PE pipes for the relining of waste water pipelines – Material requirements in the presence of stress cracking ingredients

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Advisory Leaflet ATV – M 143-3E:

"Pipe relining is classified as the drawing in or insertion of pipes into existing sewers"

Thermoplastic materials for trenchless rehabilitation procedures:

- **PE-HD**
- **PP**
- **PVC-U**

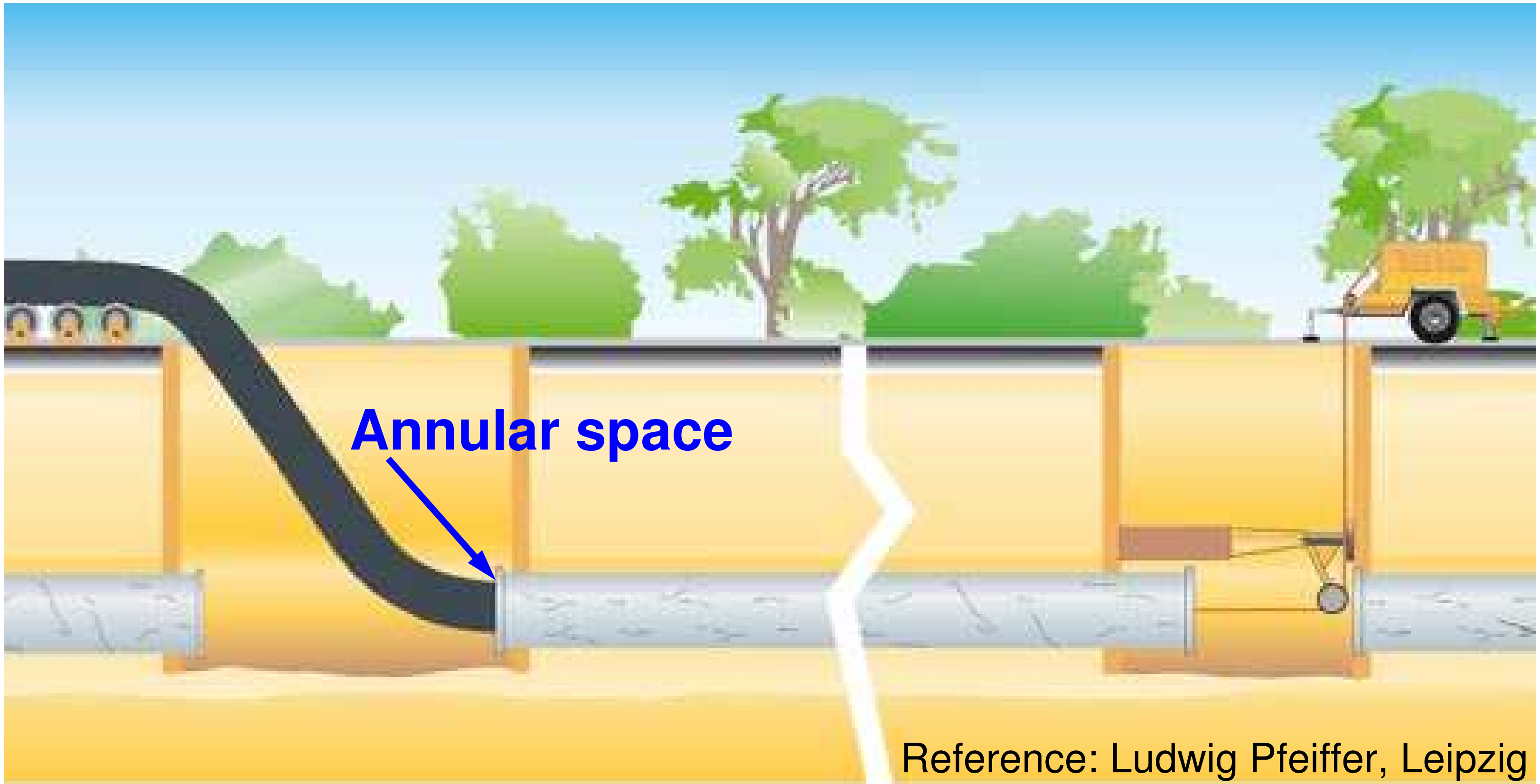
Pipe Relining methods:

- Short pipe relining – takes place via existing shafts

- Long pipe relining – takes place via open cut

- Pipeline relining – pipes are longer than open cut
  Lining with continuous pipe (Sliplining)

