TRENCHLESS ASIA 2026
THAILAND

HOW TO PREVENT ROAD COLLAPSES CAUSED BY LEAKING UNDERGROUND PIPES BEFORE THEY HAPPEN?

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How to prevent road collapses caused by leaking underground pipes before they happen?

– A Trenchless Method for Identifying Risks in the Pipe Network: the MAC system

by Roland W. Waniek, IKT – Institute for Underground Infrastructure, Germany

SCoRE – Sewer Condition and Risk Evaluation

Analysis of pipeline collapse mechanisms and risk assessment in China and Germany (here e.g.: collapse in Japan, January 2025)

Quelle: kleine zeitung

SCoRE – Sewer Condition and Risk Evaluation

Quelle: AFP

SCoRE – Sewer Condition and Risk Evaluation

Situation in China

14 collapses in total between 2014-2020
in Xining city, 2.5 million people
(Beijing： 22 million people)

Risk assessment on large scale sewers

What does Risk mean?

Risk = Probability x Effect

- **Probability of occurrence?**
  - **Condition of the sewer**
- **Consequence if it occurs?**
  - **Dimension of the sewer**

„Crater of Death“ in Munich (1994)
Collapse during Metro construction
Result: 3 dead, >30 injured

Foto: picture-alliance / dpa

What is the MAC-System?

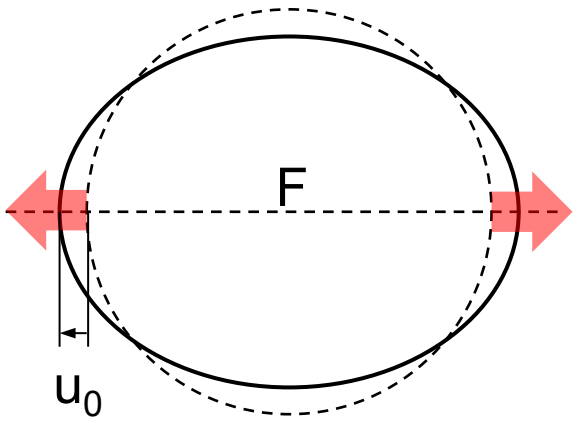
- MAC = Mechanical Assessment of Conduits
- Non-destructive testing method for the determination of both the condition and structural integrity of accessible sewers
- Developed by Olivier Thépot (Eau de Paris), in use in France since 1989,
  > 40 km surveying of sewers per year
- Cooperation between Eau de Paris and IKT
- Complement to visual inspection / man-entry inspection

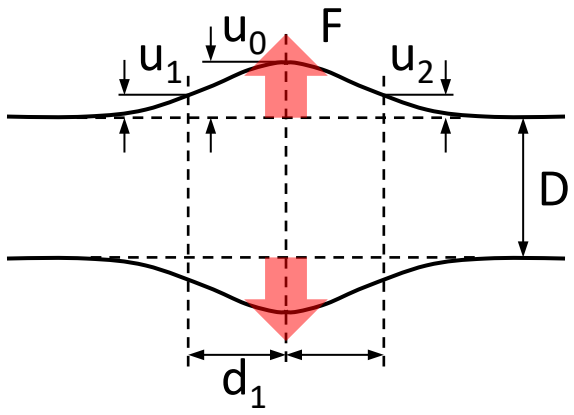
eau de Paris

neutral
independent
non-profit institute

IKT - Institute for Underground Infrastructure

Operating Principle





MAC-Stiffness :

$$K_G = F/u_0 \ [MN/m]$$

Transmission ratio:

$$\Omega_1 = \frac{u_1}{u_0}[-] \ \& \ \Omega_2 = \frac{u_2}{u_0}[-]$$

- **Can be used in various profiles (circular, egg-shaped etc.)**
- **Applicable from DN 300 up to > DN 2000**
- **Materials: Concrete, brickwork, synthetic etc.**
- **Non-destructive testing: F_{max} < 100 kN, u_{max} < 300 µm**

Application in Operation

Spacings and Measurements

– **Spacing between the measurement points: 5 to 10 m**

– **Positioning of hydraulic press and transducers: 50 to 100 cm**

– **Three testing cycles (fixing, measuring, checking)**

Various Dimensions

- Modular adaptable chassis
- multi-fit purposes
- from DN 300 to DN 800

DN 300

DN 800

Planning

- Review of plans and reports
- Preliminary FE calculation
- Securing entry and exit
- Preliminary visual inspection
- Ventilation of sewer

