

# NANO-CERAMIC®

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**Informe de Prueba EN 1504-2**

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TECHNICKÝ A SKŮŠOBNÝ ÚSTAV STAVEBNÝ, n. o.  
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## TEST REPORT No. 90-14-0025

### JOB

No.: 90130243  
Client: PT NANO CERAMIC INDONESIA  
The Central 88, Kemayoran, (The Linq)  
Jl. Trembesi Blok D3 NO. 378  
14410, Pademangan, Jakarta  
Indonesia

### OBJECT OF TESTING

Product: **Permanent Coating System (PCS) CONCRETE**  
- coating for principles 1, 5, 6 - methods 1.3, 5.1, 6.1 of EN 1504-2  
Manufacturer: manufacturer is the client  
Standard of product: EN 1504-2: 2004 Products and systems for the protection and repair of concrete structures. Definitions, requirements, quality control and evaluation of conformity. Part 2: Surface protection systems for concrete

### PRODUCT SAMPLE

Description of sample: Permanent Coating System (PCS) CONCRETE  
two-component coating material - component C1 in a can on the volume of 3000 ml,  
component C2 in a can on the volume of 400 ml  
Designation of sample by client: Permanent Coating System (PCS) CONCRETE  
Sampler: client  
Place and date of delivery: Laboratory branch in Tatranská Štrba, on 23<sup>rd</sup> September 2017  
Designation of sample by lab.: 173/13

### TESTS

Preparation and coating: Permanent Coating System (PCS) CONCRETE was prepared and applied in accordance with the manufacturer's instructions. Components C1 and C2 of product were mixed in volume ratio 7,5 : 1. Coating was applied to clean and dry substrate, application by roller in a single layer.  
The used substrates are specified below under the relevant tests.  
Concrete substrates were prepared and cured according to EN 1766. The surface was sandblasted prior to treatment.  
Determination of dry film thickness was carried out in accordance with EN 2808, wedge cut method.

#### Cross cut test - accredited test

Test procedure: EN ISO 2409: 2013 Paints and varnishes. Cross-cut test  
Description of test specimens: one treated concrete slab with dimensions of 300 mm x 300 mm, thickness 50 mm, the coating applied to one face  
- test substrate: concrete Type MC (0,40)  
- application of coating: as described above  
- curing time after application: 7 days at (23±2)°C and (50±5)% relative humidity  
Test specimens prepared by: Jozef Kukliš  
Test conditions:  
- laboratory environment  
- using cutting tool: 1c  
- distance of cuts: 4 mm according to EN 1504-2, Table 5

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Deviations from the standard: none  
Date of test: 14<sup>th</sup> November 2017  
Test personnel: Jozef Kukliš

#### Carbon dioxide permeability - accredited test

Test procedure: EN 10626: 2003 Paints and varnishes. Coating materials and coating systems for exterior masonry and concrete. Part 6: Determination of carbon dioxide permeability  
Description of test specimens: three treated circular test specimens with a diameter of 90 mm, the coating applied on one face  
- test substrate: unglazed ceramic tiles with a thickness of 6 mm  
- application of coating: as described on page 1  
- curing time after application: 7 days at (23±2)°C and (50±5)% relative humidity  
- conditioning prior to testing: in accordance with EN 1062-11, Clause 4.3. (The test specimens were subjected to three cycles comprising 24 h storage in water at (23± 2)°C and 24 h drying at (50± 2)°C). Afterwards the test pieces were dried over desiccant to constant mass.)  
- sealing compound: paraffin SASOLWAX 7837 (Manufacturer: Sasol Wax, Hamburg, Germany) mixed with refined crystalline paraffin  
- In parallel, the diffusion resistance was determined against a CO2 reference film. Parallel measurement has been established without deviations from the predetermined tolerance.

Test specimens prepared by: Jozef Kukliš  
Test conditions:  
- method A: Gravimetric method  
- exposed area of the test specimen **A** 0,005 m<sup>2</sup>  
- time interval between two weighings of the test specimens 24 h  
- used sodium hydroxide granulated for elemental analysis  
- test temperature 23°C  
- test concentration of carbon dioxide in chamber 10 % (V/V)  
- mean barometric pressure during test  $p_{amb}$  101,7 kPa  
- the diffusion coefficient of carbon dioxide in air  $D_{CO_2}$  1,38 m<sup>2</sup>/d  
- the difference in concentration of carbon dioxide  $|\Delta c|$  180 g/m<sup>3</sup>

Deviations from the standard: none  
Date of test: from 11<sup>th</sup> to 22<sup>nd</sup> November 2017  
Test personnel: Jozef Kukliš

