Fraunhofer IBP

Institution for testing, supervision and certification, officially recognized by the building supervisory authority. Approvals of new building materials, components and types of construction

Directors
Prof. Dr. Philip Leistner
Prof. Dr. Klaus Peter Sedlbauer

Test Report P-BA 195/2017e

Sound absorption coefficient acc. to DIN EN ISO 354, ZTV-Lsw 06, DIN EN 1793-1 and DB-Richtlinie 804.5501

Client:	Liaver GmbH & Co. KG Gewerbepark „Am Wald“ 17 D-98693 Ilmenau	
Test specimen:	Absorption layer out of 63 mm thick expanded glass granulate boards, product name: "REAPOR® Akustik Platten" (test object S 11063-01).	
Content:	Results 1:	Test set-up and sound absorption coefficient
	Results 2:	Test set-up and further results for sound absorption
	Results 3:	Test set-up and practical sound absorption coefficient
	Table 1:	Average values of reverberation times and sound absorption coefficient
	Figure 1:	Sketch of the test object
	Annex F9:	Test method
	Annex M1:	Measurement equipment
	Annex P20:	Description of the test facility
Assembly and date of the measurement:	Delivery:	March 10, 2017
	Assembly:	March 10, 2017 (by the client)
	Measurement date:	March 10, 2017

Stuttgart, July 24, 2017

Test Engineer: Head of the test laboratory:

Dipl.-Ing. (FH) S. Müller M.BP. Dipl.-Ing. (FH) S. Öhler

The test was carried out in laboratory facilities of the IBP which is accredited according to DIN EN ISO/IEC 17025 by the Dakks. The accreditation certificate is DP-PL-11140-01. Measurement performance and scope comply with the principles of the working group of the acoustic testing laboratories approved by the building authorities in accordance with the certification guidelines of the DIBt and the NABau, subcommittee NA 005-55-76 AA.

Any publication of excerpts is subject to written authorization of Fraunhofer Institute of Building Physics.

Fraunhofer-Institut für Bauphysik
Nobelstraße 12 · D-70569 Stuttgart
Telefon +49 (0) 711/970-00
Telefax +49 (0) 711/970-3395
www.ibp.fraunhofer.de

Prüfstelle Bauakustik und Schallimmissionsschutz
Nobelstraße 12 D-70569 Stuttgart
Telefon +49(0) 711/970-3314; Fax -3406
akustik@ipb.fraunhofer.de
www.ibp.fraunhofer.de/de/pruefstellen/bauakustik.html

ilac-MRA DAkkS Deutsche Akkreditierungsstelle D-PL-11140-11-01

Sound absorption coefficient α_s acc. to DIN EN ISO 354		P-BA 195/2017e
Client:	Liaver GmbH & Co. KG D-98693 Ilmenau	Results 1

Test specimen:

Absorption layer out of 63 mm thick expanded glass granulate boards, product name: "REAPOR® Akustik Platten" (test object S 11063-01).

composition of the granulate:	1 - 2 mm grain size, sintered (information of the manufacturer)
Size of a board:	625 mm x 625 mm (±0.5 mm) x 63 mm (±0.3 mm)
density:	270 kg/m³ (± 10 %), (information of the manufacturer)
determined density:	265 kg/m³ (from the weight of two boards)
air flow resistivity:	6.2 (kPa s)/m² (information of the manufacturer)
connection between the boards:	loose
Test set-up:	6 x 6 boards
Size of the test area:	3.75 m x 3.75 m
Test area:	14.1 m².