Time Frame

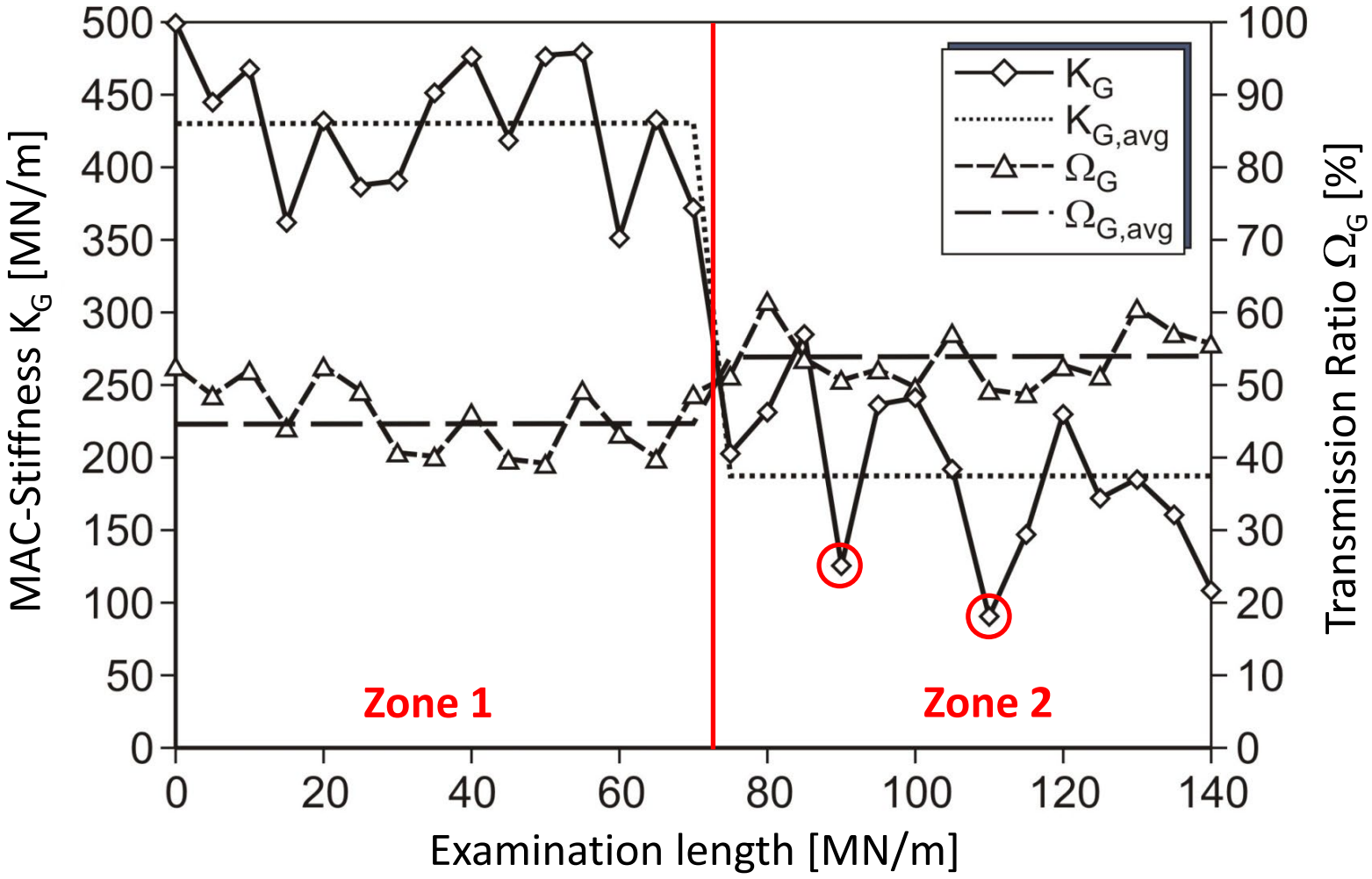
Example

- One-day test
- Egg-shaped profile DN 950/1400
- Sewer-section length: 150 / 250 m
- Measuring points: 15 /25
- Depending on sewer condition

