JoinTec

Experimental Testing at SZMF

Fredensborg, 3rd June 2009

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Agenda

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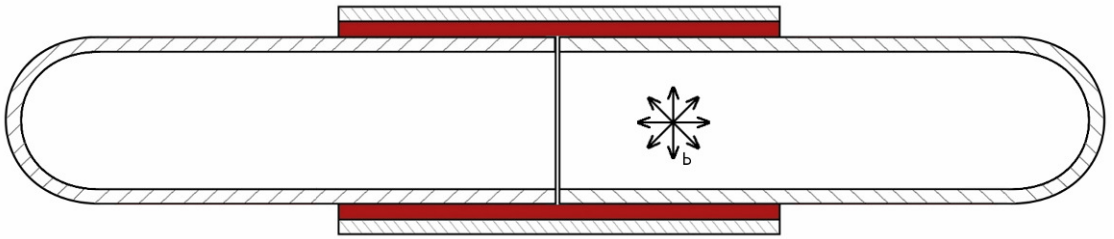
A Member of the Salzgitter Group

- Burst Tests
- Boundary Conditions
- Test Setup
- Results
- Troubleshooting & Improved Design
- Future Tests



Boundary Conditions

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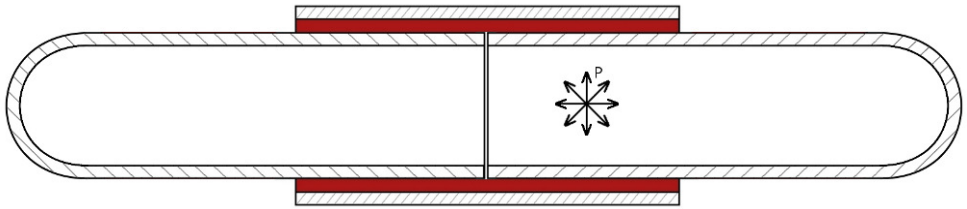
Static Pressure Containment

- 2 hydrostatic pressure tests with initial configuration accomplished (see Dr. Flügge)
- Dimensions Ø 168.3 mm x 7.1 mm



- Computed burst pressure p_b = 320 Bar
- Shear stress in adhesive @ p_b = 320 Bar
  τ = 4.5 MPa (<15MPa preliminary tests)

Test Setup

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Setup

- Pipe closed with endcaps
- Specimen placed in protective tube
- Protective tube placed in burst pit

Dimensions of specimen:

- Overall length 2000 mm
- Pipe Ø 168 mm x 7 mm
- Sleeve Ø 192 mm x 7 mm (manually manufactured)
- Sleeve length 500 mm (as required)
- Adhesive layer ~5 mm

