TEST REPORT

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Project Title:	Durability & Thermal Performance of Safeguard Europe's STORMDRY & Trial X116 Masonry Coatings
Client:	Safeguard Europe Limited Redkiln Close Horsham RH13 5QL
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CONTENTS

1 INTRODUCTION

Safeguard Europe Limited wish to demonstrate the performance of their masonry coating products, after accelerated weathering in accordance with ETAG 034:2012[1] and BS EN 16383:2016[2] which correlates to in excess 25 years in service weathering.

Safeguard Europe Limited also wish to determine what effect extended weathering has on the thermal insulating properties, water vapour permeability and super hydrophobic properties of their STORMDRY Masonry Coating and Trial Product X116 Masonry Coating.

2 TEST SPECIMENS

A brick wall was constructed in a rigid 2.6 m high x 3.2 m long steel test frame, using Warwickshire Olde English Bricks in designation (iii) mortar. The wall was split vertically into thirds, with a 10 mm x 100 mm insulated expansion joint inserted to prevent heat transfer between each section. One third was coated using Safeguard Europe's STORMDRY Masonry Coating, one third left untreated, to act as a control and the final third coated using Safeguard Europe's Trial Product X116 Masonry Coating.

Details relating to the construction and coating of the wall can be found in the Appendix.

3 PROCEDURE

3.1 Hygrothermal Conditioning

The wall frame was centrally clamped to the face of a 2.4 m high x 3.0 m test aperture, within the hygrothermal chamber and instrumented using calibrated K-Type thermocouples. The thermocouples were positioned towards the centre of the panel 3 No. used for each section of wall. The thermocouples were used to monitor the temperature, with one placed 10 mm from the front face of the wall, a second placed within the body of the wall, at a depth of 50 mm and the third placed 10 mm from rear face of the wall.

The chamber was then heated to 70°C, held for 24 hours and temperature readings from the wall, taken hourly.

The wall was then subjected to conditioning in accordance with ETAG 034:2012 and BS EN 16383:2016. The testing involved, subjecting a wall to repeated heat-rain cycles, followed by repeated wet freeze cycles at controlled humidity conditions, designed to simulate naturally occurring conditions.

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[1] ETAG 034:2012 GUIDELINE FOR EUROPEAN TECHNICAL APPROVAL of KITS FOR EXTERNAL WALL CLADDINGS

[2] BS EN 16383:2016 - Thermal insulation products for building applications - Determination of the hygrothermal behaviour of external thermal insulation composite systems with renders (ETICS)

3.1.1 Weathering Cycles

The panel was subjected to cyclic heat-rain conditions, followed by wet freeze cycles according to the following programme.

3.1.2 Heat-Rain – 80 Cycles

Heating to 70°C rising over 1 hour and maintaining at 70°C ± 5 at 10-15% RH for a further 2 hours.

Followed by spraying with water (water temperature 15 ± 5°C) at 1 l/m^2/min for 1 hour.

Draining for 2 hours.

On completion of the heat-rain cycles, the wall was conditioned for 48 hours at a temperature between 10 and 25°C, with a minimum RH of 50%.

3.1.3 Wet Freeze – 30 Cycles

30 cycles, wetting, freezing and thawing:

The test wall was initially conditioned by wetting for 8 hours with an amount of 1.5 ± 0.5 l/(m^2 min) water, with a temperature of 15 ± 5°C.

Then the following cycles were applied:

The surface of the test wall was frozen within 2 hours to −20 ± 5°C and maintained for 4 hours (in total 6 hours).

The wall was then thawed for 1 hour at temperature of 20 ± 5°C.

The wall was then wetted for 1 hour with an amount of 1.5 ± 0.5 l/(m^2 min) water, with a temperature of (15 ± 5) °C.

After the 30 cycles, the wall was conditioned at ambient temperature (20 ± 10) °C.

A repeat of the initial test was then conducted with the chamber heated to 70°C, held for 24 hours and temperature readings from the wall taken hourly. A comparison between the two sets of data taken, both before and after weathering, was then made.

