

# Collaborative research on underground infrastructure

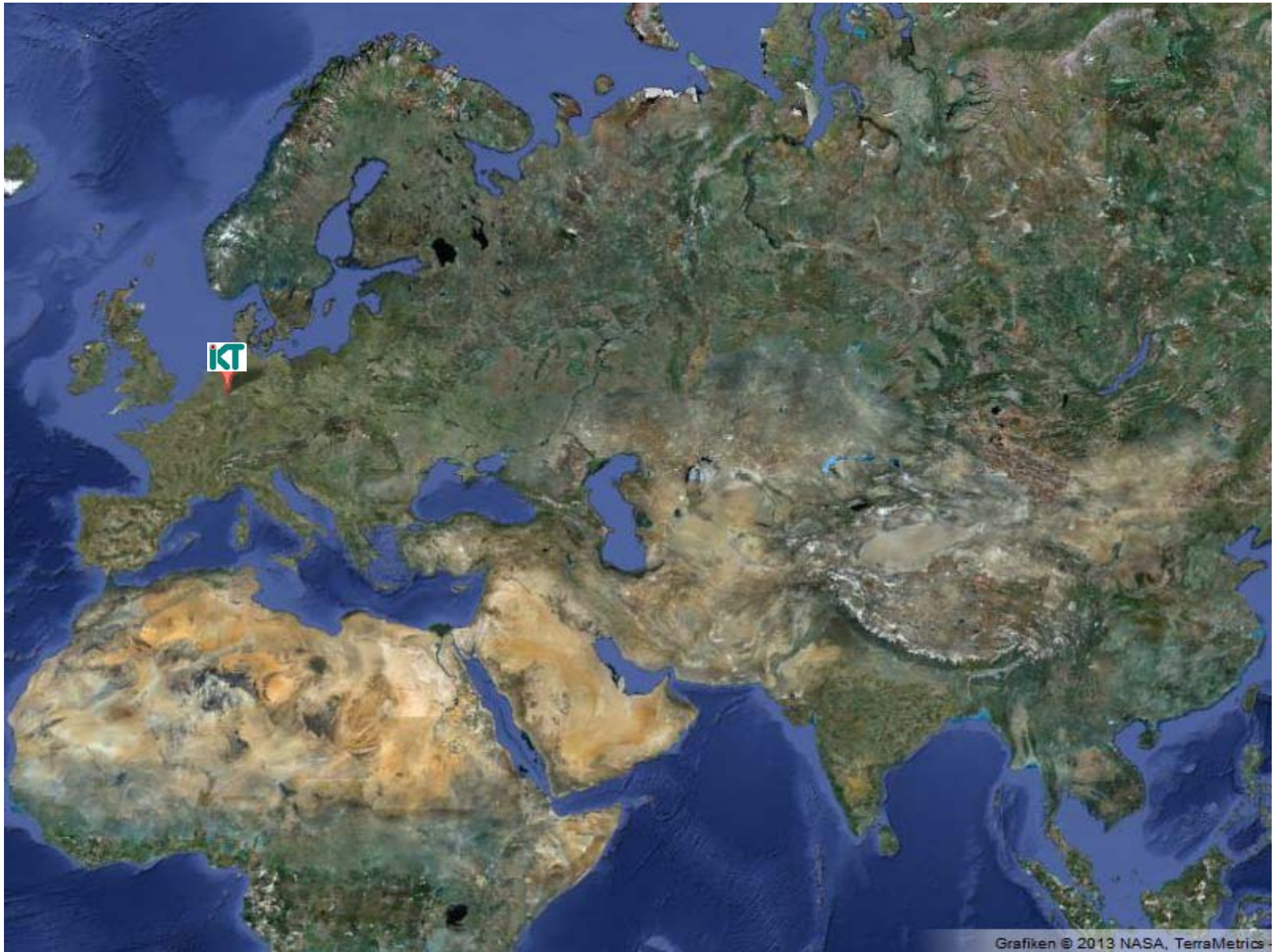
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*Gelsenkirchen (Germany) / Arnhem (NL)*





