Materialprüfanstalt Hannover
Bauwesen und Produktionstechnik

Test report no. 172847

English version

1st copy of 9 June 2017

Ordering party:	Schomburg GmbH & Co. KG Aquafinstrasse 2 - 8 32760 Detmold
Date of commission:	02.03.2016 / Mr Beyer
Subject of commission:	Tests regarding the efficiency of water resisting admixture for concrete - Freeze-thaw-salt resistance Product: BETOCRETE CL 210-WP

The test report contains 8 pages.

The testing material is used up.

Remark: This test report is the English version of original German version of 9 June 2017.

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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 19 September 2016 by an employee of the ordering party:

250 kg Cement CEM I/52,5R typ „Milke Classic“ in 5 drums à 50 kg
5 kg BETOCRETE F4 (SP), in a canister, produced by Schomburg

and on 25 January 2017:

1 kg BETOCRETE CL 210-WP, in a can, produced by Schomburg

The aggregate for manufacture the concrete was provided from the stock of MPA HANNOVER.

Weser sand 0/2
Weser gravel 2/8
Weser gravel 8/16

3. Scope

The scope of performed tests is listed in Table 1. The tests were performed each at the reference concrete (reference) and at the concrete produced with the water resisting admixture (CL 210-WP).

Table 1: Scope of testing

Test ID	Type of test	Standard	Age of sample	No. of samples
1	Bulk density of fresh concrete, Air content and Flow table test	DIN EN 12350-6:2011-03 DIN EN 12350-7:2009-08 DIN EN 12350-5:2009-08	20 min 20 min 5 min, 30 min	1 1 1
2	Freeze-thaw-salt resistance	BAW-Merkblatt „Frostprüfung von Beton“, 2012	28 d	5

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4. Results

4.1 Manufacture of samples

The samples were produced according to DIN EN 12390-2:2009-08. A forced mixer Zyklos ZK 150 was used for the mixing. The mixing time was 2 min after water addition. The superplasticizer was added together with the water; the water resisting admixture was added separately. The water content of the admixtures was taken into account with 70 M.-% for the calculation. The compositions of mixtures are listed in Table 2. From this mixture, all test specimens were prepared for the solid concrete tests, as well as the fresh concrete tests were carried out.

Table 2: Composition of mixtures

		Reference		CL 210-WP	
Raw material		Quantity	Mass kg/m³	Quantity	Mass kg/m³
Cement	-	-	350	-	350
Water	-	-	175	-	176
w/c-ratio	-	-	0.50	-	0.50
Sand 0-2 mm	M.-% of aggregate	35	630	35	630
Gravel 2-8 mm		30	526	30	536
Gravel 8-16 mm		35	627	35	627
Betocrete F 4 (SP)	M.-% of cement	0.7	2.45	1.15	4.03
Betocrete CL 210-WP		-	-	1.8	6.30

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	CL 210-WP
Air temperature	°C	20	20
Flow table test A after water addition in mm	5 min	450	460
	30 min	370	390
Fresh concrete temperature	°C	22.1	21.1
Bulk density of fresh concrete	kg/dm³	2.35	2.36
Air content	Vol.- %	2.0	1.8

4.3 Freeze-thaw-salt resistance

4.3.1 Preparation for testing

The test of the freeze-thaw resistance was carried out according to BAW-Merkblatt „Frostprüfung von Beton", version 2012. The samples were sawn, measured and prepared for testing, approximately 7 days before the start of the test. The lateral faces were sealed with solvent-free epoxy resin and glued with an aluminium foil with butyl bonding. The specimens were stored in a climate chamber at a temperature of 20 °C and a relative humidity of 65 % until testing. The weights of the specimens were determined before and after sealing of the lateral faces.

4.3.2 Capillary suction

After preparing of the specimens and the pre-storage described above, the specimens were place into the test containers on spacers with a height of 10 mm with the test surface facing the bottom. Then a test solution consisting of 3-percent sodium chloride solution was filled into the containers up to a height of 15 mm so that the specimens were immersed 5 mm deep into the test solution. The increase in weight of the test specimens was measured after two, five and seven days of storage in the test solution.

4.3.3 Freeze-thaw testing

The test specimens together with the test containers and the present test liquid were placed into a temperature-controlled chest with liquid cooling bath and subjected to freeze-thaw testing according to the test specification mentioned in section 1. One freeze-thaw cycle lasts 12 hours. Beginning at + 20 °C, the temperature was lowered in 4 hours with a constant cooling rate to –20 °C. Then it was left to cool for 3 hours at this temperature and within 4 hour increased to +20 °C again and subsequently held for one hour. The specimens were taken from the chest in specific intervals and the water uptake, the surface scaling and the dynamic E-modulus were determined according to test specification. The results of the freeze-thaw test are compiled in Table 4 as mean values. Details of the tests are listed in Appendix A1.

