

Bellaterra : 16th February 2016
Dossier number : **16/11770-298**
Petitioner Reference : **FLOWCRETE UK, LTD.**
FLOWCRETE BUSINESS PARK, BOOTH LANE
MOSTON, SANDBACH
CW11 3QF (United Kingdom)

TEST REPORT

RECEIVED MATERIAL:

On 21st May 2014, several substrates, applied with a coating for the protection and repair of concretes structures, were received at Applus Laboratories, with the following references:

DECKSHIELD RAPIDE ED2

DIN V 18026:2006 - Surface protection systems for concrete products according to DIN EN 1504-2:2005 - Classification OS11

- 1- Measurement of bond strength by pull-off , UNE-EN 1542:1999
- 2- Determination of water-vapour transmission properties, UNE-EN ISO 7783:2012
- 3- Determination of liquid water permeability, UNE-EN 1062-3:2008
- 4- Determination of carbon dioxide permeability, UNE-EN 1062-6:2003
- 5- Adhesion after thermal compatibility, UNE-EN 13687-1:2002 and UNE-EN 13687-2:2002
- 6- Abrasion resistance (Taber), UNE-EN ISO 5470-1:1999
- 7- Determination of slip resistance, UNE-EN 13066-4:
- 8- Falling-weight test, UNE-EN ISO 6272-1:2012
- 9- Determination of crack bridging properties, UNE-EN 1062-7:2004 and Method B - B.3.2
- 10- Determination of resistance to severe chemical attack, UNE-EN 13529:2005

TEST DATE: From 21/05/2014 to 04/12/2015

RESULTS : See attached pages.

Responsible for Construction Materials
LGAI Technological Center S.A.

Technician Responsible
LGAI Technological Center S.A.

The results included in this document refer exclusively to the indicated materials and has been tested according to the specifications given.

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Page 1 – The present document consists of **9** pages long, whereof **0** are appendixes

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RESULTS:

Application: 2,6 kg/m² (2 mm)

PERFORMANCE TESTS

1- Measurement of bond strength by pull-off , UNE-EN 1542:1999

The reference samples, are 300 x 300 x 100 mm specimen, with a maximum aggregate size of 8 mm or 10 mm and prepared with a grit-blasted surface, according to EN 1766 (MC 0,40).

The specimens were preserved in the laboratory covered with a plastic film for 72 hours and after that, they were conserved 21°C - 60% RH for 25 days.

There were No bubbles, cracks or surface defects after curing.

Specimen	Tensile strength (N/mm ²)	
1	2,10	(A/B)
2	1,90	(A/B)
3	2,07	(A/B)
4	2,09	(A/B)
5	2,22	(A/B)
Average	2,1	MPa

NOTE: Mode of failure is shown between brackets.

A: Cohesion failure in the concrete substrate

A/B: Adhesion failure between the substrate and product

B: Cohesion failure

Requirements according to UNE-EN 1504-2:2005 Table 5			
Flexible Systems		Rigid Systems	
Without trafficking	With trafficking	Without trafficking	With trafficking
≥ 0,8 MPa	≥ 1,5 MPa	≥ 1,0 MPa	≥ 2,0 MPa

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2- Determination of water-vapour transmission properties, UNE-EN ISO 7783:2012

- Three cylindrical test specimens have been prepared, approximate surface=0,0079 m² (100 mm diameter), to test with the substrate.
- After curing for 28 days in laboratory conditions, the test specimens undergo 3 cycles of immersion in water and drying.
- Site ambient conditions: 23°C and 50% R.H.
- Saturated solution in capsules: dihydrogen ammonium phosphate (93%RH).
- Pressure difference (Δp)= 1210 Pa.

To create an atmosphere of 93% R.H. inside the capsule, a saturated solution with dihydrogen ammonium phosphate is used, whereby a 50% humidity shall be maintained outside the capsule and 93% inside, thereby reducing the mass of the sample-capsule set.

Final results:

Test specimen	Water-vapour transmission Δm_i (mg/h)	Water-vapour transmission rate V (g/m ² * day)	Water-vapor permeation coefficient d (g/m ² x day x Pa)	Diffusion-Equivalent air layer thickness Sd (m)
1	0,13	0,40	1,9E-06	52,9
2	0,15	0,46	1,8E-06	45,8
3	0,13	0,40	1,3E-06	52,9
Average	0,1	0,4	1,7E-06	50,5

Requirements according to UNE-EN 1504-2:2005 Table 5	
Class I (permeable to water vapour)	Sd < 5 m
Class II	5m ≤ Sd ≤ 50 m
Class III (dense against water vapour)	Sd > 50 m

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3- Determination of liquid water permeability, UNE-EN 1062-3:2008

Ceramic specimens have been used as the substrate: approximate size 150x150mm, 30 mm thick, density 1650 kg/m³ and liquid water transmission index 7,5 Kg/(m²·h^{0,5}).

