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REPORT

Testing of the system
ZINGA (60-80 μm) / Zingaceram ZM EP MIO HS (120 μm) /
Zingaceram ZM PU (60 μm) according to ISO 12944-6 C5-I High

Haarlem, 4 June 2014

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1 INTRODUCTION

1.1 Order

By order of Zingametall bvba in Eke, Belgium, the Centrum voor Onderzoek en Technisch advies (COT bv) in Haarlem, The Netherlands, has tested the system ZINGA (60-8- μm) / Zingaceram ZM EP MIO HS (120 μm) / Zingaceram ZM PU (60 μm)³ according to ISO 12944-6 C5-I High.

The tests are described in the e-mail of 15 October 2013 16:06.
 The order has been given with the Bestelbon 2013/179/JVA/GW of 16-10-2013.

1.2 General information

Table 1: Samples

COT sample number	Samples	Received
14-01-14/0022	30 coated steel panels*, dimensions 100 x 150 mm	14-01-2014

* Panels coded by COT

Test specification : ISO 12944-6
 Corrosivity category : C5-I
 Durability range : High, Industrial

2 PAINT APPLICATION

The coating system has been applied by the client according to specifications.

Table 2: System build-up.

Layer	Product	No. Coats	DFT (μm)	Colour
1	ZINGA	1	60-80	Zinc
2	Zingaceram ZM EP MIO HS	1	120	Grey
3	Zingaceram ZM PU	1	60	Orange
System	Total system thickness		240-260	Orange



3 PROCEDURE

3.1 Dry film thickness

The dry film thickness of the coating has been measured in accordance with ISO 2808, method 7C using a digital gauge (COT E004) with magnetic induction probe. From a minimum of five measurements per specimen panel, the minimum, maximum, average and corresponding standard deviation have been reported, corrected for medium roughness (25 micrometers). In deviation of report procedure of ISO 2808, individual measurements are not reported here.

3.2 Adhesion

Adhesion value is determined for unexposed reference panels as well as for exposed panels, which have been acclimated for 24 hours at 23 ± 2 °C and 50 ± 5 % RH.

For systems with a nominal coating thickness (nDFT) less than 250 micrometers, the adhesion of the coating system is determined by cross-cut test with the use of a single blade cutting tool in accordance with ISO 2409.

For systems with a nDFT above 250 micrometers, the adhesion of the coating is determined by pull-off test, employing a pneumatic adhesion tester (COT A006) in accordance with ISO 4624. The coating surface and the dolly are sanded lightly and degreased with neat ethanol. An epoxy adhesive is employed and allowed to cure overnight. Prior to testing the coating is scribed around the dollies down to the substrate. The average corrected reading of performed measurements is reported.

The method most suited is employed with systems which nDFT is close to 250 μm .

3.3 Neutral Salt Spray

From January 31st 2014 to April 1st 2014, for a total of 1440 hours exposure, the resistance to neutral salt spray has been tested on three scribed test panels in accordance with ISO 9227 NSS. The scribe mark has been made through the coating down to the substrate using a sharp knife.

General data

Apparatus number	:	COT S006
Type of water	:	Demineralised water (< 1 μS)
Salt	:	Sodium chloride (NaCl) p.a.
Test temperature	:	35 °C
Collected salt solution	:	1.0 – 2.0 ml/hour/80 cm ²
pH of the collected salt solution	:	6.5 – 7.2
Salt concentration of the collected solution	:	50 \pm 5 g/l

Immediately after the test, the panels have been examined for defects according to ISO 4628. The adhesion has been determined after 24 hours reconditioning at 23 ± 2 °C and 50 ± 5 % RH.



3.4 Condensation test

From January 28th 2014 to February 27th 2014, for a total of 720 hours exposure, the resistance to water condensation has been tested on three test panels in accordance with ISO 6270-1.

General data

Apparatus	: Cleveland condensation tester (COT C001)
Temperature of the air space	: 38 ± 2 °C
Temperature environment	: 23 ± 2 °C
Exposition angle	: approx. 60° to the horizontal

Immediately after the test, the panels have been examined for defects according to ISO 4628. The adhesion has been determined after 24 hours reconditioning at 23 ± 2 °C and 50 ± 5 % RH.

3.5 Chemical immersion test

From January 30th 2014 to February 6th 2014, for a total of 168 hours exposure, the resistance to chemical immersion has been tested on three test panels for each chemical in accordance with ISO 2812-1. The immersion chemicals are 10 % aqueous H₂SO₄, 10 % aqueous NaOH and a mineral spirit with 18 % aromatics.

In each solution three test panels have been immersed for 60 %. The test temperature was 23 ± 2 °C.

