TEST REPORT: P07104-T03

Gelsenkirchen, August 9, 2018

Customer:	**Obduramus Umwelttechnik GmbH** **Brückenäckerstraße 2** **75328 Schömberg**
Test order no.:	**P07104**
Name of the test order:	**Practical testing and water leak testing of the Circum-MINI interior pipe sleeve** Testing the high pressure flushing stability per procedure 2 of DIN 19523 and leak testing per DIN EN 1610
Name of customer:	**-**
Date of order:	**22/05/2018**

This test report comprises 12 pages.

The test results pertain exclusively to the test specimens. The test report may be duplicated in part only upon written approval from the IKT – Institute for Underground Infrastructure.

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Samples

Name of sample			Entered on	Sample produced by	Description of test specimen
Con-secu-tive No.	IKT (test facility)	AG			
1	Circum-MINI DN 300	Test specimen: Circum-MINI Nominal width: DN 300 Seal material: EPDM Seal length: 350 mm Rubber thickness: middle area: 2 mm sealing lip area: 8 mm sleeve material: V4A sleeve length: 420 mm trial segment 1: PVC-PVC trial segment 2: Stoneware-stoneware trial segment 3: Concrete-concrete	01/07/2019	AG	Interior pipe sleeve Circum-MINI DN 300 of EPDM with stainless steel sleeve

Tests implemented

	Test type	Test specification	Test specimen no.
1	High pressure flush stability, practical testing	DIN 19523, procedure 2	Interior pipe sleeve Circum-MINI -1 to -3 DN 300 of EPDM with stainless steel sleeve, installed in the respective trial segments
2	Leak testing with water as the test medium	DIN EN 1610 with visual evaluation of the seal	

