Competition moves up to the test winner

Reprint of IKT product test „tube liners for lateral pipes“

Liners in the IKT product test

The contestants are close on the heels of the test winner of 2005. In the first IKT product test of house connection liner five years ago, a clearer advantage of the test winner BRAWOLINER appeared in the competition. The latter did not only watch but rather has considerably improved its products in the meantime. Now (almost) all lie WELL at the same level. Only one needs to catch up somewhat, is a prototype however.

Liner in the test

A steering committee consisting of 17 municipal representatives accompanied the product test over the entire project duration. It also made the decision for the liner selection, among others. Only bend-capable liner products were used.

Test installation

In test lines in the IKT large scale test facility, typical damage patterns such as longitudinal and transverse cracks, fragments and missing pipe pieces were reproduced. Two damage scenarios were constructed (cf. Tab. 2):

- Standard situation: Minimum requirements for bend-capable liners
- Extreme situation: Increased requirements through material and nominal width change

Evaluation criteria

The system tests in the test lines (weighting 80%) as well as the quality assurance of the procedure supplier (weighting 20%) were evaluated. Evaluation criteria of the system test were functionality, water tightness, load-bearing capacity as well as the sensitivity to buoyancy.

Tab. 1: Liners in the IKT product test house connection liner 2010

Manufacturer	Liner
Karl Otto Braun GmbH & CO. KG	BRAWOLINER XT
RS-Technik AG	RS MaxLiner-FLEX S
Trelleborg Pipe Seals Duisburg GmbH	DrainLiner
	DrainPlusLiner
	epros®DrainGlassLiner (Prototyp)
	epros®DrainPlusGlassLiner (Prototyp)
Vereinigte Filzfabriken AG	lineTEC ProFlex Liner

Tab. 2: Test installation in the IKT large-scale test facility

Standard situation (= Minimum requirement for liners)	Extreme situation (= Maximum requirement on liner)
Vitrified clay ND 150	Vitrified clay ND 125 and ND 150
Material and nominal widths are uniform	PVC ND 125
no change in dimension	Dimension change ND 125 to ND 150
no material change	Material change PVC to vitrified clay
8 Bends	12 Bends
21 Damages	22 Damages
Rehabilitation through revision opening	Rehabilitation through 90°-bends

Test results of standard situation

In the standard situation, four out of five liners show GOOD performances: BRAWOLINER XT, LineTEC ProFlex Liner, DrainLiner and RS MaxLiner FLEX S. Among the system tests weighted with 80%, all four show an equally high level (GOOD). In the quality assurance (20% weighting), they achieve VERY GOOD rating.

Test lines, extreme situation before covering: different pipe materials and diameter in the IKT large-scale test facility

IKT product test

The epros®DrainGlassLiner that entered into the race as prototype falls compared to the group of four and comes altogether to the overall grade ADEQUATE. Although it is bonded clearly stronger than the competitors with the old pipe, which however leads to significantly higher fracture risks under buoyancy load by ground water. Moreover, as a prototype it still lacks technical approval by the Deutsches Institut für Bautechnik (German Institute for Construction Technology, a government body, German abbreviation: DIBT) and environmental impact certificates.

Test results, extreme situation

In the much more demanding extreme situation, the BRAWOLINER XT qualifies best (VERY GOOD) and thus remains at the same achievement level as in the previous product test of 2005.

The other four liners follow it: DrainPlusLiner, lineTEC ProFlex Liner, RS MaxLiner FLEX S and the prototype epros®DrainPlusGlassLiner. In system test (80% weight), they are all GOOD. Only in quality assurance (20% weight), does the prototype fall because it lacks DIBt approval and UVP certification. Therefore, it attains a strong SATISFACTORY while the remaining three finished with GOOD.

Clear improvement in functionality

Even in bends and offsets, the products hardly showed considerable fold formation. Here there were clear visible improvements compared to earlier test results. Clogging dangers are hardly expected or not at all.

All liners are tight in strand test

In the air pressure test according to DIN EN 1610 all liners proved to be water tight. Even after simulated operation loads by 5-fold high-pressure cleaning and isolated chain spinning, the tested liners remained watertight. Therefore, they fulfil the legal and normative tightness requirements as far as they are correctly incorporated.

