

Use of CIPP liners expanding in Europe

Liner quality continues to be high. Slight improvements over last year. CIPP lining gaining in importance in Europe, accompanied by increasing quality awareness. Liner Report 2014 includes Dutch, Austrian and Swiss results.

by Roland W. Waniek, Dieter Homann and Barbara Grunewald

IKT – Institute for Underground Infrastructure is pleased to present its LinerReport, for the eleventh year. This report is based on nearly 1,800 CIPP-liner samples taken for Quality Control purposes at installation sites and tested by the IKT Test Centre for CIPP liners during 2014.

A market trend is becoming apparent showing the use of CIPP lining expanding in Europe. Although Germany remains the largest market for this method, it is gaining significantly in popularity in other western European countries. This is reflected in this LinerReport with nearly 30% of

the site samples tested originating from outside Germany, compared with less than 15% last year.

The 2014 data-base

The 2014 IKT LinerReport presents the results achieved by those contractors for which IKT has tested a minimum of twenty-five liner samples, of one liner type, obtained from at least five different installation sites. In 2014 eighteen companies meet these requirements and two of them are represented by more than one liner type. Three contractors were active only in the Netherlands, while one worked both in Germany and in the

Netherlands. Two companies worked in Switzerland, and one in Austria. They are indicated in the results tables by means of the national symbols (NL), (CH) and (A) in the tables.

For 76% of the samples the client that ordered the lining work (or their engineering consultancies) commissioned IKT to undertake the laboratory testing of the liner samples. A quarter of the orders for sample testing originated direct from contractors themselves (see Table 1).

Three-point bending test on a CIPP liner



Overview of test and inspection criteria

Modulus of elasticity (short-term flexural modulus)

- CIPP liners must be capable of withstanding loads such as those arising from ground-water, 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 as per DIN EN ISO 178 and DIN EN ISO 11296, Part 4/DIN EN 13 566, Part 4*
- ☞ Results: see Table 2

Flexural strength (flexural stress at rupture = short-term σ_{fb})

- This indicates the point at which the liner fails due to excessively high stress
- If flexural strength is too low, the liner may rupture before the permissible deformation is reached
- Test method: Increase of load up to failure in the three-point bending test in accordance with DIN EN ISO 178 and DIN EN ISO 11296, Part 4/DIN EN 13 566-4* (short-term flexural strength)
- ☞ Results: see Table 3

Wall thickness (mean combined thickness)

- Minimum values are specified in the structural-analysis calculations for liners
- 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 ISO 11296, Part 4** using a precision slide gauge
- ☞ Results: see Table 4

Water tightness

- A cut is made into the inner film if the latter is not an integral component of the liner; the outer film (if any) is removed
- Water containing a red dye is applied internally
- A 0.5 bar partial vacuum is applied externally
- The liner is "Not tight" if water penetrates through
- Test period: 30 min.
- ☞ Results: see Table 5

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

* DIN EN ISO 11296, Part 4 superseded DIN EN 13566, Part 4 with effect from July 2011. The test results are nonetheless evaluated on the basis of DIN EN 13566, Part 4 for a number of liner systems, since the Target data for the mechanical properties (national technical approvals) were determined in accordance with this standard.

