Deutsches Institut für Bautechnik

DIBt

General Technical Approval

Approval Body for Construction Products & Types
Construction Engineering Inspection Body
Public-law agency jointly held by the Federal German Government and the German state governments

Member of EOTA, UEAtc and WFTAO

Date: 11/01/2016

Reference no.: III 54-1.42.3-30/15

Approval No:

Z-42.3-385

Valid

from: **31 January 2016**

until: **31 January 2021**

Applicant:

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

Object of Approval:

"epros®DrainPacker method" for the rehabilitation of buried damaged sewer lines within the nominal diameter range from DN 100 to DN 800 using short and long liners

The above mentioned object of approval is hereby granted general technical approval.
The present General Technical Approval covers 19 pages and 14 appendices.
This General Technical Approval replaces the General Technical Approval No. Z-42.3-385 of 29 June 2010, revised and extended by the Decision dated 27 October 2010.

Deutsches Institut für Bautechnik

I GENERAL PROVISIONS

1 The General Technical Approval is proof of the usability or applicability of the object of approval for the purpose of the German Lands' building regulations.

2 Where the General Technical Approval calls for specific expertise and experience of the persons commissioned to manufacture construction products and construction types according to the regional German state provisions as equivalent to § 17 (5) of the Reference Building Code (*Musterbauordnung*), it is important to note that such expertise and experience can also be proven by means of equivalent supporting documents from other member states of the European Union. This may also apply to equivalent supporting documents submitted under the Agreement on the European Economic Area (EEA) or other bilateral agreements.

3 The General Technical Approval shall be no substitute for the permits, consents and certificates statutorily prescribed for the implementation of building projects.

4 The General Technical Approval is granted without prejudice to any third-party rights including but not limited to private proprietary rights.

5 Manufacturers and distributors of the object hereof shall, notwithstanding any additional regulations laid down in the "Special Provisions" chapter, provide the user of said object with copies of the General Technical Approval and shall instruct the user to the effect that the General Technical Approval must be kept at the point of use or application. Copies of the General Technical Approval shall be provided to the authorities interested whenever requested by them.

6 The General Technical Approval may not be reproduced unless in total. Any publication of part of this Approval shall require the consent of the German Institute for Construction Engineering. Texts and drawings in advertising materials shall not be contradictory to the General Technical Approval. Translations of the General Technical Approval must contain the information that the "translation of the German original version has not been verified by the German Institute for Construction Engineering".

7 The General Technical Approval is granted subject to revocation. The provisions of the General Technical Approval may be amended by subsequent modifications or additions, especially where required by new technical findings.

II. SPECIAL PROVISIONS

1 Object of approval and scope of application

This General Technical Approval applies to the short and long lining method known as the "epros®DrainPacker method" (Appendices **1** to **3**) with the two-component silicate resin systems known as "epros®ResinType W01", "epros®ResinType W" ("winter resins") and "epros®ResinType S" ("summer resin") for the rehabilitation of damaged sewer lines with circular cross section in the nominal diameters from DN 100 to DN 800. This Approval applies to the rehabilitation of sewer lines intended for the discharge of sewage as laid down in the standard DIN 1986-3[1].

The short and long lining method can be used for the rehabilitation of sewer pipes made of concrete, reinforced concrete, vitrified clay, asbestos cement, cast iron, GRP, and PVC-U, if the cross section of the sewer to be repaired meets the method-related requirements and structural stability needs.

Regardless of the aforementioned pipe material of the host line, the short and long lining method can be used for the repair of crack formations (e.g. radial cracks, or longitudinal cracks, or combinations thereof), mechanical wear, corrosion, as well as for the obstruction of laterals and sealing of leaky pipe joints, provided that the host pipe / soil system is structurally stable in itself (e.g. longitudinal cracks with little pipe deformation and verified operative lateral bedding, as may be required to be confirmed, where necessary, by long-time observations and/or by a dynamic penetration test).

The short and long lining method rehabilitates damaged sewer pipes using a resin-wetted fibreglass mat, composed of resin-wetted chopped-strand fabric layers, on an inflatable packer ("epros®DrainPacker") to be moved down the line to the point of repair where the packer is inflated and presses the fibreglass mat against the host pipe wall. The packer is maintained in this position until final cure.

2. Provisions for the method components

2.1 Properties and composition

2.1.1 Materials of the method components

2.1.1.1 Fibreglass material (Appendix **1**, Picture **1**)

The carrier materials for the resin systems shall exclusively be fibreglass mats with the product names "CRF(+) fibreglass mat 1050 g/m²" and "CRF(+) fibreglass mat 1400 g/m²", composed of roving fibreglass matting and chopped-strand fibreglass matting according to DIN 1259-1[2], and DIN 61853-1[3], and DIN 61853-2[4], as well as DIN 61854-1[5], in compliance with the formulation data kept with the German Institute for Construction Engineering. The formulation shall also be kept with the independent inspection body.

The fibreglass mats consist of one layer of woven fibreglass and one layer of chopped strands with the two layers being sown together.

---

1 DIN 1986-3 Drainage facilities for buildings and properties – Part 3: Rules for operation and maintenance; issue:2004-11

2 DIN 1259-1 Glass – Part 1: Terminology for glass types and groups; issue:2001-09

3 DIN 61853-1 Textile glass; textile glass mats for plastics reinforcement; technical delivery conditions; issue:1987-04

4 DIN 61853-2 Textile glass; textile glass mats for plastics reinforcement; classification and application; issue:1987-04

5 DIN 61854-1 Textile glass; woven glass fabrics for plastics reinforcement; woven glass filament fabric and woven roving; technical delivery conditions; issue:1987-04

The fibreglass mats have the following main properties prior to application:

1. "CRF(+) fibreglass mat 1050 g/m²"
   - Mass per unit area: 1,050 g/m² ± 10% acc. to ISO 3374[6]
   - Thickness: 1.6 mm ± 15%
   - Width: 400 mm to 2,500 mm acc. to ISO 5025[7]
2. "CRF(+) fibreglass mat 1400 g/m²"
   - Mass per unit area: 1,400 g/m² ± 10% acc. to ISO 3374[6]
   - Thickness: 1.9 mm ± 10%
   - Width: 400 mm to 2,500 mm acc. to ISO 5025[7]

2.1.1.2 Resin components

The silicate resin systems to be used, "epros®ResinType W01", "epros®ResinType W" and "epros®ResinType S", are composed of the component **A** (hardener) and the components **B** (resin). The formulation of these components must be in compliance with the formulation data kept with the German Institute for Construction Engineering. A so-called "winter quality", which is "epros®ResinType W01" and "epros®ResinType W", and a so-called "summer quality", which is "epros®ResinType S", are used for component **B**. The equipment coming in contact with the components **B**, e.g. barrels, other vessels, pipes, shall contain no water in order to avoid changes in properties.

- Component A (hardener):
  The hardener has the following main properties prior to application:
  - Density at +20°C: 1.540 g/cm³ ± 0,020 g/cm³
  - Viscosity at +20°C: 500 mPa x s ± 200 mPa x s
  - pH: 13.0 ± 0.2
  - Colour: white
- Component B (resin):
  a) The silicate resin "epros®ResinType W01" has the following main properties prior to application:
  - Density at +25°C: 1.190 g/cm³ ± 0.020 g/cm³
  - Viscosity at +25°C: 215 mPa x s ± 30 mPa x s
  - Viscosity at +20°C: 360 mPa x s ± 30 mPa x s
  - Pot time at +20°C: 6 min ± 1 min
  - Bending force: 1,800 N ± 200 N
  - Colour: brown

  b) The silicate resin "epros®ResinType W" has the following main properties prior to application:
  - Density at +25°C: 1.240 g/cm³ ± 0,020 g/cm³
  - Viscosity at +25°C: 260 mPa x s ± 30 mPa x s
  - Viscosity at +20°C: 390 mPa x s ± 30 mPa x s
  - Pot time at +20°C: 14.5 min ± 1 min
  - Bending force: 1,600 N ± 150 N
  - Colour: brown

[6] ISO 3374 Reinforcement products -- Mats and fabrics -- Determination of mass per unit area; issue:2000-06

[7] ISO 5025 Reinforcement products - Woven fabrics - Determination of width and length; issue: 1997-12

c) The silicate resin "epros®ResinType S" has the following main properties prior to application:

– Density at +25°C	1.240 g/cm³ ± 0.020 g/cm³
– Viscosity at +25°C	210 mPa x s ± 30 mPa x s
– Viscosity at +20°C	400 mPa x s ± 30 mPa x s
– Pot time at +20°C	31 min ± 2 min
– Bending force:	1,700 N ± 150 N
– Colour:	brown

The silicate resin systems are in accordance with the IR spectrums kept with the German Institute for Construction Engineering. The IR spectrums shall also be kept with the independent inspection body.

2.1.2 Environmental compatibility

The construction product meets the requirements of the DIBt principles "Assessment of the impact of construction products on soils and groundwater" (Issue: 2011). This statement applies only in case the Special Provisions of this General Technical Approval are observed.

The requirement to obtain approval from the competent water authorities or building inspectorates, especially in protected water zones, shall not be affected thereby.

2.1.3 Wall thickness and wall structure

Due to the general system design, the lining operations use resin-wetted short and long liners providing a minimum wall thickness of 4 mm after installation and cure, regardless of what the nominal diameter is. The short or long liner to be installed must be at least three-layered in case of "CRF(+) fibreglass mat 1050 g/m²", or at least two-layered in case of "CRF(+) fibreglass mat 1400 g/m²". The wall structure of the short or long liner must be composed of an outer chopped-strand layer and an inner chopped-strand layer with a woven fibreglass layer in between (Appendix **2**, picture **11**, and Appendix **7**).