3.2 Water Vapour Permeability

Fifteen square small scale specimens, having an area of 400 cm^2 were constructed using Warwickshire Olde English Bricks in designation (iii) mortar. Five of the specimens were coated using Safeguard Europe STORMDRY Masonry Coating, five coated using Safeguard Europe Trial Product X116 Masonry Coating and five left untreated to act as a control.

In addition, five square specimens, having an area of 400 cm^2 for each coating type, were cut from the weathered wall on completion of the hygrothermal conditioning.

The samples were then submitted for the determination of water vapour resistance in accordance with BS EN ISO 7783:2011[3].

Conditions were set, such that, the temperature was at 23°C with the relative humidity being 93% inside the dish (wet state) and the relative humidity being 50% outside the dish and sample (dry state).

Ammonium dihydrogen phosphate was used to obtain 93% within the dish.

The samples were stored in an environmental chamber controlled at 23°C ± 2°C and 50% ± 5% RH, the samples were weighed to three decimal places at specific time intervals.

3.3 Water Absorption

On completion of the Water Vapour Permeability Test the specimens, which had been cut from the weathered wall, were stored in ambient laboratory conditions for a period of 7 days. The specimens were tested using Lucideon In House Test Method PR 27:1998 Water Absorption Masonry Bricks. Each sample was sealed on four sides, leaving the front face exposed. This was done to ensure any water entering the sample could only do so through the front face of the sample.

The specimens were weighed and placed in water, with the front face submerged and re-measured, until two consecutive readings within 0.1 g were obtained.

The samples were then placed in a dryer at 40°C and weighed until two consecutive readings were obtained within 0.1 g. The moisture content of the samples was then calculated.

The procedure was repeated for an uncoated sample which acted as a control.

4 RESULTS

4.1 Hygrothermal Test

According to Section 6.4.6 of ETAG 034:2012, the performance requirements of the large scale hygrothermal test, is that the test sample should not show evidence of any of the following defects, during nor at the end of the test programme:

- Deterioration such as cracking, delamination or water penetration.
- Irreversible deformation.

At the end of the test programme, no water penetration shall be evident on the rear of the sample.

[3] BS EN ISO 7783:2011 Paints and varnishes. Determination of water-vapour transmission properties. Cup method.

4.1.1 Results

Safeguard Europe STORMDRY	No defects
Safeguard Europe Trial Product X116 Masonry Coat	No defects
Control	Water Penetration

The surface finish for each specimen was thoroughly examined to establish whether any cracking had occurred.

No visible damage was noted to either coating during, or on completion of the test regime. The rear face of the uncoated control wall showed signs of water penetration. Some signs of frost damage were also noted on the uncoated control wall (Plate 4).

Plate 1 shows the front face of the wall on completion of weathering.

Temperature readings taken both before and after hygrothermal cycling are given in Table 1. This shows no change in thermal insulating properties of the Safeguard Europe STORMDRY, or the Safeguard Europe Trial Product X116 Masonry Coating after completion of weathering.

Plate 2 shows a comparison of thermal images taken of the front face of the wall, both before and after weathering.

In addition, thermal images were taken of the wall during the programme, highlighting temperature differentials when wet and these are shown in the Appendix.

4.2 Water Vapour Permeability

Table 3 gives the mean water vapour resistance values for both the weathered and control samples.

The results indicate, that neither the Safeguard Europe STORMDRY Masonry Coating nor the Safeguard Europe Trial Product X116 Masonry Coating, have adversely effected the water vapour resistance of the brick substrate.

4.3 Water Absorption

Table 5 gives the water absorption of the weathered specimens.

The Safeguard Europe STORMDRY Coating showed a reduction in water absorption of 95.1%, in comparison to the uncoated specimen.

The Safeguard Europe Trial Product X116 Masonry Coating, showed a reduction in water absorption of the 93.9%, in comparison to the uncoated specimen.

5 DISCUSSION

Both the Safeguard Europe STORMDRY Masonry Coating and Trial Product X116 Masonry Coatings, showed no deterioration either in performance or aesthetic appearance, after accelerated weathering correlating to in excess of 25 years exposure.

