Deutsches Institut für Bautechnik

Eine vom Bund und den Ländern gemeinsam getragene Anstalt des öffentlichen Rechts

Zulassungs- und Genehmigungsstelle für Bauprodukte und Bauarten

Allgemeine bauaufsichtliche Zulassung / Allgemeine Bauartgenehmigung

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Nummer:
Z-42.3-468

Geltungsdauer
vom: **24 March 2023**
bis: **24 March 2028**

Antragsteller:
Trelleborg Pipe Seals Duisburg GmbH
Dr. Alfred-Herrhausen-Allee 36
47228 Duisburg

Gegenstand dieses Bescheides:
Construction products and their use for the execution of pipe liners with the designation "Trelleborg DrainLiner Process" and the resin systems "Trelleborg Epoxy HC120" and "Trelleborg Epoxy HC120+" for the rehabilitation of defective, buried sewage pipes in the nominal width range DN 100 to DN 600.

The above-mentioned subject of regulation is hereby generally approved/authorised by the building authorities.
This decision consists of 28 pages and 27 annexes.

I GENERAL PROVISIONS

1 This notice proves the usability or applicability of the subject matter of the regulation in terms of the state building regulations.

2 This notice does not replace the permits, approvals and certificates required by law for the implementation of building projects.

3 This notice is issued without prejudice to the rights of third parties, in particular private property rights.

4 Notwithstanding further provisions in the "Special Provisions", copies of this notice shall be made available to the user of the subject matter of the regulation. In addition, the user of the subject of the regulation must be informed that this notification must be available at the place of use or application. Copies must also be made available to the authorities involved upon request.

5 This notice may only be reproduced in full. Publication of excerpts requires the consent of Deutsches Institut für Bautechnik. Texts and drawings of advertising material must not contradict this notice, translations must contain the note "Translation of the original German version not verified by Deutsches Institut für Bautechnik".

6 This notice is issued revocably. The provisions may be subsequently supplemented and amended, in particular if new technical findings so require.

7 This notice refers to the information provided and documents submitted by the applicant. Any change in these basic principles is not covered by this notification and must be disclosed to Deutsches Institut für Bautechnik without delay.

II SPECIAL PROVISIONS

1 Object of regulation and scope of use or application

This notice applies to the manufacture and use of pipe liners with the designation "Trelleborg DrainLiner Process" (Appendix 1) consisting of the polyester needle-felt hoses with the designations "Trelleborg DrainLiner", "Trelleborg MainLiner" and "Trelleborg ProLiner", as well as the associated two-component epoxy resin systems with the designations "Trelleborg Epoxy HC120" and "Trelleborg Epoxy HC120+" for the renovation and rehabilitation of defective, underground wastewater pipes with circular cross-sections in the nominal sizes DN 100 to DN 600. Trelleborg MultiFlexLiner" and "Trelleborg UltraFlexLiner" are approved for the renovation and rehabilitation of damaged underground wastewater pipes with circular cross-sections in the nominal sizes DN 100 to DN 600.

This notice applies to the renovation or rehabilitation of wastewater pipes that are intended to discharge wastewater in accordance with DIN [1986-31].

The pipe liners may be used for the renovation or rehabilitation of waste water pipes made of concrete, reinforced concrete, stoneware, asbestos-free fibre cement, the plastics GRP, PVC, PE, PP and cast iron, provided that the cross-section of the waste water pipe to be rehabilitated meets the process-related requirements and the static requirements.

Defective sewage pipes are rehabilitated by inserting and subsequent hot water or steam curing of an epoxy resin impregnated, coated polyester needle fleece slack.

In the groundwater-saturated zone (groundwater infiltration), a polyethylene protective sleeve (PE preliner) must be inserted before the resin-impregnated polyester needle fleece hose is inverted.

Watertight reconnections of side inlets are to be carried out using repair or renovation procedures for which general building inspectorate approvals with the associated design approvals are valid. The reconnection of side inlets in open construction is also possible.

2 Provisions for the construction products

2.1 Properties and composition

2.1.1 General

Where applicable, the pipe liners referred to in Section 1 comply with the requirements of DIN EN ISO [11296-42] and have the specific properties and compositions listed below.

2.1.2 Materials of the process components in the "M" state

2.1.2.1 Materials for the inversion hoses (Appendix 1)

The materials of the polyester needlefelt hose (PES hose), whose coating is made of PVC (polyvinyl chloride), PUR (polyurethane), SK (silicone), TPU (thermoplastic poly- urethane) or PP (polypropylene) films, and the materials of the epoxy resin systems with the designations "Trelleborg Epoxy HC120" and "Trelleborg Epoxy HC120+", including the hardener used, must comply with the formulation details deposited with Deutsches Institut für Bautechnik.

1	DIN	1986-3Drainage systems for buildings and sites - Part 3: Rules for operation and maintenance; Edition:2004-11
2	DIN EN ISO	11296-4Plastic piping systems for the renovation of buried non-pressurised pipelines Drainage networks (gravity sewer systems) - Part 4: In-situ curing hose-lining (ISO 11296-4:2018); German version EN ISO 11296-4:2018; Ausgabe:2018-09

- The polyester needlefelt tubing has, among other things, the following properties (Appendix 1, points 1 to 4f):
  1. "Trelleborg DrainLiner" DN 100 to DN 600 with PVC coating: Weight per unit area: Appendix 2, Tables A
     Coating thickness PVC: 0.40 mm to 0.60 mm (4a)
  2. "Trelleborg MainLiner" DN 150 to DN 600 with PP coating: Weight per unit area: Appendix 6, Tables G
     Coating thickness PP: 0.30 mm to 0.60 mm (4b)
  3. "Trelleborg ProLiner" DN 100 to DN 600 with PP coating: Weight per unit area: Appendix 3 Table B
     Coating thickness PP: 0.30 mm to 0.60 mm (4c)
  4. "Trelleborg MultiFlexLiner" DN 100 to DN 250 with PUR coating: Weight per unit area: Appendix 4 Tables C and D
     Coating thickness PUR: 0.20 mm to 0.25 mm (4d)
  5. "Trelleborg UltraFlexLiner" DN 100 to DN 250 with SK coating: Weight per unit area: Appendix 5 Table F (4e)
     Coating thickness SK: 0.45 mm to 0.75 mm
  6. "Trelleborg UltraFlexLiner" DN 100 to DN 250 with TPU coating:
     Weight per unit area: Appendix 5 Table E
     Coating thickness TPU: 0.15 mm to 0.25 mm (4f)
- The resin systems "Trelleborg Epoxy HC120" and "Trelleborg Epoxy HC120+" have the following properties, among others:
  1. Epoxy resin component A "Trelleborg Epoxy HC120":
     Density at +23 °C based on
     DIN EN ISO [1183-1][3]: 1.16 g/cm³ ± 10 %
     Viscosity at +25 °C based on
     DIN EN ISO [3219-2][4]: 2,430 mPa x s ± 1,500 mPa x s[A)]
  2. Epoxy resin component A "Trelleborg Epoxy HC120+":
     Density at +23 °C based on
     DIN EN ISO [1183-1][3]: 1.23 g/cm³ ± 10 %
     Viscosity at +25 °C based on
     DIN EN ISO [3219-2][4]: 5,250 mPa x s ± 1,250 mPa x s[A)]
  3. Hardener component B "Trelleborg Epoxy HC120" and "Trelleborg Epoxy HC120+": Density at +23 °C based on
     DIN EN ISO [1183-1][3]: 0.96 g/cm³ ± 10 %
     Viscosity at +25 °C based on
     DIN EN ISO [3219-2][4]: 242 mPa x s ± 50 mPa x s[A)]

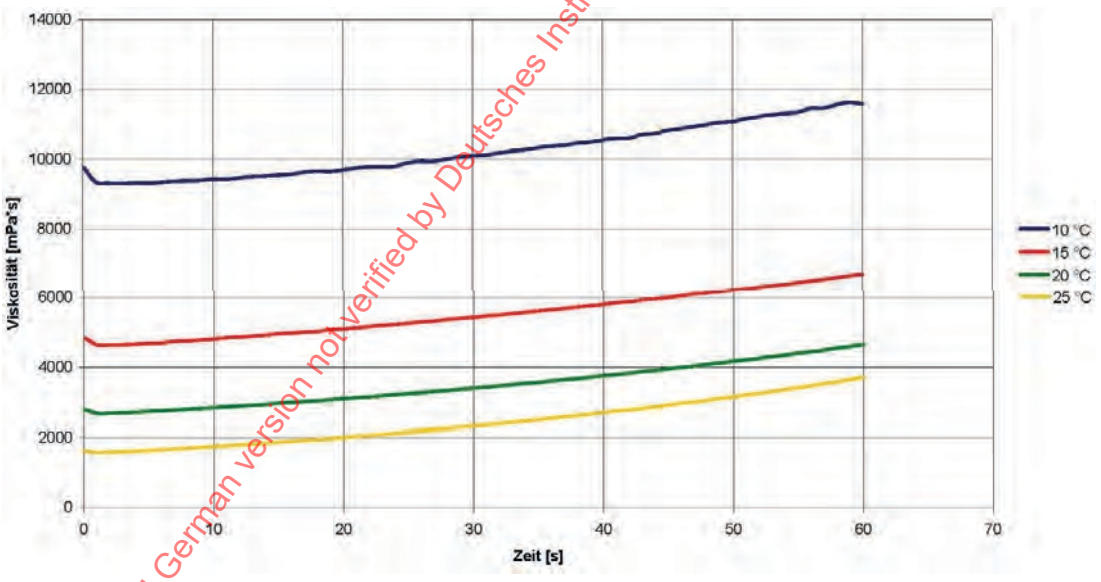
[3] DIN EN ISO 1183-1Plastics - Method for the determination of the density of non-foamed plastic materials

		materials - Part 1: Immersion method, liquid pycnometer method and titration method (ISO 1183-1:2012); German version EN ISO 1183-1:2012, Ausgabe:2013-04
4	DIN EN ISO	3219-2Rheology - Part 2: General principles of rotational and oscillatory rheometry (ISO 3219-2:2021); German version EN ISO 3219-2:2021 Ausgabe:2021-08
A)	Measurement plate / cone, α = 1° and 100 1/s radius 25 mm	

4. The epoxy resin systems "Trelleborg Epoxy HC120" and "Trelleborg Epoxy HC120+" have the following properties in the cured state, based on DIN [16946-25] Table 1, Type 1040-0, without the polyester needle fleece hose:

Density at +23 °C "Trelleborg Epoxy HC120":	1.15 g/cm³ ± 10 %
Density at +23 °C "Trelleborg Epoxy HC120+":	1.18 g/cm³ ± 10 %
Bending E-module "Trelleborg Epoxy HC120":	≈ 2,900 MPa
Bending E-module "Trelleborg Epoxy HC120+":	≈ 3,200 MPa
Bending stress σ_{fB} "Trelleborg Epoxy HC120":	≈ 120 MPa
Bending stress σ_{fB} "Trelleborg Epoxy HC120+":	≈ 85 MPa
Tensile strength "Trelleborg Epoxy HC120":	≈ 70 MPa
Tensile strength "Trelleborg Epoxy HC120+":	≈ 55 MPa
Elongation at break "Trelleborg Epoxy HC120":	> 7,0 %
Elongation at break "Trelleborg Epoxy HC120+":	> 8,5 %
Heat deflection temperature according to DIN EN ISO [75-26]:	≈ 92 °C
Reactivity (pot life) at +25 °C:	85 minutes to 140 minutes

Diagram 1: Mixing viscosity of the resin systems "Trelleborg Epoxy HC120 (A+B)" and "Trelleborg Epoxy HC120+ (A+B)".



Only epoxy resins (EP resins) according to Table 1 of DIN [169465] may be used, which must comply with the formulation details and IR spectra deposited at Deutsches Institut für Bautechnik. The IR spectra shall also be deposited with the third party inspection body by the applicant of this certificate.

5	DIN 16946-2	Reactive resin moulding materials; Casting resin moulding materials; Types; Issue:1989-03
6	DIN EN ISO	75-2Plastics - Determination of heat deflection temperature - Part 2: Plasti-materials and hard rubber (ISO 75-2:2004); German version EN ISO 75-2:2004; Publication:2004-09

2.1.2.2 Material of the swelling belt (auxiliary material)

For the swelling tape (auxiliary material) in the area of the manhole connection (Annex 17) of the pipe liner, only extruded profiles consisting of a chloroprene (CR/SBR) rubber and water-absorbing resin may be used. The swelling tapes shall have a volume increase of at least 100 % after 72 hours when immersed in water.

2.1.3 Environmental compatibility

In compliance with the Special Provisions of this notice, the construction products meet the "Principles for the Evaluation of the Impact of Construction Products on Soil and Groundwater" (version: 2011; publications of the German Institute for Construction Technology) and thus the level of protection by the building authorities specified by the "Requirements for Structural Systems with Regard to the Impact on Soil and Water" (ABuG; Annex 10 of the Model and Administrative Regulation Technical Building Regulations 2021/1).

The reservation of permission, especially in water protection zones, by the competent water authority remains unaffected.

2.2 Production, packaging, transport, storage and labelling

2.2.1 Production

2.2.1.1 Factory production of the pipe liner

The polyester needlefelt hoses with the raw wall thicknesses specified in section 2.1.2.1 shall be manufactured in the factory of the sub-supplier with an outer flexible PVC, PUR, SK, TPU or PP film. The applicant shall satisfy himself that the pre-supplier complies with the specified length dimensions and raw wall thicknesses.

The applicant shall have the properties of the resin and hardener checked by means of factory certificates 2.2 in accordance with DIN EN [102047].

The following properties must be checked as part of the incoming goods inspection: Properties of the resin:

- Density
- Viscosity

2.2.2 Packaging, transport, storage

The single-sided coated polyester needlefelt hoses delivered by the pre-supplier shall be stored on the applicant's premises before further use in such a way that the hoses are not damaged.

The components delivered by the pre-supplier for resin impregnation on the respective construction site are to be stored in suitable, separate, airtight containers on the applicant's premises until further use. The temperature range of +15 °C to approx. +35 °C must be observed. The storage time for the epoxy resin and hardener is approx. 12 months after delivery and must not be exceeded. The containers must be protected from direct sunlight. The containers must be designed in such a way that the epoxy resins and hardeners are stored in separate individual containers.

The quantities of components required for the remediation measures are to be taken from the storage containers and transported to the respective place of use in suitable, separate and hermetically sealed containers. At the place of use, the containers must be protected from the weather. The polyester needle fleece hoses must be transported in suitable transport containers in such a way that they are not damaged.

During storage and transport, the relevant accident prevention regulations and the instructions in the applicant's process manual must be observed.

7 DIN EN 10204Metallic products - Types of inspection certificates; German version EN 10204:2004; Issue:2005-01

2.2.3 Labelling

The polyester needle fleece hoses and the respective transport containers of the resin components must be marked with the mark of conformity (Ü mark) in accordance with the conformity mark ordinances of the federal states, including the notification number Z-42.3-468. The marking may only be carried out if the requirements according to section 2.3 Confirmation of conformity are fulfilled.

The manufacturer must indicate the hazard symbols and H and P phrases on the container, on the packaging, on the instruction leaflet or in the delivery note in accordance with the Ordinance on Hazardous Substances and EU Regulation No. 1907/2006 (REACH) as well as the respective current version of CLP Regulation (EC) [8] 1272/20088. The packaging must be labelled in accordance with the rules of [9] ADR9 in the respective applicable versions.

In addition, the transport containers of the polyester needlefelt hoses shall state:

- Nominal width
- raw wall thickness
- Length
- Batch number
- Foil coatings PVC, PUR, SK, TPU or PP

In addition, the transport containers for resins and hardeners must be labelled at least as follows:

- Component name
- Temperature range
- Container content (volume or weight)

2.3 Confirmation of conformity

2.3.1 General

The confirmation of conformity of the construction products with the provisions of the general building approval covered by this notice shall be made for each manufacturing plant with a declaration of conformity on the basis of a factory production control and a certificate of conformity of a certification body recognised for this purpose as well as a regular external surveillance by a recognised surveillance body including an initial test of the construction products in accordance with the following provisions.

For the issuing of the certificate of conformity and the external surveillance including the product tests to be carried out, the manufacturer of the construction products shall involve a certification body recognised for this purpose as well as a surveillance body recognised for this purpose.

The manufacturer shall submit the declaration of conformity by marking the construction products with the mark of conformity (Ü mark) with reference to the intended use.

The certification body shall provide the Deutsches Institut für Bautechnik with a copy of the certificate of conformity issued by it.

The Deutsches Institut für Bautechnik shall also be provided with a copy of the initial inspection report.

2.3.2 In-house production control

In each manufacturing plant, a factory production control shall be established and carried out. Factory production control is defined as the process to be carried out by the manufacturer.

[8] 1272/2008Regulation (EC) No 1272/2008 on classification, labelling and packaging of substances and mixtures

[9] ADREuropean Agreement concerning the International Carriage of Dangerous Goods Goods by Road (*Accord européen relatif au transport international des marchandises Dangereuses par Route)*

The term "continuous surveillance of production" is understood to mean the continuous surveillance of production by the manufacturer to ensure that the construction products manufactured by him comply with the provisions of the general building approval covered by this notice.

The factory production control shall include at least the measures listed below.

- Description and verification of the source material:

  The operator of the manufacturing plant shall satisfy himself that the required properties according to section 2.1.2 are met for each delivery of the components of PVC, PUR, SK, TPU or PP film, polyester fibres, resin and hardener.

  For this purpose, the operator of the manufacturing plant must obtain the corresponding works certificates 2.2 from the respective supplier in accordance with DIN EN 102047. Within the scope of the incoming goods inspection, the properties mentioned in section 2.1.2.1 must also be checked on a random basis (in the case of polyester needled fleece hoses, the raw wall thicknesses) in accordance with the procedures deposited with Deutsches Institut für Bautechnik.

- Checks and tests to be carried out during manufacture: The requirements according to section 2.2.1 shall be checked.

- Checking the containers:

  For each batch of resin, the requirements for labelling according to section 2.2.3 shall be checked.

The results of factory production control shall be recorded and evaluated. The records shall contain at least the following information:

- Designation of the construction products or the basic materials and the components,
- Type of control or audit,
- Date of manufacture and testing of the construction products or of the basic materials or of the constituents,
- Result of the checks and tests and, where applicable, comparison with the requirements,
- Signature of the person responsible for factory production control.

The records must be kept for at least five years and submitted to the inspection body responsible for third-party inspection. They shall be submitted to Deutsches Institut für Bautechnik and the competent supreme building supervisory authority upon request.

If the test result is unsatisfactory, the manufacturer shall immediately take the necessary measures to remedy the defect. Construction products which do not comply with the requirements shall be handled in such a way that confusion with matching products is excluded. After the defect has been remedied, the test in question must be repeated without delay, insofar as this is technically possible and necessary to prove that the defect has been remedied.

2.3.3 External monitoring

In each manufacturing plant, the factory and the factory production control shall be inspected regularly by an external inspection, but at least once every six months.

An initial test of the construction products must be carried out as part of the external surveillance. The factory production control shall be carried out within the scope of the external surveillance by means of random tests. The requirements of sections 2.1.2 and 2.2.3 shall be checked.

In addition, the requirements for production according to section 2.2.1 shall be checked on a random basis. This also includes checking the curing behaviour, density, storage stability and weight per unit area as well as IR spectroscopies.

Sampling and testing are the responsibility of the recognised inspection body. During the external inspection, the works certificates 2.1 are also to be checked in accordance with DIN EN [102047].

The results of certification and external surveillance shall be kept for at least five years. They shall be submitted by the certification body or the inspection body to Deutsches Institut für Bautechnik and the competent supreme building supervisory authority upon request.

3 Provisions for the application of the subject matter of the regulation

3.1 Planning and dimensioning

3.1.1 Planning

The details of the necessary pipe data must be checked, including in particular the routing, depth, position of the side inlets, shaft depths, groundwater, pipe connections, hydraulic conditions, inspection openings, cleaning intervals. Existing video recordings must be evaluated in relation to the application. The accuracy of the information must be checked on site. Assess the condition of the existing wastewater pipe of the property drainage system with regard to the applicability of the rehabilitation procedure.

The hydraulic efficiency of the wastewater pipes must not be impaired by the installation of a pipe liner. Proof of this must be provided if necessary.

3.1.2 Dimensioning

3.1.2.1 Hose liner in the "I" state

3.1.2.1.1 Wall thickness and wall construction

Due to the system, resin-impregnated pipe liners are used for a rehabilitation measure, which have a design wall thickness of at least 3 mm after inversion and curing (Tables 1 to 4).

