PEUTZ

Laboratory for Acoustics

TESTING
RvA L 334

Determination of the sound absorption (reverberation room method) of Pet-felt, manufacturer Smit Visual

Reportnumber A 4576-2E-RA-001 d.d. 23 May 2024

Laboratory for Acoustics

Determination of the sound absorption (reverberation room method) of Pet-felt, manufacturer Smit Visual

Principal:	Smit Visual B.V. Spaarpot 120 - 122 5667 KZ GELDROP The Netherlands
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Representative:	R.T. Allan
Author:	R.T. Allan +31 858228649 r.allan@peutz.nl

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1 Introduction

At the request of Smit Visual based in Geldrop (The Nederlands) laboratory measurements of the sound absorption (reverberation room method) were carried out on:

PET-felt
manufacturer Smit Visual

The measurements were performed in the Laboratory for Acoustics of Peutz bv, situated at Lindenlaan 41, 6584 AC in Molenhoek (the Netherlands). See Appendix 2 for a plan of the laboratory.

2 Standards and guidelines

The measurements have been carried out according to the Quality Manual of the Laboratory for Acoustics as well as:

ISO 345:2003[1,2]	Acoustics Measurement of sound absorption in a reverberation room
ISO 11654:1997	Acoustics Sound absorbers for use in buildings Rating of sound absorption
ASTM C423-23	Standard Test Method for Sound Absorption and Sound Absorption Coefficients by the Reverberation Room Method (SAA)

[1]

For these type of measurements the Laboratory for Acoustics has been accredited by the Dutch Accrediatation Council (RvA).

The RvA is member of the EA MLA (**EA MLA**: **E**uropean **A**ccreditation Organisation **M**ulti **L**ateral **A**greement: http://www.european-accreditation.org).

EA: "Certifates and reports issued by bodies accredited by MLA and MRA members are considered to have the same degree of credibility, and are accepted in MLA and MRA countries."

[2] According to this norm, the report should include for each measurement the mean reverberation times T1 and T2 at each frequency. Because these figures are not relevant for judging the quality of the product being tested, but merely for judging the accuracy of the calculations, they have been omitted in this report. It is possible of course to reproduce those figures at any time if the principal requests this.

3 Tested panels

The following data have been provided by the principal, supplemented by observations in the laboratory where applicable.

Two thicknesses of PET-felt panels were tested;

- Thickness 9 mm mass approx. 1,88 kg/m^2
- Thickness 18 mm (2 panels of 9 mm glued together) mass approx. 4,10 kg/m^2

Both types were tested in the following configurations.

Directly on the floor

With an air cavity of 50 mm

With an air cavity of 100 mm

The results as presented in this report relate only to the tested items and laboratory conditions as described in this report. The laboratory can make no judgement about the representativity of the tested samples. The test report ahead is valid as long as the tested constructions and/or materials are unchanged.

4 Measurements

4.1 Measurement results

The results of the measurements are given in table t 4.1 and in the figures of appendix 3. The measurements were made in 1/3-octave bands. The results presented in octave-bands are the arithmetic average of the results of the three 1/3-octave bands belonging to that octave band.

From those values the following one-figure ratings have been calculated and stated:

- the "weighted sound absorption coefficient α_w" according to ISO 11654;
- the "Sound Absorption Average SAA" according to ASTM-C423, being the average of the absorption coefficients (1/3 octave values) at the frequencies of 200 Hz up to and including 2500 Hz, rounded to the nearest 0,01;
- the "Sound absorption class" according to ISO 11654.

t 4.1 Measurement results

thickness	configuration	α_w ± U (k=2)	SAA	Class	record	appendix
9 mm	directly on the floor	**0,25(H)** ± 0,07	0,30	E	#73	3.1
	cavity of 50 mm	**0.55(MH)** ± 0,07	0.70	D	#184	3.2
	cavity of 100 mm	**0.75(H)** ± 0,07	0.76	C	#221	3.3
18 mm	directly on the floor	**0.45(MH)** ± 0,07	0.59	D	#110	3.4
	cavity of 50 mm	**0.75(H)** ± 0,07	0.74	C	#147	3.5
	cavity of 100 mm	**0.80(H)** ± 0,07	0.74	B	#258	3.6

The sound absorption coefficient of a material is not a material property. It should be taken into account that the sound absorption of a construction depends on the dimensions, the way of mounting of the material and its position in the room.

