



Beratung - Schadensfallaufklärung - Qualitätssicherung - Forschung - Prüfung

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## Test Report PB300/226/22

Customer: Eckart GmbH  
Günterstal 4  
91235 Hartenstein

Day of order: 2022-04-01


Receipt of samples: 2022-04-01


Period of testing: 2022-04-13 to 2022-11-08

Order: Testing of a coating system in accordance with  
DIN EN ISO 12944-9, CX

Laboratory number of order: LA3/75/22/223071


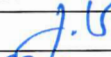

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Dresden, 2023-01-03

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Sign: 	Sign: 	Sign: 
Date: 03.01.2023	Date: 03.01.2023	Date: 03.01.2023

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

## 1 Subject

The customer provided 9 coated test panels approx. (200 x 120 x 6) mm along with the following information:

System:	B
Substrate:	steel, blast cleaned Sa2 ½
Coating system:	1 x 2K – Epoxy zinc flake primer 1 x 2K – Epoxy iron mica 1 x 2K – PUR
Total film thickness:	ca. 350 µm

The coating system was to be tested in accordance with DIN EN ISO 12944-9, annex B (CX) for areas with heavy mechanical stress.

## 2 Preparation of the test panels

The customer provided the test panels. The coating system to be tested was applied on one side. The test plates were cut to (150x100) mm and have been equipped with edge protection at the Institut für Korrosionsschutz Dresden.

## 3 Stress application

### Cyclic ageing test in accordance with DIN EN ISO 12944-9, Annex B

On each test panel, 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 panels 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/m<sup>2</sup> 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 exposure to low temperature at (-20 ± 2)°C**  
Test apparatus: Liebherr-International Deutschland GmbH (PMK 300-31.2)

Duration of stress application: 25 cycles (4200 hours)

Three test panels have been used. The test panels were stored prior to stress application under laboratory conditions.

## 4 Test

### 4.1 Film thickness

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

Method:	7B.2 – magnetic induction
Measuring device:	Fischer DELTASCOPE FMP10 (PMK 300-11.4)
Calibration:	On smooth steel sheet with foils of known thickness

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

**4.2 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

**4.3 Determination of the pull-off strength**

The pull-off test has been carried out in accordance with DIN EN ISO 4624.

- Method: B (single side)
- Adhesive: Scotch-Weld DP 490 (2K-EP, 24 hours of hardening)
- Test apparatus: PosiTest® adhesion tester by the DeFelsko company (PMK 300-15.4)

The pull-off strength and the failure pattern were determined prior to stress application (separate test panels) as well as 14 days after the end of the stress application and storage of the test panels under laboratory conditions. The values of the pull-off strength were rounded to one decimal place.

In regard to the failure pattern the percentage of the respective failure in the context of the total failure pattern was estimated to a value of 10 %.

Meaning of the failure pattern:

- B Cohesion failure in the 1<sup>st</sup> layer
- D Cohesion failure in the 3<sup>th</sup> layer

**4.4 Corrosion around the scribe line**

The corrosion around the scribe line was determined in accordance with DIN EN ISO 12944-9, annex A2. Immediately after the end of the stress application (within 8 hours) the delaminated coating around the scribe line 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 formula 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

## 5 Results

Table 1 Results prior to and after stress application

Assessment prior to stress application		specimen 7		specimen 9		specimen 11	
DIN EN ISO 2808	Film thickness $MW$ [ $\mu\text{m}$ ]	366 $\pm$ 9		360 $\pm$ 11		351 $\pm$ 5	
ISO 19840	Film thickness $MW$ [ $\mu\text{m}$ ]	341 $\pm$ 9		335 $\pm$ 11		326 $\pm$ 5	
DIN EN ISO 4624	Cross-cut	9,1	100 B	13,8	50 B, 50 D	7,3	80 B, 20 D
	Pull-off strength [MPa]	14,0	50 B, 50 D	15,1	50 B, 50 D	9,0	30 B, 70 D
	and failure pattern [%]	12,7	40 B, 60 D	14,8	50 B, 50 D	9,1	20 B, 80 D
	Mean value [MPa]	11,9	–	15,6	–	8,5	–
<b>Assessment after stress application</b>							
<b>Cyclic ageing test according to DIN EN ISO 12944-9, Annex B</b>							
Duration: 25 cycles		specimen 3		specimen 5		specimen 13	
DIN EN ISO 2808	Film thickness $MW$ [ $\mu\text{m}$ ]	367 $\pm$ 10		362 $\pm$ 5		364 $\pm$ 5	
ISO 19840	Film thickness $MW$ [ $\mu\text{m}$ ]	342 $\pm$ 10		337 $\pm$ 5		339 $\pm$ 5	
DIN EN ISO 4624	Cross-cut	5,1	100 B	3,6	100 B	6,4	100 B
	Pull-off strength [MPa]	6,1	60 B, 40 D	6,4	90 B, 10 D	7,2	100 B
	and failure pattern [%]	7,7	100 B	7,7	80 B, 20 D	5,4	100 B
	Mean value [MPa]	6,3	–	5,9	–	6,3	–
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]	5,3 $\pm$ 1,6		6,9 $\pm$ 1,1		5,6 $\pm$ 1,2	

## 6 Requirements

Coating systems pass the test in accordance with DIN EN ISO 12944-9, if two out of three test panels fulfil the following requirements:

### Prior to stress application

Pull-off strength DIN EN ISO 4624:  $\geq 5$  MPa (each measuring value);  
No adhesion failure between steel or metallised steel and first film, except for pull-off values  $\geq 5$  MPa

### After stress application

Pull-off strength DIN EN ISO 4624: min. 50% of the pull-off strength determined on unloaded test plate.  
No adhesion failure between steel or metallised steel and first film, except for pull-off values  $\geq 5$  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

in accordance with DIN EN ISO 12944-9  $\leq 8,0$  mm (coating systems for areas with heavy mechanical stress)  
 $\leq 3,0$  mm (all other coating systems)

## 7 Conformity

The tested coating system fulfils the requirements of DIN EN ISO 12944-6 for corrosivity category CX for areas with heavy mechanical stress.

The layer thickness determined according to ISO 19840 is partially up to 7% below the minimum layer thickness.

Note:

The information on conformity includes all the given characteristic values and measuring values. In regard to conformity the following decision rule was applied: The measuring uncertainty was ignored.

The mean value of the 3 individual values of each test panel was formed to evaluate the Pull-off strength.

The mean values of the test panels before and after loading were then compared. The lowest mean value determined before loading served as the basis for the evaluation.

## 8 Used accredited standards and regulations

Table 2 Used accredited standards and regulations

Standard / regulation	Edition
DIN EN ISO 12944-6	2018-06
DIN EN ISO 9227	2017-07
DIN EN ISO 2808	2019-12
ISO 19840	2012-09
DIN EN ISO 4624	2016-08
DIN EN ISO 4628, parts 2 to 5	2016-07

9 Dokumentation



Figure 1 System B after 25 cycles cyclic ageing test and subsequent testing