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Test Report No. PB 1.5/20-119-3

18 June 2021
No. Copy 1

Contracting body:	Meesenburg Großhandel KG Westerallee 162 24941 Flensburg
Task:	Material tests on profiles made of EPS before and after artificial weathering by UV radiation - bending behaviour - compression behaviour - pull-out resistance of frame screws
Name:	blaugelb Trio**therm**+ profile
Samples delivery:	06/11/2020
Persons in charge:	Dr.-Ing. Stephan Reichel Stefan Laut, Laborleiter

Dieser Prüfbericht umfasst 15 Seiten.

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1 Objectives

MFPA Leipzig GmbH was commissioned to subject EPS profiles („blaugelb Trio**therm**+ profile") to artificial ageing through weathering in an UV test cabinet. The artificial aging should correspond to the stress of half a year or a whole year.

It was then examined how UV aging affects the material properties listed below:

- compression behaviour according to EN 826,
- bending behaviour according to EN 12089,
- pull-out resistance of frame screws.

The characteristic values determined on the aged test specimens were then compared with the results of the reference tests on unaged test specimens.

The following table contains an overview of the test series.

Table 1: Tabular overview of test series

Series	UV stress	Total UV
A1	without	reference
B1	500 h	corresponding to ½ year
C1	1000 h	corresponding to 1 year

The material was handed over to MFPA Leipzig GmbH on November 6th, 2020 by an employee of the client.

2 Materials

According to the client, the "blaugelb Trio**therm**+ profiles" are part of the "Trio**therm**+ System" for the assembly of building elements in the insulation layer of facades and are made of high-density expanded polystyrene (EPS).

Profiles with dimensions of 100 mm x 85 mm x 1175 mm were used for the tests.

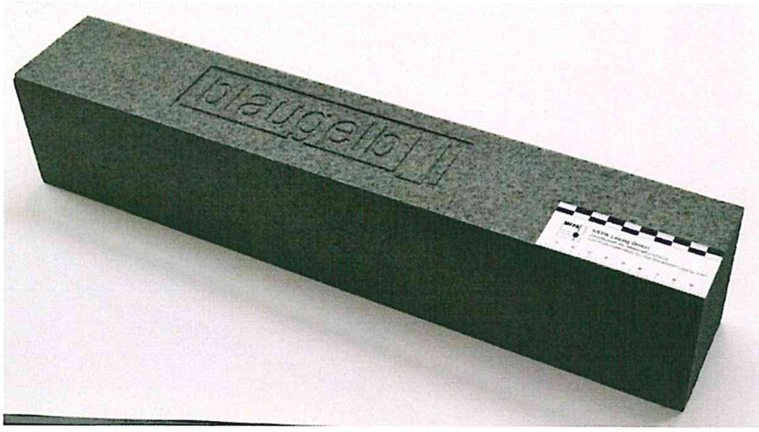

Fig. 1: „blaugelb Trio**therm**+ profile" (cut to 500 mm)

The "blaugelb Frame screw Fix FK-T30 7.5x132 mm galv." was used to determine the pull-out resistance. The srew-in depth was 60 mm.

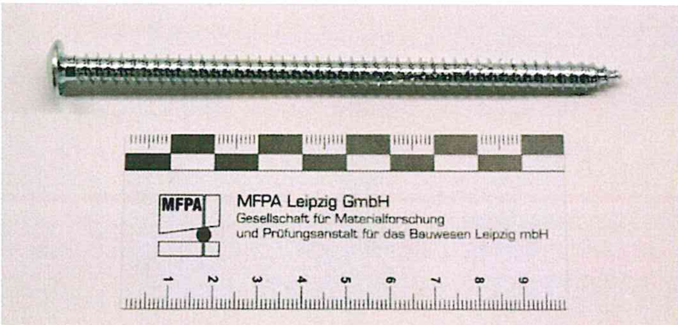

Fig. 2: „blaugelb Frame screw Fix FK-T30 7.5x132 mm galv."

3 Artificial ageing

For the investigation, three “blaugelb Trio**therm**+ profiles” with a cross-section of 100 mm x 85 mm and a length of approx. 500 mm were arranged one above the other and artificially exposed to UV stress on one side. The test device used (Atlas UV Test) has a total of eight lamps of type 1 A (UV-A 340).

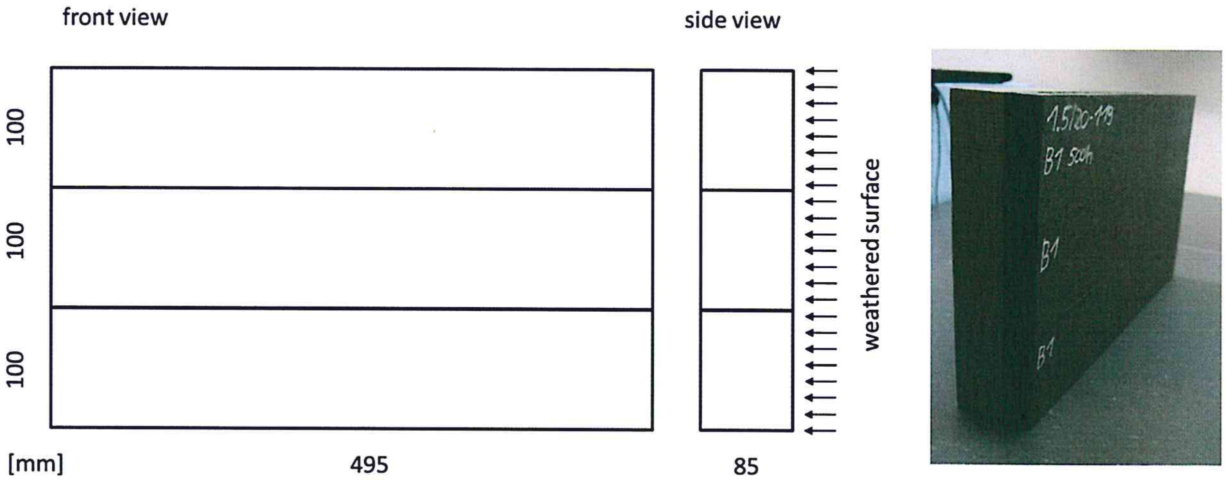

Fig. 3: left: schematic illustration; right: specimen of series B1

The artificial ageing should simulate the UV stress corresponding to an exposure of half a year or a whole year. The irradiance was determined based on an annual global radiation of 1025 kWh/m². Assuming that the share of UV radiation in global radiation is around 5-6%, this results in a total UV radiation (TUV) of approx. 220 MJ/m² for one year. This corresponds to approx. 1000 hours of artificial weathering in the UV test cabinet with an irradiance of 1.12 W/m² (black standard temperature 60 °C).

The specimens of the series B1 were removed from the test device after 500 h, the specimens of the series C1 after 1000 h.

4 Visual assessment and documentation

4.1 Documentation

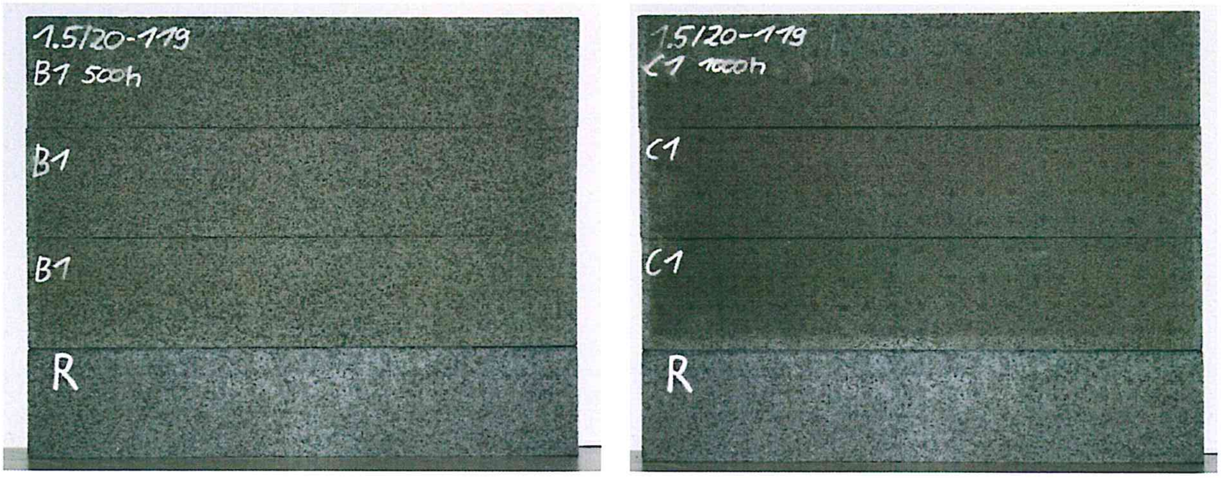

Fig. 4: Weathered specimen compared to unweathered specimen (R); left: B1 after 500 h; right: C1 after 1000 h UV irradiation

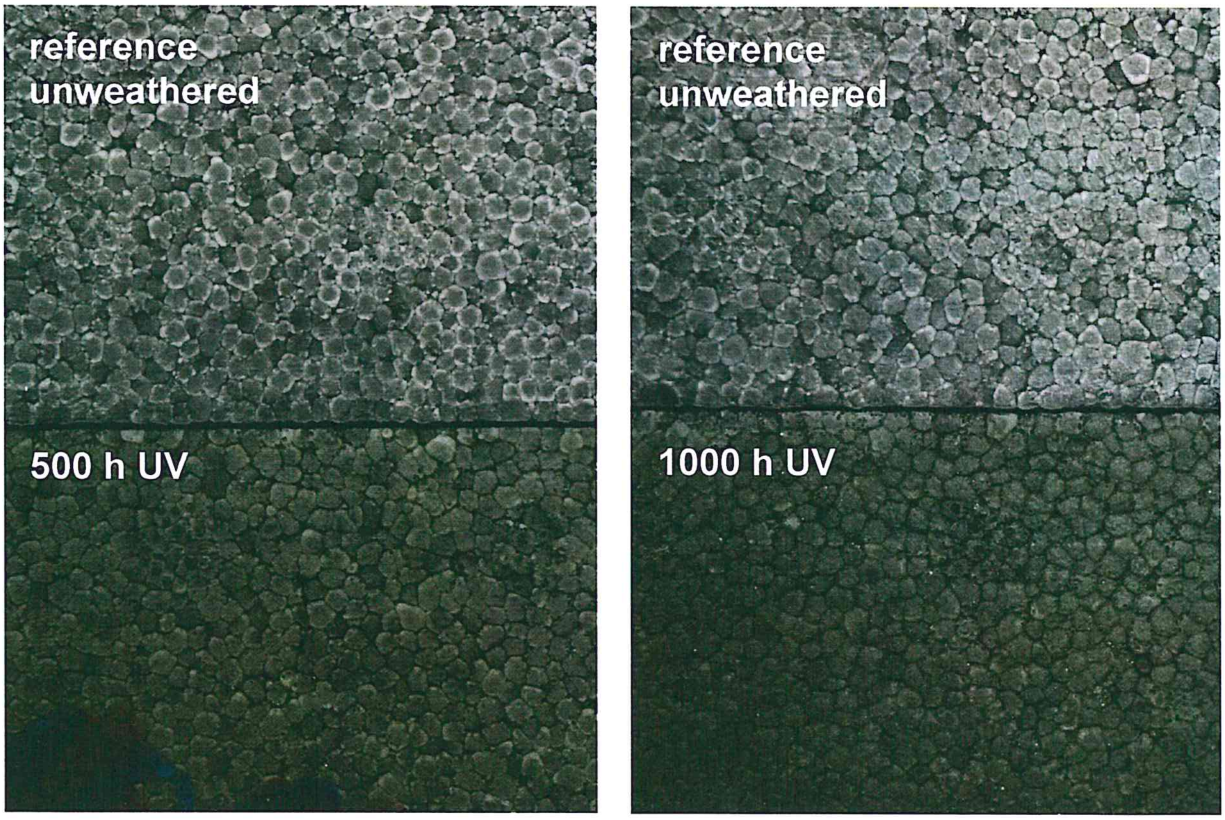

Fig. 5: Surface of sample B1 (left) und C1 (right) compared to unweathered reference specimen

4.2 Assessment

After the UV weathering, discoloration (yellow-brownish) of the weathered surface of the test specimens of series B1 and C1 could be determined. The surface structure was apparently unchanged. No detachment or damage could be found.

Fig. 6: Comparison of reference sample surface (R) and surface of weathered samples of series B1 and C1 after 500 h respective 1000 h UV weathering

5 Material parameters

5.1 Bending behaviour acc. to DIN EN 12089

DIN EN 12089 : 2013-06	Thermal insulating products for building applications – Determination of bending behaviour

Conditioning:	min. 6 hours at (23 ± 2) °C, (50 ± 5) % rel. humidity
Dimensions:	length x width x thickness = 495 mm x 100 mm x 85 mm
Test setup:	universal testing machine TT2850 S determination of dimensions with digital caliper
Load cell:	5 kN
Deformation rate:	10 mm/min
Span:	425 mm
Test method:	Test method B (span: five timest he thickness)
Execution:	In accordance to DIN EN 12089, the test specimen is placed symmetrically on two supports. A centric force is applied perpendicular to the longitudinal axis and increased at a constant deformation rate until it fails. The weathered surface was in the tensile zone.

Fig. 7: Test setup bending behaviour (exemplary representation)

Table 2: Bending strength - series A1 (reference)

Test date: 25.11.2020						
No.		Length l [mm]	Width b [mm]	Thickness d [mm]	Bending strength σ_{mb} [kPa]	Deflection at maximum load X_{mb} [mm]
A1	1	495	98.9	84.2	2563	10.7
A1	2	495	99.2	84.6	2494	10.3
A1	3	495	99.4	84.3	2518	10.3
Mean value		**495**	**99.2**	**84.4**	**2525**	**10.4**

Table 3: Bending strength - series B1 (500 h)

Test date: 28.01.2021						
No.		Length l [mm]	Width b [mm]	Thickness d [mm]	Bending strength σ_{mb} [kPa]	Deflection at maximum load X_{mb} [mm]
B1	1	495	99.2	84.1	2463	9.0
B1	2	495	98.8	84.2	2549	10.0
B1	3	495	98.6	84.4	2528	9.8
Mean value		**495**	**98.9**	**84.2**	**2513**	**9.6**

Table 4: Bending strength - series C1 (1000 h)

Test date: 28.01.2021						
No.		Length l [mm]	Width b [mm]	Thickness d [mm]	Bending strength σ_{mb} [kPa]	Deflection at maximum load X_{mb} [mm]
C1	1	495	99.3	84.4	2547	9.7
C1	2	495	98.2	84.1	2590	10.3
C1	3	495	99.4	84.3	2530	9.5
Mean value		**495**	**99.0**	**84.2**	**2556**	**9.8**

5.2 Compression behaviour acc. to DIN EN 826

DIN EN 826 : 2013-05	Thermal insulating products for building applications – Determination of compression behaviour

Conditioning: for at least 6 hours at (23 ± 2) °C, (50 ± 5) % rel. humidity

Dimensions: ca. 100 x 100 x 85 mm³

Test setup: universal testing machine TT2850 S
determination of dimensions with digital caliper

Test date: 03.02.2021

Load cell: 50 kN

Execution: In accordance to DIN EN 826 a centric force is applied perpendicular to the larger surfaces of the sample and increased at a constant deformation rate until it fails (if this occurs at a compression less than 10 %) or up to a compression of 10 %.

In addition, the compressive stress at 2 % compression was determined.

Parameter: compressive stress at 2 % compression
compressive stress at 10 % compression

Table 5: Compression behaviour - series A1 (reference)

No.		Length l [mm]	Width b [mm]	Thickness under preload d [mm]	Compressive stress at 2 % compression σ_2 [kPa]	Compressive stress at 10 % compression σ_{10} [kPa]
A1	1	100.5	98.8	84.8	1461	2121
A1	2	100.7	98.7	85.3	1408	2137
A1	3	100.7	99.6	85.0	1396	2097
A1	4	100.8	99.2	85.0	1475	2123
Mean value		**100.7**	**99.1**	**85.0**	**1435**	**2119**

Table 6: Compression behaviour - series B1 (500 h)

No.		Length l [mm]	Width b [mm]	Thickness under preload d [mm]	Compressive stress at 2 % compression σ_2 [kPa]	Compressive stress at 10 % compression σ_{10} [kPa]
B1	1	100.5	98.8	84.8	1592	2296
B1	2	100.1	99.3	84.7	1631	2405
B1	3	100.6	99.3	84.6	1581	2348
B1	4	100.4	99.0	84.7	1570	2256
Mean value		**100.4**	**99.1**	**84.7**	**1593**	**2326**

Table 7: Compression behaviour - series C1 (1000 h)

No.		Length l [mm]	Width b [mm]	Thickness under preload d [mm]	Compressive stress at 2 % compression σ_2 [kPa]	Compressive stress at 10 % compression σ_{10} [kPa]
C1	1	100.5	99.3	84.8	1614	2342
C1	2	100.7	99.5	84.9	1576	2263
C1	3	101.0	99.3	84.8	1606	2400
C1	4	100.4	99.3	84.7	1604	2309
Mean value		**100,7**	**99.3**	**84.8**	**1600**	**2328**

5.3 Pull-out-resistance of frame screws

Conditioning:	for at least 6 hours at (23 ± 2) °C, (50 ± 5) % rel. humidity
Dimensions:	halves from the bending test; approx. 250 mm x 100 mm x 85 mm
Test setup:	universal testing machine TT2850 S
Load cell:	5 kN
Screw depth:	60 mm, without pre-drilling
Execution:	The “blaugelb Frame screw Fix FK-T30 7.5x132 mm galv.” is centrically pulled out of the material at a constant deformation rate.
Distance of the screws:	from the edge: 50 mm hole distance: 40 mm

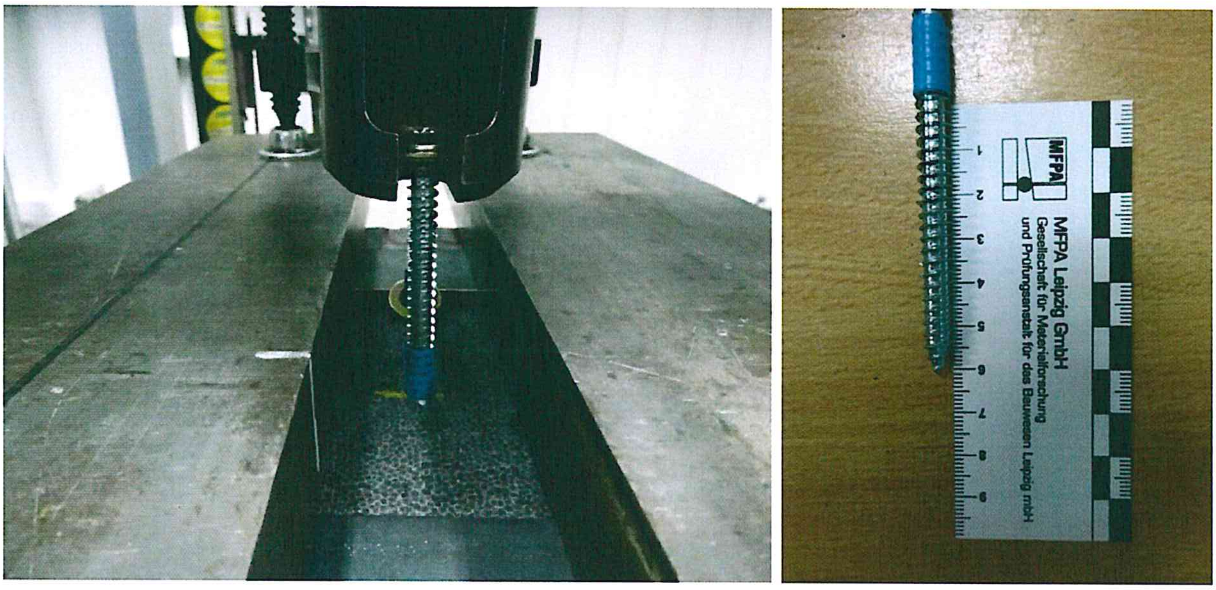

Fig. 8: Test setup pull-out resistance (exemplary representation) and screw-in depth

Table 8: Test results pull-out resistance

Test date: 29.01.2021			
No.	Pull-out force F_Z [N]		
Series	**A1** (reference)	**B1** (500 h)	**C1** (1000 h)
1	2323	2261	2301
2	2277	2250	2332
3	2150	2301	2472
4	2259	2342	2386
5	2135	2301	2473
6	2184	2257	2364
Mean value	**2221**	**2285**	**2388**

6 Summary

After artificial ageing in a UV test cabinet, the “blaugelb Trio**therm**+ profiles” were first assessed visually. The results are summarized in Table 9 below. As expected, color changes occurred on the material surface, while the surface structure remained unchanged.

Table 9: Visual assessment

Total UV	1 year´s equivalent radiation dose 220 MJ/m²
Discolouring	yes: yellow-brownish
Damage / changes to the surface	no

The results of the mechanical tests are summarized in Table 10 below. Artificial aging due to weathering in a UV test cabinet (up to 1000 h; 1 year´s equivalent radiation dose 220 MJ / m²) had no influence on the investigated material properties of the "blaugelb Trio**therm**+ profiles". The small differences in the results are within the expected range.

Table 10: Summary of mechanical parameters

Series	**A1**	**B1**	**C1**
UV weathering	**without**	**500h**	**1000h**
Bending strength [kPa]	2525	2513	2556
aged value / unaged value [-]	1.000	0.995	1.012
compressive stress σ_2 [kPa]	1435	1593	1600
aged value / unaged value [-]	1.000	1.110	1.115
compressive stress σ_{10} [kPa]	2119	2326	2328
aged value / unaged value [-]	1.000	1.098	1.099
Pull-out force [kN]	2.221	2.285	2.388
aged value / unaged value [-]	1.000	1.029	1.075

The results of the tests exclusively relate to the items tested. This document does not replace a certificate of conformity or suitability according to national and European building codes.

Leipzig, 18 June 2021

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