Assessing the MAC-Data 1

System Parameters

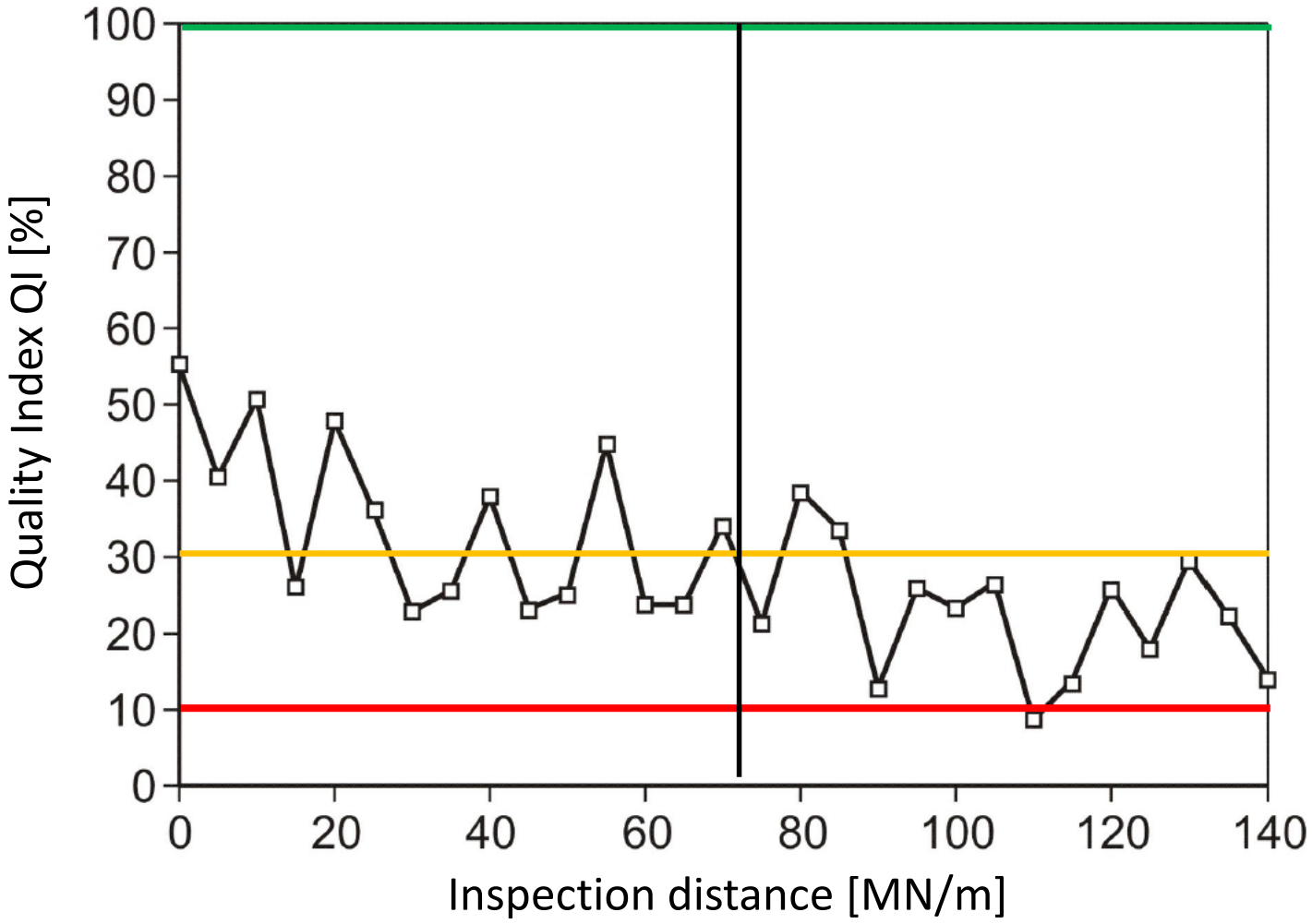
- MAC-Stiffness K_G
- Transmission ratio Ω_G



Condition of the Sewer

Quality Index QI [%]