Test Setup

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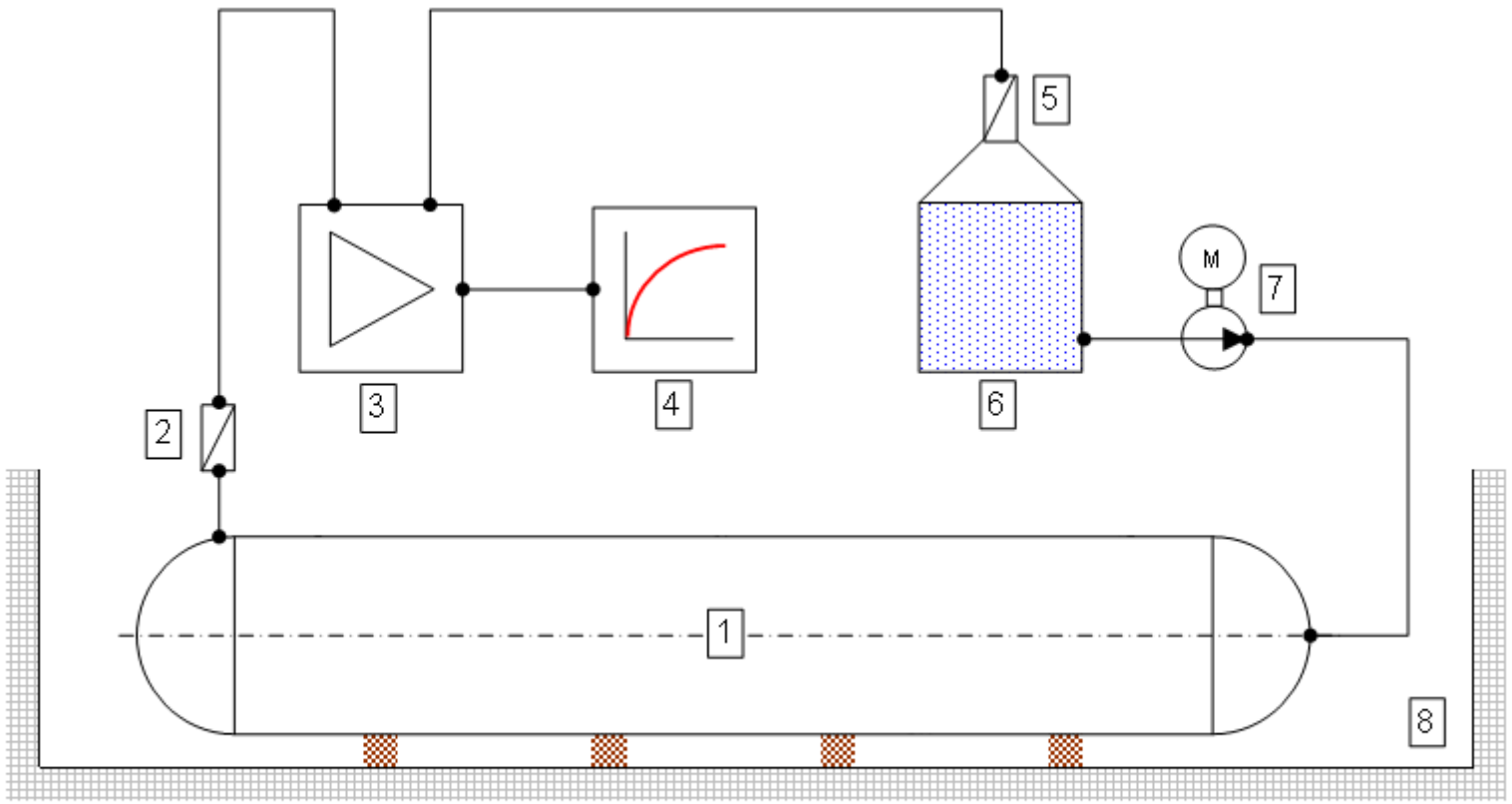

1 Test pipe
2 Pressure transducer
3 Signal conditioning
4 Signal output
5 Load cell
6 Water reservoir
7 Hydraulic pump
8 burst pit