#### Permeability to water vapour - accredited test

Test procedure: EN ISO 7783: 2012 Paints and varnishes. Determination of water-vapour transmission properties. Cup method  
Description of test specimens: three treated circular test specimens with a diameter of 90 mm, the coating applied on one face  
- test substrate: unglazed ceramic tiles with a thickness of 6 mm  
- application of coating: as described on page 1  
- curing time after application: 7 days at (23±2)°C and (50±5)% relative humidity  
- conditioning prior to testing: in accordance with EN ISO 7783, method B (The test specimens were subjected to three cycles comprising 24 h storage in water at (23± 2)°C and 24 h drying at (50± 2)°C))  
- sealing compound: paraffin SASOLWAX 7837 (Manufacturer: Sasol Wax, Hamburg, Germany) mixed with refined crystalline paraffin  
Test specimens prepared by: Jozef Kukliš  
Test conditions:  
- measuring: wet cup method  
- exposed area of the test specimen **A** 0,005 m<sup>2</sup>  
- time interval between two weighings of the test specimens 24 h  
- used saturated aqueous solution - NH<sub>4</sub>H<sub>2</sub>PO<sub>4</sub>  
- test temperature 23°C  
- relative humidity in climate chamber 50%  
- relative humidity in test cup 93%  
- water vapour pressure difference  $\Delta p_v$  1207 Pa  
- standard barometric pressure  $p_0$  1013,25 hPa  
- mean barometric pressure during test  $p$  1014,9 hPa  
- gas constant of water vapour  $R_v$  462 Nm/(kg.K)  
- test temperature **T** 296 K  
- water-vapour transmission rate of the substrate 409,6<sup>0</sup> g/(m<sup>2</sup>.d)

Deviations from the standard: none  
Date of test: from 11<sup>th</sup> to 21<sup>th</sup> November 2017  
Test personnel: Jozef Kukliš

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**Capillary water absorption and water permeability water - accredited test**

|                                       |  |
|---------------------------------------|--|
| <b>Test procedure:</b>                | EN 1062-3: 2008 Paints and varnishes – Coating materials and coating systems for exterior masonry and concrete. Part 3: Determination of liquid water permeability   |
| <b>Description of test specimens:</b> | three treated test specimens with dimensions of approximately 150 mm x 150 mm, thickness 30 mm, coating applied to one face<br>- test substrate: calcium silicate bricks<br>- application of coating: as described on page 1<br>- curing time after application: 7 days at (23±2)°C and (50±5)% relative humidity<br>- the reverse side and the edges of the test specimens were sealed with two layers of two-component epoxy varnish, subsequently drying for further 7 days at (23±2)°C and (50±5)% relative humidity<br>- conditioning prior to testing: in accordance with EN 1062-3, Clause 6.4.2 (The test specimens were subjected to three cycles comprising 24 h storage in water at (23±2)°C and 24 h drying at (50±2)°C) |
| <b>Test specimens prepared by:</b>    | Jozef Kukliš   |
| <b>Test conditions:</b>               | laboratory environment   |
| <b>Deviations from the standard:</b>  | none   |
| <b>Date of test:</b>                  | from 7 <sup>th</sup> to 08 <sup>th</sup> November 2017   |
| <b>Test personnel:</b>                | Jozef Kukliš   |

**Thermal change compatibility - Thunder-shower cycling (thermal shock) and Freeze-thaw cycling with de-icing salt immersion - accredited test**

|                                       |   |
|---------------------------------------|---|
| <b>Test procedure:</b>                | EN 13687-2: 2002 Products and systems for the protection and repair of concrete structures. Test methods. Determination of thermal compatibility. Part 2. Thunder-shower cycling (thermal shock)<br>EN 13687-1: 2002 Products and systems for the protection and repair of concrete structures. Test methods. Determination of thermal compatibility. Part 1: Freeze-thaw cycling with de-icing salt immersion  |
| <b>Description of test specimens:</b> | two treated concrete slabs with dimensions of 300 mm x 300 mm, thickness 100 mm, the coating applied to one face<br>- test substrate: concrete Type MC (0,40)<br>- application of coating: as described on page 1<br>- curing time after application: 7 days at (23±2)°C and (50±5)% relative humidity<br>- all surfaces of the specimens except the 300 mm x 300 mm test face were sealed with thermosetting resin, subsequently drying for further 7 days at (23±2)°C and (50±5)% relative humidity   |
| <b>Test specimens prepared by:</b>    | Jozef Kukliš  |
| <b>Test conditions:</b>               | Tests of the thermal change compatibility according to EN 13687-1 and EN 13687-2 were carried out on the same test samples pursuant to the requirements of EN 1504-2, Table 5. The test samples were subjected to 10 cycles of the thunder-shower and then to 20 cycles of the freeze-thaw cycling with de-icing salt immersion.<br>One cycle of the thunder-shower took 6 h and comprised the following stages:<br>- storage under radiant heat at (60±5)°C for 5 h and 45 min<br>- dousing with water at a temperature of (12±3)°C for 15 min<br>One cycle of the freeze-thaw cycling lasted for 4 h and comprised the following stages:<br>- immersion in the tank containing saturated sodium chloride solution at a temperature (-15±2)°C for 2 h<br>- storage in the water tank at a temperature of (21±2)°C for 2 h<br>After every 10 cycles and after the end of the exposure was evaluated:<br>- degree of blistering, method according to EN ISO 4628-2;<br>- degree of cracking, method according to EN ISO 4628-4;<br>- degree of flaking, method according to EN ISO 4628-5.<br>7 days after the end of the exposure was evaluated adhesion strength by pull-off test. |
| <b>Deviations from the standard:</b>  | none  |
| <b>Date of test:</b>                  | - exposure: from 14 <sup>th</sup> to 26 <sup>th</sup> November 2017<br>- pull-off test: 3 <sup>rd</sup> December 2017   |
| <b>Test personnel:</b>                | Jozef Kukliš  |