Immediately after the test, the panels have been examined for defects according to ISO 4628. The adhesion has been determined after 24 hours reconditioning at 23 ± 2 °C and 50 ± 5 % RH.

4 RESULTS

4.1 Reference Adhesion test

Table 3: Adhesion reference test

Reference No exposure		COT sample number 14-01-14/0022			Requirements
		Panel 1	Panel 2	Panel 3	
DFT (µm)	Min. - max.	254 - 280	251 - 279	225 - 258	≤ 300 µm
	Mean	264 ± 10	266 ± 12	238 ± 13	
ISO 2409	Classification	1	1	1	0 or 1
ISO 4624	(MPa) Fracture area	5.6 ± 0.8 100 % B	4.0 ± 0.6 100 % B	5.3 ± 1.6 100 % B	≥ 5 MPa, or no A/B break

4.2 Neutral Salt Spray test

Table 4: Assessment after neutral salt spray test

Exposure: Neutral salt spray ISO 9227, 1440 hours		COT sample number 14-01-14/0022			Requirements
		Panel 16	Panel 17	Panel 18	
DFT (µm)	Min. - max.	208 - 241	220 - 246	231 - 262	≤ 300 µm
	Mean	227 ± 13	234 ± 11	246 ± 12	
Blistering	ISO 4628-2	0(S0)	0(S0)	0(S0)	0(S0)
Rusting	ISO 4628-3	Ri 0	Ri 0	Ri 0	Ri 0
Cracking	ISO 4628-4	0(S0)	0(S0)	0(S0)	0(S0)
Flaking	ISO 4628-5	0(S0)	0(S0)	0(S0)	0(S0)
Corrosion from scribe (mm)		1	0	0	≤ 1 mm
ISO 2409	Classification	2	1	1	0 or 1
ISO 4624	(MPa) Fracture area	4.7 * 100 % B	5.2 * 100 % B	5.0 * 100 % B	≥ 5 MPa, or no A/B break

* Single measurement

4.3 Condensation test

Table 5: Assessment after condensation test

Exposure: Condensation ISO 6270-1, 720 hours		COT sample number 14-01-14/0022			Requirements
		Panel 19	Panel 20	Panel 21	
DFT (µm)	Min. - max.	200 - 232	217 - 251	209 - 250	≤ 300 µm
	Mean	215 ± 13	234 ± 15	227 ± 17	
Blistering	ISO 4628-2	0(S0)	0(S0)	0(S0)	0(S0)
Rusting	ISO 4628-3	Ri0	Ri0	Ri0	Ri 0
Cracking	ISO 4628-4	0(S0)	0(S0)	0(S0)	0(S0)
Flaking	ISO 4628-5	0(S0)	0(S0)	0(S0)	0(S0)
ISO 2409	Classification	1	1	1	0 or 1
ISO 4624	(MPa) Fracture area	6.4 ± 0.2 100 % B	6.4 ± 0.8 100 % B	5.3 ± 0.4 100 % B	≥ 5 MPa, or no A/B break

4.4 Chemical Immersion test

Table 6: Assessment after immersion test, 10 % NaOH.

Exposure: Immersion, 10 % NaOH ISO 2812-1, 168 hours		COT sample number			Requirements
		14-01-14/0022			
		Panel 22	Panel 23	Panel 24	
DFT (µm)	Min. - max.	199 - 255	217 - 261	212 - 262	≤ 300 µm
	Mean	229 ± 21	242 ± 16	240 ± 18	
Blistering	ISO 4628-2	0(S0)	0(S0)	0(S0)	0(S0)
Rusting	ISO 4628-3	Ri0	Ri0	Ri0	Ri 0
Cracking	ISO 4628-4	0(S0)	0(S0)	0(S0)	0(S0)
Flaking	ISO 4628-5	0(S0)	0(S0)	0(S0)	0(S0)
ISO 2409	Classification	1	1	1	0 or 1
ISO 4624	(MPa)	3.5 ± 0.1	4.6 *	3.9 *	≥ 5 MPa, or
	Fracture area	100 % B	100 % B	100 % B	no A/B break

* Single measurement

Table 7: Assessment after immersion test, 10 % H₂SO₄.

Exposure: Immersion, 10 % H ₂ SO ₄ ISO 2812-1, 168 hours		COT sample number			Requirements
		14-01-14/0022			
		Panel 25	Panel 26	Panel 27	
DFT (µm)	Min. - max.	224 - 252	229 - 241	239 - 270	≤ 300 µm
	Mean	238 ± 13	237 ± 5	252 ± 12	
Blistering	ISO 4628-2	0(S0)	2(S1)	0(S0)	0(S0)
Rusting	ISO 4628-3	Ri0	Ri0	Ri0	Ri 0
Cracking	ISO 4628-4	0(S0)	0(S0)	0(S0)	0(S0)
Flaking	ISO 4628-5	0(S0)	0(S0)	0(S0)	0(S0)
ISO 2409	Classification	0	1	1	0 or 1
ISO 4624	(MPa)	5.1 *	4.1 *	4.1 *	≥ 5 MPa, or
	Fracture area	100 % B	100 % B	100 % B	no A/B break

* Single measurement

Table 8: Assessment after immersion test, mineral spirit.