4.2 Method

The tests were conducted in accordance with the provisions of the test method in the reverberation room of "Peutz bv" in Mook (the Netherlands) (see appendix 2.1). The relevant data regarding the reverberation room are given in appendix 2.2 of this report.

By means of reverberation measurements the reverberation time of the room is measured under two conditions:

- when the reverberation room is empty
- when the construction under test is inside the reverberation room

In general, once material is placed into the reverberation room a lower reverberation time will result.

The difference in reverberation times is a measure of the amount of absorption brought into the room.

Measurements and calculations were carried out in 1/3-octave bandwidth from 100 to 5000 Hz, according to the norms. Where applicable the octave values have been calculated from these 1/3-octave values.

From the reverberation measurements in the empty reverberation room the equivalent sound absorption A_1 is calculated (per frequency band) according to 4.1 and expressed in m^2.

$$A_1 = \frac{55{,}3\,V}{cT_1} - 4Vm_1 \qquad (4.1)$$

in which:

V	the volume of the reverberation room	[m^3]
T_1	the reverberation time in the empty reverberation room	[sec]
m_1	"power attenuation coefficient" in the empty room, calculated according to formula 4.3	[m^{-1}]
c	the speed of sound in the air, in m/s, calculated according to	[m/s]

$$c = 331 + 0{,}6t \qquad (4.2)$$

in which:

t	the temperature; this formula is valid for the temperatures between 15 and 30 °C	[°C]

$$m = \frac{\alpha}{10\log(e)} \qquad (4.3)$$

in which:

α	"attenuation coefficient" according to ISO 9613-1	

In the same manner the equivalent sound absorption A_2 for the room with the test specimen is calculated according to formula 4.4, also expressed in m^2.

$$A_2 = \frac{55{,}3\,V}{cT_2} - 4Vm_2 \qquad (4.4)$$

in which:

c and V have the same definition as in formula 4.1 and

T_2	the reverberation time of the reverberation room with the test specimen placed inside	[sec]
m_2	"power attenuation coefficient" in the room with the test specimen placed inside, calculated according to formula 4.3	[m^{-1}]

The equivalent sound absorption A of the test specimen has been calculated according to formula 4.5 and is expressed in m^2.

$$A = A_2 - A_1 \qquad (4.5)$$

When the test specimen consists of one plane with an area between 10 and 12 m^2 the sound absorption coefficient α_s has to be calculated according to formula 4.6:

$$\alpha_s = \frac{A}{S} \tag{4.6}$$

in which:

S the area of the test specimen [m^2]

4.3 Measurement uncertainty

The accuracy of the sound absorption as calculated can be expressed in terms of repeatability (tests within one laboratory) and reproducibility (between various laboratories).

4.3.1 Repeatability

The repeatability describes when: - two tests are performed on identical test material - within a short period of time - by the same person or team - using the same instrumentation - under unchanged environmental conditions - the difference between the two test results.

As stated in standard EN ISO 12999-2, the repeatability related to the α_W is dependent on the measured value per 1/3-octave bands. For further explanation and measurement results provided with measurement uncertainty, see Appendix 1 of this report.

4.3.2 Reproducibility

The reproducibility describes when: - two tests are performed on identical test material - in different laboratories - by different person(s) - under different environmental conditions - the difference between the two test results.

As stated in standard EN ISO 12999-2 the reproducibility related to the α_W is dependent on the measured value per 1/3-octave bands. For further explanation and measurement results provided with measurement uncertainty, see appendix 1 of this report.

4.4 Environmental conditions during the measurements

t 4.2 Environmental conditions during the measurements

Reverberation room	temperature [°C]	relative humidity [%]	barometric pressure [kPa]
Empty	17	59	101.2
With material	17 - 18	59 - 63	101.3 – 101.5

Mook,

R.T. Allan
Laboratory Supervisor

dr. ir. M.L.S. Vercammen
Manager

This report contains 10 pages and 3 appendices.

appendix 1	Standard uncertainty	(3 pages)
appendix 2	Plans and Sections	(2 pages)
appendix 3	Measurement results	(6 pages)

Appendix 1
Standard uncertainty

For the measurement uncertainty of sound absorption, a connection is sought to the values and formulas given in standard EN-ISO 12999-2:2020.

