

Cured in Place Pipe – Underground No-Dig pipeline rehabilitation for pressure pipe application – A fully structural approach

RS Technik 



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Why CIPP?

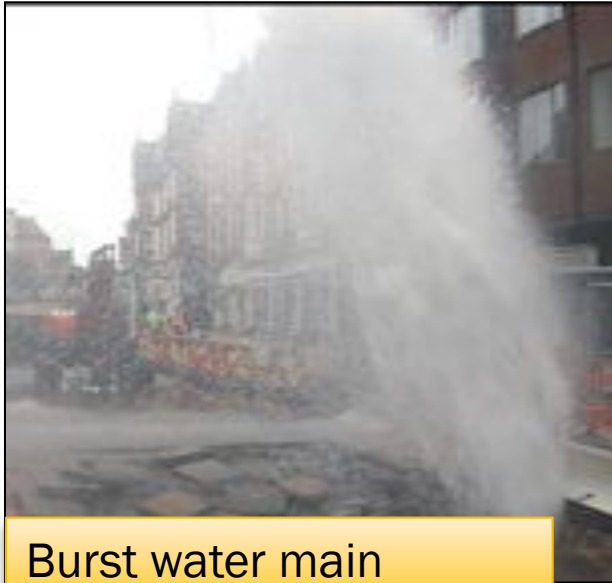
THE BEGINNING

- Invention of Inversion system of CIPP Liner in the late 60s
 - leaking irrigation pipes in greenhouse
 - soon adaptation for sewer rehabilitation



HE NEEDS HELP!

PREVENTING THIS!



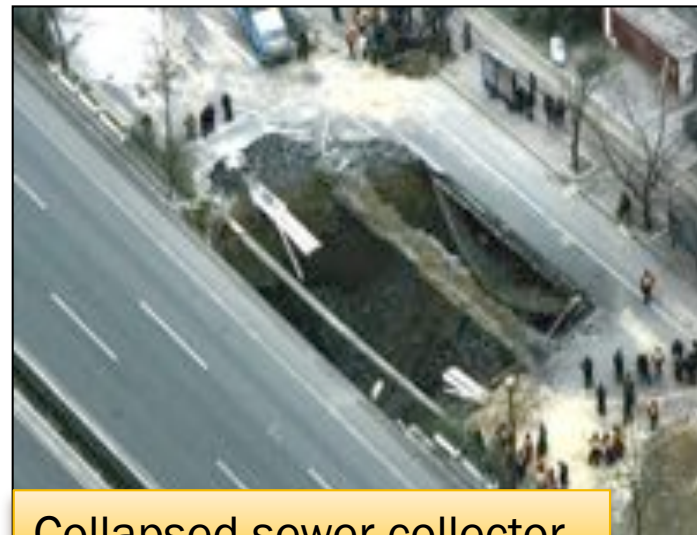
Burst water main



Collapsed sewer



Collapsed Sewer



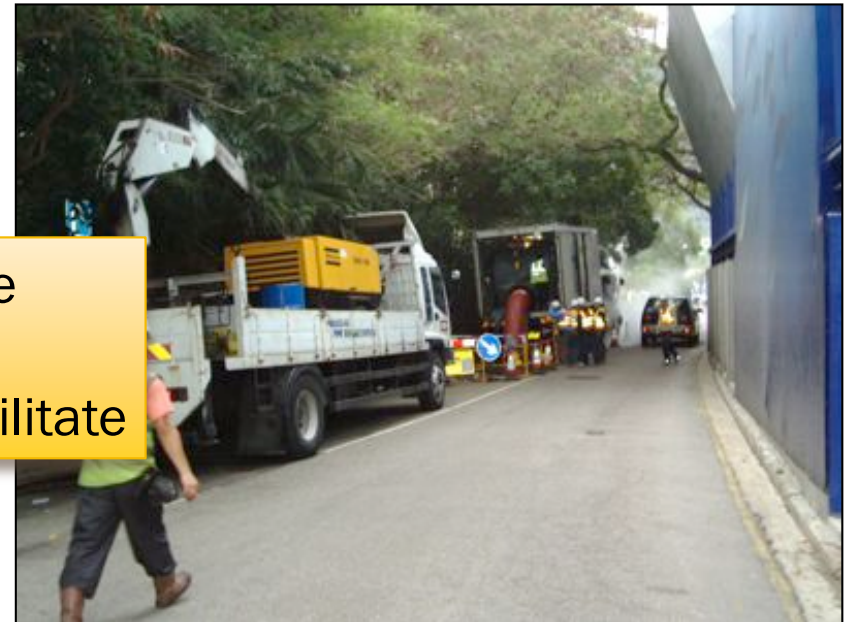
Collapsed sewer collector

WHY IS IT GROWING SO FAST NOW?