**neutral  
independent  
non-profit**

**research  
testing  
training**

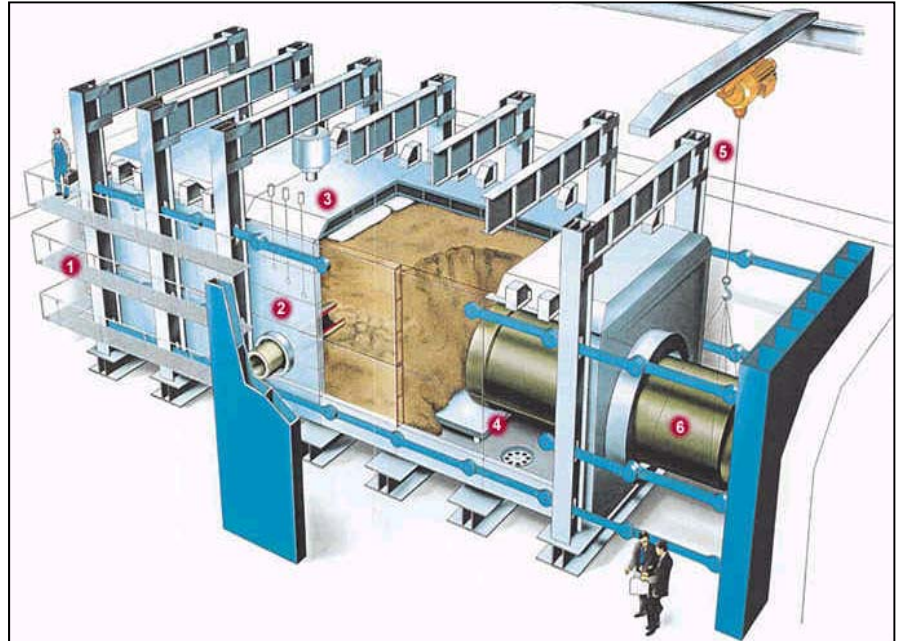


**sewers  
pipelines  
stormwater**

**life-cycle  
processes  
products**

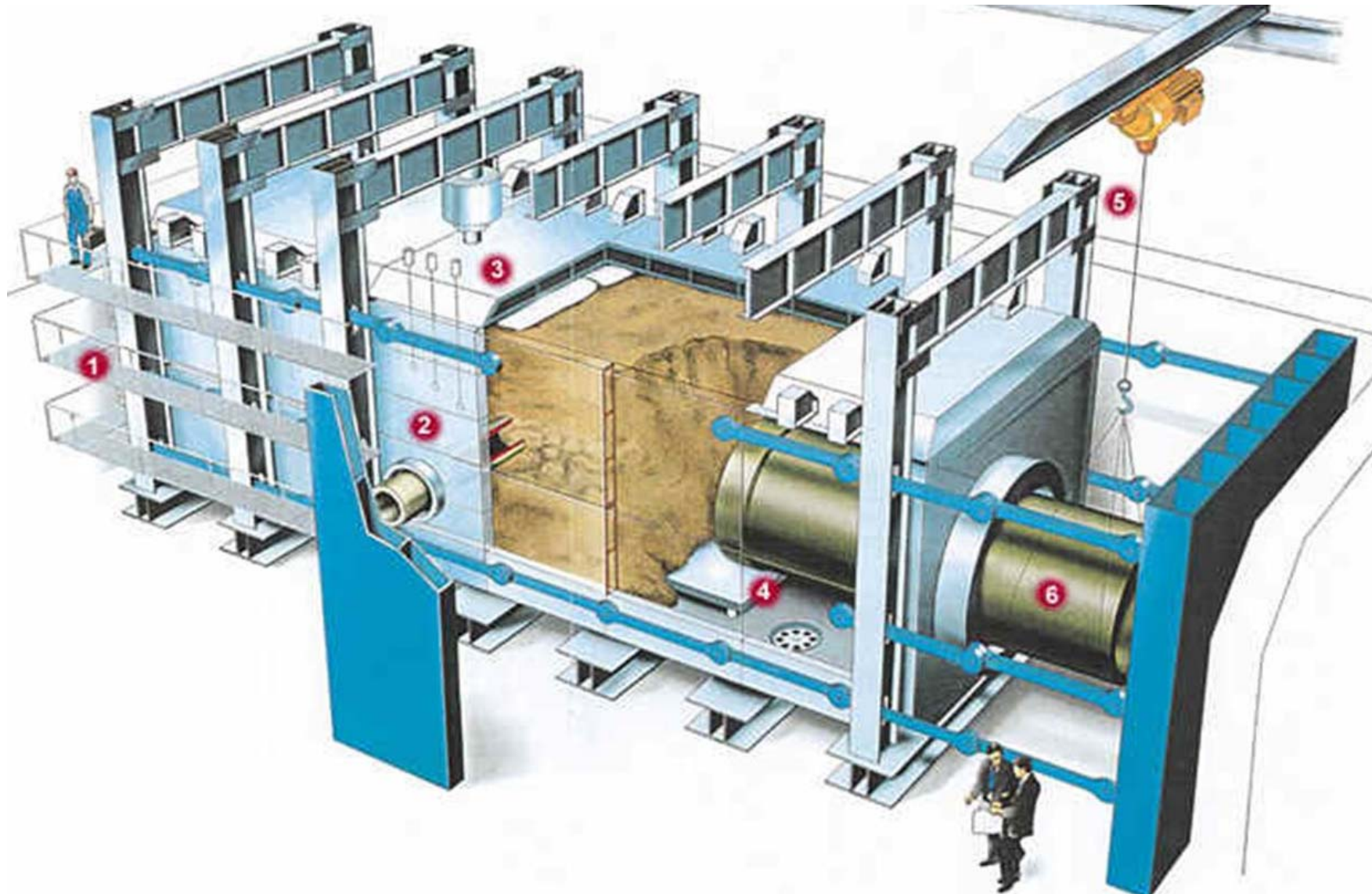


# IKT – Facilities





# IKT full scale experimental facility



**IKT research:** In depth studies of specific problems experienced by sewer network owners, identification of causes and potential solutions => **quality factors**

**IKT Compare:** Review of the products/systems/installers available in the market; design of a 1:1 scale test rig with relevant scenarios; installation on the rig and in situ by suppliers/contractors => **performance ranking**

**Quality Assurance:** Guidelines for tendering requirements and quality assurance => **continuous quality testing on site**

**Training, networking experience and more ...**

- **IKT Compare**  
Concept and experience
- **Example**  
Repair of lateral connections
- **Consequences**  
for network owners and product suppliers