Standard deviation for sound absorption coefficients (1/3 octave bands)

Formula I.1 was used to determine the standard deviation of the sound absorption coefficient α_s under reproducibility conditions.

$$\sigma_R = m\,\alpha_s + n \qquad \text{(I.1)}$$

In which:

α_s sound absorption coefficient in accordance with ISO 354

m, n Frequency-dependent numerical constants given in tabel I.3

t I.1 frequency-dependent numerical constants (derived from tabel 1 of EN ISO 12999-2)

1/3-octave band mid frequencies [Hz]	m	n
100	0,240	0,015
125	0,180	0,015
160	0,140	0,015
200	0,110	0,015
250	0,090	0,015
315	0,075	0,015
400	0,060	0,015
500	0,050	0,015
630	0,045	0,015
800	0,040	0,015
1000	0,040	0,015
1250	0,040	0,016
1600	0,037	0,018
2000	0,035	0,021
2500	0,030	0,026
3150	0,030	0,032
4000	0,030	0,040
5000	0,026	0,060

Formula I.2 was used to determine the standard deviation of the sound absorption coefficient α_s under repeatability conditions.

$$\sigma_r = 0{,}6\,\sigma_R \qquad \text{(I.2)}$$

Standard deviation for the practical sound absorption coefficient (octave bands)
Formula I.3 was used to determine the standard deviation of the practical sound absorption coefficient α_P under reproducibility conditions.

$$\sigma_R = m\,\alpha_P + n \qquad \text{(I.3)}$$

In which:

α_P the practical sound absorption coefficient determined according ISO 11654
m, n Frequency-dependent numerical constants given in table I.2

t I.2 frequency -dependent numerical constants (derived from table 2 of EN ISO 12999-2)

octave midband frequencies [Hz]	m	n
250	0,059	0,016
500	0,000	0,040
1000	0,000	0,040
2000	0,000	0,040
4000	0,000	0,050

Formula I.4 was used to determine the standard deviation of the practical sound absorption coefficient α_P under repeatability conditions.

$$\sigma_r = 0{,}6\,\sigma_R \qquad \text{(I.4)}$$

Standard deviation of single-number values

The reproducibility standard deviation of the weighted sound absorption coefficient, α_w, determined according to ISO 11654 is:

$$\sigma_R = 0{,}035$$

The repeatability standard deviation of the weighted sound absorption coefficient, α_w, determined according to ISO 11654 is:

$$\sigma_r = 0{,}020$$

Expanded uncertainty
The expanded uncertainty under reproducibility conditions, U, is calculated according to standard ISO 12999-2:2020 for the 95% confidence level, with the coverage factor k=2. It is calculated according to formula I.5:

$$U = u \cdot k \tag{I.5}$$

In which:

- u uncertainty under reproducibility or repeatability conditions
- k Coverage factor (k=2 for a 95% confidence level)