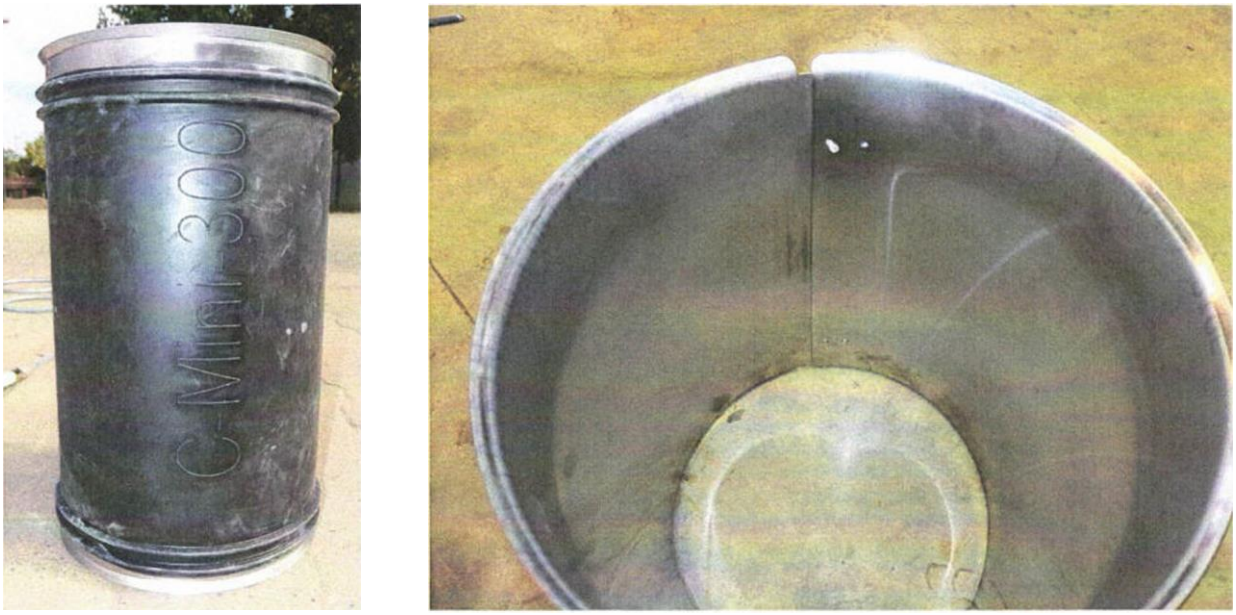


Figure 1: Interior pipe sleeve Circum-MINI DN 300

1. Reason for test and test specimen

On May 22, 2018 the Obduramus Umwelttechnik GmbH ordered IKT to implement the testing of high pressure flush stability per procedure 2 DIN 19523 on interior pipe sleeves of the type Circum-MINI (abbreviation: C-MINI).

Additionally, the leak test per DIN EN 1610 was ordered, with water as the test medium, as well as pre- and post testing of high pressure flush stability.

The Circum-MINI comprises an EPDM seal and a stainless steel sleeve with an external closure. Clamping the stainless steel sleeve by means of a packer presses the EPDM seal to the pipe's interior wall, so that the sealing lips at the ends seal the sleeves to the sewer in accord with the principle of compression sealing. Retightening the sleeve is possible at any time.

2. High pressure flush stability testing (practical testing)

2.1 Trial setup and trial implementation

The basis for the high pressure flush trial is DIN 19523, procedure 2 – practical testing, in which the requirements of the high pressure flush stability of pipe materials are defined. For practical testing, the following three trial segments of nominal width DN 300 are set up (see Figure 2):

- Trial segment 1: Stoneware-stoneware, entire length 5 m
- Trial segment 2: Concrete-concrete, entire length 5 m
- Trial segment 3: PVC-PVC, entire length 4 m

Before setting-up the trial segments, leaks were created in the pipe connections of these segments through the partial or complete removal of seals. The installation of the Circum-MINI over the pipe connections then resealed these again.

Before the start of testing, the installed Circum-MINI interior pipe sleeves were inspected visually with respect to anomalies by an IKT employee. Thereby, no visually determinable anomalies were observed.

Figure 2: Test segment 1 (stoneware-stoneware), test segment 2 (concrete-concrete) and test segment 3 (PVC-PVC) DN 300

Testing took place on July 11, 2019 on the IKT outside area with an ambient temperature of approx 18 °C and a water temperature of approx. 20 °C.

The test implementation included a total of 60 cleaning cycles without nozzle downtime in the area of the trial segment. One cycle thereby respectively comprises the injection and pulling the nozzle back through the entire pipe line. For the testing, an 8-blast radial blast nozzle (Figure 3) at a length of (17 +/- 0.5) cm, a weight of (4.5 +/- 0.1) kg and a nozzle body diameter of (8 +/- 0.5) cm is used.