After curing the product for 28 days in laboratory conditions, the test specimens undergo 3 water immersion and drying cycles, and a final drying.

Specimen	W (Kg/m ² h ^{0,5})
1	0,0007
2	0,0003
3	0,0004
Average	0,0005

Requirements according to UNE-EN 1504-2:2005 Table 5	
Capillary absorption and permeability to water	W < 0,1 Kg/(m ² * h ^{0,5})

4- Determination of carbon dioxide permeability, UNE-EN 1062-6:2003

- Three cylindrical test specimens have been prepared, approximate surface=0,0079 m² (100 mm diameter), to test with the substrate.
- After curing for 7 days in laboratory conditions, the test specimens undergo (according to Standard EN 1062-11;Sec.4.3) 3 water immersion and drying cycles.
- Finally, when the specimens reach constant mass (dessicator), the test will begin.
- Measuring gas: 10% carbon dioxide.
- Carbon dioxide absorber used: granulated sodium hydroxide for elemental analysis.
- Partial pressure difference: 10kPa (100 mbar).

Specimen	Carbon dioxide permeability (i) (g/m ² ·d)	Diffusion equivalent air layer thickness S _D (m)	Diffusion resistance number (μ)
1	2,1	119	21314
2	2,2	114	24605
3	2,2	114	28562
Average	2,1	116	24827

Requirements according to UNE-EN 1504-2:2005 Table 5	
Permeability to CO ₂	Sd > 50 m

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5- Adhesion after thermal compatibility, UNE-EN 13687-1:2002 and UNE-EN 13687-2:2002

The reference slabs are 300 x 300 x 100 mm plates made with aggregates with a maximum size between 8 and 12 mm. with a sandblasted surface with reference concrete MC (0,40) according to EN 1766:2000.

The product is applied on the reference sample in a dry state and horizontal position.

They are kept in laboratory conditions 21°C and 60% R.H. for 28 days.

Before starting the test all surfaces of the specimens, except 300x300mm, are coated with a thermosetting resin to prevent the penetration of liquid through the sides and the rear face of the specimen during testing.

Two of the samples were located in the cupboard to simulated thunder – shower cycling, the surface in the upper side and inclined (3° from the horizontal) to permit water to drain quickly. The cycle last 6 hours and has radiant hot at 60°C±5°C during 5h 45min and water spraying at 12±3°C during 15 min. The cycle repeats 10 times.

Then 2 of the specimens are immersed in water for 24 hours and then subjected to 50 cycles of freeze-thaw with de-icing salt immersion, from 21 ° C to -15 ° C. The third test is kept in a laboratory at 21 ± 2 ° C and 60 ± 10% RH. The cycle repeats 50 times.

After the cycles the 3 samples were conditioned in the laboratory at least 7 days at 21°C and 60% RH, were examined visually and tested for tensile strength according EN 1542: 1999 with the following results:

There were No bubbles, cracks or surface defects after curing.

Tensile strength (N/mm²)			
Point n°	Sample n° 1 (CYCLED)	Sample n° 2 (CYCLED)	Reference Sample
1	1,66	1,60	2,10
2	1,74	1,77	1,90
3	1,75	1,58	2,07
4	1,59	1,65	2,09
5	1,70	1,70	2,22
Average	1,7		2,1
Failure	(A/B)		(A/B)

NOTE: Mode of failure is shown between brackets.

A: cohesive failure in the concrete

A/B: adhesive failure between concrete and product.

B: Cohesion failure

Requirements according to UNE-EN 1504-2:2005 Table 5			
Flexible Systems		Rigid Systems	
No traffic loads	With traffic loads	No traffic loads	With traffic loads
≥ 0,8 MPa	≥ 1,5 MPa	≥ 1,0 MPa	≥ 2,0 MPa

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6- Abrasion resistance (Taber), UNE-EN ISO 5470-1:1999

Test conditions:

- Abraser: Taber 5150 Abraser
- Abrading wheel: H22
- Weight: 1000 g
- n° cycles: 1000

Specimen no.	Weight loss (mg)
1	1530
2	1496
3	1436
Average	1487

Requirements according to UNE-EN 1504-2:2005 Table 5	
Weight loss	< 3000 mg

7- Determination of slip resistance, UNE-EN 13066-4:

Specimen no.	Wet test	Dry test
1	70	102
2	74	98
3	72	101
4	69	102
5	70	103
Mean	71	101

Requirements according to EN 1504-3:2006
Class I: > 40 wet tested
Class II: > 40 dry tested
Class III: > 55 wet tested

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8- Falling-weight test, UNE-EN ISO 6272-1:2012

The product has been applied on a concrete surface. Impacts on the surface have been performed with a sphere-shaped head, 20 mm diameter, free mass 1000 g.