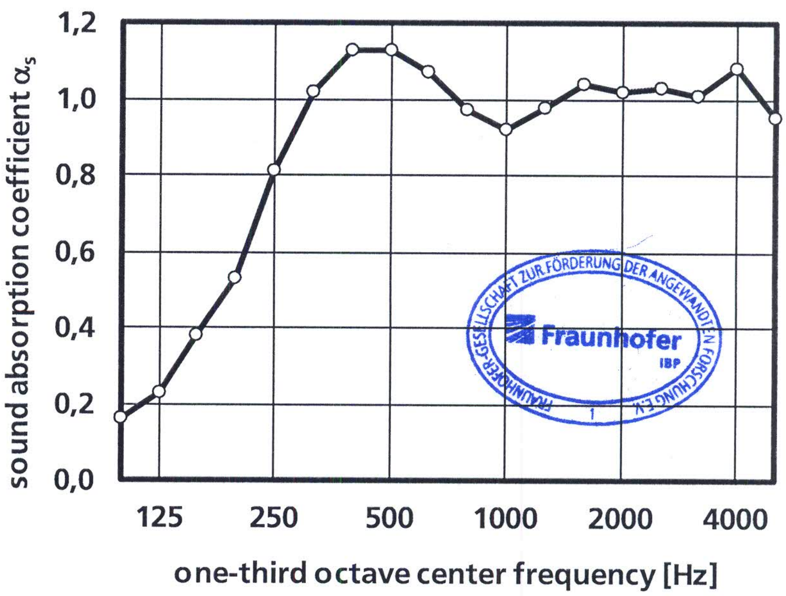
The boards were chamfered circumferential (45°, ca. 8 mm wide).

The boards were laid loosely together in a coherent surface directly on the floor. The wooden frame all around the test area was 21 mm thick and 60 mm high. The wooden frame was sealed to the floor of the reverberation room elastically an to the boards with a tape. The gaps between the boards were not be sealed.

No system errors occur because of the adaption of the elements to the test laboratory

Additional details of the boards and the test set-up see figure 1.

Test area:	14.1 m²
Test lab.:	P20
Type:	Reverberation room
Volume:	V = 392 m³
Noise:	pink noise
Air temperature	
without test object:	21.0 ± 0.3 °C
with test object:	21.1 ± 0.3 °C
Rel. Humidity	
without test object:	38 ± 2 %
with test object:	38 ± 2 %
Stat. pressure:	
without test object:	970 ± 1 hPa
with test object:	970 ± 1 hPa
Measurement date:	March 10, 2017



Fraunhofer IBP

The test was carried out in laboratory facilities of the IBP which is accredited according to DIN EN ISO/IEC 17025:2005 by the Dakks. The accreditation certificate is DP-PL-11140-01.

Stuttgart, July 24, 2017
Head of the test laboratory:

Sound absorption acc. to DIN EN 1793-1 and DB-Richtlinie 804.5501 Client: Liaver GmbH & Co. KG D-98693 Ilmenau	**P-BA 195/2017e** Results 2

Test specimen:

Absorption layer out of 63 mm thick expanded glass granulate boards, product name: "REAPOR® Akustik Platten" (test object S 11063-01).

composition of the granulate: 1 - 2 mm grain size, sintered (information of the manufacturer)

Size of a board:	625 mm x 625 mm (±0.5 mm) x 63 mm (±0.3 mm)
density:	270 kg/m³ (± 10 %), (information of the manufacturer)
determined density:	265 kg/m³ (from the weight of two boards)
air flow resistivity:	6.2 (kPa s)/m² (information of the manufacturer)
connection between the boards:	loose
Test set-up:	6 x 6 boards
Size of the test area:	3.75 m x 3.75 m
Test area:	14.1 m².

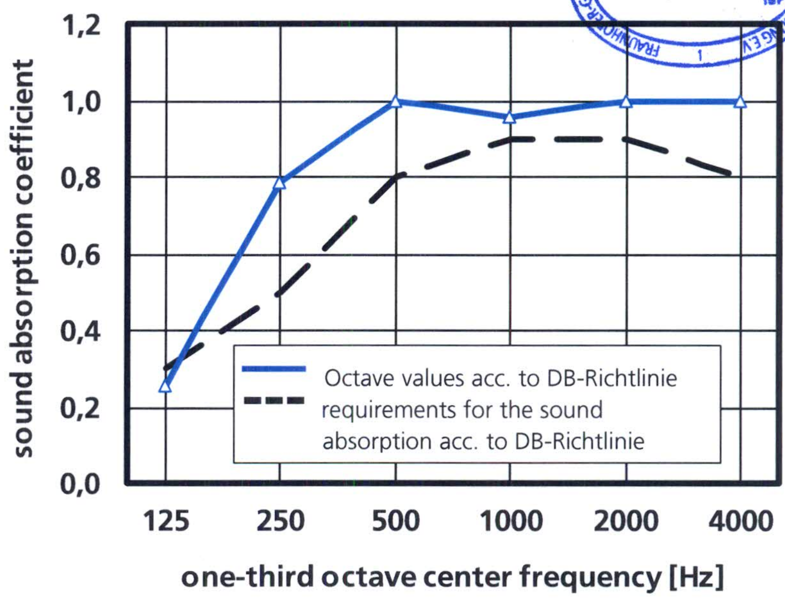
The boards were chamfered circumferential (45°, ca. 8 mm wide).

