

## 2.0 Services

### 2.1 Condition Anlyase of channel and pipes lines

Channel television	IBAK-Radias / Sirius Color-camera 450 m cable to 3.5 tonnes Vehicle Application area: D100 - 1250mm Additional equipment: <ul style="list-style-type: none"><li>- For egg-shaped channels</li><li>- For pictures of profiles track</li><li>- Evaluation with the company WinCan CD Lap AG</li></ul> IBAK-Triton / Sirius-Color-camera with 450m cable Application area: D100 - 1000mm Evaluation with the company WinCan CD Lap AG IBAK-Ceres Color-camera with 100m cable Application area: D60-150mm Evaluation with the company WinCan CD Lap AG
Investigation team	for walk-channels, program evaluation on Win Can
Pipeline pressure testing	device and test socket according to SIA standards
Places	of channels, pipes and manholes with tracking device up to 15m depth
Consultancy / Projects	Building <ul style="list-style-type: none"><li>- Condition Survey</li><li>- Renovation projects</li><li>- Cost estimates</li></ul> Advice for: <ul style="list-style-type: none"><li>- Maintenance and Renovation</li></ul>

## 2.2 Repair and renovation of sewers and pipes

### Repair methods

- 2.2.11 Primo robot system
  - 2.2.12 \* Flexiliner P ( partial relining)
  - 2.2.13 \* Flexiliner S (short relining)
  - 2.2.14 Lateral-Packer
- Renovation of supports

### Injection and sealing methods

- 2.2.21 \*PEKA-Tech injection system (3M-PUR)

### Structural repairs

- 2.2.31 ZM injection
- 2.2.32 PEKA-Tech injection system

### Renovation methods

#### \*Relining methods

- 2.2.41 Long pipe/pipeline – PEKA-Plast system
- 2.2.42 Short pipe – PEKA-Plast system

#### \*Pipe relining methods

- 2.2.51 Flexiliner II (pipe relining) diameter 200 – 1200 mm
- 2.2.52 Flexiliner H (pipe relining) diameter 80 – 300 mm

### Renewal

- 2.2.61 \*Installation method – PEKA-Plast system

**\*company's own licence**



## 2.2.11 Primo Robot System

### Procedure

*Procedure Category* Maintenance / Repair Procedures

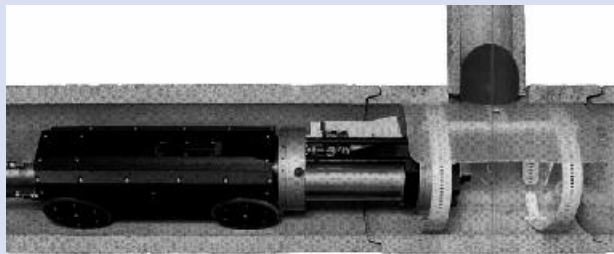
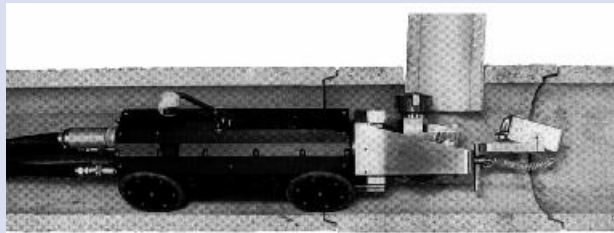
*Note* General information concerning relining procedures is available in section 4.2.1 of IP Construction<sup>1</sup>, Maintenance of Inaccessible Channels.

*Producer* PMO Dübendorf  
KRT Engineering + Handel AG Sempach

*Supplier* KRT Kanal-Service AG

*Brief description* The robots are put into the pipe section via an inspection shaft and guided to the damage site by an operator in the control vehicle using the remote camera. The damage is repaired by means of various devices capable of carrying out a variety of tasks such as grinding, drilling, injecting, filling and smoothing and sanding. The placing of rubber seals for the repair of lateral connections is also possible.

### Schematic diagram



*Materials* 2 Component epoxy resin adhesive 96101/96107/96110

*Standards* Not standardized in Switzerland

*First application* World wide / Switzerland 1994

### Area of Application

*Nature of Damage* Pipe cross-section:  
- Root penetration  
- Build up of deposits and foreign bodies

Pipe walls:  
- Axial and radial cracks  
- Flaking and holes  
- Build up of fragments

<i>Nature of damage</i>	<i>Sleeve joints:</i> <ul style="list-style-type: none"><li>- Leaks</li><li>- Outflow</li></ul> <i>Lateral connections:</i> <ul style="list-style-type: none"><li>- Protruding connections</li><li>- Defects in the connection area</li><li>- Closing and plugging of redundant connections</li><li>- Reconnection during the relining procedure</li></ul>
<i>Restrictions</i>	<i>Limitations only in the case of:</i> <ul style="list-style-type: none"><li>- Pipe wall corrosion</li><li>- Broken or collapsed pipes</li><li>- Positional shifting</li></ul>
<i>Pipe materials</i>	<i>All types, restrictions for plastics</i>
<i>Cross-Sections</i>	<i>Circular / Oval</i>
<i>Dimensions</i>	<i>Circular NW 150 mm to NW 800 mm</i> <i>Oval 300/450 mm, 400/600 mm</i>
<i>Maximum Range</i>	<i>Up to about 80 m', using cable extending kit of about 40 m'</i>
<i>Curves – U-Bends</i>	<i>Limitations to use</i>

## **Preparatory Work**

<i>Excavations</i>	<i>Not usually necessary. Access via inspection shafts</i>
<i>Pipe Cross-Section</i>	<i>High pressure cleaning</i>
<i>Lateral Connections</i>	<i>No prior measures required</i>
<i>Ground Water</i>	<i>Plugging may be required according to the nature of the damage</i>
<i>Water Treatment</i>	<i>When working in the area of the water flow and for large volumes of water use of by-pass pumps for waste water may be necessary</i>

## **Final Tasks**

<i>Inspection Shafts</i>	<i>No measures necessary</i>
<i>Lateral Connections</i>	<i>No measures necessary</i>
<i>Subsequent Treatment</i>	<i>High pressure cleaning</i>
<i>Acceptance</i>	<i>Inspection with pipe remote cameras</i> <i>Sealing test using air in accordance with SIA 190</i>