Water vapour permeability testing, in accordance with BS EN ISO 7783:2011, showed that the coatings had little effect on the water vapour diffusion of the brick substrate. The control uncoated wall having a thickness of 100 mm gave a mean SD value of 0.37. The same brick substrate sample coated with the Safeguard Europe STORMDRY Masonry Coating and Trial Product X116 Masonry Coatings, gave SD values of 0.35 and 0.30 respectively, showing that they had little effect on the breathability of the brick substrate.

Moisture content tests undertaken on the coatings after weathering, showed a water absorption of 0.61% for the Safeguard Europe STORMDRY and 0.75% Trial Product X116 Masonry Coating, in comparison to 12.37% for the control uncoated sample. This equates to a reduction of between 93.9%-95.1% in water absorption for the wall, when using the coating products.

The reduction in water absorption of the coated walls, also led to thermal performance benefits. Thermocouples placed toward the rear face of the walls to record temperature, showed that during the hygrothermal rain cycle, the uncoated wall showed on average an increase of 4^{o}C of heat loss in comparison to the coated walls. Thermal images taken of the rear of the wall during the rain cycles, clearly show the temperature differential between the coated and uncoated walls (Plate 3).

In addition the uncoated section of the wall, showed some signs of frost damage with some of the bricks spalling. Neither, the wall coated with the STORMDRY or Trial Product X116 showed any signs of frost damage.

TABLES

Table 1 - Thermocouple Readings whilst the Chamber was Maintained at 70ºC both (control) and after Weathering

Coating	Thermocouple Position (Depth through wall mm)	Control Wall	Weathered
STORMDRY	10	55ºC	54ºC
	50	43ºC	41ºC
	90	32ºC	31ºC
Trial Product X116	10	53ºC	54ºC
	50	43ºC	42ºC
	90	33ºC	31ºC
Control	10	54ºC	53ºC
	50	45ºC	43ºC
	90	33ºC	31ºC

Table 2 - Thermocouple Readings showing Temperature Differential during Rain Cycle

Coating	Horizontal Thermocouple Position	Control Wall	Weathered
STORMDRY	10	34ºC	34ºC
	50	23ºC	24ºC
	90	24ºC	24ºC
Trial Product X116	10	33ºC	35ºC
	50	23ºC	23ºC
	90	24ºC	23ºC
Control	10	35ºC	36ºC
	50	22ºC	22ºC
	90	20ºC	21ºC

Table 3 - Thermocouple Readings showing Temperature Differential during Freeze Cycle

Coating	Horizontal Thermocouple Position from Face (mm)	Control Wall	Weathered
STORMDRY	10	-18ºC	-18ºC
	50	-9ºC	-8ºC
	90	0ºC	0ºC
Trial Product X116	10	-19ºC	-18ºC
	50	-9ºC	-9ºC
	90	0ºC	0ºC
Control	10	-19ºC	-18ºC
	50	-10ºC	-9ºC
	90	0ºC	0ºC

Table 4 - Mean Water Vapour Resistance

Coating	Water Vapour Resistance (MNs/g)	
	Control	Weathered
Safeguard Europe STORMDRY Masonry Coating	1.74	1.76
Safeguard Europe Trial Product X116 Masonry	1.53	1.52
Control	1.86	1.46

Table 5 - Mean Water Vapour Diffusion Values

Coating	Mean Water Vapour Diffusion Values (SD)	
	Control	Weathered
Safeguard Europe STORMDRY Masonry Coating	0.35	0.35
Safeguard Europe Trial Product X116 Masonry	0.30	0.30
Control	0.37	0.29

Table 6 - Water Absorption Measurements after Weathering

Coating	Mass of Saturated Specimen (g)	Mass of Dry Specimen (g)	Mass of Water Absorbed (g)	Moisture Content (%)
Safeguard Europe STORMDRY Masonry Coating	2956.1	2974.4	18.3	0.61
Safeguard Europe Trial Product X116 Masonry	3132.9	3109.7	23.18	0.75
Control	3323.0	2957.1	365.9	12.37

NOTE: The results given in this report apply only to the samples that have been tested.