The boards were laid loosely together in a coherent surface directly on the floor. The wooden frame all around the test area was 21 mm thick and 60 mm high. The wooden frame was sealed to the floor of the reverberation room elastically an to the boards with a tape. The gaps between the boards were not be sealed.

No system errors occur because of the adaption of the elements to the test laboratory

Additional details of the boards and the test set-up see figure 1.

Test area:	14.1 m²
Test lab.:	P20
Type:	Reverberation room
Volume:	V = 392 m³
Noise:	Pink noise
Air temperature	
without test object:	21.0 ± 0.3 °C
with test object:	21.1 ± 0.3 °C
Rel. Humidity	
without test object:	38 ± 2 %
with test object:	38 ± 2 %
Stat. pressure:	
without test object:	970 ± 1 hPa
with test object:	
Measurement date:	March 10, 2017



Characteristic value DL_{α} acc. to DIN EN 1793-1:

DL_{α} = 15 dB

The tested system is classified according to DIN EN 1793-1, annex A, table A.1 into category **A4** and according to ZTV-Lsw 06, table 1 as "**highly absorbent**".

Fraunhofer IBP

The test was carried out in laboratory facilities of the IBP which is accredited according to DIN EN ISO/IEC 17025:2005 by the Dakks. The accreditation certificate is DP-PL-11140-01.

Stuttgart, July 24, 2017
Head of the test laboratory:

Practical absorption coefficient α_p acc. to DIN EN ISO 11654	P-BA 195/2017e
Client: Liaver GmbH & Co. KG D-98693 Ilmenau	Results 3

Test specimen:

Absorption layer out of 63 mm thick expanded glass granulate boards, product name: "REAPOR® Akustik Platten" (test object S 11063-01).

composition of the granulate: 1 - 2 mm grain size, sintered (information of the manufacturer)

Size of a board:	625 mm x 625 mm (±0.5 mm) x 63 mm (±0.3 mm)
density:	270 kg/m³ (± 10 %), (information of the manufacturer)
determined density:	265 kg/m³ (from the weight of two boards)
air flow resistivity:	6.2 (kPa s)/m² (information of the manufacturer)
connection between the boards:	loose

Test set-up:	6 x 6 boards
Size of the test area:	3.75 m x 3.75 m
Test area:	14.1 m².

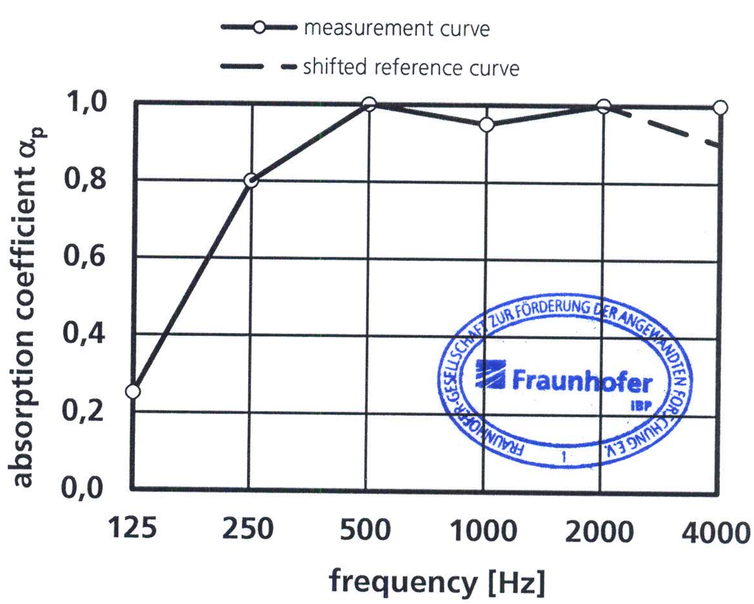
The boards were chamfered circumferential (45°, ca. 8 mm wide).

