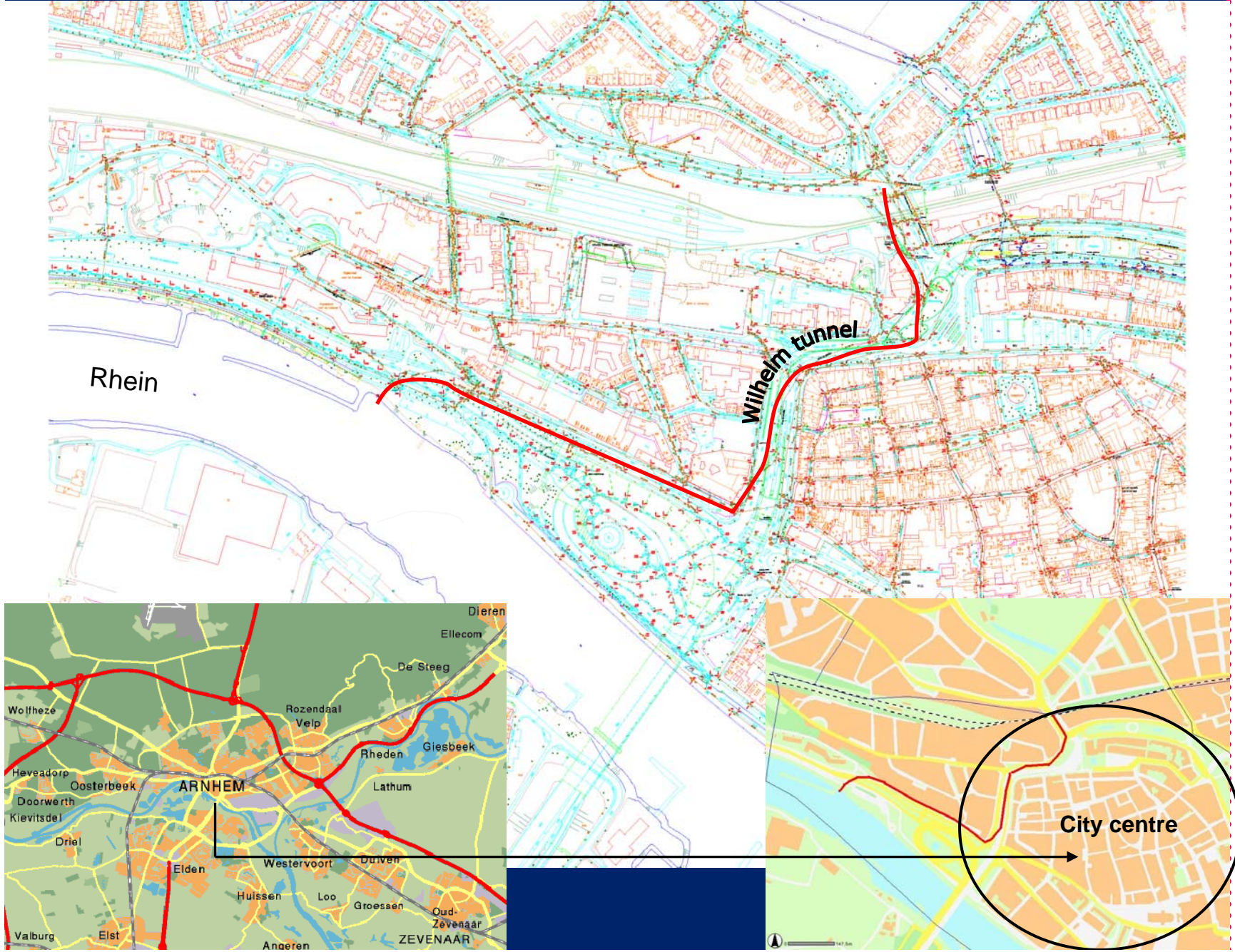


MOERRIOOL

“The great main sewer of Arnhem”