Sewage pipes whose load-bearing capacity alone (without support of the surrounding soil) is given, i.e. no cracks (except hairline cracks with crack widths of less than 0.15 mm or, in the case of reinforced concrete pipes, less than 0.3 mm) are present, may only be rehabilitated with pipe liners according to Tables 1 to 4 if the nominal stiffness SN ≥ 500 N/m² is maintained. If there are one or more continuous longitudinal cracks in the old pipe, soil investigations, e.g. by means of dynamic probing, are required and corresponding proof of calculation must be provided. In the case of infiltrations, the pipe liner must also be dimensioned with regard to deformation and buckling behaviour.

If the old pipe-floor system alone is no longer load-bearing, such wastewater pipes may only be rehabilitated with pipe liners with the design wall thicknesses listed in Tables 1 to 4 if the static loads to be absorbed by the pipe liner are verified by a stability certificate in accordance with Code of Practice DWA-A [143-210].

To calculate the short-term annular stiffness SR of the cured pipe liner, the design wall thicknesses in tables 1 to 4 must be observed.

[10] DWA-A 143-2German Association for Water, Wastewater and Waste e. V. (DWA) - Code of Practice 143: Rehabilitation of drainage systems outside buildings - Part 2: Structural calculations for the rehabilitation of wastewater pipes and sewers using lining and installation methods; Ausgabe:2015-07

Table 1: Design wall thicknesses of the pipe liner in the cured state and nominal stiffnesses SN [N/m²] a) of the "Trelleborg Epoxy HC120" resin system

Außendurchmesser des Schlauchliners	wanddicke s										
in mm	3 mm	3,5 mm	4,5 mm	6 mm	7,5 mm	9 mm	10,5 mm	12 mm	15 mm	18 mm	21 mm
100	5.547	8.946	19.617	--	--	--	--	--	--	--	--
125	2.788	4.482	9.765	--	--	--	--	--	--	--	--
150	1.594	2.557	5.547	1.3563	--	--	--	--	--	--	--
200	662	1.060	2.287	5.547	--	--	--	--	--	--	--
225	--	740	1.594	3.856	--	--	--	--	--	--	--
250	--	537	1.155	2.788	--	--	--	--	--	--	--
300	--	--	662	1.594	3.161	5.547	8.946	13.563	--	--	--
350	--	--	--	995	1.969	3.447	5.547	8.391	--	--	--
400	--	--	--	662	1.308	2.287	3.673	5.547	--	--	--
450	--	--	--	--	913	1.594	2.557	3.856	7.688	--	--
500	--	--	--	--	662	1.155	1.851	2.788	5.547	9.765	--
600	--	--	--	--	--	662	1.060	1.594	3.161	5.547	8.946

a) Calculation of the stiffnesses SN and SR with the short-time E-modulus E = 2.250 MPa according to DIN EN 1228

Table 2: Design wall thicknesses of the pipe liner in the cured state and short-term ring stiffnesses SR [N/mm²] b) of the resin system "Trelleborg Epoxy HC120".

Außendurchmesser des Schlauchliners	wanddicke s										
in mm	3 mm	3,5 mm	4,5 mm	6 mm	7,5 mm	9 mm	10,5 mm	12 mm	15 mm	18 mm	21 mm
100	0,044	0,072	0,157	--	--	--	--	--	--	--	--
125	0,022	0,036	0,078	--	--	--	--	--	--	--	--
150	0,013	0,020	0,044	0,109	--	--	--	--	--	--	--
200	0,005	0,008	0,018	0,044	--	--	--	--	--	--	--
225	--	0,006	0,013	0,031	--	--	--	--	--	--	--
250	--	0,004	0,009	0,022	--	--	--	--	--	--	--
300	--	--	0,005	0,013	0,025	0,044	0,072	0,109	--	--	--
350	--	--	--	0,008	0,016	0,028	0,044	0,067	--	--	--
400	--	--	--	0,005	0,010	0,018	0,029	0,044	--	--	--
450	--	--	--	--	0,007	0,013	0,020	0,031	0,062	--	--
500	--	--	--	--	0,005	0,009	0,015	0,022	0,044	0,078	--
600	--	--	--	--	--	0,005	0,008	0,013	0,025	0,044	0,072

b) Calculation of the stiffnesses SN and SR with the short-time E-modulus E = 2.250 MPa according to DIN EN 1228

Table 3: Design wall thicknesses of the pipe liner in the cured state and nominal stiffnesses SN [N/m²] [c] of the resin system "Trelleborg Epoxy HC120+".

Außendurchmesser des Schlauchliners	wanddicke s										
in mm	3 mm	3,5 mm	4,5 mm	6 mm	7,5 mm	9 mm	10,5 mm	12 mm	15 mm	18 mm	21 mm
100	6.410	10.337	22.668	--	--	--	--	--	--	--	--
125	3.222	5.179	11.284	--	--	--	--	--	--	--	--
150	1.842	2.954	6.410	15.673	--	--	--	--	--	--	--
200	7.65	1.224	2.642	6.410	--	--	--	--	--	--	--
225	535	855	1.842	4.456	--	--	--	--	--	--	--
250	--	620	1.334	3.222	--	--	--	--	--	--	--
300	--	--	765	1.842	3.653	6.410	10.337	15.673	--	--	--
350	--	--	--	1.150	2.275	3.983	6.410	9.696	--	--	--
400	--	--	--	765	1.512	2.642	4.245	6.410	--	--	--
450	--	--	--	535	1.055	1.842	2.954	4.456	8.884	--	--
500	--	--	--	--	765	1.334	2.138	3.222	6.410	11.284	--
600	--	--	--	--	--	765	1.224	1.842	3.653	6.410	10.337

[c] Calculation of the stiffnesses SN and SR with the short-time E-modulus E = 2,600 MPa according to DIN EN 1228

Table 4: Design wall thicknesses of the pipe liner in the cured state and short-term ring stiffnesses SR [N/mm²] [d] of the resin system "Trelleborg Epoxy HC120+".

Außendurchmesser des Schlauchliners	wanddicke s										
in mm	3 mm	3,5 mm	4,5 mm	6 mm	7,5 mm	9 mm	10,5 mm	12 mm	15 mm	18 mm	21 mm
100	0,051	0,083	0,181	--	--	--	--	--	--	--	--
125	0,026	0,041	0,090	--	--	--	--	--	--	--	--
150	0,015	0,024	0,051	0,125	--	--	--	--	--	--	--
200	0,006	0,010	0,021	0,051	--	--	--	--	--	--	--
225	0,004	0,007	0,015	0,036	--	--	--	--	--	--	--
250	--	0,005	0,011	0,026	--	--	--	--	--	--	--
300	--	--	0,006	0,015	0,029	0,051	0,083	0,125	--	--	--
350	--	--	--	0,009	0,018	0,032	0,051	0,078	--	--	--
400	--	--	--	0,006	0,012	0,021	0,034	0,051	--	--	--
450	--	--	--	0,004	0,008	0,015	0,024	0,036	0,071	--	--
500	--	--	--	--	0,006	0,011	0,017	0,026	0,051	0,090	--
600	--	--	--	--	--	0,006	0,010	0,015	0,029	0,051	0,083

[d] Calculation of the stiffnesses SN and SR with the short-time E-modulus E = 2,600 MPa according to DIN EN 1228

For the groundwater load case, the pipe liner must also be designed with regard to buckling in accordance with Code of Practice DWA-A [143-210] (see also Section 3.1.2.1.4).

Regardless of the result of the stability verification, the SDR maximum value of the design wall thickness of 135 must not be exceeded.

The followingrelationshipsapply to the nominal stiffness SN and short-term annular stiffness SR:For SN applies: For SR applies

$$SN = \frac{E \cdot s^3}{12 \cdot r_m^3} \qquad SR = \frac{E \cdot s^3}{12 \cdot r_m^3}$$

(SN = nominal stiffness based on DIN 16869-2[11]) (r_m = centre of gravity radius)

If the wastewater pipe to be rehabilitated is located in the groundwater-saturated zone, the pipe liners have a three-layer wall structure due to the PE protective film to be inserted. This consists of the PE protective film, the polyester needle fleece layer and the PVC, PUR, SK, TPU or PP film (Appendix 1). In soil conditions where there is no groundwater, the protective film can be dispensed with. In this case, the hose liners have a two-layer wall structure consisting of the polyester needle fleece layer and the PVC, PUR, SK, TPU or PP film.

3.1.2.1.2 Physical characteristics of the cured pipe liner

After curing of the polyester needle fleece layer impregnated with resin and hardener (laminate without preliner and inner coating)), cured pipe liners must have the following minimum characteristic values (testing of the test pieces with the composite wall thickness = design wall thickness plus wear layer and pure resin layer = laminate):

1) with the "Trelleborg Epoxy HC120" resin system

- Density according to DIN EN ISO [1183-212]: 1.16 g/cm³ ± 10 %
- Short-term circumferential E-modulus based on DIN EN [122813]: ≥ 2,250 MPa
- Bending modulus of elasticity according to DIN EN ISO [11296-42] or DIN EN ISO [17814]: ≥ 2,500 MPa
- Bending stress σ_{fB} following DIN EN ISO 11296-4[2] or DIN EN ISO [17814]: ≥ 75 MPa

2) with the resin system "Trelleborg Epoxy HC120+".

- Density according to DIN EN ISO [1183-212]: 1.18 g/cm³ ± 10 %
- Short-term circumferential E-modulus based on DIN EN [122813]: ≥ 2,600 MPa
- Bending modulus of elasticity according to DIN EN ISO [11296-42] or DIN EN ISO [17814]: ≥ 2,600 MPa
- Bending stress σ_{fB} following DIN EN ISO 11296-4[2] or DIN EN ISO [17814]: ≥ 55 MPa

3.1.2.1.3 Properties of the cured pipe liner based on thermal analysis (DSC analysis)

The cured polyester fibre resin composite has the following limit values, which were determined by means of Differential Scanning Calorimetry (DSC):

11	DIN 16869-2	Pipes of glass fibre reinforced polyester resin (UP-GF), centrifuged, filled- Part 2: General quality requirements, testing; Issue:1995-12
12	DIN EN ISO	1183-2Plastics - Method for the determination of the density of non-foamed plastics Plastics - Part 2: Density gradient column method (ISO 1183-2:2019); German version EN ISO 1183-2:2019; Ausgabe:2019-06
13	DIN EN	1228Plastic piping systems - Pipes made of glass-fibre reinforced thermosetting plastics Plastics (GRP) - Determination of initial specific annular stiffness; German version EN 1228:1996; Ausgabe:1996-08
14	DIN EN ISO 178	Plastics -Determination of flexural properties (ISO 178:2019); German version EN ISO 178:2019; Ausgabe:2019-08

a) Trelleborg Epoxy HC120" resin system
Glass transition temperature T_{G1} (Actual state of the reaction resin system; first heating phase)

approx. +45 °C

Glass transition temperature T_{G2} (resin system in fully cured state; second heating phase)

approx. +103 °C

b) Resin system "Trelleborg Epoxy HC120+"
Glass transition temperature T_{G1} (Actual state of the reaction resin system; first heating phase)

approx. +77 °C

Glass transition temperature T_{G2} (resin system in fully cured state; second heating phase)

approx. +106 °C

3.1.2.1.4 Static calculation of the cured pipe liner

If a structural analysis is required for renovation measures, the stability must be verified in accordance with the DWA-A [143-210] worksheet of the "Deutsche Vereinigung für Wasserwirtschaft, Abwasser und Abfall e. V. (DWA)" (German Association for Water, Wastewater and Waste) prior to execution.

For the stability verification, the following values including the partial safety factor γ_M for the pipe liner material and the reduction factor A for determining the long-term values in accordance with DIN EN [76115] must be taken into account:

1) Resin system "Trelleborg Epoxy HC120

- Short-term bending stresses σ_{fB} based on DIN EN ISO [11296-42] or DIN EN ISO [17814]:	≥ 75 MPa
- Long-term bending stresses σ_{fB}:	≥ 25 MPa
- Short-term circumferential E-modulus based on DIN EN [122813]:	≥ 2,250 MPa
- Long-term circumferential E-module:	≥ 755 MPa
- Partial safety factor γ_M:	1,35
- Reduction factor A after 10,000 h:	2,98

2) "Trelleborg Epoxy HC120+" resin system

- Short-time bending stresses σ_{fB} following DIN EN ISO [11296-42] or DIN EN ISO [17814]:	≥ 55 MPa
- Long-term bending stresses σ_{fB}:	≥ 14 MPa
- Short-term circumferential E-modulus based on DIN EN [122813]:	≥ 2,600 MPa
- Long-term circumferential E-module:	≥ 653 MPa
- Partial safety factor γ_M:	1,35
- Reduction factor A after 10,000 h:	3,98

3.2 Version

3.2.1 General

Damaged sewage pipes are rehabilitated by inserting and subsequently curing a resin-impregnated polyester needle fleece hose. For this purpose, a polyester needle fleece hose (PES hose), which is covered on the outside with a flexible polyvinyl chloride film (PVC) or a polyurethane film (PUR) or with a silicone film (SK),

15 DIN EN 761Plastic piping systems - Pipes of glass fibre reinforced thermosetting plastics Plastics (GRP) - Determination of creep factor in the dry state; German version EN 761:1994; Ausgabe:1994-08

thermoplastic polyurethane (TPU) or enclosed with a polypropylene film (PP) is impregnated with a two-component epoxy resin (EP resin).

In the case of the hose lining method with closed end (close-end method), the polyester needle fleece hose is inverted into the defective wastewater pipe to be rehabilitated by means of compressed air using an inversion drum (inversion) and curing takes place via hot water (VARIANT 1) or by means of steam curing (VARIANTS 2 and 3). When installing a pipe liner with the "water column" process variant (VARIANT 4), the polyester needle fleece hose is inverted into the pipe by means of water gravity. In the case of rehabilitation with an open end, a calibration hose is additionally or simultaneously injected. The PVC, PUR, SK, TPU or PP film is placed on the side facing the wastewater as a result of the inversion of the polyester needle fleece hose. Air or water is applied and the film is pressed positively against the inner wall of the pipe. The resin-impregnated polyester needle fleece hose is cured by means of hot water circulation.

The "Trelle- borg DrainLiner method" can be used for the following structural conditions:

a) From the starting point to the destination
b) From the starting point to the destination through an intermediate shaft
c) Starting from the starting point in a waste water pipe with a defined length, without the need for a further manhole opening
d) Side inlets, starting from the starting point to the connection point in the main sewer or from the starting point main sewer to the connection point side inlet

The starting point or target point can be a shaft, an inspection or cleaning opening or an open pipe section. The prerequisite is that the size is sufficient to attach the inversion nozzle of the inversion system.

Between the respective starting and destination points, several shafts can also be crossed, including the crossing of shafts with channel diversions. Crossings of channel diversions up to 45° are possible with the "Trelleborg DrainLiner", "Trelleborg MainLiner" and "Trelleborg ProLiner". Bends up to 90° can be rehabilitated with the "Trelleborg MultiFlexLiner" and the "Trelleborg UltraFlexLiner".

If wrinkling occurs, it must not be greater than specified in DIN EN ISO 11296-42.

The watertight restoration of side inlets must be carried out using repair or renovation methods for which general building inspectorate approvals with the associated design approvals are valid, or in open construction.

The applicant shall prepare a manual with a description of the individual steps related to the type of remediation procedure and make it available to the executor.

The applicant must also ensure that the contractors are sufficiently familiarised with the procedure. The sufficient expertise of the executing company can be documented, e.g. by a corresponding quality mark of the Güteschutz Kanalbau e. V.[16].

3.2.2 Equipment and facilities

3.2.2.1 Minimum equipment, components and facilities required for the execution of the remediation procedure

- Sewer cleaning equipment
- Dewatering equipment

[16] Güteschutz Kanalbau e. V.; Linzer Str. 21, Bad Honnef, Telephone: (02224) 9384-0, Fax: (02224) 9384-84

- Devices for sewer inspection (DWA-M [149-2][17])
- Rehabilitation facilities:
  - Polyester needle-felt hoses in the appropriate nominal sizes (Appendix 1) ("Trelleborg DrainLiner" and/or "Trelleborg MainLiner" and/or, "Trelleborg ProLiner" up to DN 100 to DN 600) as well as "Trelleborg MultiFlexLiner" and/or "Trelleborg Ultra FlexLiner" up to DN 100 to DN 250
  - Temperature and pressure resistant nominal size calibration hoses
  - Nominal size polyethylene protective hoses (PE preliners)
  - Container with resin (component A) and hardener (component B) of the resin systems "Trelleborg Epoxy HC120" and/or "Trelleborg Epoxy HC120+"
  - Equipment for dosing and mixing the resin system (Appendix 16)
  - Weather-protected impregnation point (table with conveyor belt or roller table and rolling mill), if necessary with suction device (Annex 16)
  - Vacuum system (system 16)
  - Temperature and pressure resistant nominal diameter pressure hoses for connection to the "inversion drum".
  - "Trelleborg Liner EndCap"
  - Shut-off bladders" or shut-off discs suitable for the respective nominal size
  - Inversion bends and/or inversion nozzles suitable for the respective nominal size
  - Support tubes or support hoses for taking samples on the construction site (suitable for the respective nominal size)
  - Power generator/power supply
  - Water supply
  - Container for residues
  - Temperature sensor
  - Temperature monitoring and recording device
  - Small devices such as air cutting tools
  - Hand tools, ropes
  - Social and sanitary rooms, if applicable

3.2.2.2 Additional components, devices and equipment required for the "hot water hardening process

- Hot water systems and accessories for hot water curing
- Control devices for supply and return water temperature
- Inversion drum (VARIANT 1; Appendix 7) with pressure monitoring device and hot water connection
- Inversion pipe, scaffold, cold water hose, suction pipe, hydrant connection and supply for the "water column" (VARIANT 4; Appendix 10)
- Funnel or ring for inversion, alternatively also fixing rods

17 DWA-M 149-2German Association for Water, Wastewater and Waste e. V. (DWA) - Merkblatt 149: Zustandserfassung und -beurteilung von Entwässersystemen außerhalb von Gebäuden - Teil 2: Kodiersystem für die optische Inspektion; Ausgabe:2013-12

3.2.2.3 Additional components, devices and equipment required for the "steam curing" process

- Steam system with semi-automatic control and/or manual control and supply for steam curing
- Inversion drum (VARIANT 2 and 3; systems 8 and 10) with pressure monitoring device and steam connection
- Control devices for the steam temperature
- Pressure gauge
- Steam outlet device
- Compressor, compressed air hoses, compressed air regulator
- If necessary, sealing plugs in the nominal widths DN 100 to DN 600 (steam inlet plugs)

If electrical devices, e.g. video cameras (or so-called remote sewer eyes) are inserted into the pipe to be rehabilitated, then these must be designed in accordance with VDE regulations.

3.2.3 Implementation of the rehabilitation measure

3.2.3.1 Preparatory measures (Annexes 21 to 23)

Prior to the rehabilitation measure, it must be ensured that the pipeline in question is not in operation; if necessary, appropriate shut-off bubbles must be set and diversions of the wastewater must be carried out.

The correctness of the information given in section 3.1.1 must be checked on site. For this purpose, the pipe section to be rehabilitated is to be cleaned with standard high-pressure flushing equipment to such an extent that the damage can be detected perfectly on the monitor during the visual inspection in accordance with Code of Practice DWA-M [149-217].

If necessary, remove obstacles (e.g. root ingrowths, protruding side inlet pipes, etc.). When removing such obstacles, make sure that this is only done with suitable tools so that the existing wastewater pipe is not additionally damaged.

The accident prevention regulations applicable to the application of the remediation procedure must be observed.

Equipment of the remediation method that is to be introduced into the pipeline section to be remediated may only be used if it has first been ensured by testing that no flammable gases are present in the pipeline section.

For this purpose, the relevant sections of the following regulations must be observed:

- GUV-R [12618] (previously GUV 17.6)
- DWA-M [149-217]
- DWA-A 199-1 and DWA-A [199-219]

When using steam generators and equipment for steam curing, the law on technical work equipment (Equipment Safety Act) and the ordinance on steam boiler systems (Steam Boiler Ordinance) must be observed in particular.

18	GUV-R 126Safety rules	: Working in enclosed spaces of waste water systems Installations (previously GUV 17.6); Edition:2008-09
19	DWA-A	199-1German Association for Water, Wastewater and Waste e. V. (DWA) - Worksheet 199: Service and operating instructions for the personnel of waste water plants, - Part 1: Service instructions for the personnel of waste water plants; Edition:2011-11
	DWA-A 199-2	DeutscheVereinigung für Wasserwirtschaft, Abwasser und Abfall e. V. (DWA) - Arbeitsblatt 199: Dienst- und Betriebsanweisung für das Personal von Abwasseranlagen, - Teil 2: Betriebsanweisung für das Personal von Kanalnetzen und Regenwasserbehandlungsanlagen; Ausgabe:2020-04

The applicant shall provide the executor with a manual describing the individual steps related to the type of execution.

The steps required to carry out the procedure shall be recorded using the record sheets in Appendices 24 and 25 for each impregnation and remediation.