Exposure: Immersion, mineral spirit ISO 2812-1, 168 hours		COT sample number			Requirements
		14-01-14/0022			
		Panel 28	Panel 29	Panel 30	
DFT (µm)	Min. - max.	221 - 267	215 - 241	209 - 226	≤ 300 µm
	Mean	244 ± 19	228 ± 10	216 ± 6	
Blistering	ISO 4628-2	0(S0)	0(S0)	0(S0)	0(S0)
Rusting	ISO 4628-3	Ri0	Ri0	Ri0	Ri 0
Cracking	ISO 4628-4	0(S0)	0(S0)	0(S0)	0(S0)
Flaking	ISO 4628-5	0(S0)	0(S0)	0(S0)	0(S0)
ISO 2409	Classification	1	1	1	0 or 1
ISO 4624	(MPa)	4.2 *	4.6 *	4.3 *	≥ 5 MPa, or
	Fracture area	100 % B	100 % B	100 % B	no A/B break

* Single measurement




5 CONCLUSION

The system ZINGA (60-80 μm) / Zingaceram ZM EP MIO HS (120 μm) / Zingaceram ZM PU (60 μm), applied to steel panels (COT sample number 14-01-14/0022), meets all requirements of ISO 12944-6 C5-I High.

CENTRUM VOOR ONDERZOEK
EN TECHNISCH ADVIES (COT bv)



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ANNEX

Photographs

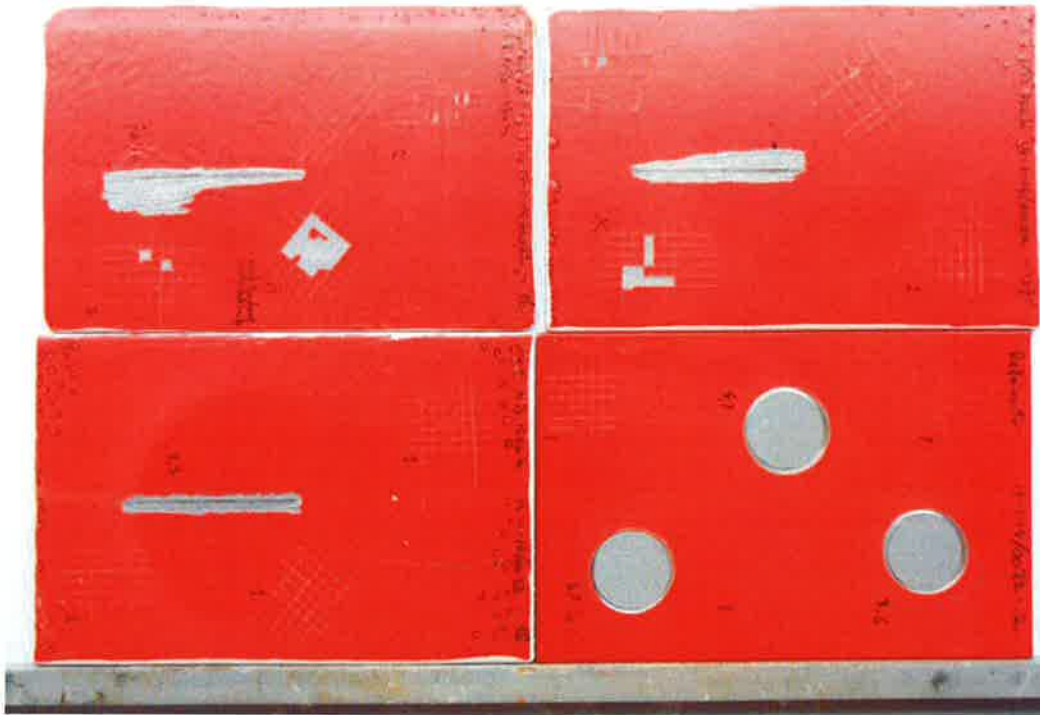


Photo 1: Panels after 1440 hours Neutral Salt Spray Test



Photo 2: Panels after 720 hours Condensation Test.



Photo 3: Panels after 168 hours NaOH Immersion Test



Photo 4: Panels after 168 hours H₂SO₄ Immersion Test



Photo 5: Panels after 168 hours Mineral Spirit Immersion Test.