Materialprüfanstalt Hannover
Bauwesen und Produktionstechnik

Test report no. 205672

1st copy of 1 December 2020

Ordering party:	Ha-Be Betonchemie GmbH Stüvestraße 39 31785 Hameln
Date of commission:	03.11.2020 / Mr Husmann
Subject of commission:	Tests regarding the efficiency of water resisting admixture for concrete Product: DURAHIT® Crystal Ad 3000 (DM)

The test report contains 11 pages.

The testing material is used up.

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1. General

The ordering party has assigned MPA HANNOVER to perform tests regarding the efficiency of water resisting admixture for concrete in comparison to a reference concrete. The scope of the tests to be carried out has been determined by the ordering party and is set out in section 3. This test report states the results of the tests.

2. Delivery of samples

On 05.11.2020 were delivered by an employee of the ordering party:

5 pcs. Concrete cubes, L x B x H = 150 x 150 x 150 mm^3
with following information:

Date of production	19.08.2020
Mixture no.	Reference

5 pcs. Concrete cubes, L x B x H = 150 x 150 x 150 mm^3
with following information:

Date of production	19.08.2020
Mixture no.	Ad 3000

3. Scope

The scope of performed tests listed in Table 1. The tests were performed each at the Reference concrete and at the concrete produced with the water resisting admixture DURAHIT® Crystal Ad 3000 (DM).

Table 1: Scope of testing

Test ID	Type of test	Age of sample	No. of samples
1*)	Flow table test DIN EN 12350-5:2019-09	5 min, 30 min	1 each
2*)	Bulk density DIN EN 12350-6:2019-09	20 min	1
3*)	Air content DIN EN 12350-7:2019-09	20 min	1
4*)	Compressive strength and bulk density DIN EN 12390-3:2019-10	2, 7 and 28 d	3
5	Depth of penetration of water under pressure DIN EN 12390-8:2019-10	> 28 d	2
6	Determination of capillary adsorption DIN EN 13057:2002	> 28 d	2
7	Chloride migration resistance BAW-Merkblatt „Chlorideindringwiderstand von Beton (MCL)“, 2004	> 56 d	2

*) Tests no. 1 – 4 were carry out by the ordering party and the results of the tests have been provided to MPA Hannover

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4. Results

4.1 Manufacture of samples

The samples were produced according to DIN EN 12390-2:2019-08 in the laboratory of Ha-Be Betonchemie GmbH, Hameln. The compositions of mixtures are listed in Table 2.

Table 2: Composition of mixtures

		Reference		Ad 3000	
Raw material		Quantity	Mass kg/m³	Quantity	Mass kg/m³
Cement	-	-	350	-	350
Water	-	-	175	-	166
w/c-ratio	-	-	0.50	-	0.48
Sand 0-2 mm	M.-% of aggregate	35	679	35	679
Gravel 2-8 mm		30	566	30	566
Gravel 8-16 mm		35	673	35	673
DURAHIT® Crystal Ad 3000 (DM)	M.-% of cement	-	-	0.50	1.75
PANTARHIT® RC683 (FM)		0.30	1.05	0.55	1.93
PANTARHEO SB40 (ST)		0.20	0.70	0.20	0.70

4.2 Bulk density of fresh concrete, air content and flow table test

The properties of fresh concrete were determined according to DIN EN 12350-5 (flow table test), DIN EN 12350-6 (bulk density) and 12350-7 (air content). The results are listed in Table 3.

Table 3: Results of test on fresh concrete*)

		Reference	Ad 3000
Air temperature	°C	22	22
Flow table test A after water addition in mm	5 min	500	550
	30 min	470	510
Fresh concrete temperature	°C	23	23
Bulk density of fresh concrete	kg/dm³	2345	2365
Air content	Vol.- %	2.6	1.9

*) Tests were carry out by the ordering party and the results of the tests have been provided to MPA Hannover

4.3 Compressive strength and bulk density

The determination of compressive strength was carried out 2, 7 and 28 days after casting according to DIN EN 12390-3 at cubes with 150 mm edge length. The means values of the results are shown in Table 4.