**Remarks** *No reduction in cross-section*  
*Inflow repair using sealing system*

**Status** *August 2001*

## Procedure **2.2.12 Flexiliner P (partial relining)**

Type of Procedure *renewal, cleaning, pipe relining*

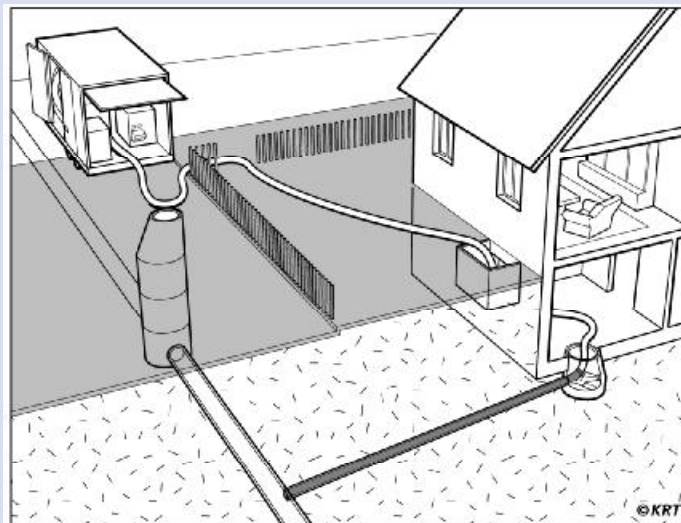
Notice *general information on the relining procedures are contained in Section 4.3.2 of the IP Construction, maintenance of non walk-in sewage systems*

License *KRT Engineering + Handel AG, Sempach*

Bidder *KRT Kanal-Service AG*

Brief Description *A hose impregnated with epoxy resin or glass fibre matting is put onto a rubber packer and inserted into the pipe section to be renovated with the help of a winch. By adding hot water to the packer circulation system, the hose is pressed against the pipe wall. After ending the hardening (30'-180'), depending on the type of resin, the pressure is reduced and withdrawn from the pipe.*

Schematic Diagram



Materials *Base material: fibre glass matting 1100 – 3600 gr/m<sup>2</sup> or synthetic fleece 4.5 - 9.0 mm  
Resin: epoxy resin system  
Layer thickness: 4.5 - 9 mm*

Standards *Not standardized in Switzerland*

*D: ATV Instruction Sheet M 143 Part 3: Relining (draft)  
ATV Worksheet A 127 (statics)*

First Application *Worldwide / Switzerland 1992*

**Damage Aspects**      *Locally restricted damage areas such as:*

- *Open or damaged sleeves*
- *Root intrusion*
- *Cracks, flaking and fragmentation in the pipe wall*
- *Corroded pipe wall*
- *Lack of pipe static*

**Restrictions**

- *Pipe collapse*
- *Deviation in position*
- *Excessive deformation in flexible pipe*

**Pipe Material**      *All materials*

**Cross-Section Forms**      *Circular profiles*

**Dimensions**      *Circular profiles NW 100 mm to NW 1000 mm*

**Maximum Range**      *up to about 100 m*

**Curves / U Bends**      *applicable*

## **Preparatory Work**

**Excavations**      *not usually required; access via inspection shafts*

**Pipe Cross-Section**      *high pressure cleaning, creation of the original cross-section by boring or cutting*

**Lateral Connections**      *cut back protruding connections*

**Groundwater**      *no measures necessary, strong infiltration to be sealed by injections*

**Draining of Water**      *pumping out of wastewater usually not necessary*

## **Final Tasks**

**Inspection Shafts**      *no measures necessary*

**Lateral Connections**      *no measures necessary*

**Treatment**      *no measures necessary*

**Acceptance**      *inspection with pipe remote camera. Tightness test as per SIA V 190*

## **Remarks**

- *minimum cross-section reduction*
- *length of sleeves:*
  - standard = 0.4 m*
  - special = any lengths (about 5.0 m)*
- *hardening in operational state: 0.5 to 3 hours*

- *examples with NW100 mm to 800 mm in Switzerland and Germany from 1994 as Shortliner, in France from 1994 as Flexojoint.*

**Status**      *January 2000*

## Procedure **2.2.13 Flexiliner S (short relining)**

*Type of Procedure* maintenance and repair procedures

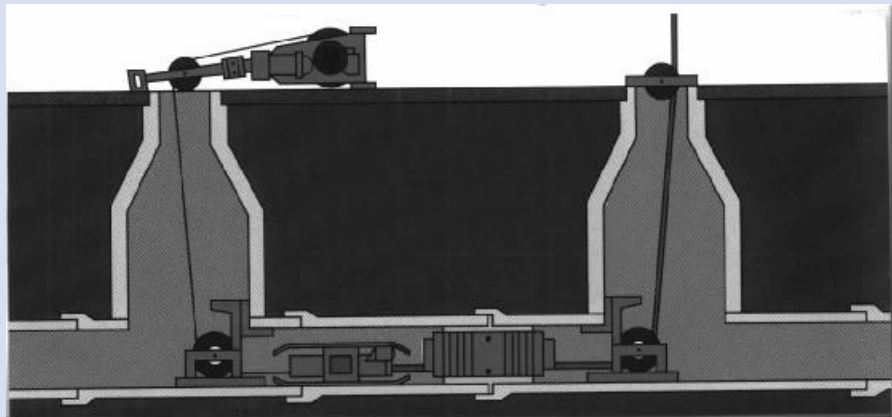
*Notice* general information on the relining procedures are contained in Section 4.2.1 of the IP Construction, maintenance of non walk-in sewage systems

*License* KRT Engineering + Handel AG, Sempach

*Bidder* KRT Kanal-Service AG

*Brief Description* An impregnated inner sleeve made of glass fibre matting of restricted length is mounted on a special packer and, with the help of a winch, positioned over the damaged point. By sending hot water into the packer, the fibre glass hose is pressed against the pipe wall, whereby the excess epoxy resin penetrates into cracks and hollow areas. After the end of the hardening process, the packer is ventilated and taken out of the pipe.