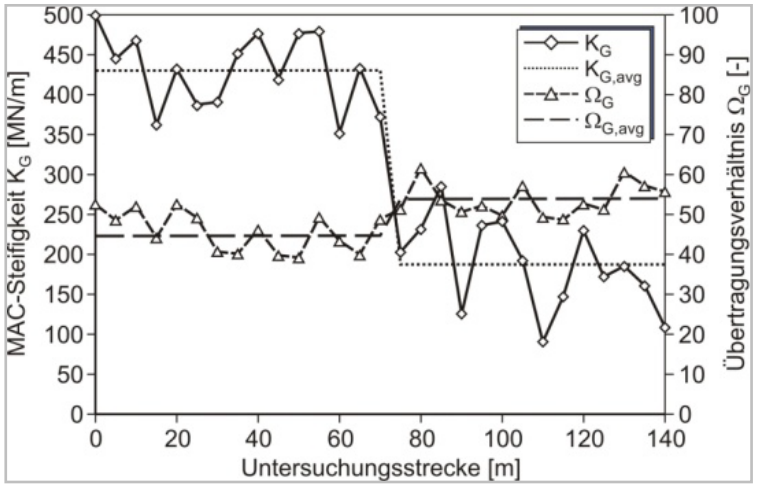
Young's modulus as a percentage of the theoretical new condition



Results of the MAC-Tests 1/3

Results of the MAC Test

- Classification into homegenious sections
- Uniformity of the pipe-soil system
- Locating weak points in the pipe-soil system
- Defining locations for core sampling



Determination of Structural Capacity

- Separation of pipe and soil by FE calculation
- Determination of e-Modulus of pipe and soil
- Structural calculation according to
  ATV-A 127 (trench laid pipes) or DWA A 143-2 (CIPP-Liners)

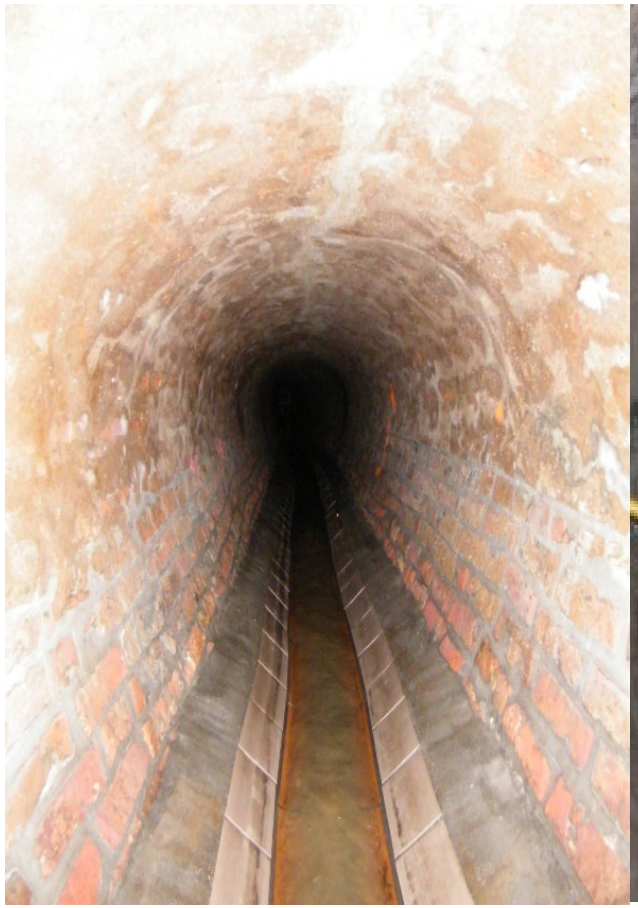
Results and Findings of the MAC-Tests 2/3

