COT bv
Independent advice, research and management for construction and industry

Consultancy
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REPORT

Testing coated samples with COT sample number 05-11-20/0514 and 19-07-21/0326
according to ISO 12944-6 C5 High, test regime 1

Haarlem, 11th of February 2022

Client	:	ZINGAMETALL BVBA Industriepark - Rozenstraat 4 B - 9810 Eke Belgium Contact person: Mr. P. Claeys

Specified system :

coat		**Product name**	**nDFT**
1st coat	:	Zinga	60 µm
2nd coat	:	Zingatarfree	90 µm
3rd coat	:	Zingatarfree	90 µm
Total	:		240 µm

Project number	:	20200273
Report number	:	LAB22-0033-REP Rev. 1
Handled by	:	Ms. F. F. Sudarso

Conclusion
The coated samples with COT sample number **05-11-20/0514 and 19-07-21/0326**
meet the requirements of ISO 12944-6 C5 High, test regime 1.
As an additional request by the client, the test duration of Neutral Salt Spray on the COT sample number **19-07-21/0326** was 2160 hours instead of the required 1440 hours.

CONTENTS

Revision 1: Corrected : - Product name,
- DFT Panel 21/326-2, Panel 21/326-2 and Panel 21/326-2

1 INTRODUCTION

1.1 Order

At the request of Zingametall BVBA in Eke, Belgium, the Centrum voor Onderzoek en Technisch advies (COT bv) in Haarlem, The Netherlands, has tested the samples with COT sample number 05-11-20/0514 and 19-07-21/0326 according to ISO 12944-6 C5 High, test regime 1.

With reference number RB/MH LAB20-0395-OFF-Revision 1, dated 7th) October 2020.

Tests marked with 'Q' are under accreditation according to ISO/IEC 17025 with registration number L535.

1.2 General information

Table 1: Received samples

COT sample number	Sample		Received
05-11-20/0514	12x	Coated steel panels, dimensions 75 x 150 x 5 mm, labelled* Pull off: 1, 10 and 12/ NSS: 11, 13 and 18/ Con : 5, 18! and 20/ IMM : 2, 8 and 14	5-11-2020
19-07-21/0326	3x	Coated steel panels, dimensions 75 x 150 x 5 mm, labelled*: 2, 3 and 5	19-7-2021

*) Labelled by the client.

The coating system has been applied to the test panels by the client.

1.3 Information received from the client

Substrate
Mild steel panels.

Surface preparation
Blasted to Sa 2.5 grade cleanliness according to ISO 8501-1.
Surface roughness Medium (G) according to ISO 8503-1.

Coating system build up and specified dry film thickness

Zinga	:	60 µm
Zingatarfree	:	90 µm
Zingatarfree	:	90 µm
Total nominal dry film thickness (nDFT)	:	240 µm

Test specification	: ISO 12944-6
Corrosivity category	: C5
Durability range	: High
Test regime	: 1

2 PROCEDURE

2.1 Determination of the dry film thickness using a magnetic induction gauge, ISO 17025 Scope number 1 (Q)

Before starting the tests the total dry film thickness of the coating system has been measured according to ISO 2808:2019-7B2, COT Instruction 30.01.12-2 with a magnetic induction dry film thickness meter (COT_E004 or COT_E005) and corrected for surface roughness (C = correction value) according to ISO 19840. On each panel 5 measurements have been carried out.

2.2 Adhesion

Before adhesion testing the panels have been conditioned for 7 days at 23 ± 2 °C and 50 ± 5 % R.H., the test has been performed under the same conditions. All individual values have been reported.

Depending on the uncorrected mean DFT of the coating system, the following methods are used:
If lower or equal to 250 micrometers; crosscut method according to ISO 2409,
If higher than 250 micrometers; pull-off method B according to ISO 4624.

2.2.1 Crosscut test assessing the resistance of paint coatings to separation from substrates when a right-angle lattice pattern is cut into the coating, penetrating through to the substrate, according to ISO 2409, ISO 17025 Scope number 3 (Q)

The adhesion of the coating system has been determined according to ISO 2409, COT Instruction 30.01.20-1 by cross-cut test using a single blade cutting tool.

Distance between incisions is determined by the nDFT of the coating system;
- <60 µm: 1 mm,
- 60-120 µm: 2 mm,
- 120-250 µm: 3 mm,
- >250 µm: method unsuitable.

