

# Resistance against abrasion

## Audit of performance / comparison

Requirements according DIN 18202-T.3

Testmethod according DIN 52108:2010-05 (abrasion "Boehme")

Mix-Design EN 480-1 (mortard)

Type: CT - C45 - F6 - A7



### Cement

Type: CEM I  
 Class: 52,5 R  
 Origin: ZW Seibel & Söhne

### Aggregates

Type: Sand / Gravel  
 Max. size: 16 mm  
 Origin: Weser

### Admixture

Brand: TOPTEC®  
 Manufacturer: BETRA GmbH  
33181 Bad Wünnenberg

Batch # 304 14 113

Date of Manuf. 14.07.2014

Dosage 1,0 M.-% CEM

Control w/o admixture					≤					Dosage				
Physical parameters					Weigth after rounds grinding/polishing [g]					loss by abrasion				
lenght [mm]	width [mm]	depth [mm]	area [cm <sup>2</sup> ]	density [g/cm <sup>3</sup> ]	22 [initial]	88	176	264	352	mass [g]	ΔV [cm <sup>3</sup> /50cm <sup>2</sup> ]	Δl [mm]		
71,00	70,00	40,10	49,70	2,12	423,31	421,08	417,45	413,65	413,25	10,05	4,73	0,09		
70,50	70,00	39,80	49,35	2,13	417,57	415,21	412,66	405,91	401,30	16,27	7,65	0,15		
70,00	70,00	39,90	49,00	2,12	414,87	408,39	405,54	401,61	397,62	17,25	8,13	0,16		
<b>Average of 3</b>				<b>2,12</b>						<b>6,84</b>		<b>0,14</b>		
<b>TOPTEC®</b>												Both samples passed requirements acc. DIN 18202-T.3. <b>Class of resistance: A7 [≤ 7 cm<sup>3</sup>/50cm<sup>2</sup>]</b>		
Physical parameters					Weigth after rounds grinding/polishing [g]					loss by abrasion				
lenght [mm]	width [mm]	depth [mm]	area [cm <sup>2</sup> ]	density [g/cm <sup>3</sup> ]	22 [initial]	88	176	264	352	mass [g]	ΔV [cm <sup>3</sup> /50cm <sup>2</sup> ]	Δl [mm]		
71,20	69,90	40,70	49,77	2,23	450,69	447,58	444,73	441,13	434,33	16,37	7,36	0,15		
71,30	69,90	40,90	49,84	2,22	453,34	452,77	448,83	443,97	442,26	11,08	4,98	0,10		
71,00	70,10	41,00	49,77	2,23	454,24	450,24	448,06	441,71	435,03	19,21	8,63	0,17		
<b>Average of 3</b>				<b>2,23</b>						<b>6,99</b>		<b>0,14</b>		

## Audit of effectiveness / performance

EN 934-2:2009-09 Tab. 9 special requirements for waterproofer (same (spread-)slump)

### Control-mortard EN 480-1 (mortard)

#### Cement

Type: CEM I  
 Class: 42,5 R  
 Origin: ZW Wittekind

#### Aggregates

Type: Normensand  
 Origin: Normensand GmbH,  
 Beckum



Hochschule Ostwestfalen-Lippe  
 University of Applied Sciences

#### Admixture

Brand: TOPTEC®  
 Manufacturer: BETRA GmbH  
33181 Bad Wünnenberg

Test cycle **Initial**

	Mix-design				fresh mortard		
	CEM I	Aggregates	Water	w/c ratio	slump	Air	density
	g / Msg	g / Msg	g / Msg	-	mm	Vol.-%	kg/m³
requir. EN 934-2	450	1350	-	-			
control	450	1350	225	0,5	133	3,4	2244
test mixture	450	1350	207,5	0,46	129	5,20	2243
comparison							

Batch # 000 667 6041  
 Date of Manuf. 12.03.2012  
 Dosage 1,0 M.-% CEM

Average of 3 each	capillary absorption 7d/7d				capillary absorption 28d/90d					
	m <sub>0</sub>	m <sub>7d</sub>	m <sub>abs.</sub>	rel.	m <sub>0</sub>	m <sub>1</sub>	m <sub>7</sub>	m <sub>28d</sub>	m <sub>abs.</sub>	rel.
	g	g	g	%	g	g	g	g	g	%
requir. EN 934-2	-	-	-	≤ 50% control	-	-	-	-	-	≤ 60% control
control	552,7	563,5	10,8		560,2	562,2	575,6	582,7	22,5	
test mixture	553,8	556,6	2,8		495,9	498,2	503	507,5	11,6	
comparison			<b>-8</b>	<b>25,9</b>					<b>10,9</b>	<b>51,6</b>

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Test cycle Initial

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	g	g	g	%	g	g	g	g	g	%
requir. EN 934-2	-	-	-	≤ 50% control	-	-	-	-	-	≤ 60% control
control	552,7	563,5	10,8		560,2	562,2	575,6	582,7	22,5	
test mixture	553,8	556,6	2,8		495,9	498,2	503	507,5	11,6	
comparison			<b>-8</b>	<b>25,9</b>					<b>10,9</b>	<b>51,6</b>

# Test report

– Rapid Chlorid Migration–



Status: as at 9th December 2014

Description: Effect of TOPTEC® admixture on chlorid migration

Investigator: BauLab3  
University of Applied Sciences  
DE-32756 Detmold



Contact: Hr. Dipl. D. Klaas [BETRA]  
Hr. I. Paycher [SealTec]

Status: Final Report - Abstract

Basics: Formless agreement between the parties mentioned above on test series to investigate the effect of TOPTEC® on the ability to block chloride migration into concrete specimen. The trials were performed in comparison to a so-called crystalline waterproofer.

