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Athens, 26/07/2013

Test Report No.: MSEL/CE 143

Determination of Crack Bridging Ability

Prepared for:

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By:

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1. Sample Description and Analysis Requested

The Material Science and Engineering Laboratory of National Technical University of Athens received a sample of “ColorTek Anti-carbonation” paint from KASSA’A Paints Group. Crack Bridging Ability of the aforementioned coating was to be determined according to BS EN 1062-7:2004 “*Paints and varnishes. Coating materials and coating systems for exterior masonry and concrete. Determination of crack bridging properties*”.

2. Method

2.1. Coating Application

The coating system was applied by brush on the mortar block substrate, using a weighting procedure in order to achieve the cover rate required. Two coats of “ColorTek Anti-carbonation” paint were applied with a minimum drying period of 24 hours between the two coats. The second coat was applied at 90° to the first one. The coated samples were maintained for three days under laboratories conditions and then were preserved at 23±2°C and 60±5% RH for a minimum of seven days prior to the testing procedure.

2.2. Determination of Crack Bridging Ability

The test was carried out at 23±2°C. Six samples of the coating were tested. The rear part of each test specimen was cut in 2mm depth at the centre of the specimen in order to create a crack. Plastic plates were then adhered to the front of the coated sample, leaving approximately 1cm free either side of the centre of the specimen. A crack was then initiated from the rear of the specimen by gently widening the slot cut of the sample. This produced a microscopic crack in the substrate up to the underside of the coating.

Each test specimen was then placed in the tensile instrument and tested under tension until the first defect was noted in the coating. The cross head movement rate was set at 0.5mm/min. The amount of extension of the crack was then measured using the extensometer of the testing machine. The outside edges of the sample were not evaluated due to edge effects that may occur.



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3. Results

Specimen No.	ColorTek Anti-carbonation	
	Extension when defect first noted (mm)	Failure mode
1	1.8	Pin hole
2	1.9	Pin hole
3	2.1	Pin hole
4	1.7	Pin hole
5	2.1	Pin hole
6	1.9	Pin hole

Notes:

-The maximum crack bridging ability of the coating "ColorTek Anti-carbonation" was found 2.1mm.

-The DFT (dry film thickness) of all samples was 200μm



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Athens, 26/07/2013

Test Report No.: MSEL/CE 140

Determination of Carbon Dioxide Permeability

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1. Sample Description and Analysis Requested

The Material Science and Engineering Laboratory of National Technical University of Athens received a sample of “ColorTek Anti-carbonation” paint from KASSA’A Paints Group. Carbon dioxide permeability of the aforementioned coating was to be determined according to prEN 1062-6:2001 “*Paints and varnishes – Coating materials and coating systems for exterior masonry and concrete – Part 6: Determination of carbon dioxide permeability*”.

2. Method

2.1. Coating Application

The coating system was applied by brush on the unglazed ceramic tile substrate, using a weighting procedure in order to achieve the cover rate required. Two coats of “ColorTek Anti-carbonation” paint were applied with a minimum drying period of 24 hours between the two coats. The second coat was applied at 90° to the first one. The coated samples were maintained for three days under laboratories conditions and then were preserved at 23±2°C and 60±5% RH for a minimum of seven days prior to the testing procedure.

2.2. Determination of Carbon Dioxide permeability

The test was carried out in triplicate at 23±2°C. A coated test piece was clumped between two halves of a permeation cell and the two halves were made gas-tight to each other and to the surroundings. Through one half of the permeation cell carbon dioxide (10% at oxygen) was passing over the coated face of the test piece at a known flow rate and pressure, whilst through the other half helium passed at the same pressure and flow rate. This carrier gas stream transported the diffused carbon dioxide to a detection system based on gas chromatography. Equilibrium conditions were achieved after 24 hours. Carbon dioxide permeability was calculated according to prEN 1062-6.