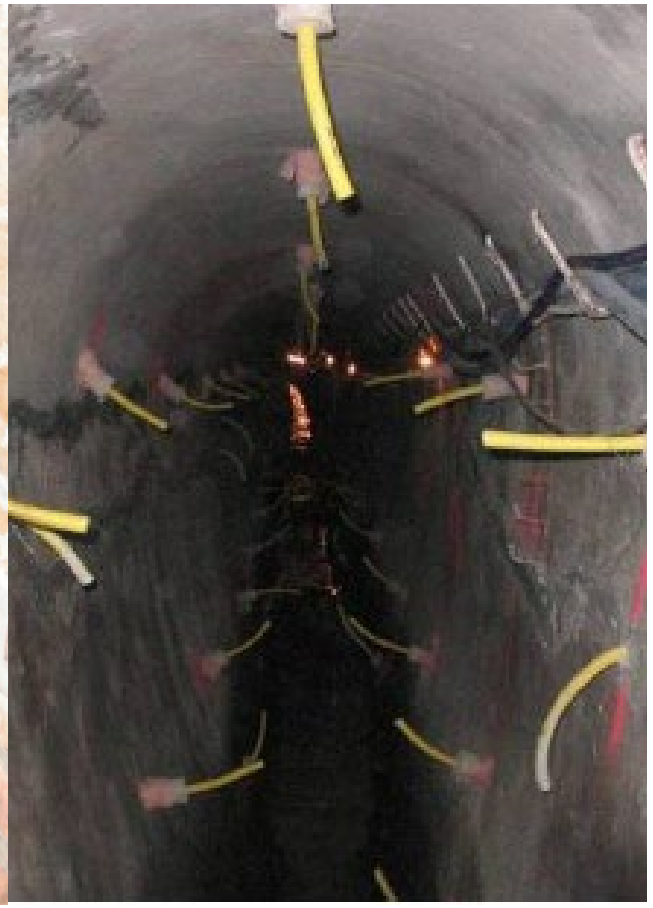
Rehabilitation Analysis

- Subdivision into rehabilitation zones
- Host pipe condition I / II
- Structural preservation / sealing / hydraulics / soil improvement