Definition:

- Casting of concrete specimen in two different mix-designs
  - 1<sup>st</sup> set usage of CEM I 42,5 R w/c ratio at 0,5
  - 2<sup>nd</sup> set usage of CEM I 42,5 R w/c ratio at 0,6
  - two different conditions of curing (dry / variation dry – wet)
- Determination of physical parameters of cured concrete
- Determination of chloride migration according to RCM-Method
- Final report

Chronology:

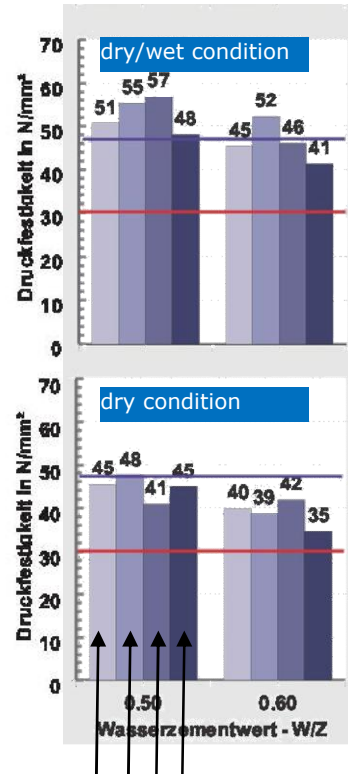
03.11.2014 – casting of 1<sup>st</sup> and 2<sup>nd</sup> set  
05.11.2014 – demoulding of 4 series consisting of  
12 cubes (150 x 150 x 150 mm)  
6 cylinders (100 mm diameter)  
05.11.2014 – start of dry curing cycle  
10.11.2014 – End of dry curing, start of wet curing cycle  
17.11.2104 – end of wet curing, start of dry curing cycle  
24.11.2014 – end of dry curing, start of wet curing cycle  
01.12.2014 – compressive strength (3 cubes each serie)  
03.12.2014 – Rapid chloride migration on 3 cylinders each

Mix-Design	Cement / Binder:	CEM I 42,5 R	Origin: DE-Wittekind plant
	Aggregates:	0/16 mm	Origin: DE-River Weser
	Admixtures:	TOPTEC®	Origin: DE-BETRA GmbH
	Admixtures	Crystalline WP	Origin: US-plant
	Mass of Cement:	340 kg/m <sup>3</sup>	
	Aggregates:	1847 kg/m <sup>3</sup>	
	Water:	1 <sup>st</sup> set: 170 kg/m <sup>3</sup> 2 <sup>nd</sup> set: 204 kg/m <sup>3</sup>	
	Admix:	2,0 % mass of CEM / additional 2,5 % mass of CEM [only TOPTEC®]	

**Compressive strenght:**

The figure on the right shows the average abstract of compressive strength. Columns on the right are values measured at specimen which were produced with water-cement-ratio of 0.6 whilst the columns on the left show all results at water-cement-ratio of 0.5.

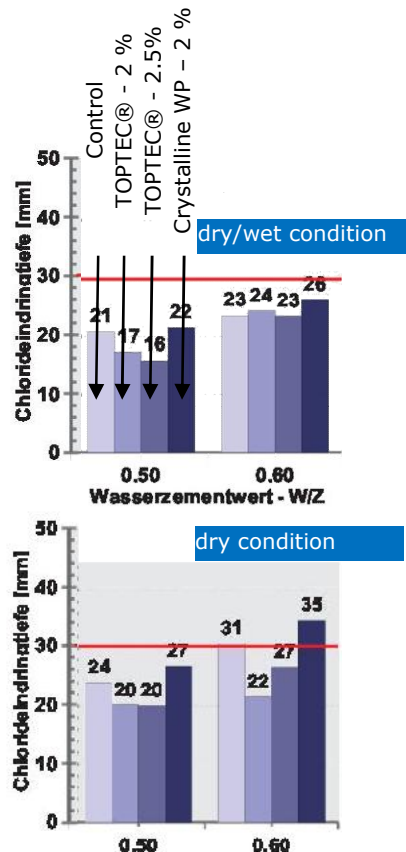
The result gives an impression on the curing process of binder under the effect of admixtures. Whilst the plain common crystalline waterproofer (dark violet) seems to affect the compressive strenght in nearly every constellation in comparison to control TOPTEC® affects the compressive strength visibly at a dosage of 2.5%. The recommended dosage of 2.0% of TOPTEC® performs herein the best result.