2.1.4 Physical characteristics of the cured short and long liners

Once cured, the resin system-wetted fibreglass mats (laminate) must show the following characteristic values:

A) <u>Use of "CRF(+) fibreglass mat 1050 g/m²"</u>:

1. Density after DIN EN ISO 1183-1[8]:

– "epros®ResinType W01":	≈ 1.45 g/cm³
– "epros®ResinType W":	≈ 1.52 g/cm³
– "epros®ResinType S":	≈ 1.51 g/cm³
– mixture of "epros®ResinType W" and "epros®ResinType S":	≈ 1.54 g/cm³

2. Calcination after DIN EN ISO 1172[9]

– "epros®ResinType W01":	≥ 57%
– "epros®ResinType W":	≥ 52%
– "epros®ResinType S":	≥ 58%

8 DIN EN ISO 1183-1 Plastics -- Methods for determining the density of non-cellular plastics -- Part 1: Immersion method, liquid pyknometer method and titration method (ISO 1183-1:2004): German version EN ISO 1183-1:2004; issue:2004-05

9 DIN EN ISO 1172 Textile-glass-reinforced plastics -- Prepregs, moulding compounds and laminates -- Determination of the textile-glass and mineral-filler content -- Calcination methods (ISO 1172:1996); German version EN ISO 1172:1998; issue:1998-12

– mixture of "epros®ResinType W" and "epros®ResinType S"[A]: ≥ 58%

3. Initial E-modulus (1-hour value) after DIN 16869-2[10]:
– "epros®ResinType W01": ≥ 5,546 N/mm²
– "epros®ResinType W": ≥ 7,850 N/mm²
– "epros®ResinType S": ≥ 6,678 N/mm²
– mixture of "epros®ResinType W" and "epros®ResinType S"[A]: ≥ 6,439 N/mm²

4. Flexural strength after DIN EN ISO 178[11]:
– flexural strength σ_{fB} with "epros®ResinType W01": ≥ 161 N/mm²
– flexural strength σ_{fB} with "epros®ResinType W": ≥ 152 N/mm²
– flexural strength σ_{fB} with "epros®ResinType S": ≥ 143 N/mm²
– flexural strength with mixture of "epros®ResinType W" and "epros®ResinType S": ≥ 124 N/mm²

B) <u>Use of "CRF(+) fibreglass mat 1400 g/m²"</u>:

1. Density after DIN EN ISO 1183-1[8]:
– "epros®ResinType W01": ≈ 1.54 g/cm³
– "epros®ResinType W": ≈ 1.62 g/cm³
– "epros®ResinType S": ≈ 1.55 g/cm³
– mixture of "epros®ResinType W" and "epros®ResinType S"[A]: ≈ 1.61 g/cm³

2. Residue on ignition after DIN EN ISO 1172[9]
– "epros®ResinType W01": ≥ 55%
– "epros®ResinType W": ≥ 57%
– "epros®ResinType S": ≥ 59%
– mixture of "epros®ResinType W" and "epros®ResinType S"[A]: ≥ 60%

3. Initial E-modulus (1-hour value) after DIN 16869-2[10]:
– "epros®ResinType W01": ≥ 5,102 N/mm²
– "epros®ResinType W": ≥ 6,429 N/mm²
– "epros®ResinType S": ≥ 5,786 N/mm²
– mixture of "epros®ResinType W" and "epros®ResinType S"[A]: ≥ 7,735 N/mm²

4. Flexural strength after DIN EN ISO 178[11]:
– flexural strength σ_{fB} with "epros®ResinType W01": ≥ 124 N/mm²
– flexural strength σ_{fB} with "epros®ResinType W": ≥ 178 N/mm²
– flexural strength σ_{fB} with "epros®ResinType S": ≥ 143 N/mm²
– flexural strength σ_{fB} with mixture of "epros®ResinType W" and "epros®ResinType S": ≥ 143 N/mm²

---

10 DIN 16869-2 Centrifugally cast filled glass fibre reinforced unsaturated polyester resin (UP-GF) pipes - Part 2: General quality requirements, testing; issue:1995-12

11 DIN EN ISO 178 Plastics – Determination of flexural properties (ISO 178:2001 + AMD 1:2004); German version EN ISO 178:2003 + A1:2005; issue:2006-04

2.1.5 Physical characteristics of the cured silicate resin mixture

The cured resin mixtures of the components **A** and **B** show the following characteristic values:

1. Density after DIN EN ISO 1183-1[8]:
- "epros®ResinType W01": ≈ 1.295 g/cm³
- "epros®ResinType W": ≈ 1.286 g/cm³
- "epros®ResinType S": ≈ 1.343 g/cm³
- mixture of "epros®ResinType W" and "epros®ResinType S"[A]: ≈ 1.341 g/cm³

2. Tensile strength after DIN EN ISO 527-2[12]:
- "epros®ResinType W01": ≥ 14.9 N/mm²
- "epros®ResinType W": ≥ 15.0 N/mm²
- "epros®ResinType S": ≥ 15.0 N/mm²
- mixture of "epros®ResinType W" and "epros®ResinType S"[A]: ≥ 14.5 N/mm²

3. E-modulus (tensile) after DIN EN ISO 527-2[12]:
- "epros®ResinType W01": ≥ 210 N/mm²
- "epros®ResinType W": ≥ 201 N/mm²
- "epros®ResinType S": ≥ 211 N/mm²
- mixture of "epros®ResinType W" and "epros®ResinType S"[A]: ≥ 195 N/mm²

4. Compressive strength after DIN EN ISO 604[13]:
- "epros®ResinType W01": ≥ 44.8 N/mm²
- "epros®ResinType W": ≥ 45.3 N/mm²
- "epros®ResinType S": ≥ 48.3 N/mm²
- mixture of "epros®ResinType W" and "epros®ResinType S"[A]: ≥ 38.4 N/mm²

5. E-modulus (compression) after DIN EN ISO 604[13]:
- "epros®ResinType W01": ≥ 739 N/mm²
- "epros®ResinType W": ≥ 766 N/mm²
- "epros®ResinType S": ≥ 698 N/mm²
- mixture of "epros®ResinType W" and "epros®ResinType S"[A]: ≥ 607 N/mm²

6. Shrinkage after ISO 2577[14]:
- "epros®ResinType W01": 0.44% ± 0.04%
- "epros®ResinType W": 0.22% ± 0.02%
- "epros®ResinType S": 0.19% ± 0.01%
- mixture of "epros®ResinType W" and "epros®ResinType S"[A]: 0.21% ± 0.02%

---

12 DIN EN ISO 527-2 Plastics -- Determination of tensile properties -- Part 2: Test conditions for moulding and extrusion plastics (ISO 527-2:1993 including Cor.1:1994); German version EN ISO 527-2:1996; issue:1996-07

13 DIN EN ISO 604 Plastics – Determination of compressive properties (ISO 604:2002; German version EN ISO 604:2003; issue:2003-12

14 DIN EN ISO 604 Plastics – Thermosetting moulding materials – Determination of shrinkage; issue: 2007-12

2.2 Manufacture, packaging, transport, storage and identification

2.2.1 Manufacture of short and long liners

The fibreglass mats with the minimum thicknesses stated in Section 2.1.1.1 shall be manufactured in the sub-supplier's factory. The Applicant shall check to make sure the specified lengths and wall thicknesses are observed by the sub-supplier.

To verify the properties of the three resins and the hardener in accordance with the formulation data, the Applicant shall cause the sub-supplier to submit test reports as laid down in 2.2 of DIN EN 10204[15].

At least the following properties shall be checked during the incoming goods inspection for the component **A** (hardener) and the three components **B** (resins: "epros®ResinType W01", "epros®ResinType W", and "epros®ResinType S").

Properties of the three resins and the hardener:
– density
– viscosity

2.2.2 Packaging, transport & handling, storage

The fibreglass mats delivered by the sub-supplier shall be stored until further use in the premises of the Applicant in a way to ensure the mats will not be damaged.

The components delivered by the sub-supplier for resin impregnation on the job site (resins and hardener) shall be stored until further use in suitable and separate airtight containers in the premises of the Applicant. The storage temperature must range between +5°C and +25°C. The shelf life is approximately 12 months as of the date of delivery and must not be exceeded. The containers shall be protected from direct sunlight. They shall be designed such that the three silicate resins (components **B**) and the hardener (component **A**) are kept separately.

The usage amounts of each component as required for the rehabilitation jobs shall be withdrawn from the storage containers and then transported in safe, separate and airtight receptacles to the place of application. There, the containers must be protected from weather. The fibreglass mats shall be transported in suitable transport packages in a way to ensure they are not damaged.

Filling operations for resin components on the Applicant's premises shall always use appropriate transport containers (e.g. plastic cans). Never fill component **B** into moist containers.

The relevant rules and regulations of accident prevention as well as the instructions given in the Applicant's method statement shall be observed.

2.2.3 Identification

The fibreglass mats and the transport containers of each of the resin components **A** (hardener) and **B** (resin) shall be identified with the compliance mark according to the applicable compliance and conformity regulations, inclusive of the Approval No. Z-42.3-385. Said identification is subject to the condition that the requirements set forth in Section 2.3 Proof of Compliance are met.

---

15 DIN EN 10204 Metallic products – Types of inspection documents; German version EN 10204:2004; issue: 2005-01

Additionally, the transport packages of the fibreglass mats shall show the following data:

– Fibreglass mat types:
”CRF(+) fibreglass mat 1050 g/m²” and ”CRF(+) fibreglass mat 1400 g/m²”
– Roll width
– Total weight
– Mass per unit area
– Batch number

In addition, the transport containers for the resins and the hardener shall be labelled with at least the following information:

– Component designation **A** (hardener) and **B** (resins)
– Winter or summer quality of the resins (“epros®ResinType W01”, “epros®ResinType W”, and “epros®ResinType S”) component **B**
– Processing temperature range from +5°C to +25°C
– Holding capacity (volume or weight)
– Where required, the label in accordance with the relevant hazardous material regulation (Dangerous Substances Ordinance)
– Batch number

2.3 Proof of Compliance

2.3.1 General

The confirmation that the method components are in compliance with the provisions of this General Technical Approval must be provided for each manufacturing plant by means of a Compliance Certificate based on in-house production control and regular third-party inspection including initial testing of the method components subject to the following conditions.

For the Compliance Certificate and for third-party inspection including associated product testing, the manufacturer shall commission a generally approved certification body as well as an inspection body having an accreditation for this purpose.

The certification body shall, for information purposes, give the German Institute for Construction Engineering a copy of the Compliance Certificate issued by said body.

In addition to that, the German Institute for Construction Engineering shall be given a copy of the initial test report for information.

2.3.2 In-house production control

In-house production control shall be implemented and carried out in every manufacturing plant. In-house production control shall mean the continuous inspection or monitoring of the production to be performed by the manufacturer to ensure that the construction products made by the manufacturer comply with the provisions of this General Technical Approval.

In-house production control shall include the following minimum requirements:

– Description and inspection of the base material

  For each delivery of incoming components, i.e. fibreglass mats, resins and hardener, the manufacturing plant operator shall check to make sure the properties required under Section 2.1.1 are met.

  For this purpose, the manufacturing plant operator shall cause each of the sub-suppliers of the resin components to submit 2.2 test reports and the plant of each of the sub-suppliers of the fibreglass mats to submit 2.1 certificates of compliance after DIN EN 10204[15].

In addition to that, the incoming goods inspection shall also include a random check to make sure the properties specified in Sections 2.1.1.1 and 2.1.1.2 hereof are in accordance with the formulation data kept with the German Institute for Construction Engineering.

Further, the ready-for-use resin mixture shall be tested for its modulus of elasticity according to Section 2.1.5 on the basis of at least three specimens to be tested in accordance with the provisions laid down in DIN 16946-1[16] Table 1 at item 6 according to the test conditions of Section 5.2.1 and according to DIN EN ISO 527-4[12] in a tensile test.

For each resin charge, shrinkage shall be tested after ISO 2577[14] on a minimum number of three specimens or according to DIN 16946-1[16] for determining the loss of mass. The test under ISO 257714 shall be carried out on specimens having been conditioned during 24 hours at +23 °C. It is recommended to use a separable metal mould for producing the specimens.

– Checks and inspections to be performed during manufacture:

  It is to be checked that the requirements laid down in Section 2.2.1 are fulfilled.

