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Bauaufsichtlich anerkannte Stelle
für Prüfung, Überwachung und
Zertifizierung
Zulassung neuer Baustoffe, Bauteile
und Bauarten

Institutsleiter
Prof. Dr. Klaus Peter Sedlbauer

Test Report P-BA 127/2014e

Sound absorption coefficient of coated expanded glass granulate boards in the reverberation room acc. to DIN EN ISO 354:2003 and DIN EN ISO 11654:1997

Client:
Liaver GmbH & Co. KG
Gewerbepark „Am Wald" 17
D-98693 Ilmenau

Stuttgart, October 17, 2014

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1. Place and date of measurement

The measurements were carried out in the test laboratories of the Fraunhofer Institute for Building Physics in Stuttgart on December 17, 2013.

2. Test specimen

Absorption layer out of 50 mm thick expanded glass granulate boards, product name: "REAPOR® Akustik Platten" with 4 mm thick coating "Acoustic Finish VP A 4109" (test object S 10639-02).

Expanded glass granulate boards "REAPOR® Akustik Platten":

composition of the granulate:	1 - 2 mm grain size, sintered (information of the manufacturer)
density:	270 kg/m³ (± 10 %), (information of the manufacturer, without coating)
air flow resistivity :	10 - 20 (kPa s)/m² (information of the manufacturer, without coating)
connection between the boards:	loose

Coating "Acoustic Finish VP A 4109":

material:	silicate based
thickness:	4 mm
mass of the coating:	5 kg/m²
kind of application:	distribution manually or with a machine, smoothing with a trowel

Size of a board:	625 mm x 625 mm (±0.5 mm) x 54 mm (±0.3 mm)
Mass per unit area of the coated boards:	17.5 kg/m² (determined with the weight of two boards)
Test set-up:	6 x 5 boards
Size of the test area:	3.75 m x 3.12 m
Test area:	11.7 m².

The coated boards were laid loosely together in a coherent surface directly on the floor. The wooden frame all around the test area was 50 mm thick and 50 mm high. The wooden frame was sealed to the floor of the reverberation room elastically. The joint between the boards and the frame was sealed with a tape.

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

3. Sampling

Delivery:	on December 13, 2013 by a forwarding agency.
Installation in test facility:	on December 17, 2013 by a specialized company.

4. Test method and test conditions

The measurements were carried out acc. to DIN EN ISO 354:2003. 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 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	[m³]
c_1	= acoustic velocity in the air at temperature t_1	[m/s]
c_2	= acoustic velocity in the air at temperature t_2	[m/s]
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 with climatic conditions during the measurement in the empty reverberation room	[1/m]
m_2	= air absorption coefficient, calculated acc. to ISO 9613-1 with climatic conditions during the measurement with the installed test object	[1/m].

Climatic conditions:

air temperature:	without sample:	20,6 °C
	with sample:	20,9 °C
rel. air humidity:	without sample:	36 %
	with sample:	30 %
air pressure:		970 hPa

Measuring equipment:

Microphones:	Brüel & Kjær 4190
Preamplifier:	Brüel & Kjær 2639
Analyser:	Norsonic 840/2
Amplifier:	Klein & Hummel AK 180
Loudspeaker:	Lanny MLS 01

5. Measurement results

Tables 2 contains the measured reverberation times in the reverberation room with and without test object, the sound absorption coefficients and the practical sound absorption coefficients as well as the weighted sound absorption coefficient acc. to DIN EN ISO 11654:1997. Figure 2 shows a diagram with the sound absorption coefficients α_s, figure 3 a diagram with the practical sound absorption coefficients α_p as a function of the frequency.

The weighted sound absorption coefficient acc. to DIN EN ISO 11654:1997 is

α_w = 0.70 (L)

sound absorber class: C.

Due to the form indicator it is urgently recommended to apply the single number rating in connection with the complete frequency spectrum of the sound absorption coefficient.

The test was carried out in a laboratory, accredited according to DIN EN ISO/IEC 17025:2005 by DAkkS. The accreditation certificate is D-PL-11140-11-01. Accomplishment and scope of the measurements comply with the principles of the working committee of acoustic test laboratories accredited by the German building supervision in coordination with the decisions of the DIBt (German Institute for Building Technology) and the NABau (Standards Committee of Construction), sub-committee NA 005-55-76 AA.

This test report consists of 4 pages of text, 2 tables and 3 figures. The measurement results exclusively refer to the investigated test specimen. Any publication of the test results, is it partial or integral, is subject to the written permission by the Fraunhofer Institute for Building Physics.