- Trenchless technology is an advanced method for the repair and renewal of underground pipelines
- Avoids digging and replacing of old and deteriorated sewer and water pipes
- No removal and disposal of soil and old pipes
- Reduction of CO₂ foot print



Dig and replace
or
Rehabilitate



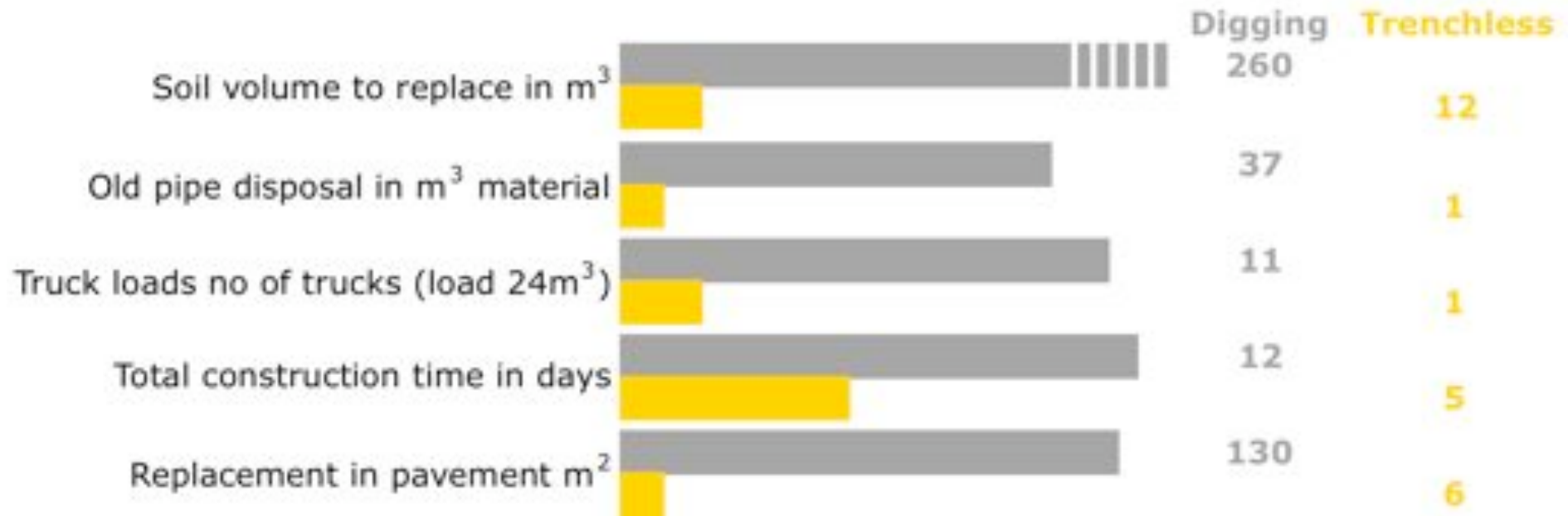
Green Solutions

GREEN SOLUTIONS

- No Styrene (as in Polyester)
- No solvents
- Non-toxic
- No excavation or limited at pressure pipe applications
- No landfill materials
- Long-lasting with 50 year design life
- Reduced greenhouse gas emissions

ENVIRONMENTAL IMPACT

Potable water pipe DN 300 - 130 m long, 2 m deep



Summary of emission reduction of all greenhouse gases emitted by construction equipment such as CO₂, CO, nitrogen oxides NO_x, and further emissions by total organic compounds TOC, and of sulfur oxides SO_x, smoke and other particles is very significant for each meter converted from digging to trenchless methods!

SUSTAINABLE SOLUTIONS

- Minimize traffic, trenching and disruption or damage to adjacent infrastructure and environment
- Extend the service life of infrastructure
- High performing, durable epoxy resins
- Technically proven processes
- Installer and environmentally safe, non-toxic materials
- Professional training and support of contractors performing installation consistently and reliably

BENEFITS OF A FULLY MOBILE AND CONTAINED SOLUTION

- No off-site wet-out or refrigerated truck required. Total on-site system solution providing for optimum QA/QC totally visible to the Owner
- No Transport of impregnated Liner (dangerous goods!)
- Higher quality product with epoxy resins, safety! (No Peroxides!)
- Automation provides data logging for quality control, and simplifies installation
- Minimizing potential for error and maximizing opportunity for consistent results in delivering sustainable pipe rehabilitation solutions

How CIPP Works

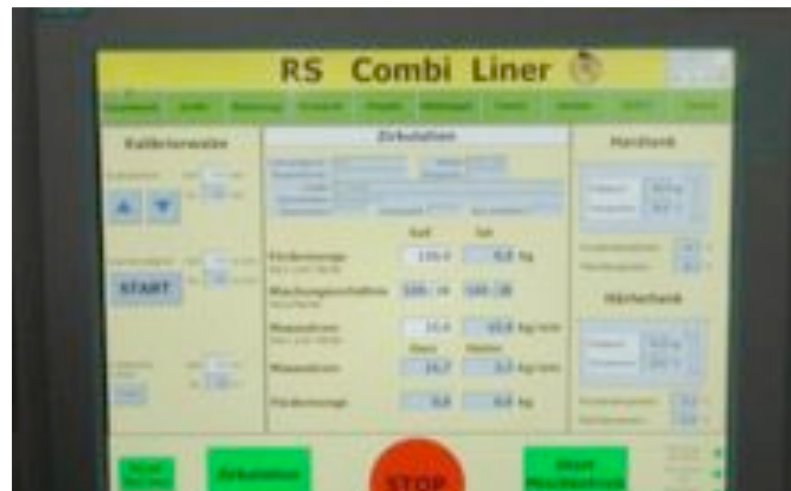
WHEN CIPP IS NEEDED

- CIPP rehabilitates aging or damaged pipelines by constructing a new liner inside an existing host pipe
- Some of the many conditions that require CIPP rehabilitation include broken pipes, infiltration, and protruding connections