**Rapid Chlorid Migration:**

On the right hand the average abstract of chloride penetration depth in comparison to control and different admixtures (such as given above). It is found that the common crystalline waterproofer has nearly no improving effect on the chloride penetration depth in comparison to control, whilst (except w/c-ratio of 0.6 dry/wet) all TOPTEC® blended specimen show less penetration.

The average service lifetime investigated in this series increases under dry/wet-conditions at w/c-ratio of 0.5 from 12 year until depassivation of rebars to 28 years by adding TOPTEC® at 2.5%. This gives an improvement of 225%. The other results shown are direct proportional to to the water-cement ratio, as by higher amount of gauging water the capillary volume increases and the chloride transport through the matrix is more active. In this investigation the common crystalline waterproofer showed no improvement in comparison to control.



Parameters: The specimen were cured before testing (RCM) for 28 days under different conditions as given before.

For test purposes a liquid solution of Potassium Hydroxide (0.2 mol/l) and 10% Sodium Chloride was used for RCM-Test, wherein the Potassium Hydroxide had been used in the upper part of migration cell and the Sodium Chloride in the lower part.

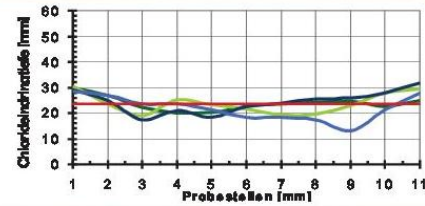
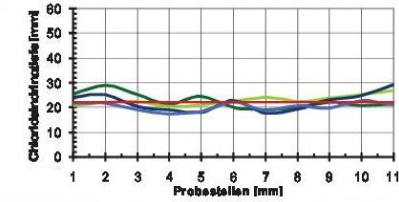
The electric current during the procedure as well as time until completing the cycle was noticed. After this process the cylinders were splitted into half and sprayed with Fluorescin first and Silver Nitrate afterwards.

Within the period of 24 h the reaction of these chemical agents form a brownish tint on the concrete surface which is permanent and can be documented as the depth whereto chlorides penetrated. The average of ten positions horizontally across the specimen were documented in ´mm´.

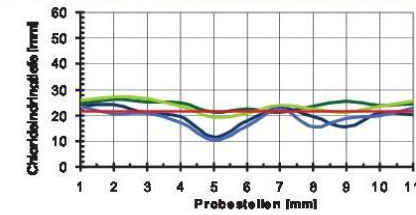
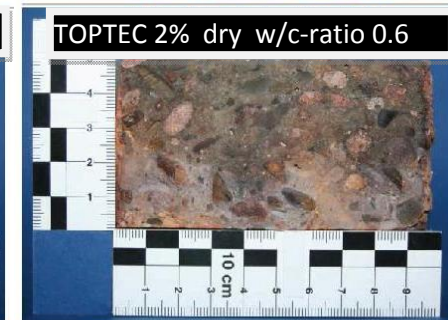
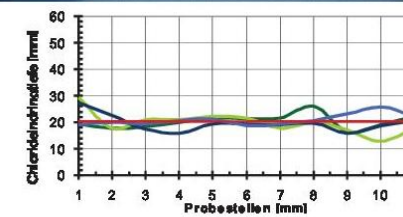
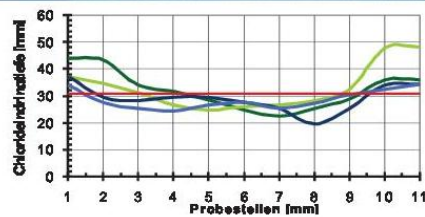
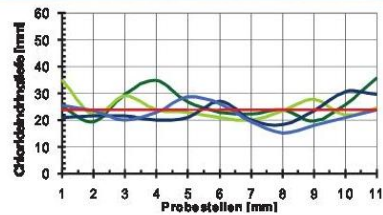
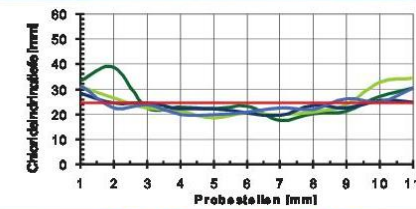
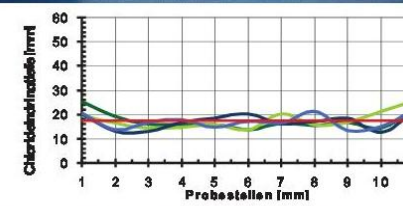
The readings need to be re-calculate into the so-called Chloride-Migration-Coefficient which is needed to read from commonly used graphs the approximate time to depassivation of rebars (called here: service lifetime).

Photodokumentation of specimen in appendix.

Chloride Penetration – Control



Chloride Penetration – TOPTEC® 2.0 %



Chloride Penetration – TOPTEC® 2.5 %

Chloride Penetration – Crystalline WP 2.0 %