The boards were laid loosely together in a coherent surface directly on the floor. The wooden frame all around the test area was 21 mm thick and 60 mm high. The wooden frame was sealed to the floor of the reverberation room elastically an to the boards with a tape. The gaps between the boards were not be sealed.

No system errors occur because of the adaption of the elements to the test laboratory

Additional details of the boards and the test set-up see figure 1.

Test area:	14.1 m²
Test lab.:	P20
Type:	Reverberation room
Volume:	V = 392 m³
Noise:	Pink noise
Air temperature	
without test object:	21.0 ± 0.3 °C
with test object:	21.1 ± 0.3 °C
Rel. Humidity	
without test object:	38 ± 2 %
with test object:	38 ± 2 %
Stat. pressure:	
without test object:	970 ± 1 hPa
with test object:	
Measurement date:	March 10, 2017



weighted sound absorption coefficient acc. DIN EN ISO 11654:

α_w = 1.00

sound absorber class: A

Fraunhofer IBP

The test was carried out in laboratory facilities of the IBP which is accredited according to DIN EN ISO/IEC 17025 by the Dakks. The accreditation certificate is DP-PL-11140-01.

Stuttgart, July 24, 2017

Head of the test laboratory:

Reverberation times and absorption coefficients	**P-BA 195/2017e**
Client: Liaver GmbH & Co. KG D-98693 Ilmenau	Table 1

Test specimen:

Absorption layer out of 63 mm thick expanded glass granulate boards, product name: "REAPOR® Akustik Platten" (test object S 11063-01).

frequency f [Hz]	T_1 [s]	T_2 [s]	sound absorption coefficient α_S DIN EN ISO 354	α_{Octav} DB-Richtlinie	requirements DB-Richtlinie	practical absorption coefficient α_p
100	18.46	11.06	0.16			
125	18.00	9.30	0.23	0.26	0.30	0.25
160	17.33	7.07	0.38			
200	17.45	5.67	0.53			
250	15.40	4.06	0.81	0.79	0.50	0.80
315	15.23	3.40	1.02			
400	12.73	3.03	1.13			
500	9.15	2.77	1.13	1.00	0.80	1.00
630	8.69	2.83	1.07			
800	8.93	3.04	0.97			
1000	9.51	3.23	0.92	0.96	0.90	0.95
1250	8.86	3.01	0.98			
1600	7.80	2.77	1.04			
2000	6.38	2.60	1.02	1.00	0.90	1.00
2500	5.23	2.37	1.03			
3150	3.98	2.10	1.01			
4000	3.12	1.78	1.08	1.00	0.80	1.00
5000	2.26	1.53	0.95			

Weighted sound absorption coefficient acc. to DIN EN ISO 11 654	$\alpha_w = 1.00$
Sound absorber class acc. to DIN EN ISO 11 654	A
characteristic sound absorption value DL_α acc. to DIN EN 1793-1	$DL_\alpha = 15$ dB
classification acc. to DIN EN 1793-1, annex A	category A4