IMPREGNATION OF TUBE

- The lining is laid out on an impregnation table or conveyor
- A vacuum is applied to remove the air
- Resin is pumped into the lining to replace the air removed by the vacuum



PLC controlling of the entire process important

WATER INVERSION AND CURE

- The resin-impregnated liner is inverted into the host pipe using water pressure
- Inversion water is then circulated and heated through a boiler, which in turn cures the resin/liner in place



AIR INVERSION & STEAM CURE

- The liner is installed using an air inversion unit and inverted into the host pipe using air pressure
- Once inversion is complete, steam is used to elevate the temperature of the air to cure the resin/liner
- During cure the resin transforms from a liquid state to a molecularly cross-linked solid with excellent static and corrosion resistance and durability



Other Trenchless Technologies

LONG PIPE RELINING, SWAGELINING ROLLOFF



•Technology

- The old pipe will be cleaned and calibrated
- Control via TV-inspection
- Welding of the new pipes
- Pull in of the new pipe by a winder

•Applications

- For almost all host materials
- DN 80 – 1000 mm

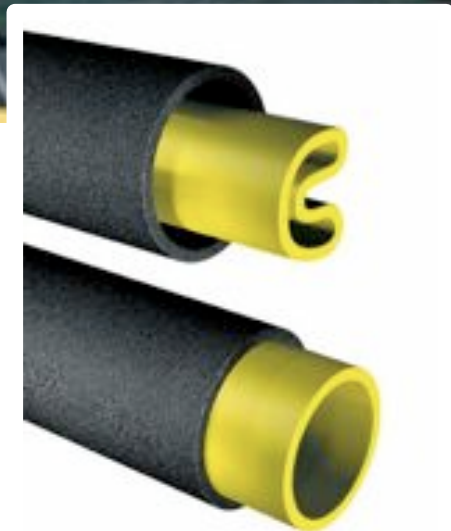
•Pros

- Factory manufactured plastic pipe, Costs at the lower end

•Cons

- Substantial reduction in cross sectional area of the new pipe
- Annular gap between host pipe and new pipe at Sliplining
- Requires a big pit excavation
- Bends restrictions
- Requires exact calibration of the host pipe
- Large space requirements as entire length of the pipe has to be laid out on the ground

CLOSE-FIT TECHNOLOGY



- **Technology**
- Usage of a reforming pipe
 - reduction of diameter
 - high elasticity
- The Close Fit liner is moved into the old pipe through existing chamber or through a small trench
- Reforming of the Close Fit Liner with temperature (and pressure)
- The new pipe is pressed exactly on the inner wall of the old pipe and take on the function of the old pipe
- **Applications**
- Drinking water, gas, industrial, oil, and sewage pipes
- Diameter DN 100 – 400 mm
- **Pros**
- Little reduction in cross-sectional area (wall thickness of the pipe)
- Minimal digging
- No welding on site
- **Cons**
- Depends exactly on calibration of host pipe, not flexible in host pipe diameter
- Limited diameter range
- Bends restrictions
- Material comparatively expensive
- Sourcing in remote countries, coils are large in DN, difficult and expensive to transport
- Inflexible in diameter changes



Expensive transport for Fold in Form Liner

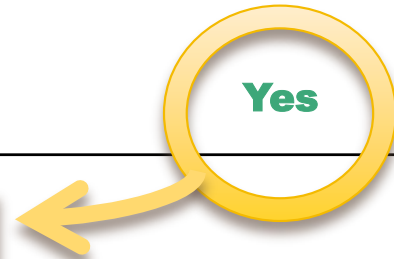
Assessment and Liner Design

PRODUCT CATEGORIES AWWA M28

Classification according to AWWA M28 – Good tool to categorise existing technologies

Liner Characteristics according to AWWA	Non-structural	Semi-Structural		Fully Structural
	Internal Coating	Internal Lining	Lining with load bearing	Bears full loads
	Class 1	Class 2	Class 3	Class 4
Internal corrosion protection	Yes	Yes	Yes	Yes
Hole and gap span at MAOP	No	Yes	Yes	Yes
Inherent ringstiffness	No	No	Yes	Yes
PN L _{iner} ≥ MAOP	No	No	No	Yes
Liner survives host pipe failure	No	No	No	Yes