– Inspection of containers:

  Every resin batch shall be checked for meeting the identification requirements set forth in Section 2.2.3.

The results of in-house production controls shall be recorded. The records shall contain at least the following information:

– Designation of the construction product or of the base product and its components
– Type of control or inspection
– Date when the construction product or base material was manufactured and inspected
– Result of the control checks and inspections and, where appropriate, comparison with the requirements
– Signature of the person responsible for in-house production controls

The records shall be kept for at least five years and submitted to the external inspection body commissioned for third-party inspection. On request, they shall be submitted to the German Institute for Construction Engineering and to the competent supreme building inspectorate.

If the inspection result is not satisfactory, the manufacturer shall immediately take the actions required for correcting the defect. Non-conforming construction products shall be handled in a way to exclude any possible confusion with conforming products. Once the defect has been corrected, the failed test or inspection shall be repeated immediately – where technically feasible and required for proving the success of the corrective action.

2.3.3 Third-party inspection

In every manufacturing plant, the in-house production control shall be inspected and verified by an external body at regular intervals, but at least twice a year.

The scope of third-party inspection includes an original inspection (initial testing) of the method components. The external inspection shall verify the proper performance of the in-house production control process on the basis of random checks. Compliance with the requirements set forth in Sections 2.1.1 and 2.2.3 shall be verified.

Furthermore, random checks shall be made to prove compliance with the manufacturing requirements laid down in Section 2.2.1. Such checks shall include the verification of the curing behaviour, density of the components A and B in Section 2.1.1.2, storage stability and mass per unit area of the “CRF(+) fibreglass mat 1050 g/m²” and “CRF(+) fibreglass mat 1400 g/m²”, as well as the IR spectroscopies.

16 DIN 16946-1 Cured casting resins; testing; issue:1989-03

The approved inspection body is responsible for sampling and testing. During third-party inspection, the 2.1 certificates of compliance and the 2.2 test reports after DIN EN 10204[15] shall be verified, too.

The results of the certification and third-party inspections shall be kept for no less than five years. When requested, they shall be submitted by the certification body or the inspection body to the German Institute for Construction Engineering and to the competent supreme building inspectorate.

3 Design provisions

The necessary pipeline data shall be verified, e.g. routing, depth, positions of lateral connections, manhole depths, groundwater, pipe joints, hydraulic conditions, inspection holes, cleaning intervals. Existing video takes must be analysed for application-specific evaluation. The accuracy of the data shall be verified on the job site. The condition of the existing sewer line of the property drainage system must be assessed in terms of the applicability of the rehabilitation method.

The hydraulic capacity of the sewer lines must remain unaffected by the installation of a short or long liner. If necessary, appropriate proof shall be furnished.

4 Work performance provisions

4.1 General

The short and long lining process known as “epros®DrainPacker method” can be used under the following structural conditions:

a) From the start to the end point

b) From the start point down into a pipe run for a defined length with no further manhole or access pit being required

c) Lateral connections from the start point down the lateral to the main/lateral interface.

The start or end point can be a manhole, an inspection hole or cleaning eye, or an open pipe socket.

Bends of up to 90 dgs can be lined in DN 100 to DN 200 pipes by means of specific packers designed for bends.

In case of wrinkles, they may not exceed the values specified in DIN EN 13566-4[17] or DIN EN ISO 11296-4[18].

The Applicant shall prepare a procedures manual with a method statement describing each of the steps to be performed in execution of the lining method.

The Applicant shall also ensure the installers are sufficiently familiarised with the method.

Sufficient technical knowledge of the installer company can be documented by means of an appropriate quality mark of the German Association for Sewer Quality Protection *Güteschutz Kanalbau e.V.*[19].

---

17 DIN EN 13566-4 Plastics piping systems for renovation of underground non-pressure drainage and sewerage networks (gravity sewers) – Part 4: Lining with cured-in-place pipes; German version EN 13566-4:2002; issue:2003-04

18 DIN EN ISO 11296-4 Plastics piping systems for renovation of underground non-pressure drainage and sewerage networks -- Part 4: Lining with cured-in-place pipes (ISO 11296-4:2009, corrected version 2010-06-01); German version EN ISO 11296-4:2011; issue:2011-07

19 Güteschutz Kanalbau e.V. Linzer Str. 21, Bad Honnef, Tel: +49-2224-9384-0, Fax: +49-2224-9384-84

4.2 Equipment and installations

Minimum requirements for equipment and installations needed for executing the lining method:

– Equipment for sewer cleaning operations
– Equipment for service containment
– Equipment for sewer inspection (refer to DWA-M 149-2[20])
– Installations & systems for lining operations:
  - Fibreglass mats ("CRF(+) fibreglass mat 1050 g/m²" and/or "CRF(+) fibreglass mat 1400 g/m²") for the nominal diameters to be lined
  - Containers with resin (component **B**: "epros®ResinType W01", "epros®ResinType W", and "epros®ResinType S") and hardener (component **A**)
  - Dosing unit for resin component filling operations
  - Mixing container with mixing tool (stirrer)
  - Weatherproof impregnation point
  - Sheeting material
  - Packer unit ("epros®DrainPacker") for the related DN pipe sizes and accessories
  - Separating agent and PE sheeting (stretch foils) for the packer
  - Camera, control unit with monitor screen
  - Air push rods for positioning the packer
  - Retaining and pull-in ropes
  - Compressed-air hoses to be connected to packer with pressure monitoring device
  - Compressor, air hoses, pressure regulator
  - Inflatable pipe plugs, or stopper discs, for the related nominal diameters
  - Water supply
  - Power supply
  - Containers for residual waste
  - Temperature sensor
  - Small equipment
  - Pneumatic drill
  - Hand tools, e.g. scissors, spatulas, spreading rolls, etc…
  - Social and sanitary rooms, where required

Any electrical equipment to be introduced in the host pipe, e.g. video cameras (or so-called crawlers), shall be in compliance with the VDE regulations.

4.3 Execution of lining work

4.3.1 Preparatory operations

Before starting the lining job, it is required to ensure that the pipe run to be repaired is out of service; if necessary, the service flow shall be stopped by inflatable pipe plugs and bypassed.

---

20 DWA-M 149-2 Deutsche Vereinigung für Wasserwirtschaft, Abwasser und Abfall e.V. (DWA) (German association for water, sewage and waste management) – Advisory Leaflet 149: Conditions and Assessment of Drain and Sewer Systems Outside Buildings – Part 2: Coding System for Optical inspection; issue: 2006-11

In preparation for the job, the entire pipe run including the lateral connections shall be set out of operation. Then the sewer line shall be cleaned with appropriate high-pressure equipment (jetting). If the interior wall surfaces of the host sewer line are smooth or if it is not possible by jetting to remove surface deposits (the so-called “sewer slime” layer) to the extent required for the lining method, then the surface should be treated (removal of sewer slime) in relation to the type of damage to be repaired. Flow obstacles shall be removed.

The inner pipe surfaces in the region of the pipe plugs and stoppers must be even.

After cleaning, it is necessary to measure the exact positions of the points of repair and lateral connections.

Before starting any operation, it is important to measure the ambient temperature in order to assess whether or not it will be possible to remain within the prescribed temperature limits of the method.

The rules and regulations of accident prevention applicable to the use of the lining method shall be observed.

Prior to the introduction and use of any process equipment, it is imperative to take appropriate inspection measures to make sure there are no inflammable gases in the sewer section to be repaired.

The relevant sections of the following codes and regulations shall be complied with:

– GUV-R 126[21] (formerly GUV 17.6)
– DWA-M 149-2[20]
– DWA-A 199-1 and DWA-A 199-2[22]

The correctness of the data stated in Section 3 shall be checked on the job site. For this purpose, the host pipe run shall be cleaned with usual high-pressure cleaning equipment (jetters) to the same extent as is necessary to be able to perfectly recognise the pipe defects on the monitor during the optical inspection according to the Advisory Leaflet DWA-M 149-2[20].

It is imperative to observe the relevant rules and regulations of accident prevention when sending persons down into manholes of sewer lines, as well as for each of the operating steps of the lining method.

The cutting to size of the fibreglass mats according to Section 4.3.3.1, the mixing or resin according to Section 4.3.3.2 and resin impregnation according to Section 4.3.3.3 shall be carried out in an enclosed weatherproof place (e.g. in the lining truck) on level supports free from any contaminations or impurities whatsoever.

For a given lining operation, the pot time according to Table **1** shall be adjusted via the mixing operation described at 4.3.3.2 in a way to ensure that during said pot time, i.e. without the curing process being started, the short or long liner is pressed against the surface of the damaged host pipe section in a close and tight fit.

The steps required for executing the method shall be recorded for each impregnation and lining job with the help of report forms (e.g. Appendices **11** and **13**).

---

21 GUV-R 126 Safety rules for work in confined spaces of wastewater facilities, (formerly GUV 17.6); issue: 2007-06

22 DWA-A 199-1 German Association for Water, Sewage and Waste Management (DWA) – Leaflet 199: Work and operating instructions for the personnel of wastewater facilities – Part 1: Work instruction for the personnel of wastewater facilities: issue:2011-11

DWA-A 199-2 German Association for Water, Sewage and Waste Management (DWA) – Leaflet 199: Work and operating instructions for the personnel of wastewater facilities – Part 2: Operating instruction for the personnel of sewer systems and stormwater treatment facilities: issue:2007-07

4.3.2 Inspection of incoming method components on the job site

The transport containers of the method components shall be checked for proper identification as specified in Section 2.2.3. The circumference dimension of the fibreglass mats as referred to the specific lining job shall be measured to be verified before resin impregnation. Also, the storage temperature to be maintained before impregnation must be checked to be between +5°C and +25°C.

4.3.3 Cutting to size and impregnation of the fibreglass mats

4.3.3.1 Cutting to size of the fibreglass mats

A) "CRF(+) fibreglass mat 1050 g/m²"

On the job site, the fibreglass mat shall be unrolled on a work table located in a weatherproof or air-conditioned room or in the lining truck and cut to a length of approx. 0.5 m to 5.0 m (planned single repair length, Appendix **8**) multiplied by 3.5 times the diameter for a three-layered short or long liner, account being taken of the overlap lengths (Appendix **3**, Picture **13**). The fibreglass mats should have a width of no less than 1.27 m to allow for the minimum single repair length of 0.5 m for a three-layered short or long liner. Care shall be taken to cut the fibreglass mats such that the front and tail ends of the final short or long liner pressed against the host pipe wall are at least 5 cm beyond the actual damage region both sides.

B) "CRF(+) fibreglass mat 1400 g/m²"

On the job site, the fibreglass mat shall be unrolled on a work table located in a weatherproof or air-conditioned room or in the lining truck and cut to a length of approx. 0.5 m to 5.0 m (planned single repair length, Appendix **8**) multiplied by 3.5 times the diameter for a two-layered short or long liner, account being taken of the overlap length of 1 cm (see Appendix **7**). Care shall be taken to cut the fibreglass mats such that the front and tail ends of the final short or long liner pressed against the host pipe wall are at least 5 cm beyond the actual damage region both sides. The format sizes given in Appendix **6** shall be observed.