Results

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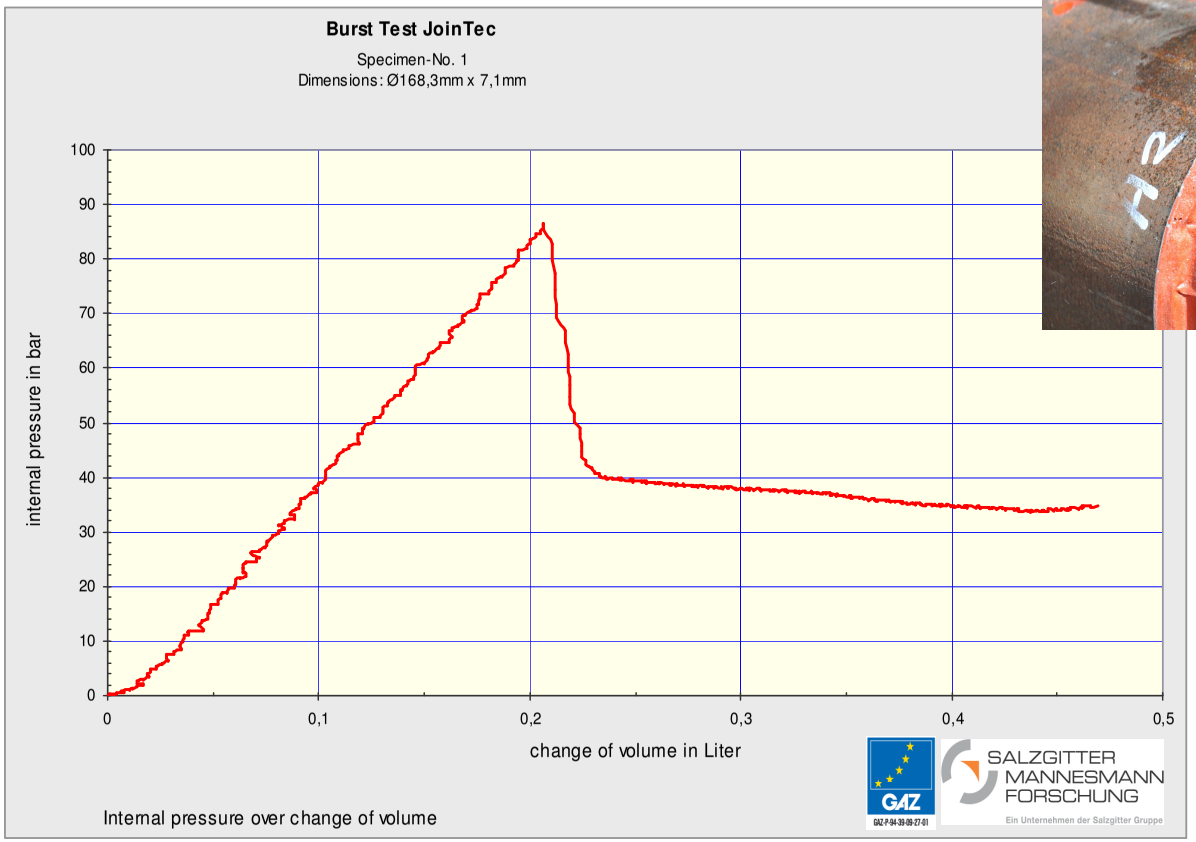
Burst Test with 1st specimen