*Schematic Diagram*



*Materials* Base material: ready-to-use sleeve made of fibre glass matting V 2400  
Resin: diverse epoxy resin systems  
Layer thickness: 3 - 5 mm

*Standards* Not standardized in Switzerland

*First Application* Worldwide / Switzerland 1992

## Area of Application

<i>Damage Aspects</i>	<i>Locally restricted damage areas such as:</i> <ul style="list-style-type: none"><li>- <i>Open or damaged sleeves</i></li><li>- <i>Root intrusion</i></li><li>- <i>Cracks, flaking and fragmentation in the pipe wall</i></li></ul>
<i>Restrictions</i>	<ul style="list-style-type: none"><li>- <i>Pipe rupture or collapse</i></li><li>- <i>Deviation in position</i></li><li>- <i>Excessive deformation in flexible pipe</i></li><li>- <i>Corroded pipe continuously</i></li></ul>
<i>Pipe Material</i>	<i>All materials</i>
<i>Cross-Section Forms</i>	<i>Circular profiles</i>
<i>Dimensions</i>	<i>Circular profiles NW 100 mm to NW 1000 mm</i>
<i>Maximum Range</i>	<i>up to about 100 m</i>
<i>Curves / U Bends</i>	<i>limitedly applicable</i>

## Preparatory Work

<i>Excavations</i>	<i>not usually required; access via inspection shafts</i>
<i>Pipe Cross-Section</i>	<i>high pressure cleaning, creation of the original cross-section by boring or cutting</i>
<i>Lateral Connections</i>	<i>cut back protruding connections</i>
<i>Groundwater</i>	<i>no measures necessary, strong infiltration to be sealed by injections</i>
<i>Draining of Water</i>	<i>pumping out of wastewater usually not necessary</i>

## Final Tasks

<i>Inspection Shafts</i>	<i>no measures necessary</i>
<i>Lateral Connections</i>	<i>no measures necessary</i>
<i>Treatment</i>	<i>no measures necessary</i>
<i>Acceptance</i>	<i>inspection with pipe remote camera. Tightness test as per SIA V 190</i>

## Remarks

- *minimum cross-section reduction*
- *length of sleeves:*
  - standard = 0.4 m*
  - special = any lengths (up to about 5 m)*
- *hardening in operational state: 0.5 to 1 hour*
  
- *examples with NW 100 mm to 800 mm in Switzerland and Germany from 1994 as Shortliner, in France from 1994 as Flexojoint*

<b>Status</b>	<i>January 2000</i>
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## 2.2.14 Lateralpacker System

### Procedure

Type of Procedure *maintenance, repair / injection procedure*

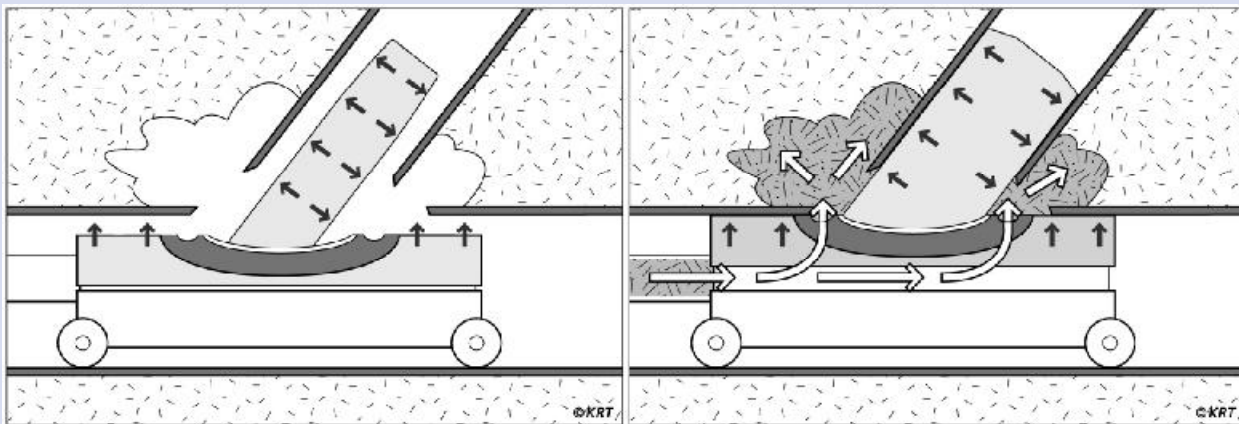
Licensor / Manufacturer *packer: Umwelttechnik Strobel GmbH Max Eyth-Strasse 3  
D-72505 Krauchenwies*

Construction: *KRT Kanalrenovationen AG*

Bidder *KRT Kanal-Service AG*

Brief Description *The connection pieces / inlets are pressed with the help of a special packer, which is placed in the main pipe and in the inlet, with injection mortar. All the hollow areas are filled as a result of the high pressure and a smooth inner wall achieved by the lagging. With the special packer the imperviousness can be tested in a separate work step. An advance sealing is usually not necessary.*

### Schematic Diagram



Materials *ZM injection mortar*

Standards and Guidelines *Not standardized in Switzerland  
VSA guideline: maintenance of sewage systems, Annex 5*

First Applications *Worldwide 1996      Facilities in use: 22  
Switzerland 1999      Facility in use: 1*

## Area of Application

<i>Damage Aspects</i>	<i>chipped and otherwise damaged connection pieces and inlets</i>
<i>Restrictions</i>	<i>reservations for statically badly damaged pipes</i>
<i>Sewage Pipe Material</i>	<i>all materials</i>
<i>Cross-Section Forms</i>	<i>Circular profiles</i>
<i>Dimensions</i>	<i>Circular profiles NW 200 mm to NW 600 mm</i>
<i>Maximum Range</i>	<i>up to about 70 m</i>
<i>Curves / U Bends</i>	<i>limitedly applicable</i>

## Preparatory Work

<i>Excavations</i>	<i>not usually required; access via inspection shafts</i>
<i>Pipe Cross-Section</i>	<i>high pressure cleaning, creation of the original cross-section by boring or cutting</i>
<i>Lateral Connections</i>	<i>cut back protruding connections</i>
<i>Groundwater</i>	<i>no measures necessary</i>
<i>Draining of Water</i>	<i>pumping out of wastewater necessary with large amounts of water</i>
<i>Ventilation</i>	<i>as per SUVA regulations; Instructions Sheet on Industrial Safety, October 1996</i>

## Final Tasks

<i>Inspection Shafts</i>	<i>no measures necessary</i>
<i>Lateral Connections</i>	<i>no measures necessary</i>
<i>Treatment</i>	<i>high pressure cleaning</i>
<i>Acceptance /- Quality Assurance</i>	<i>inspection with pipe remote camera tightness test with air as per VSA guideline</i>