Weakness laminate

The characteristics guaranteed in the DIBt approval of the laminates with respect to tightness and minimum wall thickness were not fulfilled a multiple times. More than one-fifth of the laminate test spots did not pass the water tightness test according to APS because the laminate was permeable to water.

Nevertheless, the liners were altogether watertight in the strand test. Apparently, the installation foil and/or adhesion to the old pipe assume the sealing function.

Resin leakage at damaged points

Especially at extensively damaged spots and leaky sockets, considerable quantities of liner resin leaked apparently uncontrolled into the ground. A thinner wall thickness is to be reckoned with at these points. Tightness and load-bearing capacity were characterised by the composite behaviour between liner material, resin leakage as well as old pipe and ground.

Resin leakage at damaged area

Buoyancy risks due to ground water rise

Some liners feature a goal conflict: In order to avoid seepage, they must be bonded strongly with the old pipe. A good adhesion entails, however, an increased fracture risk, namely then, when it comes to the buoyancy through ground water.

Infiltration measurements showed that the cracks in liner material can again lead to extreme infiltration quantities under outside water pressure where appropriate resulting in negligible hence in the liner material that question the rehabilitation goal - infiltration tightness.

High demands on execution

In the installation for the product test, it appeared that the execution on site required technical understanding and skill. This concerns above all the rehabilitation preparations such as cleaning and milling machine tasks as well as soaking on the spot.

Quality supervision necessary on the spot

The test results show that relevant quality characteristics could be examined in the test in detail, however are hardly understood on the spot. This applies especially to the recognition of later weaknesses under outside water pressure, verification of laminate tightness as well as measurement of wall thickness distribution over the pipe strand surface.

Conclusion

In the entire view, the IKT product test „tube liners for lateral pipes" shows that the rehabilitation of defective house connection lines with the tube lining procedure also functions in difficult line routing. This applies to the seal against exfiltration. The tested liner systems are GOOD throughout.

Somewhat different in approach is the situation with infiltration rehabilitation. Buoyancy risks caused by rising ground water occur in this case as consequence of the extensive line sealing. The buoyancy risks can lead to pipe movements and this to liner fractures. So that this does not happen, an integrated rehabilitation planning is called for, which considers the ground water level.

Results available on the Internet

The article represents the results of the IKT product test only in excerpts. The complete research report is on the Internet ready for download: www.ikt.de

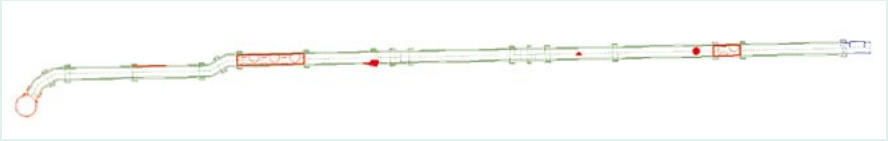
Author

Dipl.-Ing. (FH) Kathrin Harting
IKT - Institute for Underground Infrastructure

(Result tables on the following pages)

Table 3: IKT product test „tube liners for lateral pipes"

Standard situation[1]:



Rehabilitation of three connection sewage lines made of vitrified clay ND 150; correct connection with a connection pipe above the abutment of the main pipe; inversion with PVC KG revision openings at the beginning of the vitrified clay sewage line; bends: 45° and 30°; introduced damages: longitudinal cracks, transverse cracks, fragment formation, missing pipe pieces, improperly fabricated inlet, leaky pipe connections, fat deposits.