3.2.3.2 Incoming inspection of the process components on the construction site

The transport containers of the process components must be checked to ensure that the markings mentioned in section 2.2.3 are present. The circumference of the polyester needle fleece hose related to the respective object to be renovated must be measured before impregnation with resin. Check that the storage temperature of +15 °C to +35 °C is maintained before impregnating with resin.

3.2.3.3 Arrangement of support pipes and support hoses

Before the PE protective hose is pulled in, support pipes or support hoses may have to be positioned to extend the wastewater pipe to be rehabilitated or in the area of intermediate shafts so that samples (sample hoses) can be taken at these points at the end of the rehabilitation measure and to protect the hose liner from overstretching.

3.2.3.4 Pulling in the PE protective hose (preliner)

The preliner must be inserted into the sewer to be rehabilitated in such a way that damage to the preliner is avoided. The preliner is inserted by means of inversion. The preliner is to be inserted into the sewer to be rehabilitated using the inversion drum (VARIANT 1 to 3) by means of compressed air or water gravity (VARIANT 4). The preliner can also be retracted. The preliner is intended to prevent resin from the polyester needle fleece hose from passing through the defective areas into the surrounding soil. In addition, it is intended to unify the inversion of the resin-impregnated polyester needlefelt tube and prevent excess resin from escaping into the areas of defective spots during subsequent compaction due to the applied internal pressure, thus impairing the composite wall thickness at these spots. The swelling tapes to be used for the watertight connection of the pipe liner are to be positioned in the area of the manhole connections when inserting the preliner (Annex 17).

3.2.3.5 Impregnation of the polyester needlefelt hose

a) <u>Epoxy resin mixture</u>

The amount of resin required for the resin impregnation of the respective polyester needlefelt hose is to be determined before starting the resin mixing depending on the hose liner material, diameter, raw wall thickness and length (Annexes 18 and 20).

The weight mixing ratio of the epoxy resin and the hardener of the resin system "Trelleborg Epoxy HC120" is 100:33 kg and the volume mixing ratio is 100:40 litres respectively and for the resin system "Trelleborg Epoxy HC120+" the weight mixing ratio is 100:30 kg and the volume mixing ratio is 100:38 litres respectively.

After opening, add the hardener component completely to the resin. With the help of a double-barrelled stirring rod (electric or air-driven), mix the hardener component evenly with the epoxy resin in the resin container without bubble formation. For larger resin quantities of approx. 180 litres or more, use an automatic dosing and mixing unit.

The resin and hardener quantities as well as the temperature conditions are to be recorded in the protocol according to section 3.2.3.1.

Take a sample of each mixed resin quantity and check and record the reaction behaviour.

b) <u>Resin impregnation</u>

The polyester needle fleece hose is to be unrolled on the conveyor table in a weather-protected or air-conditioned room or in the renovation vehicle, if necessary also on suitable equipment.

attach the components. Before mixing the components, each individual component must be thoroughly mixed. The mixing temperature must not fall below ≥ +15 °C. To support the resin impregnation, the air contained in the polyester needle fleece hose must be largely removed. A corresponding vacuum of approx. 0.5 bar in the polyester needle fleece hose can be achieved by means of the following methods:

1. For short lengths, a vacuum cut must be made in the overlying coating at the end of the pipe liner. This cut must not be made in the seam area. Three cuts of about 15 mm are to be cut into the coating only. The suction cup of the vacuum system is to be placed on the cuts.
2. For longer lengths or pipe liner diameters, a vacuum cut must be made in the overlying coating every 7 m to 10 m, but not in the seam area. Three cuts of about 15 mm are to be cut into the coating only. Tape over the cuts that are not yet needed. Later, these additional cuts must be taped off.

Then fold the pipe liner like a "Z". The "Z" fold should be weighted down with a weight. This helps to create a vacuum between the folded liner and the suction cups. A "Z" must also be folded behind each suction cup and weighted down. Place the open side of the liner on the impregnation table and pour in the resin mixture. In order to distribute the resin evenly in the polyester needle fleece tube, the tube liner must then be conveyed through a roller drive. The hose liner is to be placed under the pressure rollers. The roller spacing must be set to twice the raw wall thickness of the pipe liner plus 2 mm. The operating and maintenance instructions to be provided must be observed.

The feed rate should be selected in such a way that the resin is distributed as evenly as possible in the matrix of the polyester needle fleece tube. The speed of the impregnation process depends on the absorption and penetration behaviour of the resin mixture. If the resin distribution is noticeably uneven, then the liner must be conveyed through the roller drive again with a narrower roller gap if necessary.

The impregnated pipe liner shall be placed in a container with a biodegradable lubricant immediately after passing through the rollers to reduce friction during subsequent inversion and to avoid unnecessary temperature increase, whereby the pipe liner shall be folded in such a way that no damage occurs to the PVC, PUR, SK, TPU or PP film.

The curing time and the temperature curve are to be recorded in the protocol according to section 3.2.3.1 both for the inversion with closed end and for the inversion with open end.

3.2.3.6 Inverting the resin-impregnated polyester needlefelt hose

3.2.3.6.1 VARIANT 1: Pressure inversion by means of inversion drum and hot water curing (Annex 7)

After the impregnation process has been completed, tie the end of the hose liner together with the control band ("liner head") and roll it into the inversion drum. For inversion, the still open end of the hose liner must be passed through the inversion hose to be connected to the inversion drum. This has to be done with the aid of a pull rope. The end of the hose liner must be fastened to the previously mounted inversion nozzle or inversion bend by means of clamps.

3.2.3.6.1.1 Inversion with closed end (close-end method, system 11) Step 1:

Inversion by means of inversion drum

The inversion nozzle or inversion bend is to be inserted with the hose liner end into the start shaft or pipe opening and positioned at the beginning of the pipe to be rehabilitated, if necessary on the PE protective liner (preliner). Then, depending on the diameter of the pipe liner and the thickness of the wall, the inversion drum is to be fitted in Appendices 18 and 20 with the specified

pressure. The application of compressed air inverts the pipe liner. This inversion process continues until it reaches the target manhole or inspection opening or the target point of the wastewater pipe to be rehabilitated. Through this process, the resin-impregnated inner side of the pipe liner either comes into contact with the inner side of the PE protective hose or directly with the inner surface of the wastewater pipe to be rehabilitated. In this way, the PVC, PUR, SK, TPU or PP film comes into contact with the side facing the waste water.

Step 2: Hot water curing

The compressed air must be released slowly at the inversion drum while the pipe liner is being filled with water in order to prevent an increase in the total pressure of the pipe liner. The pipe liner must be completely filled with water via the heating system/unit to be connected to the inversion drum, so that the positive contact with the inner surface of the wastewater pipe to be rehabilitated is maintained. The hot water generated in the heating unit is to be pumped by means of a pump in the heating circuit (Annex 7). The circulating water is to be heated to a maximum of 80 °C in the flow. The supply and return temperatures in the heating circuit as well as the temperature between the pipe liner and the inside of the pipe to be rehabilitated (at the starting, intermediate and target points) shall be measured and recorded in the invert (at the lowest point) during the entire curing time. The curing times according to Table 5 must be observed. After completion of the curing (heating phase), the heating water and the pipe liner must be cooled down to approx. +20 °C by adding cold tap water. The water must be drained off after reaching this temperature level. The curing times of the pipe liners (Table 5) depend on the epoxy resin system used according to Section 2.1.2.1 and on the ambient temperatures. The curing time and the applied pressure must be measured and recorded during the entire curing time.

3.2.3.6.1.2 Inversion with open end (open-end method, systems 12 to 15) Step 1:

Inversion by means of inversion drum

If the rehabilitation is carried out from a starting shaft or a pipe opening in the direction of an inaccessible sewer, the length of the pipe liner must be determined beforehand so that the pipe liner does not protrude beyond this end point. The end of the pipe liner must be sealed with a Teflon tape or elastic rubber band before it is rolled into the inversion drum.

The liner sealed in this way must be rolled up in the inversion drum. Carry out the same steps as described in section 3.2.3.6.1.1 step 1.

At the end of the inversion process supported by compressed air, the Teflon or rubber band is released and the pressure in the pipe liner escapes. The pipe liner is not yet applied to the inner surface of the pipe to be rehabilitated or to the PE protective hose previously installed.

The hose liner must be detached from the inversion nozzle or inversion bend. Roll a calibration hose with connected heating hose and control tape into the inversion drum. The other end of this calibration hose must be attached to the inversion nozzle or inversion bend. Then invert the calibration hose with the same pressure level as mentioned in section 3.2.3.6.1.1 step 1. The calibration hose causes a positive fit of the pipe liner to the inner surface of the pipe to be rehabilitated or to the PE protective hose.

Step 2: Hot water curing

Carry out the same steps as described in section 3.2.3.6.1.1 step 2.

After completion of the curing and cooling phase, drain the water and remove the calibration hose.

3.2.3.6.1.3 Inversion with open end and "Trelleborg Liner EndCap" (open-end process, Appendix 15) Step 1: Inversion using inversion drum

If the rehabilitation is carried out from a starting shaft or a pipe opening in the direction of an inaccessible sewage collection channel, the liner length must be determined beforehand so that the liner does not protrude beyond this end point. The end of the pipe liner must be fitted with the "Trelleborg Liner EndCap" before it is rolled into the inversion drum.

The liner sealed in this way must be rolled up in the inversion drum. Carry out the same steps as described in section 3.2.3.6.1.1 step 1.

At the end of the inversion process, which is supported by compressed air, the "Trelleborg Liner EndCap" is released and the pressure in the pipe liner escapes. The liner is not yet applied to the inner surface of the pipe to be rehabilitated or to the previously installed PE protective hose.

The hose liner must be detached from the inversion nozzle or inversion bend. Roll a calibration hose with connected heating hose and control tape into the inversion drum. The other end of this calibration hose must be attached to the inversion nozzle or inversion bend. Then invert the calibration hose with the same pressure level as mentioned in section 3.2.3.6.1.1 step 1. The calibration hose causes a positive fit of the pipe liner to the inner surface of the pipe to be rehabilitated or to the PE protective hose.

Step 2: Hot water curing

Carry out the same steps as described in section 3.2.3.6.1.1 step 2.

After completion of the curing and cooling phase, drain the water and remove the calibration hose.

3.2.3.6.2 VARIANT 2 and 3: Pressure inversion by means of inversion drum and steam curing (systems 8 and 9)

3.2.3.6.2.1 Inverting with closed end and heated hose (appendix 8) (close-end method, appendix 11)

Step 1: Inversion by means of inversion drum

Carry out the same steps as described in section 3.2.3.6.1.1 step 1.

Instead of the tied end of the hose liner, a heating hose is to be attached to the hose liner end and inverted with the hose liner. The heating hose is to be connected to the service window of the inversion drum.

Step 2: Steam curing

By means of compressed air, the corresponding curing pressure shall be kept constant via the respective control system according to annexes 19 and 20. The steam generator must be started up and connected to the control system after the respective heating time. The temperature must be continuously increased by adding steam via the respective control system. The steam/air mixture must be discharged via the start shaft or start point. The flow must be controlled with the aid of a ball valve mounted on the inversion drum. Pressure and temperature must be kept constant. The maximum steam/air temperature of +100 °C must not be exceeded.

The steam/air mixing temperature as well as the temperature between the pipe liner and the inside of the wastewater pipe to be rehabilitated (at the starting and finishing point and possibly at the existing intermediate shaft or pipe opening) must be measured and recorded during the entire curing time. The curing temperatures are to be recorded between the inverted pipe liner and the inside of the pipe surface.

The curing times according to Table 5 must be observed.

After completion of the curing (heating phase), the pipe liner must be cooled with air to +20 °C pipe liner temperature.

The curing times of the pipe liners (Table 5) depend on the epoxy resin system used according to section 2.1.2.1 and on the ambient temperatures. The curing time and the applied pressure must be measured and recorded during the entire curing time.

3.2.3.6.2.2 Inverting with closed end and steam outlet valve (appendix 9) (close-end method, appendix 11)

Step 1: Inversion by means of inversion drum

Carry out the same steps as described in section 3.2.3.6.1.1 step 1.

Instead of the tied end of the hose liner, tie in the steam outlet valve and connect it to the control band of the inversion drum.

Step 2: Steam curing

By means of compressed air, the corresponding curing pressure is to be kept constant according to system 19 and 20 via the respective control system. The steam generator must be put into operation and connected to the control unit after the respective heating time. The temperature shall be increased continuously by adding the appropriate control unit. The steam/air mixture must be discharged via the steam outlet valve at the end of the hose liner. The maximum steam/air temperature of +100 °C must not be exceeded.

The steam/air mixing temperature as well as the temperature between the pipe liner and the inside of the wastewater pipe to be rehabilitated (at the start and finish point and possibly at the existing intermediate shaft or pipe opening) are to be measured and recorded in the invert (at the lowest point) during the entire curing time. The curing temperatures are to be recorded between the inverted pipe liner and the inside of the pipe surface.

The curing times according to Table 5 must be observed.

After completion of the curing (heating phase), the pipe liner must be cooled with air to +20 °C pipe liner temperature.

The curing times of the pipe liners (Table 5) depend on the epoxy resin system used according to section 2.1.2.1 and on the ambient temperatures. The curing time and the applied pressure must be measured and recorded during the entire curing time.

3.2.3.6.2.3 Inverting with open end and heated hose (annex 8) (open-end method, annexes 12 to 15)

Step 1: Inversion by means of inversion drum

Carry out the same steps as described in section 3.2.3.6.1.2 step 1.

Instead of the hose liner, connect the heating hose to the calibration hose. Step 2: Steam curing

Carry out the same steps as described in section 3.2.3.6.2.1 step 2.

3.2.3.6.2.4 Inverting with open end and steam outlet valve (system 9) (open-end method, systems 12 to 15)

Step 1: Inversion by means of inversion drum

Carry out the same steps as described in section 3.2.3.6.1.2 step 1.

Instead of the tied end of the calibration hose, tie in the steam outlet valve and connect it to the control band of the inversion drum.

Step 2: Steam curing

Carry out the same steps as described in section 3.2.3.6.2.2 step 2.

3.2.3.6.2.5 Inverting with open end and "Trelleborg Liner EndCap" and heated hose (open-end procedure, Appendix 15)

Step 1: Inversion by means of inversion drum

Carry out the same steps as described in section 3.2.3.6.1.3 step 1.

Instead of the hose liner, the heated hose is to be connected to the "Trelleborg Liner EndCap".

Step 2: Steam curing

Carry out the same steps as described in section 3.2.3.6.2.1 step 2.

3.2.3.6.2.6 Inverting with open end and "Trelleborg Liner EndCap" and steam outlet valve (open-end process, Appendix 15)

Step 1: Inversion by means of inversion drum

Carry out the same steps as described in section 3.2.3.6.1.3 step 1.

Instead of the tied end of the "Trelleborg Liner EndCap", the steam release valve is to be integrated and connected to the control belt of the inversion drum.

Step 2: Steam curing

Carry out the same steps as described in section 3.2.3.6.2.2 step 2.

3.2.3.6.3 VARIANT 4: "Water column" water inversion by means of inversion framework and hot water curing (Annex 10)

Step 1: Inversion by means of water gravity

When installing a pipe liner with the "water column" process variant, the polyester needle fleece hose must be inverted into the wastewater pipe to be rehabilitated by means of water gravity. For this purpose, a scaffold must be erected at the starting shaft or starting point. The height of this scaffold must be dimensioned according to the required hydrostatic pressure and the shaft depth. An inversion pipe, which is related to the diameter of the wastewater pipe to be rehabilitated, is to be inserted into the starting shaft or starting point. The pipe liner is to be inserted through the inversion pipe, secured and inverted through the retaining ring. Water must then be introduced. The hydrostatic pressure causes the inversion of the pipe liner and the positive fit of the pipe liner in the wastewater pipe to be rehabilitated.

The corresponding inversion pressures can be found in Appendices 19 and 20. Step 2: Hot water curing

Carry out the same steps as described in section 3.2.3.6.1.1 step 2.

3.2.3.6.4 Curing times

The curing time of the pipe liner (Table 5) depends on the epoxy resin system used according to Section 2.1.2.1 and on the ambient or process temperatures. The curing time and the applied pressure must be recorded.

Table 5: Curing times of the epoxy resin systems "Trelleborg Epoxy HC120 (A+B)" and "Trelleborg Epoxy HC120+(A+B)".

Curing times in minutes	Curing temperatures in °C
approx. 1,140	at +10 °C
approx. 90	at +60 °C with hot water circulation
approx. 45	at +80 °C with hot water circulation
approx. 45	at +80 °C with steam

The curing times (heating phase without cooling) begin when the temperatures listed in Table 5 are reached, measured between the inverted pipe liner and the surface of the pipe to be rehabilitated (at the starting, intermediate and target points) in the invert (at the lowest point). In case of groundwater ingress or cold temperatures of the soil, the curing times must be extended.

3.2.3.7 Final work

After curing, the inner pipe is to be cut off and removed from the respective shaft wall in the start and target shafts using compressed air-driven cutting tools. In the intermediate shafts, the upper half-shell of the resulting pipe must be removed until it reaches the bottom of the shaft.

The pipe sections (circular rings) for the subsequent tests are to be taken from the support pipes or support hoses that are also to be removed (see section 3.2.4.1).

When carrying out cutting work, the relevant accident prevention regulations must be observed.

3.2.3.8 Reconnection of side inlets

Watertight reconnections of side inlets are to be carried out using repair or renovation procedures for which general building inspectorate approvals with the associated type approvals are valid. The reconnection of side inlets in open construction is also possible.

3.2.3.9 Shaft connection

Swelling tapes (auxiliary materials) (Annex 17) are to be used in the manhole connection area.

In the respective start and, if necessary, also in the target shaft, as well as in the intermediate shafts, the protrusions (see also section 3.2.3.7 Final work) of the hardened inner pipe to the end wall of the shaft (so-called mirror) and the transitions to the flow channel in the start and target shaft must be made watertight.

Manhole connections are to be made watertight using swelling auxiliary tapes, which are to be positioned in the area of the manhole connections before the PE protective hose (preliner) is inserted.

In areas where swelling tapes (auxiliary tapes) cannot be used for structural reasons, the watertight formation of the connection areas between the pipe liner and the shaft can also be carried out in the following way after the pipe liner has cured:

a) Adjusting the transitions by means of reaction resin filler, for which a general building approval is valid,
b) Adjusting the transitions by means of mortar systems for which a general building authority approval is valid,
c) GRP laminates for which a general building authority approval is valid,
d) Grouting with polyurethane (PU) or epoxy (EP) resins for which a general building approval is valid,
e) Installation of hose liner end sleeves for which a general building authority approval is valid.

The proper execution of the watertight design of the transitions must be ensured.

3.2.3.10 Lettering in the shaft

The following inscription should be permanently and easily legible in the start or end shaft of the rehabilitation measure:

- Type of rehabilitation
- Designation of the line section
- Nominal width
- Composite wall thickness of the pipe liner
- Year of renovation

3.2.3.11 Final inspection and leak test

After completion of the work, the rehabilitated pipe section must be visually inspected. It must be determined whether any material residues have been removed and no hydraulically detrimental folds are present.

After curing of the pipe liner, including the restoration of the side inlets, the tightness is to be tested, if necessary including the manhole connection areas. This can also be done in sections.

The tightness of the rehabilitated pipes must be tested using water method "W" (Annex 26) or air method "L" according to DIN EN [161020]. When testing with air, the specifications in Table 3 of DIN EN [161020], test method LD for wet concrete pipes and all other materials must be observed. The rehabilitated side inlets can also be tested separately for watertightness using suitable shut-off bladders or shut-off discs.

3.2.4 Tests on samples taken

3.2.4.1 General

Circular rings or segments shall be taken from the cured circular pipe liners at the construction site (sample certificate Annex 27). If it turns out that the test pieces are unsuitable for the tests mentioned in section 3.2.4.2 a), or if it is not possible to take samples from circular rings or segments, the following may be done

at Side inlet hose liners up to DN 200 Alternatively, a DSC analysis according to section 3.2.4.2 b) shall be carried out.

For the investigation of the characteristic material properties by means of Differential Scanning Calorimetry (DSC), test specimens shall be taken from the support at the construction site. The sampling shall be carried out by means of core drilling. The diameter of the sample shall be at least 2.5 cm.

3.2.4.2 Strength properties

a) Determination of strength properties after 3-point bending and long-term peak pressure test

The bending E-modulus and the bending stress σ_{fB} shall be determined on the specimens taken (with the composite wall thickness according to section 3.1.2.1.2).