Sliplining uses continuous pipe with smaller outer diameter than the old pipe



Lining methods using continuous pipe by reducing the cross-section of the pipe

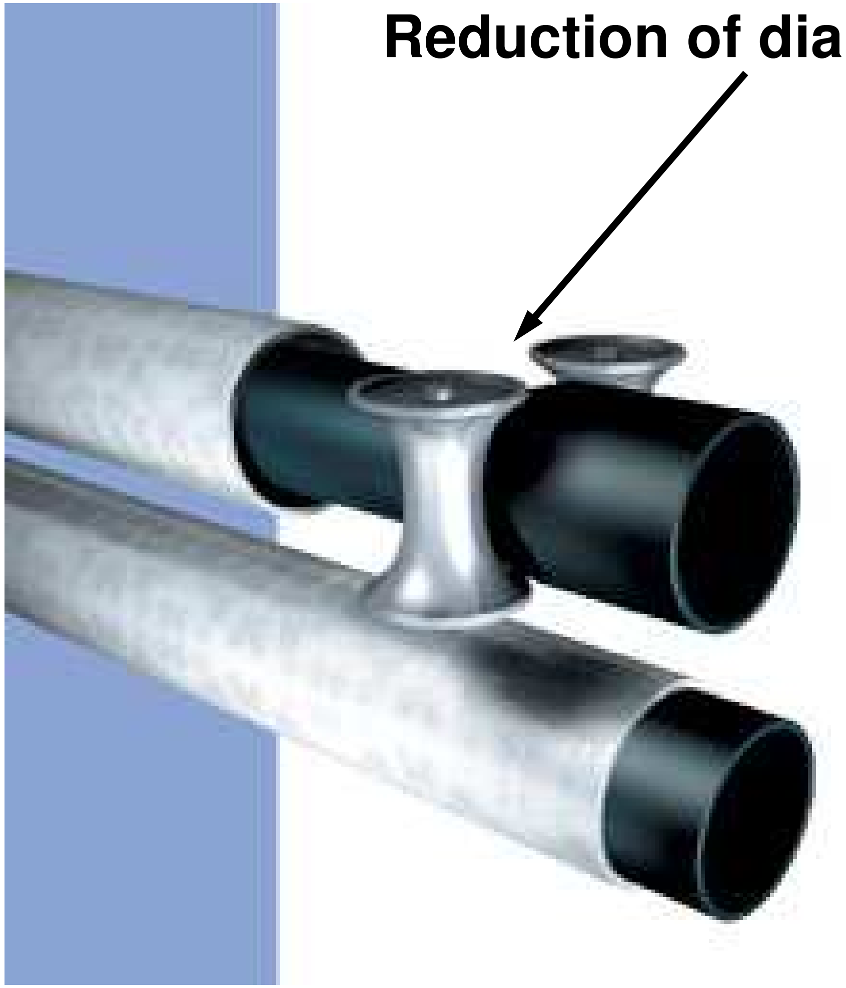
- Rolldown

- Swagelining

- Subline

Rolldown

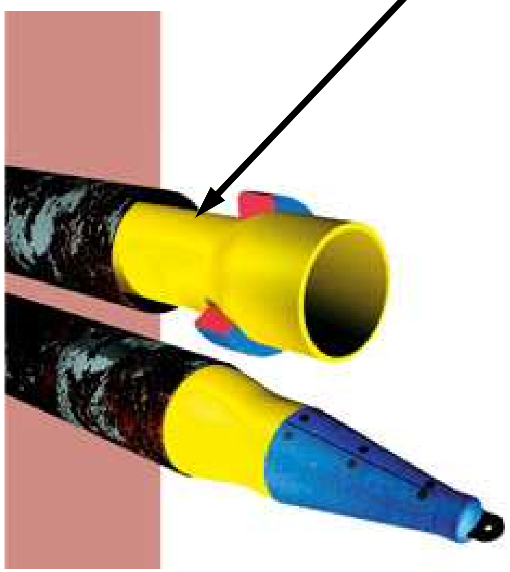
Reduction of diameter up to 10 %

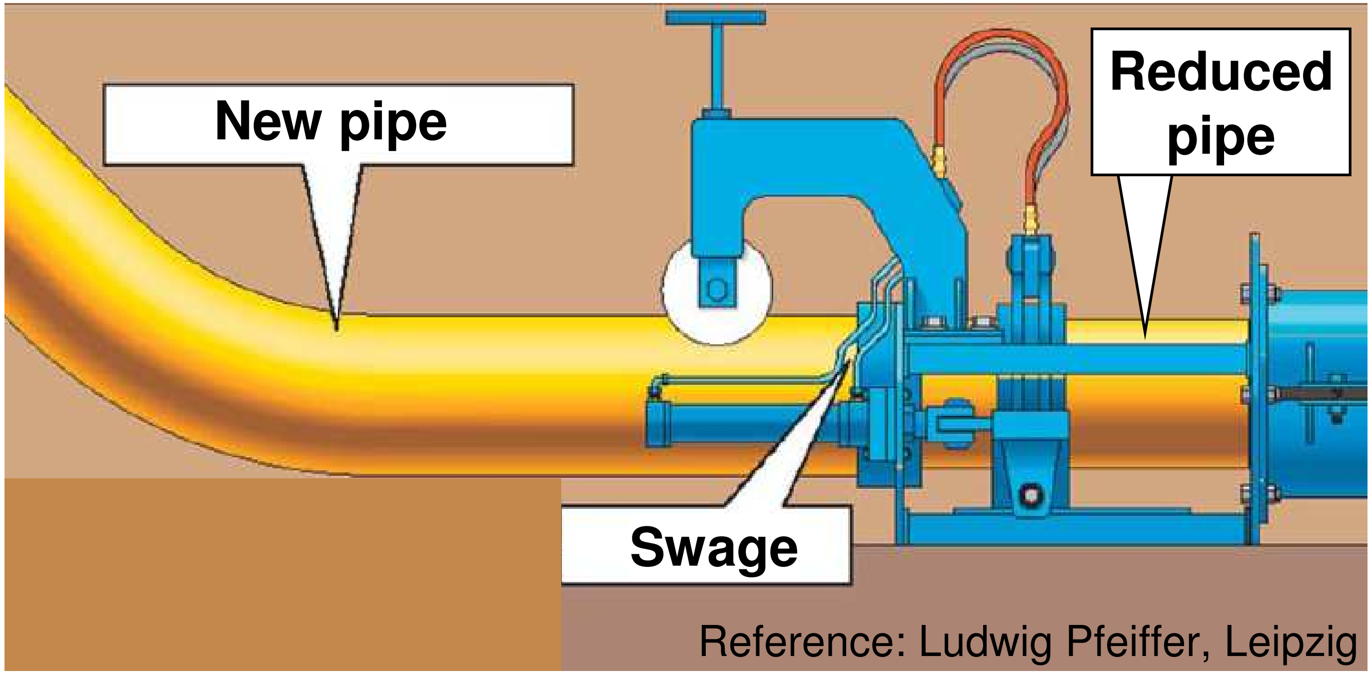


Reference: Ludwig Pfeiffer, Leipzig

