INSTITUT FÜR KORROSIONSSCHUTZ DRESDEN GMBH

Privatwirtschaftliche Forschungsstelle

Beratung - Schadensfallaufklärung - Qualitätssicherung - Forschung - Prüfung

- **Akkreditiertes Prüflabor für Korrosion, Korrosionsschutz und Korrosionsanalytik**
- DAkkS-Registrierungsnummer: **D-PL-19138-01-00**
- Institut im Verbund der Technischen Akademie Wuppertal e. V.
- Institut an der TU Bergakademie Freiberg

☎ 0351 871 7100
Fax 0351 871 7150

Institut für Korrosionsschutz Dresden GmbH • Gostritzer Str. 65 • 01217 Dresden

Test Report

PB300/045/19

Orderer:	Eckart GmbH Güntersthal 4 91235 Hartenstein
Date of order:	05.10.2018
Receipt of samples:	18.10.2018
Test period:	09.10.2018 bis 05.03.2019
Order:	Testing of the coating system 2, light blue according to DIN EN ISO 12944-6, annex B (test regime 2)
Laboratory order No.:	LA3/272/18/183173
Pages:	6
Responsible examiner:	Dr. Stephan Zeltner
Head of laboratory/ Head of department:	Dr. Andrea Rudolf

Institut für Korrosionsschutz Dresden GmbH
Gostritzer Straße 65
01217 Dresden

Dresden, 25.03.2019

Prepared: Dr. Stephan Zeltner	Checked: Dr. Andrea Rudolf	Approved: Dr. Andrea Rudolf
Sign: SZ	Sign: Ru	Sign: Ru
Date: 25.03.19	Date: 25.03.19	Date: 25.03.19

This test report was created bilingual (German and English). In case of doubt the German text applies.

1 Subject

The customer delivered 6 test panels of the coating system listed in clause 2 The coating system was to be examined in accordance with the test requirements of DIN EN ISO 12944-6, Annex B (test regime 2) for corrosivity category C5, very high durability.

2 Preparation of the test panels

The test planels with the dimensions approx (200 x 120 x 3) mm were provided by the customer The following information about the test panels was reported:

System 2 (light blue)·	manufacturing in calendar week 34/2018
Test planels	SA13, SA14, SA15, SB6, SB9 and SB14
Substrate	Steel, blast cleaned, Sa 2 ½
Coating system	1 x approx 70 µm 2C-Epoxy ProFlake Zn based Primer, cross-linked with a modified polyaminoamide adduct 1 x approx 150 µm 2C-Epoxy iron mica intermediate coat, cross-linked with a modified polyaminoamide adduct 1 x approx 100 µm 2C-Polyurethane top Coat, cross-linked with an aliphatic poly isocyanate
Overall dry-film thickness	approx. 320 µm

3 Stress application

Cyclic ageing test in accordance with DIN EN ISO 12944-6, Annex B

On each test panels, a scribe line with a width of 2 mm was introduced down to the substrate The scribe lines were introduced automatically by means of a side milling cutter with staggered tooth system Subsequently, the test planels have been exposed to the following cycle:

- **72 h of exposure to UV and condensation in accordance with ISO 16474-3, method A, cycle 1 under the following conditions:**
  - 4 hours of exposure to UVA radiation (340 nm) 0,83 W/m² at (60 ± 3) °C and
  - 4 hours of condensation of water vapour at (50 ± 3) °C

  Test apparatus Q-LAB Deutschland GmbH (PMK 300-13.3)
- **72 h of exposure to neutral salt spray, 50 g/l NaCl bei (35 ± 2) °C in accordance with DIN EN ISO 9227 (NSS)**
  Test apparatus: Weiss Umwelttechnik GmbH (PMK 300-5 5)
- **24 h of of exposure to low temperature at (-20 ± 2)°C**
  Test apparatus Liebherr-International Deutschland GmbH (PMK 300-31 2)

Duration of stress application 2688 Stunden (corresponds to 16 cycles á 168 h)

Three test planels have been used, previously cut to (150 x 100) mm

4 Testing

Dry-film thickness

The dry-film thickness was measured prior to stress application in accordance with DIN EN ISO 2808

Substrate	Steel
Method	7 C - magnetic induction
Test apparatus	Fischer DELTASCOPE FMP 10, PMK 300-11 4
Calibration	On smooth steel sheet with foils of known thickness

For the determination of the dry-film thickness in accordance with ISO 19840, a correction factor of 25 µm was subtracted from the mean value of the dry-film thickness determined in accordance with DIN EN ISO 2808.