** Determination of combined thickness remains unchanged in DIN EN ISO 11296, Part 4 vis-à-vis DIN EN 13566, Part 4.



17.56 mm

ORIGIN

Mitutoyo
ABSOLUTE

ON / OFF

ZERO / ABS

Table 1: Contractors and liner systems, 2014

Contractors	Liner systems	Liner type	Number of samples	IKT testing commissioned by	
				Contractor %	Client %
Aarsleff Rohrsanierung GmbH	iMPREG Liner	GRP	71	0	100
Aarsleff Rohrsanierung GmbH	PAA SF Liner	NF	130	3	97
Arkil Inpipe GmbH	Berolina Liner	GRP	86	0	100
Diringer & Scheidel Rohrsanierung GmbH & Co.KG	Alphaliner	GRP	92	1	99
Erles Umweltservice GmbH	iMPREG Liner	GRP	56	71	29
Geiger Kanaltechnik GmbH & Co.KG	Berolina Liner	GRP	133	9	91
Hamers Leidingtechniek B.V. (NL)	Alphaliner	GRP	87	64	36
Insituform Rioolrenovatietechnieken B.V. (NL)	Insituform Schlauchliner (NL)* Netherlands	NF	208	0	100
ISS Kanal Services AG (CH)	Alphaliner	GRP	54	87	13
Jeschke Umwelttechnik GmbH	Alphaliner	GRP	83	54	46
Jeschke Umwelttechnik GmbH	Brandenburger Liner BB 2.0 / 2.5	GRP	175	30	70
Kanaltechnik Agricola GmbH	iMPREG Liner	GRP	54	100	0
Kibag Geiger Kanaltechnik AG (CH)	iMPREG Liner	GRP	34**	0	100
KTF GmbH	iMPREG Liner	GRP	29	83	17
Rainer Kiel Kanalsanierung GmbH	SAERTEX Liner	GRP	34	15	85
Rainer Kiel Kanalsanierung GmbH (NL)	SAERTEX Liner	GRP	25	0	100
Rohrsanierung Jensen GmbH & Co.KG	Alphaliner	GRP	42	5	95
Strabag AG (A)	Brandenburger Liner BB 2.0 / 2.5	GRP	59	20	80
TKT GmbH & Co.KG	Alphaliner	GRP	135	15	85
Umwelttechnik und Wasserbau GmbH	Alphaliner	GRP	179	35	65
Van der Velden Rioleringsbeheer B.V. (NL)	iMPREG Liner	GRP	31	10	90
Total			1,797	24	76

GRP: Glass-fibre backing material

NF: Needle-felt backing material

* Insituform Schlauchliner (NL) does not have a German Institute for Building Technology (DIBt) approval, but has possessed a Dutch KOMO Foundation product certificate since 15 September 2014

** from four sites

Target vs Actual data analysis

Four characteristics of the CIPP liner samples were analysed: modulus of elasticity; flexural strength; wall thickness; and water tightness. The Actual data derived from testing was compared against the Target data specified for each system in its DIBt approval and, where necessary, against any divergent Target data specified by the client. CIPP liner systems which do not have a DIBt approval are indicated in Table 1. The Target values for wall thickness were either defined on the basis of structural-analysis calculations or are specified by the client.

dure in which it is not cut. The latter method is applied in the case of liners for which the DIBt approval (or, in the Netherlands, the KOMO Foundation certificate) confirms that the inner film as an integral element of the system and has an influence on tightness. The inner film is cut on all other needle-felt liners.

GRP liners, which do not feature an inner film which remains in the pipe, were tested without any cutting.

There are two procedures for testing of water tightness of needle-felt liners: a procedure in which the inner film layer is cut; and a proce-

Table 2: Test results for modulus of elasticity, 2014 (Short-term flexural modulus)

Contractors	2014		2013	Trend
	No. of samples	Target* achieved in in % of tests	Target* achieved in % of tests	
Aarsleff Rohrsanierung GmbH with iMPREG Liner	71	100	100	↔
Arkil Inpipe GmbH with Berolina Liner	86		100	↔
Erles Umweltservice GmbH with iMPREG Liner	56		100	↔
Geiger Kanaltechnik GmbH & Co.KG with Berolina Liner	133		100	↔
Hamers Leidingtechniek B.V.(NL) with Alphaliner	87		100	↔
ISS Kanal Services AG (CH) with Alphaliner	51		100	↔
Jeschke Umwelttechnik GmbH with Alphaliner	83		100	↔
Jeschke Umwelttechnik GmbH with Brandenburger Liner BB 2.0 / 2.5	175		100**	↔
Kanaltechnik Agricola GmbH with iMPREG Liner	54		100	↔
Kibag Geiger Kanaltechnik AG (CH) with iMPREG Liner	34		–	–
KTF GmbH with iMPREG Liner	29		–	–
Rainer Kiel Kanalsanierung GmbH (NL) with SAERTEX Liner	25		–	–
TKT GmbH & Co.KG with Alphaliner	135	99.3	98.6	↑
Diringer & Scheidel Rohrsanierung GmbH & Co.KG with Alphaliner	92	98.9	100	↓
Average		98.7	98.3	↑
Strabag AG (A) with Brandenburger Liner BB 2.0 / 2.5	59	98.3	100	↓
Umwelttechnik und Wasserbau GmbH with Alphaliner	179	97.8	99.5	↓
Rohrsanierung Jensen GmbH & Co.KG with Alphaliner	42	97.6	–	–
Rainer Kiel Kanalsanierung GmbH with SAERTEX Liner	34	97.1	97.4	↓
Aarsleff Rohrsanierung GmbH with PAA SF-Liner	130	96.9	97.5	↓
Insituform Rioolrenovatietechnieken B.V. (NL) with Insituform Schlauchliner NL	208	95.7	91.5	↑
Van der Velden Rioleringsbeheer B.V. (NL) with iMPREG Liner	31	93.5	100	↓