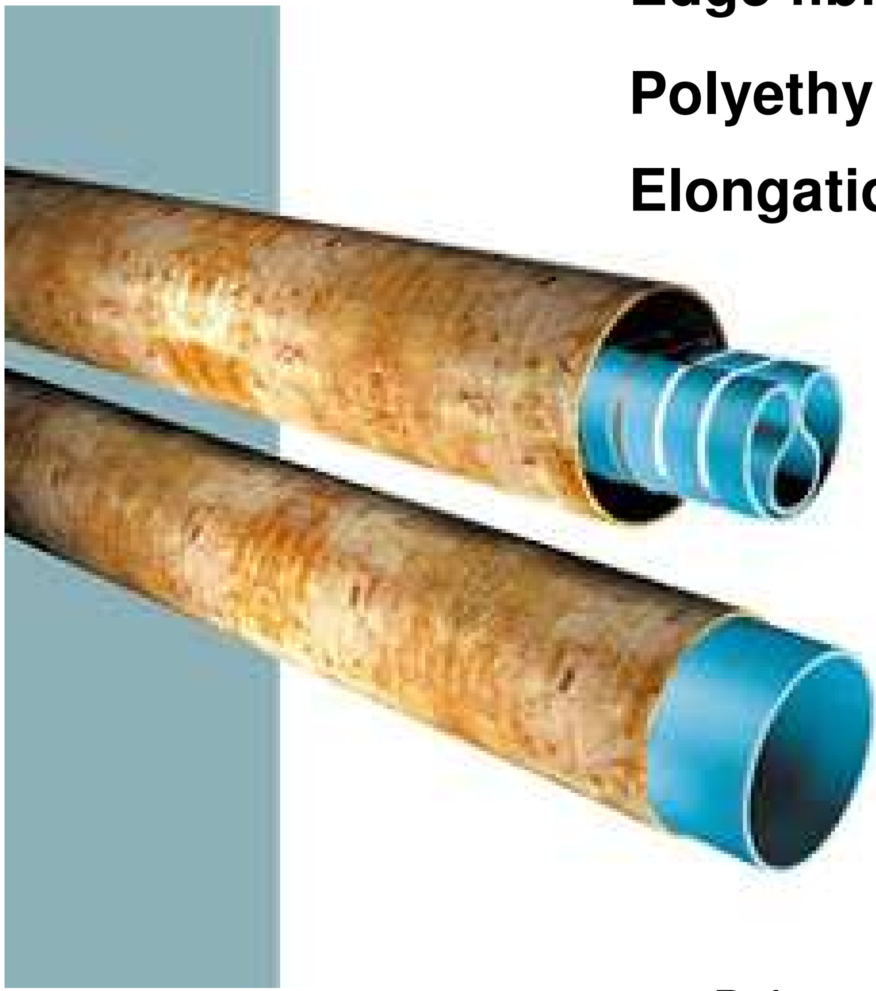
Swagelining

Reduction of diameter between 10 % and 12 %





Subline



Edge fibre expansion ?

Polyethylene High Density:

Elongation at yield = 9 %

Reference: Ludwig Pfeiffer, Leipzig

Further methods using continuous pipe with deformed cross sections

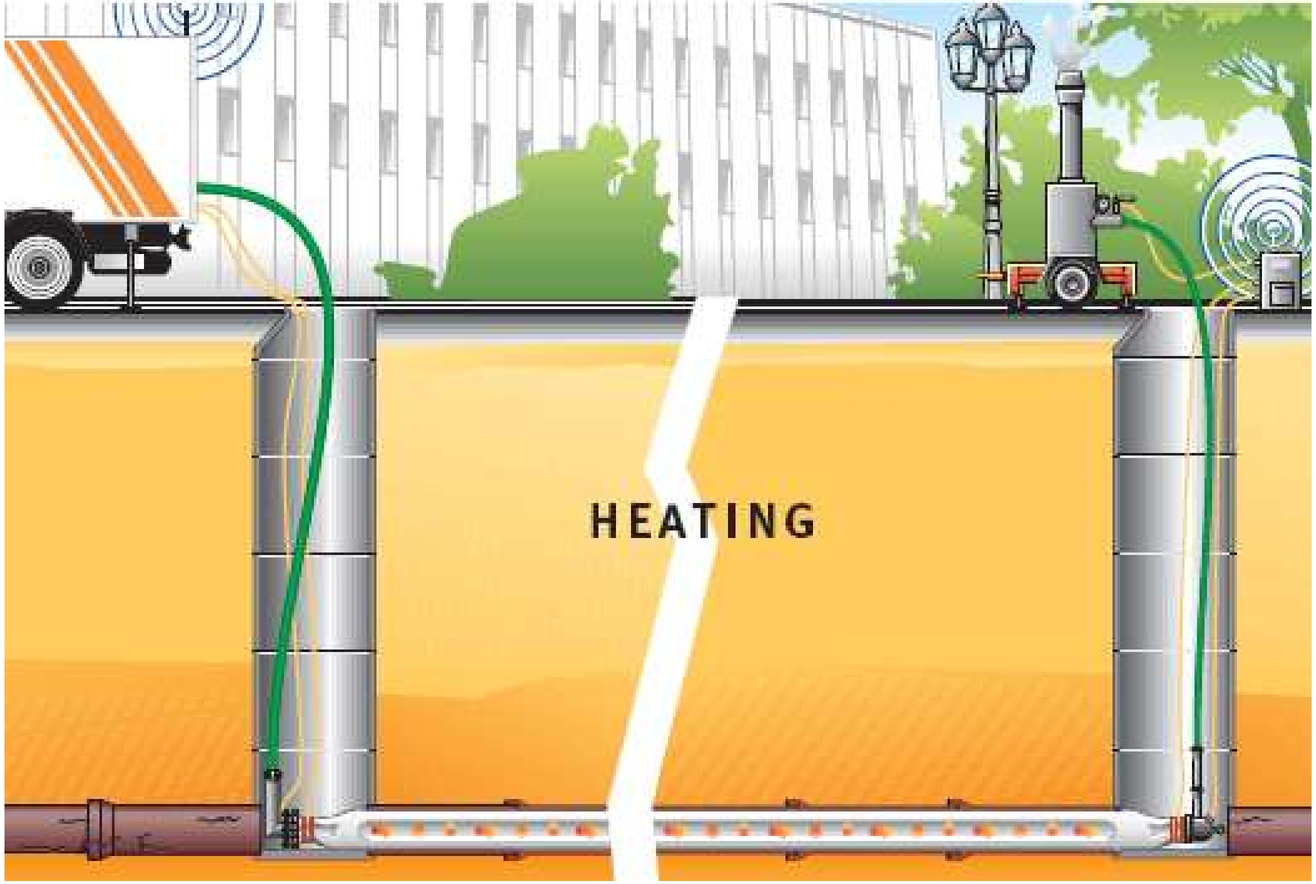
- U-Liner
- C-Liner
- Compact Pipe
- Omega-Liner