Loose paint will be removed using ISO 2409 method A1 (brushing).

On each panel three trials have been performed, with three extra when the variation of results was greater than 1 unit.

2.2.2 Pull-of adhesion according to ISO 4624 Method B

On each panel three trials have been performed.

The adhesion of the coating system has been determined by an automatic hydraulic adhesion tester (COT_A004 or COT_A012) in accordance with ISO 4624 Method B. The coating surface and the dolly (diameter 20 mm) have been sanded lightly and the epoxy adhesive has been applied. After curing of the adhesive and prior to testing, the coating and the adhesive have been scribed around the dolly down to the bare metal.

The fractures of the adhesion test have been evaluated according to this scheme:
A/B Fracture between the steel surface and 1st coat (adhesion failure).
B Fracture in the 1st coat (cohesion failure).
B/C Fracture between the 1st and 2nd coat (adhesion failure).
C Fracture in the 2nd coat (cohesion failure).
C/D Fracture between the 2nd and 3rd coat (adhesion failure).
D Fracture in the 3rd coat (cohesion failure).
-/Y Fracture between the outer coat and the glue (adhesive failure).

2.3 Determination of the resistance against corrosion in artificial atmospheres, Neutral Salt Spray, ISO 17025 Scope number 4 (Q)

Resistance to Neutral Salt Spray (NSS) has been tested in accordance with ISO 9227 NSS, COT Instruction 30.01.27-1 on three test panels. The fully cured coating system has been scribed horizontally down to the steel substrate, the scribe line being 2 mm wide and 50 mm long.

General data

Apparatus number	:	COT_S006
Type of water	:	Demineralised water (< 1 µS) (COT_D108)
Salt	:	Sodium chloride (NaCl) p.a.
Test temperature	:	35 ± 2 °C (COT_T010)
Collected salt solution	:	1.0 – 2.0 ml/hour/80 cm^2
pH of the collected salt solution	:	6.5 – 7.2 (COT_P126)
Salt concentration of the collected solution	:	50 ± 5 g/l
Exposition angle	:	approx. 20 ° from the vertical
Test duration	:	2160 hours (instead of 1440 hours)

Immediately after exposure the panels were evaluated for visual surface defects according to ISO 4628-2, -3, -4 and -5.

The corrosion at the scribe has been determined within 8 hours after the end of the exposure. The corrosion at the scribe is calculated from the equation: M=(C-W)/2, where

M = corrosion creep (mm)
C = average of the nine measurements (mm)
W = the original width of the scribe (mm)

After the assessments photos have been taken (see Annex).

2.4 Determination of the resistance to Humidity–CH test, ISO 17025 Scope number 6 (Q)

Resistance to water condensation has been tested in accordance with ISO 6270-1, COT Instruction 30.01.41 on three test panels.

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
Test duration	:	720 hours
Type of water	:	Demineralised water (< 1 µS) (COT_D108)

Immediately after the test, the panels have been examined for defects according to ISO 4628. After the assessments photos have been taken (see Annex).

3 REQUIREMENTS

Only one of the three panels shall be allowed not to comply with the requirements.

3.1 Reference adhesion before tests

Table 2: Adhesion before tests

Adhesion ISO 2409 (ISO 17025 Scope number 3)		**Requirements**
ISO 2409	Individual values	Class 0-2

3.2 Assessment after Neutral Salt Spray test

Table 3: Assessment after Neutral Salt Spray test

Neutral Salt Spray **ISO 9227- 5.2 NSS, 2160 (instead of 1440 hours)** (ISO 17025 Scope number 4)		**Requirements**
ISO 4628-2	Blistering	0(S0)
ISO 4628-3	Rusting	Ri 0
ISO 4628-4	Cracking	0(S0)
ISO 4628-5	Flaking	0(S0)
Corrosion from scribe		≤ 1.5 mm
ISO 2409	Individual values	Class 0-2

3.3 Assessment after Condensation test

Table 4: Assessment after Condensation test

Condensation **ISO 6270-1, 720 hours** (ISO 17025 Scope number 6)		**Requirements**
ISO 4628-2	Blistering	0(S0)
ISO 4628-3	Rusting	Ri 0
ISO 4628-4	Cracking	0(S0)
ISO 4628-5	Flaking	0(S0)
ISO 2409	Individual values	Class 0-2