- Leakage in adhesive layer
- Max. pressure p_{max} = 87 bar



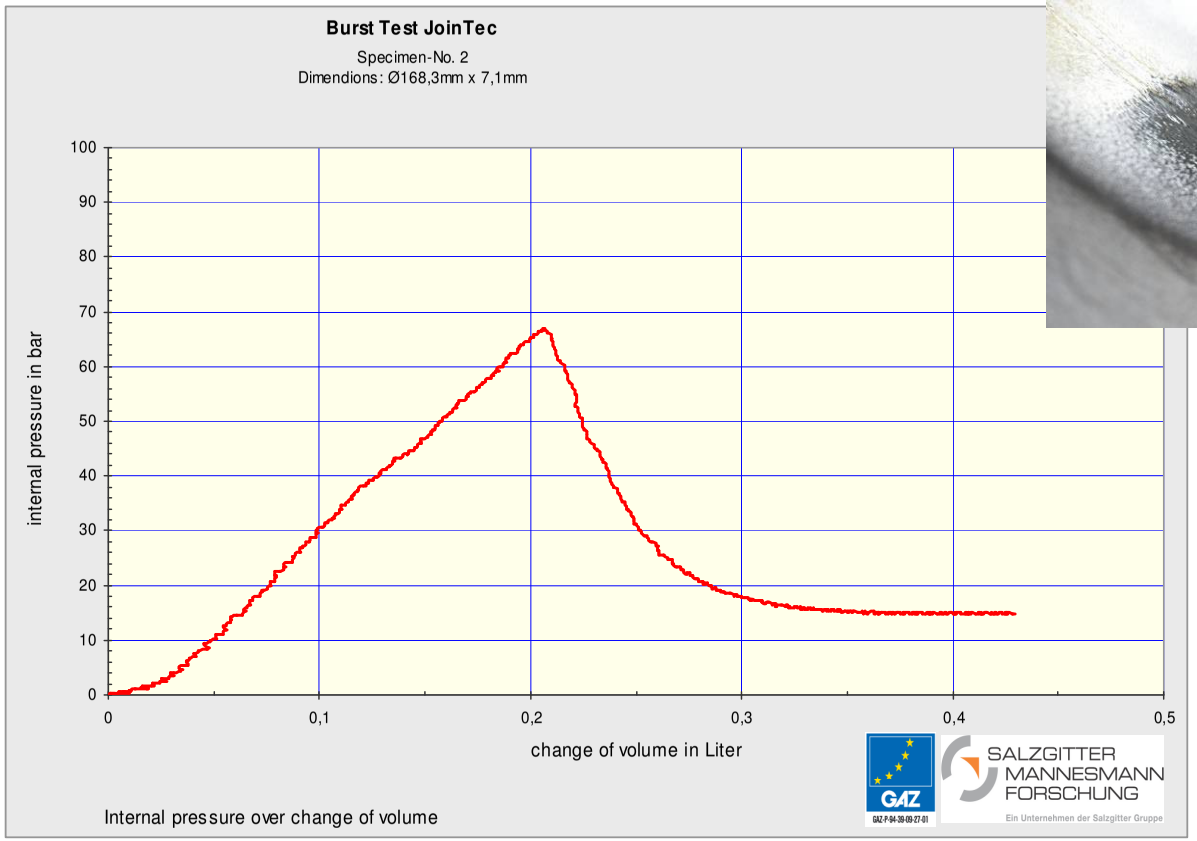
Internal pressure over change of volume

- p_b = 320 bar (comp.)
- τ = 1.23 MPa @ 87 bar

Results

Burst Test with 2nd specimen

- Leakage through borehole (vent)
- Max. pressure p_{max} = 67 bar



- p_b = 320 bar (comp.)
- τ = 0.95 MPa @ 67 bar

Results

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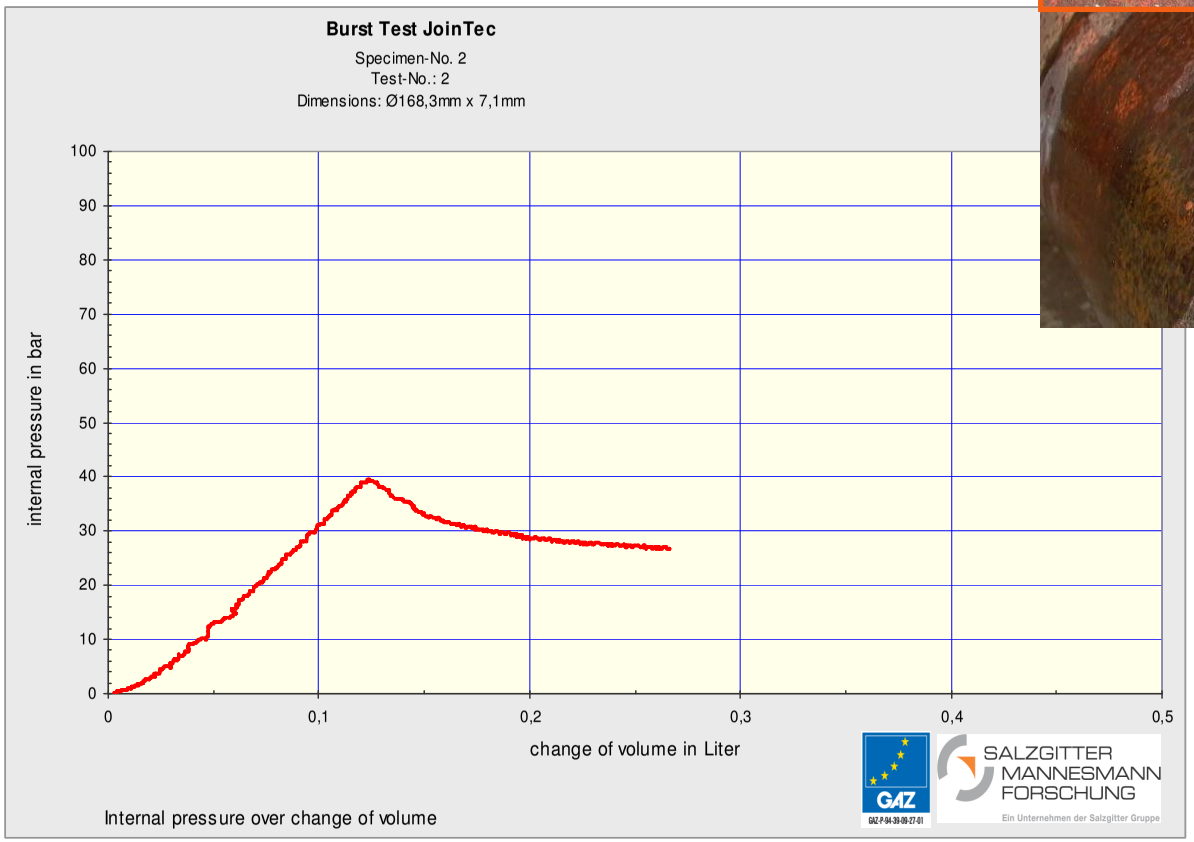
Burst Test with 2nd specimen after sealing