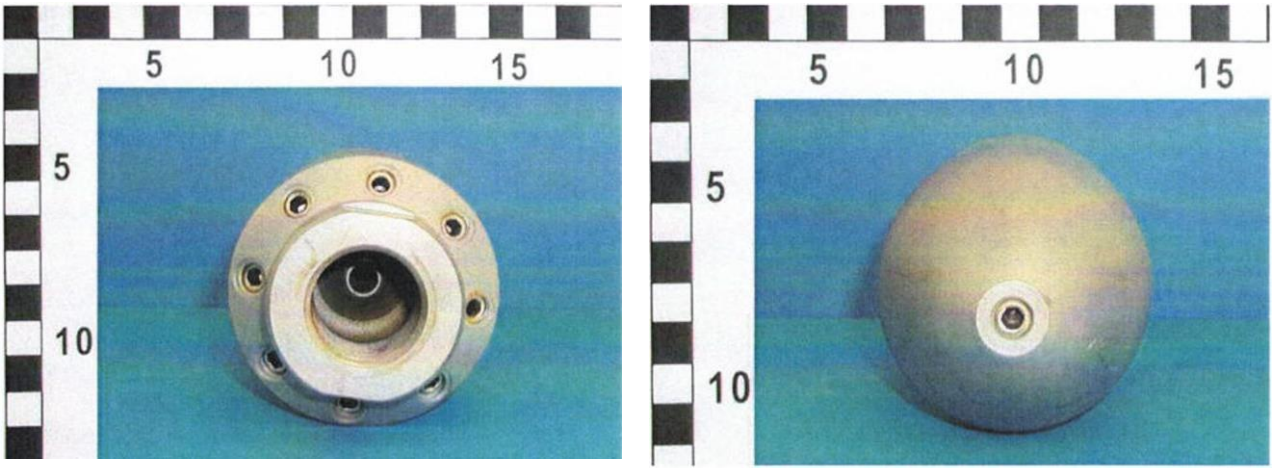


Figure 3: Test nozzle

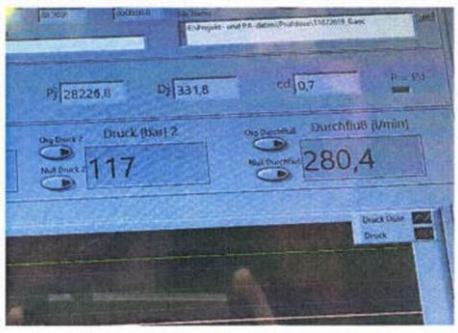
In detail, the following test parameters are to be maintained when implementing the trial:

Flow rate Q:	280 l/min to 285 l/min
Blasting angle α:	(30 ± 1)°
Nozzle assembly-Ø d before and after testing:	(2.60 ± 0.02) mm
Feed speed:	(1.0 ± 0.1) m/s
Pull-back speed:	(0.1 ± 0.02) m/s
Number of test cycles:	60
C_d-value before and after the testing:	≥ 0.7
Flush blast sealing capacity D_j before and after the test:	(330 ± 15) W/mm^2

Before the start and after concluding the testing, the pressure is determined not farther than 0.1 meter from the nozzle body at a volume flow of between 280 l/min and 285 l/min by using a pressure sensor (see Figure 4). The volume flow is determined by using a magnetic inductive flow-through measuring system (MID). During the testing the pressure is then monitored via the manometer on the vehicle.

Figure 4: Monitoring the test parameters

Ascertained test parameters:

	Before the testing	After the testing
Pressure at the nozzle [bar]	118	117
Volume flow [l/min]	283.2	280.4
Flush blast sealing capacity D_j [W/mm^2]	342	332
C_d-value	0.723	0.717
Metrology display		

After determining the test parameters, the trial segment is stressed by 60 cleaning cycles (see Figure 5 to Figure 8). Following that, the sleeves are visually inspected.

Figure 5: Trial implementation test segment 1
(direction of flush in the direction of the arrow)

Figure 6: Trial implementation test segment 2
(direction of flush in the direction of the arrow)

Figure 7: Trial implementation test segment 3
(Direction of flush in the direction of the arrow)

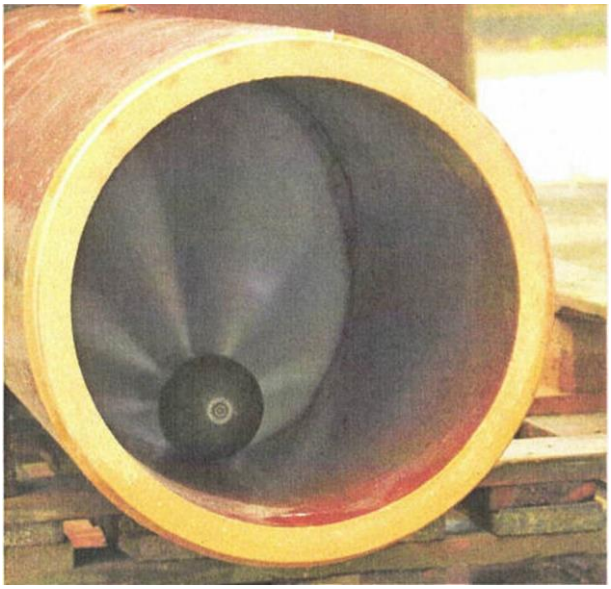


Figure 8: Test nozzle in use

3. Leak testing

The testing for water leakage takes place respectively before and after the testing of high pressure flush stability at all three test segments.