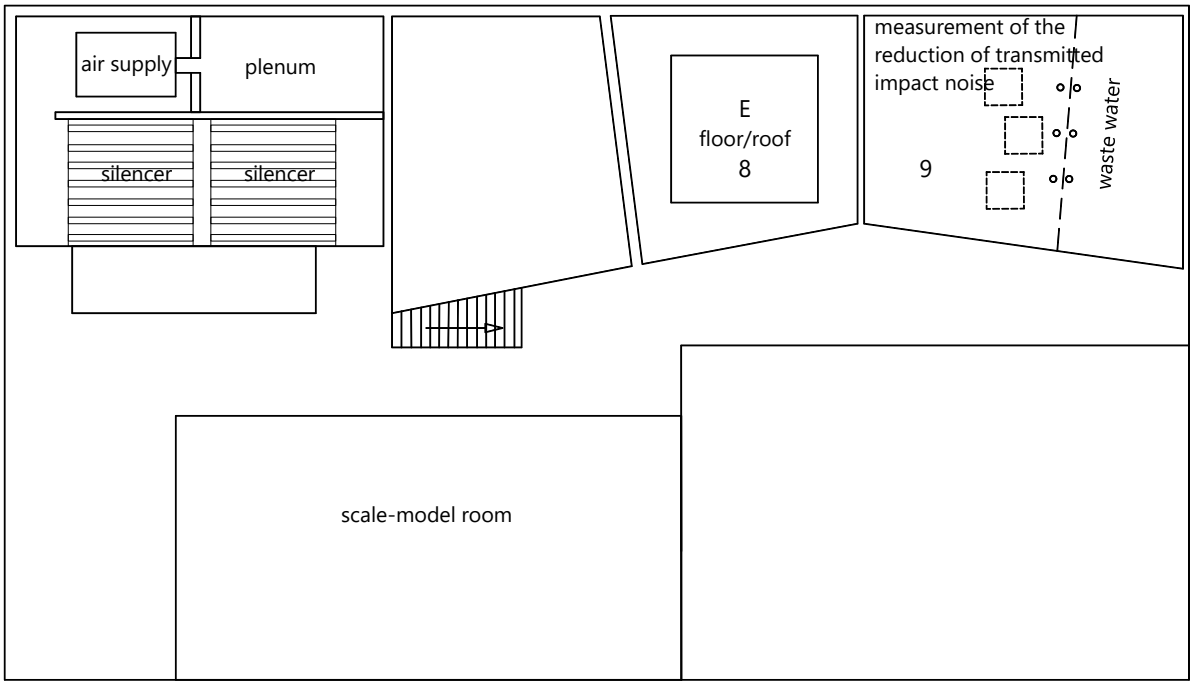
EXAMPLE

The reported weighted sound absorption coefficient, α_W should be read as: α_W = 0,70 ± 0,07 (k=2).

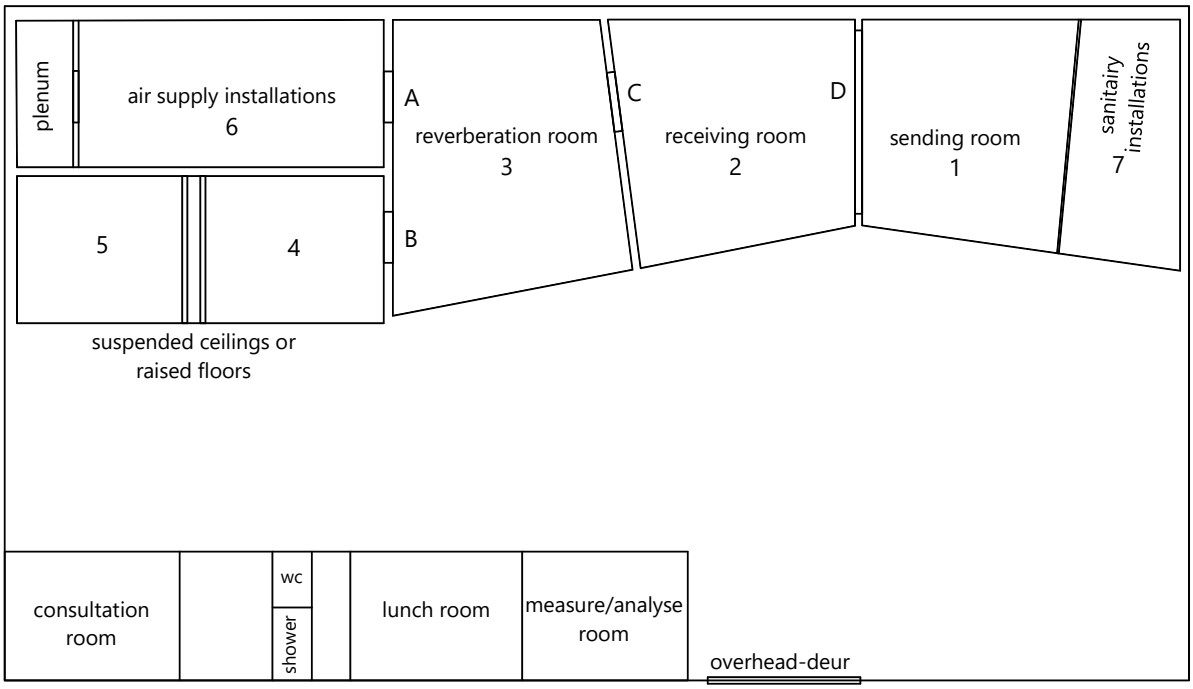
Peutz bv
Lindenlaan 41, NL-6584 AC MOLENHOEK (LB), THE NETHERLANDS