**Remarks** *no cross-section reduction, hollow areas filled*

**Status** *January 2000*

## Procedure **2.2.21 Peka-Tech Pressing System**

Type of Procedure *maintenance – injection procedure*

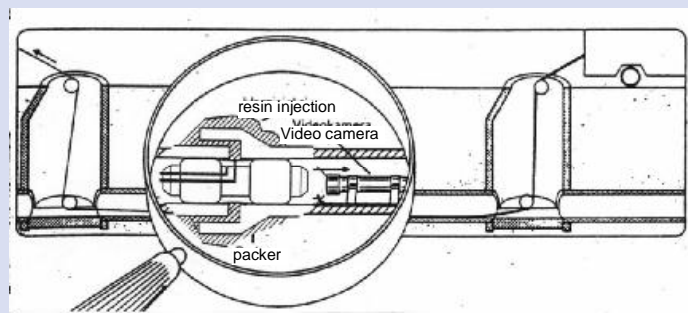
Notice *general information on the relining procedures are contained in Section 4.2.3 of the IP Construction, maintenance of non walk-in sewage systems*

Manufacturer *KRT Engineering + Handel AG Sempach  
Buchen SIS Inc.*

Bidder *KRT Kanal-Service AG*

Brief Description *The sleeves identified by a sewage system remote control camera are pressed individually with the help of special units (packers) with air or water and thus possible pressure losses are established. In leaking sleeves, in the same workstep, a 2 component gel is pressed outward into the earth or into the surrounding material. The gel polymerises and forms outside the pipe a water-impervious layer. Thereafter the imperviousness is tested again.*

Schematic Diagram



Materials *2 component polyurethane resin on an acrylic basis consisting of:*  
 - PUR prepolymer  
 - Water  
 - Additives

Standards *Not standardized in Switzerland*

First Applications *Worldwide 1960 USA  
Switzerland 1985*

### Area of Application

Damage Aspects *Locally restricted leak points in particular in the sleeve area (infiltration, exfiltration)*

Restrictions *procedure only conditionally applicable for:*  
 - longitudinal cracks  
 - very rough or uneven pipe walls  
 - statically damaged pipes

**Damage Aspects** sleeves:  
- leakiness  
- ruptures

lateral connections:  
- protruding connections  
- defects in connection area  
- closing and filling in dead connections  
- reconnecting in cases of relining procedures

**Restrictions** procedures only conditionally applicable for:  
- corroded pipe walls  
- ruptures or collapses  
- deviations in position

**Raw Materials** all materials, restrictions for plastics

**Cross-Section Forms** circular profiles

**Dimensions** circular profiles NW 200 mm to NW 800 mm  
egg-shaped 400/600

**Maximum Range** up to about 160 m

**Curves / U Bends** limitedly applicable

## **Preparatory Work**

**Excavations** not usually required; access via inspection shafts

**Pipe Cross-Section** high pressure cleaning

**Lateral Connections** no measures necessary in advance

**Groundwater** sealing required depending on the damage aspects

**Draining of Water** pumping out of wastewater necessary for tasks in the vicinity of the waterflow and for large amounts of water

## **Final Tasks**

**Inspection Shafts** no measures necessary

**Lateral Connections** no measures necessary

**Treatment** high pressure cleaning

**Acceptance / Quality Assurance** inspection with pipe remote camera  
tightness test as per SIA V 190, EN 1610, M 143 part 6, VSA appendix 6

**Remarks** no cross-section reduction

**Status** January 2000

## 2.2.41 Pekaplast Relining System

### Procedure

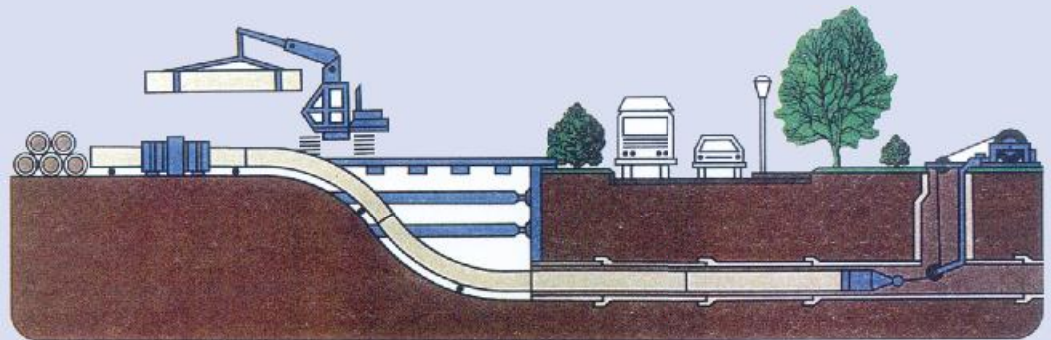
Procedure Category *Renovation/Relining Procedure*

Licencer/Producer *KRT Engineering + Handel AG, Sempach*

Supplier *KRT Kanal-Service AG*

Brief description *Flexible HDPE corrugated pipes are drawn into existing piping via an inspection shaft. The HDPE corrugated pipes are delivered in sections or rolls. Prior to insertion, sections of pipe are welded together into lengths. The ends are secured into the shafts (by packing or anchor points) and the annular gap between old and new piping must be plugged. To secure the joints, the section of the pipe in question must remain uncovered.*

### Schematic diagram



Materials *HDPE Pipes corrugated*

Dimensions *External diam. / Internal diam.: 75/64 – 90/78 – 110/96 – 125/110 – 140/120 – 160/140  
238/200 – 290/250 – 345/297 – 397/347*

*HDPE Pipes smoothed  
Dimensions: All dimensions of individual wall thicknesses :*

Standards and Guidelines *As for rebuilding*

First application *Switzerland 1987*

### Area of Application

Nature of Damage

- *Damaged surfaces or pipe walls*
- *Localised damage, such as splits, perforations, fragmenting, or open or damaged sleeve joints*

*Restrictions* See Factory Instructions for HDPE Pipes

*Pipe material* All materials

*Cross-Section* Circular profiles

*Dimensions* Circular profiles NW 80 mm to NW 400 mm

*Maximum Range* Dependant on various factors

*Curves/U-Bends* Dependant on various factors

## **Preparatory Work**

*Installation* Installation via existing inspection shafts

*Excavations* Necessary in the area where joints occur

*Pipe Cross-Section* High pressure cleaning, restoration of the original cross-section by boring or grinding (sizing)

*Lateral Connections* Grind back existing connections

*Ground Water* Plugging of the annular space in exceptional cases

*Water Treatment* Resolution on a case by case basis.

