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TEST REPORT PB 2045

Client/manufacturer:	ETS Europe BVBA Herentalsebaan 406/Unit D1 Belgium, 2160 Wommelgem
Order:	Test of a surface protection system of class OS 1 (OS A) for concrete
Description of products:	ECO HYDRO GLASS
Responsible persons:	Dipl.-Ing. Attila Höchst
Equipment:	Media test stand / mortar testing machine
Delivery date:	16/04/2012
Test period:	23/04/2012 – 30/11/2012

This report consists of 7 pages including cover sheet.

Weimar, 21/04/2020

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1 Introduction

The following tests involved all testing which were necessary for the proof of performance features of a surface protection system of the class OS 1 (OS A) in accordance with DIN V 18026 (2006).

2 Sample preparation

For the tests of the surface protection system of defined reference concretes were produced according to DIN EN 1766. Depending on the particular test two different types of concrete were needed. Substantially they differed in the water-cement ratio. The mixtures were listed in Table 1.

Table 1: Mix parameters of concrete types by DIN EN 1766

Starting material	**Type of concrete C (0.45)**	**Type of concrete C (0.70)**
	[kg/m³]	[kg/m³]
Cement 42.5 R	375.0	275.0
Water	168.8	181.5
Sand 0/2	670.0	690.0
Gravel sand 2/8	690.0	710.0
Gravel 8/16	450.0	470.0
Sum	2353.8	2326.5

The plasticizer Sika ® ViscoCrete ® -2620 was added to improve the compaction of concrete type C (0.45) 1.0 kg/m³.

3 Requirements

In Table 2 were shown the requirements of surface protection systems (OS 1) in accordance with DIN V 18026 and the concrete mixtures which were used.

Table 2: Requirements

Characteristics according to DIN EN 1504-2	Test procedure according to	Requirements	Type of concrete
Penetration depth	DIN EN 1504-2, Table 3	class I: < 10 mm class II: > 10 mm	C (0.70)
Coefficient of drying speed	DIN EN 13579	class I: > 30 % class II: > 10 %	C (0.45)
Water absorption	DIN EN 13580	absorption coefficient < 7.5 % compared with untreated sample < 10 % in alkali solution	C (0.45)

4 Methods

For conducting the investigations the specimens were produced and cured in accordance with DIN EN 1766. Afterwards they were stored at room temperature (21 ± 2 °C) at a humidity of 60 ± 10 % until the time of testing. The tests were performed according to the standards specified in Table 2.

5 Results

5.1 Penetration depth

The application of the impregnation agent ECO HYDRO GLASS was conducted after 35 days of conditioning. ECO HYDRO GLASS was applied with a brush in two operations each to 100 g/m². The samples were dried under laboratory conditions. After this the specimens were split and the penetration depth was measured to an accuracy of 0.1°mm (Table 3).

In Table 3 were shown the results of penetration depth.

Table 3: Penetration depth and application rate with concrete type C (0.70)

Sample identification	Application rate ECO HYDRO GLASS [g/m²]	Single values of penetration depth [mm]				Average value of penetration depth [mm]
1	205	2.7	2.9	2.8	2.7	2.8
2	204	2.8	2.9	2.7	2.9	
3	207	2.7	2.7	2.6	2.8	

The fracture surfaces were sprayed with water, whereby the dry edge zones represented the effective depth of the water repellent zone.

5.2 Coefficient of drying speed

The principle of the test method described in DIN EN 13 579 based on the comparison of the drying speed of treated and untreated specimens of the same concrete mixture. The speed ratio was defined as the coefficient of drying speed.

After the conditioning, 3 samples of the same concrete mixture were treated with the product ECO HYDRO GLASS in accordance with DIN EN 13579. The moisture content of specimens was as standard 4.7°%. The average material consumption was 20.5 g/m² as a result of specimen treatment.

Table 4: Testing of drying of untreated samples

Identification	Mass [g]			D_u [g/m²h]
	after 0 hours	after 6 hours	after 24 hours	
EHG 1 - untreated	2405	2404	2401	2,78
EHG 2 - untreated	2389	2388	2385	2,78
EHG 3 - untreated	2407	2405	2403	1,85
			Dum=	2.47

Table 5: Testing of drying of treated samples

Identification	Mass [g]			D_t [g/m²h]
	after 0 hours	after 6 hours	after 24 hours	
EHG 4 - treated	2381	2372.5	2371.8	0.48
EHG 5 - treated	2377	2367.3	2366.7	0.45
EHG 6 - treated	2385	2376.6	2376.0	0.44
			D_{tm}=	0.46

The coefficient of drying speed (DRC) was calculated as follows:

$$DRC = \frac{D_{tm}}{D_{um}} \cdot 100\% = \frac{0.46}{2.47} \cdot 100\% = 18.5\%$$ equation 1

D_{tm} average drying speed of 3 treated prisms
D_{um} average drying speed of 3 untreated prisms

The coefficient of drying speed (DRC) was 18.5°%. The investigated impregnation agent was associated to class II.