OVERVIEW

Story



Ground level



TEST OPENINGS (w x h):
A: 1300 x 1905 mm
B: 1000 x 2000 mm
C: 1500 x 1250 mm
D: 4300 x 2800 mm
E: 4000 x 4000 mm

0 1 2 3 4 5 m
scale

PEUTZ bv
Lindenlaan 41, 6584 AC MOLENHOEK (LB)

REVERBERATION ROOM

The reverberation room meets the requirements of ISO 354:2003.

additional data:
volume : 214 m^3
total area St (walls, floor and ceiling) : 219 m^2

diffusion: by the shape of the room and by adding 6 curved and 2 flat reflecting elements with a total area of approx. 13 m^2 a sufficient diffusion has been gained.

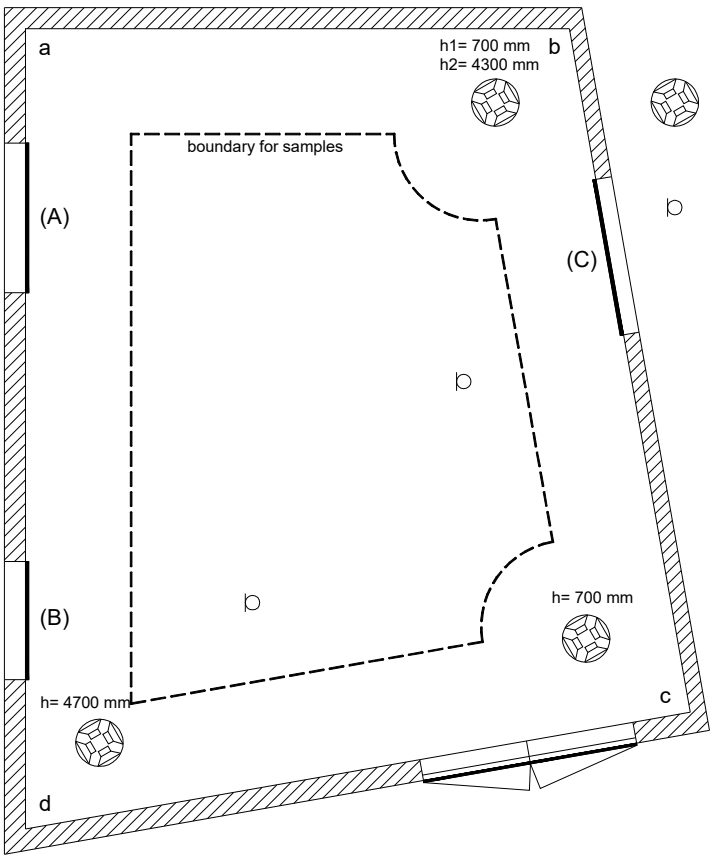
reverberation time of the empty reverberation room during measurements of 07-05-2024

frequency (1/1 oct.)	125	250	500	1000	2000	4000	Hz
reverberationtime	8,41	6,97	6,79	6,39	4,63	2,98	sec.

repeatibility r (1/1 oct.) c.f. ISO 354:1985 annex C (see chapter 4.2 of this report).

r at high α	0,13	0,04	0,04	0,02	0,02	0,08	-
r at low α	0,09	0,02	0,01	0,02	0,02	0,04	-

plan

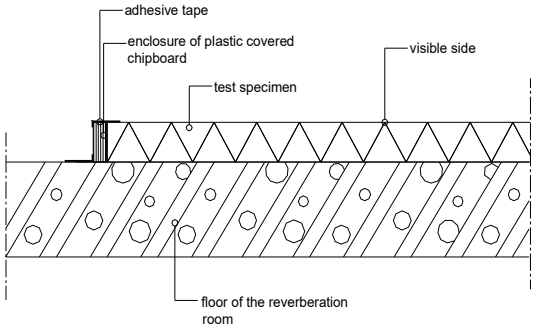


Absorb, versie 5.10.5 mode 7, PM:JK, file: a4576 E#:1-36 T_1 = 17,4 °C p_1 = 101,2 kPa h_1 = 58,5 %