Table 4: Results of test of compressive strength according to DIN EN 12390-3*)

	Reference		Ad 3000	
Age d	Bulk density kg/m³	Compressive strength $f_{c,cube}$ MPa	Bulk density kg/m³	Compressive strength $f_{c,cube}$ MPa
2	2370	43.6	2380	48.3
7	2400	56.7	2360	64.3
28	2370	68.4	2360	80.7

*) Tests were carry out by the ordering party and the results of the tests have been provided to MPA Hannover

4.4 Depth of penetration of water under pressure

The depth of penetration of water under pressure was carried out according to DIN EN 12390-8 at 2 cubes each with the dimensions of 150 x 150 x 150 mm. The age of samples was 58 days at the begin of testing. The results of the tests are shown in Table 5. The spread of water at the cracking surfaces is shown in Appendix A1.

Table 5: Results of depth of penetration of water according to DIN EN 12390-8

	Reference	Ad 3000
Sample no.	maximal depth of penetration mm	maximal depth of penetration mm
1	12	6
2	11	5
Mean	**12**	**6**

4.5 Capillary adsorption

The resistance of capillary absorption was determined based on DIN EN 13057 on two samples each with a height of 50 mm and a diameter of 99 mm. Drilled cores were used for the test in deviation to DIN EN 13057. The cores were drilled from the prior tested cubes of depth of penetration of water (see Sec. 4.4). The results are listed in Table 6. Details of the tests are listed in Appendix A2.

Table 6: Test results of resistance of capillary absorption, mean values

		Reference	Ad 3000
Water uptake after 24 h	kg/m²	1.01	0.85
Absorption coefficient S_{24h}	kg/m²*h$^{0.5}$	0.21	0.17
Resistance coefficient R_{2h}	h/m²	13000	17000

4.6 Chloride migration resistance

The determination of the chloride migration resistance was performed according to BAW-Merkblatt „Chlorideindringwiderstand von Beton", version 2012. The cubes were continuously stored under water after manufacturing. Cylinders with a diameter of 100 mm were drilled out from the samples approx. 7 days before testing. A layer of 10 mm was removed from the upper edge by sawing. A test area parallel saw cut was made at a height of approx. 50 ± 5 mm measured from the test surface. The test specimens were stored in a water bath at 20 °C until testing and were installed and tested in migration cells at the start of the test. The chloride migration coefficients calculated from the test results are shown in Appendix A3 and Table 7.

Table 7: Chloride migration coefficients

Sample no.	Chloride migration coefficient x 10^{-12} [m²/s]	
	Reference	Ad 3000
1	12.1	8.2
2	12.6	6.8
3	11.5	9.1
Mean value D_{CL}	**12.1**	**8.0**
Max. individual value $D_{CL.max}$	12.6	9.1

Depending on the given exposure class, the mean values and maximum individual values of migration coefficients given in Table 8 must be complied in accordance with BAW-Merkblatt "Chlorideindringwiderstand von Beton", version 2012.

Table 8: Mean values to be complied with and the maximum permissible individual values of the migration coefficients as a function of the exposure class

Given exposure class acc. DIN EN 206-1 /DIN 1045-2	Migration coefficient	
	Mean value	Max. individual value
-	x 10^{-12} [m²/s]	x 10^{-12} [m²/s]
XS 1, XD 1	≤ 10.0	≤ 12.0
XS 2, XD 2		
XS 3, XD 3	≤ 5.0	≤ 7.0

Hanover, 1 December 2020
Head of Testing Institute
By Proxy

(Dipl.-Ing. P. Thiessen)

Contact

(Dipl.-Ing. A. Giese)