## Goal:

- To create market transparency
- To lower investment risks

## Funding:

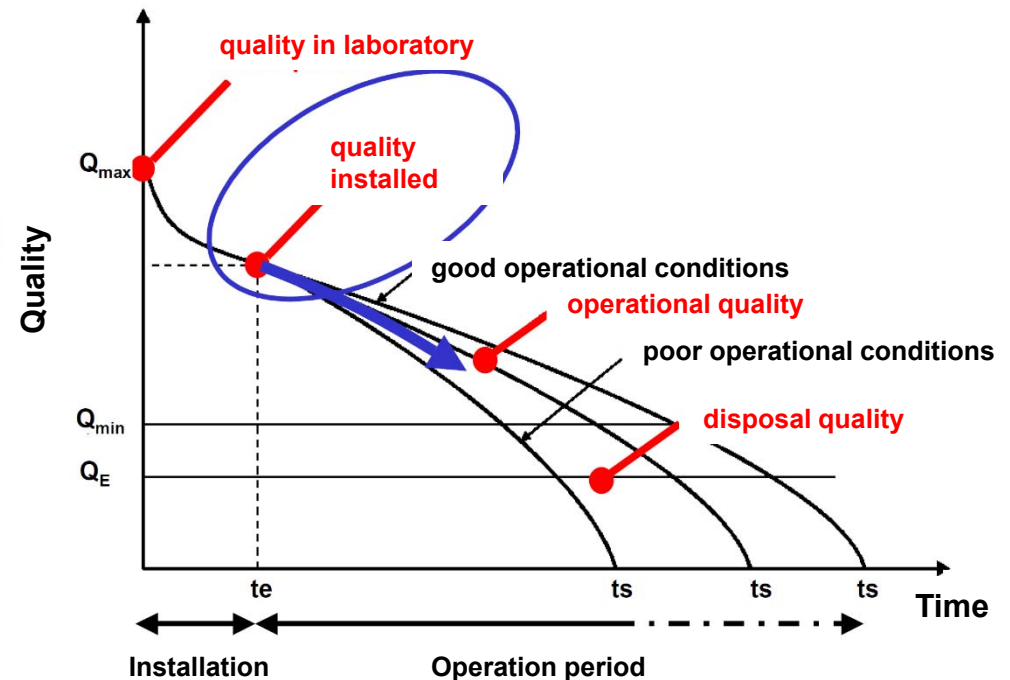
- Group of network owners (steering committee)
- State agencies (sewage fee refund)
- per project (2 years): 0.5m to 2m €

## Decisions by network owners:

- Products, methods, suppliers
- Testing goals and concepts
- Evaluation / grading of test results

## Market consequences:

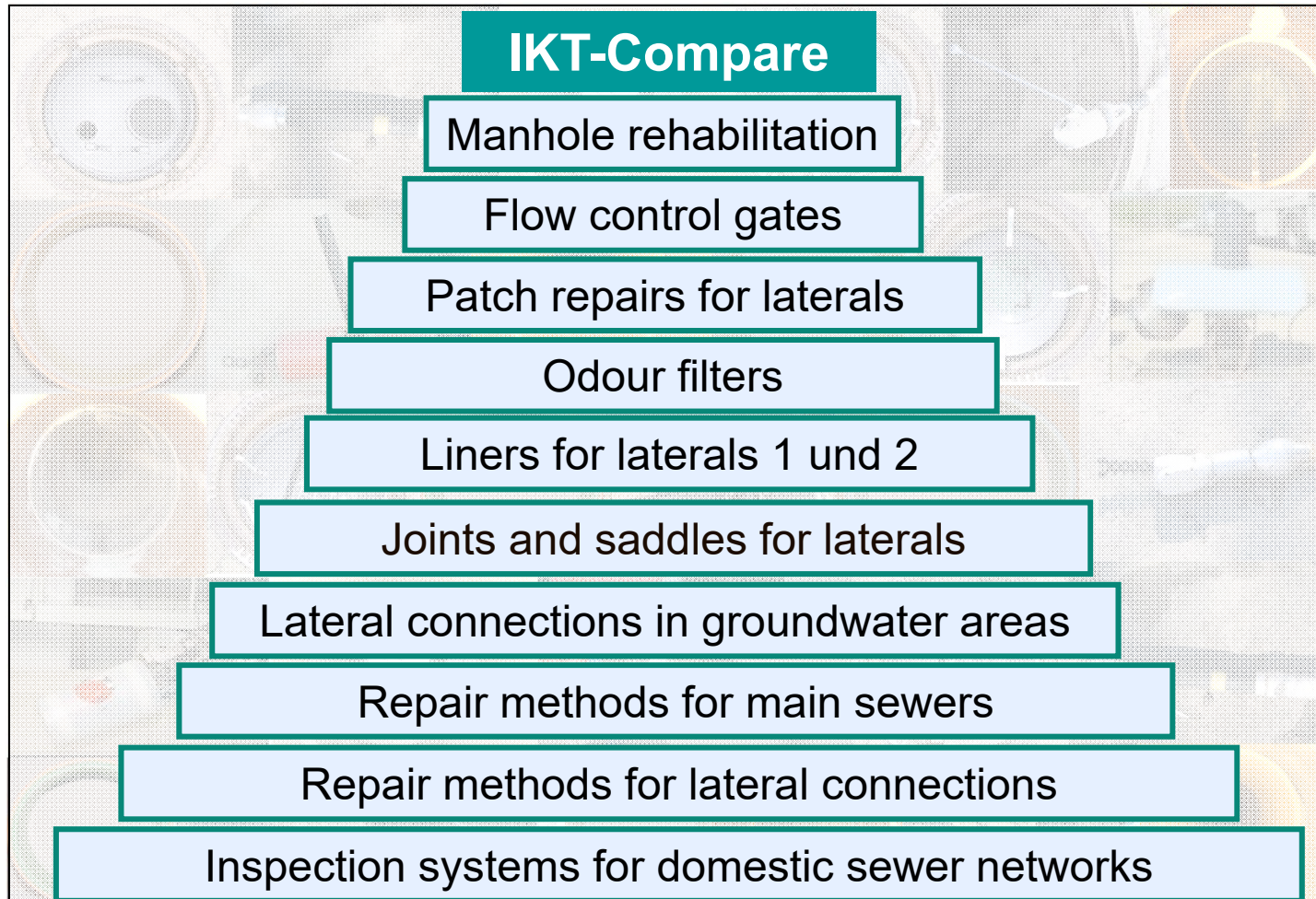
- Test results are published
- Quality assurance / product improvement