Reference: www.steppan-planungsgruppe.de

Reversion of the deformed pipe by steam

Memory effect

Close-fit

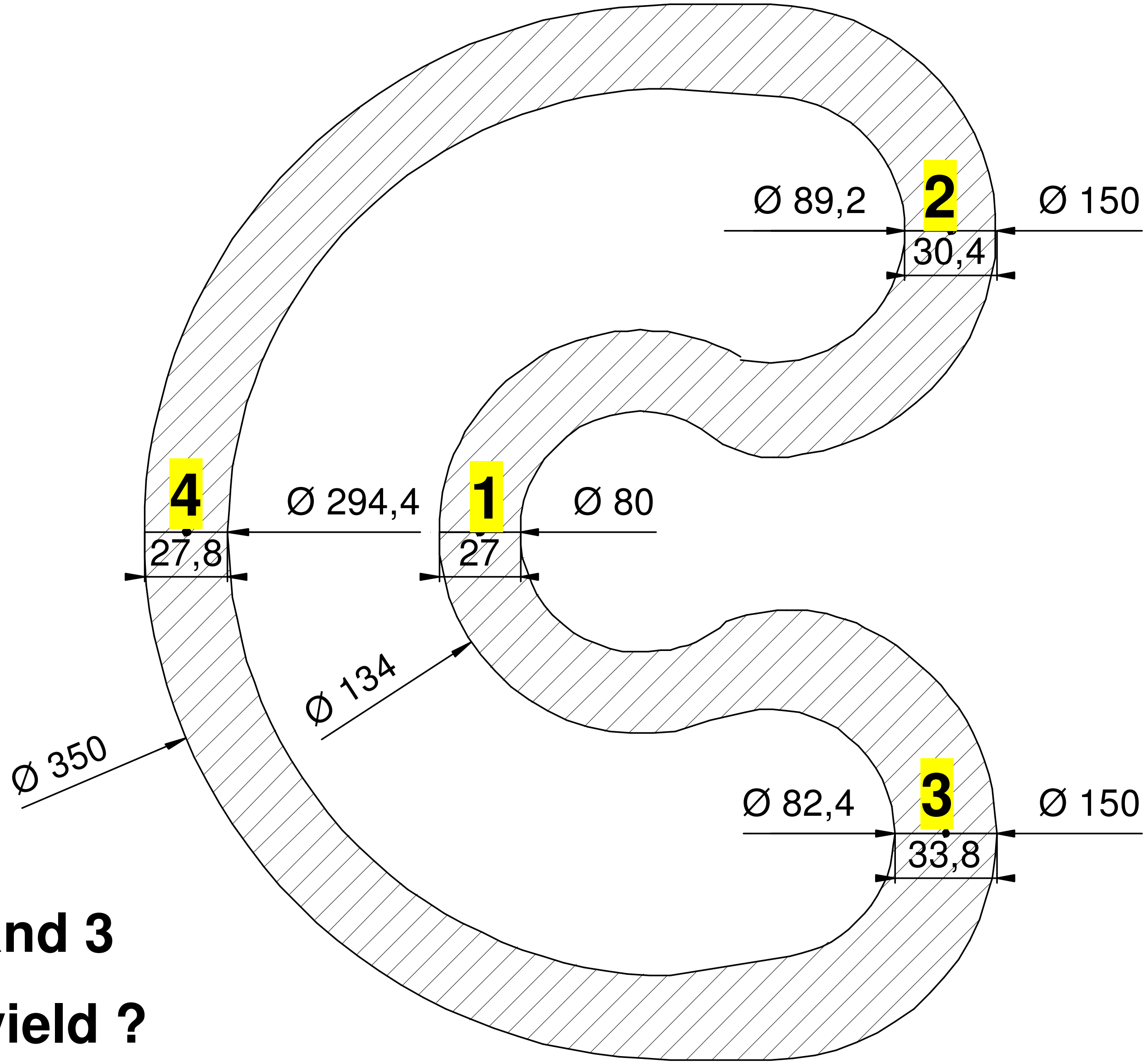


Reference: Wavin, Technical Manual for Pipeline Rehabilitation

Cross section of

C-shaped pipe

∅ 400 SDR 17



Edge fibre expansion

at pipe position 1, 2 and 3

above elongation at yield ?