Stuttgart, October 17, 2014
SMu/Be

Responsible engineer:

Dipl.-Ing. (FH) S. Müller

Head of the test laboratory:

M-BP. Dipl.-Ing. (FH) S. Öhler

Table 1 Reverberation room and measuring equipment for the measurement of the sound absorption coefficient

Geometry of the reverberation room

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

Measuring equipment

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.

Table 2 Reverberation times of the reverberation room without (T_1) and with (T_2) test object S 10639-02, numerical values of the sound absorption coefficients α_s for the diagram in fig. 2 and practical sound absorption coefficients α_p for the diagram in fig. 3.

frequency f [Hz]	T_1 [s]	T_2 [s]	Sound absorption coefficients α_s	practical absorption coefficients α_p
100	18.76	10.50	0.22	
125	17.83	8.71	0.31	0.35
160	16.36	6.55	0.49	
200	16.80	5.96	0.58	
250	15.57	4.70	0.80	0.75
315	15.20	4.45	0.85	
400	12.56	4.10	0.88	
500	9.30	3.70	0.88	0.85
630	8.64	3.85	0.77	
800	9.01	4.25	0.67	
1000	9.53	4.43	0.64	0.65
1250	8.91	4.34	0.62	
1600	7.60	3.83	0.67	
2000	6.28	3.44	0.65	0.65
2500	5.06	3.10	0.58	
3150	3.86	2.52	0.60	
4000	2.97	2.04	0.60	0.60
5000	2.19	1.57	0.63	
Weighted sound absorption coefficient acc. to DIN EN ISO 11 654				α_w = 0.70 (L)
Sound absorber class acc. to DIN EN ISO 11 654				C

FÖRDERUNG DER ANGEWANDTEN FORSCHUNG E.V. FRAUNHOFER-GESELLSCHAFT ZUR Fraunhofer IBP 1

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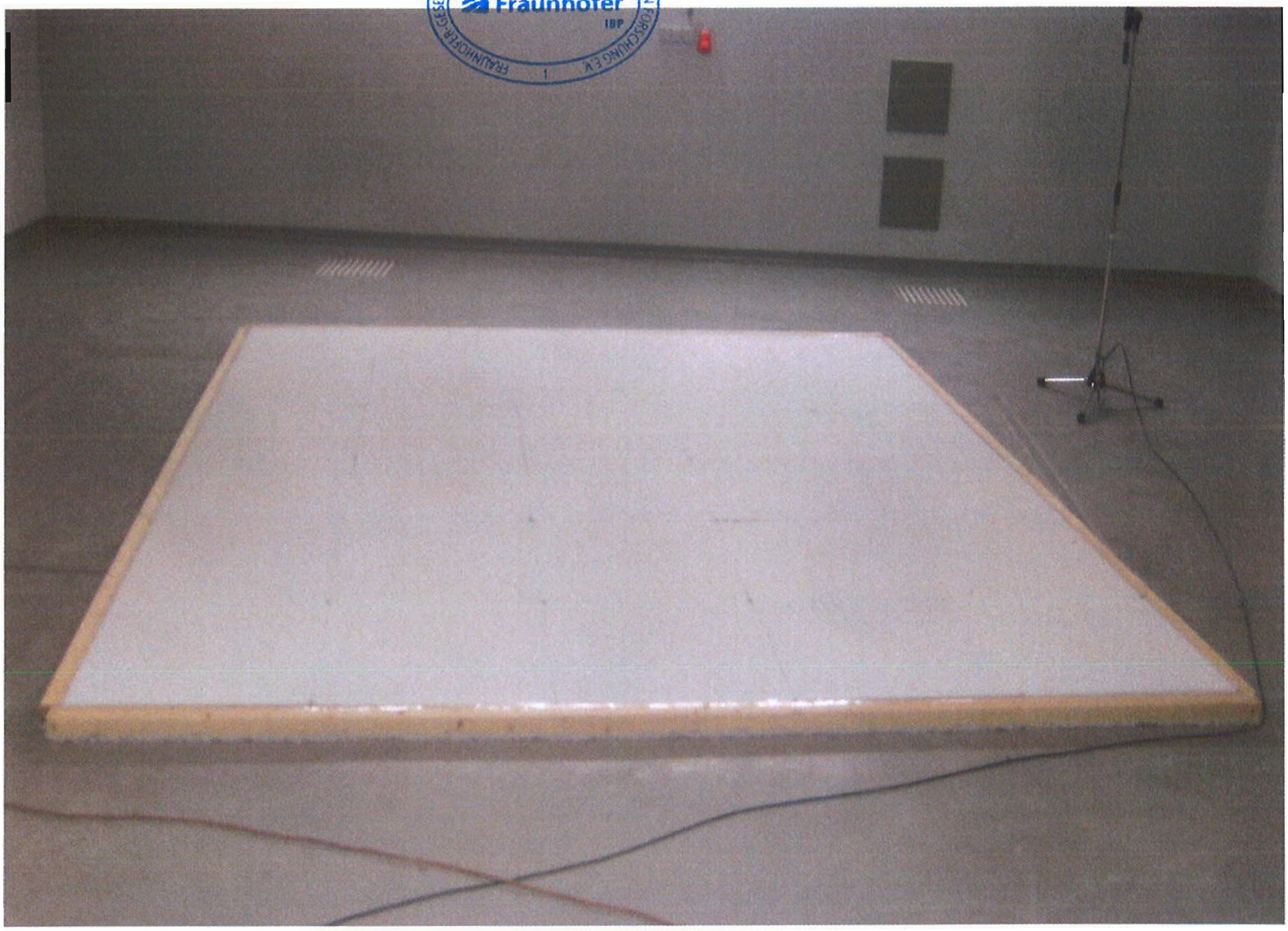