4.3.3.1 Mixing of the resin

The resin system is composed of the hardener component **A** and of the three different resin components **B** ("epros®ResinType W01", "epros®ResinType W", and "epros®ResinType S"). One volume part of component **A** shall be mixed with two volume parts of component **B** according to Table **1** or Table **2** (Appendix **1**, Picture **4**). Immediately after the removal of component **B** ***[sic!]*** (hardener), the container must be tightly closed again (airtight). The resin usage amounts required for each application shall be determined in accordance with the data given in Tables **3** and **4** as well as Appendices **4** and **6**. The components **A** and **B** shall be mixed in a mixing container by means of a stirrer (e.g. electrically operated stirrer) to form a bubble-free resin mixture with a homogeneous colour (Annex **1**, Picture **5**).

The mixing of the resin system as well as the temperature conditions shall be recorded in a report according to Section 4.3.1. Also, a retention sample from the job site shall be obtained from each resin mixture and shall be checked for its curing behaviour with the result being recorded.

Table 1: "Mixing ratio of the components **A** and **B**"
"epros®Resin Type W" and "epros®Resin Type S"

Mixing ratio by volume				Pot time at 20°C min	Cure time at 15°C min
No.	Comp. A Hardener	Comp. B "epros®Resin Type W"	Comp. B "epros®Resin Type S"		
1	3	6	–	15	115
2	3	5	1	18	120
3	3	4	2	21	140
4	3	3	3	25	165
5	3	2	4	28	180
6	3	1	5	31	200
7	3	–	6	32	260

Table 2: "Mixing ratio of the components **A** and **B**" "epros®Resin Type W01"

Mixing ratio in volume			Pot time at 10°C min	Pot time at 22°C min	Cure time at 12°C min	Cure time at 15°C min
No.	Comp. A Hardener	Comp. B "epros®Resin Type W01"				
1	1	2	13–15	4.5–7.5	35	20

Table 3: "Calculation of usage amounts of the components **A** and **B**[1] (Appendix **4**)""

Nom. width	Fibreglass mats with the designation "CRF(+)" 1050 g/m²				Resin system			
DN	Length circumfer.. = DN x 3.5	Width repair length x layers	Area	Folded layers of mat	Resin factor[2]	Total resin mixture	Comp. A Hardener silicate	Comp. B Resin
mm	m	m	m²	number	Litres/m²	Litres[3]	Litres	Litres
100	0.35	3	1.05	3	1,6	1.68	0.56	1.12
125	0.44	3	1.31	3	1,6	2.10	0.70	1.40
150	0.53	3	1.58	3	1,6	2.52	0.84	1.68
200	0.70	3	2.10	3	1,6	3.36	1.12	2.24
250	0.88	3	2.63	3	1,6	4.20	1.40	2.80
300	1.05	3	3.15	3	1,6	5.04	1.68	3.36
400	1.40	3	4.2	3	1,6	6.72	2.24	4.48
500	1.75	4	7.00	4	1,6	11.20	3.73	7.47
600	2.10	4	8.40	4	1,6	13.44	4.48	8.96
700	2.45	5	12.25	5	1,6	19.60	6.53	13.07
800	2.80	6	16.80	6	1,6	26.88	8.96	17.92

1 for a lining length of 1.00 m
2 specific resin consumption for a fibreglass mass per unit area of 1050 g/m²
3 rounded values

Table **4**: "Calculation of usage amounts of the components **A** and **B**[4] (Appendix **6**)"

Nom. width	Fibreglass mats with the designation "CRF(+)" 1400 g/m²				Resin system			
DN	Length circumfer.. = DN x 3.5	Width repair length x layers	Area	Folded layers of mat	Resin factor[5]	Total resin mixture	Comp. A Hardener silicate	Comp. B Resin
mm	m	m	m²	number	Litres/m²	Litres[6]	Litres	Litres
100	0.35	2	0.70	2	1.8	1.26	0.42	0.84
125	0.44	2	0.90	2	1.8	1.58	0.53	1.05
150	0.53	2	1.10	2	1.8	1.89	0.63	1.26
200	0.70	2	1.40	2	1.8	2.52	0.84	1.69
250	0.88	2	1.80	2	1.8	3.15	1.05	2.10
300	1.05	2	2.20	2	1.8	3.78	1.28	2.52
400	1.40	3	4.20	3	1.8	7.56	2.52	5.04
500	1.75	3	5.25	3	1.8	9.45	3.15	6.30
600	2.10	4	8.40	4	1.8	15.12	5.04	10.08
700	2.45	4	10.00	4	1.8	17.84	5.88	11.75
800	2.80	5	14.25	5	1.8	25.20	8.40	16.80

4 for a lining length of 1.00 m

5 specific resin consumption for a fibreglass mass per unit area of 1400 g/m²

6 rounded values

4.3.3.3 Impregnation with resin

After mixing, the resin shall be applied uniformly onto the woven glass fabric (top side) of the unrolled "CRF(+) fibreglass mat 1050 g/m²" (first layer) by means of a filler knife (spatula) to be moved in all directions (Appendix **1**, Picture **6** and Appendix **2**, Picture **7**). Then the fibreglass mat shall be folded once to the left (second layer; Appendix **2**, Picture **8**). The chopped-strand side shall be impregnated with the resin system in the same way as described above. Afterwards, the fibreglass mat shall be folded to the right over the second layer and the resin system shall be applied again by means of a spatula onto the chopped-strand fabric (third layer), which is now on top (Appendix **2**, Picture **9**). The three-layered fibreglass mat shall then be turned over and the resin system shall be spread onto the reverse chopped-strand side of the laminated structure (Appendix **2**, Picture **10**).

For the "CRF(+) fibreglass mat 1400 g/m²", the resin system shall be applied uniformly onto the properly spread directional-fibre side of the mat by means of a suitable spatula. A quarter length from one end of the fibreglass mat shall be folded toward the centre with 1 cm overlap (see Appendix **7**) and the resin shall be spread onto the chopped-strand side turned over. Then the remaining quarter length from the opposite end of the mat shall be folded toward the centre and the resin system shall again be spread onto the chopped-strand side. The two-layered mat thus obtained shall be turned over so that the chopped-strand bottom is up, which shall then also be uniformly impregnated.

In case of short or long liners having more than two layers ("CRF(+) fibreglass mat 1400 g/m²") or three layers ("CRF(+) fibreglass mat 1050 g/m²"), additional fibreglass mats shall be placed onto the first mat and impregnated with resin (Appendix **5**) as an additional step in between the steps illustrated in Appendix **2**, Picture **7** and Picture **8** ("CRF(+) fibreglass mat 1050 g/m²") as well as Appendix **7** Picture **1** ("CRF(+) fibreglass mat 1400 g/m²"), prior to folding. Afterwards, the same steps shall be used for the fabrication of a two or three-layered short or long liner.

Minimum wall thickness of short or long liners according to Section 2.1.3 shall be observed.

Finally, the resin should be pressed into the fabric with a spreading roll to avoid air inclusions.

Due to the above described folding into an at least two or three-layered short or long liner, one chopped-strand side of the fibreglass mat will form the side in contact with the service flow, while the other chopped-strand side will face the host pipe wall. The roving glass side of the matting thus lies in between the chopped-strand layers (Appendix **2**, Picture **11**).

The cure time as well as the ambient temperature and the temperature prevailing in the sewer line shall be recorded in the report according to Section 4.3.1.

4.3.4 Installation of the short and long liners in the host pipe

The impregnated short or long liner is installed by means of a packer ("epros®DrainPacker").

The rubber sleeve body of the packer, appropriately selected for the sewer pipe to be repaired, shall be wrapped with a protective PE film (Appendix **1**, Picture **3**), which will act as a parting film when the packer is finally withdrawn from the sewer. For proper packer selection, care must be taken to ensure the outer diameter of the packer is about 50 mm to 80 mm smaller than the inner diameter of the host pipe (Appendix **9** and Appendix **10**).

The resin-wetted fibreglass mat shall be placed and fixed onto the packer to prevent sliding and slipping (Appendix **2**, Picture **12** and Appendix **3**, Pictures **13** and **14**). It is not permitted to use lining packers other than packers running on rollers. The rollers must be arranged such that the resin-wetted fibreglass mat cannot touch the host pipe wall when the packer is introduced into and moved within the sewer line.

Before the introduction of the packer into the host pipe, an air hose from the compressor shall be connected to the packer, which shall be pulled or pushed into the sewer line by means of previously attached ropes or air push rods and moved and positioned at the point of repair (Appendix **3**, Pictures **15** to **17**). Compressed air is applied according to Appendix **9** and Appendix **10** thereby causing the packer sleeve to expand and press the resin-wetted fibreglass mat against the inner wall of the host pipe. The pressure must be maintained until complete cure of the resin system (Tables **1** and **2** as well as Appendix **5**). Excess resin shall be prevented from passing out. Then the air shall be removed from the rubber sleeve and the deflated packer shall be withdrawn from the sewer line back to the starting point (Appendix **3**, Picture **18**).

5 Job data in manhole

The following job data should be indicated by means of a permanent and readily legible inscription in the start manhole or end manhole of the pipelining job:

– Type of lining
– Designation of the pipe run
– Nominal diameter
– Wall thickness of the short or long liner
– Year the lining operation was performed

6 Final inspection and tightness test

After completion of the lining operations, the repaired pipe section shall undergo an optical inspection and a documentation shall be prepared (Appendix **12**). The inspection shall check that all residual material has been removed and that there are no wrinkles impairing the hydraulic capacity.

Once the short or long liner has cured, the sewer line shall be subjected to a tightness test according to DIN EN 1610[23]. Then the repaired sewer can be reset into operation.

7 Testing of samples (Appendix 14)

7.1 Curing

At least four times per year, the installer shall produce a short or long liner sample in the nominal width of the latest lining job by means of a sampling tube (e.g. in a PVD-U pipe) on the given job site. The annular sample thus obtained (test ring) shall be tested twice a year for its short-term E-modulus values (1-hour value, 24-hour value). The 1-hour value and the 24-hour value shall be used to determine whether the creep behaviour is **Kn ≤ 11%** according to the following formula:

$$K_n = \frac{E_{1h} - E_{24h}}{E_{1h}} \; x \; 100$$

7.2 Water tightness of the samples

The water tightness of the cured short or long liner can be tested either on a liner segment (test ring) or on specimens taken from the cured short or long liner. For testing the short or long liner section, it may be necessary in a first step to remove the film used to protect the packer.

The samples can be tested either with a positive pressure or a negative pressure of 0.5 bar.

For the negative pressure test, water shall be supplied to one end of the sample. A negative pressure of 0.5 bar is applied to and no leakage of water shall be visible at the opposite end of the sample for a load period of 30 minutes,

For the positive pressure test, a water pressure of 0.5 bar shall be applied for a load period of 30 minutes. Again, there shall be no visible leakage at the opposite end of the sample.