Location



Engravings 1909

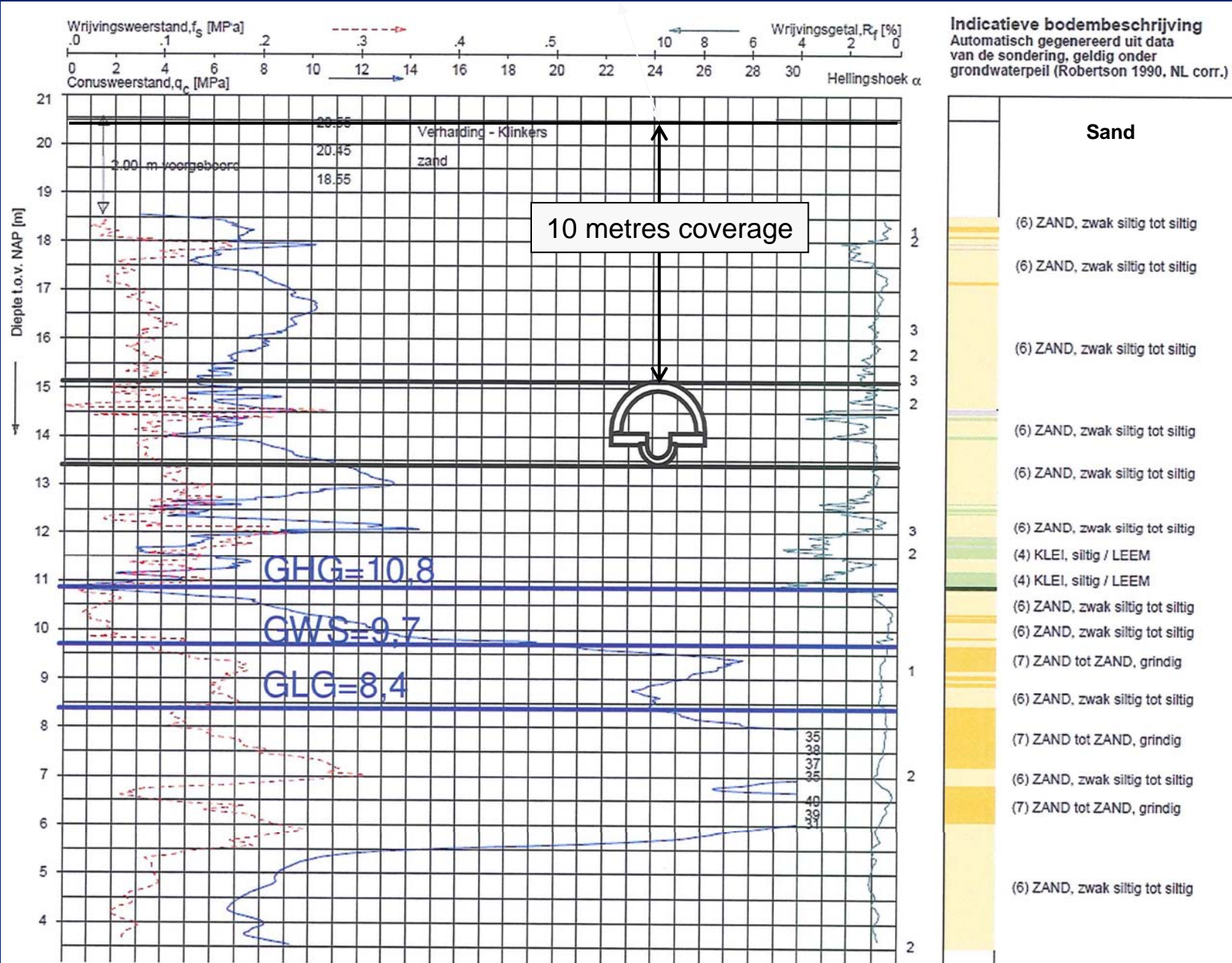


J.E
XXV III
1909

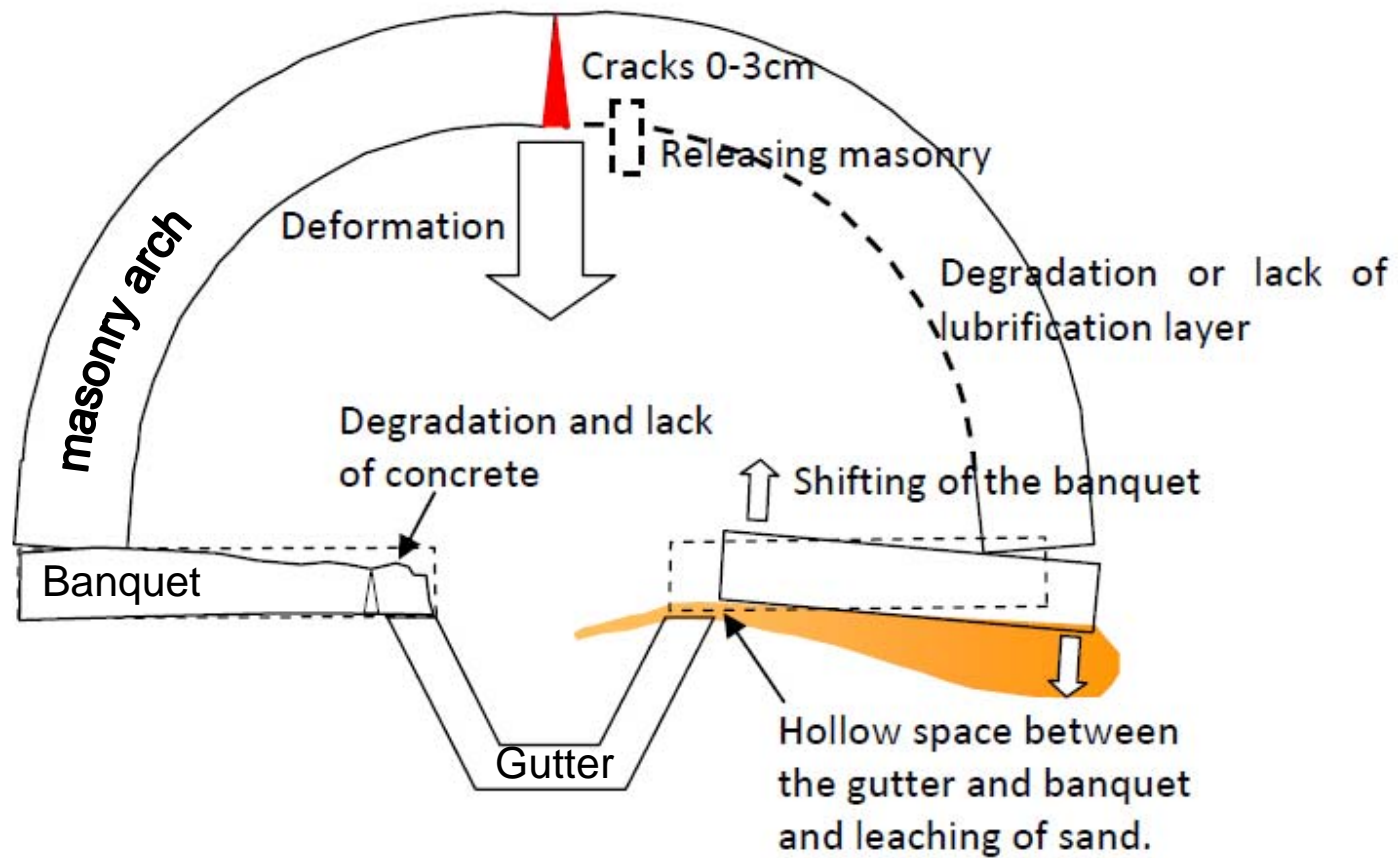


Inside view Sewer

Sewer shape with coverage soil



Structure of Moerriool, cross-section



Banquets in detail



Corrosion damage

Sags with inclination
(bedding material flushed out)