Liner supplier			Karl Otto Braun GmbH & CO. KG	VFG Vereinigte Filzfabriken AG	RS-Technik AG	Trelleborg Pipe Seals Duisburg GmbH	Trelleborg Pipe Seals Duisburg GmbH
Tube liner			BRAWOLINER XT 	lineTEC ProFlex Liner 	RS MaxLiner-FLEX S 	DrainLiner 	epros®DrainGlassLiner (Prototype) 
Used substrate material			Polyester fibre tube with polyester urethane film	Polyester fibre tube with polyurethane film	Polyester fibre tube with polyurethane film	Polyester needle felt tube with polyvinylchloride film	Polyester needle felt tube/ECR glass with Polyurethane film
Used resin system			BRAWO I	Biresin lineTEC EP 40	MaxPox 15-40	EPROPOX VIS A2 / B2	EPROPOX VIS A4 / B4
IKT - Test assessment: Standard situation*			**good (1.6)**	**good (1.8)**	**good (1.9)**	**good (2.1)**	**adequate (3.7)**
System test (weighting 80%)			**good (1.8)**	**good (2.1)**	**good (2.1)**	**good (2.4)**	**satisfactory (3.3)**
Functional capability[2] (20%)			1.6	2.1	1.9	1.9	2.3
Tightness (60%)			1.6	1.8	1.8	1,8	1.8
Tightness (60%)		After rehabilitation (30%)	1.0	1.0	1.0	1.0	1.0
	Pipeline test (40%)	After HP cleaning (10%)	1.0	1.0	1.0	1.0	1.0
	Laminate test (10%)	APS-test [3] (10%)	4.4	6.0	6.0	6.0	6.0
		Seepage (2%)	1.0	1.0	1.0	1.0[9]	1.0[9]
	Outside water pressure (10%)	Peeling of interior film (4%)	1.0	1.0	1.0	1.0	1.0
		Bulging (4%)	1.0	1.0	1.0	1.0	1.0
Load-bearing capacity of structure (20%)			2.6	2.6	3.1	4.6	3.5
		Combine thickness[4] (6%)	3.0	3.0	3.0	3.0	6.0
		E-Modulus[5] (6%)	4.4	1.0	1.0	6.0	1.0
Load-bearing capacity of structure (20%)		24h-Creep tendency[6] (6%)	1.0	4.4	6.0	6.0	4.4
		Tightness[7] (2%)	1.0	1.0	1.0	1.0	1.0
Sensitivity under buoyancy[8]			Risk observed	Risk observed	Risk conceivable	Risk conceivable	Risk to expect (depreciation[10])
Quality assurance (weighting 20%)			**very good (1.0)**	**very good (1.0)**	**very good (1.0)**	**very good (1.0)**	**poor (5.5)**
DIBt-certification[11] (50%)			yes	yes	yes	yes	no
environmental impact certificates of the resin presented[11] (10%)			yes	yes	yes	yes	no
Process handbook and training [11] (20%)			yes	yes	yes	yes	no
External monitoring[11] (10%)			yes	yes	yes	yes	no
Proof of disposal suitability[11] (10%)			yes	yes	yes	yes	yes
Construction sites investigation			practice friendly installation	practice friendly installation	practice friendly installation	practice friendly installation	practice friendly installation
Additional information: Available for			ND 100 to ND 200	ND 100 to ND 200	ND 100 to ND 200	ND 100 to ND 300	ND 100 to ND 400
Pipeline test after mechanical cleaning			tight	tight	tight	tight	tight
Recommended improvements			Solving target conflict between adhesion and offset possibility under buoyancy. Strong adhesion led in two test stretches to buoyancy damages.	Solving target conflict between adhesion and offset possibility under buoyancy. Strong adhesion led in two test stretches to buoyancy damages.	Solving target conflict between adhesion and offset possibility under buoyancy. Strong adhesion could lead to buoyancy damages.	Solving target conflict between adhesion and offset possibility under buoyancy. Strong adhesion could lead to buoyancy damages.	Solving target conflict between adhesion and offset suitability under buoyancy. Strong adhesion led in all test stretches to buoyancy damages.