Directly after the drying tests the specimens were stored in separate, airtight containers over a saturated potassium-sulfate solution for further investigations of the water absorption and alkali resistance.

5.3 Water absorption and alkali resistance

The impregnations of concrete surfaces decreased the penetration ability of water and salt solutions in the concrete. The test described in DIN EN 13580 based on the comparison of water absorption of treated and untreated concrete prisms produced of the same mixture of concrete.

The ratio of speed of treated prisms and untreated prisms was defined as an absorption coefficient. The long-term durability was demonstrated by measurements of the water absorption according to a defined alkali stress. In Table 6 and Table 7 were shown the results of water absorption before the alkali exposure.

Table 6: Water absorption before alkali exposure of untreated prisms

Sample identification	i_1	i_2 (1h)	I_u
	[g]	[g]	[g/m^{2}h^{0,5}]
EHG 1 - untreated	2387.2	2391.8	76.7
EHG 2 - untreated	2364.2	2368.3	68.3
EHG 3 - untreated	2353.4	2357.3	65.0
		I_{um}	70.0

Table 7: Water absorption before alkali exposure of treated prisms

Sample identification	i_1	i_2 (24h)	I_t
	[g]	[g]	[g/m^{2}h^{0,5}]
EHG 4 - treated	2375.0	2375.9	3.1
EHG 5 - treated	2369.8	2370.4	2.0
EHG 6 - treated	2379.0	2380.1	3.8
		I_{tm}	3.0

The coefficient of absorption resulted from:

$$AR = \frac{I_{tm}}{I_{um}} \cdot 100\% = \frac{3.0}{70.0} \cdot 100\% = 4.2\%$$ [equation 2]

I_{tm} average speed of increase in mass of 3 treated prisms
I_{um} average speed of increase in mass of 3 untreated prisms

Additionally the treated prisms were exposed in a defined potassium hydroxide solution for 21 days. Afterwards the specimens were dried under laboratory conditions on initial mass (prism mass before water absorption, Table 7: i_1). If the initial mass was achieved the water absorption was measured again (see Table 8).

Table 8: Water absorption after alkali exposure of treated prisms

Sample identification	i_1	i_2 (24h)	I_t
	[g]	[g]	[g/m²h^{0,5}]
EHG 4 - treated	2369.2	2370.9	5.7
EHG 5 - treated	2362.9	2364.5	5.5
EHG 6 - treated	2372.8	2374.4	5.4
		$I_{tm(alk)}$	5.5
		$AR_{(alk)}$	7.9%

This resulted in the coefficient of absorption (AR_{alk}):

$$AR_{(alk)} = \frac{I_{tm(alk)}}{I_{um}} \cdot 100\% = \frac{5.5}{70} \cdot 100\% = 7.9\%$$ [equation 3]

$I_{tm(alk)}$ the average speed of the increase in mass of 3 specimens after immersion in potassium hydroxide in grams

Before the alkali test was the absorption coefficient 4.2 %.

6 Conclusions

Tests with the impregnation ECO HYDRO GLASS were conducted in accordance with DIN V 18026 (2006) as proof of the characteristics of a surface protection system class OS 1 (OS A)
The results are shown in Table 9 and were compared with standard requirements.

Table 9: Results of testing

Characteristics according to DIN EN 1504-2	Test procedure according to	Results of ECO HYDRO GLASS	Requirements
Penetration depth	DIN EN 1504-2, Table 3	class I: < 10 mm	class I: < 10 mm class II: > 10 mm
Coefficient of drying speed	DIN EN 13579	class II: > 10 %	class I: > 30 % class II: > 10 %
Water absorption	DIN EN 13580	absorption coefficient 4.2 % compared with untreated sample 7.9 % in alkali solution	absorption coefficient < 7.5 % compared with untreated sample < 10 % in alkali solution

The product ECO HYDRO GLASS (hydrophobic impregnation agent) considered the requirements of a surface protection system class OS 1 (OS A) in accordance with DIN V 18026 (2006) with regard to the tested properties.