Cracks in the masonry arch



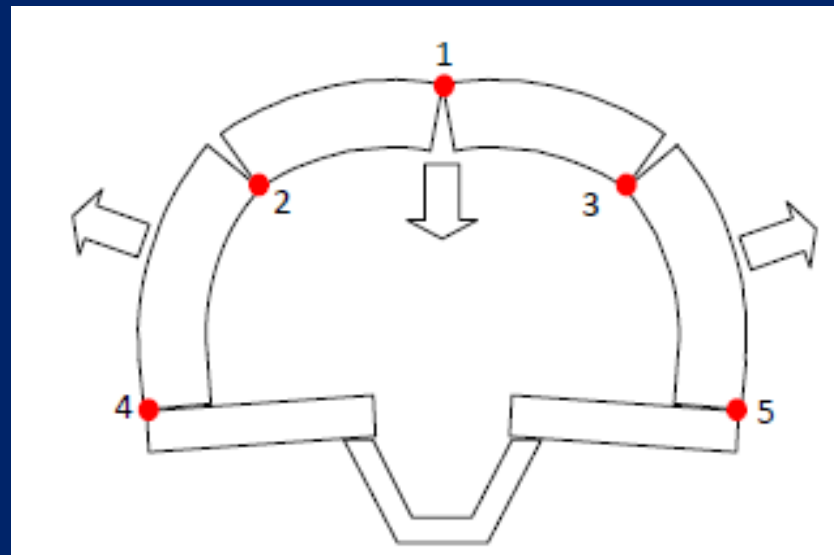
Crack 1



Crack 2 and 3

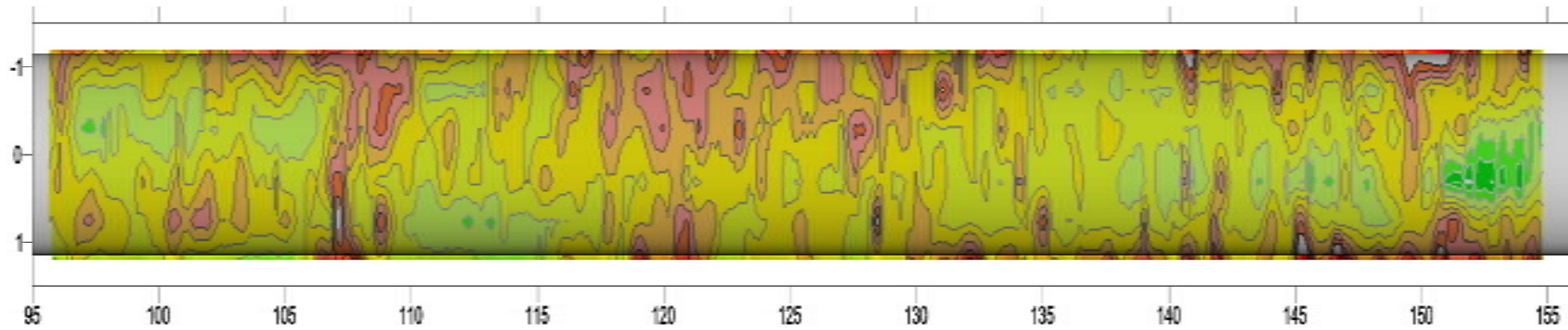


Crack 4 and 5

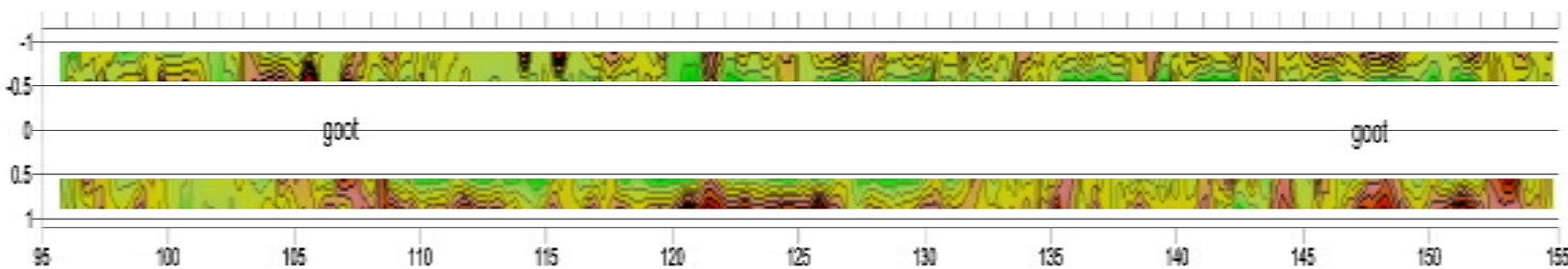


Location cracks

Radar images Wilhelm tunnel



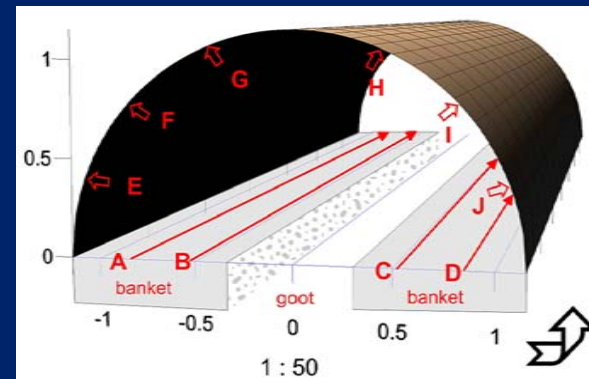
Around masonry arch



Under Banquets

Stabile Zone

Instabile Zone



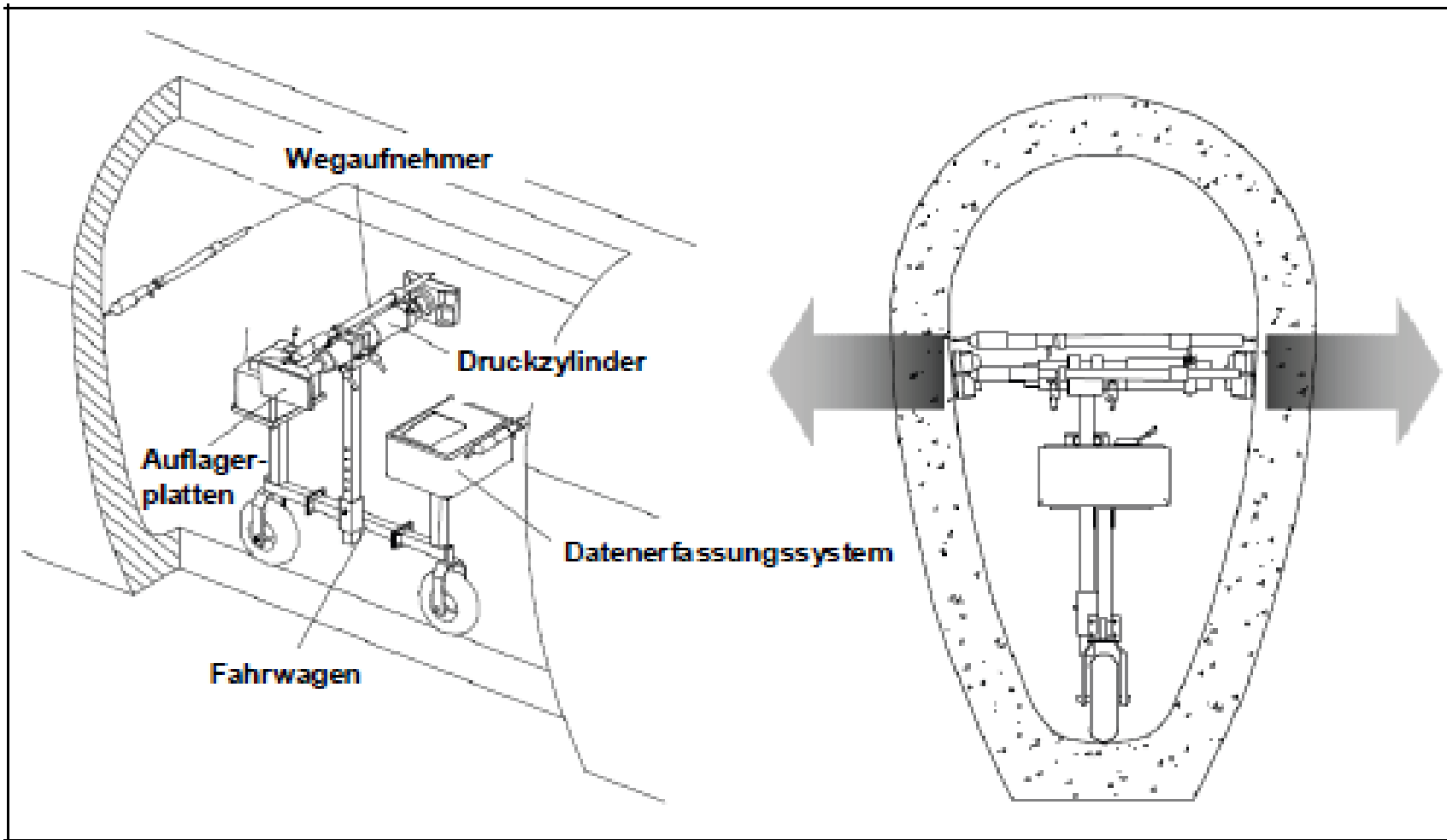
Discussion



Safety Risk Analysis



The MAC – testing device



MAC Process

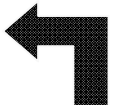


Condition assessment of large sewers

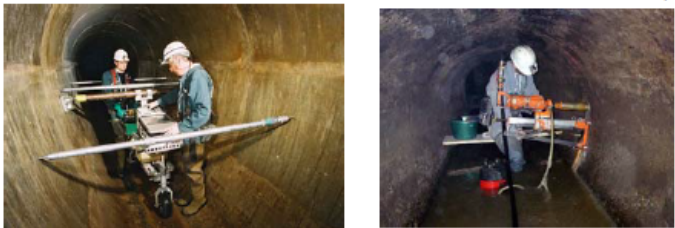
(Zustandserfassung begehbare Kanäle)
(Schritt 1: Kanalbegehung)



Step 1
Person-entry inspection



(Schritt 2: Prüfungen (zerstörungsfreie kombiniert mit zerstörenden Techniken))



Step 2
Testing (non destructive combine with destructive technique)



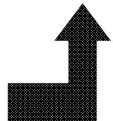
MAC testing
(MAC-Untersuchung)

Coring
(Kernbohrungen)

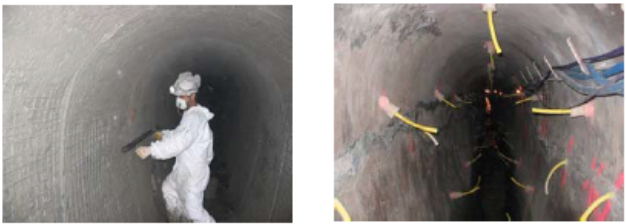
Bad	(Schlecht)
Average	(Durchschnitt)
Fair	(Gut)

(Schritt 3: Bewertung des baulichen und betrieblichen Zustandes)

Step 3
Structural and service condition ratings



(Schritt 4: Sanierungsmaßnahmen (Injektionen, Spritzbeton))



Step 4
Rehabilitation actions (grouting, shotcreting...)