8 Declaration of Compliance for the installed liner

The installing company shall confirm that the lining job as performed by it complies with the provisions laid down in this General Technical Approval by issuing a Declaration of Compliance based on the specifications given in Table **5** and Table **6**. The Declaration of Compliance shall be accompanied by appropriate records showing the properties of the method components according to Section 2.1.1 and the results of the tests according to the tables **5** and **6**.

The manager of the lining job or an appropriate deputy of the job manager shall be present on the job site during the lining operations. He shall see to the correct execution of the works in accordance with the provisions laid down in Section 4 and especially shall carry out or arrange

23 DIN EN 1610 Construction and testing of drains and sewers; German version EN 1610:1997; issue:1997-10 in conjunction with DIN EN 1610 Supplementary Sheet 1; issue:1997-10

for the tests shown in Table **5** and to arrange for the tests shown in Table **6**. The number and scope of the tests shown are minimum requirements.

The tests on specimens according to Table **6** shall be carried out by an inspection body properly accredited for this purpose (see Schedule of test laboratories, inspection bodies and certification bodies under the Lands' building regulations, Part V, No. 9).

Every six months, the aforementioned inspection body shall take a sample from a short or long liner of a lining job actually performed. Also, said body shall inspect the documentation of the tests carried out according to Table **5** for the lining job.

Table **5:** "Tests accompanying the lining method"

Test object	**Requirement**	**Frequency**
Optical inspection of the line	according to 4.3.1 and DWA-M 149-2[20]	before each lining job
Optical inspection of the line	according to 6 and DWA-M 149-2[20]	after each lining job
Equipment	according to 4.2	each job site
Final inspection	according to 6	
Identification of containers of method components	according to 2.2.3	
Resin mixture, usage amount and cure behaviour of each short or long liner	Mixing report acc. to 4.3.3.2	
Cure time and pressure in the packer	according to 4.3.4	

The manager of the lining job or his technical deputy shall see to the tests mentioned in Table **6**. The samples for the tests mentioned in Table **6** shall be taken from the above described sample liner tubes.

Table **6:** "Tests to be carried out on specimens"

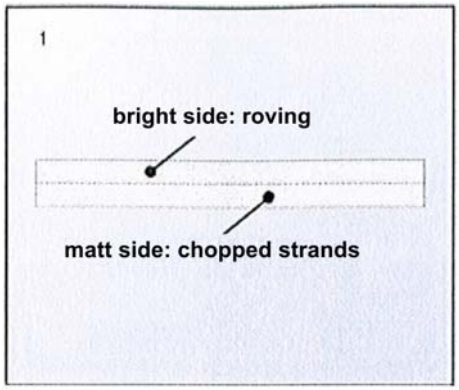
Test object	**Requirement**	**Frequency**
Short-term E-modulus (1-hour and 24-hour values) and creep behaviour	according to 7.1	every sixth month of manufacture for each installer
Characteristic physical values	according to 2.1.4	
Water tightness of the sample	without protective film according to 7.2	
Wall thickness & wall structure	according to 2.1.3	

The test results shall be recorded and evaluated; they shall be submitted to the German Institute for Construction Engineering on request. The number and scope of the tests given in the tables shall be minimum requirements.

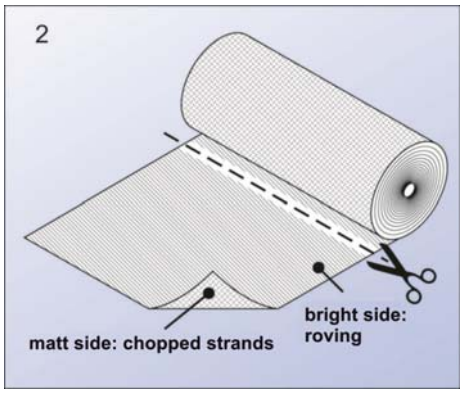
[DIBt stamp]

Rudolf Kersten
Head of Unit

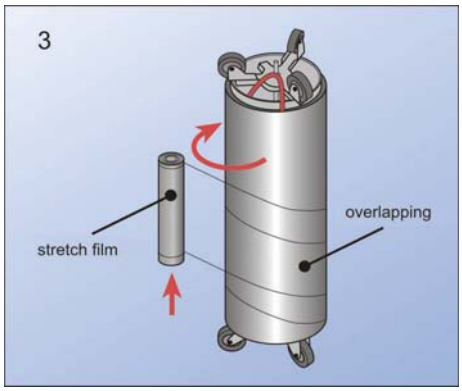
Attested
[signature]



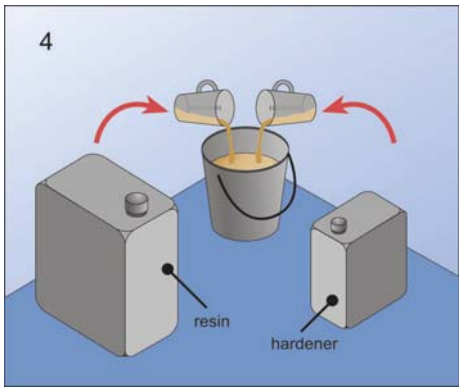
Cross-sectional view of the fibreglass mat



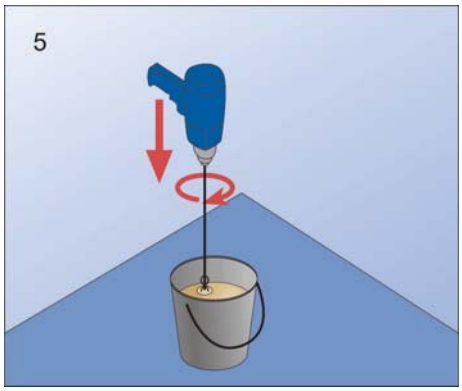
Preparation of the fibreglass mat



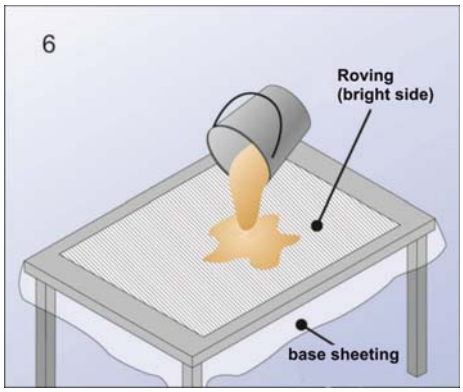
Wrap stretch film with overlapping edges around the packer and fix the ends with adhesive tape.



Calculate the resin usage amount.
Pour resin and hardener into the container used for mixing.

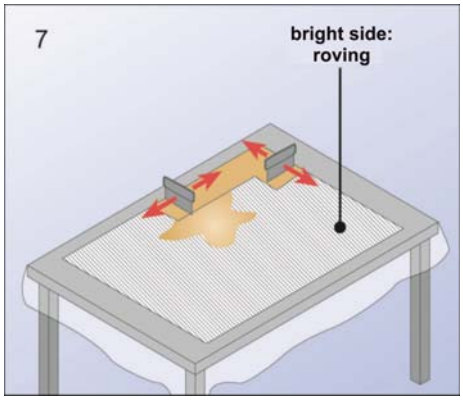


Mix the resin and the hardener.

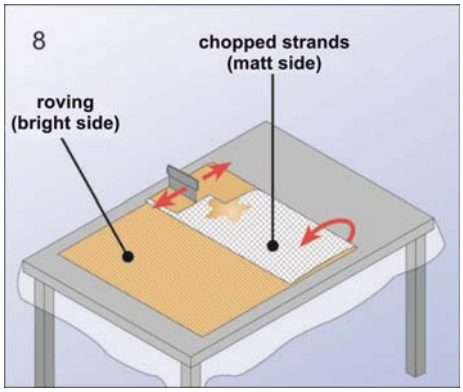


Pour a partial amount of the epros®SilicateResin system onto the roving (bright) side of the fibreglass mat.

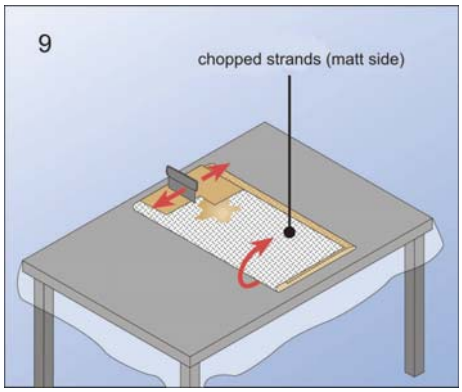
"epros®DrainPacker method" for the rehabilitation of buried damaged sewer lines from DN 100 to DN 800 using short and long liners	
DrainPacker Method Processing Instructions Part 1	Appendix 1



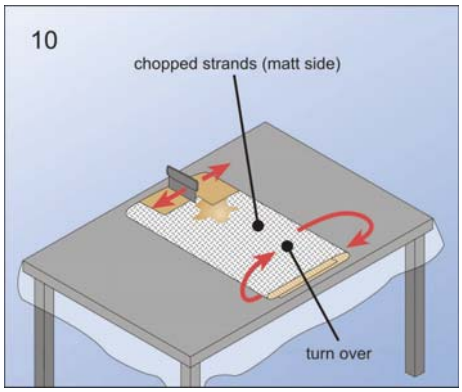
Spread the epros®SilicateResin system uniformly with the hand spatula.



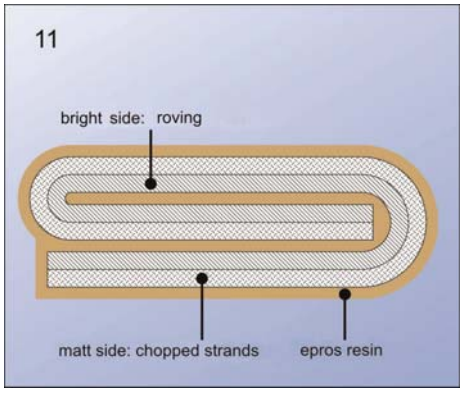
Fold over one third of the impregnated CRF(+) 1050 g/m² fibreglass mat for one third, the CRF(+) 1400 g/m² fibreglass mat according to the 2-layer folding technique. Apply the epros®SilicateResin system onto the chopped-strand side (top) and impregnate uniformly with the hand spatula.



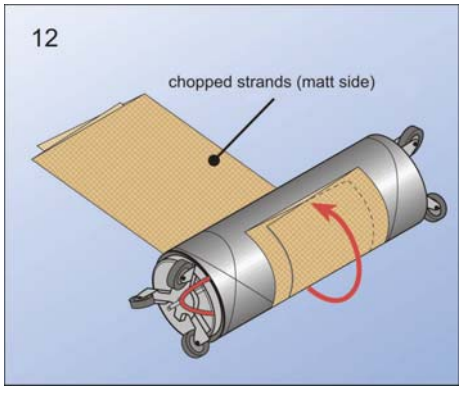
Fold the fibreglass mat again. Apply the epros®SilicateResin system onto the chopped-strand side (top) and impregnate uniformly with the hand spatula.