# IKT Compare – Tested products





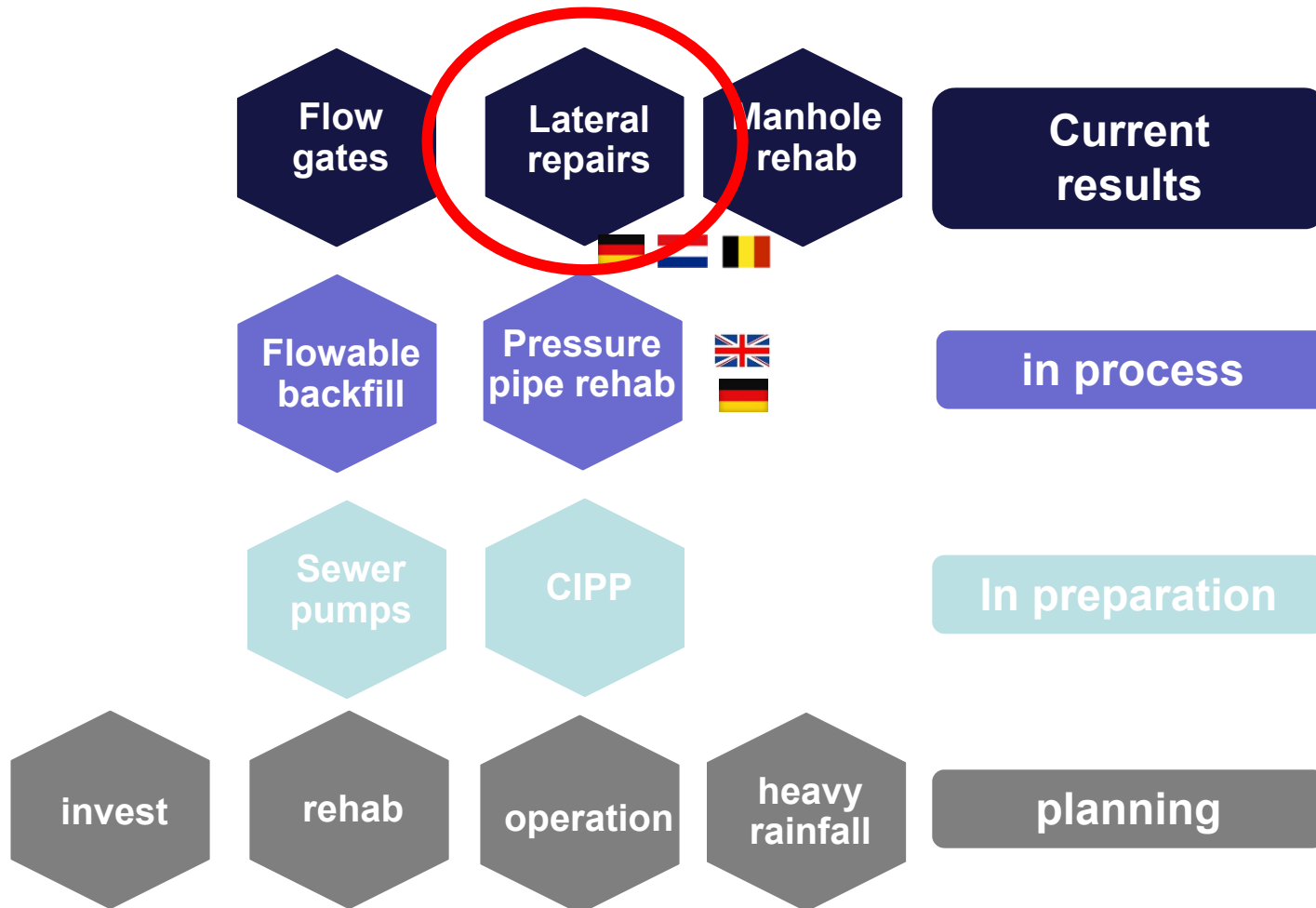






- **Quality factors:**  
Men / Machines / Methods / Materials
- **Quality: Robustness against application errors!**  
(bore holes, surface preparation, mixing and processing, ...)
- **Steering committee:**  
**project experience is more than just a table of results**  
(product selection, performance criteria, in situ experience, ...)
- **Market reaction discloses product capabilities and limits**  
(geometries, damage scenarios, ground water, ...)
- **Reactions of suppliers: large range ...**