MEASUREMENT OF SOUND ABSORPTION IN A REVERBERATION ROOM ACCORDING TO EN-ISO 354:2003

principal: Smit Visual

#1; PET-felt thickness 9 mm



volume reverberation room: 214 m^3

surface area sample: 10,8 m^2

heigth of the construction: 9 mm

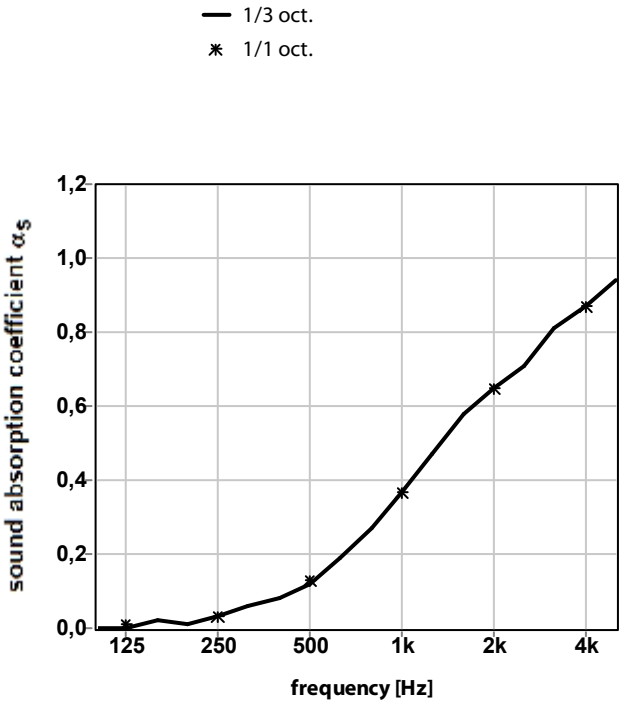
measured at: Peutz Laboratory for Acoustics

signal: broad-band noise

bandwidth: 1/3 octave

α_w (ISO 11654) = 0,25(H)

SAA (ASTM - C423) = 0,30



	0,00	0,01	0,08	0,27	0,58	0,81
1/3 oct.	0,00	0,03	0,12	0,37	0,65	0,87
	0,02	0,06	0,19	0,47	0,71	0,94
1/1 oct.	**0,01**	**0,03**	**0,13**	**0,37**	**0,65**	**0,87**

Mook, measured at 07-05-2024

Absorb, versie 5.10.4 / 5.10.5 mode 7, PM: JK, file: a4576 E#:1-36 F#:37-72 A#:73 T_1 = 17,4 °C T_2 = 17,5 °C p_1 = 101,2 kPa p_2 = 101,3 kPa h_1 = 58,5 % h_2 = 58,5 %

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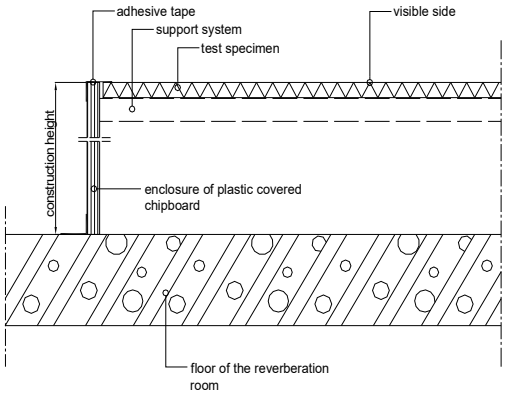
MEASUREMENT OF SOUND ABSORPTION IN A REVERBERATION ROOM ACCORDING TO EN-ISO 354:2003