The answer to a new pipeline



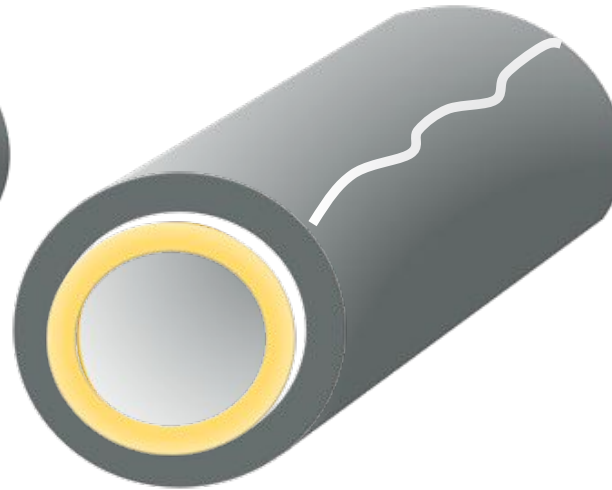
CLASSIFICATION AWWA 28

Interactive



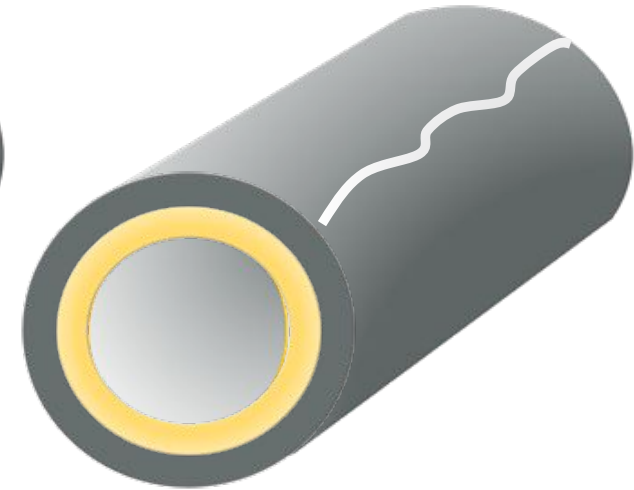
- Bonded Lining Class II
- Woven Textile hose with Epoxy resin
- Sometimes combined with a felt layer

Independent



- Loose fit structural Liner Class 3 and 4
- Sliplining with plastic pipes
- Gap between host pipe and new pipe

Indequent



- Close fit structural Liner Class 3 and 4
- CIPP, Fold in Form, Rolldown, Swagelining
- No gap between host pipe and new pipe

CIRCULAR WOVEN LININGS



- Circular Woven Textile hose, Polyester yarns, various coatings available
- Class II Lining
- High tensile elongation at break > than tensile elongation of host pipe material
- Material strength needed relatively low due to direct pressure transfer – tensile Strength > 25 MPa
- Only corrosion protection and limited gap span capabilities at hole corrosion and joints



Lumps caused by ground water pressure

No external load bearing capacities



Burst concrete pipe due to pressure transfer

pipe must be structurally sound

Host pipe material	
<u>Suitable</u>	<u>Not suitable</u>
Steel in good Condition	Cast Iron Concrete, PSCP, PCCP Asbestos cement

STRUCTURAL CIPP LININGS

3 types of Lining exist with variations thereof

Polyester Needle felt with meshed fibre glass content

- Improved external load bearing capacity with limited improvement of internal pressure resistance
- Consistent layer construction, homogenous wall thickness
- Consistent results after installation
- Tensile Strength < 50 MPa



Class III yes – Class IV ?

Polyester needle felt with separate glass layer

- Improved external load bearing capacity
- Improved internal pressure resistance at smaller wall-thickness
- Layer structure inconsistent in glass/felt content
- Larger DN/thickness lower properties
- In-homogenous glass/felt bonding - loose overlap – inconsistent results after installation
- Tensile Strength < 80 MPa



Class III Yes – Class IV ?

Polyester needle felt with oriented glass structure

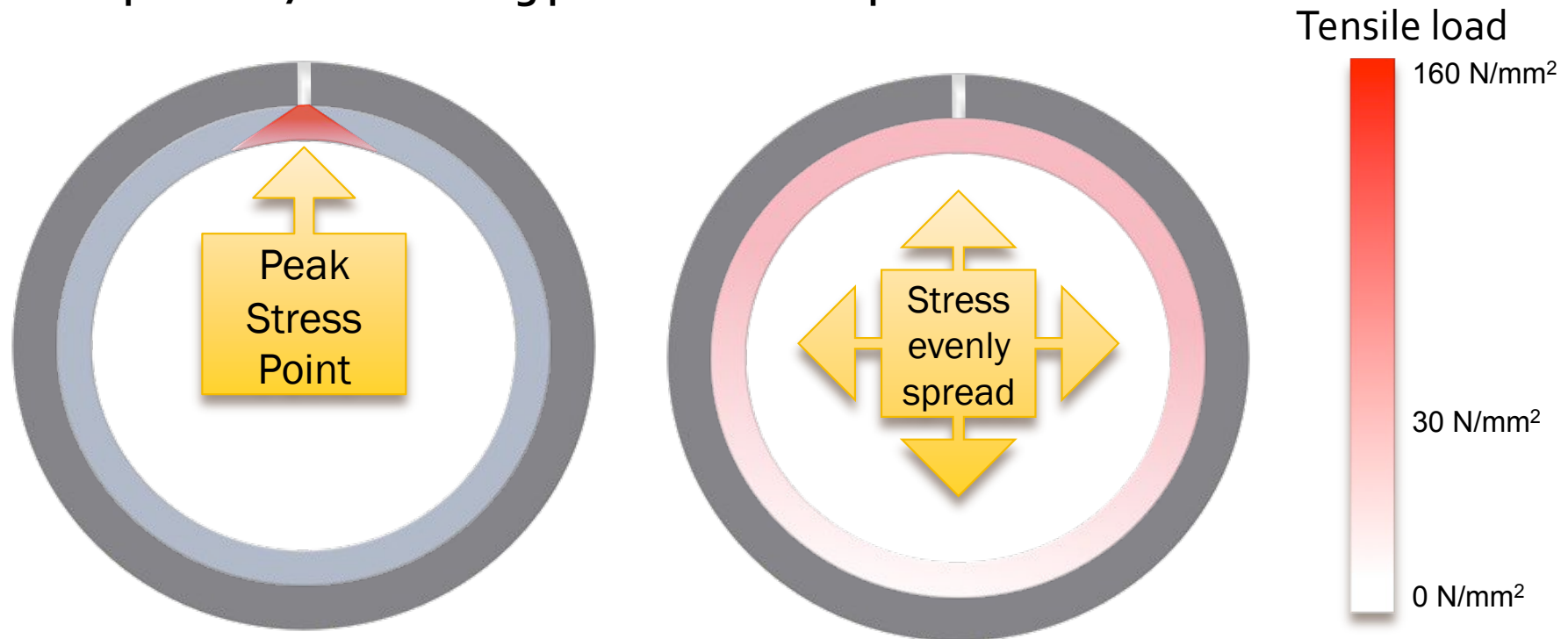
- High external and internal load bearing capacities
- Layer structure consistent in glass/felt content at all thicknesses
- Each DN and thickness delivers same properties
- Consistent results after installation
- Tensile Strength up to 170 MPa



