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Business Division V – Geotechnics
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Working Group 5.1 – Structural Sealing

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Subject: *Secco horizontal barrier sticks* –
Testing the efficacy of the injection material as subsequent horizontal seal to prevent capillary water absorption in masonry

Client: redstone GmbH
Haferwende 1
28357 Bremen

Sample receipt number: 1745 / 25/08/2016

Testing period: September 2016 - May 2017

Person responsible: Dipl.-Ing. (FH) Kautetzky

This document comprises 6 pages and 2 annexes.

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1 Scope of tasks

The product *Secco horizontal barrier sticks* offered by the company redstone GmbH is to be examined with regard to its efficacy as a subsequent horizontal barrier to reduce capillary moisture transport in masonry. The basis for the efficacy test is WTA Technical Data Sheet 4-10-15/D [1].

2 Basic principles

2.1 General

The following information and documents were available for the examinations:

[1] WTA Technical Data Sheet 4-10-15/D, March 2015: Inspection procedure with certified injection materials to prevent capillary moisture transfer

[2] Material supplied by the client on 25/08/2016: *Secco horizontal barrier sticks*:; Batch number: DRO99EXP0817; sample receipt number: 1745

2.2 Injection material

According to the information from the client, the *Secco horizontal barrier sticks* sealing sticks are profiled rods which are soaked in highly concentrated active substances. They *Secco horizontal barrier sticks* are 18 cm in length and are white in colour in their condition on delivery. The sealing sticks are supplied in packs of 10 in foil bags, and are inserted manually into pre-prepared boreholes.

2.3 Test specimens and test conditions

The subject of the examinations is the efficacy of the injection material in moist masonry. In preparation for the test, three masonry test specimens were prepared according to WTA Technical Data Sheet, Section A.2.4, Fig. 5 using the specified bricks and mortar formula with total dimensions of 74 x 57 x 24 [cm]. The brick batch had the following properties:

• Type of brick	Muhr VMz-12-1,6-NF
• Mean dimensions	240 x 115 x 73 [mm]
• Bulk brick density according to DIN 105, part 1	ρ_f = 1.65 g/cm³
• Compressive strength according to DIN 105, part 1	β_{ST} = 30.0 N/mm²
• Water absorption	14.2% mass

In addition to the large test specimens, three 6-block test specimens were prepared with which the measuring instrument used for the efficacy test was calibrated. The following test conditions were selected in consultation with the client:

Application:	Application by the manufacturer's representative in the presence of an MFPA Leipzig employee
Injection pressure:	without pressure
Insulation:	not necessary / none
Degree of moisture penetration:	95% ± 5% (Table 1, WTA Technical Data Sheet 4-10)
Drilling grid:	single row
Drill hole spacing, single row:	approx. 12 cm, boreholes in the joints
Drilling angle:	approx. 90° (horizontal)
Drilling length:	approx. 18 cm
Hole diameter:	12 mm
Pre-treatment:	Drilled channels cleaned with *borehole cleaner*
Injection:	1 round
Efficacy test:	Moisture measurement with microwave measurement technology, Darr method
Operating principle:	hydrophobic

The masonry body used under the designation PK 7 (test specimen 2) and also moistened to (95 ± 5)% served as a reference test specimen. It was not injected but was subjected to the same test conditions.

3 Description of the tests carried out

3.1 Application of the test specimens

At the time of application, the test specimens were at least three months old. After one month of conditioning and drying, the saturation moisture was adjusted on all test specimens for several weeks by immersing the test specimens with a slowly rising water level in an appropriately large container. After reaching the previously calculated mass, all test specimens were provided with an almost airtight coating and stored in the test hall for a further four weeks until the start of application in order to even out the moisture content.

In preparation for the application, the test specimen to be applied was drilled by the manufacturer's representative. The holes were drilled at an angle of approx. 90° with a depth of approx. 18 cm with low impact energy, Annex 1, Figure 1. A total of 6 holes with a diameter of 12 mm and an average spacing of approx. 12 cm were drilled into each specimen. The residual drilling dust in the drilled channels was removed with the borehole cleaner, Annex 1, . The *Secco horizontal barrier sticks* were inserted into the cleaned drilled channels manually, Annex 1, Figure 3. The boreholes were then sealed with mortar. A total of 6 *Secco horizontal barrier sticks*, each with a length of 18 cm, were inserted into the test specimen. Immediately after application, the trough-like carriers were filled with water and the rear and side surfaces of the test specimens were sealed airtight. At the beginning of the efficacy test the test specimens were wrapped airtight on all sides with a shrink film without covering the top.