*Ventilation* In accordance with SUVA<sup>1</sup> safety regulations

## **Final Tasks**

*Inspection Shafts* Secure into shaft using shaft packing, or anchoring points

*Lateral Connections* Lateral connections should be tightly jointed with saddle pieces and constructed in the open.

*Subsequent Treatment* None

*Acceptance* Inspection with pipe remote cameras / video recording

*Quality Assurance* Sealing test using air in accordance with VSA guidelines

**Remarks** Large reduction in cross-section  
Slope to be taken into consideration

**Status** January 2000

## Procedure

# 2.2.42 PE Short Pipe Relining System

Procedure Category

Renovation/Relining Procedure

Licencer/Producer

KRT Engineering + Handel AG, Sempach

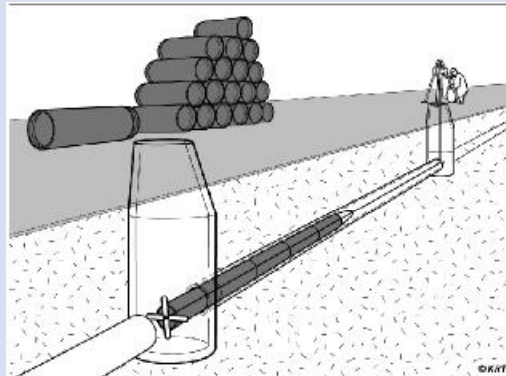
Supplier

KRT Kanal-Service AG

Brief description

Short sleeve jointed HDPE pipes are inserted or drawn into the existing pipe-work via an inspection shaft. Individual short pipes are assembled in the inspection shaft and are either inserted, bolted or welded together. The ends are secured into the shafts (by packing or anchor points) and the annular gap between old and new piping must be plugged. To secure the joints, the section of the pipe in question must remain uncovered.

Schematic Diagram



Materials

HDPE-Pipes

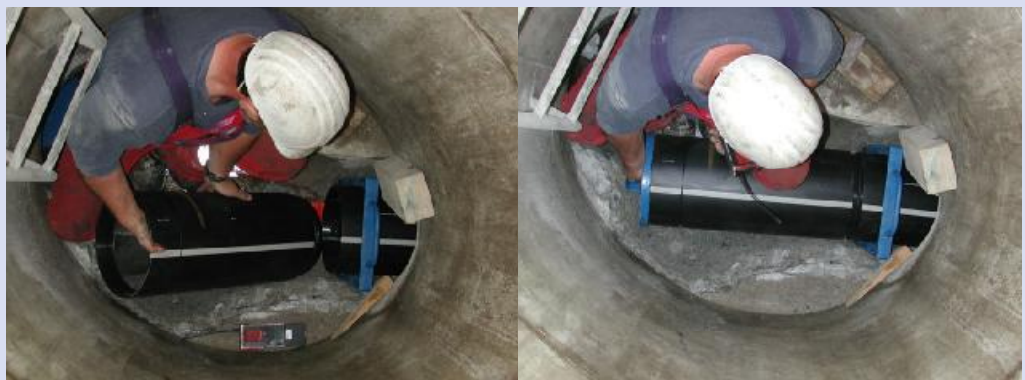
Material Strength: According to manufacturer (varies)

Standards and Guidelines

As for rebuilding

First application

World-wide 1984  
Switzerland 1993



## Area of Application

<i>Nature of Damage</i>	<i>- Damaged surfaces or pipe walls - Localised damage, such as splits, perforations, fragmenting, or open or damaged sleeve joints</i>
<i>Restrictions</i>	<i>See Factory Instructions</i>
<i>Pipe material</i>	<i>All materials</i>
<i>Cross-Section</i>	<i>Circular profiles</i>
<i>Dimensions</i>	<i>Circular profiles NW 100 mm to NW 400 mm</i>
<i>Maximum Range</i>	<i>In accordance with Factory Instructions</i>
<i>Curves/U-Bends</i>	<i>Only possible with adjacent excavation</i>

## Preparatory Work

<i>Installation</i>	<i>Installation via existing inspection shafts</i>
<i>Excavations</i>	<i>Necessary in the area where joints occur</i>
<i>Pipe Cross-Section</i>	<i>High pressure cleaning, restoration of the original cross-section by boring or grinding (sizing)</i>
<i>Lateral Connections</i>	<i>Grind back existing connections</i>
<i>Ground Water</i>	<i>Penetration by ground water should be sealed off</i>
<i>Water Treatment</i>	<i>Necessary to use waste water by-pass pumps</i>
<i>Ventilation</i>	<i>In accordance with SUVA<sup>1</sup> safety regulations</i>

## Final Tasks

<i>Inspection Shafts</i>	<i>Secure into shaft using shaft packing, or anchoring points</i>
<i>Lateral Connections</i>	<i>Lateral connections should be tightly jointed with saddle pieces and constructed in the open.</i>
<i>Subsequent Treatment</i>	<i>High pressure cleaning / Sizing</i>
<i>Acceptance</i>	<i>Inspection with pipe remote cameras / video recording</i>
<i>Quality Assurance</i>	<i>Sealing test using air in accordance with VSA guidelines</i>

## Remarks

*Large reduction in cross-section  
Slope to be taken into consideration*

## Status

*January 2000*

**Procedure**

## 2.2.51 Flexiliner II (pipe relining) Typ Plus: (Inversion)

*Type of Procedure*

renewal, cleaning, pipe relining

*Notice*

general information on the relining procedures are contained in Section 4.3.2 of the IP Construction, maintenance of non walk-in sewage systems