Edge fibre expansion:

$$w'' = \frac{M(t,\vartheta)}{E(t,\vartheta)\cdot I} = \frac{1}{r}$$

Equation of the bending line

$$\sigma(t,\vartheta) = \frac{M(t,\vartheta)}{I}\cdot z = \frac{M(t,\vartheta)}{W}$$

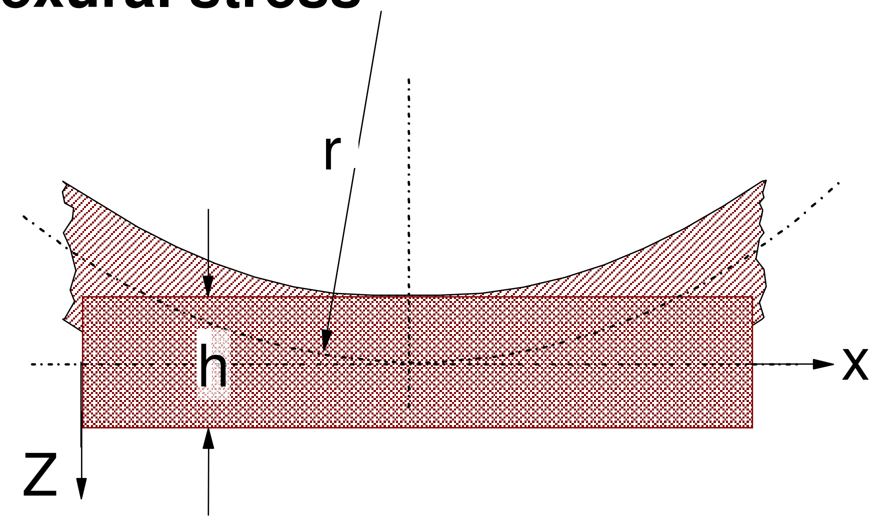
Flexural stress

$$\sigma(t,\vartheta) = E(t,\vartheta)\cdot\varepsilon$$

Viscoelasticity

$$\varepsilon = \frac{z}{r}$$

$$\varepsilon_{max} = \frac{\left(\frac{h}{2}\right)}{r}$$



$$\text{Expansion} = \frac{\text{Distance between edge fibre and neutral axis}}{\text{Radius of the curvature}}$$

