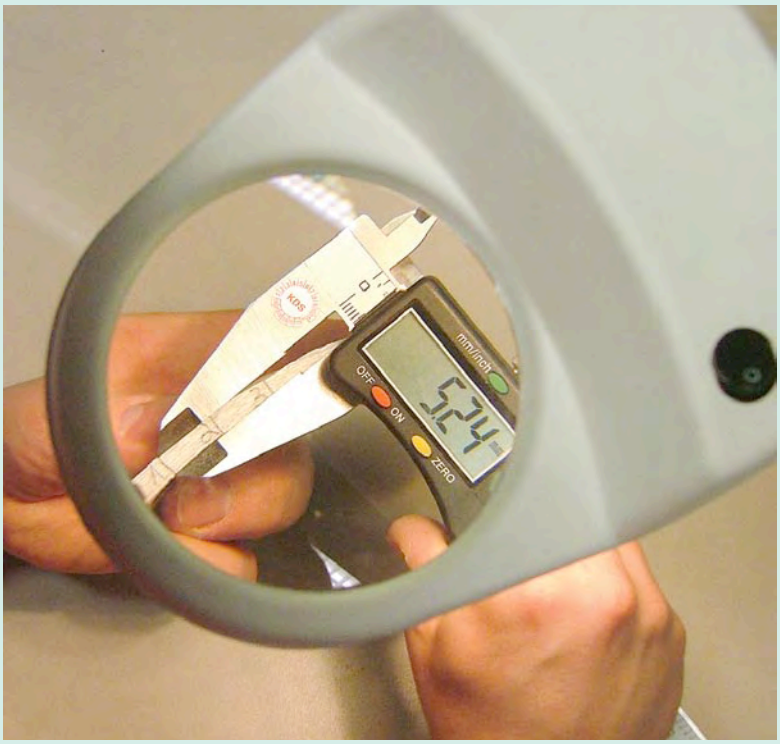
* Target data in accordance with client's information (stress analysis/sample traveller card) | ( ) Result of comparison against DIBt target | ** No DIBt approval
– Not evaluated, insufficient liner samples

Table 3: Test results for flexural strength (Short-term-σ_{fb})

Installation contractor	2007			2006	Tendency
	No. of samples	Target* achieved in % of tests		Target* achieved in % of tests	
Brandenburger Kanalsanierungs-GmbH	67	100.0	(95.5)	100.0	↔
Jeschke Umwelttechnik GmbH	77	100.0	(100.0)	–	–
Linertec GmbH	39	100.0	(**)	100.0	↔
NordiTube GmbH	26	100.0	(100.0)	–	–
Rose Kanal- und Umwelttechnik	34	100.0	(100.0)	–	–
U&W Umwelttechnik u. Wasserbau GmbH	73	100.0	(100.0)	–	–
Van der Velden Rioleringsbeheer B.V. (NL)	32	100.0	(100.0)	–	–
Diringer & Scheidel Rohrsanierung GmbH	71	97.2	(87.3)	87.9	↑
KS Kanal Sanierung Friedrich e. K.	34	97.1	(94.1)	100.0	↓
ARKIL INPIPE GmbH	66	97.0	(97.0)	92.4	↑
Swietelsky-Faber GmbH Kanalsanierung	73	95.9	(94.5)	86.1	↑
FLEER-TECH GmbH	46	95.7	(95.7)	85.4	↑
Average		**92.5**		**83.5**	↑
Arpe AG (Switzerland)	25	92.0	(92.0)	–	–
KMG Pipe Technologies GmbH	31	87.1	(87.1)	–	–
Insituform Rohrsanierungstechniken GmbH	168	78.0***	(78.0)	56.3	↑
Frisch & Faust Tiefbau GmbH	77	77.9	(32.5)	78.9	↓

* Target data in accordance with client's information (stress analysis/sample traveller card) | ( ) Result of comparison against DIBt target | ** No DIBt approval
*** DIBt approval modified with effect from June 15, 2007 DIBt; target now lower than in preceding year | – Not evaluated, insufficient liner samples