Turn over the fibreglass mat. Apply the epros®SilicateResin system onto the chopped-strand side (top) and impregnate uniformly with the hand spatula.

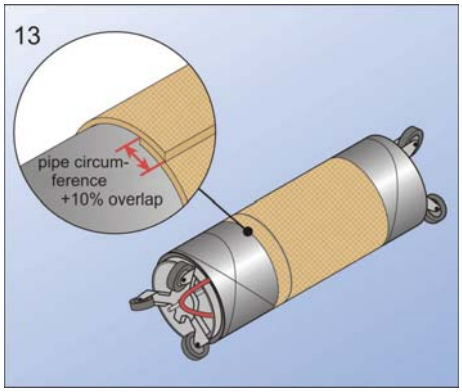


Cross-sectional view of the impregnated fibreglass mat wetted with the epros®SilicateResin system.

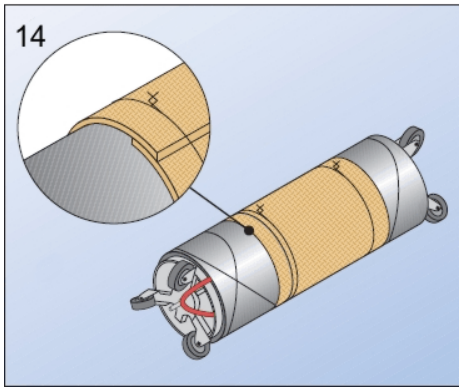


Wrap the impregnated fibreglass mat around the packer.

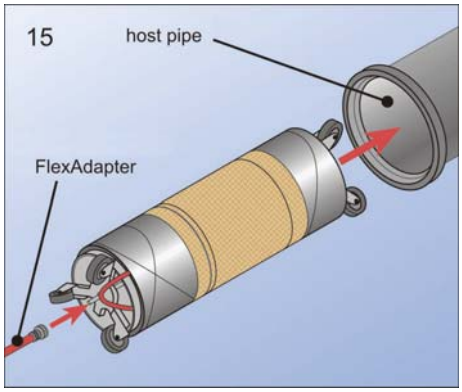
"epros®DrainPacker method" for the rehabilitation of buried damaged sewer lines from DN 100 to DN 800 using short and long liners	
DrainPacker Method Processing Instructions Part 2	Appendix 2



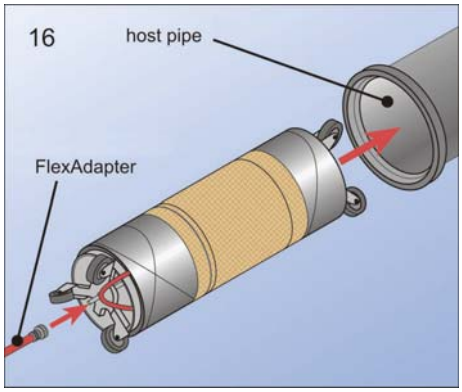
The fibreglass mat must be prefabricated with an overlap allowance.



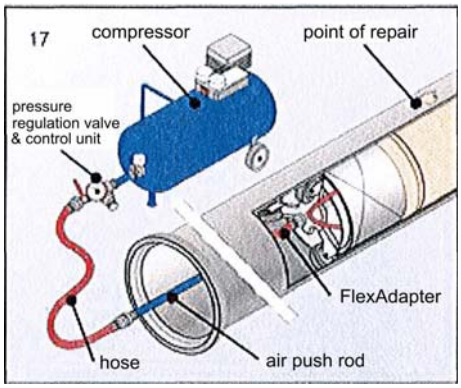
Fix the fibreglass mat with a binder wire.



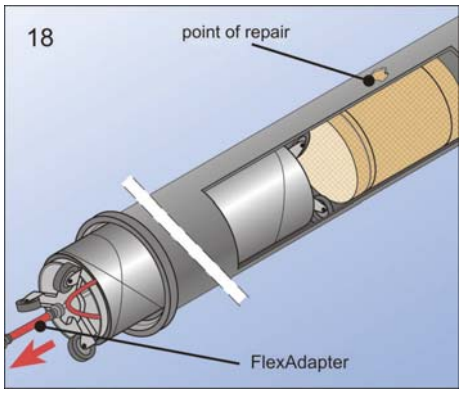
Introduce the packer into the pipe.



Move the packer down to the point of repair and position it.



Inflate the packer at the permissible pressure. The impregnated fibreglass mat is then pressed against the inner wall surface of the host pipe.



After complete cure, deflate the packer and remove it from the line.

"epros®DrainPacker method" for the rehabilitation of buried damaged sewer lines from DN 100 to DN 800 using short and long liners	Appendix 3
DrainPacker Method Processing Instructions Part 3	

Resin Usage Amounts & Cut Sizes
for epros®DrainPacker Fibreglass Matting CRF(+) 1050 g/m²

Resin system: epros®SilicateResin W01 W and S

- Circumferential coefficient for calculating the packer wrapping overlap: Pipe diameter (D) x 3.5
- Overlap allowance for 2-layered design: 1 cm
- Format size of additional layer/s: Repair length (m) x diameter (m) x 3.5 = surface area (m²)

Pipe diam.	Fibreglass mat CRF(+) 1050 g/m²								Resin system amount	Silicate	Resin
	Circum-ference D x 3.5	Repair length example	Glassfibre layers		Cut size length x width	Cut size of add. layer/s length x width	Total area[1]	Resin amount factor	Components A + B	Comp. A	Comp. B
mm	m	m	Layers total	Additional layer(s)	m	m	m²	Litre/m²	Litres * 2	Litres	Litres
100	0.35	1.0	3	0	3.01 x 0.35	—	1.05	1.6	1.80	0.60	1.20
125	0.44	1.0	3	0	3.01 x 0.44	—	1.32	1.6	2.25	0.75	1.50
150	0.53	1.0	3	0	3.01 x 0.53	—	1.58	1.6	2.55	0.85	1.70
200	0.70	1.0	3	0	3.01 x 0.70	—	2.11	1.6	3.45	1.15	2.30
225	0.79	1.0	3	0	3.01 x 0.79	—	2.37	1.6	3.90	1.30	2.60
250	0.88	1.0	3	0	3.01 x 0.88	—	2.63	1.6	4.35	1.45	2.90
300	1.05	1.0	3	0	3.01 x 1.05	—	3.16	1.6	5.10	1.70	3.40
350	1.23	1.0	3	0	3.01 x 1.23	—	3.69	1.6	6.00	2.00	4.00
375	1.31	1.0	3	0	3.01 x 1.31	—	3.95	1.6	6.45	2.15	4.30
400	1.40	1.0	3	0	3.01 x 1.40	—	4.21	1.6	6.75	2.25	4.50
450	1.58	1.0	3	0	3.01 x 1.58	—	4.74	1.6	7.65	2.55	5.10
500	1.75	1.0	4	1	3.01 x 1.75	1.0 x 1.75	7.02	1.6	11.25	3.75	7.50
525	1.84	1.0	4	1	3.01 x 1.84	1.0 x 1.84	7.37	1.6	11.85	3.95	7.90
600	2.10	1.0	4	1	3.01 x 2.10	1.0 x 2.10	8.42	1.6	13.50	4.50	9.00
675	2.36	1.0	5	2	3.01 x 2.36	1.0 x 2.36	11.84	1.6	19.05	6.35	12.70
700	2.45	1.0	5	2	3.01 x 2.45	1.0 x 2.45	12.27	1.6	19.65	6.55	13.10
750	2.63	1.0	5	2	3.01 x 2.63	1.0 x 2.63	13.15	1.6	21.15	7.05	14.10
800	2.80	1.0	6	3	3.01 x 2.80	1.0 x 2.80	16.83	1.6	27.00	9.00	18.00

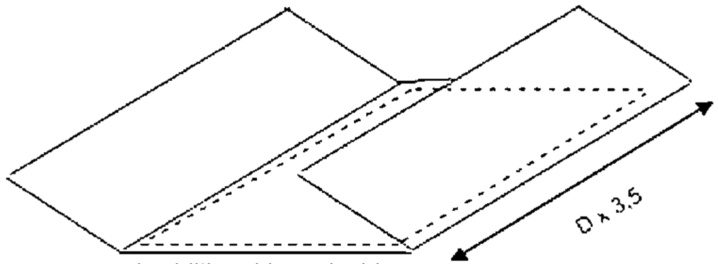
Litres *2: rounded values for easier dosing

General Technical Approval
No. Z-42.3-385 11 January 2015

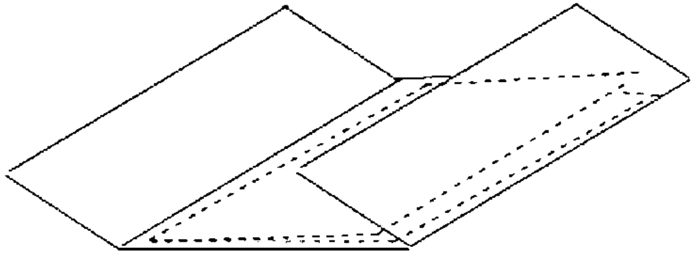
Deutsches Institut für Bautechnik

DIBt

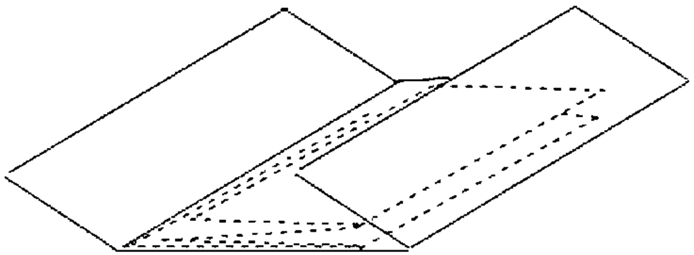
Additional fibreglass layers CRF(+) 1050 g/m² and 1400 g/m²



1 additional layer inside



2 additional layers inside



3 additional layers inside

Number of additional layers	CRF(+) 1050 g/m2 at pipe diameter (mm)	CRF(+) 1400 g/m2 at pipe diameter (mm)
1	500, 525, 600	375, 400, 450, 500, 525
2	675, 700, 750	600, 675, 700
3	800	750, 800

Reaction times as a function of temperature:

Resin type	W	W
Temperature °C	**Pot time minutes**	**Cure time minutes**
18	16 – 19	75 – 100
23	15 – 17	60 – 70
28	10 – 12	45 – 55
33	7 – 9	40 – 45

W = epros®SilicateResin Type W

Resin type	S	S
Temperature °C	**Pot time minutes**	**Cure time minutes**
18	32 – 35	120 – 136
23	30 – 32	90 – 100
28	20 – 23	70 – 85
33	14 – 16	65 – 75

S = epros®SilicateResin Type S

"epros®DrainPacker method" for the rehabilitation of buried damaged sewer lines from DN 100 to DN 800 using short and long liners