*License*

KRT Engineering + Handel AG, Sempach

*Bidder*

KRT Kanal-Service AG

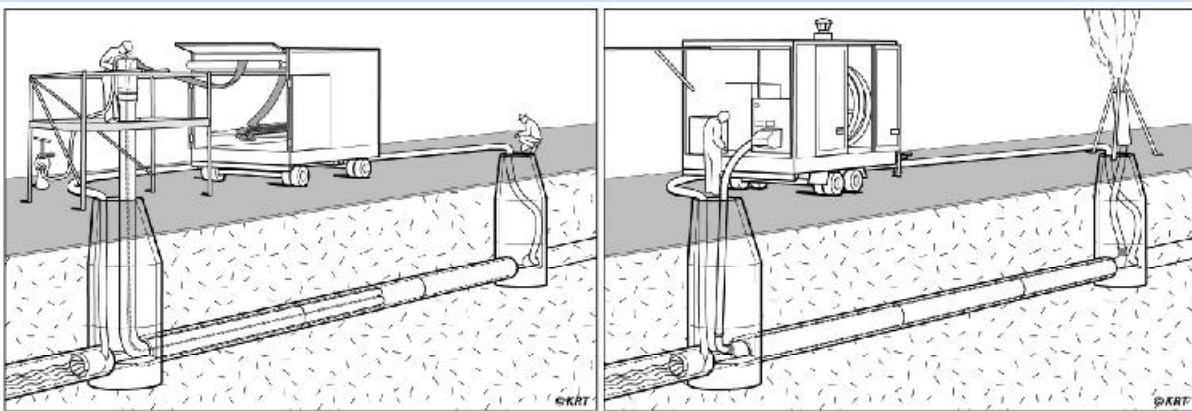
*Brief Description*

A flexible hose which has been saturated with epoxy resin is inserted into an existing manhole and inverted into the sewer pipe which is to be renovated using water after which it is inflated against the sewer walls using compressed air. The epoxy resin is hardened under pressure achieved by blowing in steam or heated water. Seamless sheathing of the sewer pipe which lies tightly onto the pipe without leaving a circular gap is thus ensured.

*Schematic Diagram*

- Insertion Phase

- Hardening Phase



*Materials*

**Base material:** ready-to use hose made of synthetic polyester fleece, if required, reinforced by glass fibre fabric

**Resin:** diverse epoxy resin systems

**Layer thickness:** 3.0 mm to 24 mm depending on pipe diameter and load

*Standards*

**EU:** DIN / EN 135566-4-2002

**D:** ATV Instruction Sheet M143 Part 3: Relining (draft)  
ATV Worksheet A 127 (statics)

*First Applications*

Worldwide	1979 F (Copaflex)
Switzerland	1985 (Flexliner I)
Switzerland	1995 (Flexliner II)
	1998 (Flexliner II Plus)

## Area of Application

*Damage Aspects*

- Open or damaged sleeves
- Cracks, flaking and light fragmentation in the pipe wall
- Corroded pipe walls

*Further Applications*

- Increase in performance capacity
- Increase or restoration of the static strength

*Restrictions*

Procedure only conditionally applicable for:

- Pipe collapse
- Deviation in position
- Excessive deformation in flexible pipes

*Pipe Material*

All materials

*Cross-Section Forms*

Circular, egg-shape and special profiles

*Dimensions*

Circular profiles NW 100 mm to NW 1250 mm

*Maximum Range*

depending on the dimensions up to about 125 m

*Curves / U Bends*

with reservations (wrinkling)

## Preparatory Work

*Excavations*

not usually required; access via inspection shafts

*Pipe Cross-Section*

high pressure cleaning, creation of the original cross-section by boring or cutting

*Lateral Connections*

cut back protruding connections

*Groundwater*

intensive groundwater flooding to be sealed in advance

*Draining of Water*

pumping out of wastewater and the lateral connections required

## Final Task

*Inspection Shafts*

transition from pipe / inspection shaft re-worked with special mortar. Tightness between pipe and relining in the transition area to be made safe with cladding

*Lateral Connections*

Reconnect from outside or cut the relining with sewage pipe robots from the inside. Thick wrapping of the connection pipe by commensurate measures (pressing, levelling out, shaped pieces)

*Treatment*

high pressure cleaning

*Acceptance*

inspection with pipe remote camera. Tightness test as per SIA N 190

## Remarks

- reduction of cross-section according to layer thickness
- wrinkling in curves dependent on pipe diameter, radius and angle
- No cladding between relining and pipe when using an outer foil
- In France until the end of 1990 about 17.5 km so executed; in Switzerland, until the end of May 1997, about 55 km

## Advantages of the System

- no excavations
- minimum traffic obstruction
- minimum cross-sectional losses
- short renewal time (1 day per sewage unit)
- improvement in pipe static
- improvement in the roughness value
- simple installation, mobile, also possible on the inside of buildings and in open terrain
- adherent connections using friction possible
- minimum installation requirements
- guaranteed service life of 50 years

## Status

January 2000

**Procedure**

## 2.2.51 Flexiliner II (pipe relining) Typ Perfect: (Heeling)

*Type of Procedure*

renewal, cleaning, pipe relining

*Notice*

general information on the relining procedures are contained in Section 4.3.2 of the IP Construction, maintenance of non walk-in sewage systems

*License*

KRT Engineering + Handel AG, Sempach

*Bidder*

KRT Kanal-Service AG

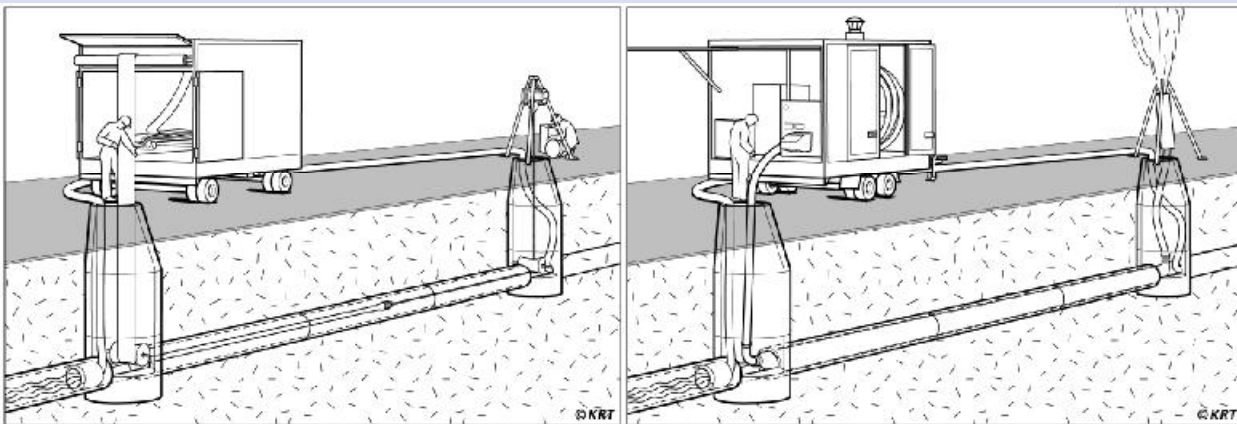
*Brief Description*

A flexible, tube impregnated with epoxy resin is inserted via existing inspection shafts by cable winch into the pipe section to be renovated. Then the tube is expanded using compressed air and pressed against the pipe wall. The hardening of the resin takes place under pressure by blowing in steam. A jointless cladding is created which fits tightly without annular gap to the existing pipe.