In these tests, the short-term value, the 1-hour value and the 24-hour value of the flexural modulus of elasticity as well as the short-term value of the flexural stress σ_{fB} shall be recorded. During the test, it must also be determined whether the creep tendency is maintained in accordance with DIN EN ISO [899-221] according to the following relationship or from diagrams 2 and 3:

[20] DIN EN 1610 Installation and testing of waste water pipes and sewers; German version EN 1610:2015; Issue:2015-12

[21] DIN EN ISO 899-2 Plastics - Determination of creep behaviour - Part 2: Creep rupture flexure test at Three-point load (ISO 899-2:2003); German version EN ISO 899-2:2003; Publication:2003-10

$$K = \frac{E1h - E24h}{E_{1h}} \times 100$$

The creep tendency depends on the post-cross-linking of the resin and can thus be taken from diagrams 2 and 3, taking into account the sample age.

Diagram 2: "Evaluation of the creep tendency as a function of the sample age of the "Trelleborg Epoxy HC120" resin system

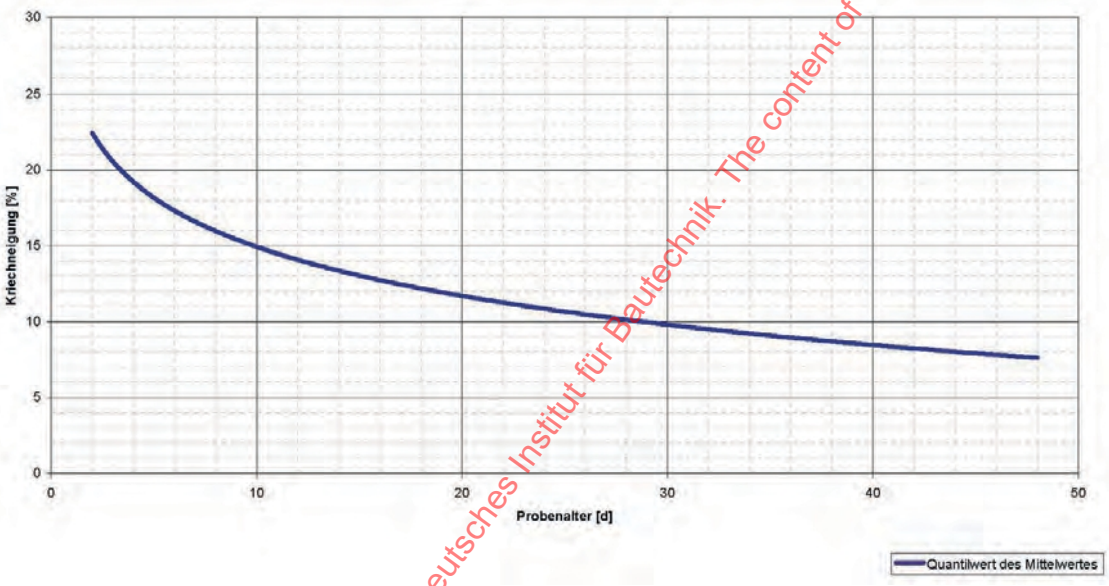
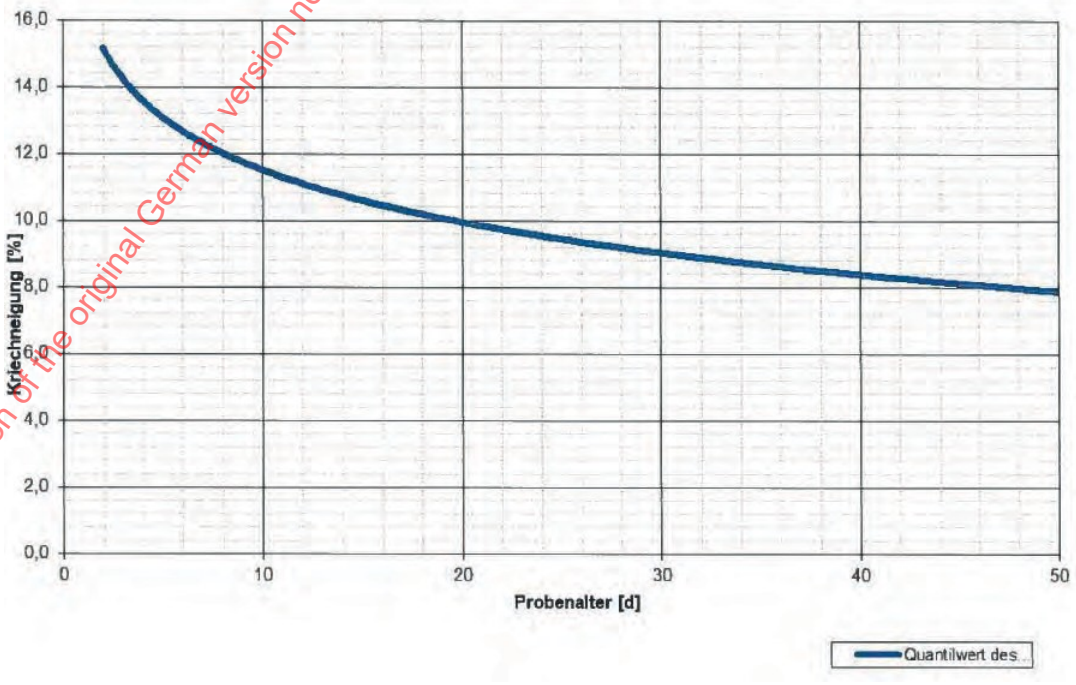


Diagram 3: "Evaluation of the creep tendency depending on the sample age of the resin system "Trelleborg Epoxy HC120+"".



The creep slope determined in the test on the sample taken on site must not exceed the value of the creep slope from diagrams 2 and 3, depending on the age of the sample.

In addition, the bending modulus of elasticity and the bending stress σ_{fB} shall be determined on the cured pipe liner according to DIN EN ISO 11296-4[2] or DIN EN ISO 178[5] (three-point bending test), using curved test bars from the corresponding circular profile, which shall have a minimum width of 50 mm in the axial direction. When testing and calculating the modulus of elasticity, the support distance measured between the support points of the test bar must be taken into account.

The determined short-term values of the Young's modulus and the bending stress σ_{fB} shall be equal to or greater than the value given in clause 3.1.2.1.4 and clause 3.1.2.1.2.

When changing the resin supplier, the short-time value, the 1-hour value and the 24-hour value of the ring stiffness must also be determined on the circular rings taken. The ring stiffness test shall be carried out according to the procedure described in DIN [53769-322]. The creep tendency shall also be determined.

b) Determination of the strength properties by means of DSC analysis

for side inlet hose liner up to DN 200

If it is not possible to take samples from circular rings or segments, a DSC analysis can be carried out alternatively on the samples taken on site for side inlet hose liners up to DN 200.

For this purpose, the following test procedure must be followed:

1. Cutting through the drill core by means of diamond cutting
2. Measurement of the composite wall thickness of the load-bearing laminate at three points
3. Qualitative assessment of the laminate in the area of the saw cut according to DIN [18820-323], section 5.2
4. Removal of the sample piece for DSC analysis from the laminate
5. DSC analysis according to DIN EN ISO [11357-224] Half-step height method
6. Evaluation of the results according to section 10 of DIN EN ISO [11357-224]

3.2.4.3 Waterproofness of the samples

The watertightness of the cured pipe liner can be tested either on a pipe liner section (circular ring) without film coating or on test pieces taken from the cured pipe liner without film coating. For the test, the film coating of the liner section or the test piece must either be removed or perforated. The laminate must not be damaged in the process.

The test on test pieces can be carried out either with overpressure or underpressure of 0.5 bar each.

For the negative pressure test, the sample must be impacted with water on one side. At a negative pressure of 0.5 bar, no water leakage must be visible on the unpressurised side of the sample during a test period of 30 minutes.

When testing by means of overpressure, apply a water pressure of 0.5 bar for 30 minutes. Also with this method, no water leakage must be visible on the unimpacted side of the sample.

[22] DIN 53769-3Testing of pipelines made of glass-fibre reinforced plastics; short-time and Long-term crushing test on pipes; Edition:1988-11

[23] DIN 18820-3Laminates of textile glass reinforced unsaturated polyester and phenacrylate resins

for load-bearing components (GF-UP, GF-PHA); protective measures for the load-bearing laminate; Ausgabe:1991-03

[24] DIN EN ISO 11357-2Plastics - Differential dynamic thermal analysis (DSC) - Part 2: Determination of the

Glass transition temperature and glass transition step height (ISO 11357-2: 2013), German version EN ISO 11357-2:2014; Issue:2014-07.

3.2.4.4 Wall thicknesses and wall construction

The wall structure according to section 3.1.2.1.1 is to be checked on cut surfaces, e.g. using a light microscope with approx. 10x magnification. In particular, the design wall thickness and composite wall thickness as well as the thickness of the pure resin layer or wear layer shall be checked. In addition, the average area of any voids must be checked according to DIN EN ISO [782225].

3.2.4.5 Physical characteristics of the cured pipe liner

The characteristic values specified in section 3.1.2.1.2 shall be checked on the samples taken.

3.2.5 Declaration of conformity on the executed renovation measure

Confirmation of the conformity of the executed remediation measure with the provisions of the general design approval covered by this notice shall be provided by the executing company with a declaration of conformity based on the specifications in Tables 6 and 7. The declaration of conformity shall be accompanied by documents on the properties of the process components according to section 2.1.2 and the results of the tests according to Tables 6 and 7.

The head of the remediation measure or a competent representative of the head must be present on the construction site during the execution of the remediation. He shall ensure that the work is carried out properly in accordance with the provisions of Section 3.2 and shall in particular carry out or arrange for the tests in accordance with Table 6 and arrange for the tests in accordance with Table 7. For the tests mentioned in Table 7, samples according to 3.2.3.3 shall be taken from the described sample tubes. The number and scope of the determinations carried out are minimum requirements.

The tests on test specimens according to Table 7 are to be carried out by a monitoring body recognised by the building authorities (see List of Testing, Monitoring and Certification Bodies according to the State Building Regulations, Part V, No. 9).

Once every six months, the sampling of a pipe liner of an executed remediation measure shall be carried out by the aforementioned monitoring body. In addition, the monitoring body must check the documentation of the work carried out in accordance with Table 6 of the remediation measure.

Table 6: "In-process audits"

Subject of the examination	Type of requirement	Frequency
Visual inspection of the pipe	according to section 3.2.3.1 and DWA-M [149-216]	Before any renovation
Visual inspection of the pipe	according to section 3.2.3.11 and DWA-M [149-216]	After each renovation
Equipment	according to section 3.2.2	every construction site
Labelling of the containers of the remediation components	according to sections 2.2.3 and 3.2.3.2	
Air or water tightness	according to section 3.2.3.11	
Resin mixture, resin quantity and curing behaviour per hose	Mixing protocol according to section 3.2.3.5	
Curing temperature and curing time	according to section 3.2.3.6.4	

25 DIN EN ISO 7822Textile glass reinforced plastics - Determination of the amount of voids present - Loss on ignition, mechanical decomposition and statistical evaluation methods (ISO 7822:1990); German version EN ISO 7822:1999; Publication:2000-01

Table 7: "Tests on test pieces

Subject of the examination	Type of requirement	Frequency
Short-time bending modulus E, short-time bending stress σ_{fB} and creep tendency on pipe sections or on circular rings	according to sections 3.2.4.1 and 3.2.4.2 a)	every construction site, at least every second pipe liner
Density of the sample without preliner and without coating foil	according to the Sections 3.1.2.1.2 and 3.2.4.5	
Watertightness of the sample of variants a) to e) without preliner and without PVC-, PP, SK, PUR or TPU film	according to sections 2.1.2.1 and 3.2.4.3	
Wall thicknesses and wall construction	according to section 3.2.4.4	
Checking the glass transition temperature T_{G1} and T_{G2} by means of DSC analysis * for side inlet hose liners up to DN 200	according to the Sections 3.1.2.1.3 and 3.2.4.2 b) (alternative)	
Resin identity by means of IR spectroscopy	according to section 2.1.2.	with each change of resin supplier with declaration of the resins
Short-term E-module (short-term annular stiffness) and creep tendency on pipe sections or -cuttings	according to the Sections 3.1.2.1.2 and 3.2.4.2 a)	with each change of resin supplier with declaration of the resins
Creep on pipe sections or -cuttings	according to section 3.2.4.2 a)	if the short-term limit specified in section 3.1.2.1.4 is not reached. E-module and at least 1 x hose liner per half year

* If compliance with the glass transition temperatures T_{G1} and T_{G2} specified in section 3.1.2.1.3 has been verified on the samples taken on site by means of DSC analysis, this shall also be deemed to be proof of compliance with the physical characteristic values of the cured polyester fibre/resin composite specified in section 3.1.2.1.2.

The test results shall be recorded and evaluated; they shall be submitted to Deutsches Institut für Bautechnik on request.

Ronny Schmidt
Head of Unit

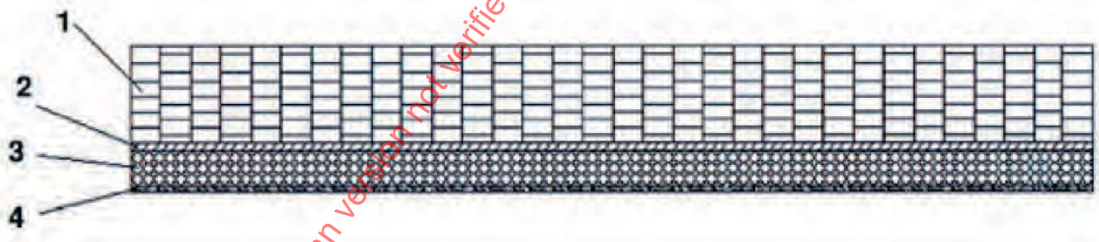
Certified
Graeber

Deutsches Institut für Bautechnik DIBt

Schlauchlinerquerschnitte

1	Altrohr		
2	Preliner		
3	Ausgehärteter imprägnierter DrainLiner, MainLiner, ProLiner, MultiFlexLiner und UltraFlexLiner		
4a	DrainLiner	DN100 – DN 600 PVC-Beschichtung	Dicke 0,40 – 0,60 mm
4b	MainLiner	DN150 – DN 600 PP-Beschichtung	Dicke 0,30 – 0,60 mm
4c	ProLiner	DN100 – DN 600 PP-Beschichtung	Dicke 0,30 – 0,60 mm
4d	MultiFlexLiner	DN100 – DN 250 PUR-Beschichtung	Dicke 0,20 – 0,25mm
4e	UltraFlexLiner	DN100 – DN 250 Silikon-Beschichtung	Dicke 0,45 – 0,75 mm
4f	UltraFlexLiner	DN100 – DN 250 TPU-Beschichtung	Dicke 0,15 – 0,25 mm

Die Beschichtung der Varianten 4a bis 4f dienen als Einbringhilfe des Schlachliners.



Bauprodukte und deren Verwendung zur Ausführung von Schlauchlinern mit der Bezeichnung "Trelleborg DrainLiner Verfahren" und den Harzsystemen "Trelleborg Epoxy HC120" und "Trelleborg Epoxy HC120+" zur Sanierung schadhafter, erdverlegter Abwasserleitungen in dem Nennweiten DN 100 bis DN 600

Anlage 1

Schlauchlinerquerschnitte

Deutsches Institut für Bautechnik DIBt

Tabelle A: Trelleborg DrainLiner PVC, Eigenschaften vor dem Einbau

Nenndurch-messer	Einbau-wanddicke	Rohwand-dicke	Flächengewicht (ohne Beschichtung)	Schlauchliner Gesamt-Gewicht inkl. Naht / Beschichtung 300 µm	Schlauchliner Gesamt-Gewicht inkl. Naht / Beschichtung 500 µm	Schlauchliner Gesamt-Gewicht inkl. Naht / Beschichtung 600 µm	Maximale Abweichung
DN	mm	mm	g/m2	g/lfm	g/lfm	g/lfm	+/- %
100	3,0	>3,0	790	368	425	453	15
100	3,5	>3,5	1040	439	495	523	15
100	4,5	>4,5	1170	475	532	560	15
125	3,0	>3,0	790	445	516	551	15
125	3,5	>3,5	1040	533	604	639	15
125	4,5	>4,5	1170	579	650	685	15
150	3,0	>3,0	790	522	607	649	15
150	3,5	>3,5	1040	628	713	755	15
150	4,5	>4,5	1170	683	768	810	15
150	6,0	>6,0	1580	857	942	984	15
200	3,0	>3,0	790	676	789	846	15
200	3,5	>3,5	1040	817	930	987	15
200	4,5	>4,5	1170	891	1004	1060	15
200	6,0	>6,0	1580	1123	1236	1292	15
225	3,0	>3,0	790	753	880	944	15
225	3,5	>3.5	1040	912	1039	1103	15
225	4,5	>4,5	1170	995	1122	1185	15
225	6,0	>6,0	1580	1255	1383	1446	15
250	3,0	>3,0	790	830	971	1042	15
250	3,5	>3,5	1040	1007	1148	1219	15
250	4,5	>4,5	1170	1099	1240	1311	15
250	6,0	>6,0	1580	1388	1530	1600	15
300	3,0	>3,0	790	984	1154	1238	15
300	3,5	>3,5	1040	1196	1366	1450	15
300	4,5	>4,5	1170	1306	1476	1561	15
300	6,0	>6,0	1580	1654	1823	1908	15
300	7,5	>7,5	2000	2010	2180	2265	15
300	9,0	>9,0	2380	2332	2502	2586	15
300	10,5	>10,5	2780	2671	2841	2926	15
300	12,0	>12,0	3190	3019	3188	3273	15
350	3,0	>3,0	790	1138	1336	1435	15
350	3,5	>3.5	1040	1385	1583	1682	15
350	4,5	>4,5	1170	1514	1712	1811	15
350	6,0	>6,0	1580	1920	2117	2216	15
350	7,5	>7,5	2000	2335	2533	2632	15
350	9,0	>9.0	2380	2711	2909	3008	15
350	10,5	>10,5	2780	3106	3304	3403	15
350	12,0	>12,0	3190	3512	3710	3809	15
400	4,5	>4,5	1170	1722	1948	2061	15
400	6,0	>6,0	1580	2185	2411	2524	15
400	7,5	>7.5	2000	2660	2886	3000	15
400	9,0	>9,0	2380	3089	3316	3429	15
400	10,5	>10,5	2780	3542	3768	3881	15
400	12,0	>12,0	3190	4005	4231	4344	15
450	6,0	>6,0	1580	2451	2705	2832	15
450	7,5	>7,5	2000	2985	3240	3367	15
450	9,0	>9.0	2380	3468	3722	3850	15

Bauprodukte und deren Verwendung zur Ausführung von Schlauchlinern mit der Bezeichnung "Trelleborg DrainLiner Verfahren" und den Harzsystemen "Trelleborg Epoxy HC120" und "Trelleborg Epoxy HC120+" zur Sanierung schadhafter, erdverlegter Abwasserleitungen in dem Nennweiten DN 100 bis DN 600

Anlage 2

Tabelle A : Drainliner, Eigenschaften vor dem Einbau

Deutsches Institut für Bautechnik DIBt

Tabelle B: Trelleborg ProLiner PP, Eigenschaften vor dem Einbau

Nenndurchmesser	Einbauwanddicke	Rohwanddicke	Flächengewicht (o. Beschichtung)	Schlauchliner Gesamtgewicht / Beschichtung 300 µm	Schlauchliner Gesamtgewicht / Beschichtung 500 µm	Schlauchliner Gesamtgewicht / Beschichtung 600 µm	Maximale Abweichung
DN	mm	mm	g/m²	g/m	g/m	g/m	+/- %
100	3	>3,0	650	303	360	388	15
100	4,5	>4,5	900	374	431	459	15
125	3	>3,0	650	371	441	477	15
125	4,5	>4,5	900	459	530	565	15
150	3	>3,0	650	438	522	565	15
150	4,5	>4,5	900	544	628	671	15
150	6	>6,0	1200	671	756	798	15
200	3	>3,0	650	572	685	742	15
200	4,5	>4,5	900	713	826	883	15
200	6	>6,0	1200	883	996	1052	15
225	3	>3,0	650	639	766	830	15
225	4,5	>4,5	900	798	925	989	15
225	6	>6,0	1200	989	1116	1180	15
250	3	>3,0	650	706	847	918	15
250	4,5	>4,5	900	883	1024	1095	15
250	6	>6,0	1200	1095	1236	1307	15
300	3	>3,0	650	840	1010	1095	15
300	4,5	>4,5	900	1052	1222	1307	15
300	6	>6,0	1200	1307	1476	1561	15
300	7,5	>7,5	1500	1561	1731	1815	15
300	9	>9,0	1800	1815	1985	2070	15
300	10,5	>10,5	2100	2070	2239	2324	15
300	12	>12,0	2400	2324	2494	2578	15
350	3	>3,0	650	975	1172	1271	15
350	4,5	>4,5	900	1222	1420	1519	15
350	6	>6,0	1200	1519	1716	1815	15
350	7,5	>7,5	1500	1815	2013	2112	15
350	9	>9,0	1800	2112	2310	2409	15
350	10,5	>10,5	2100	2409	2607	2706	15
350	12	>12,0	2400	2706	2903	3002	15
400	4,5	>4,5	900	1391	1618	1731	15
400	6	>6,0	1200	1731	1957	2070	15
400	7,5	>7,5	1500	2070	2296	2409	15
400	9	>9,0	1800	2409	2635	2748	15
400	10,5	>10,5	2100	2748	2974	3087	15
400	12	>12,0	2400	3087	3313	3426	15
450	6	>6,0	1200	1943	2197	2324	15
450	7,5	>7,5	1500	2324	2578	2706	15
450	9	>9,0	1800	2706	2960	3087	15
450	10,5	>10,5	2100	3087	3341	3469	15
450	12	>12,0	2400	3469	3723	3850	15
450	15	>15,0	3000	4232	4486	4613	15
500	9	>9,0	1800	3002	3285	3426	15
500	10,5	>10,5	2100	3426	3709	3850	15
500	12	>12,0	2400	3850	4133	4274	15
500	15	>15,0	3000	4698	4981	5122	15
500	18	>18,0	3600	5546	5828	5970	15
600	9	>9,0	1800	3596	3935	4104	15
600	10,5	>10,5	2100	4104	4444	4613	15
600	12	>12,0	2400	4613	4952	5122	15
600	15	>15,0	3000	5630	5970	6139	15
600	18	>18,0	3600	6648	6987	7157	15
600	21	>21,0	4200	7665	8004	8174	15