**Thermal change compatibility – Freeze-thaw cycling without de-icing salt impact - accredited test**

|                                       |  |
|---------------------------------------|--|
| <b>Test procedure:</b>                | EN 13687-3: 2002 Products and systems for the protection and repair of concrete structures. Test methods. Determination of thermal compatibility. Part 3. Thermal cycling without de-icing salt impact   |
| <b>Description of test specimens:</b> | two treated concrete slabs with dimensions of 300 mm x 300 mm, thickness 100 mm, the coating applied on one face<br>- test substrate: concrete Type MC (0,40)<br>- application of coating: as described on page 1<br>- curing time after application: 7 days at (23±2)°C and (50±5)% relative humidity<br>- all surfaces of the specimens except the 300 mm x 300 mm test face were sealed with thermosetting resin, subsequently drying for further 7 days at (23±2)°C and (50±5)% relative humidity  |
| <b>Test specimens prepared by:</b>    | Jozef Kukliš   |
| <b>Test conditions:</b>               | The test samples were subjected to 20 cycles of the freeze-thaw cycling according to EN 13687-3, Clause 7.2.<br>One cycle took 24 h and comprised the following stages:<br>- 2 h water storage at (21±2)°C<br>- 3 h cooling with air at (-15±2)°C<br>- 4 h storage at (-15±2)°C:<br>- 15 min heating with water at (21±2)°C<br>- 1 h 15 min water storage at (21±2)°C<br>- 1 h 30 min heating air at (60±2)°C<br>- 10 h air storage at (60±2)°C<br>- 15 min cooling with water at (21±2)°C<br>- 1 h 45 min water storage at (21±2)°C<br>After 10 cycles and after the end of the exposure were evaluated:<br>- degree of blistering, method according to EN ISO 4628-2;<br>- degree of cracking, method according to EN ISO 4628-4;<br>- degree of flaking, method according to EN ISO 4628-5.<br>7 days after the end of the exposure was evaluated adhesion strength by pull-off test. |
| <b>Deviations from the standard:</b>  | none   |
| <b>Date of test:</b>                  | - exposure: from 14 <sup>th</sup> November to 05 <sup>th</sup> December 2017<br>- pull-off test: 12 <sup>th</sup> December 2017  |
| <b>Test personnel:</b>                | Jozef Kukliš   |

**Thermal change compatibility – ageing at 70°C - accredited test**

|                                       |   |
|---------------------------------------|---|
| <b>Test procedure:</b>                | EN 1062-11: 2002 Paints and varnishes. Coating materials and coating systems for exterior masonry and concrete Part 11: Methods of conditioning before testing  |
| <b>Description of test specimens:</b> | two treated concrete slabs with dimensions of 300 mm x 300 mm, thickness 100 mm, the coating applied on one face<br>- test substrate: concrete Type MC (0,40)<br>- application of coating: as described on page 1<br>- curing time after application: 7 days at (23±2)°C and (50±5)% relative humidity  |
| <b>Test specimens prepared by:</b>    | Jozef Kukliš  |
| <b>Test conditions:</b>               | The test samples were subjected to aging at temperature 70°C over a period 7 days.<br>Immediately after the end of the exposure was evaluated:<br>- degree of blistering, method according to EN ISO 4628-2;<br>- degree of cracking, method according to EN ISO 4628-4;<br>- degree of flaking, method according to EN ISO 4628-5.<br>7 days after the end of the exposure was evaluated adhesion strength by pull-off test. |
| <b>Deviations from the standard:</b>  | none  |
| <b>Date of test:</b>                  | - exposure: from 14 <sup>th</sup> to 21 <sup>st</sup> November 2017<br>- pull-off test: 28 <sup>th</sup> November 2017  |
| <b>Test personnel:</b>                | Jozef Kukliš  |

**Resistance to temperature shock** - accredited test

**Test procedure:** EN 13687-5: 2002 Products and systems for the protection and repair of concrete structures. Test methods. Determination of thermal compatibility. Part 5: Resistance to temperature shock

**Description of test specimens:** two treated concrete slabs with dimensions of 400 mm x 400 mm, thickness 50 mm, the coating applied on one face  
 - test substrate: concrete Type MC (0,40)  
 - application of coating: as described on page 1  
 - curing time after application: 7 days at (23±2)°C and (50±5)% relative humidity

**Test specimens prepared by:** Jozef Kukliš

**Test conditions:**  
 - Testing liquid: silicone oil  
 - Test temperature: +150°C

Immediately after the end of the exposure was evaluated:  
 - degree of blistering, method according to EN ISO 4628-2;  
 - degree of cracking, method according to EN ISO 4628-4;  
 - degree of flaking, method according to EN ISO 4628-5.

48 h after the end of the exposure was evaluated adhesion strength by pull-off test.