Practise MAC - testing device



Hydraulic Press

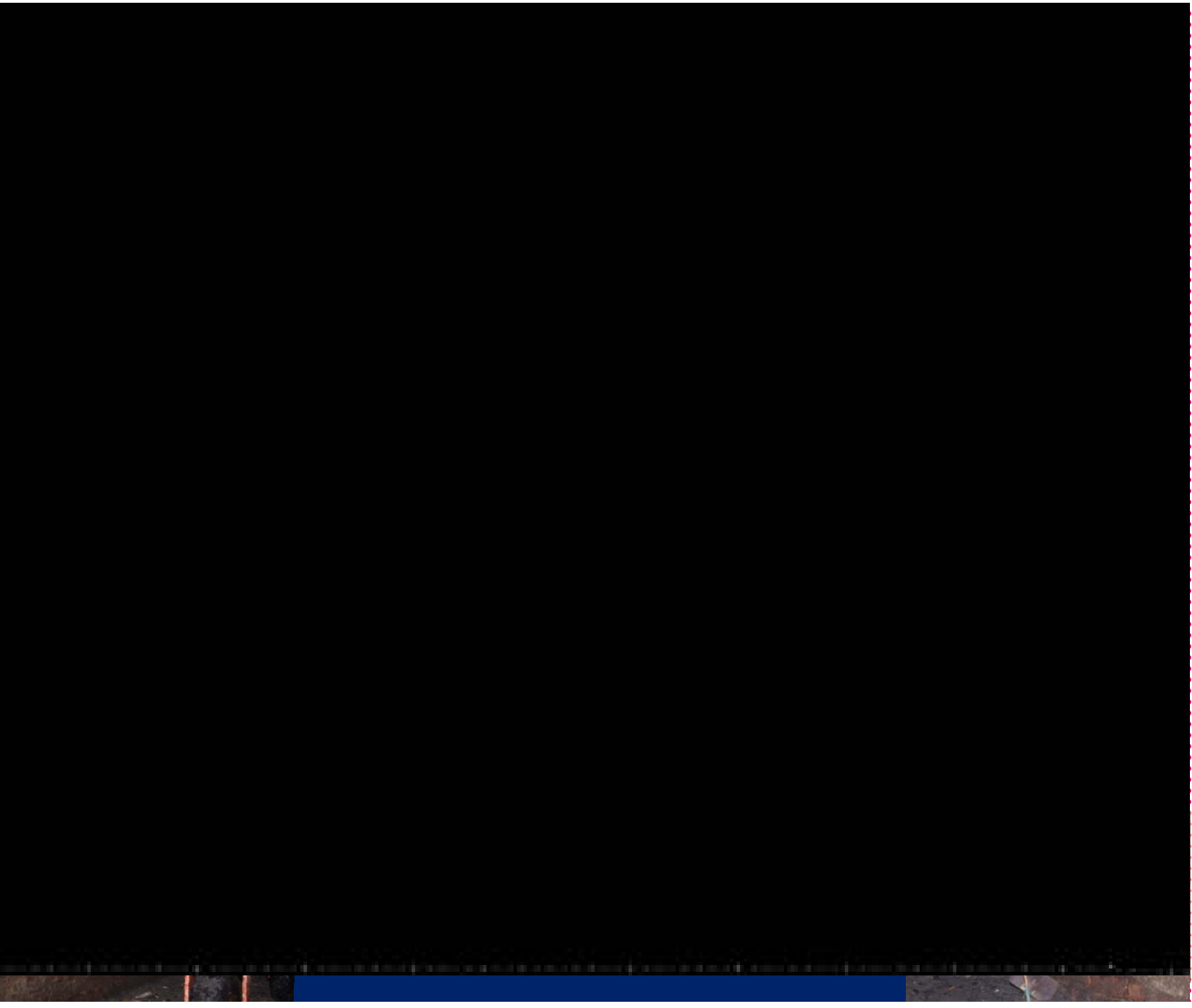
Displacement transducers



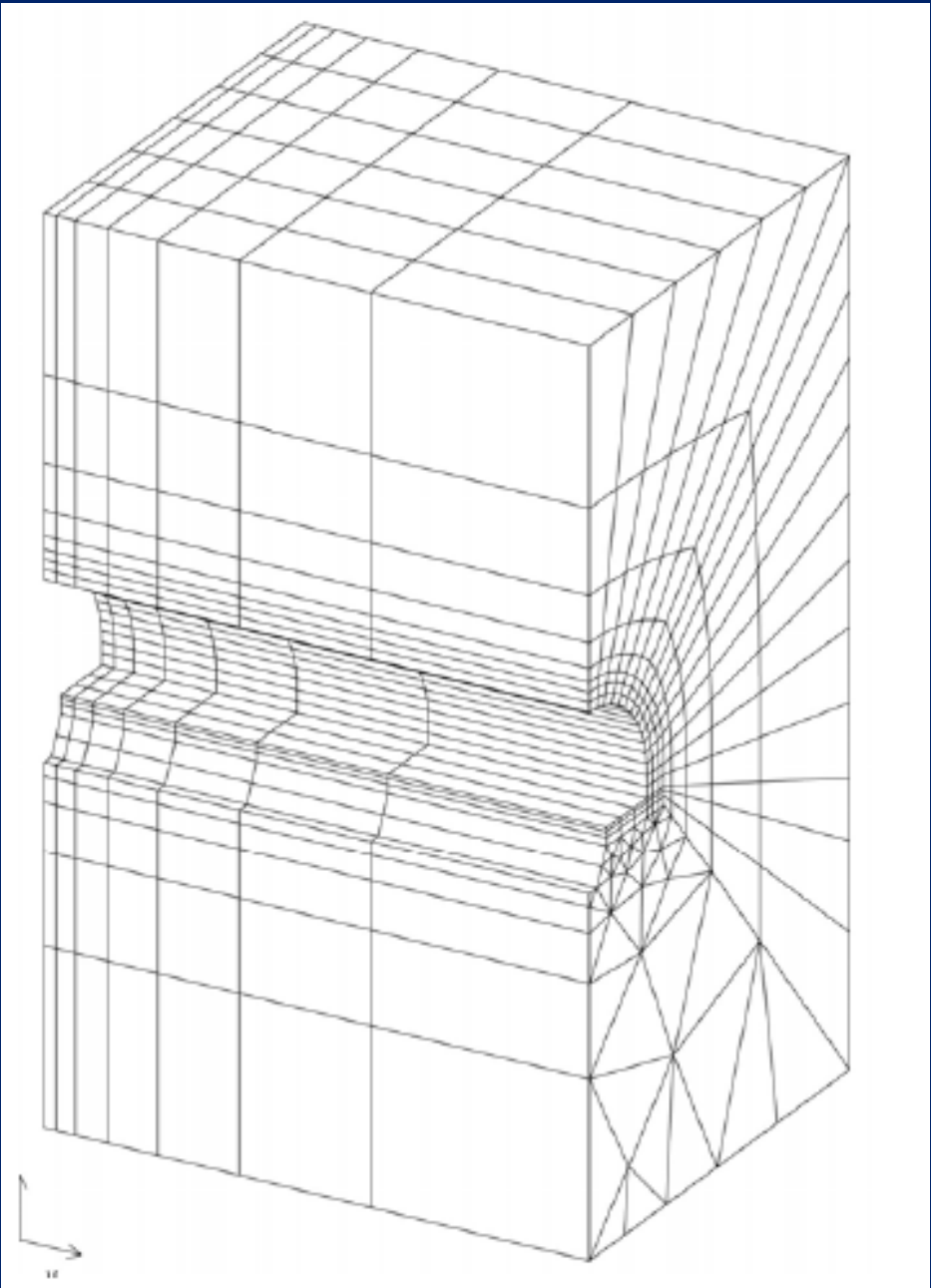
Detail
Press



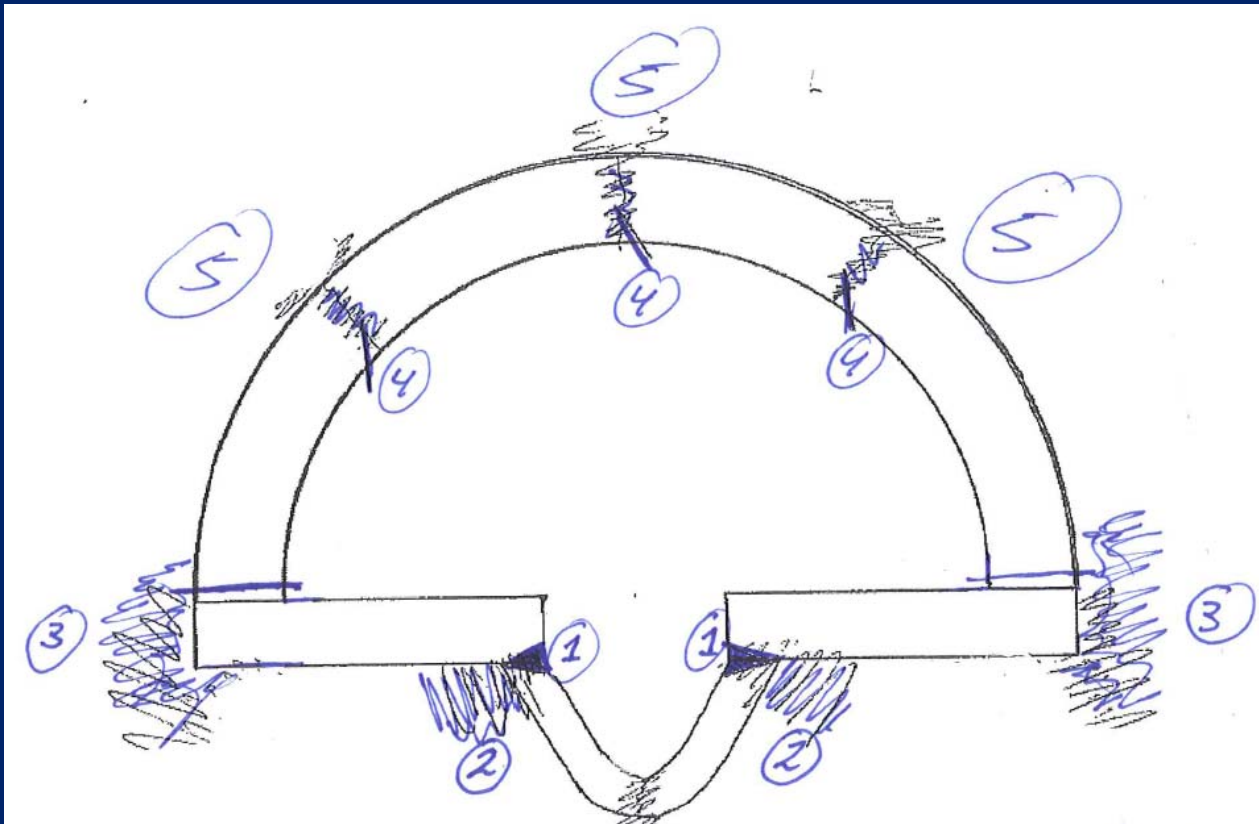
Detail
Sensor



Structural analysis



Urgent Measures



1. Mortar injection Banquets;
2. Polyurethan Injection between / behind Banquets and Gutter;
3. Polyurethan Injection behind Banquets and brickwork arch;
4. Sealed and Reprofiled upper crack areas;
5. Polyurethan Injection the upper cavities.