Bauprodukte und deren Verwendung zur Ausführung von Schlauchlinern mit der Bezeichnung "Trelleborg DrainLiner Verfahren" und den Harzsystemen "Trelleborg Epoxy HC120" und "Trelleborg Epoxy HC120+" zur Sanierung schadhafter, erdverlegter Abwasserleitungen in dem Nennweiten DN 100 bis DN 600

Anlage 3

Tabelle B : Trelleborg ProLiner, Eigenschaften vor dem Einbau

Deutsches Institut für Bautechnik DIBt

Tabelle C: MultiFlexLiner mit 9% Untermaß, Eigenschaften vor dem Einbau

Nenndurch-messer	Einbau-wanddicke	Rohwand-dicke	Flächengewicht (o. Beschichtung)	Schlauchliner Gesamt-gewicht inkl. Naht und Beschichtung	Maximale Abweichung
DN	mm	mm	g/m²	g/lfm	+/- %
100	3	>3,0	416	198	15
125	3	>3,0	416	244	15
150	3	>3,0	416	290	15
200	3	>3,0	416	381	15
225	3	>3,0	416	427	15
250	3	>3,0	416	473	15

Tabelle D: MultiFlexLiner mit 18% Untermaß, Eigenschaften vor dem Einbau

Nenndurch-messer	Einbau-wanddicke	Rohwand-dicke	Flächengewicht (o. Beschichtung)	Schlauchliner Gesamt-gewicht inkl. Naht und Beschichtung	Maximale Abweichung
DN	mm	mm	g/m²	g/lfm	+/- %
100	3	>3,0	416	180	15
125	3	>3,0	416	221	15
150	3	>3,0	416	263	15
200	3	>3,0	416	345	15
225	3	>3,0	416	386	15
250	3	>3,0	416	428	15

Bauprodukte und deren Verwendung zur Ausführung von Schlauchlinern mit der Bezeichnung "Trelleborg DrainLiner Verfahren" und den Harzsystemen "Trelleborg Epoxy HC120" und "Trelleborg Epoxy HC120+" zur Sanierung schadhafter, erdverlegter Abwasserleitungen in dem Nennweiten DN 100 bis DN 600

Anlage 4

Trelleborg MultiFlexLiner mit 9% und 18% Untermaß | Eigenschaften vor dem Einbau

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Tabelle E: UltraFlexLiner TPU, Eigenschaften vor dem Einbau

Nenndurch-messer	Einbau-wanddicke	Rohwand-stärke	Flächengewicht (o. Beschichtung)	Schlauchliner Gesamt-gewicht inkl. Naht und Beschichtung	Maximale Abweichung
DN	mm	mm	g/m²	g/lfm	+/- %
100	>4,0	>5,0	800	270	15
125	>4,0	>5,0	800	337	15
150	>4,0	>5,0	800	433	15
200	>4,0	>5,0	800	574	15
225	>4,0	>5,0	800	607	15
250	>4,0	>5,0	800	675	15

Tabelle F: UltraFlexLiner Silikon, Eigenschaften vor dem Einbau (bei 10% Untermaß)

Nenndurch-messer	Einbau-wanddicke	Rohwand-dicke	Flächengewicht (o. Beschichtung)	Schlauchliner Gesamt-gewicht inkl. Naht und Beschichtung	Maximale Abweichung
DN	mm	mm	g/m²	g/lfm	+/- %
100	>4,0	>5,0	800	481	15
125	>4,0	>5,0	800	601	15
150	>4,0	>5,0	800	721	15
200	>4,0	>5,0	800	961	15
225	>4,0	>5,0	800	1081	15
250	>4,0	>5,0	800	1202	15

Bauprodukte und deren Verwendung zur Ausführung von Schlauchlinern mit der Bezeichnung "Trelleborg DrainLiner Verfahren" und den Harzsystemen "Trelleborg Epoxy HC120" und "Trelleborg Epoxy HC120+" zur Sanierung schadhafter, erdverlegter Abwasserleitungen in dem Nennweiten DN 100 bis DN 600

Anlage 5

UltraFlexLiner mit Silikon oder TPU Beschichtung | Eigenschaften vor dem Einbau

Durchmesser	Wanddicke	Wanddicke	(ohne Beschichtung)	Naht /Beschichtung 300 µm	Naht /Beschichtung 450 µm	Abweichung
DN	mm	mm	g/m²	g/lfm	g/lfm	+/- %
150	4,0	>4,0	650	403	467	15
150	6,0	>6,0	1050	573	636	15
200	4,0	>4,0	650	537	622	15
200	6,0	>6,0	1050	763	848	15
200	7,0	>7,0	1130	809	894	15
200	8,0	>8,0	1300	905	990	15
225	4,0	>4,0	650	604	700	15
225	6,0	>6,0	1050	859	954	15
225	7,0	>7,0	1130	910	1005	15
225	8,0	>8,0	1300	1018	1113	15
250	4,0	>4,0	650	672	778	15
250	6,0	>6,0	1050	954	1060	15
250	7,0	>7,0	1130	1011	1117	15
250	8,0	>8,0	1300	1131	1237	15
250	9,0	>9,0	1530	1294	1400	15
300	4,0	>4,0	650	806	933	15
300	6,0	>6,0	1050	1145	1272	15
300	7,0	>7,0	1130	1213	1340	15
300	8,0	>8,0	1300	1357	1484	15
300	9,0	>9,0	1530	1552	1680	15
350	4,0	>4,0	650	940	1089	15
350	6,0	>6,0	1050	1336	1484	15
350	7,0	>7,0	1130	1415	1564	15
350	8,0	>8,0	1300	1583	1732	15
350	9,0	>9,0	1530	1811	1959	15
400	4,0	>4,0	650	1074	1244	15
400	6,0	>6,0	1050	1527	1696	15
400	7,0	>7,0	1130	1617	1787	15
400	8,0	>8,0	1300	1810	1979	15
400	9,0	>9,0	1530	2070	2239	15
400	10,0	>10,0	1700	2262	2432	15
500	6,0	>6,0	1050	1909	2121	15
500	7,0	>7,0	1130	2022	2234	15
500	8,0	>8,0	1300	2262	2474	15
500	9,0	>9,0	1530	2587	2799	15
500	10,0	>10,0	1700	2828	3040	15
600	6,0	>6,0	1050	2290	2545	15
600	7,0	>7,0	1130	2426	2680	15
600	8,0	>8,0	1300	2714	2969	15
600	9,0	>9,0	1530	3105	3359	15
600	10,0	>10,0	1700	3393	3647	15
600	12,0	>12,0	2100	4072	4326	15

Bauprodukte und deren Verwendung zur Ausführung von Schlauchlinern mit der Bezeichnung "Trelleborg DrainLiner Verfahren" und den Harzsystemen "Trelleborg Epoxy HC120" und "Trelleborg Epoxy HC120+" zur Sanierung schadhafter, erdverlegter Abwasserleitungen in dem Nennweiten DN 100 bis DN 600

Anlage 6

Trelleborg MainLiner | Eigenschaften vor dem Einbau

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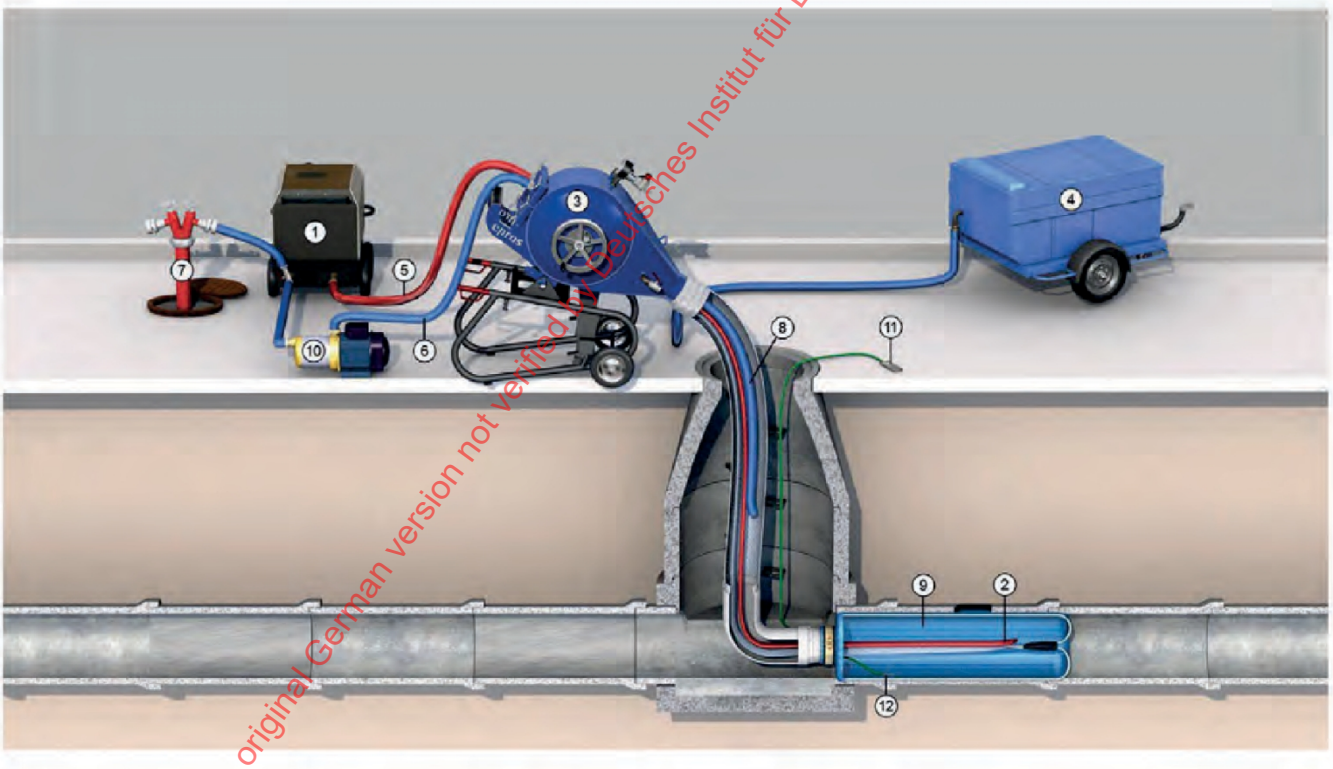
Variante 1 : Warmwasseraushärtung mit Zirkulation | Systemübersicht

Pos.	Beschreibung		
1	Heißwasser-Generator	6	Kaltwasser-Rückführleitung
2	Zirkulations-Flachschlauch Heißwasser bzw. Schubschlauch	7	Wasserversorgung
3	Inversionstrommel oder Inversions-druckschleuse	8	Zirkulationsleitung Saugschlauch bzw. Schubschlauch
4	Luftversorgung	9	Schlauchliner
5	Heißwasser-Zufuhrleitung	10	Zirkulationspumpe



Bauprodukte und deren Verwendung zur Ausführung von Schlauchlinern mit der Bezeichnung "Trelleborg DrainLiner Verfahren" und den Harzsystemen "Trelleborg Epoxy HC120" und "Trelleborg Epoxy HC120+" zur Sanierung schadhafter, erdverlegter Abwasserleitungen in dem Nennweiten DN 100 bis DN 600

Anlage 7

Variante 1 | Warmwasseraushärtung mit Zirkulation

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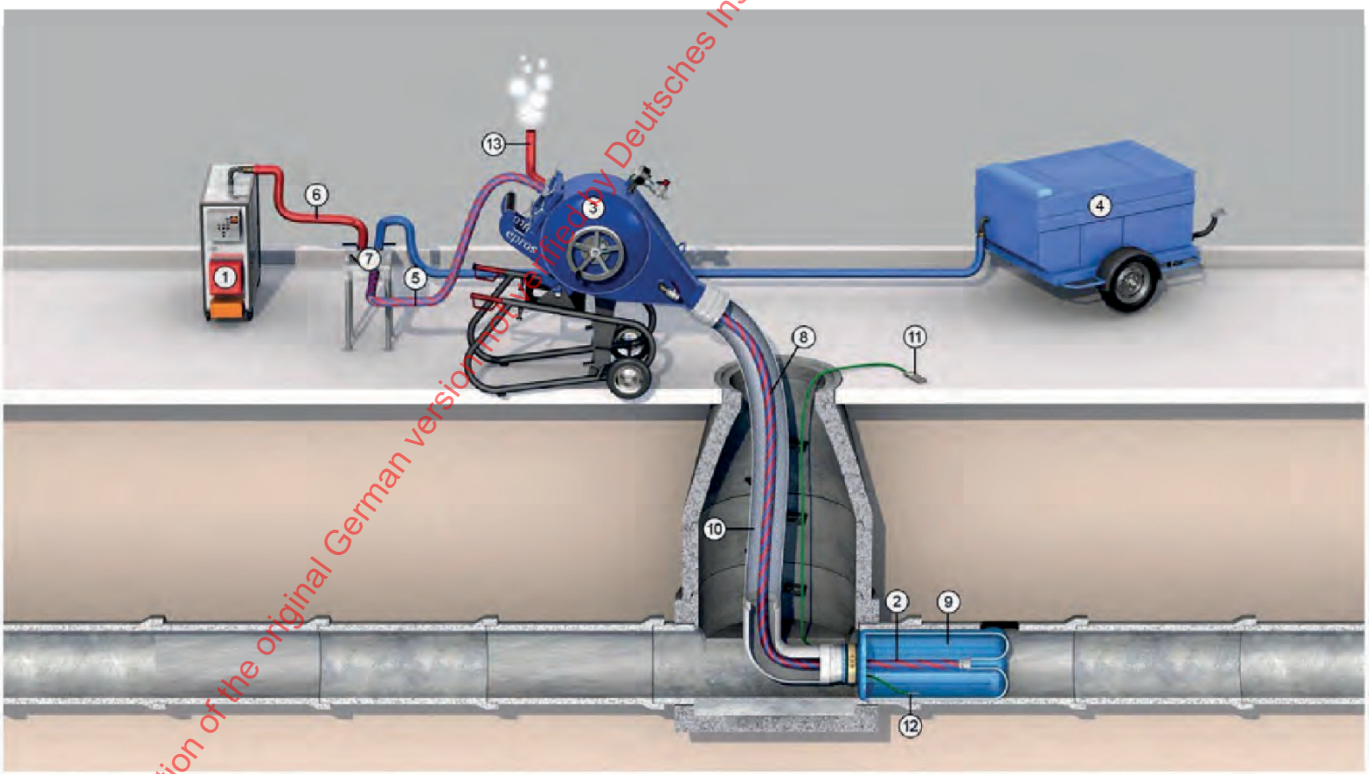
Variante 2 : Dampfaushärtung mit Heizschlauch | Systemübersicht

Pos.	Beschreibung
1	Dampferzeuger
2	Steuerband
3	Inversionstrommel oder Inversionsdruckschleuse
4	Luftversorgung
5	Dampf / Luft-Zuführleitung
6	Dampfleitung
7	Dampf-Telemetrie-Anlage
8	Heizschlauch
9	Schlauchliner
10	Inversionsschlauch dampfbeständig
11	Temperatur-Messgerät
12	Temperaturmessstelle in der Sohle der Leitung
13	Dampf-Auslassschlauch



Bauprodukte und deren Verwendung zur Ausführung von Schlauchlinern mit der Bezeichnung "Trelleborg DrainLiner Verfahren" und den Harzsystemen "Trelleborg Epoxy HC120" und "Trelleborg Epoxy HC120+" zur Sanierung schadhafter, erdverlegter Abwasserleitungen in dem Nennweiten DN 100 bis DN 600

Anlage 8

Variante 2 | Dampaushärtung mit Heizschlauch

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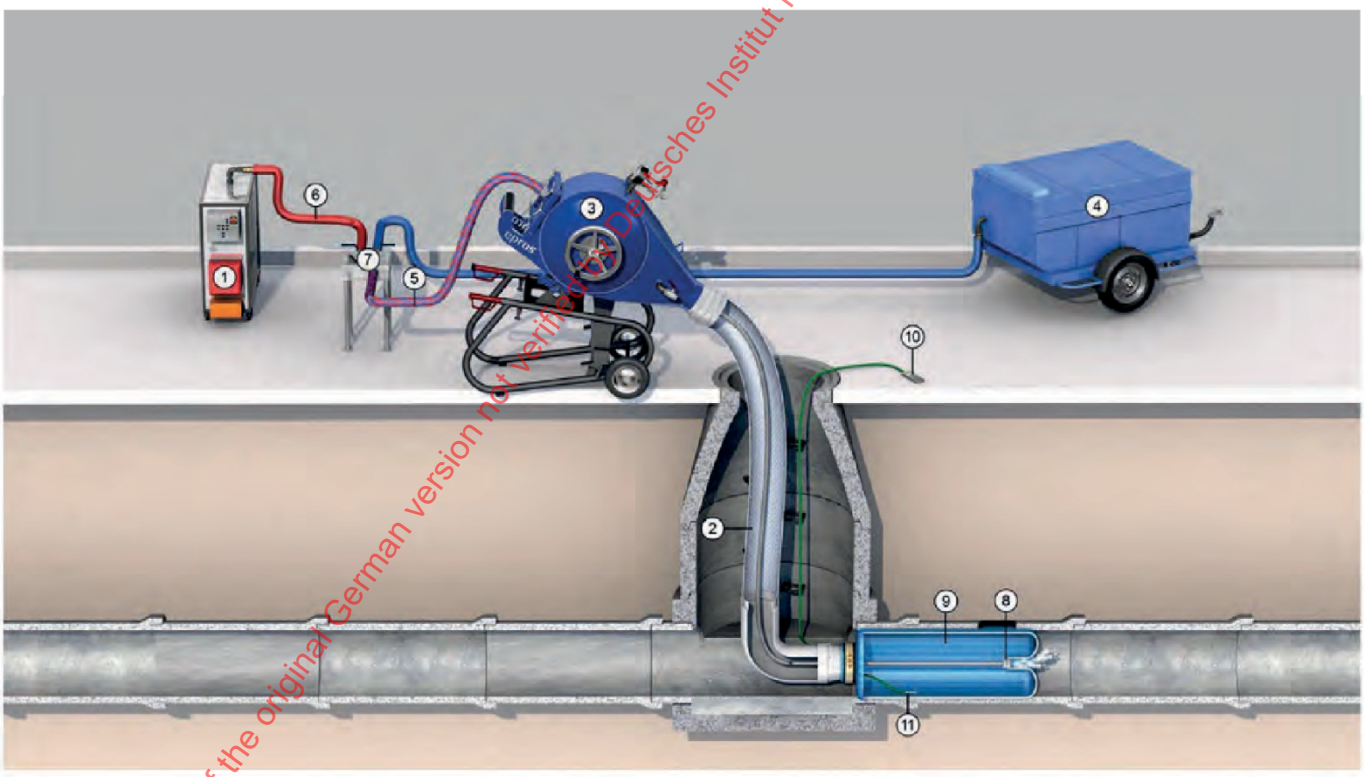
Variante 3: Dampfaushärtung mit Dampfauslassventil | Systemübersicht

Pos.	Beschreibung
1	Dampferzeuger
2	Steuerband
3	Inversionstrommel oder Inversionsdruckschleuse
4	Luftversorgung
5	Dampf / Luft-Zuführleitung
6	Dampfleitung
7	Dampf-Telemetrie-Anlage
8	Dampfauslassventil
9	Schlauchliner
10	Temperatur-Messgerät
11	Temperaturmessstelle in der Sohle der Leitung