1 The designation „Standard situation" refers to the geometry of the connection sewage.
2 Assessment of the functionality through optical assessment of the rehabilitated standard situation through network operators: 100 Points = 1.0 to 0 points = 6.0; computation by means of a non-linear function.
3 Assessment: 100 % Passed tightness tests according to APS guideline = 1.0; a test series according APS guideline leaky = 4.4; from 2 test series according APS guideline leaky = 6.0.
4 Assessment: Demanded combine thickness kept = 1.0; composite thickness is not attained at individual points, but reaches the means, the demanded value = 3.0; demanded composite thickness predominantly not reached = 6.0.
5 Assessment: Demanded E-modulus in accordance with DIBt certification observed in 3 tests = 1.0; observed in 2 tests = 4.4; observed in only one or no tests observed = 6.0.
6 Assessment: Permissible 24-hr E-modulus in accordance with DIBt certification observed in 3 tests = 1.0; observed in 2 tests = 4.4; observed in only one or in no tests observed = 6.0.
7 Assessment: Demanded tightness in accordance with DIBt certification observed in 3 tests = 1.0; observed in 2 tests = 4.4; observed in only one or no tests observed = 6.0.
8 Assessment: Buoyancy damages did not occur in the test = risk conceivable, buoyancy damages occurred in the test = risk observed; buoyancy damages occurred in the test = risk to expect.
9 Attachment from the house connection line to the main sewage with an LCR brim, made of optical fibre reinforced polypropylene with silicate resin system type W (winter resin) under the use of a pipe rehabilitation device (LCR packer).
10 Depreciation of partial result „System test" by one grade (from 2.3 auf 3.3) because in every test stretches at least a Mal damages were observed under drive load.
11 Assessment: Available = yes; not available = no; allowances/testimonies/proofs must apply to the materials used in the test.
* Grade calculation based on unrounded value

Assessment key of test results: Very gut = 1.0 - 1.5 good = 1.6 - 2.5 satisfactory = 2.6 - 3.5 adequate = 3.6 - 4.5 inadequate = 4.6 - 5.5. poor = 5.6 - 6.0.

Table 4: IKT product test „tube liners for lateral pipes"

Extreme situation[1]:

Rehabilitation of three connection sewages made of vitrified clay and PVC-KG of nominal width ND 125 and ND 150; correct connection with a connection pipe in the abutment of the main tube; inversion through a vitrifed clay bend 90° ND 125 at the beginning of the stone sewage; bends: 45°, 30° and 15°; introduced damages: longitudinal cracks, transverse crack, fragment formation, missing pipe pieces, improperly fabricated material change vitrified clay on PVC KG, improperly fabricated nominal change ND 125 on ND 150, leaky pipe connections, fat deposits.

Liner supplier			Karl Otto Braun GmbH & CO. KG	Trelleborg Pipe Seals Duisburg GmbH	VFG Vereinigte Filzfabriken AG	RS-Technik AG	Trelleborg Pipe Seals Duisburg GmbH
Tube liner			BRAWOLINER XT 	DrainPlusLiner 	lineTEC ProFlex Liner 	RS MaxLiner-FLEX S 	epros®DrainPlusGlassLiner (prototype) 
			Polyester fibre tube with polyester urethane film	Polyester needle felt tube with polyurethane film	Polyester fibre tube with polyurethane film	Polyester fibre tube with polyurethane film	Polyester needle felt tube with polyurethane film
Used resin system			BRAWO I	EPROPOX VIS A2 / B2	Biresin lineTEC EP 40	MaxPox 15-40	EPROPOX VIS A4 / B4
IKT - Test assessment: Extreme situation*			**very good (1.3)**	**good (1.8)**	**good (1.9)**	**good (1.9)**	**satisfactory (2.9)**
System test (weighting 80%)			**very good (1.3)**	**good (2.0)**	**good (2.1)**	**good (2.1)**	**good (2.3)**
Functional capability[2] (20%)			2.1	2.6	2.2	2.5	2.4
Tightness (60%)			1.0	1.0	1.8	1.8	1.8
Tightness (60%)		After rehabilitation (30%)	1.0	1.0	1.0	1.0	1,0
	Pipeline test (40%)	After HP cleaning (10%)	1.0	1.0	1.0	1.0	1,0
	Laminate test (10%)	APS-test[3] (10%)	1.0	1.0	6.0	6.0	6,0
		Seepage (2%)	1.0	1.0[9]	1.0	1.0	1,0[9]
	Outside water pressure (10%)	Peeling of interior film (4%)	1.0	1.0	1.0	1.0	1,0
		Bulging (4%)	1.0	1.0	1.0	1.0	1,0
Load-bearing capacity of structure (20%)			1.6	4.6	2.6	2.6	3.5
Load-bearing capacity of structure (20%)		combine thickness[4] (6%)	3.0	3.0	3.0	3.0	6.0
		E-Modulus[5] (6%)	1.0	6.0	4.4	1.0	1.0
		24h-Creep tendency[6] (6%)	1.0	6.0	1.0	4.4	4.4
		Tightness[7] (2%)	1.0	1.0	1.0	1.0	1.0
Sensitivity under buoyancy[8]			Risk conceivable	Risk observed	Risk conceivable	Risk conceivable	Risk observed
Quality assurance (weighting 20%)			**very good (1.0)**	**very good (1.0)**	**very good (1.0)**	**very good (1.0)**	**poor (5.5)**
DIBt-certification[10] (50%)			yes	yes	yes	yes	no
environmental impact certificates of the resin presented[10] (10%)			yes	yes	yes	yes	no
Process handbook and training [10] (20%)			yes	yes	yes	yes	no
External monitoring[10] (10%)			yes	yes	yes	yes	no
Proof of disposal suitability[10] (10%)			yes	yes	yes	yes	yes
Construction sites investigation			practice friendly installation	practice friendly installation	practice friendly installation	practice friendly installation	practice friendly installation
Additional information: Available for			ND 100 to ND 200	ND 100 to ND 300	ND 100 to ND 200	ND 100 to ND 200	ND 100 to ND 400
Pipeline test after mechanical cleaning			tight	tight	tight	tight	tight
Recommended improvements			Solving target conflict between adhesion and offset suitability under buoyancy. Strong adhesion could lead to buoyancy damages.	Solving target conflict between adhesion and offset suitability under buoyancy. Strong adhesion led in a test stretch to buoyancy damages.	Solving target conflict between adhesion and offset suitability under buoyancy. Strong adhesion could lead to buoyancy damages.	Solving target conflict between adhesion and offset suitability under buoyancy. Strong adhesion could lead to buoyancy damages.	Solving target conflict between adhesion and offset suitability under buoyancy. Strong adhesion led in two test stretches to buoyancy damages.