**Deviations from the standard:** none

**Date of test:**  
 - exposure: 19<sup>th</sup> November 2017  
 - pull-off test: 21<sup>st</sup> November 2017

**Test personnel:** Jozef Kukliš

**Resistance to severe chemical attack** - accredited test

**Test procedure:** EN 13529: 2003 Products and systems for the protection and repair of concrete structures. Test methods. Resistance to severe chemical attack

**Description of test specimens:** one treated concrete slab with dimensions of 300 mm x 300 mm, thickness 50 mm, the coating applied on one face  
 - test substrate: concrete Type C (0,45) with a maximum size of aggregate of 8 mm  
 - application of coating: as described on page 1  
 - curing time after application: 7 days at (23±2)°C and (50±5)% relative humidity

**Test specimens prepared by:** Jozef Kukliš

**Test conditions:**  
 - laboratory environment  
 - the test duration: Class I: 3 days without pressure  
 - used testing liquids:  
 a) testing liquid for group 1. Petrol  
 Composition of testing liquid in accordance to EN 13529, Table A1:  
 - 47,5 % Vol.-% toluene  
 - 30,4 % Vol.-% isooctane  
 - 17,1 % Vol.-% n-heptane  
 - 3,0 % Vol.-% methanol  
 - 2,0 % Vol.-% tert.-butanol  
 b) chlorinated water  
 Testing solution was prepared according to EN 14891 with the addition of 200 mg/l sodium chloride and 200 mg/l sodium sulphate to fresh water.

Immediately after the end of the exposure was evaluated:  
 - degree of blistering, method according to EN ISO 4628-2;  
 - degree of cracking, method according to EN ISO 4628-4;  
 - degree of flaking, method according to EN ISO 4628-5

24 h after removal of the testing liquids the hardness was measured by Buchholz indentation test according to EN ISO 2815.

**Deviations from the standard:** none

**Date of test:**  
 - exposure: from 22<sup>nd</sup> to 25<sup>th</sup> November 2017  
 - Buchholz indentation test: 26<sup>th</sup> November 2017

**Test personnel:** Jozef Kukliš

**Impact resistance** - accredited test

**Test procedure:** EN ISO 6272-1: 2004 Paints and varnishes – Rapid-deformation (impact resistance) tests. Part 1: Falling-weight, large-area indenter

**Description of test specimens:** one treated concrete slab with dimensions of 300 mm x 300 mm, thickness 50 mm, the coating applied on one face  
 - test substrate: concrete Type MC (0,40)  
 - application of coating: as described on page 1  
 - curing time after application: 14 days at (23±2)°C and (50±5)% relative humidity

**Test specimens prepared by:** Jozef Kukliš

**Test conditions:** laboratory environment

**Deviations from the standard:** none

**Date of test:** 14<sup>th</sup> November 2017

**Test personnel:** Jozef Kukliš

**Adhesion strength by pull-off test** - accredited test

**Test procedure:** EN 1542: 1999 Products and systems for the protection and repair of concrete structures. Test methods. Measurement of bond strength by pull-off

**Description of test specimens:** one treated concrete slab with dimensions of 300 mm x 300 mm, thickness 100 mm, the coating applied on one face  
 - test substrate: concrete Type C (0,70)  
 - application of coating: as described on page 1  
 - curing time after application: 7 days at (23±2)°C and (50±5)% relative humidity

**Test specimens prepared by:** Jozef Kukliš

**Test conditions:** laboratory environment

**Deviations from the standard:** none

**Date of test:** 19<sup>th</sup> November 2017

**Test personnel:** Jozef Kukliš

**Behaviour after artificial atmospheric agents** - accredited test

**Test procedure:** EN 1062-11: 2002 Paints and varnishes. Coating materials and coating systems for exterior masonry and concrete. Part 11: Methods of conditioning before testing

**Description of test specimens:** three treated test specimens with dimensions of 300 mm x 300 mm, coating applied to one face  
 - test substrate: fibre cement board  
 - application of coating: as described on page 1  
 - curing time after application: 14 days at (23±2)°C and (50±5)% relative humidity

**Test specimens prepared by:** Jozef Kukliš

**Test conditions:** The test samples were subjected for total exposure duration 2000 hours to UV-A radiation and humidity in accordance with STN EN 1062-11, Clause 4.2.  
 Exposure consisted of the following cycles:  
 - 4 h UV irradiation (dry phase) at a Black Standard Temperature (BST) of (60 ± 3)°C. Used laboratory light source: fluorescent lamps type 2 UV-A (340 nm)  
 - 4 h wetting without UV radiation at a Black Standard Temperature (BST) of (50 ± 3)°C  
 After 2000 h of the exposure were evaluated:  
 - degree of blistering, method according to EN ISO 4628-2;  
 - degree of cracking, method according to EN ISO 4628-4;  
 - degree of flaking, method according to EN ISO 4628-5.

