

Table 3. Results, Case 1: Lateral reconnection to a liner-rehabilitated main sewer IKT Comparative Product-Test of repair methods for lateral connections



Rehabilitation task: Rehabilitation of three damage scenarios in each case in a liner-rehabilitated concrete main sewer (DN 300)

- Damage Scenario I: "Defective (leaking) sewer connection" at the side zone of the main sewer (45° angle to/in the main sewer's longitudinal axis); DN 150 vitrified-clay pipe is presented up to the concrete pipe (main sewer); influx of groundwater at start of rehabilitation
- Damage Scenario II: "Defective (leaking) sewer connection" at the crown of the main sewer (90° angle to the longitudinal axis of the main sewer); DN 150 vitrified-clay pipe is inserted into the concrete pipe (main sewer) at a distance from the CIPP liner of approx. 2 cm
- Damage Scenario III: "Defective (leaking) sewer connection" between side zone and crown of the main sewer (45° bend outgoing perpendicular to the longitudinal axis of the main sewer); DN 150 vitrified-clay pipe is inserted (to approx. half wall thickness of the concrete pipe) into the concrete pipe (main sewer)

Contractor	Kuchem GmbH	KATEC Kanaltchnik Müller & Wahl GmbH	Swietelsky-Faber GmbH Kanalsanierung	PLITT-ROHRSANIERUNGS-GESELLSCHAFT mbH	Onyx Rohr- und Kanal-Service GmbH	IBG HydroTech GmbH ¹
Robot-based method using Resin system	KA-TE PMO with EPOXONIC EX 1824 rapid	KA-TE PMO with EPOXONIC EX 1013 EPOXONIC EX 1824 rapid MC BAUCHEMIE Korodur Roboprox 10	KA-TE PMO with resimovation Harz 10	KA-TE PMO with Sika Robotec 61	KA-TE PMO with EPOXONIC EX 1355 EPOXONIC EX 1824 rapid	IBG HydroCut injection system with EPOXONIC EX 1824 rapid
IKT test results	VERY GOOD (1.5)	GOOD (1.6)	GOOD (2.0)	GOOD (2.3)	ADEQUATE (3.9)	DEFICIENT (5.0)
System tests in test lengths (85 %)	Good (1.6)	Good (1.8)	Good (2.0)	Good (2.5)	Adequate (4.0)	Inadequate (5.6)
Functionality² (50 %)	2.2	2.1	2.2	1.7	3.2	5.1
after completion (20 %)	2.2	1.9	2.1	1.6	3.2	5.1
after HP cleaning (80 %)	2.2	2.2	2.2	1.7	3.2	5.1
Tightness³ (50 %)	1.0	1.4 ⁴	1.8	3.3	4.8	6.0 ⁴
Short-term groundwater exposure 2.0 m (20 %)	1.0	1.0	1.0	2.5	4.0	6.0
Long-term groundwater exposure 2.0 m (80 %)	1.0	1.5	2.0	3.5	5.0	6.0
Quality assurance⁴ (15 %)	Very Good (1.0)	Very Good (1.0)	Good (2.0)	Very Good (1.0)	Satisfactory (3.0)	Good (2.0)
Process manual (20 %)	+	+	+	+	+	+
Operator training (20 %)	+	+	+	+	-	+
Test certificates for materials used (20 %)	+	+	- (no DIBT approval)	+	+	+
Third-party supervision (20 %)	+	+	+	+	+	-
No particular abnormalities (20 %)	+	+	+	+	- (Material use-by date expired)	+
Additional information:						
Impression from on-site investigations	Practically-orientated implementation	Practically-orientated implementation	Practically-orientated implementation	Practically-orientated implementation	No date possible	No date stated
External water-pressure load 4.50 m	6x no problem	4x no problem, 1x infiltration, 1x not evaluated	4x no problem, 2x discoloration/noise	4x no problem, 2x discoloration/noise	2x no problem, 3x infiltration, 1x discoloration/noise	5x infiltration, 1x not evaluated
Internal pressure testing at 0.5 bar after completion of the test programme and opening	5x tight, 1x not tight	3x tight, 1x not tight, 2x not evaluated	3x tight, 3x not tight	2x tight, 3x not tight, 2x not evaluated	3x tight, 3x not tight	5x not tight, 1x not evaluated
Visually apparent abnormalities from HP cleaning (max.)	6 abnormalities	3 abnormalities	No abnormalities	3 abnormalities	1 abnormality	No abnormalities
Year of manufacture of robot	approx. 1997	approx. 2008	2011	not known	approx. 1992	approx. 2012
Days of use on site	2.5 days	3.5 days	3 days	3.5 days	4.5 days	4.5 days
Time needed for rehabilitation (cutting) of 6 lateral connections (ca.)	9.3 hours (7.1 hours)	13.0 hours (4.6 hours)	16.5 hours (7.6 hours)	15.8 hours (11.0 hours)	21.1 hours (7.3 hours)	26.8 hours (3.8 hours) ⁵
Material consumption for 6 lateral connections (ca.)	30 kg	34 kg	32 kg	41 kg	32 kg	27 kg
Costs per lateral connection (net) ⁶ depot (ca.)	670 €/NRW	810 €/NRW	880 €/NRW	630 €/Lower Saxony	650 €/Lower Saxony	440 €/Hesse

1. All cutting work was performed by contractor Hocht Dröge; this company also supplied the equipment for further work.
 2. Evaluation using visual assessment by municipalities by means of award of grades (1-6), decimal places permissible (20 % weighting after completion; 80 % weighting after HP cleaning)
 3. Evaluation on the basis of external water-pressure exposure. Grades awarded by points: No infiltration 0/green; Problems - 0.5/yellow; Perceptible infiltration - 1.5/red. 0 points = 1.0; 1 point = 2.0; 2 points = 3.0; 3 points = 4.0; 4 points = 5.0; above 5 points = 6.0
 4. Damage Scenario 2: NF lined pipe, not evaluated due to cracking in connecting sewer (causes not clearly apparent)
 5. Evaluation: "+" = demonstrated; "-" = deficient; Approval/Certificates/Analyses must apply to the materials used in the test
 6. Three lateral connections were injected a second time
 Evaluation key for test results: Very Good = 1.0 - 1.5; Good = 1.6 - 2.5; Satisfactory = 2.6 - 3.5; Adequate = 3.6 - 4.5; Deficient = 4.6 - 5.5; Inadequate = 5.6 - 6.0