



25/10/2022

# Test Report

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## ZINGA on laser cleaned panels

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### Content

1. Introduction.....	2
2. Coating properties .....	2
3. System.....	2
4. Test methods.....	2
5. Requirements .....	3
5.1. Assessment before tests.....	3
5.2. Assessment after Salt Spray Corrosion test .....	3
6. Test Results .....	3
6.1. Surface roughness measurement.....	3
6.2. Assessment before qualification testing .....	4
6.3. DFT measurement.....	4
6.4. Salt Spray Corrosion test.....	5
6.5. Assessment after qualification testing.....	7
7. Conclusions.....	8

# 1. Introduction

Laser cleaning is getting more attention as a clean alternative for blast cleaning as it practically eliminates (toxic) dust production and is much safer to work with.

This test is to see how ZINGA would be suitable for steel surfaces which are cleaned and given a desired surface profile by the method of laser cleaning. Two steel panels were cleaned using this method as also two panels which were previously hot dip galvanised after which ZINGA was applied to examine the compatibility.

For this test, a LASERFLUX laser cleaning device of 300 W was used which is able to create a roughness pattern.

## 2. Coating properties

ZINGA	
Density (g/cm <sup>3</sup> )	2.67
Solid by volume (%)	58%
Solid by weight (%)	80
VOC (g/l)	474
Gloss	Matt
Colour	Grey

## 3. System

Product	Application Type	Required DFT (µm)	Application Method	Dilution	Solvent	Overcoat time (20°C)
ZINGA	Full Coat	60	Conv. Spray	15%	Zingasolv	1 week
ZINGA	Full Coat	60	Conv. Spray	15%	Zingasolv	NA

## 4. Test methods

Test Method	Standard
Cross cut	ISO 2409
Pull off	ISO 4624 method B
Salt spray corrosion test*	ISO 9227
Cyclical ageing*	ISO 12944-9
Immersion	ISO 2812-2
Surface roughness measurement	ISO 8503-5
DFT measurement**	ISO 19840

\*A scribe line shall be made on each test panel to ensure full exposure to all the elements of the test.

\*\*As stated in ISO 19840, the DFT of a coating is the thickness remaining over the peaks of a rough surface when the coating has hardened. The correction value of 25 µm is applied (Table 2 ISO 19840, medium surface profile).

## 5. Requirements

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

### 5.1. Assessment before tests

Method	Requirements
ISO 4624 method B Pull Off (MPa)	$\geq 2,5$ MPa

### 5.2. Assessment after Salt Spray Corrosion test

Method	Requirements
ISO 4624 method B Pull Off (MPa)	$\geq 2,5$ MPa
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 (mm)	$\leq 1,5$ mm

## 6. Test Results

### 6.1. Surface roughness measurement

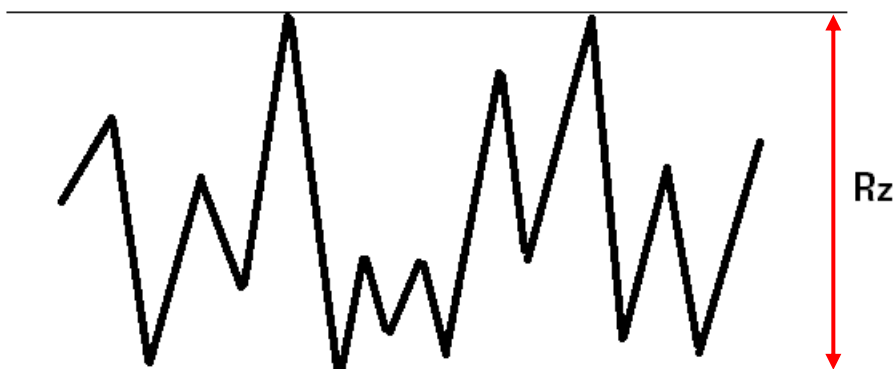


Figure 1. Simplified representation of rough surface with Rz measurement.

	Panel 1 (HDG)	Panel 2 (HDG)	Panel 3	Panel 4
Surface Roughness = Rz ( $\mu\text{m}$ )	68 – 84	96 – 110	72 – 78	60 – 64

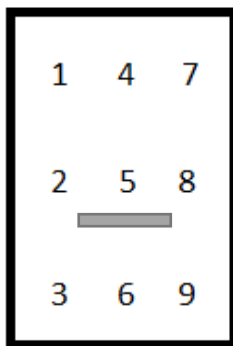
## 6.2. Assessment before qualification testing

Method		Test panel 1	Test panel 2
ISO 4624 method B Pull Off	Rz (µm)	68 – 84	96 – 110
	DFT (µm)	190 (130µm HDG + 60µm ZINGA)*	190 (130µm HDG + 60µm ZINGA)*
	Value (MPa)	3,8	5,6
	Brake	100% A/B	100% A/B
Comments:			

Method		Test panel 3	Test panel 4
ISO 4624 method B Pull Off	Rz (µm)	72 – 78	60 – 64
	DFT (µm)	50*	60*
	Value (MPa)	2,9	3,6
	Brake	100% A/B	100% A/B
Comments:			

\*A pull-off was done on the first layer of ZINGA. After the pull off-test, a second layer of ZINGA was applied on the complete panel surface to cover the damaged sections.