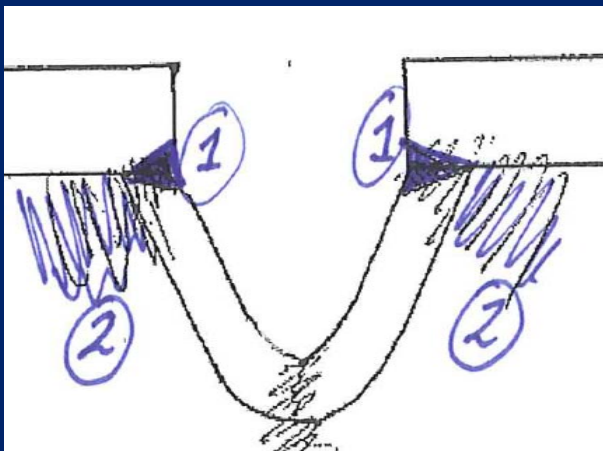
1: Gab between gutter and banquet filled with mortar



befor



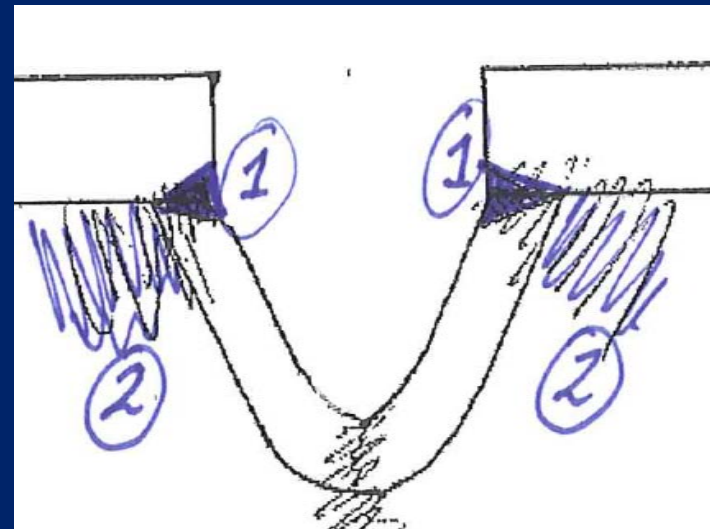
after



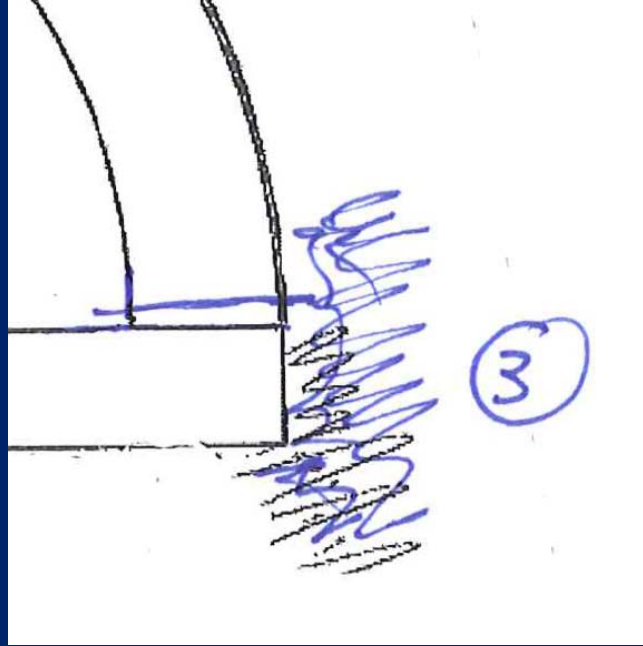
2: Injection packers for Polyurethane Injection Between / behind Banquets and Gutter