**Deviations from the standard:** none

**Date of test:** from 11<sup>th</sup> November 2017 to 4<sup>th</sup> February 2018

**Test personnel:** Jozef Kukliš

**Applied instrumentation:**

| ID      | Name   | Range                     | Unit    | Division   |
|---------|--|---------------------------|---------|------------|
| M900007 | Calliper   | (0 - 250,00)              | mm      | 0,01       |
| M900008 | Pull-off tester ERICHSEN 417                                 | 0 až 47,00                | MPa     | 0,5        |
| M900009 | Balance Kern PRJ 6200-2NM                                    | 0 až 6200                 | g       | 0,01       |
| M900011 | Stopwatch  | (0 - 1800)                | s       | 0,1        |
| M900018 | Analytical balance Sartorius BP 300 S                        | (0 - 303,00)              | g       | 0,0001     |
| M900031 | Digital calliper   | (0 - 150,00)              | mm      | 0,01       |
| M900037 | Coating thickness gauge PIG                                  | 0 až 2                    | mm      | 0,02       |
| M900044 | Automatic recorder of temperature and humidity               | ((-25) - 45)<br>(15 - 95) | °C<br>% | 0,1<br>1,0 |
| Z900001 | Climatized chamber Vötsch VC 4034                            | -40 až +180               | °C      | 0,1        |
| Z900002 | Laboratory ventilated oven STERIMAT 354.3                    | +20 až +250               | °C      | 1          |
| Z900015 | Aluminium cups with free test area of 0,005 m <sup>2</sup>   |                           |         |            |
| Z900021 | Falling-weight apparatus                                     |                           |         |            |
| Z900023 | Barometer  | 960 až 1040               | hPa     | 1          |
| Z900024 | Desiccator   |                           |         |            |
| Z900028 | Test chamber CO <sub>2</sub>                                 | +20 až +250               | °C      | 1          |
| Z900026 | Buhholz hardness Tester                                      |                           |         |            |
| Z900030 | Equipment with radiant surface heater                        |                           |         |            |
| Z900029 | Equipment for water sprinkler                                |                           |         |            |
| Z900034 | Apparatus for artificial ageing Q-U-V tester                 |                           |         |            |
| Z600037 | Programmable climatic cabinet                                |                           |         |            |
| Z900040 | Steel-cylinder   |                           |         |            |
| Z900045 | Moulds for preparing concrete plates                         |                           |         |            |
| Z900047 | Concrete mixer 125 l   |                           |         |            |
| Z900050 | Scarecrows electric table for compacting concrete            |                           |         |            |
| Z900053 | Magnifying glass - with a magnification of 10 x<br>Hot plate |                           |         |            |

**TEST RESULTS****1) Cross cut test**

| Number of measurement | Thickness of coating (µm) | Classification degree |
|-----------------------|---------------------------|-----------------------|
| 1                     | 38                        | 1                     |
| 2                     | 42                        | 1                     |
| 3                     | 40                        | 1                     |

- complied the classification degree 1

**2) Carbon dioxide permeability**

| Test specimen No.      | Mean value of the test specimen thickness $s$ (m) | Mass difference of two weighings at constant change of mass $d_m$ (g) | Carbon dioxide permeability $i$ (g/(m <sup>2</sup> .d)) | Diffusion-equivalent air layer thickness $s_d$ (m) | Diffusion resistance number $m$ (-) |
|------------------------|---|---|---|--|-------------------------------------|
| 1                      | 0,000044  | 0,0107  | 2,10  | 117,76   | 2,68.10 <sup>6</sup>                |
| 2                      | 0,000048  | 0,0149  | 2,93  | 84,54  | 1,76.10 <sup>6</sup>                |
| 3                      | 0,000048  | 0,0123  | 2,42  | 102,43   | 2,13.10 <sup>6</sup>                |
| <b>Average</b>         | 0,000047  | 0,0126  | 2,48  | <b>101,57</b>                                      | 2,19.10 <sup>6</sup>                |
| Extended uncertainty U |   |   | 0,54  | 21,72  | 0,57.10 <sup>6</sup>                |

**3) Permeability to water vapour**

| Test specimen No.      | Mean value of the test specimen thickness $d$ (m) | Mass difference of two weighings at constant change of mass (g) | Rate of flow of water vapour $G_{cs}$ (g/h) | Water-vapour transmission rate $V$ (g/(m <sup>2</sup> .d)) | Water-vapour diffusion-equivalent air layer thickness $s_d$ (m) | Water-vapour resistance factor $m$ (-) |
|------------------------|---|---|---|--|---|--|
| 1                      | 0,000042  | 0,0095  | 3,9583.10 <sup>-4</sup>                     | 1,9120   | 10,670  | 254040                                 |
| 2                      | 0,000048  | 0,0093  | 3,8750.10 <sup>-4</sup>                     | 1,8715   | 10,900  | 227088                                 |
| 3                      | 0,000042  | 0,0088  | 3,6667.10 <sup>-4</sup>                     | 1,7705   | 11,522  | 274343                                 |
| <b>Average</b>         | 0,000044  | 0,00920   | 3,8333.10 <sup>-4</sup>                     | 1,8513   | <b>11,031</b>   | 251824                                 |
| Extended uncertainty U |   |   |   |  | 1,215   | 37194,02                               |

**4) Capillary water absorption and water permeability water**

| Test specimen No.      | Thickness of coating (µm) | Width of the test area (mm) | Length of the test area (mm) | Initial weight (g) | Weight after immersion test (g) | Weight increase (g) | Liquid water permeability $w$ (kg/(m <sup>2</sup> .h <sup>0,5</sup> )) |
|------------------------|---------------------------|-----------------------------|------------------------------|--------------------|---------------------------------|---------------------|--|
| 1                      | 30                        | 132                         | 150                          | 1299,46            | 1300,20                         | 0,74                | 0,008  |
| 2                      | 39                        | 135                         | 150                          | 1246,62            | 1247,28                         | 0,66                | 0,007  |
| 3                      | 34                        | 130                         | 154                          | 1210,28            | 1211,13                         | 0,85                | 0,009  |
| <b>Average</b>         | 34                        | 132                         | 151                          | 1252,12            | 1252,87                         | 0,75                | <b>0,008</b>   |
| Extended uncertainty U |                           |                             |                              |                    |                                 |                     |  |