3.2 Efficacy test

During the efficacy test, all test specimens are placed in a water bath so that half of the lower brick layer is constantly immersed in water. At regular time intervals at previously marked measuring points (three measuring points in each of the 1st to 4th brick layers from above), the moisture distribution is measured (moisture indices) with a microwave measuring device, Annex 1, Figure **4**. The mean value is calculated from all the values measured on a test specimen at one time. The efficacy is assessed on the basis of the comparison between the reference test specimen and injected test specimens, taking into account the comparative values determined on the 6-block test specimens and the real moisture contents determined at the end of the trials (drying test). The reference value of the reference test piece is determined after a test period of 60 days.

4 Results and evaluation

The efficacy was tested by means of comparative moisture measurements. The following table summarises the essential measurement data for the test specimens tested with a degree of moisture penetration of (95 ± 5)%. The values given in this table represent the mean value of all measured values of a test specimen above the lower three brick layers. In Annex 2 the results of the non-destructive moisture measurements are shown graphically. At the end of the test period, the specimens were dismantled and inspected visually.

Tabelle 1 Test results

Time	Test specimen 7 (reference)		Test specimen 1		Test specimen 2	
	Moisture index	≅ approx. rel. moisture content [%]	Moisture index	≅ approx. rel. moisture content [%]	Moisture index	≅ approx. rel. moisture content [%]
immediately before application	1722	14.4	1687	14.0	1666	13.8
Start of efficacy test (14 days after application)	1711	14.3	1118	7.3	1131	7.5
60 – days – value	1330	**9.8**	984	5.7	959	5.4
83 – days – value	---	---	960	5.5	910	5.0
152 – days – value	---	-----	870	**4.4**	846	**4.3**
1st, 2nd, 3rd row of bricks from above; average DARR test after 182 days	---	---	---	4.6 %	---	4.6 %

The disassembly of the test specimens did not reveal any abnormalities. Outside the boreholes the active substance could not be seen at the application level. Below the application level, the bricks were still heavily soaked.

From the 1st to 3rd brick layer from above, the moisture content was determined on one brick at a time using the Darr method. Together with the comparison values determined with the 6-block test specimens this was used to convert the moisture indices to relative moisture values. To assess the efficacy, the moisture indices were converted to relative moisture using the calibration curve determined on the 6-block test specimens. The moisture content values determined subsequently in the Darr test from the 1st to 3rd brick layers from above do not need to be taken into account. They do however show a significant drop in moisture content compared to the initial state.

The test results show that the capillary water absorption is reduced considerably by the application of *Secco horizontal barrier sticks* in heavily damp masonry. The reference value of the reference test specimen is 9.8% after 60 days. The efficacy criteria - reduction of the relative moisture content by approximately 50% - is achieved by the test specimens with *Secco horizontal barrier sticks* applied after a test period of 152 days. The moisture content subsequently continues to drop slightly.

As a result of the efficacy test based on the WTA Technical Data Sheet [1], it can be determined that the capillary water absorption of brick masonry with a degree of moisture penetration of (95 ± 5)% is reduced by the application of *Secco horizontal barrier sticks.* Complete drying does not occur under the selected environmental conditions (severe obstruction of drying out due to all-round coating of the vertical surfaces). When transferring the results to practical applications, it should be noted that the drying period is strongly influenced not only by the component geometry but also by the drying conditions (air humidity, air movement, air exchange). Supporting the drying process by accompanying measures is recommended. The criteria of the WTA efficacy test for injection into masonry with a degree of moisture penetration of (95 ± 5)% are fulfilled by *Secco horizontal barrier sticks.*