END OF REPORT

PLATES

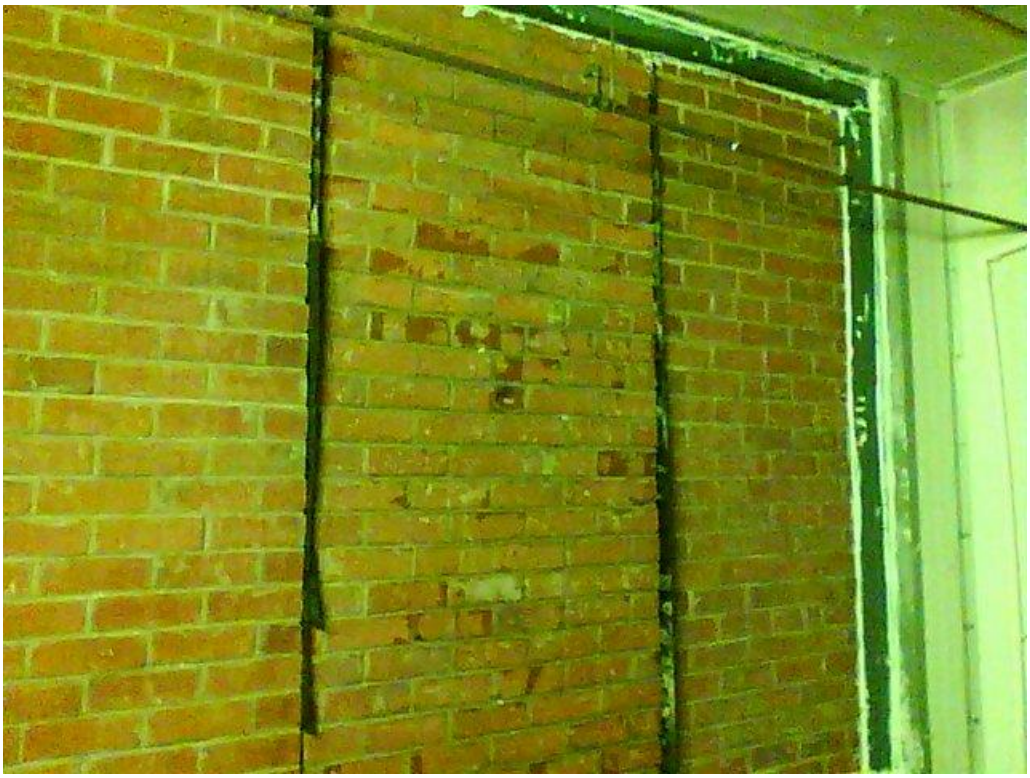
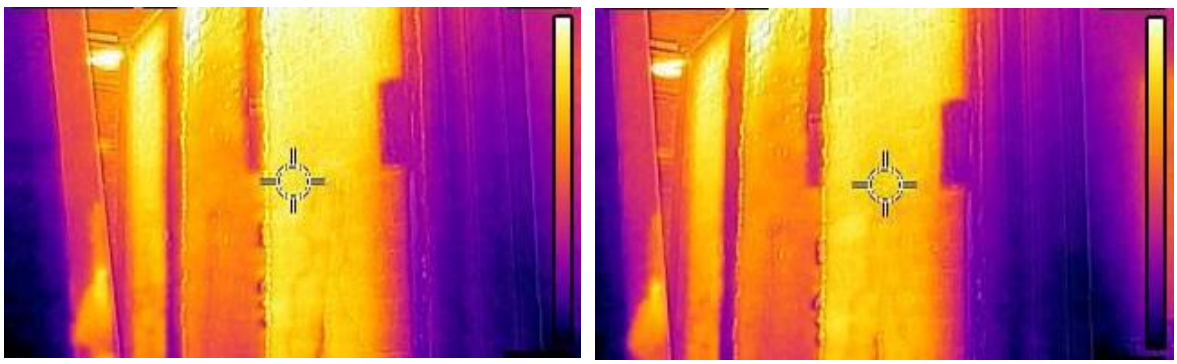