- Borehole sealed with threaded plug
- Max. pressure p_{max} = 40 bar



- p_b = 320 bar (comp.)
- τ = 0.56 MPa @ 40 bar
- Premature damage from first test

Troubleshooting – Failure Modes

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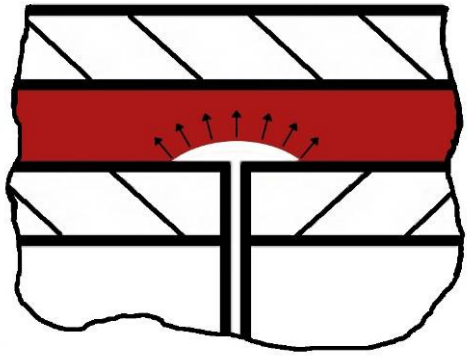
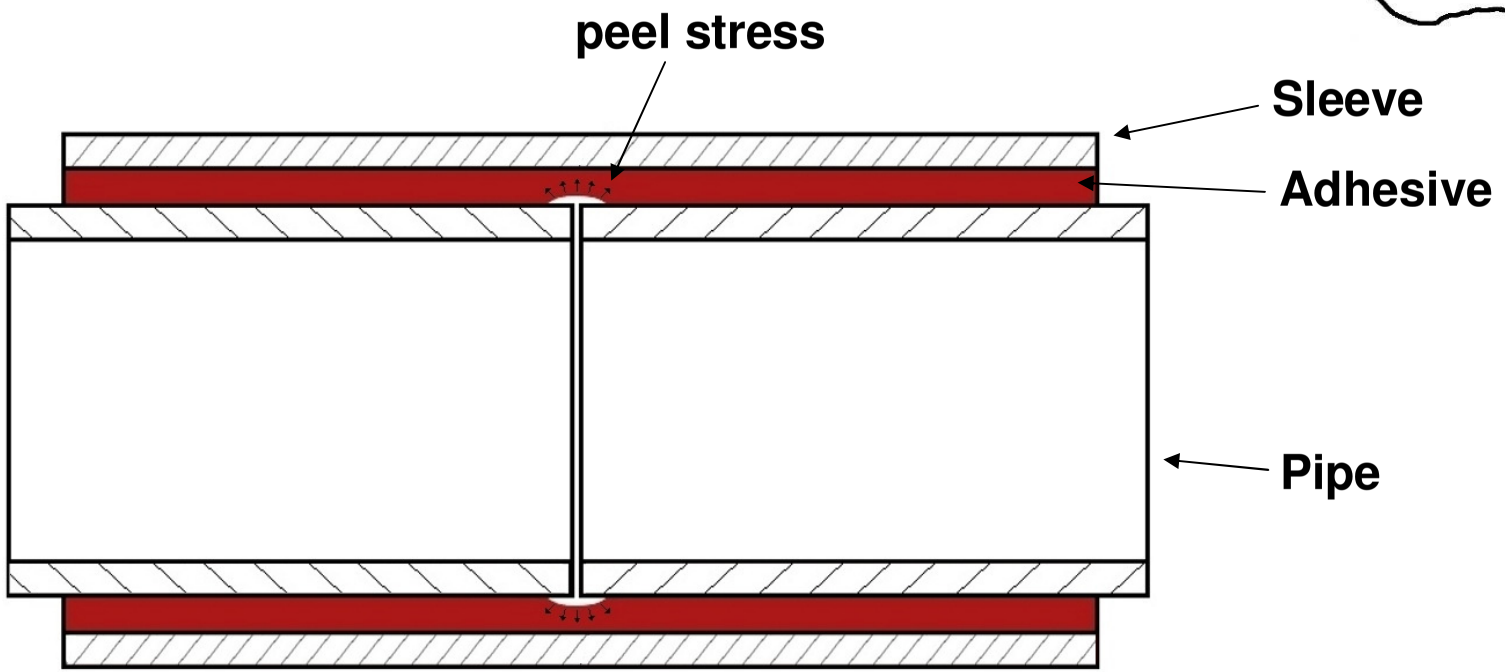
Failure