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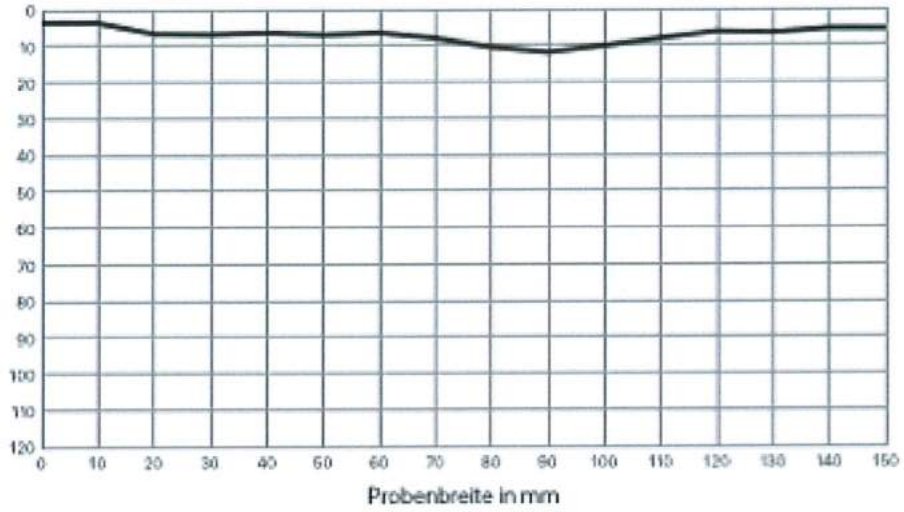
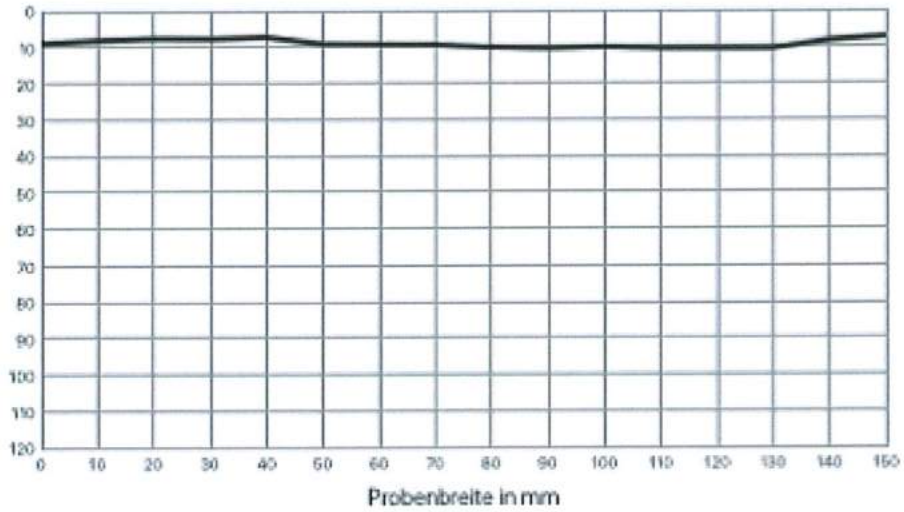
APPENDIX

Appendix A1: Depth of penetration of water

Appendix A1-1: Depth of penetration of water, Reference: 1, max. depth of penetration t = 12 mm



Appendix A1-2: Depth of penetration of water, Reference: 2, max. depth of penetration t = 11 mm