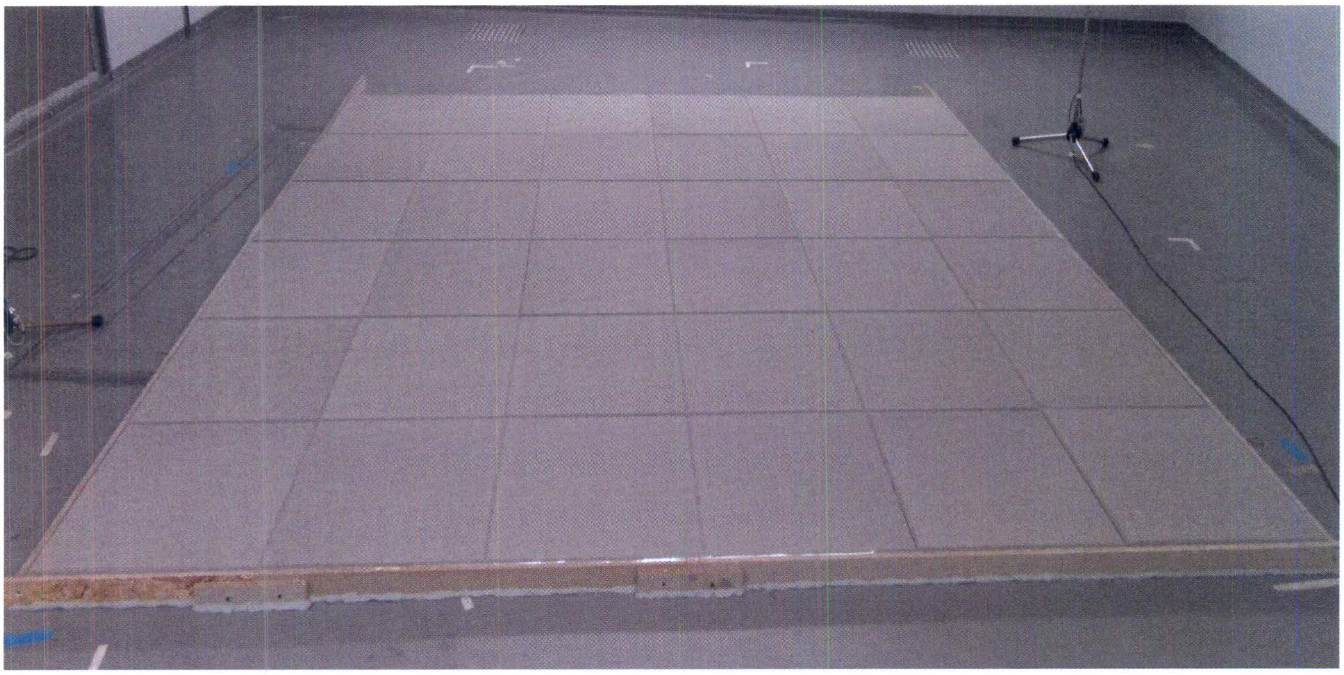
Fraunhofer IBP

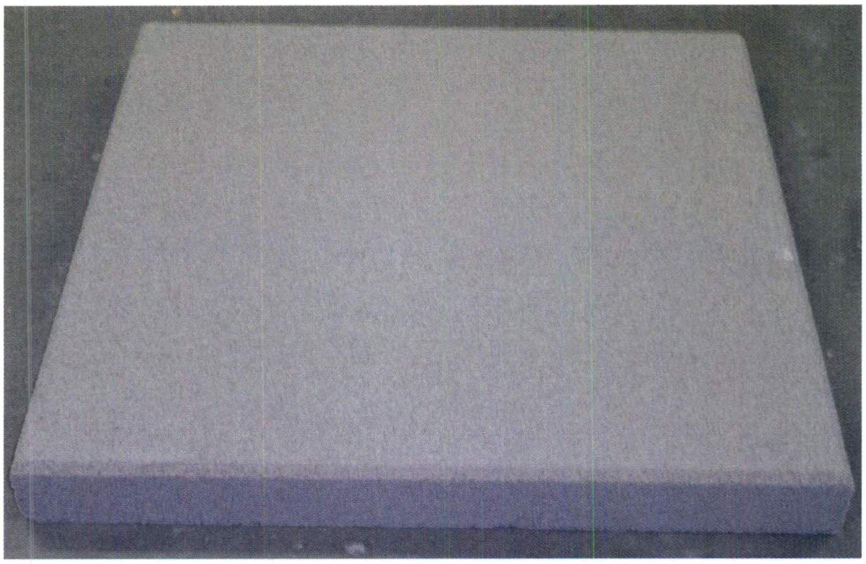
The test was carried out in laboratory facilities of the IBP which is accredited according to DIN EN ISO/IEC 17025 by the Dakks. The accreditation certificate is DP-PL-11140-01.

Description of the test object:		**P-BA 195/2017e**
Client:	Liaver GmbH & Co. KG D-98693 Ilmenau	Figure 1

Test specimen:

Absorption layer out of 63 mm thick expanded glass granulate boards, product name: "REAPOR® Akustik Platten" (test object S 11063-01).