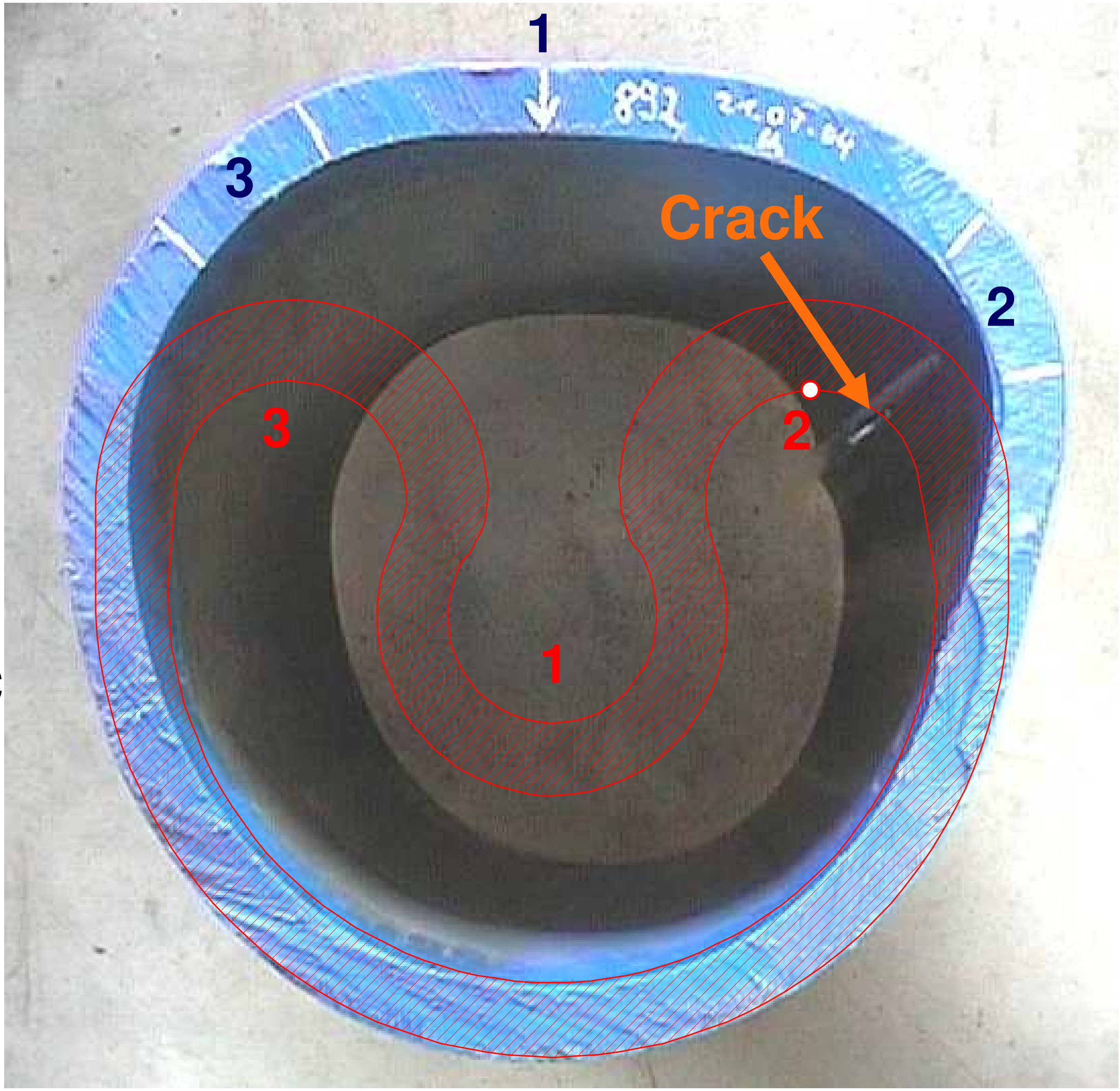
Deformed pipe with failure in service

Material: PE 100

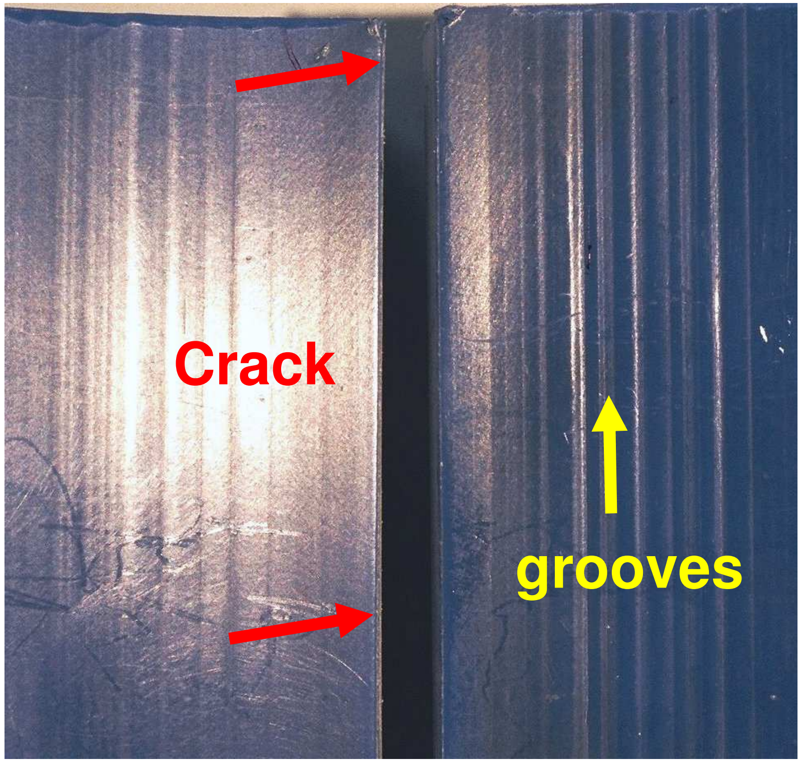
Medium: Waste water

Time to failure: 3,5 years

Service temperature: 35 °C



Crack at pipe position no. 2



Pipe wall

Brittle fracture surface

Creep rupture curve of PE 100 according to DIN 8075