Plate 1 - Safeguard Wall on Completion of 25 Years Accelerated Weathering (STORMDRY Masonry Coating LHS/Control Centre/Trial Product X116 Masonry Coating RHS)



70°C Before Weathering

70°C After Weathering

Plate 2 - Comparison of Thermal Performance before and after Accelerated Weathering

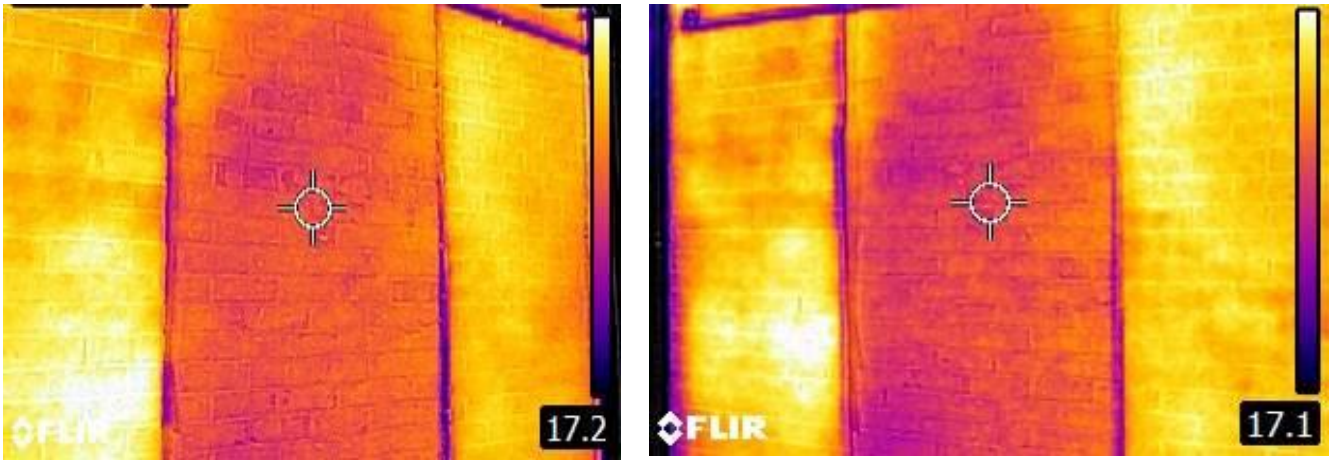


Plate 3 - Rear Face of Wall showing Temperature Differential between Uncoated and Coated Samples during Hygrothermal Rain Cycle

Plate 4 - Front Face of Wall with the Uncoated Bricks showing Signs of Frost Damage

APPENDIX 1 - Sample Construction

(i) Hygrothermal Wall

The systems were applied to a brick wall constructed by Lucideon Limited.

A brick wall was constructed in a rigid 2.6 m long x 3.2 m high steel test frame, using Warwickshire Olde English bricks in designation (iii) mortar. The wall was split vertically into thirds and a 10 mm x 100 mm insulated expansion joint was inserted, to prevent heat transfer between each section. A damp proof membrane was then used to seal the joint to prevent water ingress. The wall was allowed to cure for 28 days.

System 1 Safeguard Europe Trial Product X116 Masonry Coating **(Right Hand Side of Wall)**

A 5 litre container of Safeguard Europe Trial Product X116 Masonry Coating was stirred by hand and applied to the left hand third of the wall using a brush. The coating was allowed to cure for 28 days prior to commencement of hygrothermal testing.

System 2 Control (Middle of Wall)

The middle third of the wall was left uncoated so as to act as a control during the hygrothermal testing.

System 3 Safeguard Europe STORMDRY (Left Hand Side of Wall)

A 5 litre container of Safeguard Europe STORMDRY Masonry Coating was stirred by hand and applied to the left hand third of the wall using a brush. The coating was allowed to cure for 28 days prior to commencement of hygrothermal testing.