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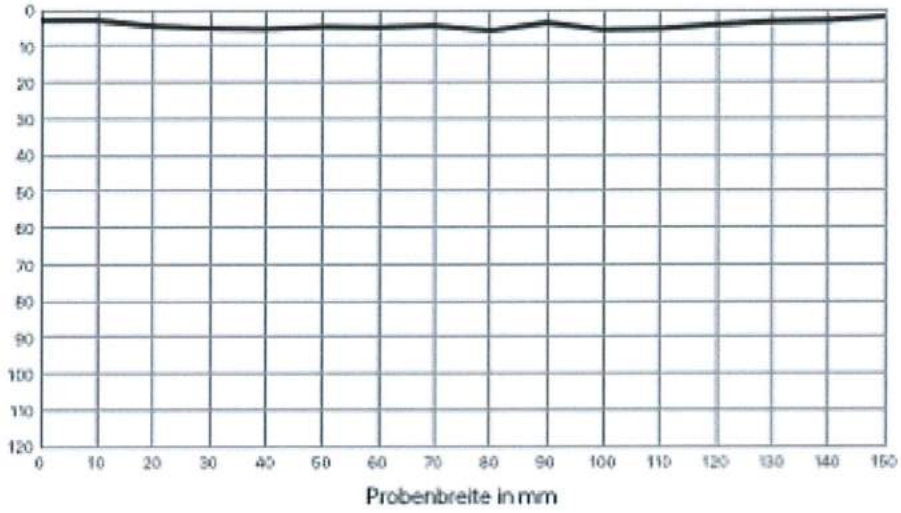
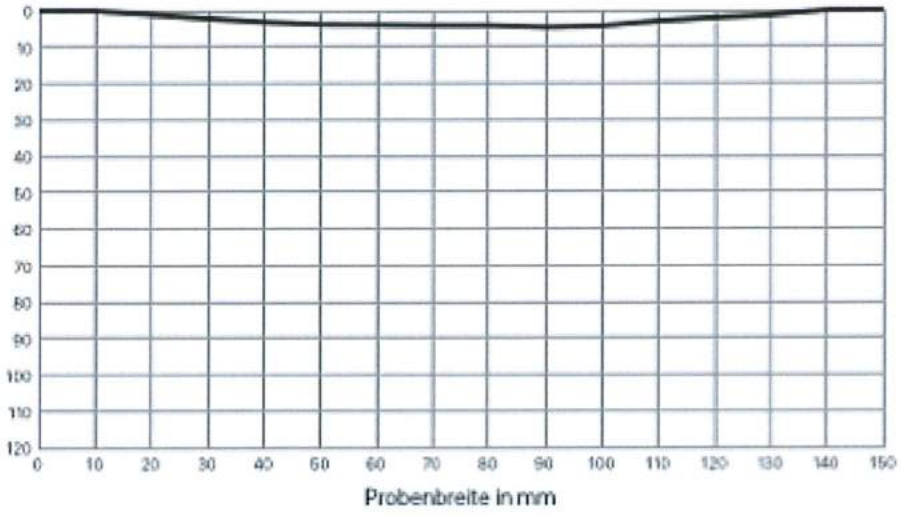
Appendix A1-3: Depth of penetration of water, AD 3000: 1, max. depth of penetration t = 6 mm



Appendix A1-4: Depth of penetration of water, AD 3000: 2, max. depth of penetration t = 5 mm



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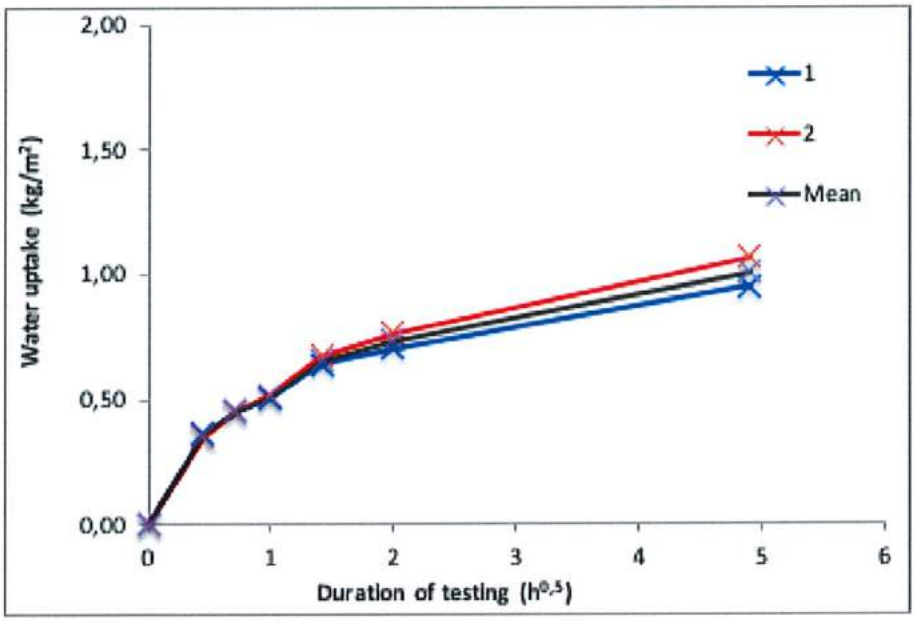
Appendix A2: Capillary adsorption