DrainPacker Method
Additional Fibreglass Layers

Appendix 5

General Technical Approval
No. Z-42.3-385 11 January 2015

Deutsches Institut für Bautechnik DIBt

Resin Usage Amounts & Cut Sizes
for epros®DrainPacker Fibreglass Matting CRF(+) 1400 g/m²

Resin system: epros®SilicateResin W01, W and S

- Circumferential coefficient for calculating the packer wrapping overlap: Pipe diameter (D) x 3.5
- Overlap allowance for 2-layered design: 1 cm
- Format size of additional layer/s: Repair length (m) x diameter (m) x 3.5 = surface area (m²)

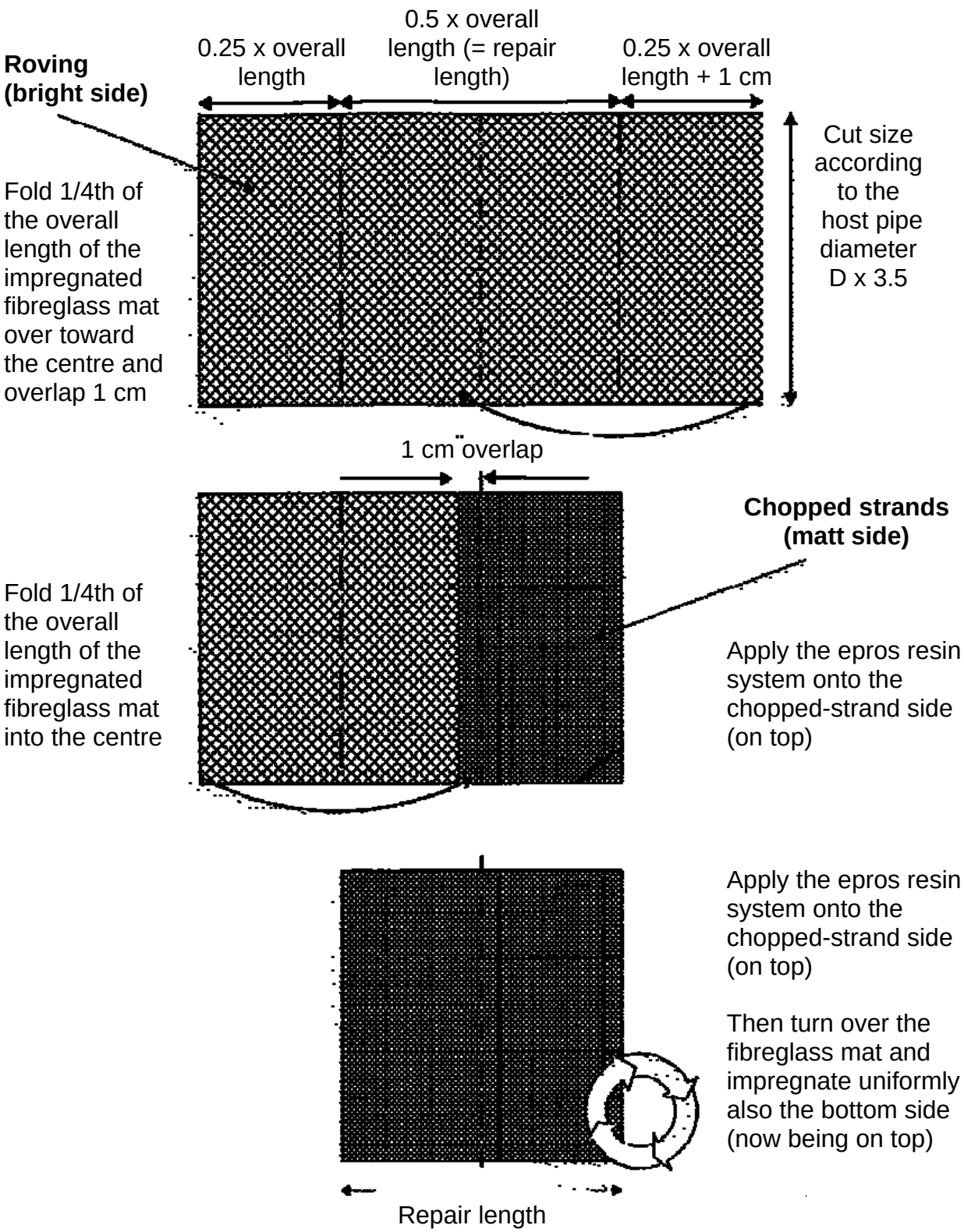
Pipe diam.	Fibreglass mat CRF(+) 1400 g/m²								Resin system amount	Silicate	Resin
	Circum-ference D x 3.5	Repair length example	Glassfibre layers		Cut size length x width	Cut size of add. layer/s length x width	Total area[1]	Resin amount factor	Components A + B	Comp. A	Comp. B
mm	m	m	Layers total	Additional layer(s)	m	m	m²	Litre/m²	Litres * 2	Litres	Litres
100	0.35	1.0	2	0	2.01 x 0.35	—	0.70	1.8	1.35	0.45	0.90
125	0.44	1.0	2	0	2.01 x 0.44	—	0.88	1.8	1.65	0.55	1.10
150	0.53	1.0	2	0	2.01 x 0.53	—	1.06	1.8	1.95	0.65	1.30
200	0.70	1.0	2	0	2.01 x 0.70	—	1.41	1.8	2.55	0.85	1.70
225	0.79	1.0	2	0	2.01 x 0.79	—	1.58	1.8	2.85	0.95	1.90
250	0.88	1.0	2	0	2.01 x 0.88	—	1.76	1.8	3.30	1.10	2.20
300	1.05	1.0	2	0	2.01 x 1.05	—	2.11	1.8	3.90	1.30	2.60
350	1.23	1.0	2	0	2.01 x 1.23	—	2.46	1.8	4.50	1.50	3.00
375	1.31	1.0	3	1	2.01 x 1.31	1.0 x 1.31	3.95	1.8	7.20	2.40	4.80
400	1.40	1.0	3	1	2.01 x 1.40	1.0 x 1.40	4.21	1.8	7.65	2.55	5.10
450	1.58	1.0	3	1	2.01 x 1.58	1.0 x 1.58	4.74	1.8	8.55	2.85	5.70
500	1.75	1.0	3	1	2.01 x 1.75	1.0 x 1.75	5.27	1.8	9.60	3.20	6.40
525	1.84	1.0	3	1	2.01 x 1.84	1.0 x 1.84	5.53	1.8	10.05	3.35	6.70
600	2.10	1.0	4	2	2.01 x 2.10	1.0 x 2.10	8.42	1.8	15.30	5.10	10.20
675	2.36	1.0	4	2	2.01 x 2.36	1.0 x 2.36	9.47	1.8	17.10	5.70	11.40
700	2.45	1.0	4	2	2.01 x 2.45	1.0 x 2.45	9.82	1.8	17.10	5.90	11.80
750	2.63	1.0	5	3	2.01 x 2.63	1.0 x 2.63	13.15	1.8	23.70	7.90	15.80
800	2.80	1.0	5	3	2.01 x 2.80	1.0 x 2.80	14.03	1.8	25.35	8.45	16.90

Litres *2: rounded values for easier dosing

"epros®DrainPacker method" for the rehabilitation of buried damaged sewer lines from DN 100 to DN 800 using short and long liners

DrainPacker Method
Resin Usage Amounts Table 1400 g/m²

Appendix 6



Place the fully impregnated CRF(+) 1400 g/m² fibreglass mat onto the appropriate packer.

"epros®DrainPacker method" for the rehabilitation of buried damaged sewer lines from DN 100 to DN 800 using short and long liners	
DrainPacker Method Cutting & Folding	Appendix 7

epros®LongPacker: Maximum repair lengths in mm (= installation lengths of the epros fibreglass mat)

Long packer nominal size (mm)	Packer length (meters)	For installation in pipe diameter of: 100 mm	150 mm	200 mm	250 mm	300 mm	350 mm	400 mm	450 mm	500 mm	550 mm	600 mm	650 mm	700 mm	750 mm	800 mm
100 - 150	1.50	1200	1000													
100 - 150	2.00	1700	1620													
100 - 150	2.50	2300	2220													
100 - 150	3.00	2800	2720													
100 - 150	4.00	3800	3720													
100 - 150	5.00	4700	4620													
150 – 200	1.50		1250	1170												
150 – 200	2.00		1750	1670												
150 – 200	2.50	none	2250	2170												
150 – 200	3.00		2750	3670												
150 – 200	4.00		3750	3670												
150 – 200	5.00		4750	4670												
200 – 300	1.50			1210	1130	1050										
200 – 300	2.00			1710	1630	1550										
200 – 300	2.50	none		2210	2130	2050										
200 – 300	3.00			2710	2630	2550										
200 – 300	4.00			3710	3630	3550										
200 – 300	5.00			4710	4630	4550										
300 – 400	1.50					1210	1130	1050								
300 – 400	2.00					1710	1630	1550								
300 – 400	3.00	none				2710	2630	2550								
300 – 400	4.00					3710	3630	3550								
300 – 400	5.00					4710	4630	4550								
400 – 500	1.50							1190	1110	1030						
400 – 500	2.00							1690	1610	1530						
400 – 500	3.00	none						2690	2610	2530						
400 – 500	4.00							3690	3610	3530						
400 – 500	5.00							4690	4610	4530						
500 – 600	1.50									1140	1060	990				
500 – 600	2.00									1640	1560	1490				
500 – 600	3.00	none								2640	2560	2490				
500 – 600	4.00									3640	3560	3490				
500 – 600	5.00									4520	4440	4360				
600 – 800	1.50											1165	1085	1000	930	850
600 – 800	2.00											1560	1480	1400	1330	1250
600 – 800	3.00	none										2660	2580	2500	2430	2350
600 – 800	4.00											3665	3585	3500	3430	3350
600 – 800	5.00											4565	4480	4400	4330	4250

"epros®DrainPacker method" for the rehabilitation of buried damaged sewer lines from DN 100 to DN 800 using short and long liners

DrainPacker Method
Technical Data: Long Packer

Appendix 8

Technical Information on epros®ShortPacker with wheelset and bypass

Nominal size (mm)	Application range		Prescribed filling pressure (bar)	Weight (kg)	Non-inflated packer		Length of rubber sleeve (mm)
	Min. diameter (mm)	Max. diameter (mm)			Length (mm)	Diameter (mm)	
150-200	150	200	2.0	6.2	960	115	800
250-300	250	300	2.0	12.6	1010	205	800
300-350	300	350	1.5	16.9	1010	250	800
350-400	350	400	1.5	19.2	1010	305	800
450-500	450	500	1.5	29.8	1010	380	800
600-700	600	700	1.0	50.2	1180	465	970

"epros®DrainPacker method" for the rehabilitation of buried damaged sewer lines from DN 100 to DN 800 using short and long liners

DrainPacker Method
Technical Data: Short Packer

Appendix 9

General Technical Approval
No. Z-42.3-385 11 January 2015

Deutsches Institut für Bautechnik
DIBt

Technical Information on epros®FlexPacker with wheelset and bypass (bypass for DN 150/250 or higher)