- In adhesive layer
- Unfavourable load case for adhesive
- Water forces its way between adhesive and pipe





Troubleshooting – Failure Modes

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Stresses in adhesive layer @ p_{max} = 87 bar

- Load Case: Axial Force

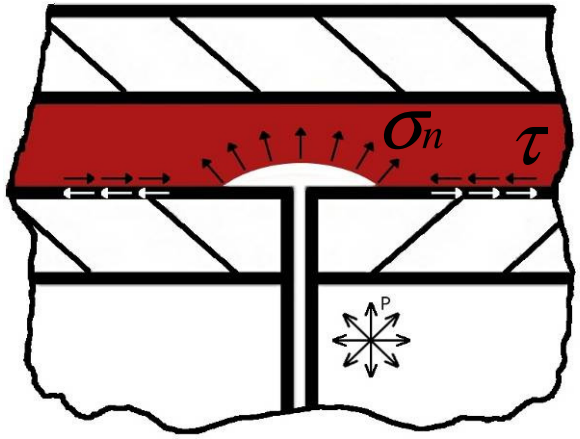
$$\tau = \frac{F_x}{D_a \times \pi \times l} = 1.23\ MPa$$

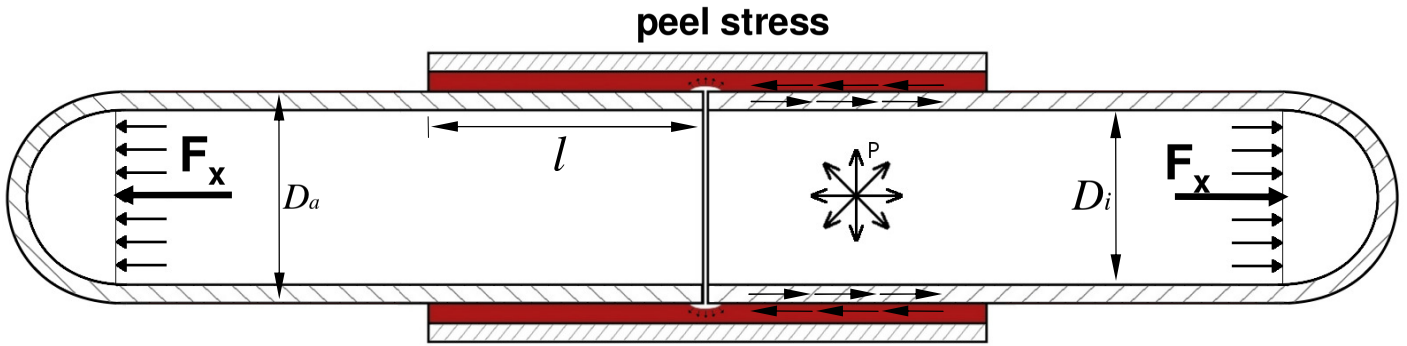
- Load Case: Direct hydrostatic pressure

$$\sigma_n = 8.7\ MPa$$

- Resulting stresses (von Mises):