Appendix A2-1: Test results of capillary absorption, Reference
Production of samples: 19.08.2020
Time of testing: 25.11.2020 – 26.11.2020

Sample no.	Duration of testing (h)							absorption coefficient	resistance coefficient
	0	0.2	0.5	1	2	4	24	S_{24h}	R_{2h}
	Water uptake (kg/m²)							kg/m²*h$^{0.5}$	h/m²
1	0.00	0.36	0.45	0.51	0.64	0.70	0.95	0.19	11000
2	0.00	0.35	0.45	0.52	0.68	0.77	1.07	0.22	14000
Mean	**0.00**	**0.36**	**0.45**	**0.51**	**0.66**	**0.73**	**1.01**	**0.21**	**13000**

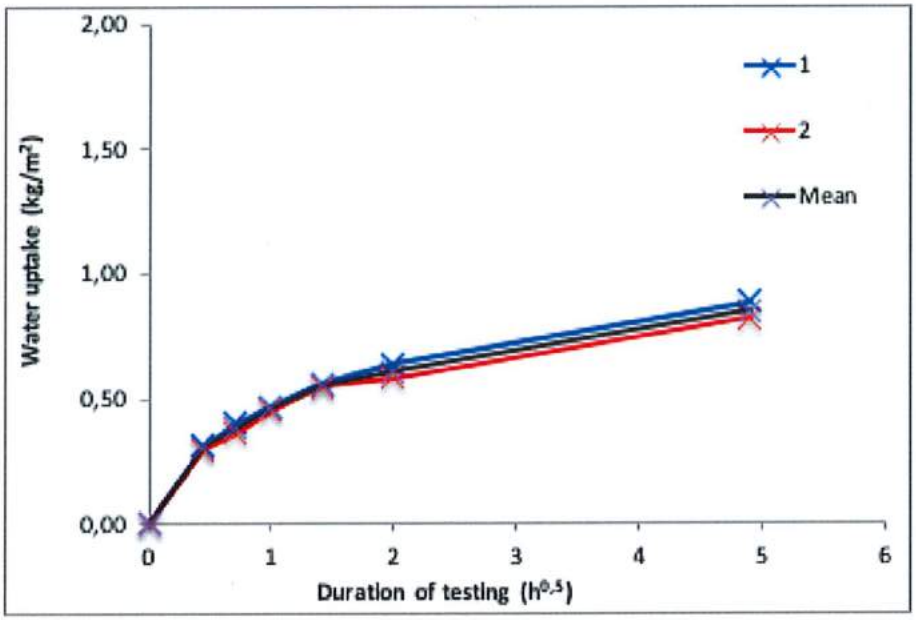
Appendix A2-2: Graph of the capillary absorption, Reference



Appendix A2-3: Test results of capillary absorption, Ad 3000
Production of samples: 19.08.2020
Time of testing: 25.11.2020 - 26.11.2020

Sample no.	Duration of testing (h)							absorption coefficient	resistance coefficient
	0	0.2	0.5	1	2	4	24	S_{24h}	R_{2h}
	Water uptake (kg/m²)							kg/m²*h$^{0.5}$	h/m²
1	0.00	0.31	0.40	0.47	0.56	0.64	0.88	0.18	14000
2	0.00	0.30	0.36	0.45	0.55	0.58	0.82	0.17	20000
Mean	**0.00**	**0.31**	**0.38**	**0.46**	**0.55**	**0.61**	**0.85**	**0.17**	**17000**

Appendix A2-4: Graph of the capillary absorption, Ad 3000



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Appendix A3: Chloride migration