*Schematic Diagram*

- Insertion Phase

- Hardening Phase



*Materials*

**Base material:** ready-to use hose made of synthetic polyester fleece, if required, reinforced by glass fibre fabric

**Resin:** diverse epoxy resin systems

**Layer thickness:** 3.0 mm to 24 mm depending on pipe diameter and load

*Standards*

**D:** ATV Instruction Sheet M143 Part 3: Relining (draft)  
ATV Worksheet A 127 (statics)

*First Applications*

Worldwide 1979 F (Copaflex)  
Switzerland 1985 (flexliner I)  
Switzerland 1995 (flexliner II)

## Area of Application

Damage Aspects

- Open or damaged sleeves
- Cracks, flaking and light fragmentation in the pipe wall
- Corroded pipe walls

Further Applications

- Increase in performance capacity
- Increase or restoration of the static strength

Restrictions

Procedure only conditionally applicable for:

- Pipe collapse
- Deviation in position
- Excessive deformation in flexible pipes

Pipe Material

All materials

Cross-Section Forms

Circular, egg-shape and special profiles

Dimensions

Circular profiles NW 100 mm to NW 1250 mm

Maximum Range

depending on the dimensions up to about 125 m

Curves / U Bends

with reservations (wrinkling)

## Preparatory Work

Excavations

not usually required; access via inspection shafts

Pipe Cross-Section

high pressure cleaning, creation of the original cross-section by boring or cutting

Lateral Connections

cut back protruding connections

Groundwater

intensive groundwater flooding to be sealed in advance

Draining of Water

pumping out of wastewater and the lateral connections required

## Final Task

Inspection Shafts

transition from pipe / inspection shaft re-worked with special mortar. Tightness between pipe and relining in the transition area to be made safe with cladding

Lateral Connections

Reconnect from outside or cut the relining with sewage pipe robots from the inside. Thick wrapping of the connection pipe by commensurate measures (pressing, levelling out, shaped pieces)

Treatment

high pressure cleaning

Acceptance

inspection with pipe remote camera. Tightness test as per SIA N 190

## Remarks

- reduction of cross-section according to layer thickness
- wrinkling in curves dependent on pipe diameter, radius and angle
- No cladding between relining and pipe when using an outer foil
- In France until the end of 1990 about 17.5 km so executed; in Switzerland, until the end of May 1997, about 55 km

## Advantages of the System

- no excavations
- minimum traffic obstruction
- minimum cross-sectional losses
- short renewal time (1 day per sewage unit)
- improvement in pipe static
- improvement in the roughness value
- simple installation, mobile, also possible on the inside of buildings and in open terrain
- adherent connections using friction possible
- minimum installation requirements
- guaranteed service life of 50 years

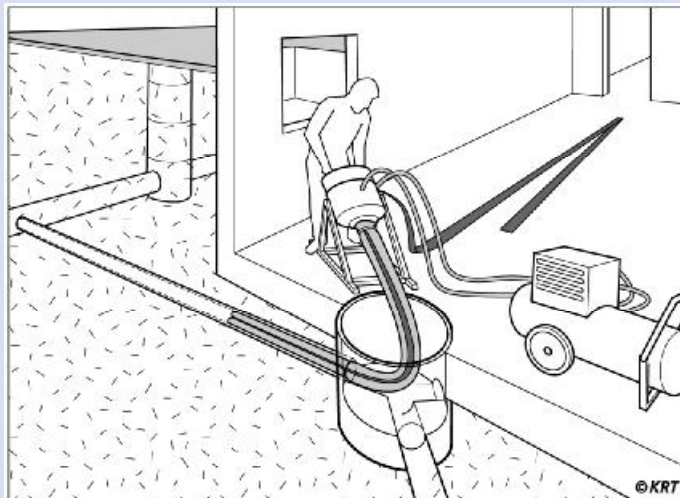
## Status

January 2000

## Procedure **2.2.52 Flexiliner H (hose relining)**

Type of Procedure	<i>maintenance and repair / renewal and relining procedures</i>
Notice	<i>general information on the relining procedures are contained in Section 4.3.2 of the IP Construction, maintenance of non walk-in sewage systems</i>
License	<i>KRT Engineering + Handel AG, Sempach</i>
Bidder	<i>KRT Kanal-Service AG</i>
Brief Description	<i>A hose impregnated with epoxy resin is blown into a pipe section to be renovated using an inversion unit. By adding hot water to the circulation system, the hose is pressed against the pipe wall. After the hardening phase has ended (30' – 180'), depending on the type of resin, the pressure is drained out.</i>

### Schematic Diagram



Materials	<i>Base material: synthetic polyester 3 – 6 mm or polyester textile hose Resin: epoxy resin system Layer thickness: 3 - 6 mm</i>
Standards	<i>Not standardised in Switzerland</i>  <i>D: ATV Instruction Sheet M143 Part 3: Relining (draft) ATV Worksheet A 127 (statics)</i>
First Application	<i>Worldwide / Switzerland 1992</i>

## Area of Application

<i>Damage Aspects</i>	<i>Locally restricted damage areas such as:</i> <ul style="list-style-type: none"><li>- Open or damaged sleeves</li><li>- Root intrusion</li><li>- Cracks, flaking and fragmentation in the pipe wall</li><li>- Corroded pipe wall</li><li>- Lack of pipe static</li></ul>
<i>Restrictions</i>	<ul style="list-style-type: none"><li>- Pipe collapse</li><li>- Deviation in position</li></ul>

## Excessive deformation in flexible pipe

<i>Pipe Material</i>	<i>All materials</i>
<i>Cross-Section Forms</i>	<i>Circular profiles</i>
<i>Dimensions</i>	<i>Circular profiles NW 100 mm to NW 300 mm</i>
<i>Maximum Range</i>	<i>up to about 50 m</i>
<i>Curves / U Bends</i>	<i>applicable</i>