## 6.3. DFT measurement



The total DFT is measured on 9 spots (correction for roughness is applied).

Test panel 1 :			
Average DFT HDG (µm)	<b>130</b>		
Average DFT ZINGA (µm)	<b>169</b>		
Total DFT (µm)	285	294	288
	285	300	267
	318	352	303
Total Average (µm)	<b>299</b>		

Test panel 2 :			
Average DFT HDG (µm)	<b>130</b>		
Average DFT ZINGA (µm)	<b>137</b>		
Total DFT (µm)	253	255	253
	281	278	246
	268	292	277
Total Average (µm)	<b>267</b>		

Test panel 3 :			
Total DFT (µm)	111	112	108
	116	118	103
	111	117	98
Total Average (µm)	<b>110</b>		

Test panel 4 :			
Total DFT (µm)	124	136	136
	129	135	140
	128	139	130
Total Average (µm)	<b>133</b>		

## 6.4. Salt Spray Corrosion test

Start test: 5/04/2022

Stop test: 8/06/2022

**0 hours**

	System	DFT	Observations
Test panel 1	HDG + ZINGA	299	No observations
Test panel 2	HDG + ZINGA	267	No observations
Test panel 3	ZINGA	110	No observations
Test panel 4	ZINGA	133	No observations



Figure 2. Panels 1 - 4 (left to right) at start of salt spray testing.

\*The areas underneath the orange blocks are not taken into account due to reduced coating thickness by previous testing (pull off).

**645 hours**

	System	DFT	Observations
Test panel 1	HDG + ZINGA	299	No observations
Test panel 2	HDG + ZINGA	267	No observations
Test panel 3	ZINGA	110	No observations
Test panel 4	ZINGA	133	No observations



Figure 3. Panels 1 - 4 (left to right) at 645 of salt spray testing.



**1000 hours**

	<b>System</b>	<b>DFT</b>	<b>Observations</b>
<b>Test panel 1</b>	HDG + ZINGA	299	No observations
<b>Test panel 2</b>	HDG + ZINGA	267	No observations
<b>Test panel 3</b>	ZINGA	110	No observations
<b>Test panel 4</b>	ZINGA	133	No observations



Figure 4. Panels 1 - 4 (left to right) at 1000 hour of salt spray testing.

**1440 hours**

	<b>System</b>	<b>DFT</b>	<b>Observations</b>
<b>Test panel 1</b>	HDG + ZINGA	299	No observations
<b>Test panel 2</b>	HDG + ZINGA	267	No observations
<b>Test panel 3</b>	ZINGA	110	Rust in scribe
<b>Test panel 4</b>	ZINGA	133	Rust in scribe



Figure 5. Panels 1 - 4 (left to right) at 1440 hour of salt spray testing.



## 6.5. Assessment after qualification testing

Method		Test panel 1	Test panel 2
Rz (µm)		68 – 84	96 – 110
DFT (µm)		299	267
ISO 4628-2 Blistering		0 (S0)	0 (S0)
ISO 4628-3 Rusting		Ri 0	Ri 0
ISO 4628-4 Cracking		0 (S0)	0 (S0)
ISO 4628-5 Flaking		0 (S0)	0 (S0)
Corrosion from scribe (mm)		0,0	0,0
ISO 4624 method B Pull Off	DFT (µm)	320 / 290	260 / 290
	Value (MPa)	5,3 / 4,9	5,2 / 4,6
	Brake	100% B/Y / 100% B/Y	100% B/Y / 100% B/Y
Comments:		Pull off: glue failure	Pull off: glue failure

Method		Test panel 3	Test panel 4
Rz (µm)		72 – 78	60 – 64
DFT (µm)		110	133
ISO 4628-2 Blistering		0 (S0)	0 (S0)
ISO 4628-3 Rusting		Ri 0	Ri 0
ISO 4628-4 Cracking		0 (S0)	0 (S0)
ISO 4628-5 Flaking		0 (S0)	0 (S0)
Corrosion from scribe (mm)		0,0	0,0
ISO 4624 method B Pull Off	DFT (µm)	150 / 140	160 / 165
	Value (MPa)	4,6 / 3,4	3,4 / 3,0
	Brake	100% B/Y / 100% B/Y	90% A/B – 10% B/Y / 80% A/B – 20% B/Y
Comments:		Pull off: glue failure	Rust underneath ZINGA layer



Figure 6. Pull off on panels 1 - 4 (left to right) after qualification testing.

## **7. Conclusions**

The panels all passed the requirements of ISO12944-C5 High as no visible defects were observed after 1440 hours of salt spray testing. Adhesion values have increased after artificial ageing (salt spray chamber). The latter values would be even higher as almost all pull offs experienced glue failure due to the high salt formation on top of ZINGA.

This concludes that laser cleaning, with surface profile creation, can be used as surface preparation on steel and on HDG for the application of ZINGA in a C5 High environment with a life expectancy of 15 to 25 years.

For a higher life expectancy, longer testing needs to be done.