Table 4: Results of the test of Freeze-thaw-salt resistance, mean values

		Surface scaling in g/m²		rel. dyn. E-modulus in %	
		Reference	CL 210-WP	Reference	CL 210-WP
Frost-thaw cycle	0	0	0	100	100
	4	36	53	99	99
	10	167	227	94	99
	14	386	384	91	98
	18	1053	671	85	97
	24	2591	1300	73	97
	28	3680	1792	70	96

Hanover, 9 June 2017
Head of Testing Institute

(ORR Dr.-Ing. H. Höveling)

Materialprüfanstalt Hannover MPA HANNOVER Bauwesen und Produktionstechnik

Contact

(Dipl.-Ing. A. Giese)

APPENDIX

Appendix A1: Freeze-thaw-salt testing

Appendix A1-1: Dimensions and mass for specimen preparation, reference

Specimen			1	2	3	4	5
Weight	without belt	g	2703	2736	2802	2788	2787
	with belt		2803	2819	2900	2890	2889
Dimensions w/o sealing	Length	mm	151	150	152	152	151
	Width		108	111	111	111	111
	Height		72	72	72	72	72

Appendix A1-2: Water uptake, reference

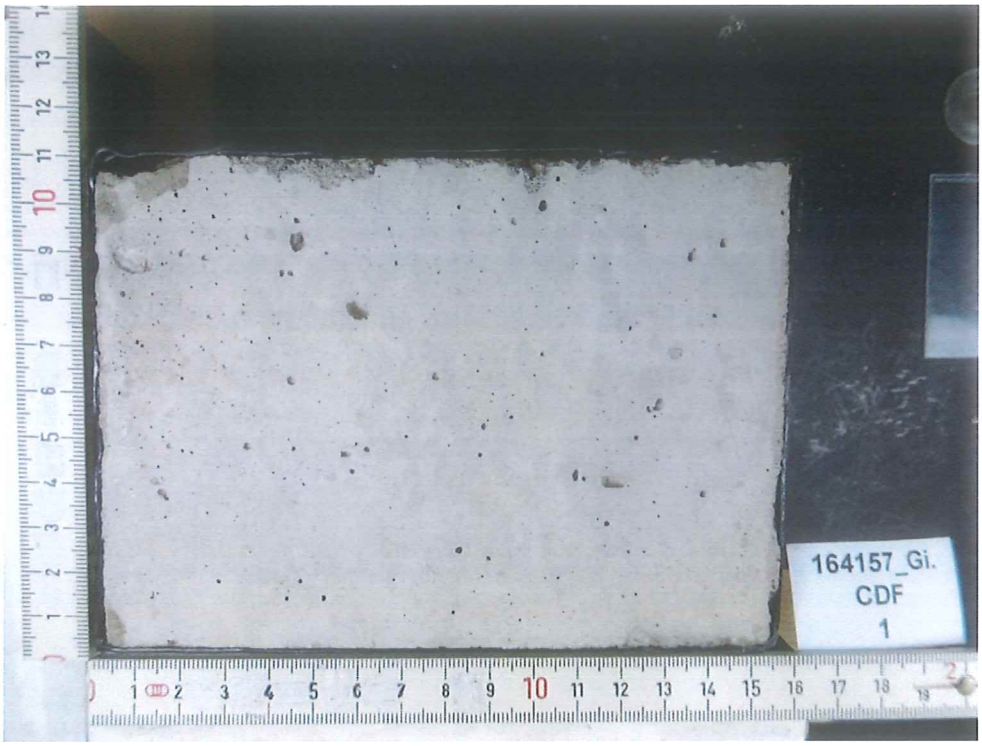
Begin of test:									09.11.2016
Probe	after d		1	2	3	4	5	Mean	Standard deviation
Capillary suction in d	-7	M.- %	-0.68	-0.88	-0.78	-0.67	-0.74	-0.75	0.09
	-5		-0.20	-0.26	-0.21	-0.18	-0.19	-0.21	0.03
	-2		-0.06	-0.08	-0.06	-0.06	-0.05	-0.06	0.01
	0		0.00	0.00	0.00	0.00	0.00	0.00	0.00
Frost-thaw cycle	4		0.15	0.22	0.19	0.16	0.18	0.18	0.03
	10		0.53	0.69	0.59	0.53	0.62	0.59	0.07
	14		0.82	1.04	0.89	0.80	0.90	0.89	0.09
	18		1.12	1.23	1.15	1.05	1.15	1.14	0.06
	24		1.36	1.25	0.90	1.58	1.25	1.27	0.24
	28		1.42	1.35	0.91	1.63	1.29	1.32	0.26

Appendix A1-3: Relative dynamic E-modulus of the specimens, reference

Frost-thaw cycle	Relative dynamic E-modulus in %						
	1	2	3	4	5	Mean	Standard deviation
0	100	100	100	100	100	100	0
4	98	99	98	100	98	99	1
10	95	94	95	94	93	94	1
14	92	91	90	92	91	91	1
18	87	86	82	85	84	85	2
24	78	79	76	58	77	73	9
28	74	71	73	64	69	70	4

Appendix A1-4: Surface scaling of the specimens by weathering, reference

Frost-thaw cycle	Surface scaling in g/m^2						
	1	2	3	4	5	Mean	Standard deviation
0	0	0	0	0	0	0	0
4	30	35	41	33	42	36	5
10	160	165	166	143	202	167	22
14	334	402	400	305	491	386	72
18	847	1141	1110	785	1380	1053	241
24	2319	2741	2455	2448	2990	2591	271
28	3373	3872	3519	3604	4030	3680	267
95 % - quantile after 28 frost-thaw cycles						4294	---