Selection and Implementation

- Selection of methods and materials
- Implementation of rehabilitation work





Results of the MAC-Tests 3/3

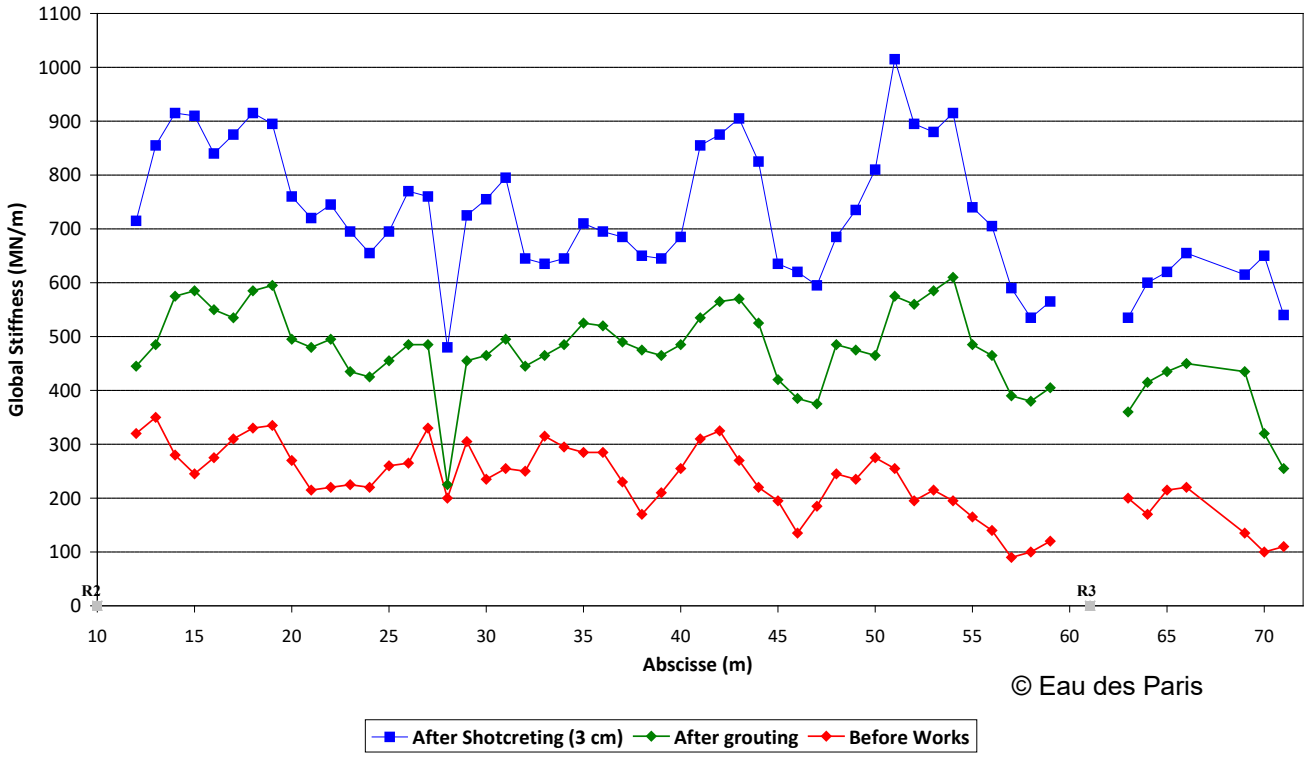
Quality Assurance of Rehabilitation

- Repeat MAC Test
- Direct before-and-after comparison

Verification of long-term effectiveness

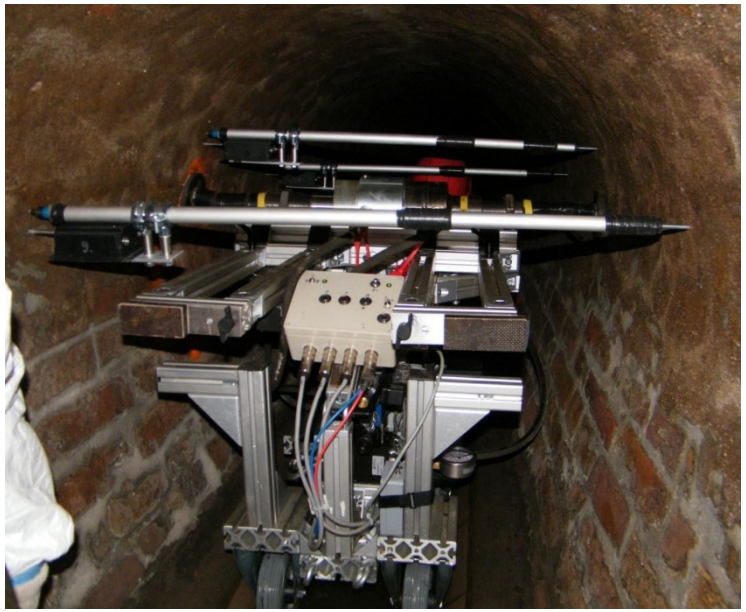
MAC-Tests at defined intervals

- Development over a longer period

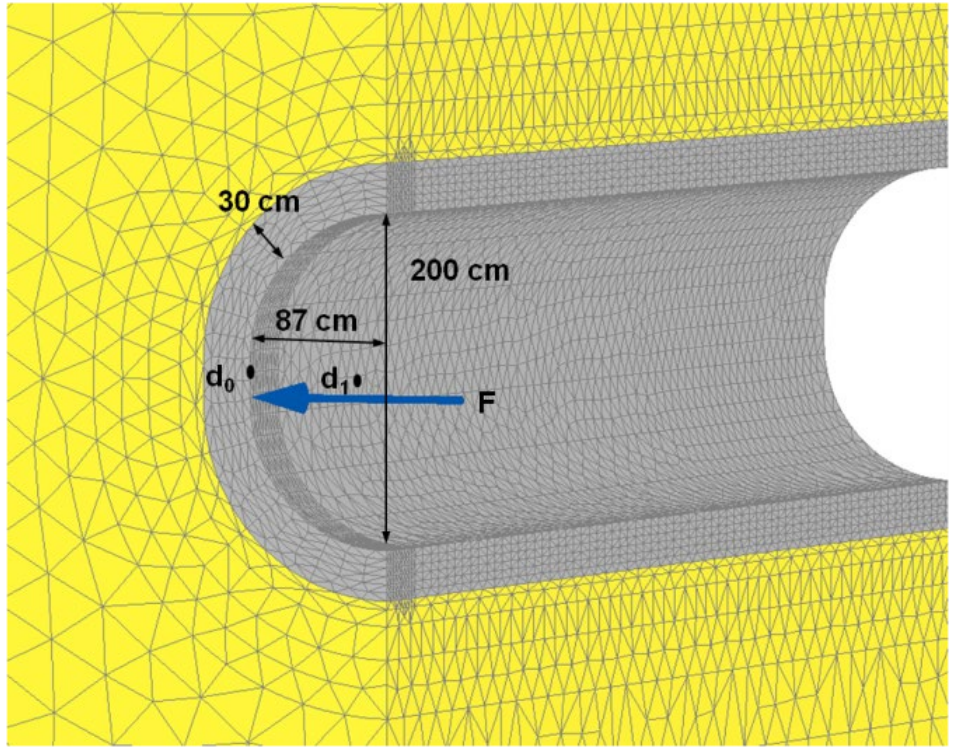


Complete Package 1/2

1. **MAC-Test:**
   Determination of system parameters: K_G und Ω_G



2. **FE calculation:**
   Convert system parameters into Young's moduli of sewer and soil