* Target values as per client's data (structural-analysis/sample data sheet)

** Brandenburger Liner BB+75 / 120

– not evaluated, too few liner samples

Precision slide gauge is used to measure combined thickness and the pure-resin layer



Table 3: Test results for flexural strength, 2014 (Short-term σ_{fb})

Contractors	2014		2013	Trend
	No. of samples	Target* achieved in % of tests	Target* achieved in % of tests	
Aarsleff Rohrsanierung GmbH with iMPREG Liner	71	100	98.3	↑
Arkil Inpipe GmbH with Berolina Liner	86		100	↔
Diringer & Scheidel Rohrsanierung GmbH & Co.KG with Alphasliner	92		100	↔
Erles Umweltservice GmbH with iMPREG Liner	56		99.3	↑
Geiger Kanaltechnik GmbH & Co.KG with Berolina Liner	133		100	↔
Hamers Leidingtechniek B.V.(NL) with Alphasliner	87		100	↔
ISS Kanal Services AG (CH) with Alphasliner	51		100	↔
Jeschke Umwelttechnik GmbH with Alphasliner	83		100	↔
Jeschke Umwelttechnik GmbH with Brandenburger Liner BB 2.0 / 2.5	175		100**	↔
Kanaltechnik Agricola GmbH with iMPREG Liner	54		100	↔
Kibag Geiger Kanaltechnik AG (CH) with iMPREG Liner	34		–	–
KTF GmbH with iMPREG Liner	29		–	–
Rainer Kiel Kanalsanierung GmbH with SAERTEX Liner	34		100	↔
Rohrsanierung Jensen GmbH & Co.KG with Alphasliner	42		–	–
TKT GmbH & Co.KG with Alphasliner	135		100	↔
Aarsleff Rohrsanierung GmbH with PAA SF-Liner	130	99.2	97.5	↑
Average		98.7	98.5	↑
Strabag AG (A) with Brandenburger Liner BB 2.0 / 2.5	59	98.3	96.3	↑
Umwelttechnik und Wasserbau GmbH with Alphasliner	179	97.8	99.5	↓
Rainer Kiel Kanalsanierung GmbH (NL) with SAERTEX Liner	25	96.0	–	–
Van der Velden Rioleringsbeheer B.V. (NL) with iMPREG Liner	31	93.5	100	↓
Insituform Rioolrenovatietechnieken B.V. (NL) with Insituform Schlauchliner NL	208	92.8	85.4	↑

* Target values as per client's data (structural-analysis/sample data sheet)

** Brandenburger Liner BB+75 / 120

– not evaluated, too few liner samples





Table 4: Test results for wall thickness, 2014 (mean combined thickness in accordance with DIN EN ISO 11296, Part 4)

Contractors	2014		2013	Trend
	No. of samples	Target* achieved in % of tests	Target* achieved in % of tests	
Aarsleff Rohrsanierung GmbH with PAA SF-Liner	75	100,0	95.8	↑
Diringer & Scheidel Rohrsanierung GmbH & Co.KG with Alphaliner	53		90.9	↑
Erles Umweltservice GmbH with iMPREG Liner	38		97.0	↑
Hamers Leidingtechniek B.V.(NL) with Alphaliner	87		100	↔
Jeschke Umwelttechnik GmbH with Brandenburger Liner BB 2.0 / 2.5	175		100**	↔
Kanaltechnik Agricola GmbH with iMPREG Liner	54		100	↔
KTF GmbH with iMPREG Liner	29		–	–
Rohrsanierung Jensen GmbH & Co.KG with Alphaliner	42		–	–
Jeschke Umwelttechnik GmbH with Alphaliner	75	98.7	100	↓
Umwelttechnik und Wasserbau GmbH with Alphaliner	97	97.9	100	↓
Arkil Inpipe GmbH with Berolina Liner	84	97.6	91.4	↑
Kibag Geiger Kanaltechnik AG (CH) with iMPREG Liner	31	96.8	–	–
Average		96.8	96.5	↑
ISS Kanal Services AG (CH) with Alphaliner	54	96.3	100	↓
Rainer Kiel Kanalsanierung GmbH (NL) with SAERTEX Liner	25	96.0	–	–
Aarsleff Rohrsanierung GmbH with iMPREG Liner	34	94.1	96.0	↓
Insituform Rioolrenovatietechnieken B.V. (NL) with Insituform Schlauchliner NL	182	92.9	76.8	↑
TKT GmbH & Co.KG with Alphaliner	85	91.8	95.9	↓
Geiger Kanaltechnik GmbH & Co.KG with Berolina Liner	60	91.7	95.2	↓
Van der Velden Rioleringsbeheer B.V. (NL) with iMPREG Liner	28	89.3	97.1	↓
Rainer Kiel Kanalsanierung GmbH with SAERTEX Liner	21	85.7	100	↓
Strabag AG (A) with Brandenburger Liner BB 2.0 / 2.5	7	***	100	–