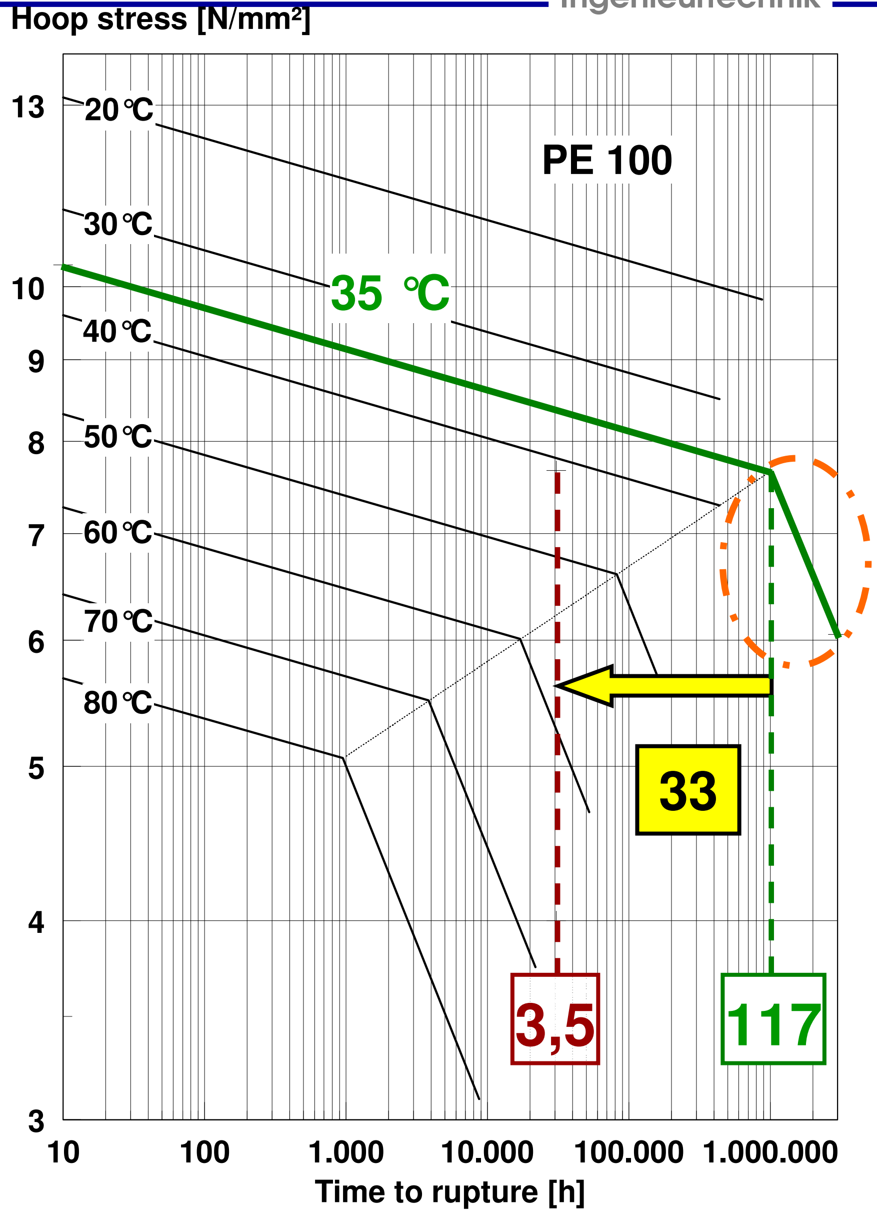
Brittle failure => 2nd branch

35 °C => t > 117 years

Time to failure in service:

3,5 years

Time-reduction factor: f > 33



Time-reduction caused by

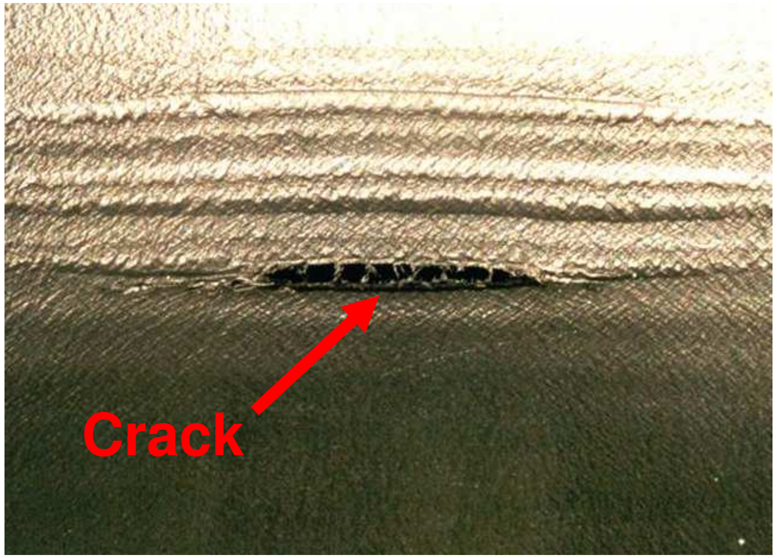
- Pre-existing damage ?

- Wastewater

Pre-existing damage ?