**5) Thermal change compatibility****Thunder-shower cycling (10 cycles) and Freeze-thaw cycling with de-icing salt immersion (20 cycles)****5a) Visual assessment after exposure**

| Test specimen No.  | Degree of blistering STN EN ISO 4628-2 | Degree of cracking STN EN ISO 4628-4 | Degree of flaking STN EN ISO 4628-5 |
|--|--|--------------------------------------|-------------------------------------|
| after 10 cycles of thunder-shower  |  |                                      |                                     |
| 1  | 0 (S0)                                 | 0 (S0)                               | 0 (S0)                              |
| 2  | 0 (S0)                                 | 0 (S0)                               | 0 (S0)                              |
| after 10 cycles of thunder-shower and 10 cycles freeze-thaw with de-icing salt immersion |  |                                      |                                     |
| 1  | 0 (S0)                                 | 0 (S0)                               | 0 (S0)                              |
| 2  | 0 (S0)                                 | 0 (S0)                               | 0 (S0)                              |
| after 10 cycles of thunder-shower and 20 cycles freeze-thaw with de-icing salt immersion |  |                                      |                                     |
| 1  | 0 (S0)                                 | 0 (S0)                               | 0 (S0)                              |
| 2  | 0 (S0)                                 | 0 (S0)                               | 0 (S0)                              |

**5b) Adhesion strength by pull-off test after exposure**

Test specimen No. 1

| Number of measurement  | Adhesion strength by pull-off (N/mm <sup>2</sup> ) | Type of Failure |
|------------------------|--|-----------------|
| 1                      | 2,6  | A 100 %         |
| 2                      | 2,7  | A 100 %         |
| 3                      | 2,4  | A 100 %         |
| 4                      | 2,4  | A 100 %         |
| 5                      | 2,8  | A 100 %         |
| <b>Average</b>         | <b>2,6</b>   | -               |
| Extended uncertainty U |  |                 |

Note:  
A - cohesion failure in concrete substrate

Test specimen No. 2

| Number of measurement  | Adhesion strength by pull-off (N/mm <sup>2</sup> ) | Type of Failure |
|------------------------|--|-----------------|
| 1                      | 2,3  | A 100 %         |
| 2                      | 2,6  | A 100 %         |
| 3                      | 2,8  | A 100 %         |
| 4                      | 2,7  | A 100 %         |
| 5                      | 2,5  | A 100 %         |
| <b>Average</b>         | <b>2,6</b>   | -               |
| Extended uncertainty U | 0,2  |                 |

Note:  
A - cohesion failure in concrete substrate

|  |                             |
|--|-----------------------------|
| Average value of adhesion strength by pull-off test after exposure of two test specimens | <b>2,6 N/mm<sup>2</sup></b> |
|--|-----------------------------|

## 6) Thermal change compatibility Freeze-thaw cycling without de-icing salt impact (20 cycles)

### 6a) Visual assessment after exposure

| Test specimen No.  | Degree of blistering STN EN ISO 4628-2 | Degree of cracking STN EN ISO 4628-4 | Degree of flaking STN EN ISO 4628-5 |
|--|--|--------------------------------------|-------------------------------------|
| after 10 cycles of freeze-thaw without de-icing salt immersion |  |                                      |                                     |
| 1  | 0 (S0)                                 | 0 (S0)                               | 0 (S0)                              |
| 2  | 0 (S0)                                 | 0 (S0)                               | 0 (S0)                              |
| after 20 cycles of freeze-thaw without de-icing salt immersion |  |                                      |                                     |
| 1  | 0 (S0)                                 | 0 (S0)                               | 0 (S0)                              |
| 2  | 0 (S0)                                 | 0 (S0)                               | 0 (S0)                              |

### 6b) Adhesion strength by pull-off test after exposure

Test specimen No. 1

| Number of measurement  | Adhesion strength by pull-off (N/mm <sup>2</sup> ) | Type of Failure |
|------------------------|--|-----------------|
| 1                      | 2,9  | A 100 %         |
| 2                      | 2,5  | A 100 %         |
| 3                      | 3,3  | A 100 %         |
| 4                      | 2,7  | A 100 %         |
| 5                      | 2,8  | A 100 %         |
| <b>Average</b>         | <b>2,8</b>   | -               |
| Extended uncertainty U | 0,3  |                 |

Note:  
A - cohesion failure in concrete substrate

Test specimen No. 2

| Number of measurement  | Adhesion strength by pull-off (N/mm <sup>2</sup> ) | Type of Failure |
|------------------------|--|-----------------|
| 1                      | 2,5  | A 100 %         |
| 2                      | 2,5  | A 100 %         |
| 3                      | 2,6  | A 100 %         |
| 4                      | 2,4  | A 100 %         |
| 5                      | 2,5  | A 100 %         |
| <b>Average</b>         | <b>2,5</b>   | -               |
| Extended uncertainty U | 0,1  |                 |

Note:  
A - cohesion failure in concrete substrate

|  |                             |
|--|-----------------------------|
| Average value of adhesion strength by pull-off test after exposure of two test specimens | <b>2,7 N/mm<sup>2</sup></b> |
|--|-----------------------------|