1 The designation „Extreme situation" refers to the geometry of the connection sewage.
2 Assessment of the functionality through optical evaluation of the rehabilitated standard situation by network operators: 100 Points = 1.0 to 0 points = 6.0; computation by means of a non-linear function.
3 Assessment: 100% Passed tightness tests according to APS guideline = 1.0; a test series according APS guideline leaky = 4.4; from two test series according APS guideline leaky = 6.0.
4 Assessment: Demanded combine thickness kept = 1.0; composite thickness is not attained at individual points, but reaches the means, the demanded value = 3.0; demanded composite thickness predominantly not reached = 6.0.
5 Assessment: Demanded E-modulus in accordance with DIBt certification observed in three tests = 1.0; observed in 2 tests = 4.4; observed in only one or no tests observed = 6.0.
6 Assessment: Permissible 24-hr E-modulus in accordance with DIBt certification observed in three tests = 1.0; observed in 2 tests = 4.4; observed in only one or in no tests observed = 6.0.
7 Assessment: Demanded tightness in accordance with DIBt certification observed in three tests = 1.0; observed in 2 tests = 4.4; observed in only one or no tests observed = 6.0.
8 Assessment: Buoyancy damages did not occur in the test = risk conceivable, buoyancy damages occurred in the test = risk observed; buoyancy damages occurred in the test = risk to expect.
9 Attachment from the house connection line to the main sewage with an LCR brim, made of optical fibre reinforced polypropylene with silicate resin system type W (winter resin) under the use of a pipe rehabilitation device (LCR packer).
10 Assessment: Available = yes; not available = no; allowances/testimonies/proofs must apply to the materials used in the test.
* Grade calculation based on unrounded values

Assessment key of test results: Very gut = 1.0 - 1.5 good = 1.6 - 2.5 satisfactory = 2.6 - 3.5 adequate = 3.6 - 4.5 inadequate = 4.6 - 5.5. poor = 5.6 - 6.0.

neutral
independent
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 more than 120 cities, among them Berlin, Hamburg, Cologne and London (Thames Water). They hold together 66.6% of IKT.

b) IKT-Association of Industry and Service:
Members are more than 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

IKT is located
ca. 30 min. off Düsseldorf
International Airport.

Published: September 2010
Circulation: 3.000 copies
Protective charge: 19,95 €