Class III Yes – Class IV Yes

STRUCTURAL CIPP LININGS – BONDING OR NON-BONDING?

Example for a 7 bar working pressure Lined Pipe

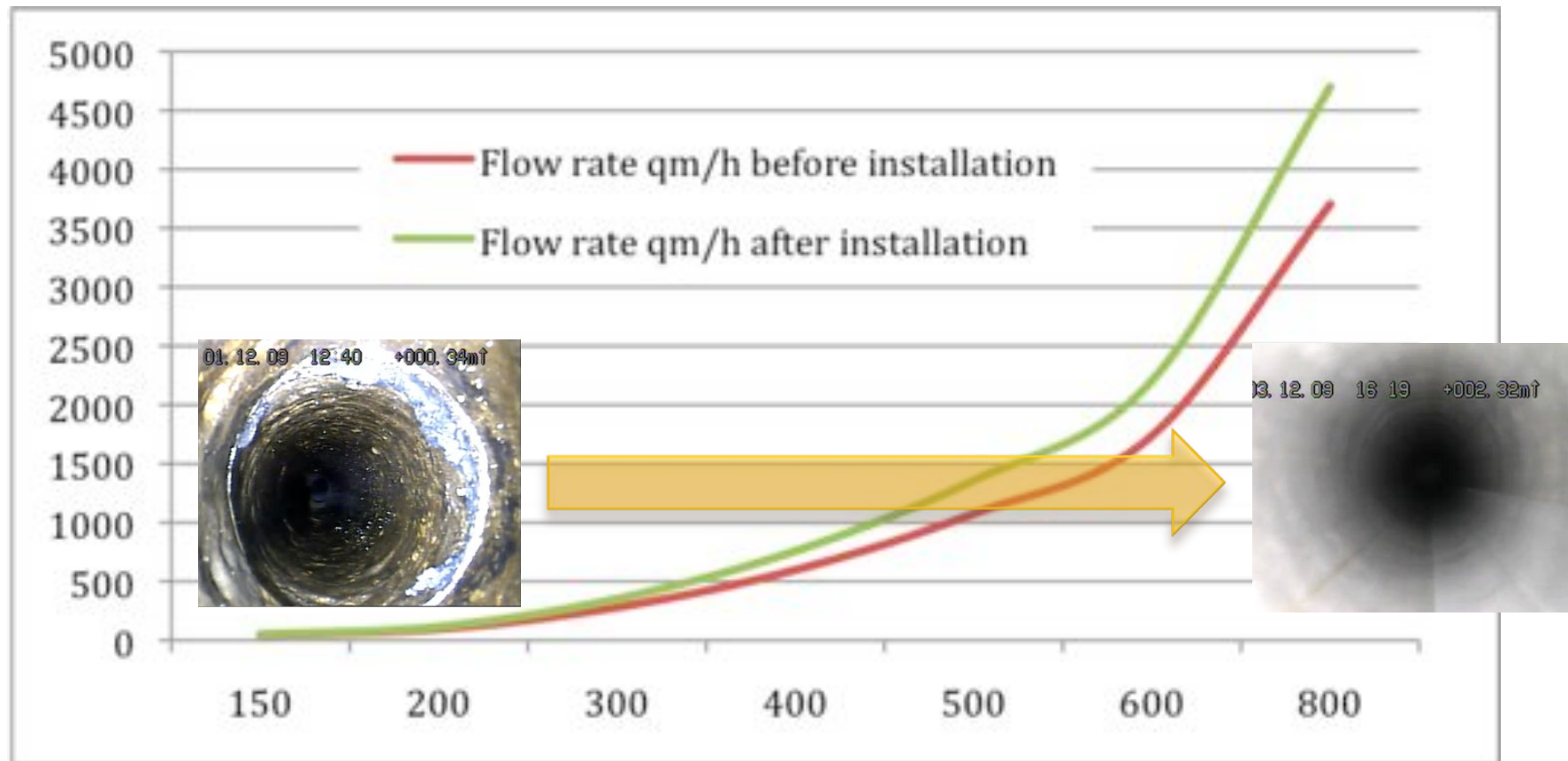


The lesson learned:

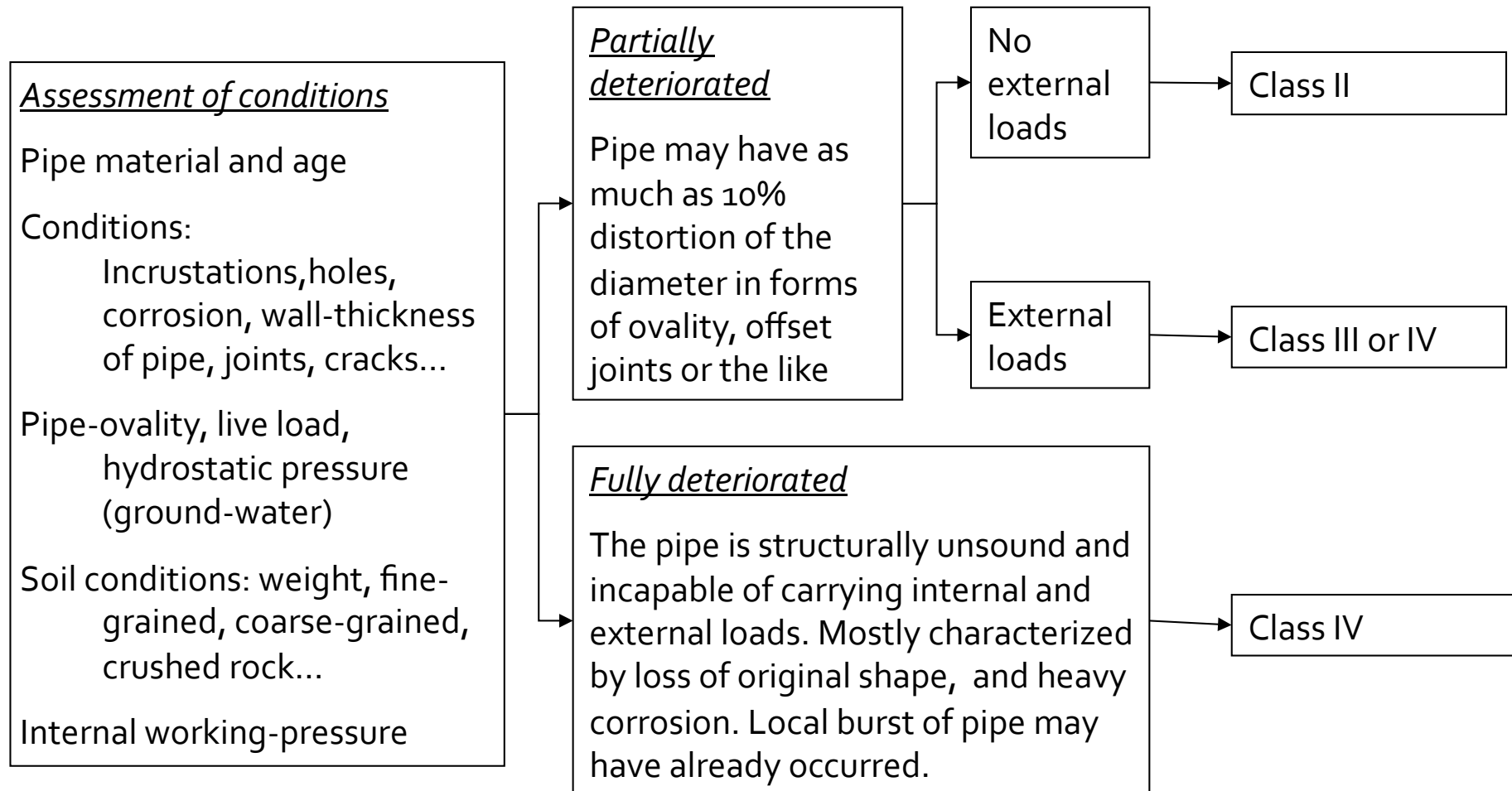
Any Class III or IV CIPP Liner bonding onto the host pipe has limited capabilities for internal pressure resistance, and relies entirely on the structural integrity of the host pipe for its pressure resistance. A bonded Liner can never be a fully structural solution.

STRUCTURAL LININGS – IMPACT ON HYDRAULICS

- Just to illustrate an example based on Hazen-Williams
- Minor cross sectional loss is generally offset by the increased laminar flow due to smooth inner surface of the Liner



DESIGN ASTM 1216 - ASSESSMENT



LINER DESIGN – ASTM 1216 FULLY DETERIORATED

External resistance

$$t = 0.721 \times D \left(\frac{\left(\frac{N \times q_T}{C} \right)^2}{R_W \times B' \times E_L \times E'_S} \right)^{\frac{1}{3}}$$

Full hydrostatic, soil and live load without considering the host pipe

External resistance

$$t = \frac{D}{\sqrt[3]{\frac{2KE_L C}{H_W (1-\nu^2) N} + 1}}$$

Full hydrostatic load on the Liner, soil and live load still carried by the host pipe