# IKT-Compare, current examples



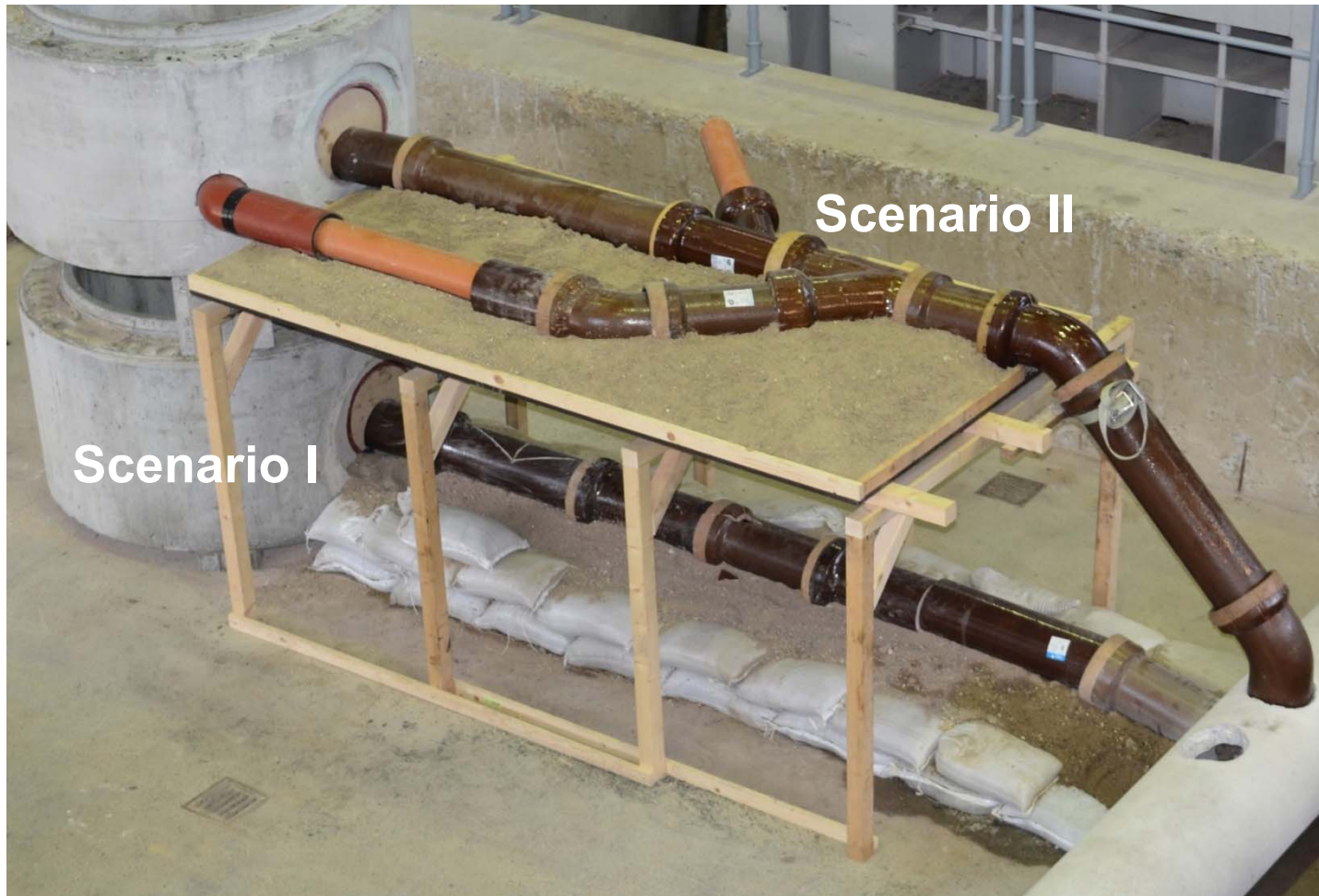
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# Testing: damage scenario model for part liners