Cut made into inner film, with limitation of cut depth



Measurement of liner-wall thickness

Tightness test: liner above „Not tight", liner below „Tight"

Table 4: Test results for wall thickness (mean combined thickness in accordance with DIN EN 13 566, Part 4)

Installation contractor	2007		2006	Tendency
	No. of samples	Target* achieved in % of tests	Target* achieved in % of tests	
Frisch & Faust Tiefbau GmbH	77	100.0	100.0	◂▸
KMG Pipe Technologies GmbH	31	100.0	–	–
Linertec GmbH	39	100.0	97.7	▲
Jeschke Umwelttechnik GmbH	77	98.7	–	–
Insituform Rohrsanierungstechniken GmbH	175	97.1	80.8	▲
Van der Velden Rioleringsbeheer B.V. (NL)	32	96.9	–	–
Diringer & Scheidel Rohrsanierung GmbH	71	95.8	100.0	▼
Brandenburger Kanalsanierungs-GmbH	66	89.5	89.5	◂▸
Average		**87.8**	**82.7**	▲
FLEER-TECH GmbH	46	84.8	95.0	▼
NordiTube GmbH	26	84.6	–	–
ARKIL INPIPE GmbH	63	82.5	68.6	▲
Rose Kanal- und Umwelttechnik	34	79.4	–	–
KS Kanal Sanierung Friedrich e. K.	26	76.9	62.5	▲
U&W Umwelttechnik u. Wasserbau GmbH	73	74.0	–	–
Swietelsky-Faber GmbH Kanalsanierung	73	56.2	63.2	▼
Arpe AG (Switzerland)	25	56.0	–	–

* Target data in accordance with client's information (stress analysis/sample traveller card)

– Not evaluated, insufficient liner samples

Table 5: Test results for water-tightness (in accordance with APS test and inspection code)

Installation contractor	2007		2006	Tendency
	No. of samples	Watertight in % of tests	Watertight in % of tests	
Arpe AG (Switzerland)	25	100.0	–	–
Brandenburger Kanalsanierungs-GmbH	63	100.0	100.0	◂▸
Diringer & Scheidel Rohrsanierung GmbH	71	100.0	100.0	◂▸
Rose Kanal- und Umwelttechnik	34	100.0	–	–
Swietelsky-Faber GmbH Kanalsanierung	73	100.0	100.0	◂▸
U&W Umwelttechnik u. Wasserbau GmbH	73	100.0	–	–
Van der Velden Rioleringsbeheer B.V. (Netherlands)	32	100.0	–	–
ARKIL INPIPE GmbH	88	97.8	97.8	◂▸
Frisch & Faust Tiefbau GmbH	77	97.4	93.3	▲
Linertec GmbH	39	97.4	100.0	▼
KS Kanal Sanierung Friedrich e. K.	34	97.1	98.8	▼
NordiTube GmbH	26	96.2	–	–
Jeschke Umwelttechnik GmbH	77	94.8	–	–
Average		**93.8**	**88.8**	▲
FLEER-TECH GmbH a) in accordance with APS test and inspection code b) with reference to DIN EN 1610*	 36 10	 86.1 100.0	61.9	▲
KMG Pipe Technologies GmbH a) in accordance with APS test and inspection code b) with reference to DIN EN 1610*	 24 7	 75.0 85.7	–	–
Insituform Rohrsanierungstechniken GmbH a) in accordance with APS test and inspection code b) with reference to DIN EN 1610* c) with reference to APS test and inspection code with lower test pressures and times in some cases**	 113 44 25	 70.8 75.0 92.0	68.8	▲

– Not evaluated, insufficient liner samples | * State of the art is nowadays testing in accordance with the APS test and inspection code. Only a few clients insist on tests with reference to DIN EN 1610, which tolerates a certain amount of permeation of water through the liner wall. | ** At the request of one individual client.