## 7) Thermal change compatibility – ageing at 70°C for 7 days

### 7a) Visual assessment after exposure

| Test specimen No. | Degree of blistering STN EN ISO 4628-2 | Degree of cracking STN EN ISO 4628-4 | Degree of flaking STN EN ISO 4628-5 |
|-------------------|--|--------------------------------------|-------------------------------------|
| 1                 | 0 (S0)                                 | 0 (S0)                               | 0 (S0)                              |
| 2                 | 0 (S0)                                 | 0 (S0)                               | 0 (S0)                              |

### 7b) Adhesion strength by pull-off test after exposure

Test specimen No. 1

| Number of measurement  | Adhesion strength by pull-off (N/mm <sup>2</sup> ) | Type of Failure |
|------------------------|--|-----------------|
| 1                      | 2,8  | A 100 %         |
| 2                      | 3,1  | A 100 %         |
| 3                      | 2,8  | A 100 %         |
| 4                      | 2,9  | A 100 %         |
| 5                      | 3,0  | A 100 %         |
| <b>Average</b>         | <b>2,9</b>   | -               |
| Extended uncertainty U | 0,2  |                 |

Note:  
A - cohesion failure in concrete substrate

Test specimen No. 2

| Number of measurement  | Adhesion strength by pull-off (N/mm <sup>2</sup> ) | Type of Failure |
|------------------------|--|-----------------|
| 1                      | 2,8  | A 100 %         |
| 2                      | 3,0  | A 100 %         |
| 3                      | 2,6  | A 100 %         |
| 4                      | 2,9  | A 100 %         |
| 5                      | 2,8  | A 100 %         |
| <b>Average</b>         | <b>2,8</b>   | -               |
| Extended uncertainty U | 0,2  |                 |

Note:  
A - cohesion failure in concrete substrate

|  |                             |
|--|-----------------------------|
| Average value of adhesion strength by pull-off test after exposure of two test specimens | <b>2,9 N/mm<sup>2</sup></b> |
|--|-----------------------------|

## 8) Resistance to temperature shock

- Test temperature: +150°C

### 8a) Visual assessment after exposure

| Test specimen No. | Degree of blistering STN EN ISO 4628-2 | Degree of cracking STN EN ISO 4628-4 | Degree of flaking STN EN ISO 4628-5 |
|-------------------|--|--------------------------------------|-------------------------------------|
| 1                 | 0 (S0)                                 | 0 (S0)                               | 0 (S0)                              |
| 2                 | 0 (S0)                                 | 0 (S0)                               | 0 (S0)                              |

### 8b) Adhesion strength by pull-off test after exposure

Test specimen No. 1

| Number of measurement  | Adhesion strength by pull-off (N/mm <sup>2</sup> ) | Type of Failure |
|------------------------|--|-----------------|
| 1                      | 2,3  | A 100 %         |
| 2                      | 2,4  | A 100 %         |
| 3                      | 2,6  | A 100 %         |
| 4                      | 2,6  | A 100 %         |
| 5                      | 2,4  | A 100 %         |
| <b>Average</b>         | <b>2,5</b>   | -               |
| Extended uncertainty U | 0,2  |                 |

Note:  
A - cohesion failure in concrete substrate

Test specimen No. 2

| Number of measurement  | Adhesion strength by pull-off (N/mm <sup>2</sup> ) | Type of Failure |
|------------------------|--|-----------------|
| 1                      | 2,7  | A 100 %         |
| 2                      | 2,9  | A 100 %         |
| 3                      | 2,4  | A 100 %         |
| 4                      | 2,6  | A 100 %         |
| 5                      | 2,5  | A 100 %         |
| <b>Average</b>         | <b>2,6</b>   | -               |
| Extended uncertainty U | 0,2  | -               |

Note:  
A - cohesion failure in concrete substrate

|  |                             |
|--|-----------------------------|
| Average value of adhesion strength by pull-off test after exposure of two test specimens | <b>2,6 N/mm<sup>2</sup></b> |
|--|-----------------------------|

### 9) Resistance to severe chemical attack

- 3 days without pressure

9a) Testing liquids: group 1. Petrol according to EN 13529

Visual assessment

| Number of measurement | Degree of blistering STN EN ISO 4628-2 | Degree of cracking STN EN ISO 4628-4 | Degree of flaking STN EN ISO 4628-5 |
|-----------------------|--|--------------------------------------|-------------------------------------|
| 1                     | 0 (S0)                                 | 0 (S0)                               | 0 (S0)                              |

Buchholz indentation test

| Number of measurement  | Thickness of coating (μm) | Before exposure              |  | After exposure               |  |
|------------------------|---------------------------|------------------------------|--|------------------------------|--|
|                        |                           | Length of indentation / (mm) | Resistance to indentation α <sub>B</sub> (-) | Length of indentation / (mm) | Resistance to indentation α <sub>B</sub> (-) |
| 1                      | 52                        | 0,6                          | 166,7  | 0,6                          | 166,7  |
| 2                      |                           | 0,6                          | 166,7  | 0,7                          | 142,9  |
| 3                      |                           | 0,5                          | 200,0  | 0,6                          | 166,7  |
| 4                      |                           | 0,6                          | 166,7  | 0,7                          | 142,9  |
| 5                      |                           | 0,5                          | 200,0  | 0,6                          | 166,7  |
| <b>Average</b>         |                           | 0,6                          | <b>180,0</b>                                 | 0,6                          | <b>157,2</b>                                 |
| Extended uncertainty U |                           | 0,05                         | 16,9   | 0,05                         | 12,1   |