3. **Structural calculation:**
   Structural stability

Complete Package 2/2

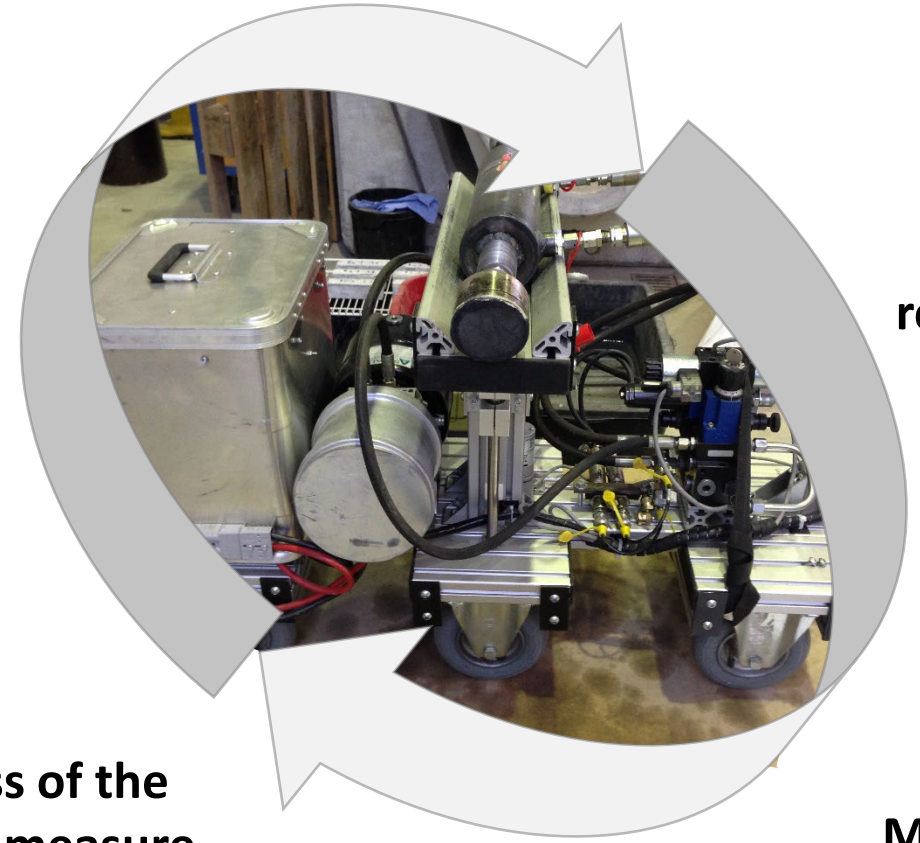
1 Find weak point in the sewer

2 Determine rehabilitation method

3 Monitoring of rehabilitation

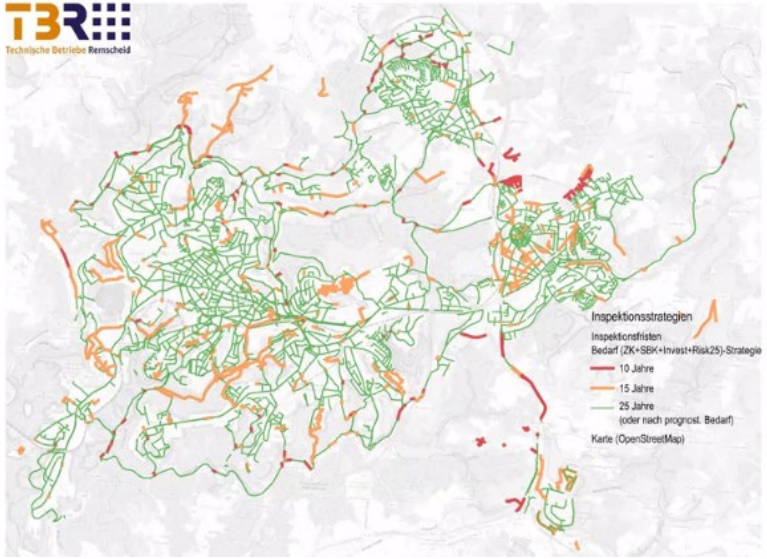
4 Verify success of the rehabilitation measure in the sewer

5 Demonstrate long-term effectiveness of the measure



AI based forecast of sewer condition

AI-based forecast of condition development and optimisation of inspection and cleaning strategies, etc.



1. Ageing model
2. Remaining useful life
3. Risk
4. Implementation of the inspection strategy

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