* Target values as per client's data (structural-analysis/sample data sheet)

** Brandenburger Liner BB+75 / 120

***too few samples with statement of Target value for combined thickness

– not evaluated, too few liner samples

Modulus of elasticity and flexural strength results remain at a high level

The two test criteria of modulus of elasticity and flexural strength exhibit, on average, a slight improvement over the previous year, by +0.4 percentage points (%P) and +0.2 %P, respectively. They have remained at an encouragingly high level with an average pass rate of 98.7% for these two test criteria that are significant for the structural properties of a liner.

For both criteria, GRP liners, with pass rates of 99.2% for modulus of elasticity and 99.5% for flexural strength, performed better on average

than needle-felt (NF) liners, which had pass rates of 96.2% and 95.3% respectively. GRP liners have improved slightly for modulus of elasticity, by +0.3 %P, and NF by +0.9 %P. GRP liners have improved by +0.2 %P and NF liners by +1.0 %P on the criterion of flexural strength.

Wall-thicknesses results show some volatility

The test results for wall-thickness have also improved compared to the previous year, by an average of +0.3 %P, to 96.8%. However, GRP liners regressed by 0.8 %P, whereas NF liners achieved a significant rise, of +6.4 %P.

The analysis of all test results across a period of ten years performed in last year's LinerReport demonstrated that of all the tests wall-thickness has exhibited the most volatility across the years. The changes are continue to be clearly pronounced in 2014.

Outlier affects water tightness results

In 2014 the average pass value for the water tightness test regressed tangibly for the first time in many years, by 1.9 %P, from 98.5% to 96.6%. This was caused primarily by liner samples from a Dutch contractor, which achieved

a 79.8% pass rate; a significantly poorer result than other contractors. These results also draw the average of the NF liner system test results downward by 9.7 %P, whereas the GRP results remain constant at the level of the previous year. However, if this outlier is disregarded the test

results for water tightness remain at an overall good level.

Table 5: Test results for water tightness, 2014

Contractors	2014		2013	Trend
	No. of samples	Watertight in % of tests	Watertight in % of tests	
Aarsleff Rohrsanierung GmbH with PAA SF-Liner*	126	100,0	100	↔
Geiger Kanaltechnik GmbH & Co. KG with Berolina Liner	133		98.6	↑
Hamers Leidingtechniek B.V.(NL) with Alphaliner	87		100	↔
ISS Kanal Services AG (CH) with Alphaliner	54		100	↔
Jeschke Umwelttechnik GmbH with Alphaliner	83		100	↔
Jeschke Umwelttechnik GmbH with Brandenburger Liner BB 2.0 / 2.5	175		100**	↔
Kanaltechnik Agricola GmbH with iMPREG Liner	54		100	↔
KTF GmbH with iMPREG Liner	29		–	–
Rainer Kiel Kanalsanierung GmbH with SAERTEX Liner	34		100	↔
Rainer Kiel Kanalsanierung GmbH (NL) with SAERTEX Liner	25		–	–
Rohrsanierung Jensen GmbH & Co.KG with Alphaliner	42		–	–
Strabag AG (A) with Brandenburger Liner BB 2.0 / 2.5	59		100	↔
Diringer & Scheidel Rohrsanierung GmbH & Co.KG with Alphaliner	92	98.9	100	↓
Arkil Inpipe GmbH with Berolina Liner	86	98.8	100	↓
TKT GmbH & Co.KG with Alphaliner	135	98.5	97.1	↑
Umwelttechnik und Wasserbau GmbH with Alphaliner	179	97.8	99.0	↓
Aarsleff Rohrsanierung GmbH with iMPREG Liner	71	97.2	98.1	↓
Van der Velden Rioleringsbeheer B.V. (NL) with iMPREG Liner	31	96.8	92.9	↑
Average		96.6	98.5	↓
Kibag Geiger Kanaltechnik AG (CH) with iMPREG Liner	34	94.1	–	–
Erles Umweltservice GmbH with iMPREG Liner	56	89.3	98.6	↓
Insituform Rioolrenovatietechnieken B.V. (NL) with Insituform Schlauchliner NL	208	79.8***	91.5	↓