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3. Results

Property	ColorTek Anti-carbonation		
	Specimen No.		
	1	2	3
Carbon dioxide permeability (g/m ² ·d)	0.5877	0.5877	0.5822
Carbon dioxide diffusion coefficient (cm ² /s)	7.58 x 10 ⁻⁸	7.51 x 10 ⁻⁸	7.49 x 10 ⁻⁸
Air layer thickness (m)	422	422	426
Diffusion resistance number (μ-value)	2.11 x 10 ⁶	2.11 x 10 ⁶	2.13 x 10 ⁶
Thickness of the coating (μm)	200	200	200

Notes:

According to Klopfer, an anti-carbonation coating has an equivalent air layer thickness greater than 50m (Sd>50).



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Athens, 26/07/2013

Test Report No.: MSEL/CE 141

Determination of Chloride Ion Permeability

Prepared for:

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1. Sample Description and Analysis Requested

The Material Science and Engineering Laboratory of National Technical University of Athens received a sample of “ColorTek Anti-carbonation” paint from KASSA'A Paints Group. Chloride ion diffusion coefficient of the aforementioned coating was to be determined, according to ASTM C1202-97 “*Standard Test Method for Electrical Indication of Concrete's Ability to Resist Chloride Ion Penetration*”.

2. Method

2.1. Coating Application

The coating system was applied by brush on the concrete substrate, using a weighting procedure in order to achieve the cover rate required. Two coats of “ColorTek Anti-carbonation” paint were applied with a minimum drying period of 24 hours between the two coats. The second coat was applied at 90° to the first one. The coated samples were maintained for three days under laboratories conditions and then were preserved at 23±2°C and 60±5% RH for a minimum of seven days prior to the testing procedure.

2.2. Determination of Chloride Ion Permeability

The test was carried out in triplicate at 23±2°C. The specimen was positioned in the measuring cell, containing a fluid reservoir at each face of the specimen. One reservoir was filled with a sodium chloride (3.0% NaCl) solution, the other with a sodium hydroxide (0.3 N NaOH) solution. The coated face of the specimen was placed in the NaCl reservoir. The reservoir containing the NaCl was connected to the negative terminal, the NaOH reservoir to the positive terminal of the Power Supply Unit. The test measures the electrical current passing through the specimen for a period of standard 6 hours at a standard voltage of 60 VDC. The temperature was monitored with a probe inserted in the NaCl reservoir. The coating was characterized regarding chloride ions permeability according to ASTM C1202-97.

2.3. Determination of the Chloride Ion Diffusion Coefficient

In order to determine the chloride ion diffusion coefficient of the coating under test, the same procedure was followed. Test samples were placed between the reservoirs and a standard voltage of 30 VDC was applied for a standard period of 4 hours. After the completion of the test, the specimens were split and the penetration depth of the chlorides was determined by a silver nitrate solution on the split surface. The diffusion coefficient was then calculated.



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3. Results

Property	ColorTek Anti-carbonation		
	Specimen No.		
	1	2	3
Charge Passed (Coulombs)	756	699	732
Chloride ion permeability	Very Low	Very Low	Very Low
Chloride ingress diffusion coefficient (cm ² /s)	2.34 x 10 ⁻⁹	2.31 x 10 ⁻⁹	2.39 x 10 ⁻⁹
Thickness of the coating (μm)	200	200	200

Notes:

The Coulombs are, according to ASTM C 1202-97, an indication of the coated substrate's ability to resist chloride ion penetration at 60 VDC and 6 hours of testing. For a specimen with a diameter of 95mm (3 ¾") and 50mm long, chloride ion permeability is based on charge passed as follows:

Charge Passed (Coulombs)	Chloride Ion Permeability
>4000	High
4000-2000	Moderate
2000-1000	Low
1000-100	Very low
<100	Negligible



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Athens, 26/07/2013

Test Report No.: MSEL/CE 142

Determination of Liquid-Water Transmission Rate (Permeability)

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1. Sample Description and Analysis Requested

The Material Science and Engineering Laboratory of National Technical University of Athens received a sample of “ColorTek Anti-carbonation” paint from KASSA’A Paints Group. Liquid-water transmission rate of the aforementioned coating was to be determined according to DIN EN 1062-3 (2008-04) “*Paints and varnishes - Coating materials and coating systems for exterior masonry and concrete - Part 3: Determination of liquid water permeability*”.