$$\sigma_v = 9.0\ MPa$$





+ Adhesive layer contains non cured parts

Burst Tests with improved design

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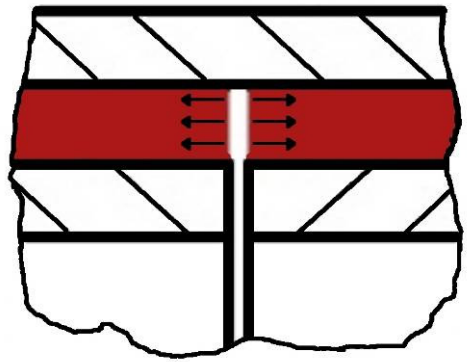
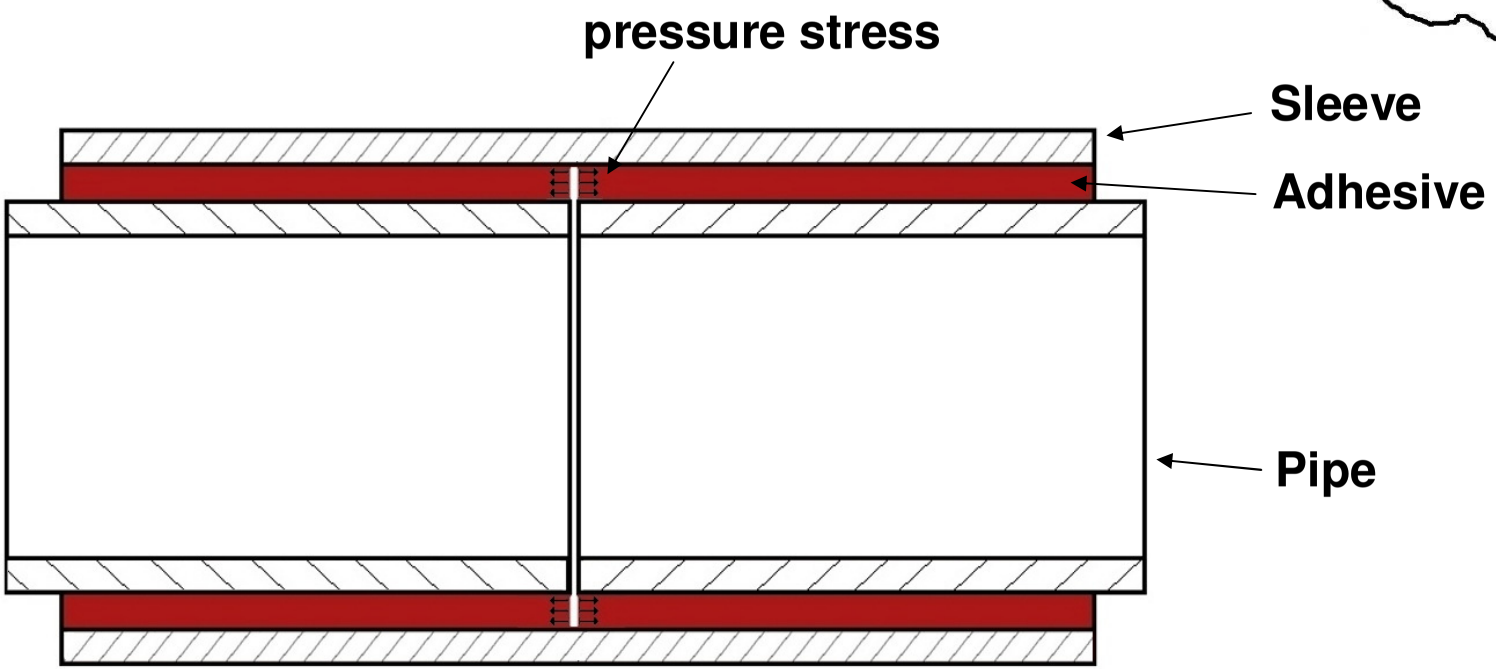
Altering the load case

- Create gap in adhesive layer
- Load case changes to pressure
- Pressure stress in adhesive (pure slip)
- Adhesive has to be impermeable ?