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# Experimental set-up



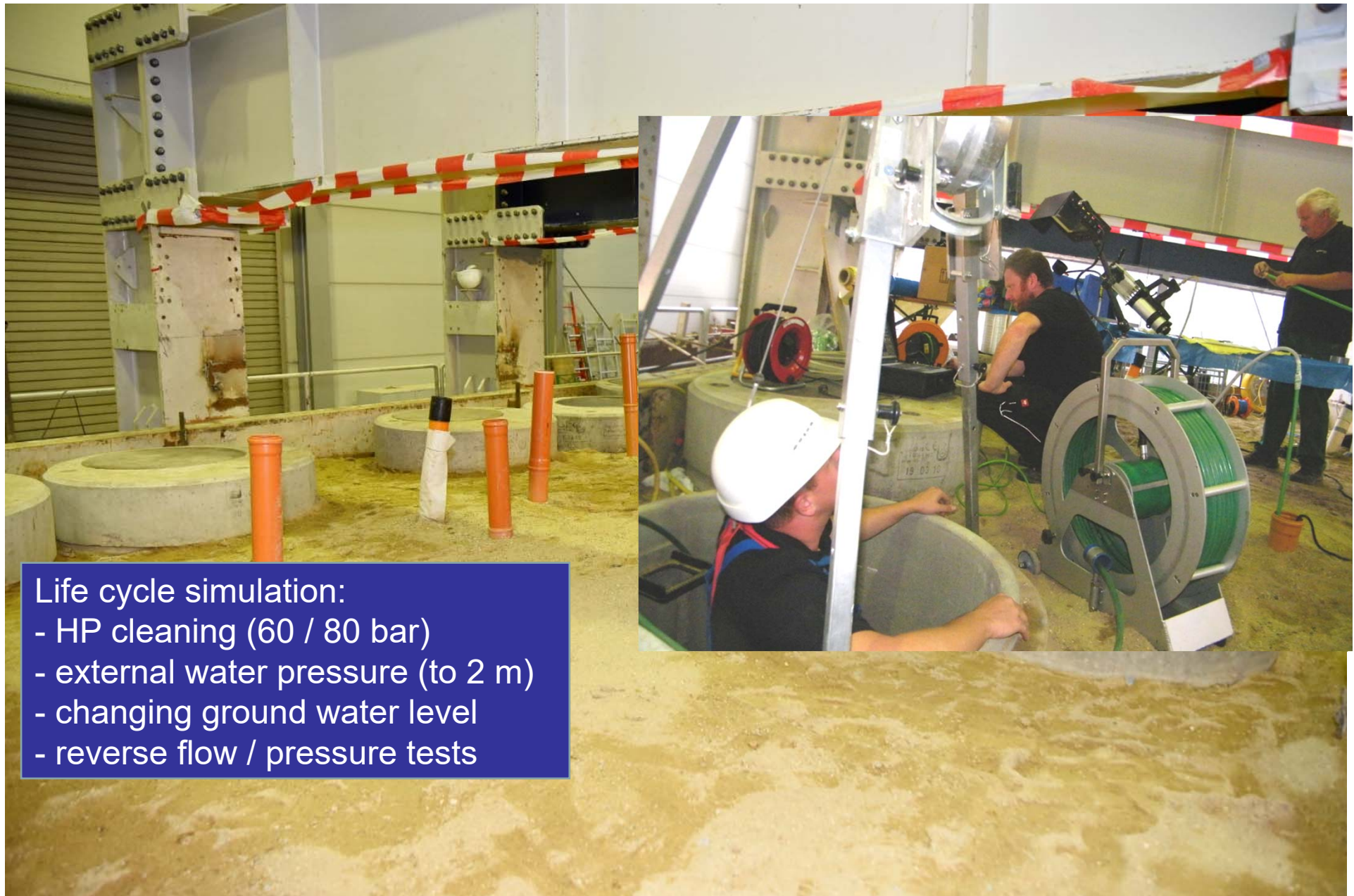


# Experimental set-up



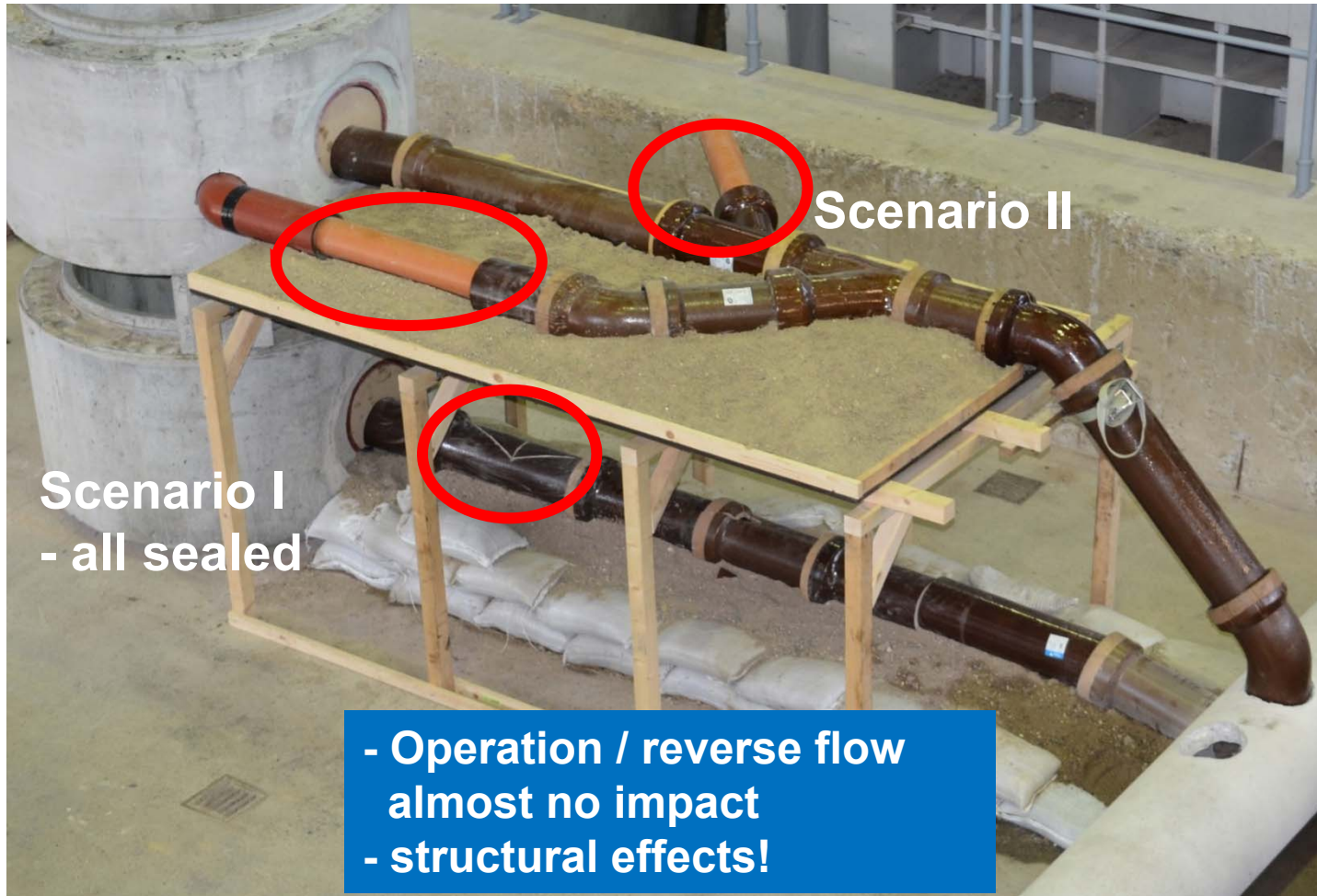


# Experimental set-up



- Life cycle simulation:
- HP cleaning (60 / 80 bar)
  - external water pressure (to 2 m)
  - changing ground water level
  - reverse flow / pressure tests

# Test results, example



Scenario I  
- all sealed

Scenario II

- Operation / reverse flow  
almost no impact  
- structural effects!