* without cutting of the integrated inner film

** Liner type: Brandenburger Liner BB+75 / 120

*** from 15 September 2014 without cutting of the integrated inner film, due to Dutch KOMO Foundation certificate

– not evaluated, too few liner samples

Table 6: Test results by liner types, 2014

Liner system	Water tightness		Modulus of elasticity		Flexural strength		Wall thickness	
	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
Brandenburger Liner BB 2.0/2.5	234	100	234	99.6	234	99.6	182	100
Alphaliner	672	99.0	669	99.0	669	99.4	493	97.6
PAA SF-Liner	126	100**	130	96.9	130	99.2	75	100
Berolina Liner	219	99.5	219	100	219	100	144	95.1
iMPREG Liner	275	96.0	275	99.3	275	99.3	214	97.2
SAERTEX Liner	59	100	59	98.3	59	98.3	46	91.3
Insituform Schlauchliner (NL)	208	79.8***	208	95.7	208	92.8	182	92.9
Average		96.6		98.7		98.7		96.8

equal to or above average

below average

* Target values as per client's data (structural-analysis/sample data sheet)

** without cutting of the integrated inner film

*** from 15 September 2014 without cutting of the integrated inner film, due to Dutch KOMO Foundation certificate



Tightness test on a CIPP liner

Table 7: Test results compared to previous year

Liner type	Water tightness in % of tests			Modulus of elasticity Target* achieved in % of tests			Flexural strength Target* achieved in % of tests			Wall thickness Target* achieved in % of tests		
	2014	2013	+/-	2014	2013	+/-	2014	2013	+/-	2014	2013	+/-
Average												
All samples	96.6	98.5	-1.9 ↓	98.7	98.3	+0.4 ↑	98.7	98.5	+0.2 ↑	96.8	96.5	+0.3 ↑
GRP	98.7	98.7	0.0 ↔	99.2	98.9	+0.3 ↑	99.5	99.3	+0.2 ↑	97.3	98.1	-0.8 ↓
NF	87.4	97.1	-9.7 ↓	96.2	95.3	+0.9 ↑	95.3	94.3	+1.0 ↑	95.0	88.6	+6.4 ↑

GRP: Glass-fibre backing material

NF: Needle-felt backing material

* Target values as per client's data (structural-analysis/sample data sheet)

Dutch results

A significant number of test results obtained on Dutch site samples is included in the IKT LinerReport for the first time this year. A brief consideration of the situation in this country is therefore appropriate.

Three of the four contractors examined in the Netherlands use CIPP-liner methods, which are also extremely popular in Germany and originate from German suppliers. Only Insituform Riool-

renovatietechnieken B.V. installs a proprietary system which is not available on the German market. In addition, one German contractor included in the IKT LinerReport – Rainer Kiel Kanalsanierung GmbH – also offers its services in the Netherlands.

The Dutch test results are on average 2 to 4 %P below the overall results for the criteria of modulus of elasticity, flexural strength and wall-thickness. However, for water tightness the pass

rate is 87.7%, well below the overall average of 96.6%. It is also notable that NF liners play a much greater role in the Netherlands than in Germany, and account for more than 50% of the site samples originating from that country.

Table 8: Test results, Netherlands, 2014

Contractors	No. of samples **	Water tightness	Modulus of elasticity	Flexural strength	Wall thickness
		Watertight in % of tests	Target* achieved in % of tests	Target* achieved in % of tests	Target* achieved in % of tests
Hamers Leidingtechniek B.V.(NL) with Alphaliner	87	100	100	100	100
Rainer Kiel Kanalsanierung GmbH (NL) with SAERTEX Liner	25	100	100	96	96
Van der Velden Rioleringsbeheer B.V. (NL) with IMPREG Liner	31	96,8	93.5	93.5	89.3
Insituform Rioolrenovatietechnieken B.V. (NL) with Insituform Schlauchliner NL	208	79.8***	95.7	92.8	92.9
Average NL		87.7	96.9	94.9	94.7