9b) Testing liquids: chlorinated water

Visual assessment

| Number of measurement | Degree of blistering STN EN ISO 4628-2 | Degree of cracking STN EN ISO 4628-4 | Degree of flaking STN EN ISO 4628-5 |
|-----------------------|--|--------------------------------------|-------------------------------------|
| 2                     | 0 (S0)                                 | 0 (S0)                               | 0 (S0)                              |

Buchholz indentation test

| Number of measurement  | Thickness of coating (μm) | Before exposure              |  | After exposure               |  |
|------------------------|---------------------------|------------------------------|--|------------------------------|--|
|                        |                           | Length of indentation / (mm) | Resistance to indentation α <sub>B</sub> (-) | Length of indentation / (mm) | Resistance to indentation α <sub>B</sub> (-) |
| 1                      | 52                        | 0,6                          | 166,7  | 0,6                          | 166,7  |
| 2                      |                           | 0,6                          | 166,7  | 0,6                          | 166,7  |
| 3                      |                           | 0,6                          | 166,7  | 0,6                          | 166,7  |
| 4                      |                           | 0,5                          | 200,0  | 0,6                          | 166,7  |
| 5                      |                           | 0,6                          | 166,7  | 0,6                          | 166,7  |
| <b>Average</b>         |                           | 0,6                          | <b>173,4</b>                                 | 0,6                          | <b>166,7</b>                                 |
| Extended uncertainty U |                           | 0,05                         | 13,9   | 0,04                         | 0,03   |

### 10) Impact resistance

| Number of measurement             | Impact resistance - the mass of the falling weight 1000 g |                |              |
|-----------------------------------|---|----------------|--------------|
|                                   | Height 60 cm  | Height 62,5 cm | Height 65 cm |
| 1                                 | pass  | pass           | fail         |
| 2                                 | pass  | pass           | fail         |
| 3                                 | pass  | pass           | pass         |
| 4                                 | pass  | pass           | fail         |
| 5                                 | pass  | pass           | pass         |
| <b>Impact resistance: 6,13 Nm</b> |   |                |              |

### 11) Adhesion strength by pull-off test

| Number of measurement  | Adhesion strength by pull-off (N/mm <sup>2</sup> ) | Type of Failure |
|------------------------|--|-----------------|
| 1                      | 3,4  | A 100 %         |
| 2                      | 3,1  | A 100 %         |
| 3                      | 2,9  | A 100 %         |
| 4                      | 2,9  | A 100 %         |
| 5                      | 3,5  | A 100 %         |
| <b>Average</b>         | <b>3,2</b>   | -               |
| Extended uncertainty U | 0,3  | -               |

Note:  
A - cohesion failure in concrete substrate


### 12) Behaviour after artificial atmospheric agents

Visual assessment after 2000 hours of UV irradiation and humidity

| Test specimen No. | Degree of blistering STN EN ISO 4628-2 | Degree of cracking STN EN ISO 4628-4 | Degree of flaking STN EN ISO 4628-5 |
|-------------------|--|--------------------------------------|-------------------------------------|
| 1                 | 0 (S0)                                 | 0 (S0)                               | 0 (S0)                              |
| 2                 | 0 (S0)                                 | 0 (S0)                               | 0 (S0)                              |
| 3                 | 0 (S0)                                 | 0 (S0)                               | 0 (S0)                              |

Date of report: 06<sup>th</sup> February 2014

Prepared by: Ing. Erika Halčinová

Authorized by:   
Ing. Pavel Kazár  
Head of Laboratory Branch



#### Notes:

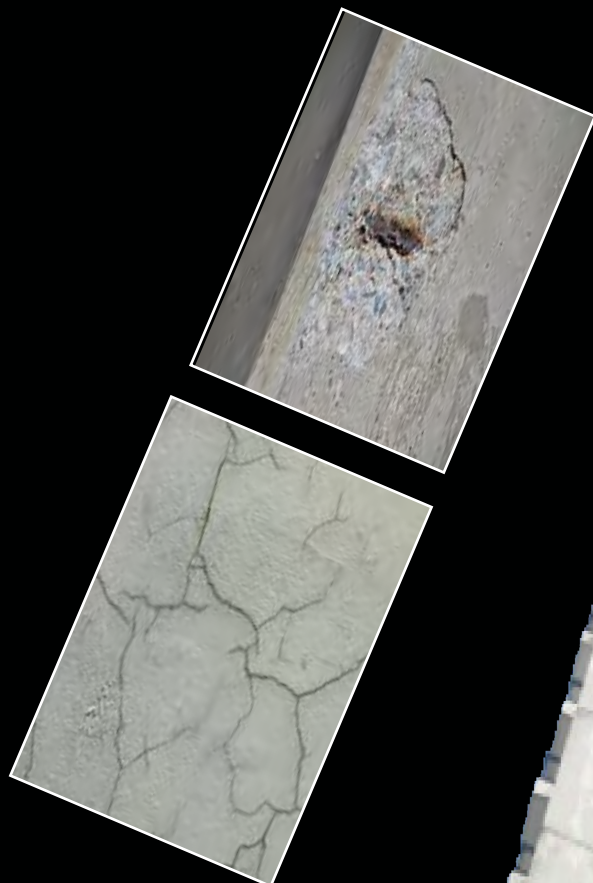
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