# Test results, example

IKT - Institute for Underground Infrastructure

## IKT Compare „Short Liner for House Connections“

Test task: Rehabilitation of damaged house connections and subsequent evaluation against groundwater pressure, operational loadings and backed-up water

Supplier		Twinbond Liner	Trelleborg Pipe Seals	Bodenbender	BKP Berolina	Cosmic Engineering	MC-Bauchemie	alocit Chemie	I.S.T.
System		TbL-Verfahren	epros DrainPacker	Point-Liner-System	Berolina Repair System	TopHat System	Konudur LM-Liner	Alocit Short Liner	Spot Repair System
Installer		JT-elektronik GmbH	Trelleborg Pipe Seals	Bodenbender	Casseler-Kanal-Technik	Cosmic Engineering	Sanierungstechnik Dommel	KANAL PLUS	I.S.T.
<b>IKT – Test Result*</b>		<b>VERY GOOD 1.2</b>	<b>VERY GOOD 1.4</b>	<b>GOOD 1.7</b>	<b>GOOD 2.5</b>	<b>GOOD 2.5</b>	<b>GOOD 2.5</b>	<b>SATISFACTORY 2.7</b>	<b>SATISFACTORY 2.9</b>
<b>System tests</b>	<b>85 %</b>	<b>very good 1.2</b>	<b>very good 1.5</b>	<b>good 1.9</b>	<b>good 2.7</b>	<b>satisfactory 2.6</b>	<b>satisfactory 2.8</b>	<b>satisfactory 3.0</b>	<b>satisfactory 3.2</b>
<b>1. Water tightness</b>	<b>60 %</b>	<b>1.0</b>	<b>1.0</b>	<b>2.1</b>	<b>3.1</b>	<b>3.2</b>	<b>3.1</b>	<b>3.5</b>	<b>3.6</b>
... under groundwater pressure and operating loads <sup>1</sup> - Infiltration I	70 %	1.0	1.0	2.3	3.5	3.8	3.0	3.8	3.5
• Test Setup I	50 %	1.0	1.0	2.5	1.0	3.0	1.0	2.0	1.0
• Test Setup II	50 %	1.0	1.0	2.0	6.0	4.5	5.0	5.5	6.0
... under heavy rain conditions - Infiltration II (backed-up water in pipe, groundwater pressure changes) <sup>2</sup>	30 %	1.0	1.0	1.8	2.3	1.8	3.3	3.0	3.8
• Test Setup I	50 %	1.0	1.0	2.5	3.0	2.0	1.5	1.0	1.5
• Test Setup II	50 %	1.0	1.0	1.0	1.5	1.5	5.0	5.0	6.0
<b>2. Operational reliability</b>	<b>20 %</b>	<b>2.2</b>	<b>2.4</b>	<b>2.1</b>	<b>1.9</b>	<b>2.5</b>	<b>2.1</b>	<b>1.9</b>	<b>2.1</b>
Hydraulic performance <sup>3</sup>	50 %	2.5	2.6	1.8	2.0	2.6	1.9	2.1	2.3
Cross-section reduction	30 %	1.7	2.6	3.0	2.0	2.4	2.5	1.6	2.1
CCTV inspection <sup>3</sup>	20 %	2.3	1.9	1.6	1.7	2.1	1.8	1.9	1.7
<b>3. Structural stability</b>	<b>20 %</b>	<b>1.0</b>	<b>2.1</b>	<b>1.0</b>	<b>2.3</b>	<b>1.0</b>	<b>2.6</b>	<b>2.6</b>	<b>3.2</b>
Short liner stability	70 %	1.0	2.5	1.0	1.5	1.0	2.0	2.0	2.0
Prevention of soil penetration	30 %	1.0	1.0	1.0	4.0	1.0	4.0	4.0	6.0
<b>Quality assurance<sup>4</sup></b>	<b>15 %</b>	<b>very good 1.0</b>	<b>very good 1.0</b>	<b>very good 1.0</b>	<b>very good 1.0</b>	<b>gut 2.0 no DIBt approval</b>	<b>very good 1.0</b>	<b>very good 1.0</b>	<b>very good 1.0</b>
<b>Additional information (not graded)</b>									
Pressure test after excavation, number of: water tight / leaking / not assessable		8 / 0 / 0	6 / 0 / 2 <sup>5</sup>	3 / 1 / 4 <sup>5</sup>	7 / 1 / 0	0 / 0 / 8 <sup>5</sup>	6 / 1 / 1 <sup>5</sup>	2 / 1 / 5 <sup>5</sup>	5 / 1 / 2 <sup>5</sup>
Adhesive tensile strength Ø / minimum (N/mm <sup>2</sup> )		3.1 / 2.9	2.0 / 1.7	not assessable <sup>7</sup>	1.9 / 0.8	not assessable <sup>8</sup>	0.5 / 0.3	not assessable <sup>7</sup>	3.2 / 2.8
Initial inspection / substrate preparation / cleaning		yes / no / yes <sup>9</sup>	yes / milling / yes <sup>9</sup>	yes / no / yes <sup>10</sup>	yes / roughening / yes <sup>10</sup>	yes / roughening / yes <sup>9</sup>	yes / milling / yes	yes / no / yes <sup>10</sup>	yes / milling / yes <sup>9</sup>
Days on site / Number of staff		2 days / 3 persons	3 days / 3 persons	3 days / 2 persons	2 days / 2 persons	2 days / 2 persons	3 days / 2 persons	3 days / 2 persons	3 days / 2 persons
Time required for preliminary work and installation (ca.)		20 min / 14 h	165 min / 24 h	15 min / 25 h	25 min / 13 h	330 min / 10 h	200 min / 29 h	10 min / 10 h	300 min / 23 h
Costs excl. VAT (ca.)		- <sup>11</sup> EUR	1.900 EUR	3.600 EUR	800 <sup>12</sup> EUR	- <sup>11</sup> EUR	3.000 EUR	6.500 EUR	4.700 EUR