Inner surface of a

folded and re-rounded pipe



Inner surface of a

squeezed and re-rounded pipe

Wastewater

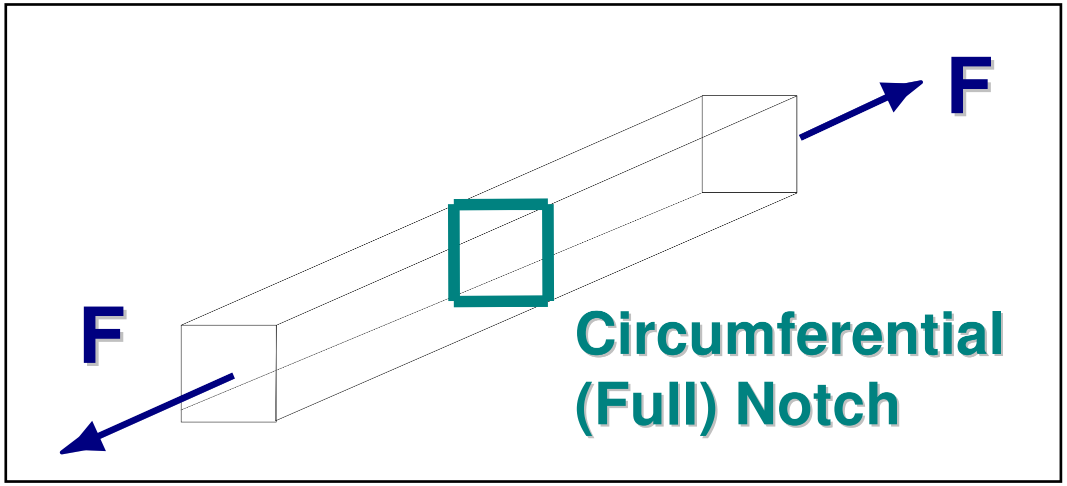
Stress cracking

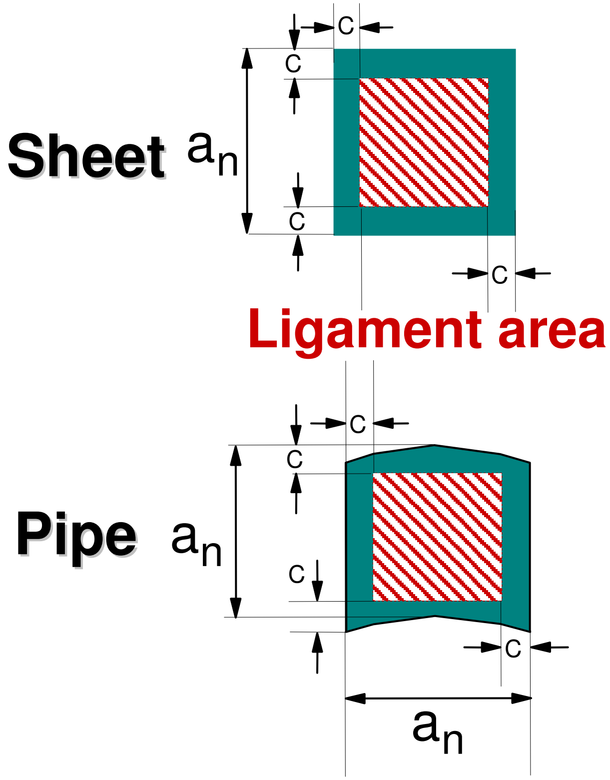
Domestic-sewage, which originates primarily from kitchen, bathroom, and laundry sources, contains surfactants, which generate stress cracking in PE

Pipe wall

FNCT - Full Notch Creep Test according to ISO 16770

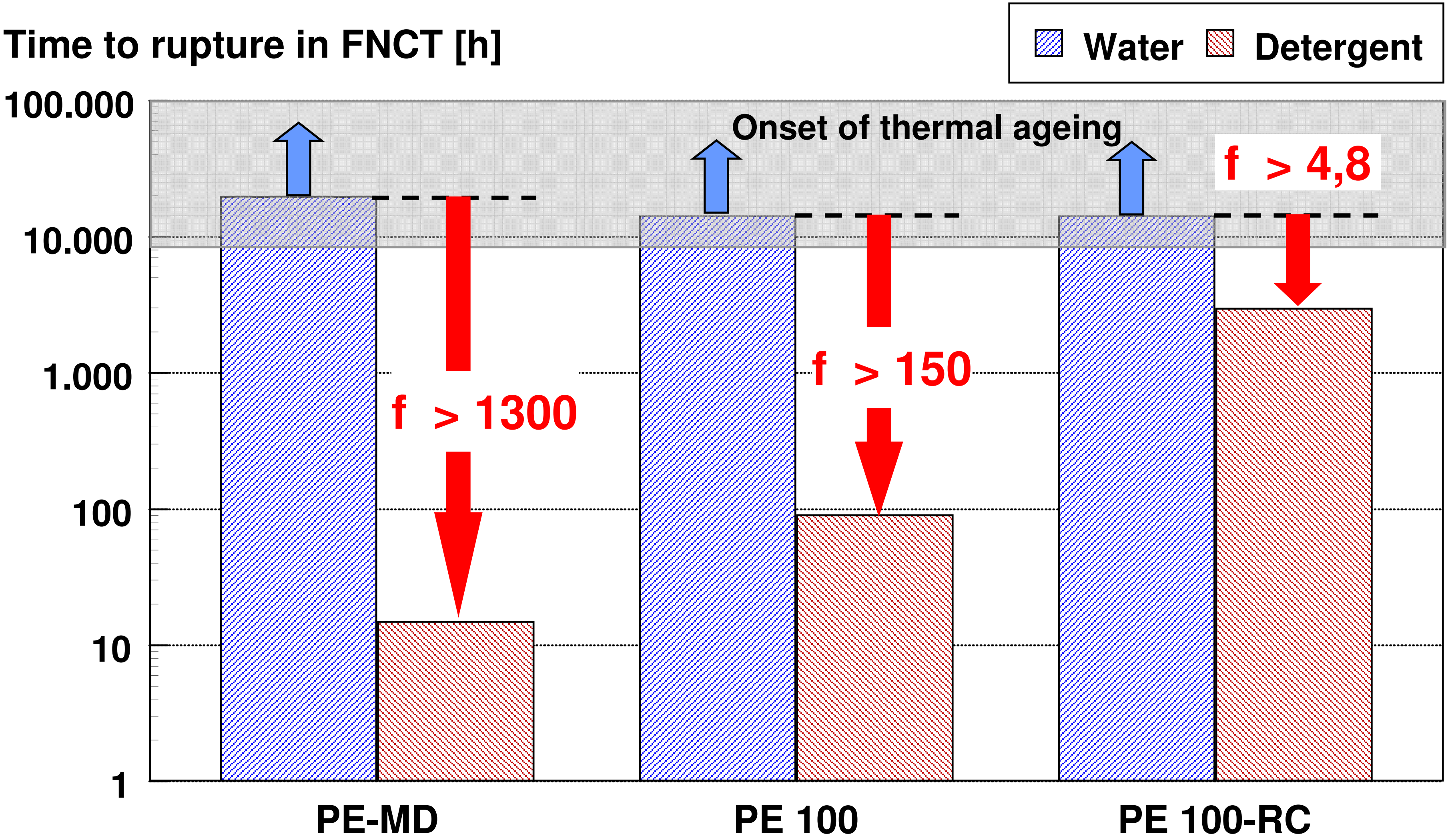
Tensile creep test with notched specimens





$C = 0{,}17 \times a_n \pm 2\ \%$

Creep rupture times in detergent and in water at 80°C



Conclusion 1:

Pipes for the transport of gas and water

PE 80 and PE 100 are established and fit for this purpose

Conclusion 2:

Pipes (predeformed) for the transport of waste water

PE 100-RC as specified in PAS 1075

PAS 1075: Pipes made from Polyethylene
for alternative installation techniques -
Dimensions, technical requirements and testing

End

Thank you for your attention