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MA 39 – VFA 2018-0788.03-.04

Vienna, 29-th of August 2018

Laboratory Report

concerning

heat-reflecting coating containing infrared pigments under cyclic radiation

Applicant: Lengheim Consulting und Entwicklung GmbH

Ordering date: 21-th of June 2018

Test samples: Two concrete boards covered with same thermal insulation composite system (in German: WDVS-System), but one with additional IR-coating at the outside plaster surface and one uncoated (reference sample).

Testing program: Measuring of absolute surface-and difference-temperatures during outside-radiation.
The outside radiation has been done cyclical during the whole testing time (switching on and off the IR-lamps by a simple timer).

Shortcut of result: By radiating the two samples at the outside by two 250 W IR-lamps under similar conditions up to outdoor surface temperatures of 69,4 °C, an averaged surface-temperature-difference in favour of the IR-coated sample of approximately -3,6 K during the radiation cycles at the center of the samples (position 2) has been detected.

The test report includes 5 pages and one appendix (7 pages).

1 General

The producing company of the described IR-coating (with infrared pigments, in German: "Folienbeschichtung") ordered measurements of thermal performance at MA 39.

1.1 Order

Due to the additional order from 21-th of June 2018 following a short discussion with the producer two simplified qualitative measurements of thermal performance concerning the described samples below (coated and uncoated) have been carried out. Due to the applicant a simple derivable effect has been expected.

It is noticed that these measurements are due to scientific interest only and not covered by adequate standards and are carried out only as a rough test (indication) and first approach. For further simulation also simple instationary processes of the radiation lamps (switching them on and off) have been included to watch cyclical behaviour.

Since the executed tests do not give a complete view of the infrared reflecting behaviour of the coating, additional measurements — for instance measuring of the thermal emission ε, as described in /3/, — are recommended.

1.2 Documents, Descriptions

/1/ photographs of the samples and measurement procedure look at the appendix.

/2/ EN 1121 doors; Behaviour between two different climates - Test method, see appendix A (latest version).

/3/ EN 16012 Thermal insulation of buildings — Reflective insulation products — Determination of declared thermal performance, see annex D (latest version).

/4/ Bericht 1445/2015/2 – HG der Holzforschung Austria über Bewitterung eines transparenten diffusionsoffenen Beschichtungssystems im Außenbereich über einem Jahr gemäß ÖNORM EN 927-3 vom 14. Februar 2017

2 Testsamples

On the 6-th of July 2018 the following samples have been prepared at MA 39 by a co-worker of MA 39 and by the applicant (see also pictures within the appendix):

sample uncoated:	From inside to outside (total thickness appr. 93 mm) - 34 mm concrete plate (500 mm x 500 mm) - 4 mm glue ("Profi Klebespachtel 3750") - 50 mm thermal composite system with XPS - appr. 5 mm outside plaster (applied by the applicant)

sample coated:	From inside to outside (total thickness appr. 93 mm) - 34 mm concrete plate (500 mm x 500 mm) - 4 mm glue ("Profi Klebespachtel 3750") - 50 mm thermal composite system with XPS - appr. 5 mm outside plaster (applied by the applicant) with additional IR –pigmented coating (applied by the applicant)

3 Tests and results

3.1 Testing device

3.1.1 General

Both concrete plates with additional same thermal composite system at the outside (coated and uncoated) were in good approximation of same outer size of ca. 500/500/93 mm (width/height/depth). The thickness of the thermal insulation boards (XPS, rose-red coloured) amounted to be 50 mm.

For the measurement of absolute temperatures and difference temperatures within the surfaces thermocouples have been adjusted, see also appendix at page 1 (informative). For additional comparison with the surface temperatures also a touchless laser-sensor has been used.

Absolute temperatures and temperature differences were measured by thermocouple-pairs in series connexion in time-intervals of 10 min. For good comparison of the results among both samples always the same thermocouples (and also the same masking tapes) have been used at the same positions.

The samples have been additionally protected from the laboratory air at their backside by the same insulation board (6 cm XPS, coloured blue).

3.1.2 Outside Radiation

The thermal performance of the IR-coating has been investigated with the help of two 250 W radiation lamps showing a spectrum mainly in the near infrared.

The used IR-lamps with description: "Philips Incandescent 230 – 250 V 250 W E27 infrared, double reflective system IR RE ES 173 x 125 mm" show a spectrum distribution primary including the near infrared spectrum (mainly to a wavelength of ca. 2500 nm).