Differing from DIN EN 1610, according to which an addition of water of 0.15 l per m^2 of wetted pipe wall is permissible for the holding leakage test on the construction site in a test time of 30 minutes, a visual check of the test specimen took place here to evaluate the water tightness. Visible leakage of water means the test has not been passed. The interior sleeve must seal the pipe connections during the leakage testing with a test pressure of 0.5 bar for a period of 30 minutes. The test pressure of 0.5 bar is set with a 5 m high water column over the apex of the pipe (see Figure 9). Moreover, the seal of the Circum-MINI in all trial segments and in each load condition was additionally tested with a water internal pressure of 1.0 bar for 30 minutes following the testing of the high pressure flush stability in all trial segments. This test pressure was implemented with a 10 m high water column over the apex of the pipe (see Figure 10).

Securing straps helped prevent the sealing bubble from squeezing out and the individual pipes from sliding apart. (see Figure 9 and Figure 10).

Figure 9: Test setup for the leakage test at 0.5 bar (5 m water column)

Figure 10: Test setup for the leakage test with 0.1 bar (10 m water column)

4. Results

4.1. High pressure flush stability testing (practical testing)

After the stress of 60 cleaning cycles with a flushing blast sealing capacity between 332 W/mm^2 and 342 W/mm^2 and a volume flow between 280.4 l/min and 283.2 l/min, the investigated sleeves for all of the trial segments showed no damage. The stainless steel sleeves show only scratch marks in the base area (Figure 11).

Figure 11: Circum-MINI (interior pipe collar DN 300 after 60 cycles

4.2. seal testing

Subsequently, the results of the sealing testing with water as the test medium were illustrated per trial segment.

Trial segment 1: Circum-MINI, DN300, stoneware-stoneware

Time	test medium	Test pressure [bar]	Testing time [min]	Test criterion	Test passed [yes/no]
Before high pressure flush stability	Water	0.5	30	Visual for water leakage	YES
After high pressure-flush stability	Water	0.5	30	Visual for water leakage	YES
After high pressure flush stability	Water	1.0	30	Visual for water leakage	YES

Trial segment 2: Circum-MINI, DN300, concrete-concrete

Time	test medium	Test pressure [bar]	Testing time [min]	Test criterion	Test passed [yes/no]
Before high pressure flush stability	Water	0.5	30	Visual for water leakage	YES
After high pressure flush stability	Water	0.5	30	Visual for water leakage	YES
After high pressure flush stability	Water	1.0	30	Visual for water leakage	YES

Trial segment 1: Circum-MINI, DN300, PVC-PVC

Time	test medium	Test pressure [bar]	Testing time [min]	Test criterion	Test passed [yes/no]
Before high pressure flush stability	Water	0.5	30	Visual for water leakage	YES
After high pressure flush stability	Water	0.5	30	Visual for water leakage	YES
After high pressure flush stability	Water	1.0	30	Visual for water leakage	YES

5. Summary

The investigated Circum-MINI DN300 interior pipe sleeves from the Obduramus Umwelttechnik GmbH company, which were installed at the pipe connection in a stoneware pipe, a concrete pipe and a PVC pipe, have passed a practical test of high pressure flushing stability per procedure 2 of DIN 19523.

Additionally, the Circum-MINI in the three trial segments and also before as well as following the high pressure flush stability test passed the leakage tests with a test time of 30 minutes and a water pressure of 0.5 bar. Moreover, the interior pipe sleeves also passed the leakage test after testing the high pressure flush stability, with a test time of 30 minutes and water pressure of 1.0 bar. In no case was a water leak determined visually.