* Targets as per client's data (structural-analysis/sample data sheet)

** In some case, only few samples with statement of Target for the „wall-thickness“ test criterion

*** from 15 September 2014 without cutting of the integrated inner film, due to KOMO Foundation certificate in NL

Conclusions

In 2014, the quality of installed CIPP liners continues to be predominantly "good" to "very good" based on the test results produced by the IKT CIPP Liner Test Centre. The results amount to around a 97% to 99% pass rate when all the site samples tested are included. The product innovations of recent years appear to be generating positive benefits. In the eleventh year of the IKT LinerReport, CIPP lining clients continue to enjoy, on the whole, an extremely reliable refurbishing method.

The figures for modulus of elasticity, flexural strength and wall-thickness actually improved slightly on average compared to the previous year. They declined in the case of water tightness, though this can be attributed primarily to some site samples from the Netherlands. The refurbishing market in that country is still in its infancy, compared to the German market, but is developing dynamically. German refurbishing market itself required a couple of years "run-up" until it could approach its current quality level.

Signals from the market indicate that Dutch sewer network operators also favour quality and are increasingly having refurbishing installations results tested independently and impartially. It can therefore be anticipated that the Dutch test results will match the German ones in the foreseeable future. A clear trend is that CIPP lining is gaining significantly in importance in western European countries - the CIPP liner is going European!

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IKT - Institute for Underground Infrastructure

ABOUT IKT



IKT - Institute for Underground Infrastructure is a research, consultancy and testing institute specialised 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 was established in 1994 as a spin-off from Bochum University, Germany.

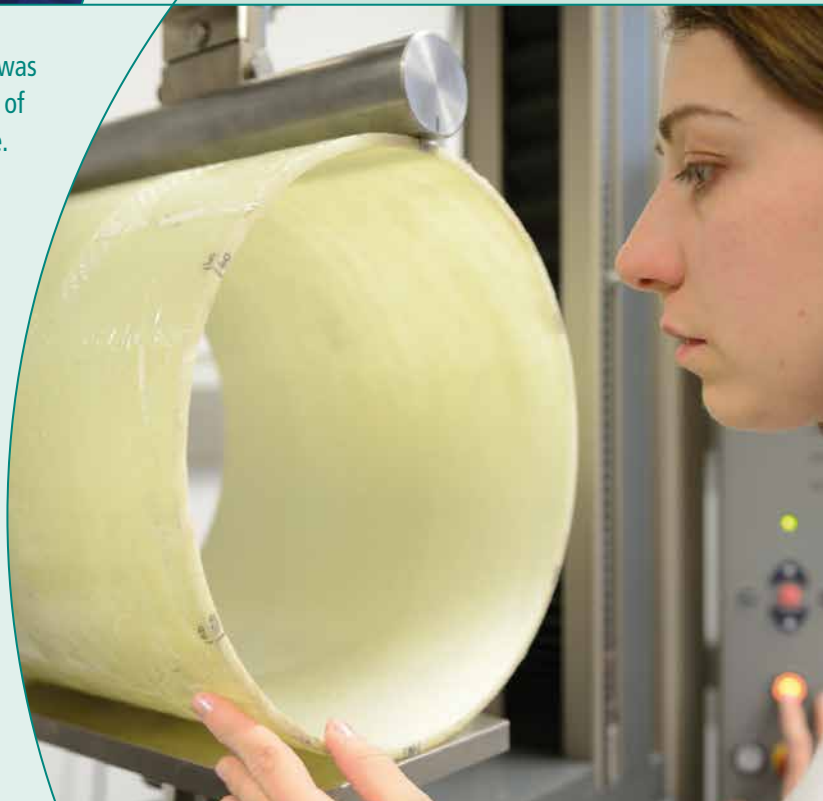
The initial funding for setting up the institute was provided by the Ministry for the Environment of the State of North-Rhine Westphalia, Germany's largest federal state.

However, IKT is not owned by the Government. Its owners are two associations which are also non-profit organisations:

- a) IKT-Association of Network Operators:**
Members are more than 130 cities, among them Berlin, Hamburg, Cologne and London (Thames Water). Together they hold 66.6% of IKT.
- b) IKT-Association of Industry and Service:**
More than 70 companies are members. Together they hold 33.3% of IKT.

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