Appendix A1-5: Sample before testing, reference

Appendix A1-6: Sample after testing, reference

Appendix A1-7: Dimensions and mass for specimen preparation, CL 210-WP

Specimen			1	2	3	4	5
Weight	without belt	g	2545	2707	2753	2611	2753
	with belt		2603	2767	2815	2669	2814
Dimensions w/o sealing	Length	mm	150	150	150	150	150
	Width		109	109	111	112	113
	Height		67	71	72	68	71

Appendix A1-8: Water uptake, CL 210-WP

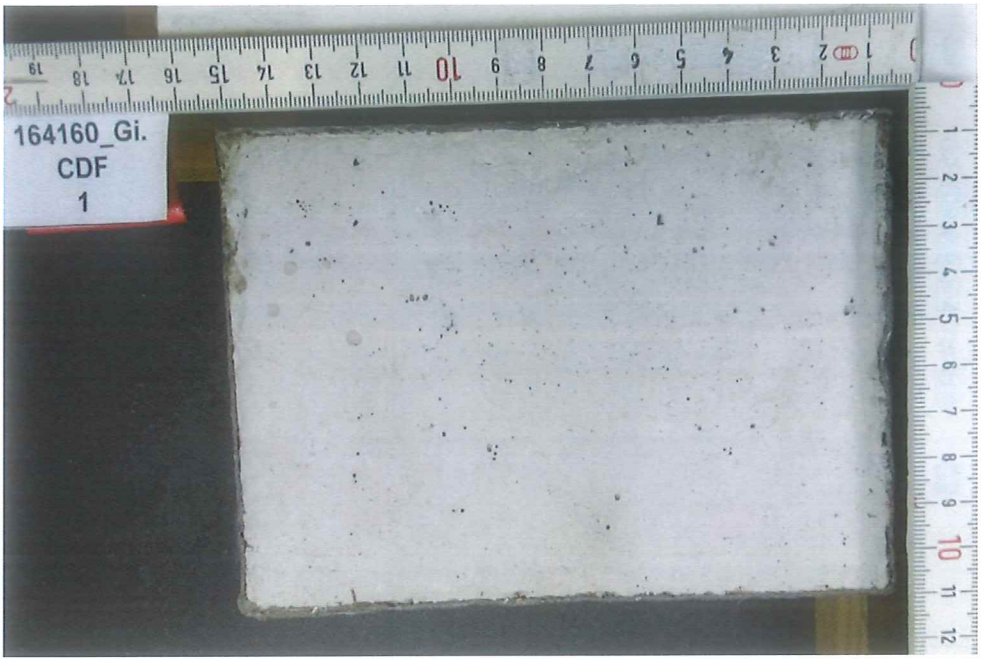
Begin of test:									22.02.2017
Probe	after d		1	2	3	4	5	Mean	Standard deviation
Capillary suction in d	-7	M.- %	-0.65	-0.62	-0.61	-0.66	-0.62	-0.63	0.02
	-5		-0.11	-0.13	-0.12	-0.11	-0.12	-0.12	0.01
	-2		-0.02	-0.05	-0.06	-0.02	-0.04	-0.04	0.02
	0		0.00	0.00	0.00	0.00	0.00	0.00	0.00
Frost-thaw cycle	4		0.22	0.18	0.16	0.21	0.25	0.21	0.04
	10		0.48	0.36	0.38	0.42	0.46	0.42	0.05
	14		0.60	0.51	0.53	0.59	0.62	0.57	0.04
	18		0.71	0.58	0.60	0.71	0.59	0.64	0.07
	24		0.88	0.70	0.74	0.75	0.85	0.78	0.08
	28		1.00	0.81	0.79	0.81	0.98	0.88	0.11

Appendix A1-9: Relative dynamic E-modulus of the specimens, CL 210-WP

Frost-thaw cycle	Relative dynamic E-modulus in %						
	1	2	3	4	5	Mean	Standard deviation
0	100	100	100	100	100	100	0
4	99	99	99	99	99	99	0
10	100	100	98	97	98	99	1
14	99	98	97	97	97	98	1
18	99	97	97	97	97	97	1
24	97	97	97	97	97	97	0
28	95	95	97	96	94	96	1

Appendix A1-10: Surface scaling of the specimens by weathering, CL 210-WP

Frost-thaw cycle	Surface scaling in g/m^2						
	1	2	3	4	5	Mean	Standard deviation
0	0	0	0	0	0	0	0
4	45	53	56	60	53	53	6
10	251	213	198	213	259	227	27
14	403	370	348	365	434	384	34
18	696	707	659	679	612	671	37
24	1227	1301	1205	1303	1466	1300	102
28	1632	1777	1804	1769	1977	1792	123
95 % - quantile after 28 frost-thaw cycles						2075	



Appendix A1-11: Sample before testing, CL 210-WP

Appendix A1-12: Sample after testing, CL 210-WP

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