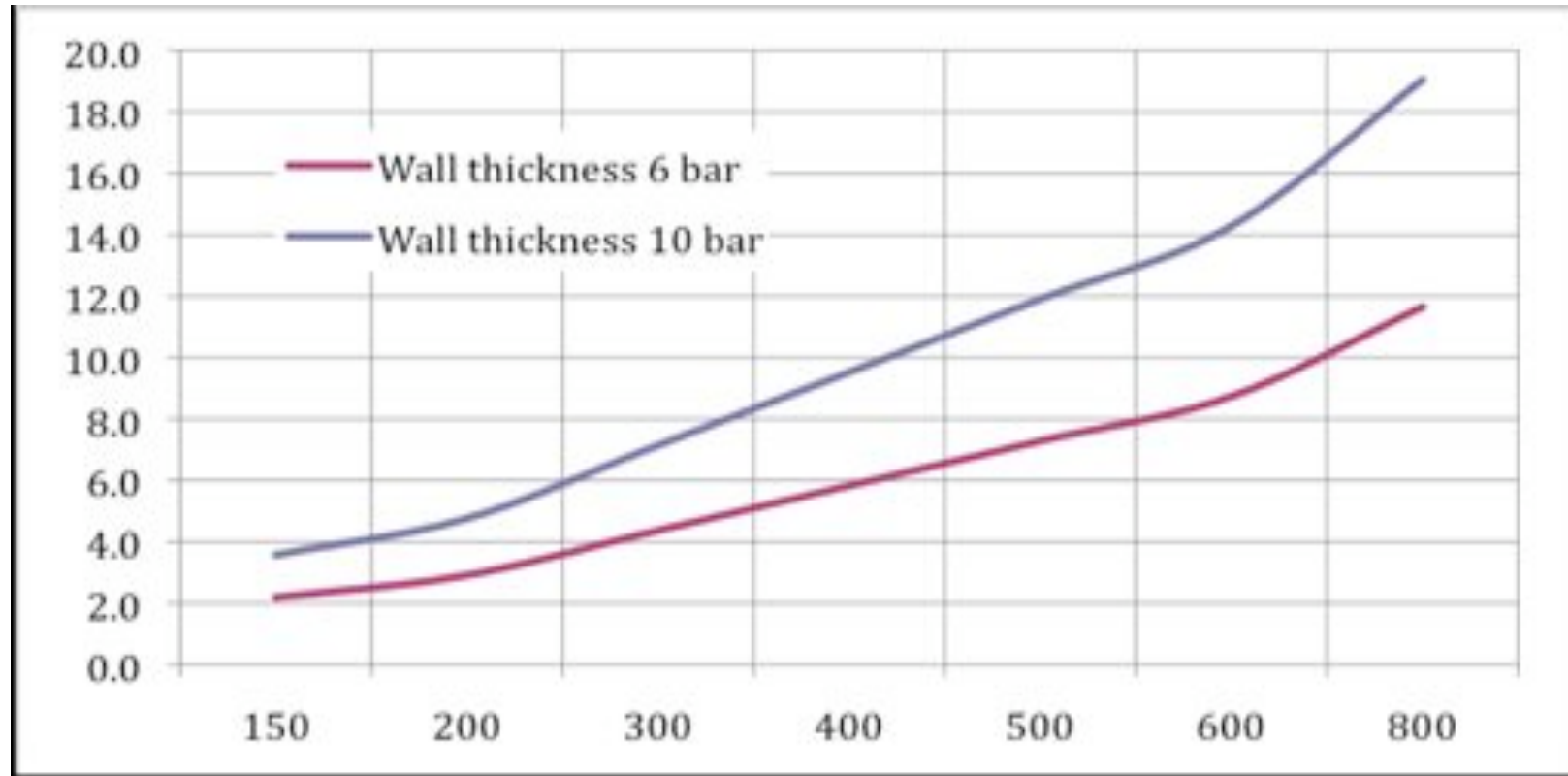
Internal resistance

$$t = \frac{D}{\frac{2\sigma_{TL}}{PN} + 2}$$

Full internal pressure on the Liner without any distribution of the host pipe - "**Stand-alone**"

Highest result of wall thickness to be considered

LINER DESIGN THICKNESS – EXAMPLE FOR A FULLY STRUCTURAL SOLUTION



Design values*: E-Modulus 6441 MPa, Flexural Strength 165 MPa, Tensile Strength 105 MPa