Polyurethan



3: Injection behind Banquet and masonry arch



4: Upper Cracks sealed with Polyurethane and reprofiled with mortar



5: Upper cavities filled with injection material



Mobile construction

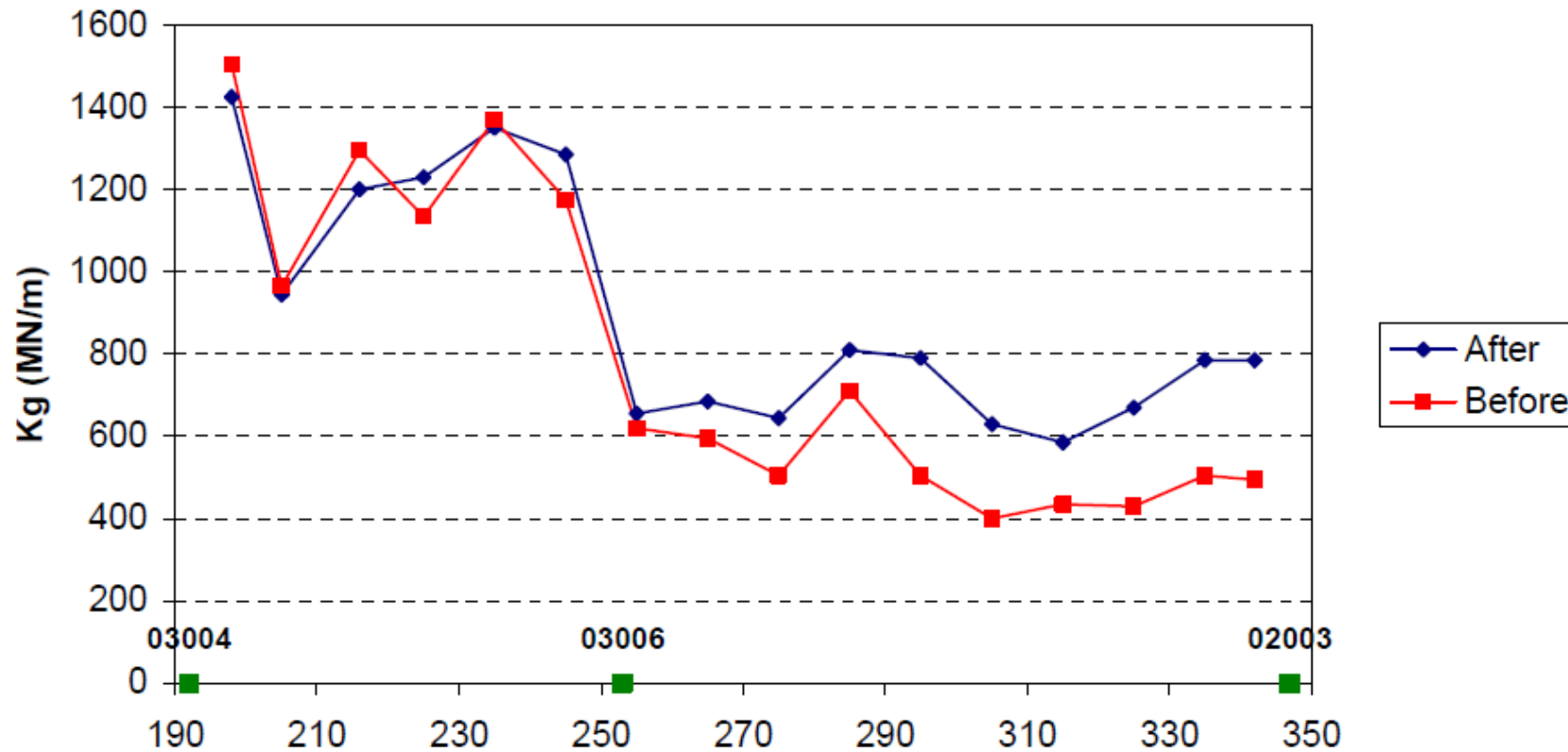


Laser measurements



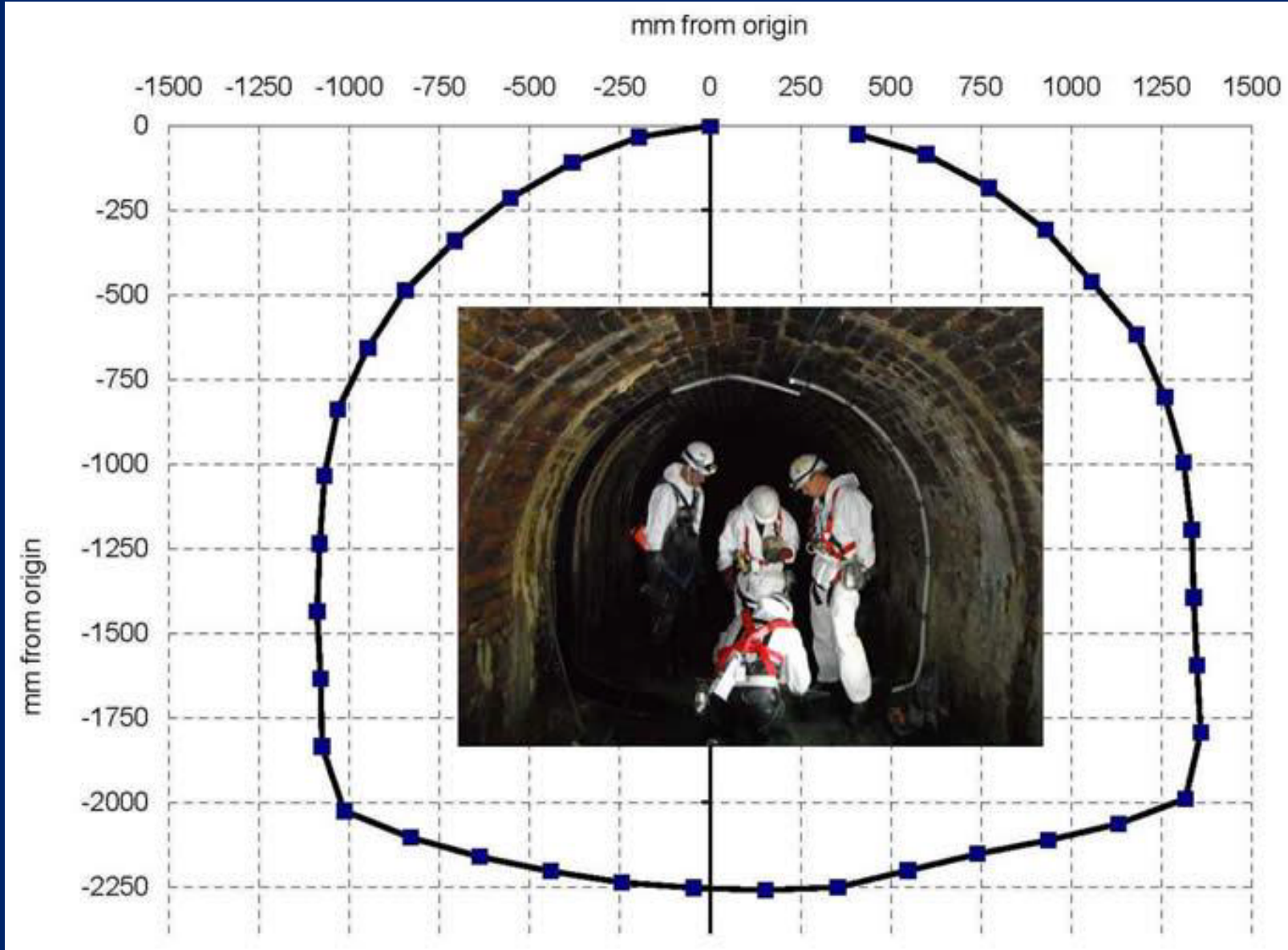
Global Stiffness Moerriool after PU-Injection

ARNHEM - MOERRIOOL - MAC test
From manhole 03004 to manhole 02003 - 149 mL
Global Stiffness before and after Works (PU injection)