Bauprodukte und deren Verwendung zur Ausführung von Schlauchlinern mit der Bezeichnung "Trelleborg DrainLiner Verfahren" und den Harzsystemen "Trelleborg Epoxy HC120" und "Trelleborg Epoxy HC120+" zur Sanierung schadhafter, erdverlegter Abwasserleitungen in dem Nennweiten DN 100 bis DN 600

Anlage 9

Variante 3 | Dampfaushärtung mit Dampfauslassventil

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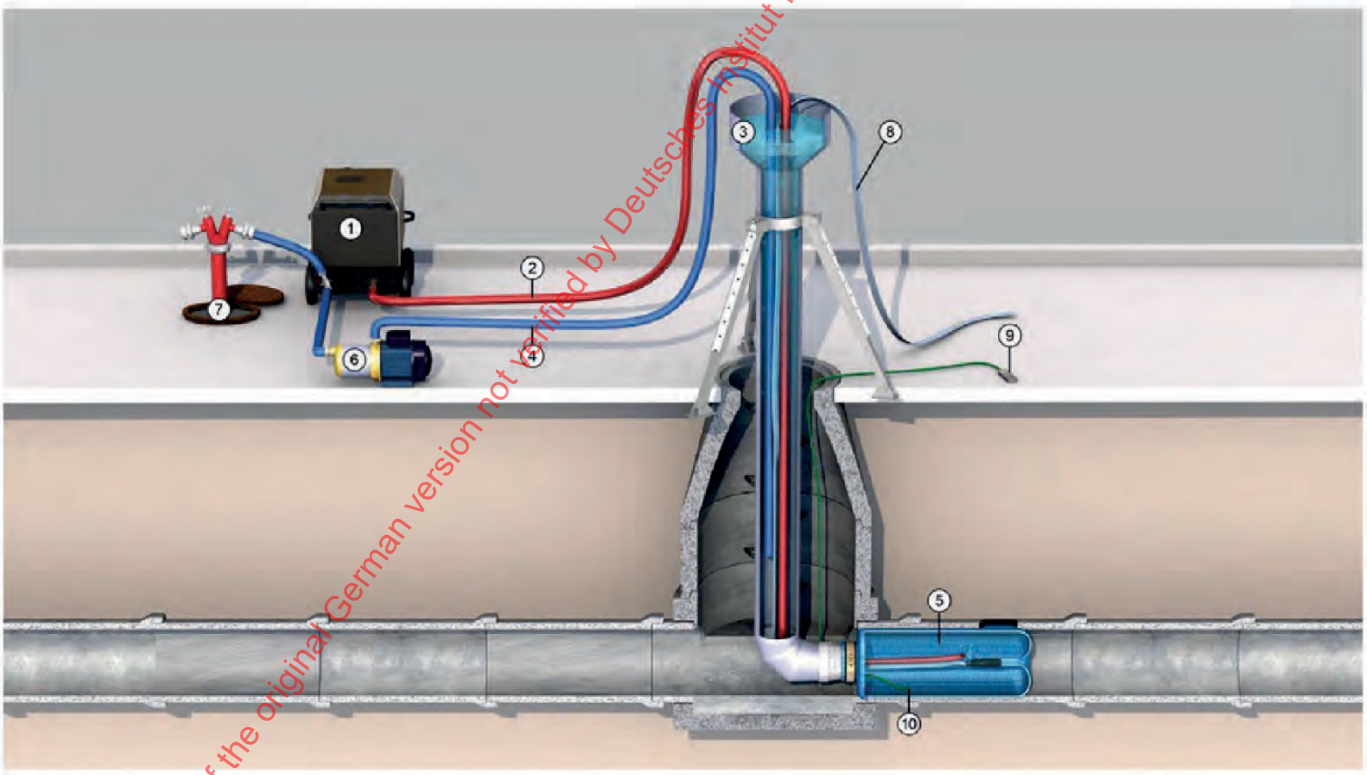
Variante 4: Wasserinversion (Wassersäule) mit Warmwasseraushärtung | Systemübersicht

Pos.	Beschreibung
1	Heißwasser Generator
2	Zirkulations(flach-)schlauch Heißwasser
3	Inversionsrohr
4	Zirkulationsleitung Saugschlauch Rückführleitung
5	Schlauchliner
6	Zirkulationspumpe
7	Wasserversorgung
8	Steuerband
9	Temperatur-Messgerät
10	Temperaturmessstelle in der Sohle der Leitung



Bauprodukte und deren Verwendung zur Ausführung von Schlauchlinern mit der Bezeichnung "Trelleborg DrainLiner Verfahren" und den Harzsystemen "Trelleborg Epoxy HC120" und "Trelleborg Epoxy HC120+" zur Sanierung schadhafter, erdverlegter Abwasserleitungen in dem Nennweiten DN 100 bis DN 600

Anlage 10

Variante 4 | Wasserinversion mit Warmwasser-Aushärtung

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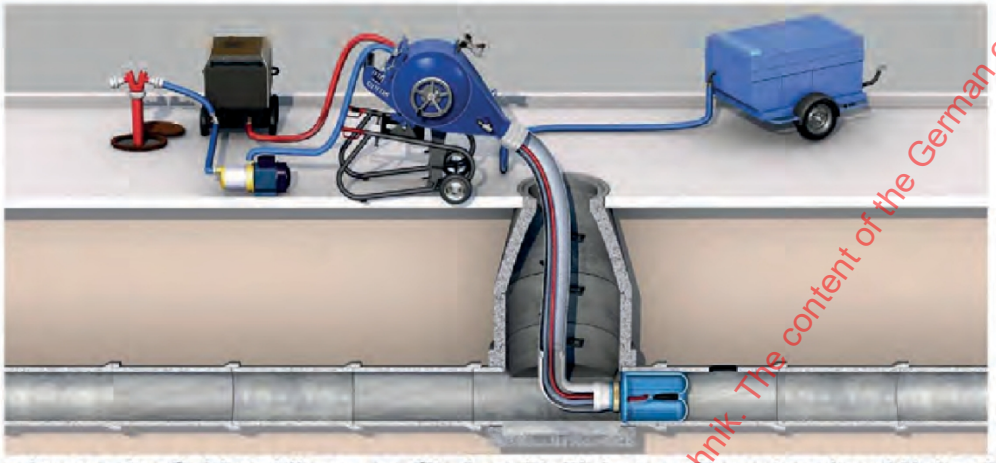
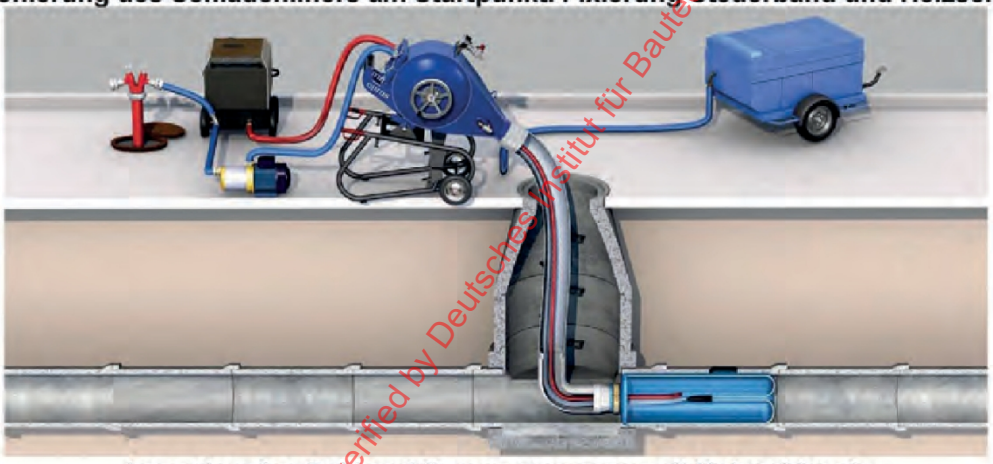
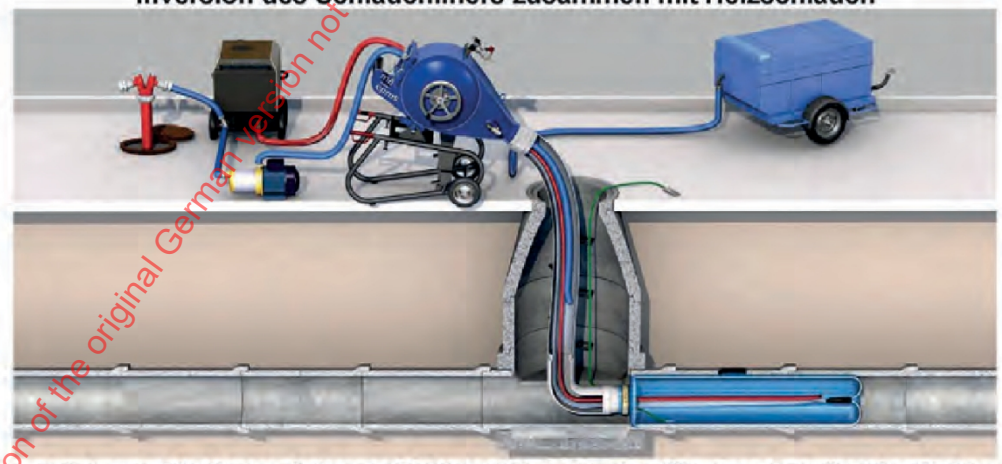
Warmaushärtung mit Zirkulation / Dampfauslassventil | Geschlossenes Ende



Positionierung des Schlauchliners am Startpunkt. Fixierung Steuerband und Heizschlauch



Inversion des Schlauchliners zusammen mit Heizschlauch



Warmwasseraushärtung: Medium wird zum Schlauchlinerkopf geführt und strömt im Schlauchliner zurück. Alternativ: Mit Dampfauslassventil strömt das Dampf-/Luft-Gemisch in Inversionsrichtung und tritt am Schlauchlinerkopf aus

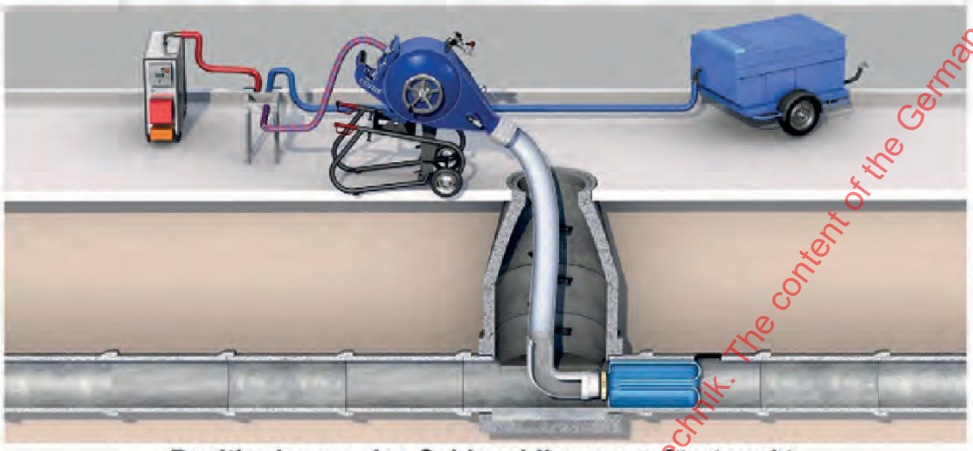
Bauprodukte und deren Verwendung zur Ausführung von Schlauchlinern mit der Bezeichnung "Trelleborg DrainLiner Verfahren" und den Harzsystemen "Trelleborg Epoxy HC120" und "Trelleborg Epoxy HC120+" zur Sanierung schadhafter, erdverlegter Abwasserleitungen in dem Nennweiten DN 100 bis DN 600

Anlage 11

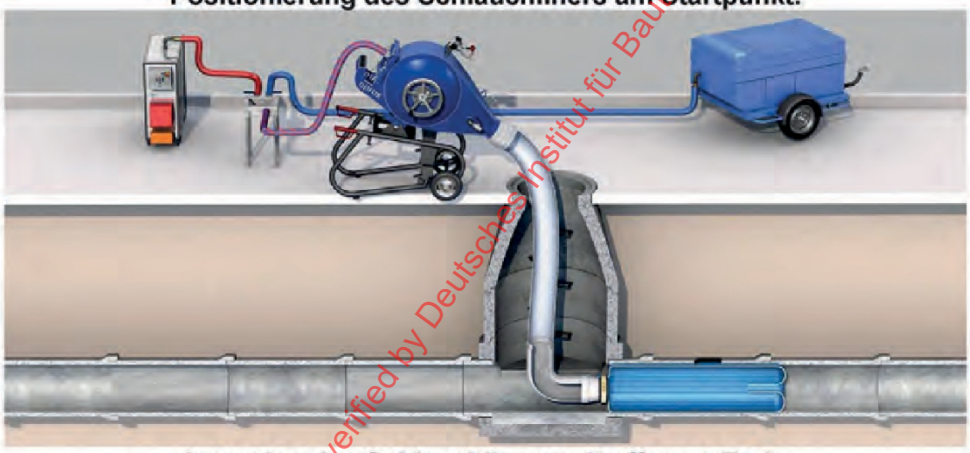
Sanierung mit geschlossenem Ende (Closed End)

Deutsches Institut für Bautechnik DIBt

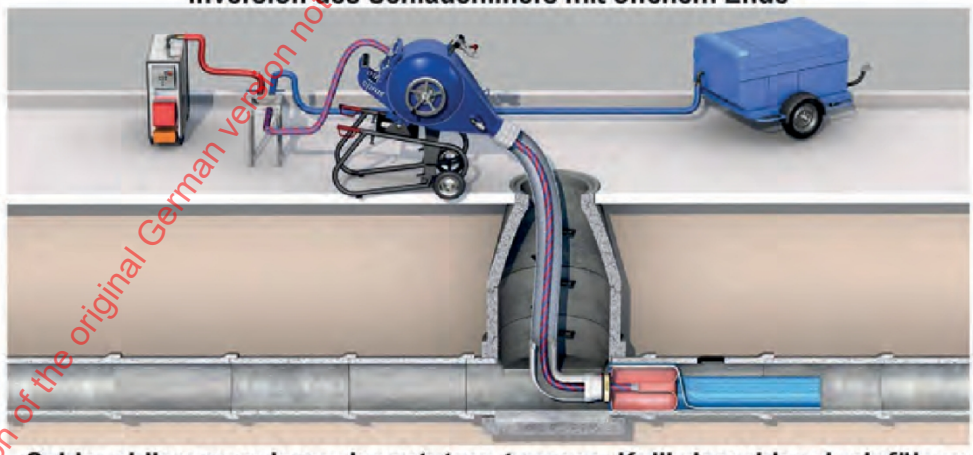
Warmaushärtung mit Zirkulation / Dampfauslassventil
Offenes Ende – Kalibrierschlauch nachträglich (Teil 1)



Positionierung des Schlauchliners am Startpunkt.



Inversion des Schlauchliners mit offenem Ende



Schlauchliner vom Inversionsstutzen trennen, Kalibrierschlauch einführen und am Startpunkt positionieren

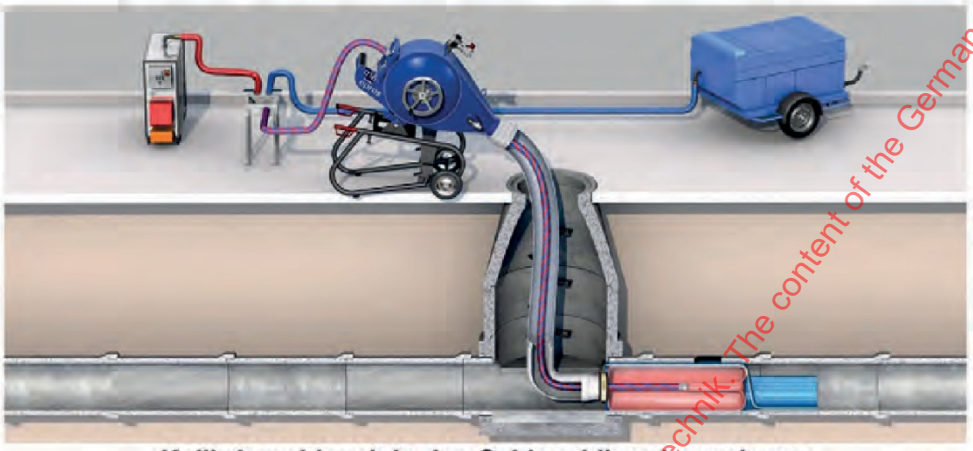
Bauprodukte und deren Verwendung zur Ausführung von Schlauchlinern mit der Bezeichnung "Trelleborg DrainLiner Verfahren" und den Harzsystemen "Trelleborg Epoxy HC120" und "Trelleborg Epoxy HC120+" zur Sanierung schadhafter, erdverlegter Abwasserleitungen in dem Nennweiten DN 100 bis DN 600

Anlage 12

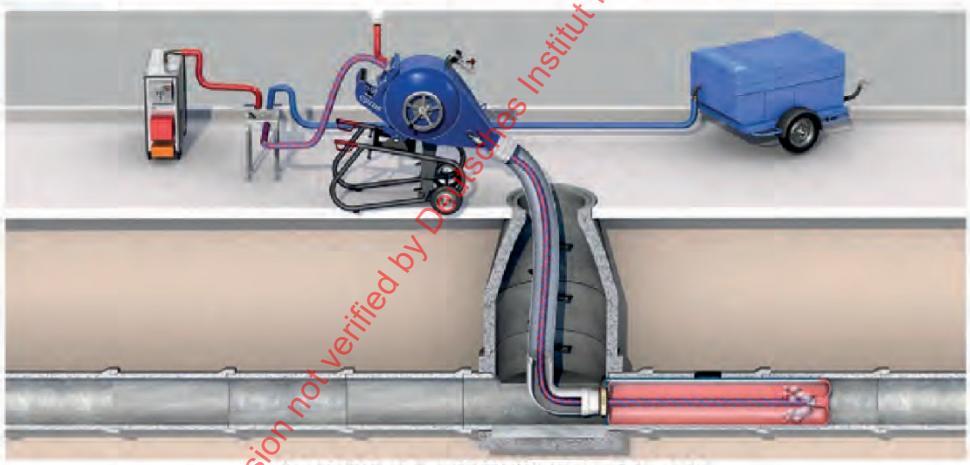
Sanierung mit offenem Ende (Open End) und nachträglichem Inversieren des Kalibrierschlauchs (Teil 1 von 2)

Deutsches Institut für Bautechnik DIBt

Warmaushärtung mit Zirkulation / Dampfauslassventil
Offenes Ende – Kalibrierschlauch nachträglich (Teil 2)



Kalibrierschlauch in den Schlauchliner inversieren.
Für Zirkulation den Heizschlauch mit inversieren, andernfalls das Dampfauslassventil an den Kalibrierschlauchkopf einbinden



Aushärtung mit Kalibrierschlauch:
Heißes Medium wird zum Schlauchlinerkopf geführt und strömt im Schlauchliner zurück.

Alternativ:
Mit Dampfauslassventil strömt das Dampf-/Luftgemisch in Inversionsrichtung und tritt am Schlauchlinerkopf aus

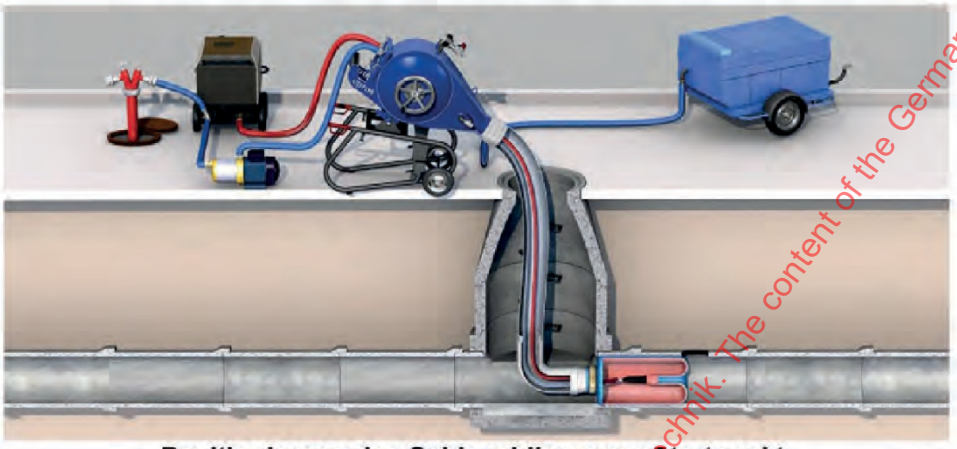
Bauprodukte und deren Verwendung zur Ausführung von Schlauchlinern mit der Bezeichnung "Trelleborg DrainLiner Verfahren" und den Harzsystemen "Trelleborg Epoxy HC120" und "Trelleborg Epoxy HC120+" zur Sanierung schadhafter, erdverlegter Abwasserleitungen in dem Nennweiten DN 100 bis DN 600

Anlage 13

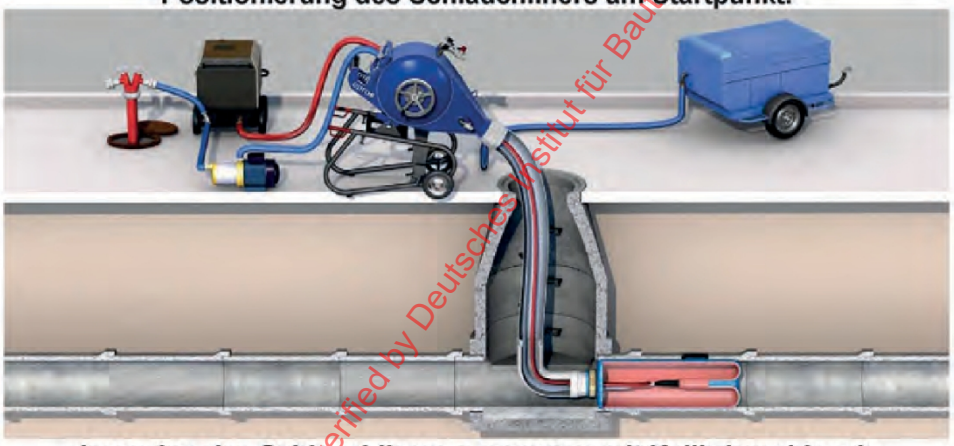
Sanierung mit offenem Ende (Open End) und nachträglichem Inversieren des Kalibrierschlauchs (Teil 2 von 2)

Deutsches Institut für Bautechnik DIBt

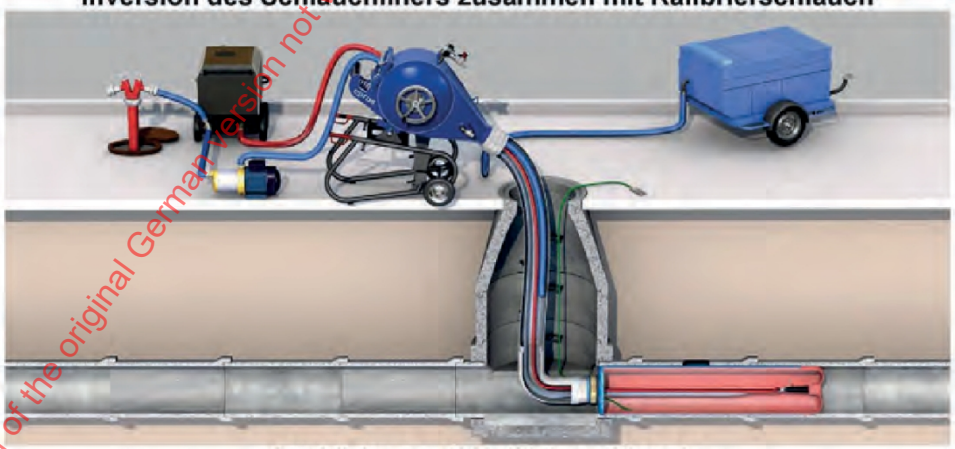
Warmaushärtung mit Zirkulation / Wasser oder Dampf
Offenes Ende – Kalibrierschlauch gleichzeitig



Positionierung des Schlauchliners am Startpunkt.



Inversion des Schlauchliners zusammen mit Kalibrierschlauch



Aushärtung mit Kalibrierschlauch:
Heißes Medium wird zum Schlauchlinerkopf geführt und strömt im Schlauchliner zurück.
Alternativ: Mit Dampfauslassventil strömt das Dampf-/Luftgemisch in Inversionsrichtung durch den Schlauchliner und tritt am Schlauchlinerkopf aus

Bauprodukte und deren Verwendung zur Ausführung von Schlauchlinern mit der Bezeichnung "Trelleborg DrainLiner Verfahren" und den Harzsystemen "Trelleborg Epoxy HC120" und "Trelleborg Epoxy HC120+" zur Sanierung schadhafter, erdverlegter Abwasserleitungen in dem Nennweiten DN 100 bis DN 600

Anlage 14

Sanierung mit offenem Ende (Open End) und gleichzeitigem Inversieren des Kalibrierschlauchs

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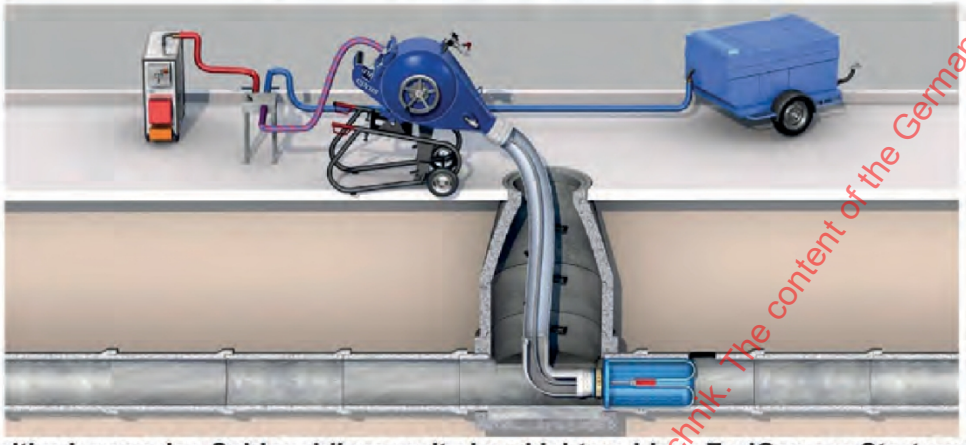
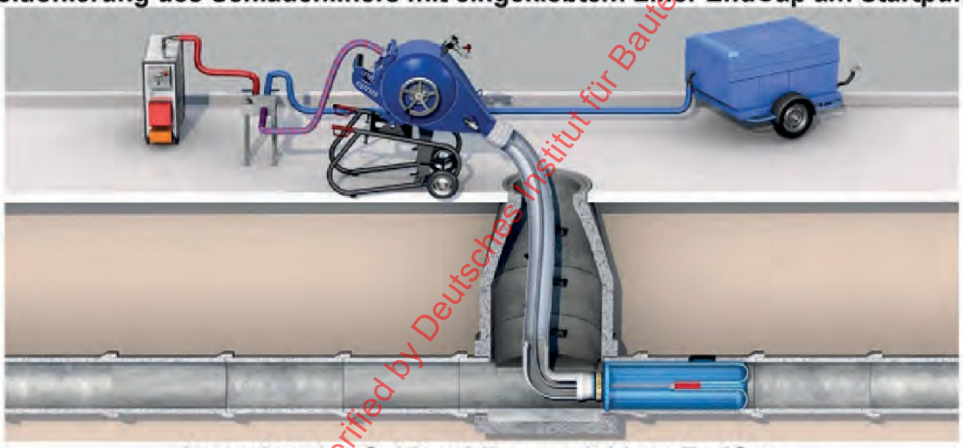
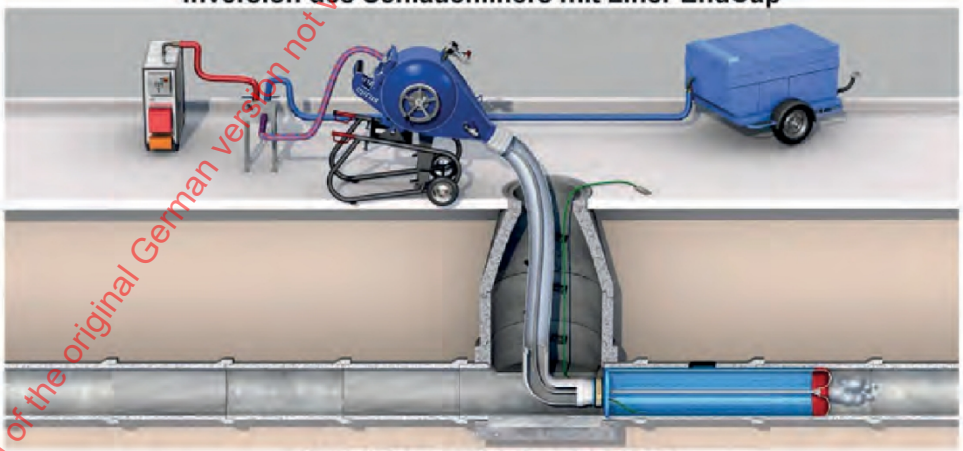
Warmaushärtung mit Zirkulation / Dampfauslassventil
Offenes Ende – mit Liner EndCap



Positionierung des Schlauchliners mit eingeklebtem Liner EndCap am Startpunkt.



Inversion des Schlauchliners mit Liner EndCap



Aushärtung mit Liner EndCap:
Heißes Medium wird zum Schlauchlinerkopf geführt und strömt im Schlauchliner zurück.
Alternativ: Mit Dampfauslassventil strömt das Dampf-/Luftgemisch in Inversionsrichtung durch den Schlauchliner und tritt am Schlauchlinerkopf aus

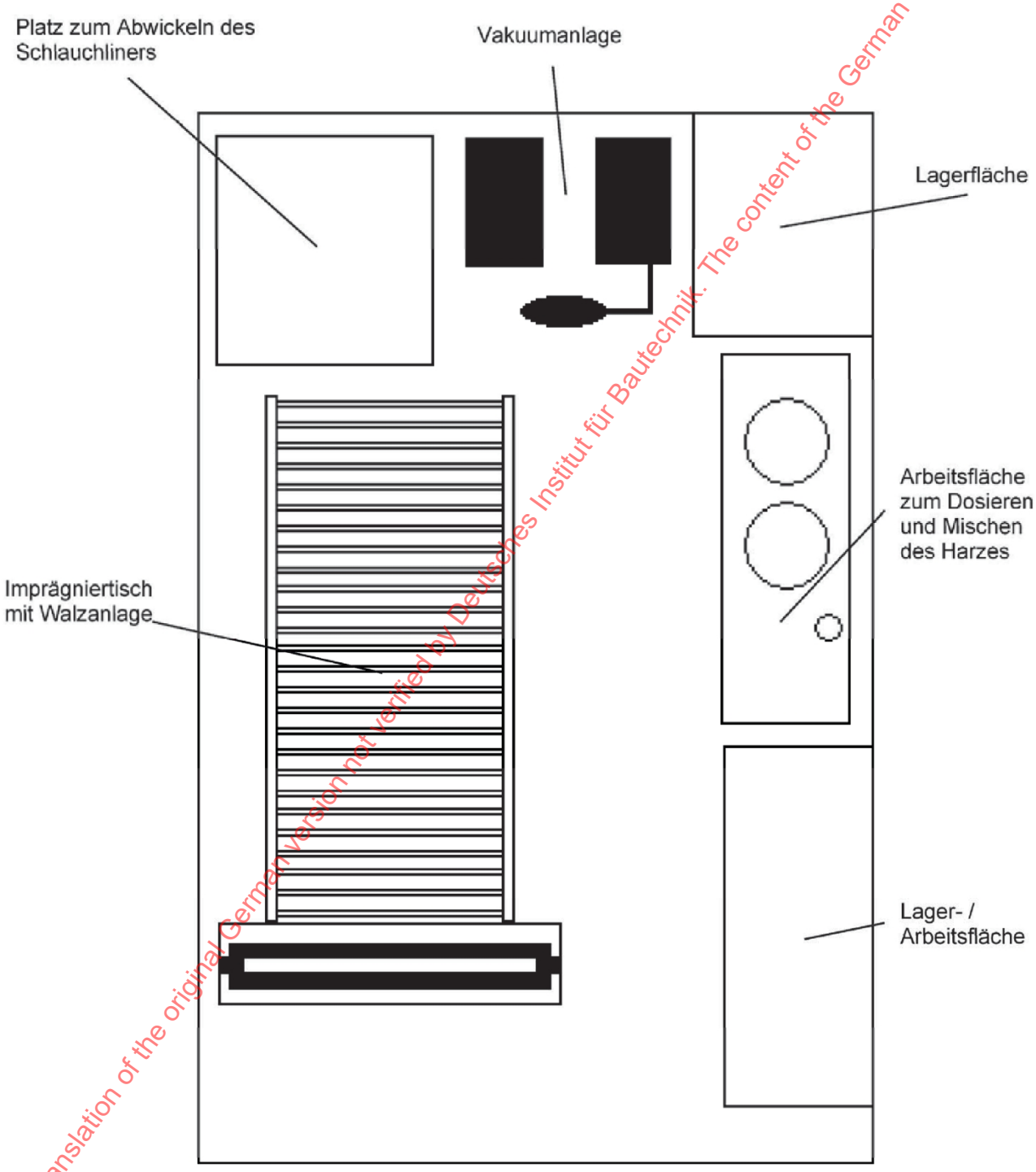
Bauprodukte und deren Verwendung zur Ausführung von Schlauchlinern mit der Bezeichnung "Trelleborg DrainLiner Verfahren" und den Harzsystemen "Trelleborg Epoxy HC120" und "Trelleborg Epoxy HC120+" zur Sanierung schadhafter, erdverlegter Abwasserleitungen in dem Nennweiten DN 100 bis DN 600

Anlage 15

Sanierung mit offenem Ende (Open End) und gleichzeitigem Inversieren des Kalibrierschlauchs

Deutsches Institut für Bautechnik DIBt

Anhängeraufbau | Systemübersicht



Bauprodukte und deren Verwendung zur Ausführung von Schlauchlinern mit der Bezeichnung "Trelleborg DrainLiner Verfahren" und den Harzsystemen "Trelleborg Epoxy HC120" und "Trelleborg Epoxy HC120+" zur Sanierung schadhafter, erdverlegter Abwasserleitungen in dem Nennweiten DN 100 bis DN 600

Anlage 16

Trelleborg DrainLiner Verfahren | Anhängeraufbau

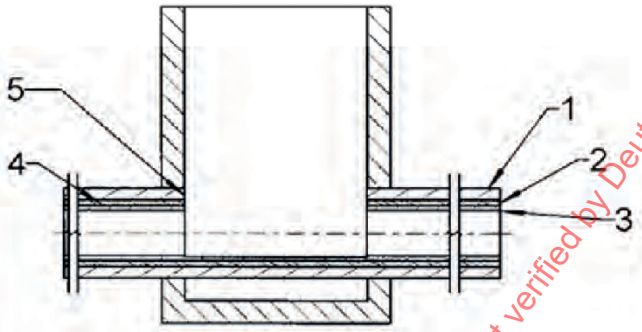
Deutsches Institut für Bautechnik DIBt

Schachtanbindung

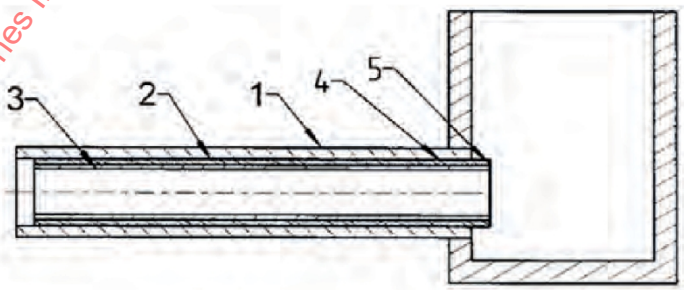
Option 1
1 Altrohr
2 Preliner (PE-Schutzschlauch)
3 Imprägnierter Polyester Nadelvliesschlauch (Schlauchliner)
4 Quellband
5 Abdichtung mit Mörtel

Option 2
1 Altrohr
2 Preliner (PE-Schutzschlauch)
3 Imprägnierter Polyester Nadelvliesschlauch (Schlauchliner)
4 LinerEndSeal

Zwischenschacht



Endschacht



Bauprodukte und deren Verwendung zur Ausführung von Schlauchlinern mit der Bezeichnung "Trelleborg DrainLiner Verfahren" und den Harzsystemen "Trelleborg Epoxy HC120" und "Trelleborg Epoxy HC120+" zur Sanierung schadhafter, erdverlegter Abwasserleitungen in dem Nennweiten DN 100 bis DN 600

Anlage 17

Trelleborg DrainLiner Verfahren| Schachtanbindung

Deutsches Institut für Bautechnik DIBt

Harzsystem Trelleborg Epoxy HC 120 und Trelleborg HC120+

Inversions-, Aushärtedrücke und Harzmenge für MultiFlexLiner 9% Untermaß

Nennweite Schlauchliner	Wanddicke	Einbau- und Aushärtedruck	Harzmenge
mm	mm	bar	Liter /m
100	3	0,3	1,02
125	3	0,4	1,27
150	3	0,1	1,53
200	3	0,2	2,04
225	3	0,2	2,29
250	3	0,2	2,68

Inversions-, Aushärtedrücke und Harzmenge für MultiFlexLiner 18% Untermaß

Nennweite Schlauchliner	Wanddicke	Einbau- und Aushärtedruck	Harzmenge
mm	mm	bar	Liter /m
100	3	0,3	0,92
125	3	0,3	1,15
150	3	0,3	1,34
200	3	0,3	1,83
225	3	0,2	2,06
250	3	0,2	2,42

Deutsches Institut für Bautechnik DIBt

Harzsystem Trelleborg Epoxy HC 120 und Trelleborg HC120+

Inversions-, Aushärtedrücke und Harzmenge für UltraFlexLiner Silikon

Nennweite Schlauchliner	Rohrdurchmesser	Wanddicke	Einbaudruck	Aushärtedruck	Harzmenge
mm	mm	cm	bar	bar	Liter /m
100	100	4,5	0,40	0,30	1,80
	125	3,7	0,50	0,40	
	150	3,0	0,60	0,60	
125	125	4,5	0,30	0,25	1,01
	150	3,0	0,40	0,40	
150	150	4,5	0,25	0,25	1,90
	200	3,0	0,30	0,30	
200	200	4,5	0,20	0,20	2,56
	225	3,7	0,20	0,20	
	250	3,0	0,25	0,25	
225	225	4,5	0,20	0,20	2,92
	250	3,7	0,20	0,20	
250	250	4,5	0,20	0,15	3,36

Inversions-, Aushärtedrücke und Harzmenge für UltraFlexLiner TPU

Nennweite Schlauchliner	Rohrdurchmesser	Wanddicke	Einbaudruck	Aushärtedruck	Harzmenge
mm	mm	cm	bar	bar	Liter /m
100	100	4,5	0,40	0,30	1,80
	125	3,7	0,50	0,40	
	150	3,0	0,60	0,60	
125	125	4,5	0,30	0,25	1,01
	150	3,0	0,40	0,40	
150	150	4,5	0,25	0,25	1,90
	200	3,0	0,30	0,30	
200	200	4,5	0,20	0,20	2,56
	225	3,7	0,20	0,20	
	250	3,0	0,25	0,25	
225	225	4,5	0,20	0,20	2,92
	250	3,7	0,20	0,20	
250	250	4,5	0,20	0,15	3,36

Bauprodukte und deren Verwendung zur Ausführung von Schlauchlinern mit der Bezeichnung "Trelleborg DrainLiner Verfahren" und den Harzsystemen "Trelleborg Epoxy HC120" und "Trelleborg Epoxy HC120+" zur Sanierung schadhafter, erdverlegter Abwasserleitungen in dem Nennweiten DN 100 bis DN 600

Anlage 19

Inversions-, Aushärtedrücke und Harzmenge für UltraFlexLiner Silikon und TPU

Deutsches Institut für Bautechnik DIBt

Inversions-, Aushärtedrücke und Harzmenge Trelleborg DrainLiner / ProLiner + MainLiner (MainLiner ab DN 150)