To simulate more realistic conditions — also including instationary temperature changes — the IR-lamps were regulated (switched on and off) by a time-clock (time of radiation of averaged cycles: appr. 07:49 - .17:49 o´clock)

The distance of the IR-lamps to the radiated sample surface has been equidistantly fixed at 50 cm for both experiments.

Both lamps were adjusted diagonal at a distance of 28 cm. Therefore the inclination angle at the marked positions 1 and 3 have been close to perpendicular incidence of the radiation (see picture 2 in the appendix). At position 2 the cones of the two lamps have overlapped each other at the center of the samples.

3.2 Duration of measurements

The total testing time lasted from the 10-th of July 2018 until the 2-th of August 2018.

3.3 Measurement results

3.3.1 Uncoated sample (reference-sample) radiated

After reaching a quasi-stationary thermal equilibrium the following averaged absolute surface-temperatures in [°C] and difference-temperatures in [K] have been obtained.

	K2-OFL **Oberflächentemperatur Position 2 Vorderseite** **[°C°]**	K2-RÜCKSEITE-OFL **Oberflächentemperatur Position 2 Rückseite** **[°C]**	K2-DIFF **Differenztemperatur Position 2** **[K]**	K3-DIFF **Differenztemperatur Position 3** **[K]**
MIN	64,0	22,9	37,6	26,1
MW	68,8	27,8	41,0	29,2
MAX	69,4	31,2	45,1	33,0

Note: at measuring position 1 the glueing tape has dissolved during the measurement

Additional chanel: heat flow meter plate 92004 (qualitative resulting heat flow distribution appendix page 5)

The two middle intervalls of 07:49 – 17:49 o´clock have been averaged

For grafic illustration of temperature distributions and heat flow densities look into the appendix pages 4 to 5.

3.3.2 IR-coated sample radiated

After reaching a quasi-stationary thermal equilibrium the following averaged absolute surface temperatures in [°C] and temperature-differences in [K] have been obtained.

	K1-DIFF **Oberflächentemperatur Position 1 Vorderseite** **[°C]**	K2-OFL **Oberflächentemperatur Position 2 Vorderseite** **[°C]**	K2-RÜCKSEITE-OFL **Oberflächentemperatur Position 2 Rückseite** **[°C]**	K2-DIFF **Differenztemperatur Position 2** **[K]**	K3-DIFF **Differenztemperatur Position 3** **[K]**
MIN	19,0	62,8	21,2	35,8	20,2
MW	21,7	65,2	26,3	38,9	22,7
MAX	25,8	65,9	29,5	43,0	26,3

Additional chanel: heat flow meter plate 92004 (qualitative resulting heat flow distribution appendix page 7)

The two middle intervalls of 07:49 – 17:49 o´clock have been averaged

For grafic illustration of temperature distributions and heat flow densities look into the appendix pages 6 to 7.

3.3.3 Difference of results

By a rough comparence of the coated with the uncoated sample an averaged lower outside surface temperature at position 2 (K2, approximately at the center of the sample with overlapping radiation cones – hottest area) of 65,2°C – 68,8°C= **-3,6 K** can be calculated at the radiated surface in favour of the IR-coated sample. It is noted hereby that this result also depends on the inclination angle of the applied radiation.

At the opposite side of the samples the following (smaller) temperature-difference at position 2 has been obtained: 26,3°C – 27,8°C = **-1,5 K** also in favour of the IR-coated sample. The surface temperature difference at the unradiated side has been smaller also due to the applied thermal composite system.

The temperature differences at the diagonal opposite positions 1 and 3 (marked „K1" and „K3" with mainly perpendicular inclination angle of radiation) have been also clearly smaller in favour of the sample with IR-coated surface as can be seen in the appendix at pages 5 and 6. In both cases the temperature differences at the diagonal positions (1 and 3) have been angle dependent significantly smaller than the temperature difference within the center (position 2).

The differences between the samples comparing instationary processes (after switching on and off the IR-lamps) are also in favour of the IR-coated sample as can be seen comparing the (qualitative) values of resulting (lateral and perpendicular) heat flow densities in the appendix at pages 5 and 7. The coating therefore shows a smoothing effect (immediately after switching on and off the IR-lamps) concerning the peaks of heat flow density.

4 Conclusion

As it can be seen a clear tendency of measuring lower surface temperatures and lower heat flow densities (immediately after switching on and off the IR-lamps) in favour of the IR-coated sample could be detected under the given boundary conditions.

Note: It is noticed that these measurements are due to scientific interest only and not covered by adequate standards and are carried out only as a rough test (indication) and first approach. For further simulation also simple instationary processes of the radiation lamps (switching them on and off) have been included to watch cyclical behaviour.

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Outside radiation experiment:

photo nr. 1

outside view (measurement positions 1 – 3) of tested sample (IR-coated)

on the front side:
two radiation infrared lamps for heating the surface of the (within this picture IR-coated) plaster covering the thermal composite system

note:
surface temperatures have been also measured and compared – additional to the thermocouples and also outside of the blue adhesive masking tapes – touchless with the help of laser sensor

photo nr. 2

radiation-lamps for heating the front surface of the plaster covering the thermal composite system. The surface temperatures (outside at the plaster-surface and inside at the inner concrete surface) have been measured with calibrated thermocouples

brand name / imprint of radiation lamps:

"Philips Incandescent 230 – 250 V 250 W E27 infrared, double reflective system IR RE ES 173 x 125 mm"

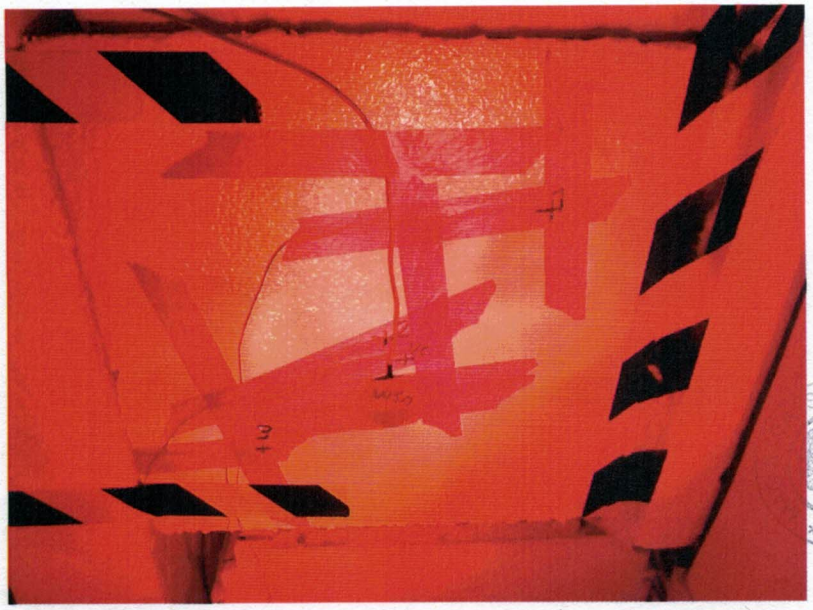

photo nr. 3

outside view of tested sample (coated)

Radiation with two infrared lamps.

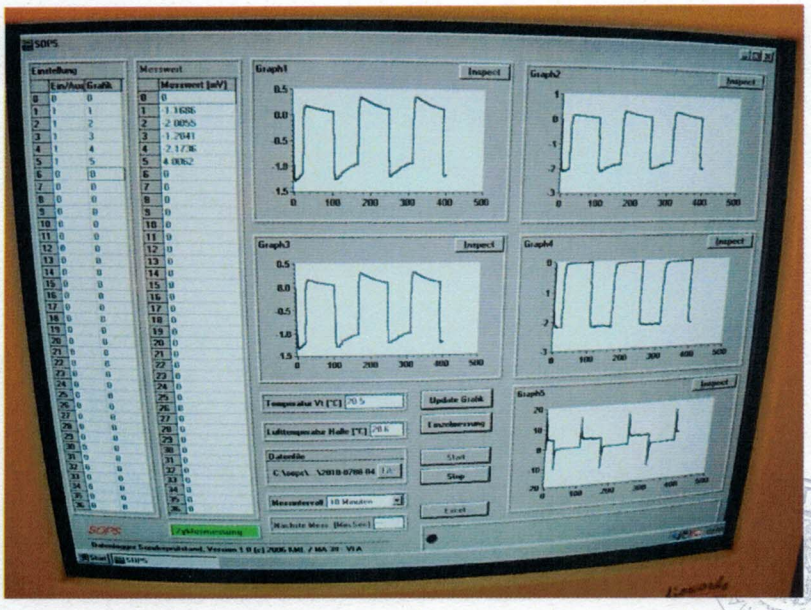

photo nr. 4

Measurements of electric voltages of thermocouples and heat flow meter during the experiment.