Visual evaluation

Visually detectable changes have been evaluated immediately after the end of the stress application with normal sight and under artificial light in accordance with DIN EN ISO 13076

Degree of blistering:	DIN EN ISO 4628-2
Degree of rusting	DIN EN ISO 4628-3
Degree of cracking	DIN EN ISO 4628-4
Degree of flaking:	DIN EN ISO 4628-5

Determination of the pull-off strength

The pull-off test has been carried out in accordance with DIN EN ISO 4624 on one side, on the stressed front side

Adhesive:	Scotch-Weld DP 490 (2K-EP, 24 hours of hardening)
Test apparatus	Posi Test adhesion tester by the TQC company (PMK 300-15 4)

The pull-off strength and the failure pattern were determined prior to stress application as well as 7 days after the end of the stress application and storage of the test panels under laboratory conditions In regard to the failure pattern the percentage of the respective failure in the context of the total failure pattern is given

Meaning of the failure pattern.

C/D	Adhesion failure between 2nd layer and 3rd layer
D	Cohesion failure in the 3rd layer

Corrosion around the scribe line

Immediately after the end of the stress application (<8h) the delaminated coating around the scratch was removed by using a scalpel The width of the corroded area around the scribe line was measured in 9 locations and the arithmetic mean value was calculated.

The corrosion around the scribe line M, in millimetres, was calculated in accordance with the following equation and the result was rounded to one decimal place.

$$M = \frac{C - W}{2}$$

C - Width of the corroded area (arithmetic mean value)
W - Initial width of the scribe line

5 Results

Table 1: Test Results prior to and after stress application

Assessment prior to stress application									
Tests prior to stress application		Panel 2/4 (SB9)		Panel 2/5 (SB6)		Panel 2/6 (SA14)			
DIN EN ISO 2808	Dry-film thickness [µm]	314 ± 8		307 ± 8		339 ± 7			
ISO 19840	Dry-film thickness [µm]	289		282		314			
DIN EN ISO 4624	Pull-off strength [MPa] and Failure pattern [%]	7	100 D	5	100 D	7	100 D		
		7	100 D	7	100 D	7	100 D		
		7	100 D	7	100 D	6	100 D		
Assessment after stress application									
Cyclic ageing test according to DIN EN ISO 12944-6, Annex B									
Duration: 2688 h		Panel 2/1 (SB14)		Panel 2/2 (SA13)		Panel 2/3 (SA15)			
DIN EN ISO 2808	Dry-film thickness [µm]	330 ± 18		350 ± 7		355 ± 14			
ISO 19840	Dry-film thickness [µm]	305		325		330			
DIN EN ISO 4624	Pull-off strength [MPa] and Failure pattern [%]	5	10 C/D, 90 D	5	10 C/D, 90 D	6	10 C/D, 90 D		
		7	10 C/D, 90 D	7	10 C/D, 90 D	5	10 C/D, 90 D		
		6	10 C/D, 90 D	8	10 C/D, 90 D	6	10 C/D, 90 D		
DIN EN ISO 4628-2	Degree of blistering	0(S0)		0(S0)		0(S0)			
DIN EN ISO 4628-3	Degree of rusting	Ri0		Ri0		Ri0			
DIN EN ISO 4628-4	Degree of cracking	0(S0)		0(S0)		0(S0)			
DIN EN ISO 4628-5	Degree of flaking	0(S0)		0(S0)		0(S0)			
Corrosion around the scribe line	Mean value [mm]	1,4 ± 0,4		1,0 ± 0,5		1,6 ± 0,6			

6 Requirements

Coating systems pass the test in accordance with ISO 12944-6, test regime 2, if two of the three test panels fulfil the following requirements

Prior to stress application	
Cross-cut value DIN EN ISO 2409 (only for dry-film thicknesses ≤ 250 µm)	≤ 2
Pull-off strength DIN EN ISO 4624	Pull-off strength ≥ 2,5 MPa (for each measuring value), no adhesion failure to the substrate (A/B), except for pull-off values ≥ 5 MPa
After stress application	
Cross-cut value ISO 2409 (only for dry-film thicknesses ≤ 250 µm)	≤ 2
Pull-off strength DIN EN ISO 4624·	Pull-off strength ≥ 2,5 MPa (for each measuring value), no adhesion failure to the substrate (A/B), except for pull-off values ≥ 5 MPa
Degree of blistering DIN EN ISO 4628-2	0 (S0)
Degree of rusting DIN EN ISO 4628-3	Ri 0
Degree of cracking DIN EN ISO 4628-4	0 (S0)
Degree of flaking DIN EN ISO 4628-5:	0 (S0)
Corrosion around the scribe line· DIN EN ISO 12944-6	≤ 3,0 mm