2. Method

2.1. Coating Application

The coating system was applied by brush on the mortar slab substrate, using a weighting procedure in order to achieve the cover rate required. Two coats of “ColorTek Anti-carbonation” paint were applied with a minimum drying period of 24 hours between the two coats. The second coat was applied at 90° to the first one. The coated samples were maintained for three days under laboratories conditions and then were preserved at 23±2°C and 60±5% RH for a minimum of seven days prior to the testing procedure.

2.2. Determination of Water Vapor transmission Rate

The test was carried out in triplicate at 23±2°C. The coated specimens were initially weighed to 0.01g accuracy. A container was afterwards filled with deionized water which was allowed to reach 23±2°C. The specimens were placed in the container supported on a plastic rack with the coated surface facing downwards so that it was 1cm below the surface of the water. After 1h, 2h, 3h, 6h and 24 h the test specimens were removed from the water, wiped carefully and dried using absorbent paper and were finally weighted to 0.1g accuracy.

The mass increase of the test specimen was plotted as a function of square root of time. Liquid-water transmission rate was calculated from the linear part of the curve after dividing the mass increase by the area of the test surface, as described in DIN EN 1062-3 (2008-04).



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3. Results

Property	ColorTek Anti-carbonation		
	Specimen No.		
	1	2	3
Liquid - Water Transmission Rate ($\text{kg/m}^2 \cdot \text{h}^{0.5}$)	0.19	0.17	0.20
Classification	II	II	II

Notes:

Classification by liquid-water transmission rate shall be by the following categories according to DIN EN 1062-3 (2008-04).

Class	Liquid-Water Transmission Rate ($\text{g/m}^2 \cdot \text{d}$)
I (high)	>0.5
II (medium)	0.1 to 0.5
III (low)	<0.1



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Athens, 26/07/2013

Test Report No.: MSEL/CE 139

Determination of Water Vapour Transmission Rate

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1. Sample Description and Analysis Requested

The Material Science and Engineering Laboratory of National Technical University of Athens received a sample of “ColorTek Anti-carbonation” paint from KASSA’A Paints Group. Water vapour transmission rate of aforementioned coating was to be determined according to BS EN ISO 7783:2011 “*Paints and varnishes. Determination of water-vapour transmission properties. Cup method*”.

2. Method

2.1. Coating Application

The coating system was applied by brush on the unglazed ceramic tile substrate, using a weighting procedure in order to achieve the cover rate required. Two coats of “ColorTek Anti-carbonation” paint were applied with a minimum drying period of 24 hours between the two coats. The second coat was applied at 90° to the first one. The coated samples were maintained for three days under laboratories conditions and then were preserved at 23±2°C and 60±5% RH for a minimum of seven days prior to the testing procedure.

2.2. Determination of Water Vapor transmission Rate

The test was carried out in triplicate at 23±2°C. Dishes, containing a saturated solution of ammonium dihydrogen phosphate producing an atmosphere immediately above it of 93% relative humidity were closed by a porous substrate coated with the product to be tested. The dishes were placed in an enclosure at controlled temperature and relative humidity. The face of the coating system was the external side, facing the lower relative humidity 50±5 % and the other side was facing higher relative humidity (93%). Test dishes were weighted at suitable intervals of time and the water-vapour transmission rate was determined from the change in mass when this change had become directly proportional to the time interval. Equilibrium conditions were achieved after seven days. Water vapour transmission rate was calculated according to BS EN ISO 7783:2011 “*Paints and varnishes. Determination of water-vapour transmission properties. Cup method*”.



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3. Results

Property	ColorTek Anti-carbonation		
	Specimen No.		
	1	2	3
Water vapour transmission rate (g/m ² ·d)	98.4277	92.7492	96.2382
Diffusion coefficient (cm ² /s)	2.38E-04	2.17E-04	2.27E-04
Air layer thickness (m)	0.21	0.23	0.22
Diffusion resistance number	1050	1150	1100
Thickness of the coating (μm)	200	200	200

Notes:

Classification by water-vapour transmission rate shall be by the following categories according to BS EN ISO 7783:2011

Class	Water Vapour Transmission Rate (g/m ² ·d)	S _d (m)
I (high)	>150	<0.14
II (medium)	15 to 150	0.14 to 1.4
III (low)	<15	>1.4



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