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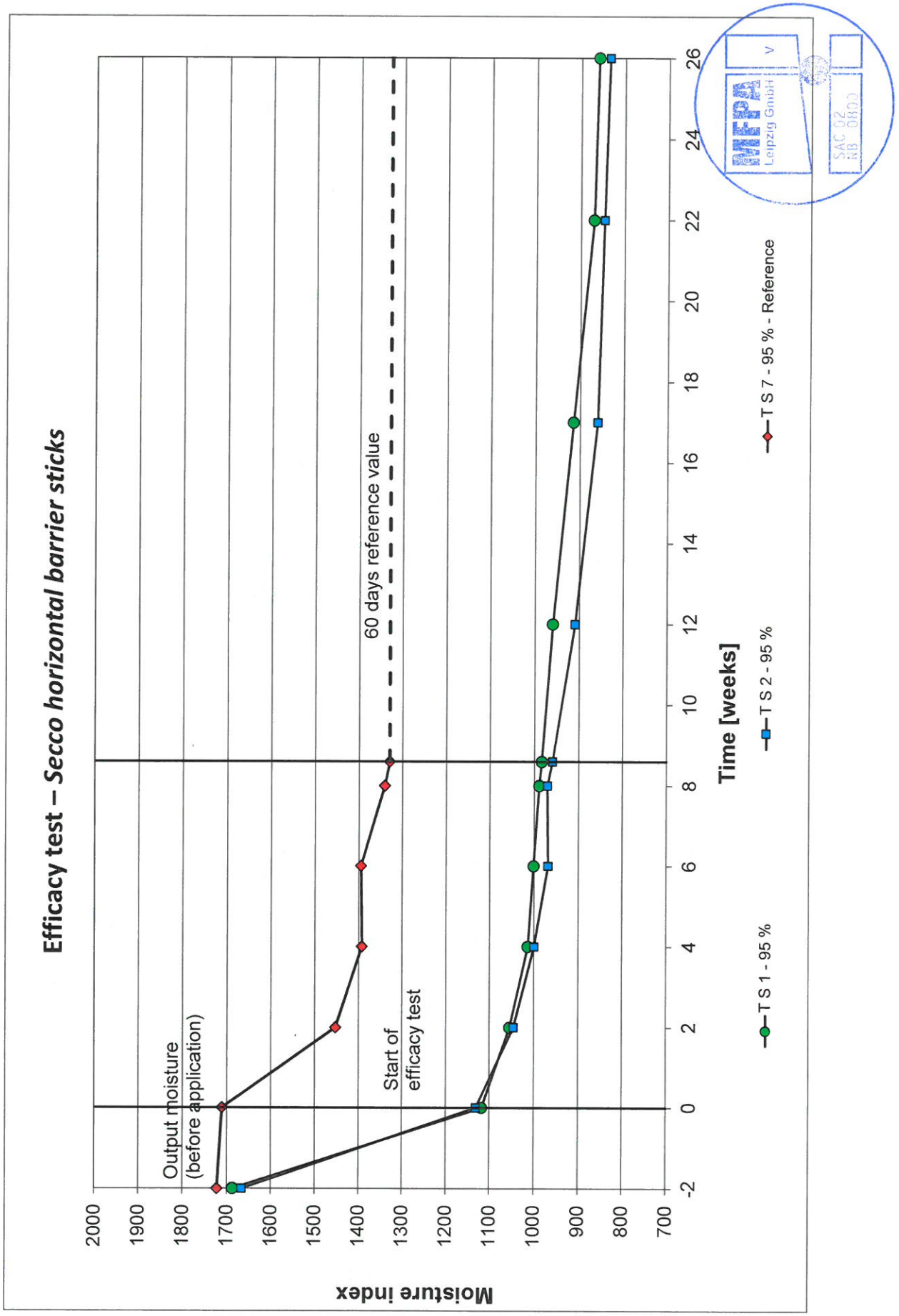
Figure 1 Drilling the boreholes

Figure 2 Cleaning the boreholes

Figure 3 Inserting the Secco horizontal barrier sticks

Figure 4 Measuring principle of moisture measurements with microwave moisture meter


Efficacy test – Secco horizontal barrier sticks
Moisture index
2000
1900
1800
1700
1600
1500
1400
1300
1200
1100
1000
900
800
700
Output moisture
(before application)
Start of
efficacy test
60 days reference value
-2
0
2
4
6
8
10
12
14
16
18
20
22
24
26
Time [weeks]
T S 1 - 95 %
T S 2 - 95 %
T S 7 - 95 % - Reference