Burst Tests with improved design

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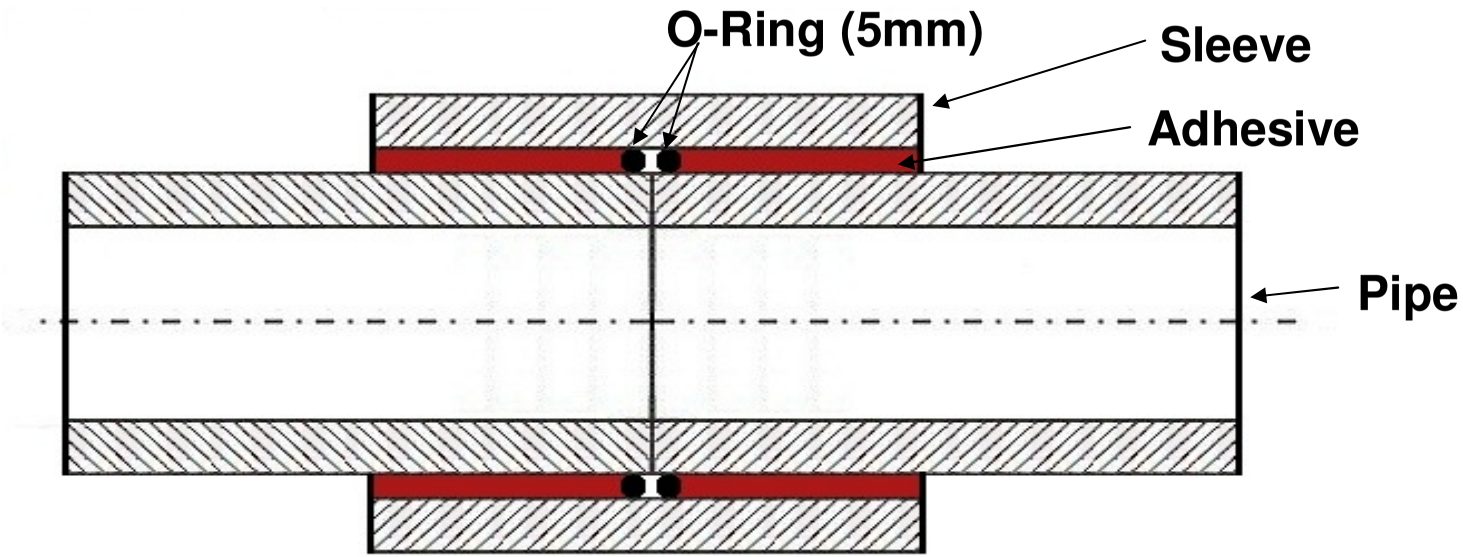
Sealing is provided by O-rings

- Sleeve Ø 193.7 mm x 8.0 mm
  (pipe material / not manually manufactured)
- Adhesive holds O-rings in position
  - Fixation of O-rings (no slot to keep the design simple) or
  - Simultaneous filling required



Future Tests

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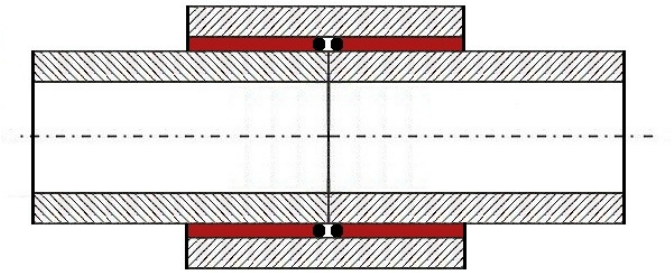
Burst Tests

	No.	Pipe material D_a [mm]	t [mm]	Material	Testing Procedure [-]	sleeve length [mm]	Amount [-]	
Small-scale test	A	168	7	S235	Internal static pressure	550	2	failed
	B				Internal cyclic pressure		2	
	C				Tensile Test		2	
	D				Torsion Test		2	
Full-scale tests	E	508	9	X60	Internal static pressure	700	2	
	F				Internal cyclic pressure		2	
	G				Torsion Test		2	
	H				Tensile Test		2	



- Two hydro-tests without epoxy-primer planned
- Two hydro-tests with additional sealing intended
- Results mandatory for following tests

➡ max. effective $\tau = 1.23$ MPa (<15 MPa preliminary tests)