\* Grade calculation is on the basis of unrounded values

1 External water pressure load 85 days (external water pressure: Test Setup I 2 m head, Test Setup II 1 m head).

2 Seven changing groundwater loads and 14 water backing-up events.

3 Evaluation on the basis of video inspections by the steering committee members (weighting: 20% directly after refurbishment; 40% after HD cleaning standard pressure and 40% after HD cleaning max. pressure).

4 Evaluation criteria: manual of procedures, training courses, DIBt approval (German Government's approval body), arrangements for external production monitoring and any special anomalies observed.

5 Not assessable, as no pressure build-up was possible due to unexpected damage to the host pipe.

6 Not assessable due to the design system.

7 Test of adhesive tensile strength not possible due to unexpected cracks in the host pipe.

8 Test of adhesive tensile strength cannot be carried out due to the system, as a full-surface bond between the old pipe and the short liner is not intended.

9 Cleaning of host pipe before renovation with high pressure jetting.

10 Cleaning host pipe before renovation with hose pipe using domestic water supply pressure.

11 No costs charged.

12 Installation costs without material, as material costs were borne by the system provider BKP Berolina.

Grading of results:

Very good	= 1.0 - 1.5	Sufficient	= 3.0 - 4.5
Good	= 1.6 - 2.5	Poor	= 4.6 - 5.0
Satisfactory	= 2.6 - 3.5	Insufficient	= 5.0 - 6.5

### TEST SETUP

#### Test Setup I:

Vitrified clay pipe DN 150:

- Pattern of cracks
- Broken out shard (pipe burst/collapse)
- Offset (radially displaced pipe joint)
- Angular deflection (pipe joint displaced at an angle)

#### Test Setup II:

Pipe with a branch into two pipes (vitrified clay pipe, PVC, cast iron – DN100/125/150):

- Damaged change of material joint
- Nominal diameter and material change (2x)
- Broken out shard (pipe burst / collapse) in a 45° bend

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### **For network owners:**

- **Reducing investment risks, what do I get for my money?**
- **Market overview, product performance**
- **QA/QC recommendation, tender documents**
- **Competition on a higher quality level**

### **And for IKT?**

### **For suppliers:**

- **Chance for performance prove / test winner**
- **Market pressure / definition of customer requirements**
- **Improvement potential / additional tests**



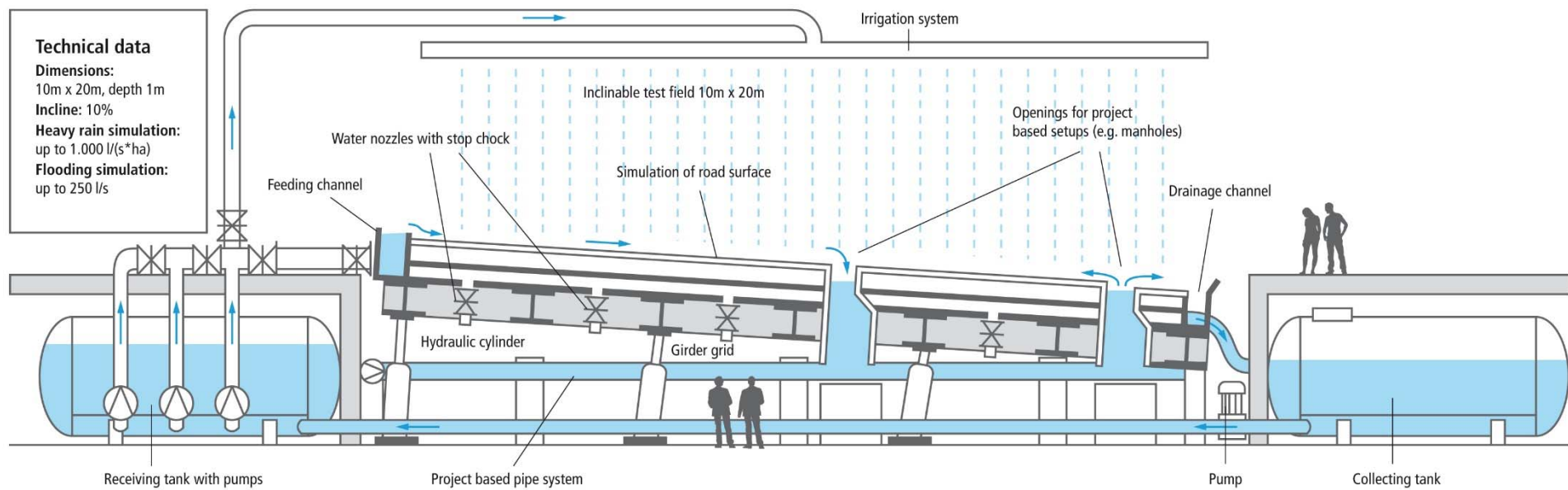
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# EFRE-Investment „research infrastructures“: IKT – testing facilities: heavy rainfalls and new products and materials

Join in!





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