APPENDIX 2 - Construction Detail (plates)

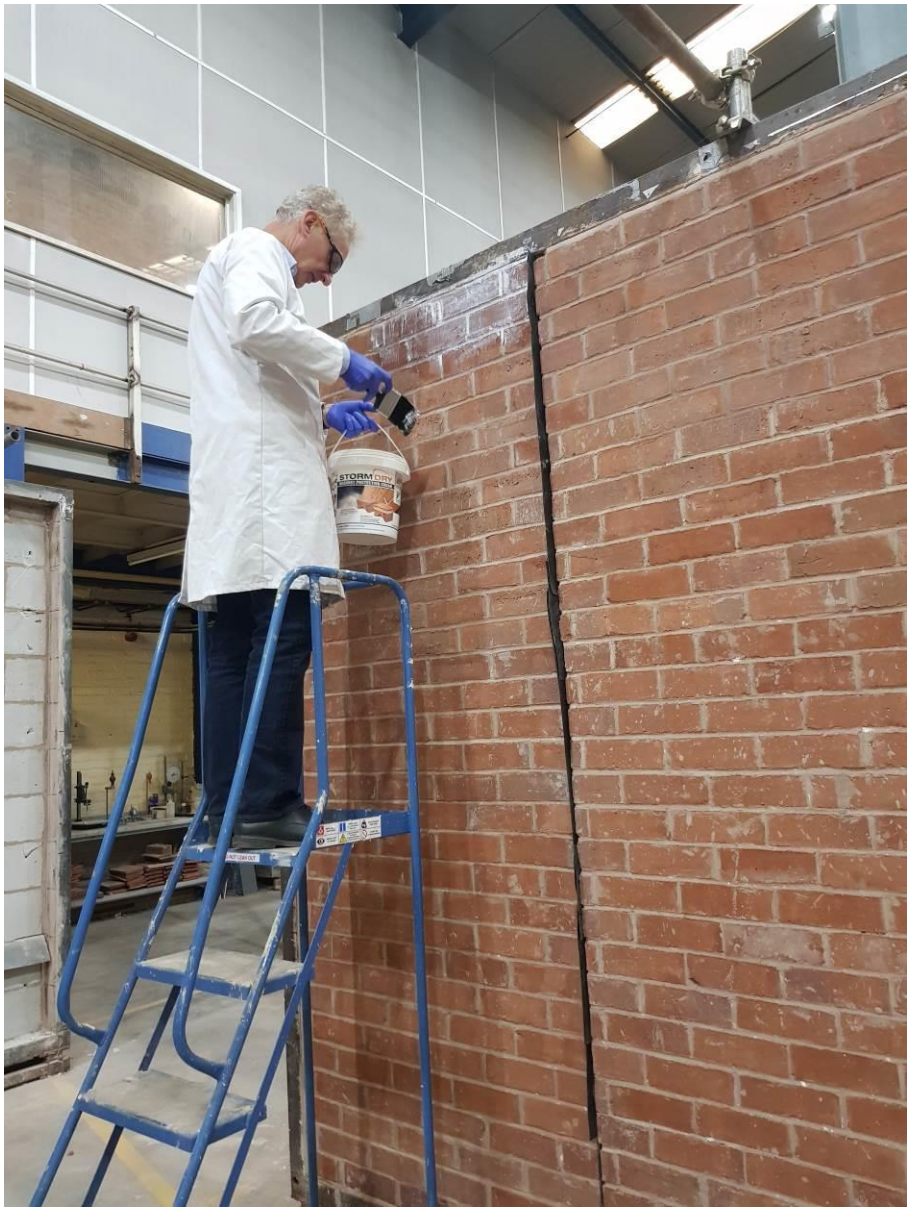


Plate A2-1 – Application of Safeguard Europe STORMDRY Masonry Coating

Plate A2-2 – Application of Safeguard Europe Trial Product X116 Masonry Coating

APPENDIX 3 - Batch Details

Product	Batch Reference	Image of Label
Safeguard Europe STORMDRY Masonry Coating	SD 507 EXP 22/01/21	
Safeguard Europe Trial Product X116 Masonry Coating	Safeguard Europe Trial Product X116 Masonry Coating Batch No. ISD