4 RESULTS

4.1 Dry film thickness

Table 5: Dry film thickness test panels (ISO 17025 Scope number 1).
Test date: 8-1-2020

Q	Dry film thickness ISO 19840 (C = 25 µm)	COT sample number 05-11-20/0514 and 19-07-21/0326				
		Panel 0514-1(1)	**Panel 0514-2(10)**	**Panel 0514-3(12)**	**Panel 0326-2**	**Panel 0326-3**
	Readings (n=5)	236 235 291 275 244	312 301 326 298 278	233 255 263 233 231	246 234 233 236 232	246 238 254 249 236
	Min. - Max. (µm) Average, SD (µm)	235 - 291 256 ± 25	278 - 326 303 ± 18	231 - 263 243 ± 15	232 - 246 236 ± 6	236 - 254 245 ± 8
		Panel 0326-5	**Panel 0514-7(5)**	**Panel 0514-8(18!)**	**Panel 0514-9(20)**	**Panel 0514-10(2)**
	Readings (n=5)	242 246 242 245 260	242 247 271 260 240	243 266 297 264 256	231 223 257 221 206	268 265 294 300 286
	Min. - Max. (µm) Average, SD (µm)	242 - 260 247 ± 7	240 - 271 252 ± 13	243 - 297 265 ± 20	206 - 257 228 ± 19	265 - 300 283 ± 16
		Panel 0514-11(8)	**Panel 0514-12(14)**			
	Readings (n=5)	292 240 298 284 274	244 211 283 265 256			
	Min. - Max. (µm) Average, SD (µm)	240 - 298 278 ± 23	211 - 283 252 ± 27			

4.2 Assessment before tests

Table 6: Reference Assessment of coating adhesion. (ISO 17025 scope No. 3)
Test date : 15-11-2021

Q	Reference Adhesion ISO 4624 Pull-off test ISO 2409 cross-cut test		COT sample number 05-11-20/0514 and 19-07-21/0326		
			Panel 0514-1(1)	Panel 0514-2(10)	Panel 0514-3(12)
	ISO 4624 Adhesion Break area	(MPa), (%)	6.8 100% D	7.7 100% D	7.5 100% D
			6.3 100% D	6.7 100% D	7.8 100% D
			7.8 100% D	8.2 100% D	7.8 100% D

4.3 Assessment after Neutral Salt Spray test

Table 7: Assessment after Neutral Salt Spray test. (ISO 17025 scope No. 4)
Test date : 29-07-2021 till 27-09-2021, adhesion 15-11-2021

Q	Neutral Salt Spray ISO 9227-5.2 NSS Exposure 1440 hours		COT sample number 05-11-20/0514 and 19-07-21/0326		
			Panel 0326-2	Panel 0326-3	Panel 0326-5
Q	ISO 4624-2	Blistering	0(S0)	0(S0)	0(S0)
Q	ISO 4624-3	Rusting	Ri 0	Ri 0	Ri 0
Q	ISO 4624-4	Cracking	0(S0)	0(S0)	0(S0)
Q	ISO 4624-5	Flaking	0(S0)	0(S0)	0(S0)
	Corrosion from scribe (mm)		0.8	0.6	0
	ISO 4624 Adhesion Break area	(MPa) (%)	4.1 100% B	4.5 100% B	4.8 100% B
			4.8 100% B	4.8 100% B	3.4 100% B
			5.3 100% B	5.3 100% B	3.2 100% B

4.4 Assessment after Condensation test

Table 8: Assessment after Condensation test. (ISO 17025 scope No. 6)
Test date : 17-11-2020 till 17-12-2020, adhesion 24-12-2020

Q	Condensation ISO 6270-1 Exposure 720 hours		COT sample number 05-11-20/0514 and 19-07-21/0326		
			Panel 0514-7(5)	Panel 0514-8(18!)	Panel 0514-9(20)
Q	ISO 4624-2	Blistering	0(S0)	0(S0)	0(S0)
Q	ISO 4624-3	Rusting	Ri 0	Ri 0	Ri 0
Q	ISO 4624-4	Cracking	0(S0)	0(S0)	0(S0)
Q	ISO 4624-5	Flaking	0(S0)	0(S0)	0(S0)
	ISO 4624 Adhesion Break area	(MPa) (%)	7.6 100% D	3.6 100% D	6.4 100% D
			6.8 100% D	7.3 100% D	6.5 100% D
			6.4 100% D	6.8 100% D	7.9 100% D