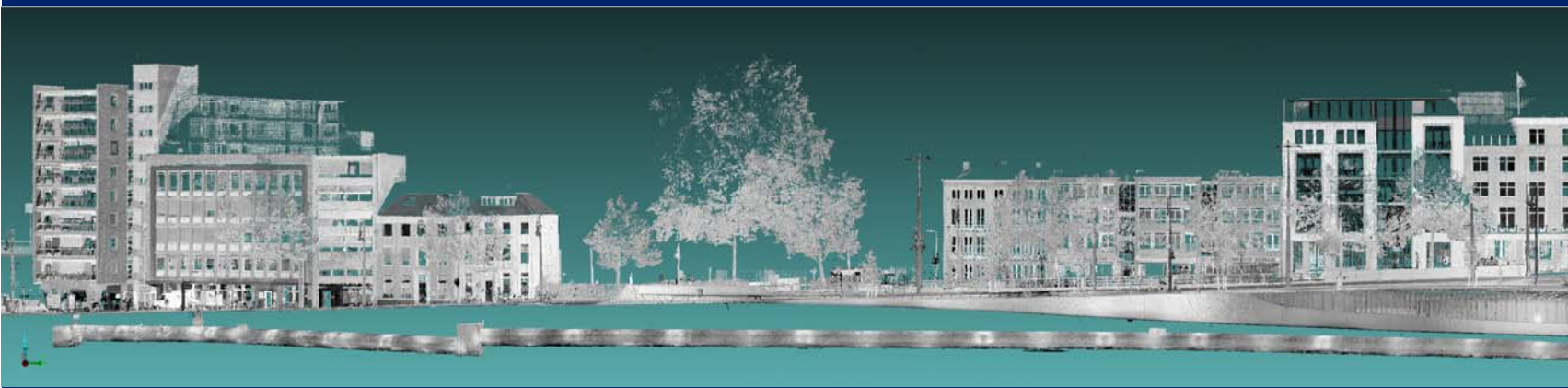
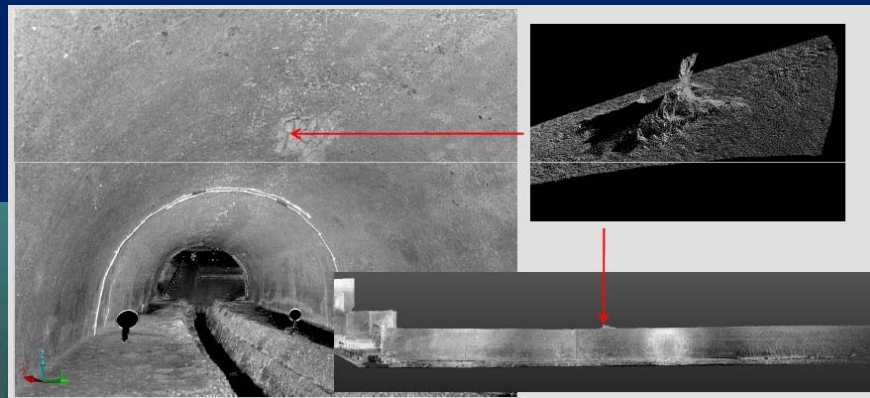


Critical areas between 250 and 350 = +53.2%.

Monitoring System Shape Accel Array Field (SAAF)



Laser scan “Starting Situation”

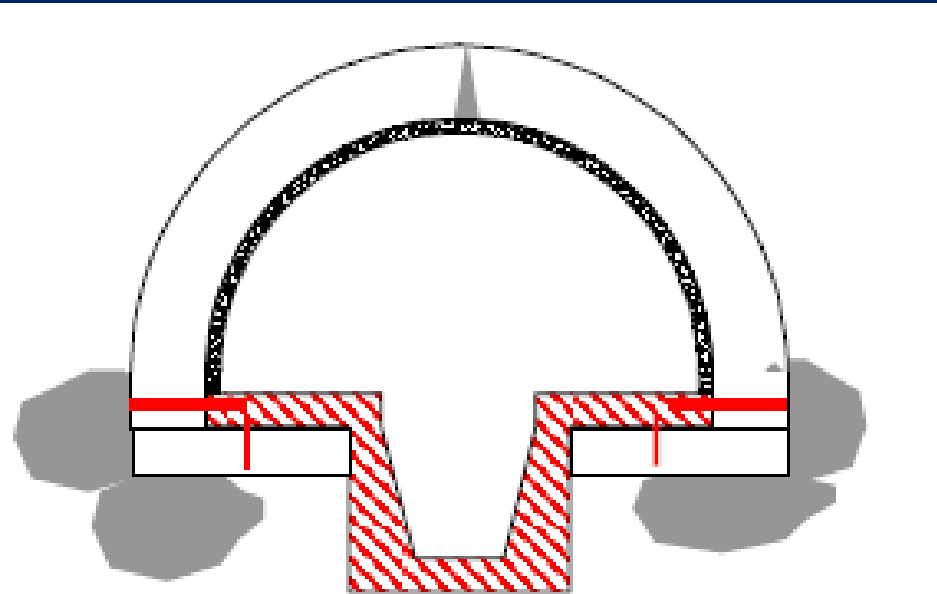


Further steps



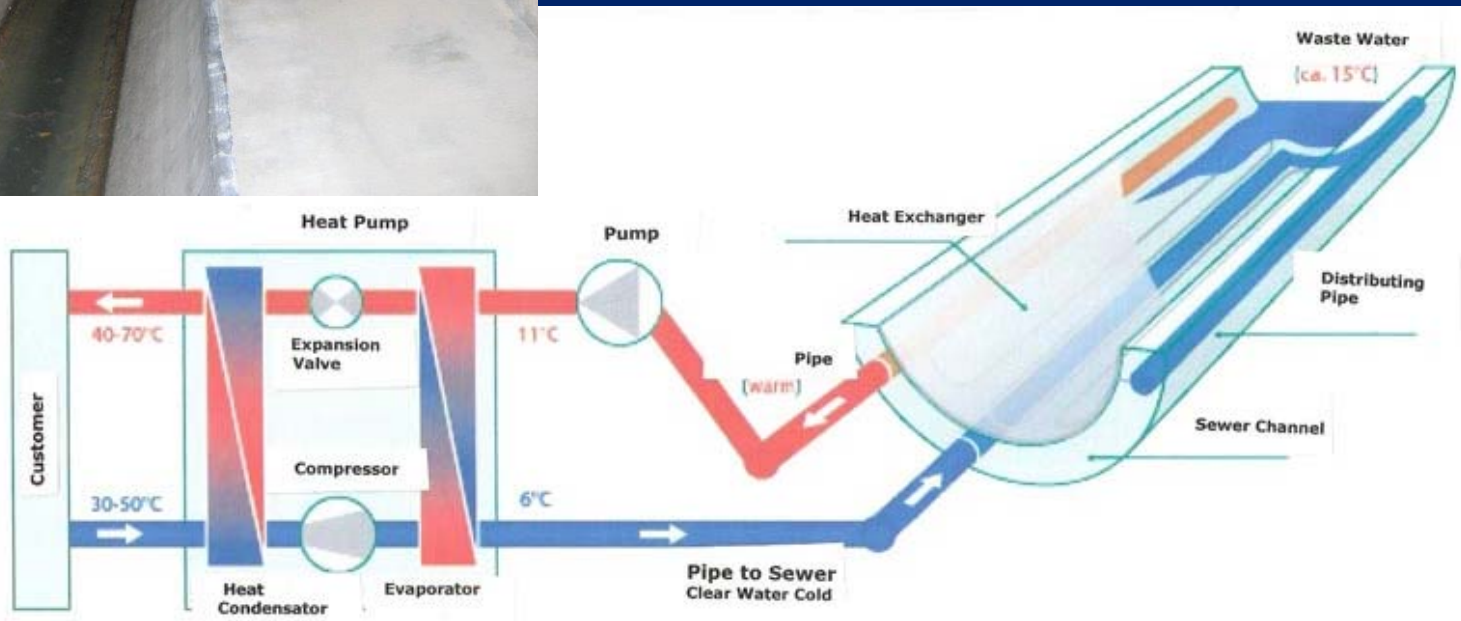
Lining of the brickwork with shotcrete

Reconstruction of the gutter and the banquet



Energy

Heat recovery from Waste Water



Thank you for your attention.