## Preparatory Work

<i>Excavations</i>	<i>not usually required; access via inspection shafts</i>
<i>Pipe Cross-Section</i>	<i>high pressure cleaning, creation of the original cross-section by boring or cutting</i>
<i>Lateral Connections</i>	<i>cut back protruding connections</i>
<i>Groundwater</i>	<i>no measures necessary, strong infiltration to be sealed by injections</i>
<i>Draining of Water</i>	<i>pumping out of wastewater usually not necessary</i>

## Final Tasks

<i>Inspection Shafts</i>	<i>no measures necessary</i>
<i>Lateral Connections</i>	<i>no measures necessary</i>
<i>Treatment</i>	<i>no measures necessary</i>
<i>Acceptance</i>	<i>inspection with pipe remote camera. Tightness test as per SIA V 190</i>

<b>Remarks</b>	<ul style="list-style-type: none"><li>- minimum cross-section reduction</li><li>- good curve response</li></ul>
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<b>Status</b>	<i>January 2000</i>
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## 2.2.61 PEKAPLAST – System

**Procedure:**

**Process group:**

*Installation procedure  
The procedure used for renovation (full or partial lining) in man-entry pipelines and constructions.*

**Operating Range:**

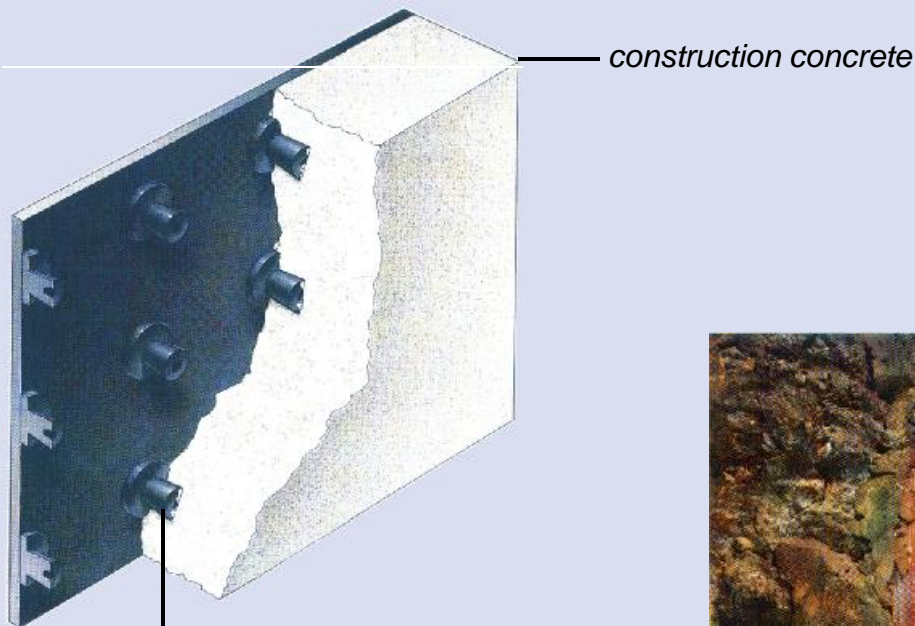
*Diameters from 600 mm upwards  
Cross-sectional shapes, circular, ovoid and special profiles*

**Material:**

*Polyethylen (PE-HD) normal use  
Polypropylen PP or Polypropylene  
Polyvinylidenflouride PVDV for special purposes  
The sheets are fitted with a definite number of conical anchor stubs.*

**Implementation:**

*The individual sheet elements are inserted as liner sections into the pipeline being renovated from an existing manhole or from another open entry point and joined together. The circular space left between the new lining and the original pipe wall is filled using a special quick setting liquid cement. After hardening the joints of the liner are welded tight using an extruder thus providing a complete new water-tight pipe within the older sewer line. The seams are checked per radio-electrical means after completion of the work. When necessary a pressure test using water can be made.*



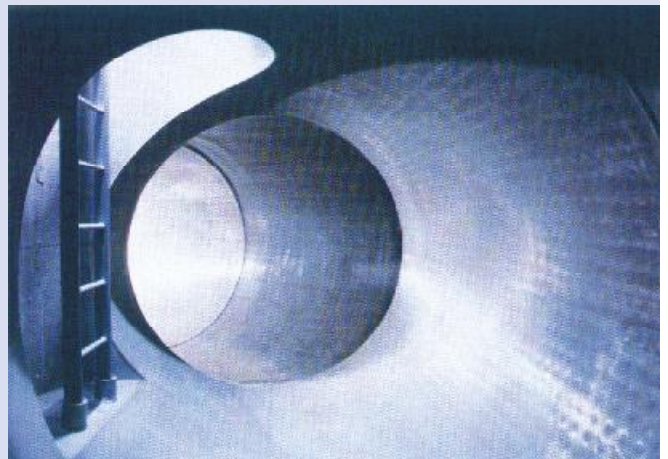
*mechanical anchoring  
using anchoring stubs*



# KRT Group

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- *gas and water tightness of the sealed system*
- *equal mechanical attaching of the inner pipe to the original carrier pipe*
- *no differential expansion caused by different expansion coefficients of concrete and plastics*
- *Corrosion and chemical resistance of the lined sewer, against concentrated acids and alkaline liquids within the scope of the extensive resistance lists which are available.*
- *Reliability through extensive experience of lining operations in acidic protection in an environment where strong mechanical, thermal, and chemical demands are present.*
- *Higher flow speeds, reduced sedimentation resulting in less decomposition and accumulation of H<sub>2</sub>S are the result of the smooth anti-adhesive surface of the lining.*
- *Rodent hostile environment*
- *Repetitive repairs possible*
- *High level of hit toughness high loading*
- *Strong close fitting jointing with the concrete pipe which cannot be undone.*



## 2.3 Manufacture of sewer repair and renovation systems

### **Repair methods**

*Primo robot system (partner of the company PMO)*

- *Flexiliner P (partial relining)*
- *Flexiliner S (short relining)*
- *Support renovation system*

### **Injection and sealing methods**

*PEKA-Tech injection system (3M-PUR)*

### **Structural repair methods**

*ZM injection*

*PEKA-Tech injection system*

### **Renovation methods**

#### **Pipe relining methods**

*Flexiliner II (pipe relining) diameter 200 – 1200 mm*

*Flexiliner H (pipe relining) diameter 80 – 300 mm*