Durchmesser		Wanddicke		min. Inversionsdruck		max. Inversiondruck		min. Aushärtedruck bei 10 °C		min. Aushärtedruck bei 80 °C		max. Aushärtedruck		Harzmenge	
mm	inch	mm	inch	bar	psi	bar	psi	bar	psi	bar	psi	bar	psi	Liter/m	Gallon (US) / feet
100	4	3	0,12	0,32	4,6	1,12	16,2	0,40	5,8	0,27	3,9	0,45	6,5	1,04	0,08
100	4	4,5	0,18	0,48	7,0	1,68	24,4	0,60	8,8	0,40	5,8	0,67	9,7	1,56	0,13
125	5	3	0,12	0,32	4,6	1,12	16,2	0,40	5,8	0,27	3,9	0,45	6,5	1,30	0,10
125	5	4,5	0,18	0,48	7,0	1,68	24,4	0,60	8,8	0,40	5,8	0,67	9,7	1,95	0,16
150	6	3	0,12	0,32	4,6	1,12	16,2	0,40	5,8	0,27	3,9	0,45	6,5	1,56	0,13
150	6	4,5	0,18	0,48	7,0	1,68	24,4	0,60	8,8	0,40	5,8	0,67	9,7	2,34	0,19
150	6	6	0,24	0,64	9,3	2,24	32,5	0,81	11,7	0,54	7,8	0,90	13,0	3,12	0,25
200	8	3	0,12	0,24	3,5	0,88	12,8	0,32	4,6	0,21	3,1	0,35	5,1	2,08	0,17
200	8	4,5	0,18	0,40	5,8	1,28	18,6	0,46	6,7	0,31	4,5	0,51	7,4	3,12	0,25
200	8	6	0,24	0,48	7,0	1,68	24,4	0,60	8,8	0,40	5,8	0,67	9,7	4,15	0,33
225	9	3	0,12	0,24	3,5	0,88	12,8	0,32	4,6	0,21	3,1	0,35	5,1	2,34	0,19
225	9	4,5	0,18	0,40	5,8	1,28	18,6	0,46	6,7	0,31	4,5	0,51	7,4	3,50	0,28
225	9	6	0,24	0,48	7,0	1,68	24,4	0,60	8,8	0,40	5,8	0,67	9,7	4,67	0,38
250	10	4,5	0,18	0,32	4,6	0,96	13,9	0,35	5,0	0,23	3,3	0,38	5,6	3,9	0,31
250	10	6	0,24	0,40	5,8	1,36	19,7	0,49	7,1	0,33	4,7	0,54	7,9	5,2	0,42
250	10	9	0,35	0,56	8,1	2,00	29,0	0,72	10,4	0,48	7,0	0,80	11,6	7,8	0,63
300	12	6	0,24	0,32	4,6	1,12	16,2	0,40	5,8	0,27	3,9	0,45	6,5	6,3	0,51
300	12	9	0,35	0,48	7,0	1,68	24,4	0,60	8,8	0,40	5,8	0,67	9,7	9,4	0,76
300	12	12	0,47	0,64	9,3	2,24	32,5	0,81	11,7	0,54	7,8	0,90	13,0	12,5	1,01
350	14	6	0,24	0,32	4,6	1,12	16,2	0,40	5,8	0,27	3,9	0,45	6,5	7,3	0,59
350	14	9	0,35	0,48	7,0	1,68	24,4	0,60	8,8	0,40	5,8	0,67	9,7	10,9	0,88
350	14	12	0,47	0,64	9,3	2,24	32,5	0,81	11,7	0,54	7,8	0,90	13,0	14,6	1,18
375	15	6	0,24	0,24	3,5	0,88	12,8	0,32	4,6	0,21	3,1	0,35	5,1	7,8	0,63
375	15	9	0,35	0,40	5,8	1,28	18,6	0,46	6,7	0,31	4,5	0,51	7,4	11,7	0,94
375	15	12	0,47	0,48	7,0	1,68	24,4	0,60	8,8	0,40	5,8	0,67	9,7	15,6	1,26
400	16	6	0,24	0,24	3,5	0,88	12,8	0,32	4,6	0,21	3,1	0,35	5,1	8,3	0,67
400	16	9	0,35	0,40	5,8	1,28	18,6	0,46	6,7	0,31	4,5	0,51	7,4	12,5	1,01
400	16	12	0,47	0,48	7,0	1,68	24,4	0,60	8,8	0,40	5,8	0,67	9,7	16,6	1,34
450	18	6	0,24	0,24	3,5	0,72	10,4	0,26	3,8	0,17	2,5	0,29	4,2	9,4	0,76
450	18	9	0,35	0,32	4,6	1,12	16,2	0,40	5,8	0,27	3,9	0,45	6,5	14,0	1,13
450	18	12	0,47	0,40	5,8	1,52	22,0	0,55	7,9	0,36	5,3	0,61	8,8	18,7	1,51
450	18	15	0,59	0,56	8,1	1,84	26,7	0,66	9,6	0,44	6,4	0,74	10,7	23,4	1,88
500	20	9	0,35	0,32	4,6	0,96	13,9	0,35	5,0	0,23	3,3	0,38	5,6	15,6	1,26
500	20	12	0,47	0,32	4,6	1,28	18,6	0,46	6,7	0,31	4,5	0,51	7,4	20,8	1,68
500	20	15	0,59	0,40	5,8	1,60	23,2	0,58	8,4	0,38	5,6	0,64	9,3	26,0	2,09
500	20	18	0,71	0,56	8,1	1,92	27,8	0,69	10,0	0,46	6,7	0,77	11,1	31,2	2,51
600	24	9	0,35	0,24	3,5	0,80	11,6	0,29	4,2	0,19	2,8	0,32	4,6	18,7	1,51
600	24	12	0,47	0,32	4,6	1,12	16,2	0,40	5,8	0,27	3,9	0,45	6,5	24,9	2,01
600	24	18	0,71	0,48	7,0	1,68	24,4	0,60	8,8	0,40	5,8	0,67	9,7	37,4	3,01
600	24	21	0,83	0,56	8,1	1,92	27,8	0,69	10,0	0,46	6,7	0,77	11,1	43,6	3,51

Bauprodukte und deren Verwendung zur Ausführung von Schlauchlinern mit der Bezeichnung "Trelleborg DrainLiner Verfahren" und den Harzsystemen "Trelleborg Epoxy HC120" und "Trelleborg Epoxy HC120+" zur Sanierung schadhafter, erdverlegter Abwasserleitungen in dem Nennweiten DN 100 bis DN 600

Anlage 20

Trelleborg DrainLiner Verfahren | Einbau, Aushärtedrücke und Harzmenge PVC/PP SchlauchLiner / DrainLiner (PVC) / ProLiner und MainLiner (PP)

Deutsches Institut für Bautechnik DIBt

TRELLEBORG

PROTOKOLL BAUSTELLENBESICHTIGUNG Sanierung / Reparatur von erdverlegten Abwasserleitungen					
Einzelbericht pro Sanierung:		Schmutzwasser ☐	TV-Voruntersuchung:		Aufmaß vom (Datum):
Baustelle:	Projekt-Nr.:	Regenwasser ☐	vorhanden ☐		Name:
Strasse:		Mischwasser ☐	nicht vorhanden ☐		Name:

Von Schacht (1) Nummer	Bis Schacht (2) Nummer	Schacht-tiefe (1)	Schacht-tiefe (2)	DN (mm) überprüft?	DN laut Lageplan	Länge Meter	Profilform Profilform	Bei Ei-Profil Rohrumfang	Bemerkungen Aufmaß Schachtmitte bis Schachtmitte

Entfernungen zum Gerüst oder Inversionstrommel			Bemerkungen:	ggf. Skizze
Überflurhydrant		m		
Unterflurhydrant		m		
Schlauchbrücken	ja	☐		
	nein	☐		
Straßenbreite		m		
mit Fahrzeug anfahrbar	ja	☐		
	nein	☐		
	Entfernung /m			
gegebene Verkehrsdichte	Privatgelände	☐		
	Seitenstraße	☐		
	Hauptstraße	☐		
Verkehrsregelung notwendig	ja	☐		
	nein	☐		
Wasserhaltung	ja	☐		
	nein	☐		
Wasserhaltung durch	Rückstau	☐		
	Pumpen	☐		
HA-Wasserhaltung	ja	☐	Revisionsschacht vorhanden ja ☐ nein ☐	
	nein	☐		

Bauprodukte und deren Verwendung zur Ausführung von Schlauchlinern mit der Bezeichnung "Trelleborg DrainLiner Verfahren" und den Harzsystemen "Trelleborg Epoxy HC120" und "Trelleborg Epoxy HC120+" zur Sanierung schadhafter, erdverlegter Abwasserleitungen in dem Nennweiten DN 100 bis DN 600	**Anlage 21**
Baustellenbesichtigung	

Deutsches Institut für Bautechnik DIBt

TRELLEBORG

Baustelleninformation:	
Sanierungsfahrzeug:	
Operateur:	
Bauleitung:	
Baumaßnahme:	
Kostenstelle:	
Auftraggeber:	
Ansprechpartner:	
Treffpunkt:	
Leistungen:	
Subunternehmer:	
Sonstiges:	

Bauprodukte und deren Verwendung zur Ausführung von Schlauchlinern mit der Bezeichnung "Trelleborg DrainLiner Verfahren" und den Harzsystemen "Trelleborg Epoxy HC120" und "Trelleborg Epoxy HC120+" zur Sanierung schadhafter, erdverlegter Abwasserleitungen in dem Nennweiten DN 100 bis DN 600

Anlage 22

Baustelleninformation

Deutsches Institut für Bautechnik DIBt

TRELLEBORG

Schlauchliner Herstellungsprotokoll

Projektdaten

Sanierungsfahrzeug:		Datum:		Baustellen-Nr.	
Bauvorhaben:					
Strasse:		PLZ:		Ort:	
Auftraggeber:					
Sanierung Nr.:		Von Punkt:		Bis Punkt:	
Profilform:		DN:	mm	Liner Länge:	
				Soll-Wandstärke	

Material / Materialverbrauch

Trägermaterial (bitte ankreuzen - keine Mehrfachauswahl)

Trelleborg ProLiner	☐	Ident.-Nummer/ Stärke:	/	mm
Trelleborg MainLiner	☐	Ident.-Nummer/ Stärke:	/	mm
Trelleborg MultiFlex Liner	☐	Ident.-Nummer/ Stärke:	/	mm
Trelleborg UltraFlex Liner	☐	Ident.-Nummer/ Stärke:	/	mm

Verwendetes Harzsystem Name / Typbezeichnung:

Basisdaten

Angaben zum Harz	Soll*	Ist
Lagertemperatur	15 - 35 °C	°C
Mischungsverhältnis Harz : Härter (kg)	Harz : Härter	Harz : Härter
Mischungstemperatur	> 15 °	
Verarbeitungszeit bei 25 °C in Minuten		
Verbrauch Komponente A (kg)		
Verbrauch Komponente B (kg)		
Summe Verbrauch Komponenten A + B		
Chargen Nr. Komp. A:		
Chargen Nr. Komp. B:		

Fertigungsbedingungen

		Soll*	Ist
Imprägnierung	Vakuum	0,5 bar	
	Walzenabstand	2x „s" + 2 mm	
Temperaturen °C	Umgebung		
	Harz		
	Härter		
	Liner nach Imprägnierung		
Zeiten		Start (Uhr)	Ende (Uhr)
	Mischen Soll: 3 Minuten		
	Imprägnierung		
	Inversion		
	Wasser befüllen		

Baustellenrückstellmuster:

Trägermaterial / Baustellen-Beschreibung

Trägermaterial / Baustellen-Beschreibung

Bemerkungen

Datum Unterschrift

*) Sollwerte müssen aus den Technischen Datenblättern entsprechend dem Harzsystem entnommen werden

Bauprodukte und deren Verwendung zur Ausführung von Schlauchlinern mit der Bezeichnung "Trelleborg DrainLiner Verfahren" und den Harzsystemen "Trelleborg Epoxy HC120" und "Trelleborg Epoxy HC120+" zur Sanierung schadhafter, erdverlegter Abwasserleitungen in dem Nennweiten DN 100 bis DN 600

Anlage 23

Herstellungsprotokoll

Deutsches Institut für Bautechnik DIBt

TRELLEBORG

Grabenlose Sanierung schadhafter Abwasserleitungen
Einbauprotokoll Liner

Projektdaten

Sanierungsfahrzeug: Datum: Baustellen-Nr.:
Bauvorhaben:
Strasse: PLZ: Ort:
Auftraggeber:

Sanierung Nr.: Von Punkt: Bis Punkt:
Profilform: DN: mm Liner Länge:
Soll-Wandstärke:

Vorbereitung

Verkehrssicherung: ja / nein Vorbefahrung: ja / nein
Arbeitssicherheit: ja / nein Untergrundvorbereitung: ja / nein
Kanal gereinigt: ja / nein Nachreinigung: ja / nein
Durchmesser überprüft: ja / nein Abwasserfreiheit vorh.: ja / nein

Einbaubedingung

Grundwasser vorhanden? ja / nein Kalibrierschlauch verwendet? ja / nein
Preliner inversiert? ja / nein

Inversionsverfahren

Wassersäule
Gerüsthöhe + Schacht: Meter
Wasserdruck: bar

Soll-Druck min - max lt. TDB
Inversionsdruck: - bar
Aushärtedruck: - bar

Inversionstrommel
Inversionsdruck: bar
Aushärtedruck: bar

Inversion mit Gefälle geschlossenes Ende
Inversion gegen Gefälle offenes Ende

Aushärtungsverfahren

Warmwasser **Dampf** **Kalt**

Für die Warmaushärtung benötigte Wassermenge: m³

Aushärtung von **Uhr bis** **Uhr** **Kontrolle Name:**
Abkühlung von **Uhr bis** **Uhr** **Kontrolle Name:**

Probeentnahme aus Schacht: **Entnahmeposition:**
Wandausschnitt
Stützrohr

Dokumentation

Nacharbeiten: ja / nein Dichtheitsprüfung: ja / nein
TV-Abnahme: ja / nein Sanierungsziel erreicht: ja / nein

Bemerkungen

Datum Unterschrift

Bauprodukte und deren Verwendung zur Ausführung von Schlauchlinern mit der Bezeichnung "Trelleborg DrainLiner Verfahren" und den Harzsystemen "Trelleborg Epoxy HC120" und "Trelleborg Epoxy HC120+" zur Sanierung schadhafter, erdverlegter Abwasserleitungen in dem Nennweiten DN 100 bis DN 600

Anlage 24

Einbauprotokoll

Deutsches Institut für Bautechnik DIBt

TRELLEBORG

Aushärteprotokoll Schlauchliner

Datum:

Projekt:

Kunde:

Haltung: Anlagebediener:

Anlage:

Zuordnung der Messpunkte

a	–	Lufttemperatur	°C
b1	–	Warmwasser Vorlauf / Mischtemperatur Dampf/Luft	°C
b2	–	Warmwasser Rücklauf / Linertemperatur	°C
c	–	Aushärtedruck	bar

Zeit	a (°C)	b1 (°C)	b2 (°C)	c (bar)	Bemerkung

Deutsches Institut für Bautechnik DIBt

Protokoll Dichtheitsprüfung für Hauptleitungen gem. DIN EN 1610

1. Angaben zum Bauvorhaben:

Bauvorhaben:			
Anschrift:		PLZ/Ort:	
Auftraggeber:			
Anschrift:		PLZ/Ort:	
Sanierungsfirma:			
Anschrift:			
Herstellertyp:	○ Schlauchliner ○ Kurzliner	Produktbezeichnung:	
Dichtheitsprüfung:			
Anschrift:		PLZ/Ort:	

2. Angaben zum Abwasserkanal / -leitung:

Abwasserart:	○ Schmutzwasser	○ Regenwasser	○ Mischwasser
Rohrgeometrie:	○ Kreisprofil	○ Eiprofil	
Linermaterial:		Nennweite:	Sanierungsdatum:
Haltungsnummer:			
Haltungslänge:			
von Schacht:		bis Schacht:	

3. Dichtheitsprüfung mit Luft:

Prüfmethode:	○ LA	○ LB	○ LC	○ LD
Prüfdruck p_0:	_____ mbar	Beruhigungszeit:	_____ min	
zul. Druckabfall Dp:	_____ mbar	Prüfdauer:	_____ min	
Druck zu Beginn:	_____ mbar			
Druck am Ende:	_____ mbar	Druckabfall:	_____ mbar	

4. Dichtheitsprüfung mit Wasser:

○ nur Rohrleitungen ○ Schächte und Inspektionsöffnungen ○ Rohrleitung mit Schacht

Prüfdauer:	30 min
Höhe der Wassersäule über Rohrscheitel zu Beginn der Prüfung:	_____ kPa (= mWS · 10)
Wasserzugabe:	_____ l
Wasserzugabe / Haltungslänge:	_____ L/m²
Zulässige Wasserzugabe pro m² benetzter Umfang gem. nach DIN EN 1610:	0,15 L/m²
Rechnerische zul. Gesamt-Wasserzugabe bezogen auf die Prüfstrecke:	_____ L
tatsächliche Wasserzugabe:	_____ L

5. Ergebnis

Prüfung bestanden:	○ ja	○ nein
Bemerkungen:		
Ort / Datum:		Unterschrift:

Bauprodukte und deren Verwendung zur Ausführung von Schlauchlinern mit der Bezeichnung "Trelleborg DrainLiner Verfahren" und den Harzsystemen "Trelleborg Epoxy HC120" und "Trelleborg Epoxy HC120+" zur Sanierung schadhafter, erdverlegter Abwasserleitungen in dem Nennweiten DN 100 bis DN 600

Anlage 26

Dichtheitsprüfprotokoll

Deutsches Institut für Bautechnik DIBt

PROBEBEGLEITSCHEIN ZUR MATERIALPRÜFUNG VON SCHLAUCHLINERN

☐ *ERSTPRÜFUNG* ☐ *WIEDERHOLUNGSPRÜFUNG* *zu Prüfbericht Nr.:*

1. Angaben zur Probeentnahme:

entnommen durch:		Prüfinstitut:	
Datum: / Uhrzeit:		Adresse:	

2. Probenidentifikation:

Bauvorhaben:			Material-ID:		
Bauherr:			Probenbezeichnung:		
Kostenstelle:			Haltungsbezeichnung:		
Ausführende Firma:			Nennweite:		
Hersteller Schlauchliner:			Einbaudatum:		
Träger-Material:			Altrohrzustand:	O I	O II O III
Harz-Material:			Entnahmestelle:	O Haltung	O Endschacht O ZW-Schacht
Rohrgeometrie:	O Kreisprofil	O Eiprofil	Entnahmeposition:	O Scheitel	O Kämpfer O Sohle

3. Geforderte Kurzzeit-Eigenschaften gemäss statischen Nachweis:

Biege-E-Modul$_{DIN}$ E_f [N/mm²]:		Umfangs-E-Modul E_U [N/mm²]:	
Biegespannung $_{beim\ ersten\ Bruch}$ σ_{fB} [N/mm²]:		Anfangs-Ringsteifigkeit S_0 [N/m²]:	
Wanddicke d [mm]:		max. Kriechneigung K_{N24} [%]:	
Abminderungsfaktor A_f:		Dichte δ [g/cm³]:	

4. Prüfergebnisse:

Biege-E-Modul, Biegespannung nach DIN EN ISO 178

☐	Prüfdatum	E_f [N/mm²]	σ_{fB} [N/mm²]	h [mm]
		Prüfrichtung:	O axial	O radial

24 h Kriechneigung in Anlehnung an DIN EN ISO 899-2

☐	Prüfdatum	K_N [%]

Umfangs-E-Modul, Anfangs-Ringsteifigkeit nach DIN EN 1228

☐	Prüfdatum	E_U [N/mm²]	S_0 [N/m²]	h [mm]

24 h Kriechneigung in Anlehnung an DIN EN 761

☐	Prüfdatum	K_N [%]

Wasserdichtheit nach DIN EN 1610

☐	Prüfdatum	Prüfzeit 30 Minuten	Prüfdruck [bar]	Prüfergebnis	
				O dicht	O undicht

Kalzinierungsverfahren nach DIN EN ISO 1172

☐	Prüfdatum	Harzanteil [%]	Rückstand gesamt [%]	Glasanteil [%]	Zuschlagstoff [%]

Spektralanalyse in Anlehnung an ASTM D 5576 (FT-IR)

☐	Prüfdatum	EP-Harz	UP-Harz	VE-Harz	sonst. Harz

Dichte nach DIN EN ISO 1181-1 oder -2

☐	Prüfdatum	δ [g/cm³]

Thermische Analyse nach DIN EN ISO 11357-1 / DSC-Analyse DIN 53765 Verfahren A

☐	Prüfdatum	Glasübergangstemperatur [°C]			Enthalpie [J/g]	
		T_{G1} T_{G2}		ΔT_G	O exotherm	O endotherm

Reststyrolgehalt nach DIN 53394-2 (GC)

☐	Prüfdatum	Einwaage [mg]	Reststyrolgehalt [mg/kg]	Reststyrolgehalt [%]	Einwaage bezogen auf	
					O Gesamteinwaage	O Reinharz

5. Bewertung der Ergebnisse:

Anforderungen	erfüllt	nicht erfüllt
Biege-E-Modul E_f	O	O
Biegespannung σ_{fB}	O	O
Wanddicke d	O	O
Wasserdichtheit	O	O

Anforderungen	erfüllt	nicht erfüllt
Umfangs-E-Modul E_U	O	O
Anfangs-Ringsteifigkeit S_0	O	O
24 h Kriechneigung K_N	O	O
Dichte δ	O	O

6. Bemerkungen:

7. Unterschrift Prüfer / Labor:

Bauprodukte und deren Verwendung zur Ausführung von Schlauchlinern mit der Bezeichnung "Trelleborg DrainLiner Verfahren" und den Harzsystemen "Trelleborg Epoxy HC120" und "Trelleborg Epoxy HC120+" zur Sanierung schadhafter, erdverlegter Abwasserleitungen in dem Nennweiten DN 100 bis DN 600

Anlage 27

Probenbegleitschein