Fraunhofer IBP

top: Picture of the test set-up in the reverberation room.
bottom: Picture of a board.

Test Method

The measurements were carried out acc. to DIN EN ISO 354:2003 and evaluated acc. to DIN EN 1793-1 as well as to the german regulations „Zusätzliche Technische Vorschriften und Richtlinien für die Ausführung von Lärmschutzwänden an Straßen" (ZTV-Lsw 06 (2006) and „DB Richtlinie 804.5501 (2007), Lärmschutzanlagen an Eisenbahnstrecken". The reverberation room and measuring equipment are described in table 1. The test signal was pink noise, filtered by 1/3 octave band pass filters. Measuring signal was the reverberation time in the reverberation room with and without test object.

The caculation of the characteristic sound absorption value $DL\alpha$ was carried out acc. to DIN EN 1793-1:2013. The individual sound absorption coefficients depending on the frequency were compared to the requirements of DB Richtlinie 804.5501 (2007).

The sound absorption coefficient was determined as follows:

$$\alpha_s = A_T/S.$$

with:

α_s	=	sound absorption coefficient	
A_T	=	equivalent sound absorption area of the test object	[m²]
S	=	area covered by the test object	[m²].

The equivalent sound absorption area A_T of the test object was calculated according to DIN EN ISO 354:2003:

$$A_T = A_2 - A_1 = 55{,}3\ V\,(1/c_2T_2 - 1/c_1T_1) - 4\ V\,(m_2 - m_1).$$

with:

A_1	=	equivalent sound absorption area of the empty reverberation room	[m²]
A_2	=	equivalent sound absorption area of the reverberation room with test object	[m²]
V	=	volume of the empty reverberation room	
c_1	=	acoustic velocity in the air at temperature t_1	
c_2	=	acoustic velocity in the air at temperature t_2	
T_1	=	reverberation time of the empty reverberation room	[s]
T_2	=	reverberation time of the reverberation room after installing the test object	[s]
m_1	=	air absorption coefficient, calculated acc. to ISO 9613-1:1993 with climatic conditions during the measurement in the empty reverberation room	[1/m]
m_2	=	air absorption coefficient, calculated acc. to ISO 9613-1:1993 with climatic conditions during the measurement with the installed test object	[1/m].

Measurement equipment

Measurement equipment used:

Microphone:	Brüel & Kjær 4190 S/N 2122340
Microphone:	Brüel & Kjær 4190 S/N 2172092
Preamplifier:	Brüel & Kjær 2639 S/N 1688866
Preamplifier:	Brüel & Kjær 2639 S/N 1222159
Pistonfon	Brüel & Kjær 4220 S/N 1048377
Analyzer:	Norsonic 840/1 S/N 17855
Amplifier:	Klein & Hummel AK 240 S/N 2076
Loudspeaker:	Lanny MLS 87

The analyzer used in the test was an analyzer of accuracy grade 1. The measuring chain had a valid calibration.

Test facility

The measurements were performed in the reverberation room P20 of the Fraunhofer Institute for Building Physics. The test faciliy meets the requirements of DIN EN ISO 354. Walls and ceilings are made of concrete.

<u>Geometry of the reverberation room</u>

Width:	7.05 m ... 7.75 m
Length:	7.86 m ... 8.46 m
Height:	5.92 m ... 7.08 m
Volume:	392 m³
Surface:	322 m²

Angle between opposite walls:	approx. 5°,
Angle between floor and ceiling	approx. 8°.

10 diffusors à	1.60 m x 1.25 m
5 diffusors à	1.25 m x 1.25 m
Overall surface (one-side) of the diffusors:	27.8 m²
Material:	composite sheet, slightly curved

<u>Measuring equipment</u>

Loudspeakers: Dodecahedral shape, diameter approx. 0.5 m, placed in three corners of the room.
Microphones: 4 microphone positions per loudspeaker position, placed from 1.75 m to 2.25 m above floor level, distributed in a random pattern around the sample.
At least 3 reverberation time evaluations per microphone position.

<u>Ground plan and sectional view of the test facility</u>