Fig. 1 Picture of the test setup in the reverberation room; (test object S 10639-02)

Sound absorption coefficient acc. to DIN EN ISO 354:2003

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Fig. 2

Client: Liaver GmbH & Co. KG
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Additional description and technical data see page 2 of the test report P-BA 127/2014e as well as figure 1.

Test area: 11.7 m²

Reverberation room:
With tilted surfaces and 15 diffusors:
10 pcs. à 1.60 m x 1.25 m
5 pcs. à 1.25 m x 1.25 m
Volume: V = 392 m³

Test conditions:

Air temperature:	without sample:	20.6 °C
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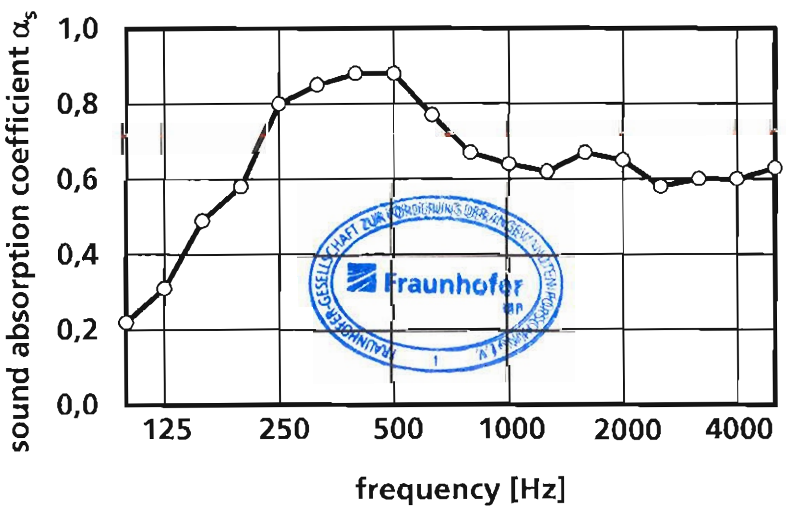
Rel. humidity:	without sample:	36 %
	with sample:	30 %
static pressure:		970 hPa

Excitation noise: pink noise

Test date: December 17, 2013



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Head of the test laboratory:

Sound absorption coefficient acc. to DIN EN ISO 11654:1997

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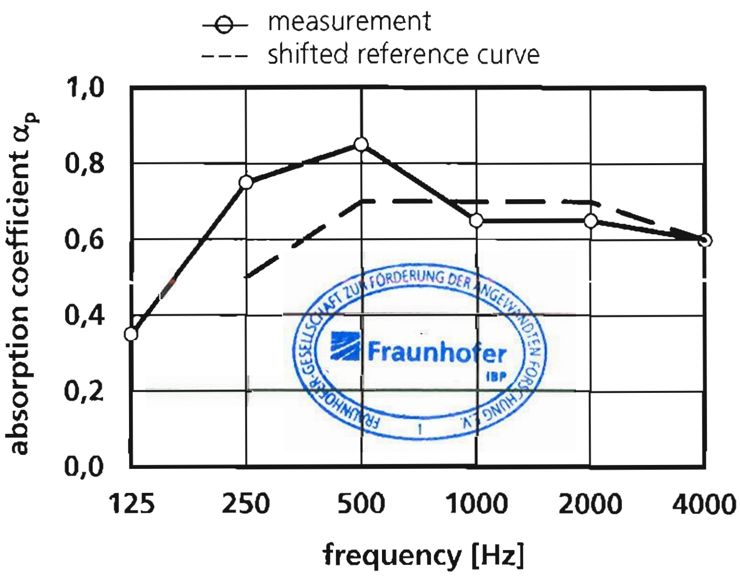

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