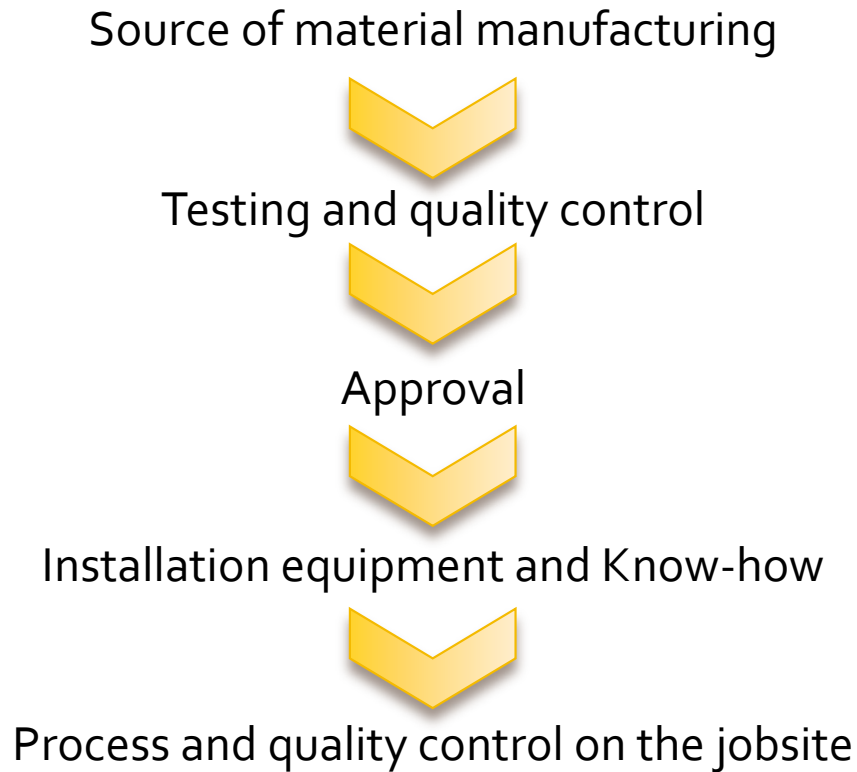
*RS BlueLine® Technology RS WFS Pull In

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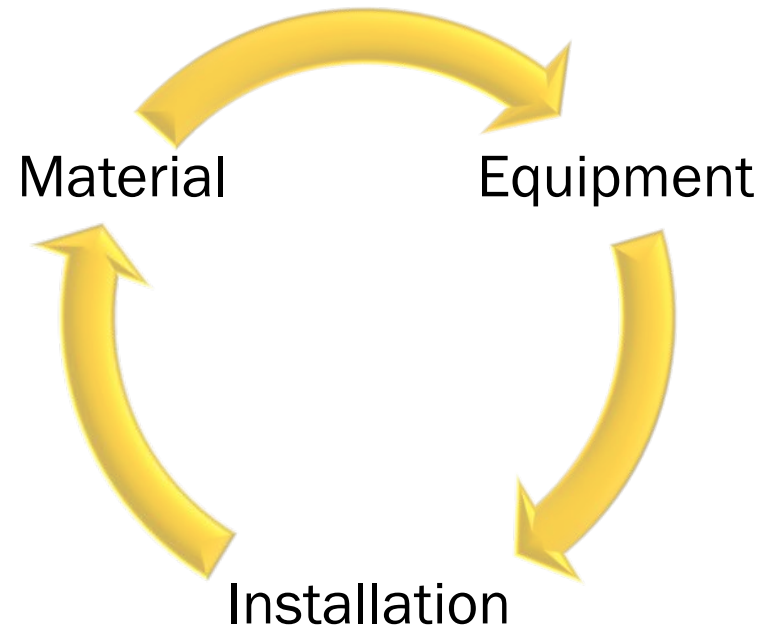


Application

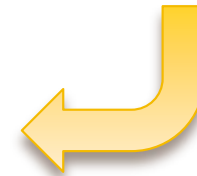
CONTROL THE PROCESS



Watch the circle!



One source for all key for success!



APPLICATION KNOW-HOW = PROCESS CONTROL

Resin Mixing



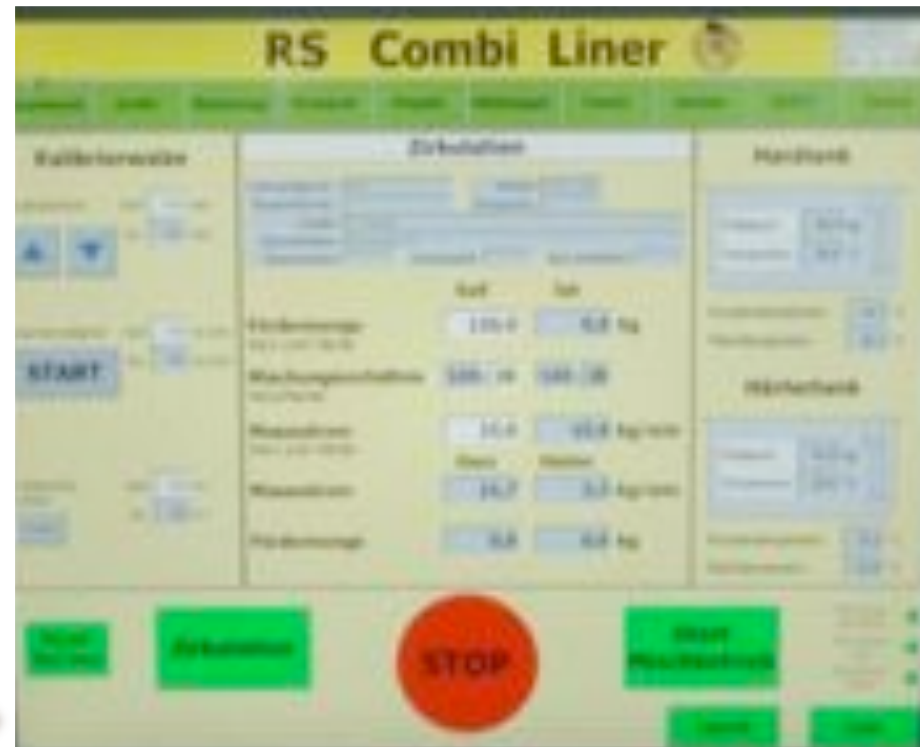
Impregnation



APPLICATION KNOW-HOW = PROCESS CONTROL

- Documentation of all relevant impregnation and installation parameter
- Quality control as per DIBT (Germany Institute for Construction) or equivalent certification
- Accredited laboratory with expertise in CIPP trenchless technologies for testing, quality control and evaluation
- If locally not available seek partnership with an experienced engineering company

PLC Controlled process



THANK YOU - SHUKRAN

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