Height from which the first cracks are produced	> 2500 mm*
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* From this height NO cracks are produced

Diameter of the trace produced from 2500 mm	1,1 mm
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IR value (Impact Resistance) from a 2500 mm height	24,5 Nm
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Requirements according to UNE-EN 1504-2:2004 Table 5	
Class	No cracking or de-lamination
I	≥ 4 Nm
II	≥ 10 Nm
III	≥ 20 Nm

9- Determination of crack bridging properties, UNE-EN 1062-7:2004 and Method B - B.3.2

Method B: C.3 Dynamic tensile test

The reference samples are specimens of dimensions 160x40x40 mm, manufactured according UNE-EN 1062-7, C.3.2 section.

Conditioning Method before test: 7 days at 70°C according to EN 1062-11 4.1

The obtained results after conditioning method are as follows:

After the artificial weathering, there were no observed changes in appearance such as chalking, blistering, peeling or flaking following the methods described in to EN ISO 4628-2, EN ISO 4628-4 and EN ISO 4628-5
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- Test description

The tests were developed according to the applicable sections of the UNE-EN 1062-7:2004. The dynamic tensile test 1 (section C.3) for a class B (ANNEX B) of the UNE-EN 1062-7:2004 has been performed.

Prior to the test, an instant crack is created at the midpoint of the notch, with a crack width of less than 100µm.

Given below the measure of the resistance to cracking of the coating is shown, according to method B section 8 of the reference standard.

The test is developed with a crack width control by a COD extensometer.

The test consist of periodically change the width of the crack at the defined test temperature.

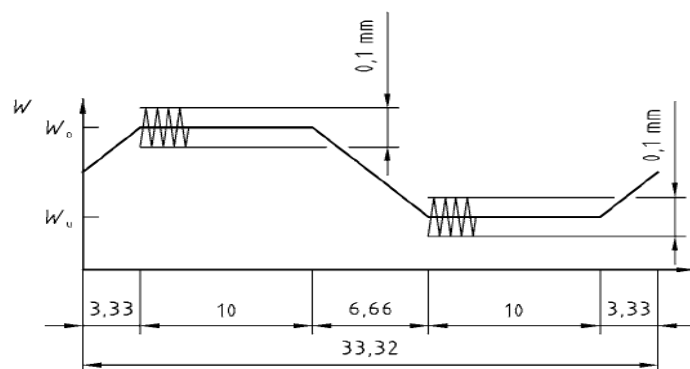
The curve is defined by the frequency f, the width w/2 and the average width of the crack. For B 3.2 class test parameters are shown in the table 2 and figure 1.

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Table 2. Class B 3.2 test parameters.

Wave Form	Max width (w_0)	Min width (w_u)	Cracking cycles number (n)	Frequency (f)	Fissure movement (w_L)	Cracking cycles number (n)	Frequency (f)
Trapezoidal	0,50mm	0,20mm	1.000 cycles	0,03 Hz	$\pm 0,05$ sinusoidal	20.000	1 Hz

Figure 1. Modification of the crack width versus time for B 3.2 class.



- Final Results at -20°C

- Sample 1: After 20.000 sinusoidal cycles no cracks appear in any of the layers of the system.
- Sample 2: After 20.000 sinusoidal cycles no cracks appear in any of the layers of the system.
- Sample 3: After 20.000 sinusoidal cycles no cracks appear in any of the layers of the system.

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2- Determination of resistance to severe chemical attack, UNE-EN 13529:2005

The list of chemicals reagents used was as follows:

Group	Testing Liquid
1. Petrol	47,5 Vol.-% toluene 30,4 Vol.-% isooctane 1. Petrol 17,1 Vol.-% n-heptane 3,0 Vol.-% methanol 2,0 Vol.-% tert.-butanol
3. Heating oil and diesel fuel and unused motor and gear oils	20,0 Vol.-% methylnaphthalene 80,0 Vol.-% n-paraffine (C12 - C18)
10. Inorganic acids up to 20 % and acidic hydrolysing salts in aqueous solution (pH < 6) except hydrofluoric acid and oxidizing acids and their salts	sulfuric acid (20 %)

Results after 3 days of test without pressure:

After 3 days in contact with chemical reagents no flaws were observed in the test conducted (blistering, flaking, cracking, or loss of colour etc.)

Reduction in Hardness Shore (%)	Group 1	Group 3	Group 10
	2	1	3

Requirements according to UNE-EN 1504-2:2004 Table 5

Class I: 3 d without pressure	According to UNE-EN 1504-2:2005, Reduction in hardness of less than 50% when measured according to Buchholz method, EN ISO 2815, or Shore method EN ISO 868 24 h after the coating is removed from immersion in the test liquid.
Class II: 28 d without pressure	
Class III: 28 d with pressure	

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Within our improvement program we would be grateful if you would send us any commentary that you consider opportune, to the person in charge who signs this document, or to the Quality Manager of Applus+, in the following e-mail address: satisfaccion.cliente@appluscorp.com