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	39	97.4	39	100.0	39	100.0	39	100.0
	Berolina Liner	161	98.8	139	100.0	139	96.4	136	68.4
	Brandenburger Liner	338	98.5	342	99.1	342	99.1	333	84.4
	Saertex-Liner	148	98.6	148	90.5	148	87.2	148	98.0
NF	Uniliner	26	96.2	26	100.0	26	100.0	26	84.6
	KM Inliner	24	75.0	31	96.8	31	87.1	31	100.0
	CityLiner	36	86.1	46	60.9	46	95.7	46	84.8
	Insituform Schlauchliner	113	70.8	168	88.7	168	78.0	175	97.1
Average			**93.8**		**94.1**		**92.5**		**87.8**

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

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		
	2007	2006	+/–	2007	2006	+/–	2007	2006	+/–	2007	2006	+/–
Average												
of all samples	93.8	88.8	+5.0 ↑	94.1	89.9	+4.2 ↑	92.5	83.5	+9.0 ↑	87.8	82.7	+5.1 ↑
GRP	98.5	97.4	+1.1 ↑	97.4	95.3	+2.1 ↑	96.0	90.7	+5.3 ↑	85.1	82.2	+2.9 ↑
NF	77.4	70.1	+7.3 ↑	86.0	79.3	+6.7 ↑	84.1	69.2	+14.9 ↑	94.2	84.0	+10.2 ↑

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

Summary of 2007 test results

The test results obtained in 2007 produce an all-in-all more positive picture than in the preceding year. The averages for all four test criteria and for all samples rose by no less than 4 to 9 percentage points (see Table 7).

A particular leap forward was achieved by the needle-felt liner group. Their averages improved by around 7 to 15 percentage points, but remained below the overall averages for water-tightness, modulus of elasticity and bending strength. They are clearly above average only in terms of their wall thickness.

GRP liners also improved on average, whereby the increases here were significantly more modest than those for needle-felt liners, admittedly from an already higher starting level. As in previous years, wall-thickness remains the problem area, and is below the overall average.

A glance at the individual results (see Tables 2 to 5) in some cases reveals extremely divergent performances by the contractors, however. Performance was, in some cases, better, but in some cases poorer, than last year. The same also applies to the individual liner types (see Table 6).

Conclusions

The higher overall quality level of tube liners in 2007 is pleasing. It remains to be seen whether these improvements compared to 2006 constitute a sustainable trend or are merely „once-only" effects. A whole series of signals from the market does, however, indicate that the installation contractors are taking the continuing quality debate extremely seriously. Work is being invested in product and process innovations, and these companies are taking steps to tackle systematically the weak points outlined in previous IKT LinerReports.

These constructive responses by the renewal sector must be expressly welcomed and encouraged; one thing is certain: clients want tube liner technology. The coming years will feature many renewal projects, and reliable methods are needed for them. System operators have, however, become significantly more sensitive to the question of quality than in previous years, a positive result of the continuing quality debate.

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

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non-profit institute

IKT - Institute for Underground Infrastructure

ABOUT IKT

IKT - Institute for Underground Infrastructure is a research, consultancy and testing institute specialized in the field of sewers. It is neutral and independent and operates on a non-profit basis. It is oriented towards practical applications and works on issues surrounding underground pipe construction. Its key focus is centred on sewage systems. IKT provides scientifically backed analysis and advice.

IKT has been established in 1994 as a spin-off from Bochum University, Germany.

The initial funding for setting up the institute has been provided by the Ministry for the Environment of the State of North-Rhine Westphalia, Germany's largest federal state.

However, IKT is not owned by the Government. Its owners are two associations which are again non-profit organizations of their own:

a) IKT-Association of Network Operators: Members are about 100 cities, among them Berlin, Hamburg, Cologne and London (Thames Water). They hold together 66.6% of IKT.

b) IKT-Association of Industry and Service Providers: Members are about 60 companies. They hold together 33.3% of IKT.

You can find information on projects and services at: **www.ikt.de**

IKT – Institute for Underground Infrastructure

Exterbruch 1
45886 Gelsenkirchen
Germany

phone: +49 209 178060
fax: +49 209 17806-88
email: info@ikt.de

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