Appendix A3-1: Measured values of the test, Reference

Sample no.	Test start		Test end		Amperage start	Amperage end	Duration of test
	Date	Time	Date	Time	mA	mA	h
1	17.11.20	16:30	18.11.20	07:00	69.0	73.3	14.50
2	17.11.20	16:30	18.11.20	07:00	78.7	77.8	14.50
3	17.11.20	16:30	18.11.20	07:00	62.2	63.1	14.50

Sample no.	Test liquid		Test sample				
	Temperature		Height	Diameter	Mass after		Bulk density Water storage
	Start	End			Water storage	Testing	
	°C	°C	mm	mm	g	g	[kg/m³]
1	22.4	21.3	49.0	99.0	876.82	878.40	-
2	22.4	21.3	50.0	99.0	892.63	893.75	-
3	22.4	21.3	50.0	99.0	893.81	894.71	-

Penetration depths:

[mm]	Sample 1 half 1	Sample 1 half 2	Sample 2 half 1	Sample 2 half 2	Sample 3 half 1	Sample 3 half 2
Point 1	20.0	20.9	25.4	25.5	16.3	16.9
Point 2	16.5	17.3	22.1	21.4	13.1	13.0
Point 3	17.7	17.7	18.6	18.8	18.0	17.8
Point 4	20.7	20.6	17.4	17.8	17.8	16.3
Point 5	22.5	20.7	17.5	20.1	14.1	12.9
Point 6	16.0	15.6	17.5	17.0	16.0	17.7
Point 7	14.2	17.2	17.1	17.0	18.5	17.2
Point 8	15.7	16.0	16.7	17.6	16.9	18.8
Point 9	15.7	16.0	16.1	15.4	15.1	16.5
Point 10	15.9	16.9	16.5	15.4	16.6	17.4
Point 11	18.7	18.3	26.7	22.8	24.3	24.2
Mean value x_d	**17.2**	**17.6**	**17.7**	**17.8**	**16.2**	**16.4**
Max. value x_{max}	22.5	20.7	22.1	21.4	18.5	18.8

Remark: Blue values were not included in the evaluation!

Appendix A3-2: Measured values of the test. AD 3000

Sample no.	Test start		Test end		Amperage start	Amperage end	Duration of test
	Date	Time	Date	Time	mA	mA	h
1	17.11.20	16:30	18.11.20	07:00	58.3	55.9	14.50
2	17.11.20	16:30	18.11.20	07:00	55.3	51.5	14.50
3	17.11.20	16:30	18.11.20	07:00	57.2	53.1	14.50

Sample no.	Test liquid		Test sample				
	Temperature		Height	Diameter	Mass after		Bulk density Water storage
	Start	End			Water storage	Testing	
	°C	°C	mm	mm	g	g	[kg/m³]
1	22.4	21.3	49.0	99.0	872.53	873.53	-
2	22.4	21.3	49.0	99.0	894.87	895.60	-
3	22.4	21.3	49.0	99.0	890.75	891.71	-

Penetration depths:

[mm]	Sample 1 half 1	Sample 1 half 2	Sample 2 half 1	Sample 2 half 2	Sample 3 half 1	Sample 3 half 2
Point 1	13.7	13.3	19.7	21.3	19.3	14.0
Point 2	13.2	11.3	12.3	12.8	13.6	12.5
Point 3	12.1	12.0	11.9	13.9	12.5	15.4
Point 4	11.3	10.8	12.0	11.1	11.3	14.7
Point 5	12.2	13.0	12.2	12.3	14.0	11.4
Point 6	12.7	12.4	9.7	9.7	13.2	14.1
Point 7	12.8	11.5	8.8	8.5	13.1	12.1
Point 8	12.8	12.0	6.6	7.1	15.6	13.7
Point 9	12.1	11.7	6.7	7.8	14.0	13.8
Point 10	11.2	11.4	9.6	10.6	13.5	12.4
Point 11	25.3	25.2	10.8	10.3	18.2	19.9
Mean value x_d	**12.3**	**11.8**	**10.0**	**10.4**	**13.4**	**13.3**
Max. value x_{max}	13.2	13.0	12.3	13.9	15.6	15.4

Remark: Blue values were not included in the evaluation!

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