5 SUMMARY

Table 9: Summary of the test results of samples with COT sample number 25-11-20/0539

Test method	**Test duration**	**Pass / Fail**
Reference adhesion (ISO 17025 Scope number 3)	N.A.	Pass
Neutral Salt Spray ISO 9227 (ISO 17025 scope number 4)	2160 instead of 1440 hours	Pass
Condensation test ISO 6270-1 (ISO 17025 scope number 6)	720 hours	Pass

6 CONCLUSION

The coated samples with COT sample number **05-11-20/0514 and 19-07-21/0326** meet the requirements of ISO 12944-6 C5 High, test regime 1.

As an additional request by the client, the test duration of Neutral Salt Spray on the COT sample number **19-07-21/0326** was 2160 hours instead of the required 1440 hours.

CENTRUM VOOR ONDERZOEK
EN TECHNISCH ADVIES (COT bv)

F.F. Sudarso
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ANNEX

Photographs

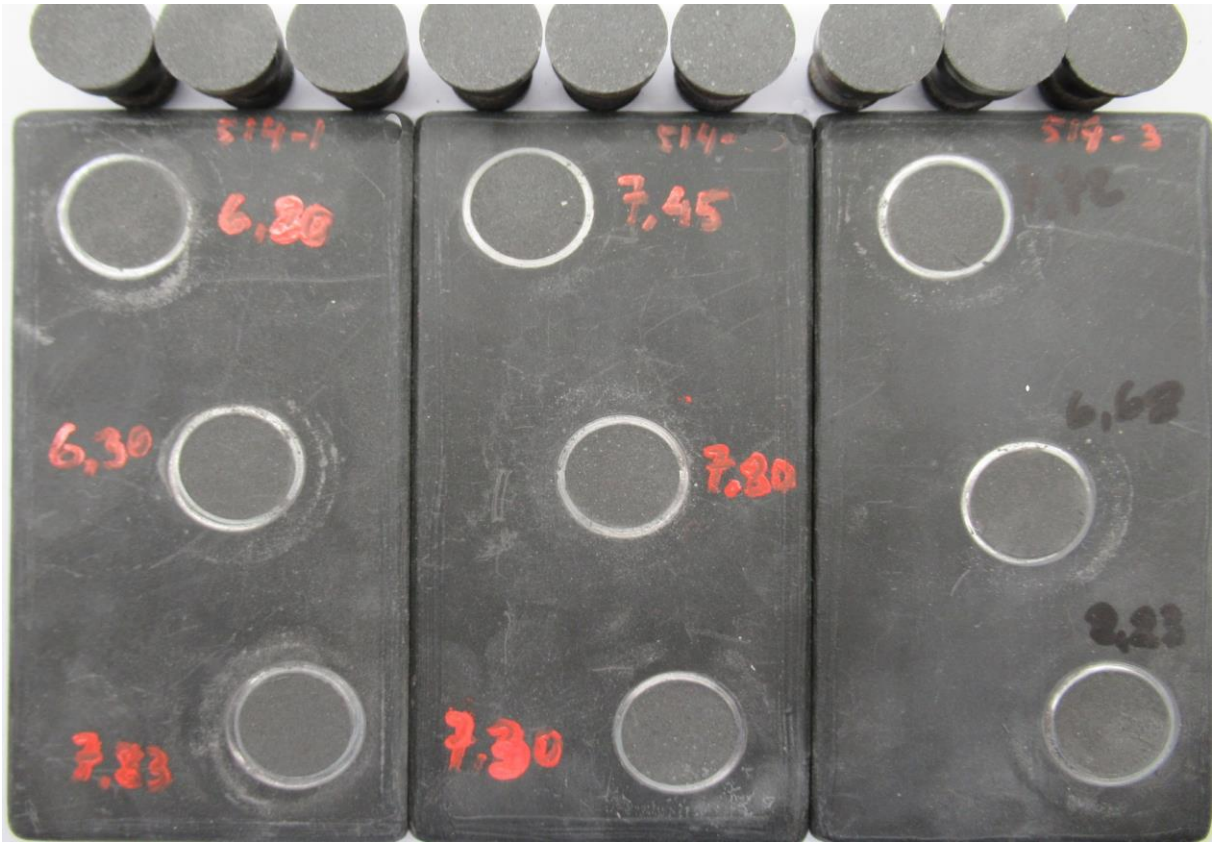
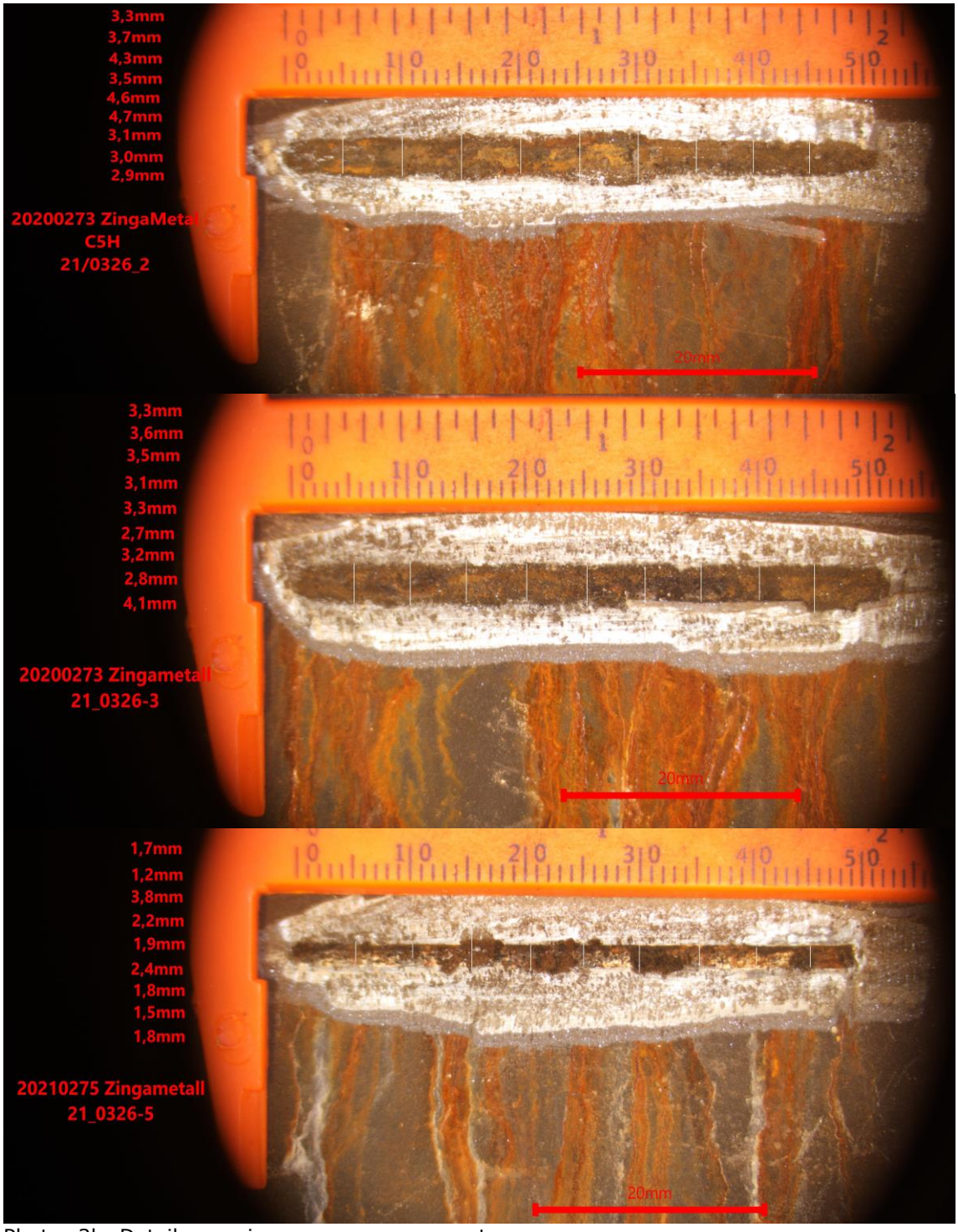


Photo 1: Panels 20/0514-1(1), 20/0514-2(10) and 20/514-3(12) Reference adhesion

Photo 2a: 21/0326-3, 21/0326-3 and 21/0326-5 after 1440 hours Neutral Salt Spray test



Photos 2b: Detail corrosion creep measurements

Photo 3: Panels 20/0514-7(5), 20/0514-9(20) and 20/514-8(18!) after 720 hours Water Condensation test