Nominal size		Application range				Non-inflated packer		
Diameter (mm)	Length (m)	Min. diameter (mm)	Max. diameter (mm)	Prescribed filling pressure (bar)	Weight (kg)	Length (mm)	Diameter (mm)	Length of rubber sleeve (mm)
100-150	1.0	100	150	2.5	2.1	1080	65	1000
100-150	2.0	100	150	2.5	3.5	1980	65	1900
100-150	2.5	100	150	2.5	3.6	2580	65	2500
100-150	3.0	100	150	2.5	4.2	3080	65	3000
100-150	4.0	100	150	2.5	5.0	4080	65	4000
100-150	5.0	100	150	2.5	6.0	4980	65	4900
150-250	1.0	150	250	2.0	8.3	1210	112	1000
150-250	2.0	150	250	2.0	11.0	2110	112	1900
150-250	2.5	150	250	2.0	12.7	2710	112	2500
150-250	3.0	150	250	2.0	13.9	3210	112	3000
150-250	4.0	150	250	2.0	17.4	4210	112	4000
150-250	5.0	150	250	2.0	20.5	5110	112	4900
300-400	1.0	300	400	1.5	19.6	1240	210	1120
300-400	2.0	300	400	1.5	24.3	2140	210	2120
300-400	2.5	300	400	1.5	25.0	2740	210	2620
300-400	3.0	300	400	1.5	26.5	3240	210	3120
300-400	4.0	300	400	1.5	31.1	4240	210	4120
300-400	5.0	300	400	1.5	35.8	5140	210	4880
450-600	1.0	450	600	1.2	33.0	1240	340	1120
450-600	2.0	450	600	1.2	41.2	2140	340	2020
450-600	2.5	450	600	1.2	45.8	2740	340	2620
450-600	3.0	450	600	1.2	49.0	3140	340	2880
600-800	1.0	600	800	1.0	36.0	1740	400	1620
600-800	2.0	600	800	1.0	40.5	2140	400	2020
600-800	2.5	600	800	1.0	45.8	2740	400	2620
600-800	3.0	600	800	1.0	49.0	3140	400	2880

"epros®DrainPacker method" for the rehabilitation of buried damaged sewer lines from DN 100 to DN 800 using short and long liners

DrainPacker Method
Technical Data: Flex Packer

Appendix 10

epros®DrainLiner method – rehabilitation of underground pipes
Site visit for sectional repair / relining of sewers

Single report for each repair		foul water ❑	TV pre-inspection	Date of survey:
Job site	Project No.:	storm water ❑	available ❑	Name:
Street address		combined sewer ❑	not available ❑	Name:

From manhole (1) no.	To manhole (2) no.	MH depth (manhole 1)	MH depth (manhole 2)	DN (mm) checked?	DN acc. to site plan	Length in metre	Profile shape	Egg-shaped: pipe circumference	Remarks MH centre to MH centre distance

Distances or inversion drum	from rig		Remarks:	Sketch if necessary
Standpost hydrant		m		
Undergr. hydrant		m		
Hose racks	no	❑		
	yes	❑		
Road width		m		
Truck accessibility	yes	❑		
	no	❑		
	distance (m)			
Traffic load	private site	❑		
	side road	❑		
	main road	❑		
Traffic control required	yes	❑		
	no	❑		
Service flow management	yes	❑		
	no	❑		
Flow management by	plugging	❑		
	pumping	❑		
Containment of lateral flow	yes	❑	inspection manhole available: yes ❑ no ❑	
	no	❑		

"epros®DrainPacker method" for the rehabilitation of buried damaged sewer lines from DN 100 to DN 800 using short and long liners

DrainPacker Method
Site Visit Report

Appendix 11

Leakage Test Report

1. Project Data:			
Project:			
Address:		ZIP/town:	
Project owner:			
Address:		ZIP/town:	
Installer:			
Address:			
Type of liner:	○ CIPP liner ○ Short liner	Product description:	
Leakage test:			
Address:		ZIP/town:	
2. Drain/Sewer Line Data			
Sewage type:	○ Foul water ○ Stormwater ○ Combined		
Pipe geometry:	○ Circular ○ Egg-shaped		
Liner material:		DN size/bore:	Lining date:
Pipe section #			
MH-to-MH length:			
from manhole		to manhole:	
3. Air tightness test:			
Test method:	○ LA ○ LB ○ LC ○ LD		
Test pressure p_0:	mbar	Stabilisation time:	min
adm.press.loss Δp	mbar	Test duration:	min
Start pressure:	mbar		
Final pressure:	mbar	Pressure drop:	mbar
4. Water tightness test:			
○ Pipes only	○ Manholes and inspection holes	○ Pipe with manhole	
Test duration:		30	min
Water head above pipe crown at start of test (water gauge [WG]))			kPa (= mWG· 10)
Top-up water:			L
Top-up water / manhole-to-manhole length:			L/m²
Admissible top-up water per m of wetted area acc. to DIN EN 1610:		0.15	L/m²
Calculated admissible total top-up water as referred to the test section			L
Actual amount of top-up water			L
5. Result			
Test passed:	○ yes ○ no		
Comments:			
Place / date:		Signature	

epros®DrainPacker process / Installation & Fabrication Report

	Project No.
Client:	Contractor:
Street address:	Street address:
Town/city:	Town/city:
Contact:	Contact:
Telephone:	Telephone:
Job site	
Town/city:	Street address:
From manhole/connection point:	To manhole/connection point:
Pipe section no.: _____ Section length _____ m	Pipe material:
Inner diameter:	Short liner positioned at:
DVD / VIDEO:	Picture no.:
Job preparations	
Approval required: ❑ YES ❑ NO	Site safety measures required: ❑ YES ❑ NO
Flow control required: ❑ YES ❑ NO	Sewer pipe in operation: ❑ YES ❑ NO
Flow control by: ❑ plugging ❑ overpumping	Repair area free of faeces ❑ YES ❑ NO
	Date pipe was flushed: _____
Preparatory treatment of point of repair	
Directly before installation: ❑ high-pressure cleaning ❑ mechanical cleaning ❑ milling ❑ grinding / milling	Important: Smooth pipe walls must be prepared by grinding, concrete or similar pipe walls by milling. Make sure the surface treatment at both liner ends overlaps by half the pipe diameter to the inside (DN divided by 2), at least 300 mm either side.
Weather conditions: ❑ dry ❑ wet	Outdoor temperature (ACTUAL) _____ °C Sewer temperature (ACTUAL) _____ °C
Material storage & delivery	
epros® resin type (Component B) ❑ W01 ❑ W ❑ S	Batch number: _____ Batch number: _____ Batch number: _____
epros® hardener (Component A)	Batch number: _____
epros®CRF(+) fibreglass matting ❑ 1050 g/m² ❑ 1400 g/m²	Batch number: _____
Storage temperature between +5 and +25 °C (TARGET)	Storage temperature (ACTUAL) _____ °C
Storage time ≤ 12 months ❑ YES ❑ NO	Maximum 6 months after delivery
Material undamaged ❑ YES	If damaged, specify: _____
Anomalies found in handling ❑ NO	If yes, specify: _____
Mixing process	
Total usage amount in litres _____ (ACTUAL) Maximum mixing volume 15 litres	epros® resin type (Component B) ❑ W01 _____ litres ❑ W _____ litres ❑ S _____ litres
Mixed to homogenous colour: ❑ YES ❑ NO	epros® hardener (Component A) _____ litres _____ litres _____ litres
Mixing time (duration):	from (time) _____ to (time) _____
Repair operation	
Packer used:	Length: _____ Type: _____
Repair length:	Length: _____
Number of CRF(+) layers _____	epros®CRF(+) 1050 g/m² (TARGET: ≥ 3 layers) epros®CRF(+) 1400 g/m² (TARGET: ≥ 2 layers)
Contact pressure maintained:	from start time: _____ to end time: _____
Processing time vs. pot time:	_____ minutes (ACTUAL) _____ minutes (TARGET)
Working pressure:	_____ bar (ACTUAL) _____ bar (TARGET)
Cure time:	_____ minutes (ACTUAL) _____ minutes (TARGET)
Ventilation of packer:	_____ (time)
	_____ Date, signature

SAMPLE DELIVERY NOTE FOR TESTING OF LINER MATERIAL

☐ *INITIAL TEST* ☐ *REPEATED TEST* *for Test Report No.* ____

1. Sampling data:

Sample taken by:		Test institute:	
Date / time:		Address:	

2. Sample identification:

Project:			Material ID:			
Project owner / client:			Sample description:			
Cost centre:			Sewer line description:			
Installer firm:			Nominal diameter:			
Liner manufacturer:			Date installed:			
Carrier material:			Host pipe condition:	O I	O II	O III
Resin material:			Sampling location:	O MH-MH line	O final MH	O interm. MH
Pipe geometry:	O circular	O egg shape	Sampling position:	O crown	O springline	O invert

3. Required initial properties according to structural design calculations:

Flexural E-modulus$_{DIN}$ E_f [N/mm²]:		Circumferential E-modulus E_U [N/mm²]:	
Flexural stress$_{at\ first\ break}$ σ_{fB} [N/mm²]:		Initial ring stiffness S_0 [N/m²]:	
Wall thickness **d** [mm]:		Maximum creep K_{N24} [%]:	
Reduction factor A_1:		Density δ [g/cm³]:	

4. Test results:

Flexural modulus, bending stress acc. to DIN EN ISO 178

Date tested	E_f [N/mm²]	σ_{fB} [N/mm²]	h [mm]
	Load type	O axial	O radial

24 h creep after DIN EN ISO 899-2

Date tested	K_N [%]

Circumf. E-modulus, initial ring stiffness acc. to DIN EN 1228

Date tested	E_U [N/mm²]	S_0 [N/m²]	h [mm]

24 h creep after DIN EN 761

Date tested	K_N [%]

Water tightness acco. to DIN EN 1610

Date tested	Load period	Test pressure [bar]	Test result	
	30 minutes		O passed (tight)	O failed (leaking)

Calcination method acc. to DIN EN ISO 1172

Date tested	Resin [%]	Total residues [%]	Glass content [%]	Additive [%]

Spectral analysis after ASTM D 5576 (FT-IR)

Date tested	EP resin	UP resin	VE resin	Other resin

Density acc. to DIN EN ISO 1181-1 or -2

Date tested	δ [g/cm³]

Thermal analysis acc. to DIN EN ISO 11357-1 / DSC analysis DIN 53765 Method A

Date tested	Glass transition temperature [°C]			Enthalpy [J/g]	
	T_{G1}		ΔT_G	O exothermic	O endothermic
	T_{G2}				

5. Evaluation of results:

Requirement	met	not met	Requirement	met	not met
Flexural-E-modulus E_f	O	O	Circumfer. E-modulus E_U	O	O
Flexural stress σ_{fB}	O	O	Initial ring stiffness S_0	O	O
Wall thickness **d**	O	O	24 h creep K_N	O	O
Water tightness	O	O	Density δ	O	O

6. Remarks:

7. Signature of tester / laboratory: