Department of Building Physics
Laboratory for Thermal Performance and Acoustics

ZAG

ZAVOD ZA GRADBENIŠTVO SLOVENIJE

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Ljubljana, 27/1/2015

Report

No. P 83/15-520-1

About measurements of airborne sound insulation properties of sealant foam sample "PURlogic® EASY"

Client:	Adolf Würth GmbH & Co. KG., 74650 Künzelsau, Deutschland
Contract:	Order form No. 11/015 dated 22/1/2015

Responsible investigator:
Rok Rudolf, B.Sc. (Phys.)

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Head of Laboratory:
za Friderik Knez, B.Sc. (Phys.)

Director:
Assoc. Prof. Dr. Andraž Legat

1. Introduction

Measurements noted in this report were performed as part of the ongoing research within a Competence center - sustainable and innovative construction (Slovenian abbreviation: KC TIGR). At the request of the client, we have prepared this report that includes measurements of the airborne sound insulation of one sealant foam, from a series of samples measured. Purpose of the measurements was to compare insulation properties of five samples with different chemical compositions, each sealing two cracks of different thickness. This report includes results for sealant foam of a single chemical composition; designated "PURlogic® EASY" measured for samples 10 mm and 20 mm thick.

2. Test data

2.1. Test specimen

Samples in a solid state were delivered as two 10 mm and 20 mm thick strips, each 100 mm wide and 1200 mm long. Measurements were performed for both thicknesses. Samples arrived labeled and had a chemical composition identical to that of "PURlogic® EASY", confirmed later by manufacturer's declaration.

Chemical composition of the samples was not verified past visual inspection.

2.2. Test specimen designation: A-32/11

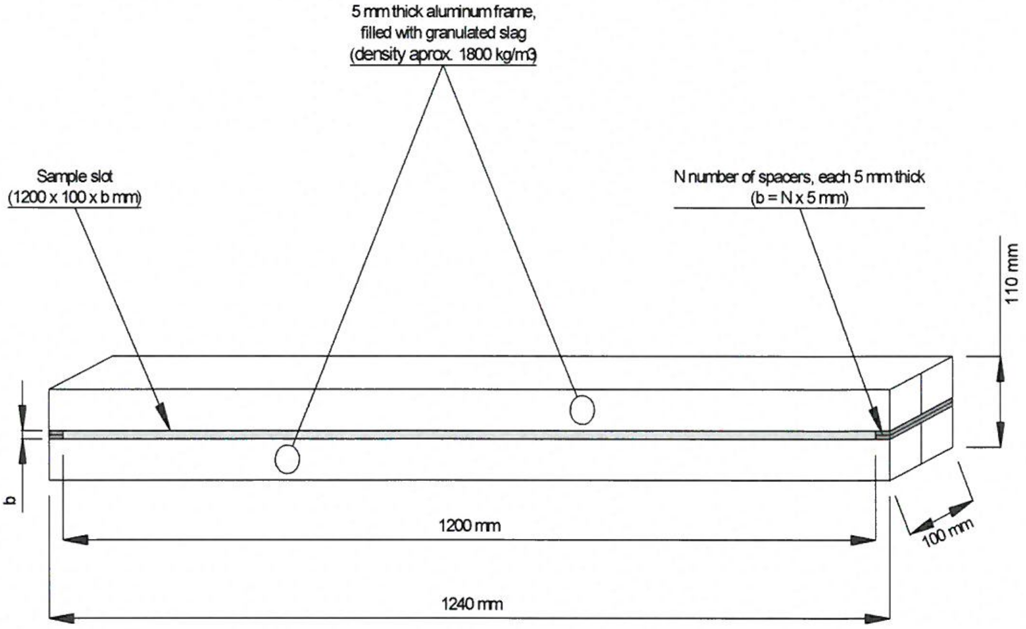
2.3. Method of obtaining the test specimens:

Samples of two 10 mm and 20 mm thick strips were delivered on 7/8/2011.

2.4. Description of the test specimen

Samples were installed between laboratories 1 and 2 at the Laboratory for Acoustics of the Slovenian National Building and Civil Engineering Institute. Strips were inserted into the slot between metal frames with high sound attenuation - 5 mm thick aluminum frames, filled with granulated slag (sand) with a density of approx.1800 kg/m^3. For 1 cm thick sample, frames used had cross-sections of 50 mm x 50 mm, while 2 cm thick sample was framed with the upper frame being a smaller cross section of 40 mm x 50 mm - thus providing additional space for thicker sample. To avoid samples being overly compressed, a number of 5mm thick aluminum spacers were inserted between upper and lower frames along the edges. We ensured that the combined thickness of all spacers was equal to the total thickness of installed sample. In all cases, the width of the sample arrangement was 2 frames of 50 mm each, equaling 100 mm, which is also the width of all samples, and the length was 1240 mm. Schematic of installation setup is shown in Figure 1, details are shown in photographs in Annex B of this report.

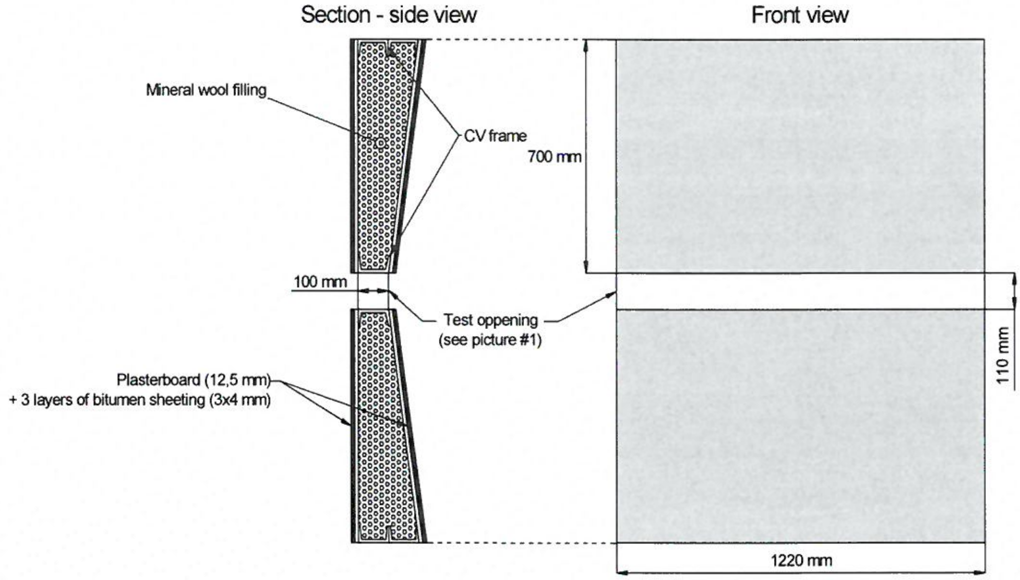
Figure 1 – *Schematic of sample installation setup – sample slot between metal frames*



Each sample was inserted between metal frames, and afterwards all frames were installed into a suitable slot in the window opening between laboratories 1 and 2. Window opening is located in the double wall made of 20 cm wide concrete blocks, completely filled with mortar. Said wall is plastered on both sides with coarse and fine plaster with a combined thickness of approx. 2 cm. Total width of the wall is approx. 44 cm. Doorway opening that is also present in the same wall was closed on both sides with two layers of plasterboard panels and the enclosed cavity completely filled with mineral wool.

Installation slot for samples between metal frames has been fashioned in the window opening by installing two plasterboard barriers with high acoustic attenuation covering upper and lower part of the opening. Both barriers were filled with mineral wool. Barrier panels facing laboratory 2 (quiet side), were also inclined as a measure to reduce any resonant responses. The incline was created by simply making the base of the barriers wider at the base then at the gap where samples were inserted. In order to achieve higher surface density and further diminish the resonant responses of plasterboard, 3 layers of bituminous waterproofing was pasted on each side of the barriers. Average thickness of each layer with a surface density of 5.4 kg/m^2 was at least 4.5 mm. All joints between barrier frames and window opening were tightly sealed. Resulting slot in the window opening where samples between metal frames were inserted is shown as a schematic in Figure 2.

Figure 2 – *Construction of a sample slot in the standard window openings. Resulting test opening was used to install the prepared samples (see Figure 1) between laboratories 1 and 2.*



Sealing tape was laid around the circumference at all points of contact between the barrier frames and the window opening. All contacts between the barrier panels and the opening facing laboratory 2 (quiet side), were further sealed with silicone paste. Photos of final assembly are included in Annex B.

Samples were compared to a reference sample – consisting of mineral wool inserted into sample slot between metal frames. Slot opening on each side was closed with wooden strips of the same thickness (10 mm). All joints between the strips and metal frames were well sealed. Additional aluminum frame filled with slag was pressed and secured over the slot on one side and plasterboard panel secured over the other side. In this way, the slot for the installation of the sample was completely enclosed. Sound reduction index measured for such completely enclosed slot served as a reference value - $R_{ST, w, max}$. It is considered to be the largest value of sound reduction which could practically be achieved by described sample installation and setup. Curves representing sound reduction index as a frequency of time for all other samples are compared to such curve for this reference sample. Reference sample photos are included in Annex B.

2.5. Test method

Measurement of airborne sound insulation performed according to standard SIST EN ISO 140-3 (1997).

2.6. Testing location

The test was carried out at the Laboratory for Thermal Performance and Acoustics of the Slovenian National Building and Civil Engineering Institute in Ljubljana-Slovenia.

2.7. Measuring equipment

• Acoustic analyser	type 2260	B&K,	ID 3340108
• Calibrator	type 4231	B&K,	ID 1290305
• Omni-directional sound source	type 4296	B&K,	ID 5290104
• Amplifier	type 2716	B&K,	ID 5290105
• Rotary microphone stand	type 3923	B&K,	ID 3340102
• Microphone	type 4189	B&K,	Serial No. 2395368
• Microphone	type 4189	B&K,	Serial No. 2395369

2.8. Date of testing: 7/9/2011 (sample 1), 6/9/2011 (sample 2)

2.9. Measuring conditions

Temperature: 23^{O}C (6/9/2011), 23°C (7/9/2011)
Humidity: 65% (6/9/2011), 63% (7/9/2011)

2.10. Measurements performed by: Rok Rudolf, B.Sc.(Phys.)
Davor Radič, Civ.Eng.

3. Test results

Results are given as a sound reduction index, calculated according to the following formula:

$$R_{ST} = L_1 - L_2 + 10 \cdot \log\left(\frac{S_N \cdot I}{A \cdot I_N}\right) \qquad (1)$$

Components of the formula above correspond to:
R_{ST} – Sound reduction index of the sample [dB],
L_1 – Measured sound level (source room) [dB],
L_2 - Measured sound level (receiver room) [dB],
S_N – Reference surface area (10 m^2),
l_N – Reference slot length (1 m)
l – Actual slot length [m],

A – Equivalent absorption surface of the receiver room, obtained by the equation $A = 0{,}16 \cdot \frac{V}{T}$,

Where components of the above formula further correspond to:
V – Volume of the receiver room [m^3],
T – Measured average reverberation time [s].

In all cases, receiver room was laboratory 2 (quiet side) and source room was laboratory 1.

All weighted single value sound reduction indexes ($R_{ST,\,w}$) are calculated according to SIST EN ISO 717-1 (1997).

Results obtained by measuring sound reduction index for a slot, normalized to reference length, can be used to calculate sound reduction index of a complex element comprised of several smaller elements - for example, a window installed with slots sealed with sample sealing foam. In such case, we would consider the slot itself as a specific separate element with its own sound reduction index $R_{ST,\ w}$. Calculation can be carried out in accordance with Annex B to the standard SIST EN 12354-3. It should be noted however, that such a calculation is considered to provide only informative measure of the total sound reduction index for a complex element. Acoustic properties like sound reduction index are determined only by measuring them directly on a complete complex element. Calculating total sound reduction index from such indexes corresponding to individual elements is usually only made to estimate the impact that different individual elements can have on the total value - for example, to assess the contribution of different sealing solutions to total sound reduction index of a window.

Since the purpose of our measurements was to compare different sealing foam samples with regard to their insulation properties to airborne sound, the choice of sound reduction index normalized for slot length, as calculated using equation (1), seems entirely appropriate.

Both samples are compared with a reference sample as described in section 2.4 and are listed in the following table along their corresponding sound reduction indexes. Sound reduction index measured with reference sample ($R_{ST,w,max}$) is also listed for comparison.

Table 1 – *Results for both samples, compared to result obtained for the reference sample.*

Sample Designation	**Thickness [mm]**	**$R_{ST,w}$ (C;C_{tr}) [dB]**
PURlogic® EASY	10	58 (-2;-7)
	20	57 (-2;-7)
Reference sample (Described in section 2.4)	10	$R_{ST,w,max}$ (C;C_{tr}) 58 (-2;-7) dB

Measured and calculated values of sound reduction indexes $R_{ST,w}$ are meant for comparison purposes only, since the absolute values also depend on the flanking transmission of sound between source and receiver rooms. Sound reduction indexes in each 1/3 octave frequency bands reported according to standard SIST EN ISO 140-3 (1997) and rated according to standard SIST EN ISO 717-1 (1997) are shown as diagrams in Annex A.

Rok Rudolf, B.Sc.(Phys.)

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LABORATORY MEASUREMENTS OF AIRBORNE SOUND INSULATION ACCORDING TO THE STANDARD SIST EN ISO 140-3 (1997)

Annex A
Page: 1/2

CLIENT: *Adolf Würth GmbH & Co. KG* *74650 Künzelsau* *Deutschland*	SPECIMEN No.: A-32/11 MEASURED IN: Lab.1, Lab. 2 DATE: 7/9/2011

SAMPLE LABEL AND THICKNESS

PURlogic® EASY - 10 mm

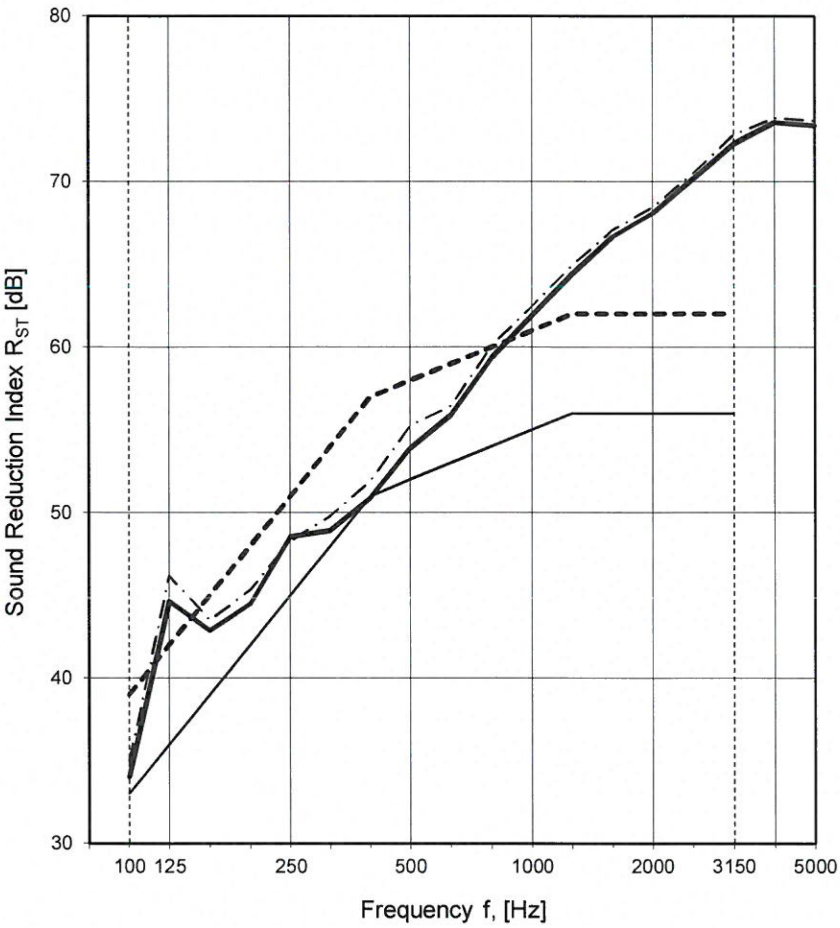
ASSEMBLY METHOD AND DESCRIPTION OF THE TEST SPECIMEN

Insulating foam sample in solid state with dimensions 120 x 10 x 1 [cm] - provided by client. Sample was installed into a slot between metal frames and the frames inserted into prepared test opening. Metal frames as well as construction forming the opening had high insulation properties to airborne sound. Reference sample sound reduction index curve is presented for comparison.

Sample thickness:	10 mm
Air temperature:	23°C
Relative air humidity:	63%
Receiving room volume:	51,5 m3

Legend:
- Sample sound reduction index R_{ST} (f) [dB]
- Reference sample $R_{ST,max}$ (f) [dB]
- Adjusted curve of reference values
- Frequency range
- Reference values curve (ISO 717-1)

Frequency f [Hz]	R (third oct.) [dB]
50	
63	
80	
100	34,0
125	44,6
160	42,9
200	44,5
250	48,5
315	48,9
400	50,9
500	53,9
630	55,9
800	59,4
1000	61,9
1250	64,4
1600	66,7
2000	68,1
2500	70,1
3150	72,3
4000	73,6
5000	73,4



Rating according to SIST EN ISO 717-1 (1997) :

$R_{ST,w}$ (C;C_{tr}) = 58 (-2, -7) dB

Evaluation based on laboratory measurement results.

MEASUREMENTS PERFORMED BY:	HEAD OF LABORATORY:
Davor Radič, Civ.Eng.	Friderik Knez, B.Sc.(Phys.)
Rok Rudolf, B.Sc.(Phys.)	

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LABORATORY MEASUREMENTS OF AIRBORNE SOUND INSULATION ACCORDING TO THE STANDARD SIST EN ISO 140-3 (1997)	Annex A Page: 2/2

CLIENT: *Adolf Würth GmbH & Co. KG*
74650 Künzelsau
Deutschland

SPECIMEN No.: A-32/11
MEASURED IN: Lab.1, Lab. 2
DATE: 6/9/2011

SAMPLE LABEL AND THICKNESS

PURlogic® EASY - 20 mm

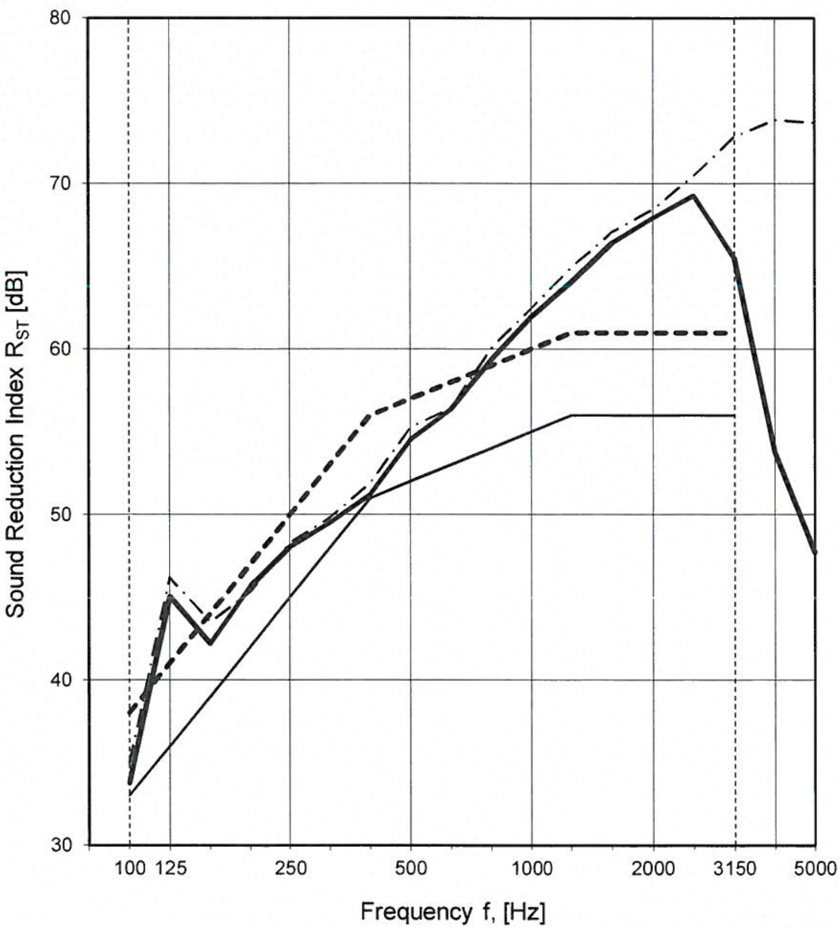
ASSEMBLY METHOD AND DESCRIPTION OF THE TEST SPECIMEN

Insulating foam sample in solid state with dimensions 120 x 10 x 2 [cm] - provided by client. Sample was installed into a slot between metal frames and the frames inserted into prepared test opening. Metal frames as well as construction forming the opening had high insulation properties to airborne sound. Reference sample sound reduction index curve is presented for comparison.

Sample thickness:	10 mm
Air temperature:	23°C
Relative air humidity:	65%
Receiving room volume:	51,5 m3

Legend:
- Sample sound reduction index R_{ST} (f) [dB]
- Reference sample $R_{ST,max}$ (f) [dB]
- Adjusted curve of reference values
- Frequency range
- Reference values curve (ISO 717-1)

Frequency f [Hz]	R (third oct.) [dB]
50	
63	
80	
100	33,7
125	45,0
160	42,2
200	45,7
250	48,0
315	49,5
400	51,2
500	54,5
630	56,4
800	59,4
1000	62,0
1250	64,1
1600	66,4
2000	67,9
2500	69,3
3150	65,5
4000	53,8
5000	47,7



Rating according to SIST EN ISO 717-1 (1997) :

$R_{ST,w}$ (C;C_{tr}) = 57 (-2,-7) dB

Evaluation based on laboratory measurement results.

MEASUREMENTS PERFORMED BY:
Davor Radič, Civ.Eng.
Rok Rudolf, B.Sc.(Phys.)

HEAD OF LABORATORY:
Friderik Knez, B.Sc.(Phys.)

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Photos of samples, assembly and details

Different samples

Photo No. 24378d-21

Detail of a sample slot (empty, 20mm)

Photo No. 24299d-05

Installed sample (10mm)

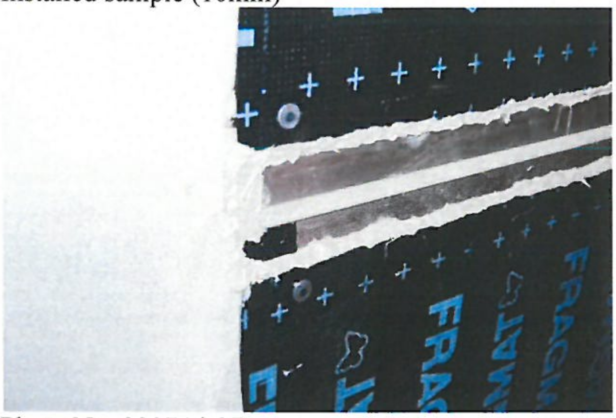

Photo No. 22974d-07

Installed sample (20mm)

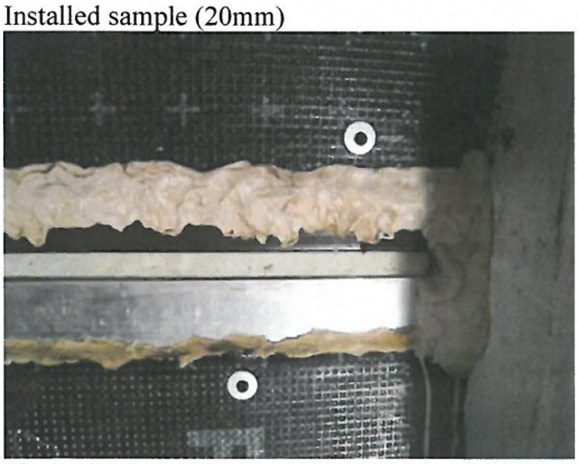

Photo No. 24514d-10

Closing the slot for reference sample $R_{ST,w,max}$
(detail during assembly – mineral wool w/o cover)

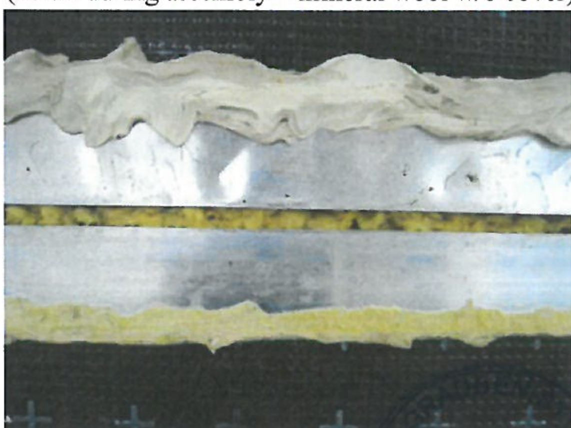

Photo No. 24534d-19

Annex B
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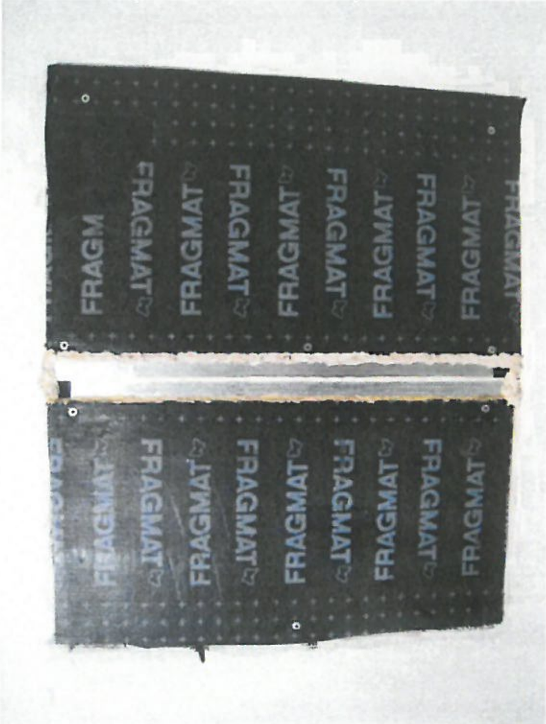
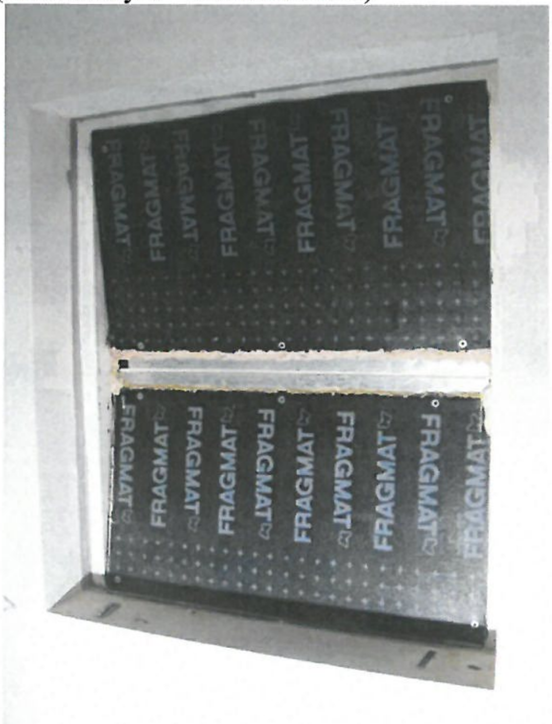
Photos of samples, assembly and details

Test opening during measuring
(Laboratory 1 – source room)



Test opening during measuring
(Laboratory 2 – receiver room)



Closed sample slot (reference sample - $R_{ST,w,max}$)
(Laboratory 1 – source room)

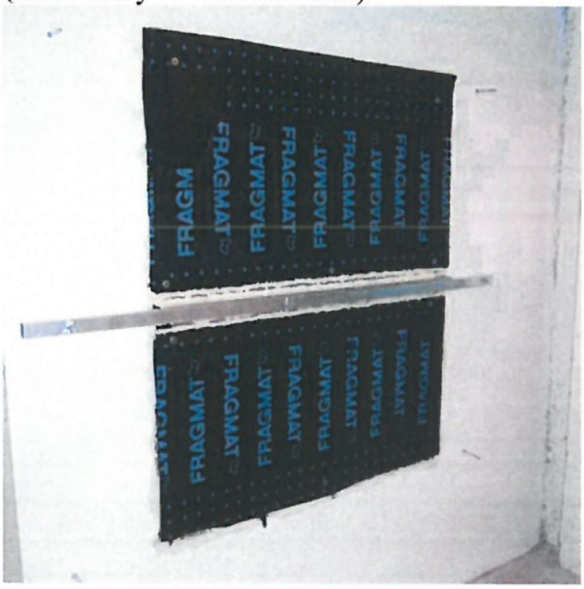


Photo No. 24378d-01

Closed sample slot (reference sample - $R_{ST,w,max}$)
(Laboratory 2 – receiver room)

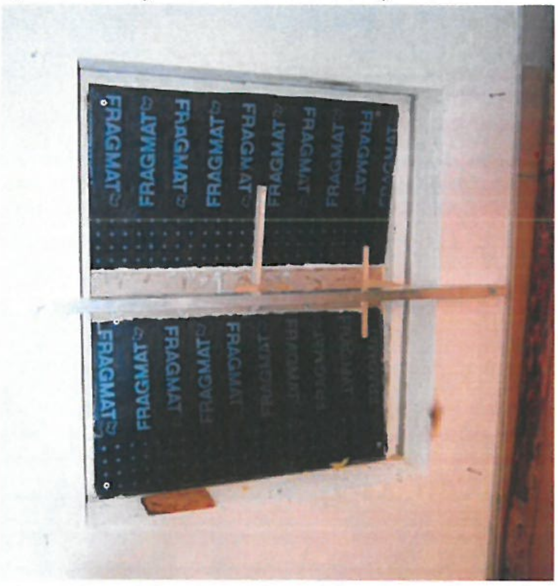


Photo No. 24378d-06

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