7 Conclusions from the test results [1]

The tested coating system (listed in clause 2) fulfils the requirements of DIN EN ISO 12944-6 for corrosivity category C5, very high durability, in accordance with test regime 2

8 Accredited standards and regulations

Table 2: Accredited standards and regulations

Standard / regulation	Edition
DIN EN ISO 12944-6	2018-04
DIN EN ISO 16474-3	2014-03
DIN EN ISO 9227	2017-07
DIN EN ISO 2808	2007-05
ISO 19840	2012-09
DIN EN ISO 4624	2016-08
DIN EN ISO 4628, Parts 2-5	2016-07

[1] Not within the accredited scope

9 Documentation

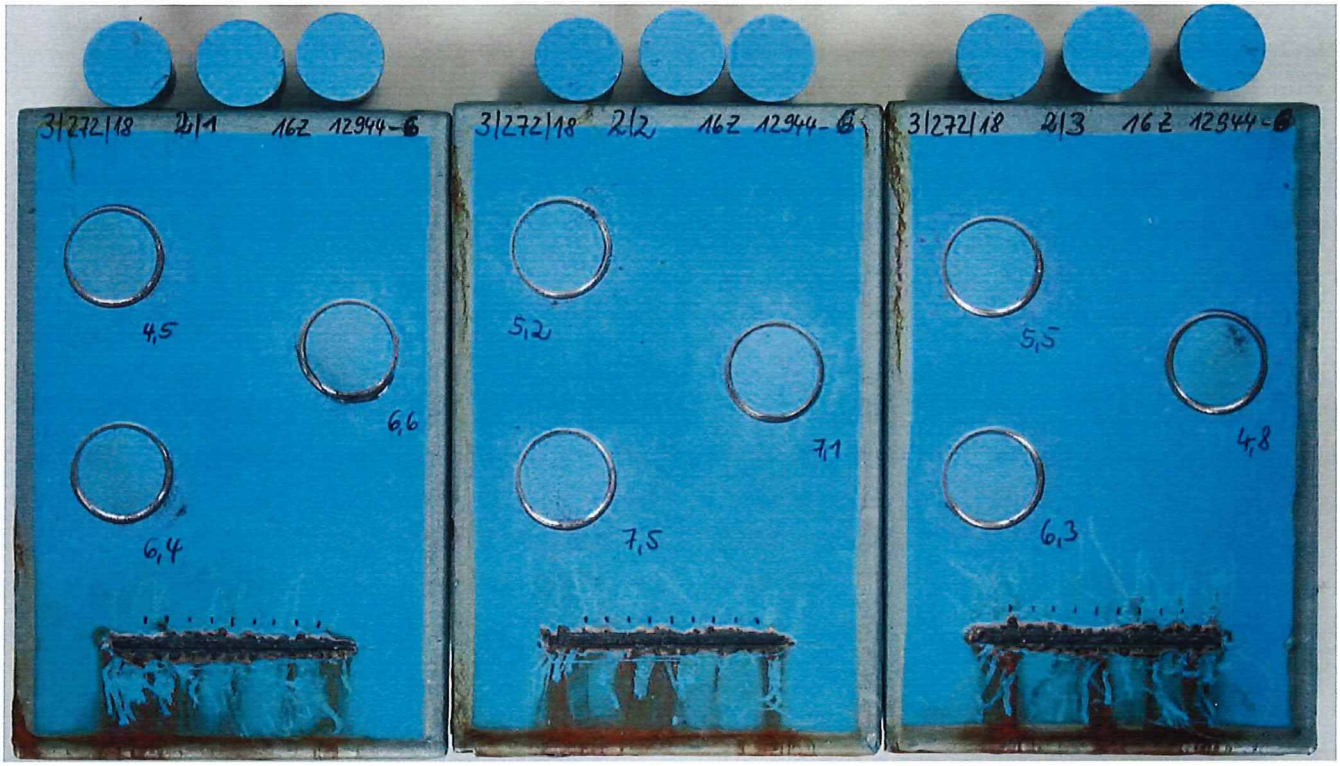

Figure 1: Panels after Cyclic ageing test