TESTEN RvA L 334

principal: Smit Visual

#4; PET-felt thickness 9 mm with 50 mm cavity



volume reverberation room: 214 m^3

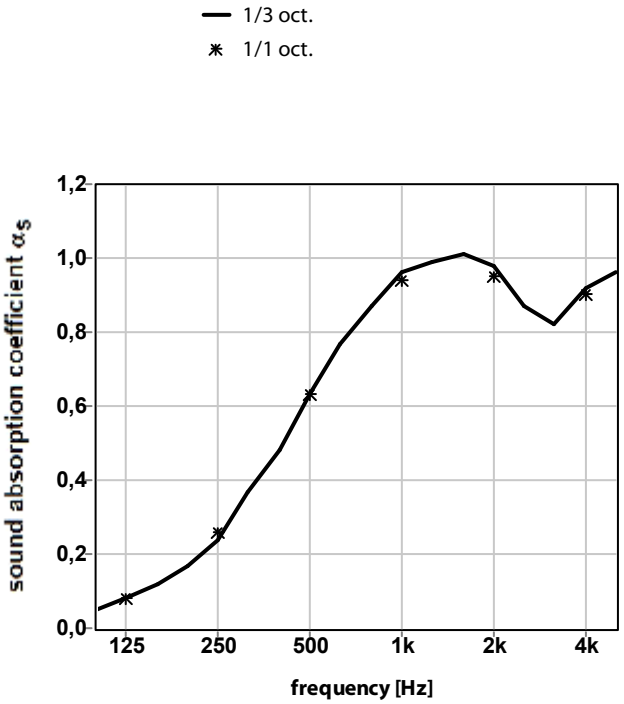
surface area sample: 10,8 m^2

heigth of the construction: 59 mm

measured at: Peutz Laboratory for Acoustics

signal: broad-band noise

bandwidth: 1/3 octave



α_w (ISO 11654) = 0,55(MH)

SAA (ASTM - C423) = 0,70

	0,05	0,17	0,48	0,87	1,01	0,82
1/3 oct.	0,08	0,24	0,63	0,96	0,98	0,92
	0,12	0,37	0,77	0,99	0,87	0,96
1/1 oct.	**0,08**	**0,26**	**0,63**	**0,94**	**0,95**	**0,90**

Mook, measured at 07-05-2024

Absorb, versie 5.10.4 / 5.10.5 mode 7, PM: JK, file: a4576 E#:1-36 F#:148-183 A#:184 T_1 = 17,4 °C T_2 = 17,9 °C p_1 = 101,2 kPa p_2 = 101,4 kPa h_1 = 58,5 % h_2 = 62,3 %

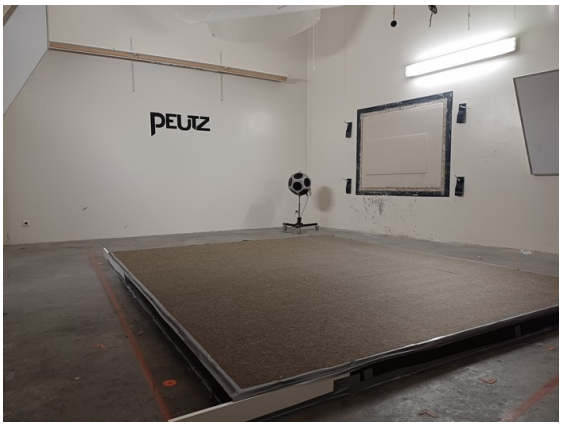
A 4576-2E-RA-001 I:DA8E710B\ REMKO

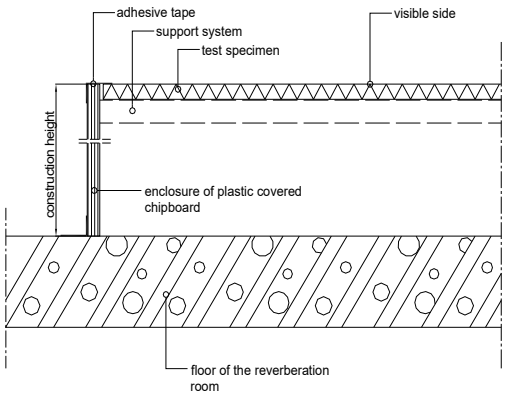
MEASUREMENT OF SOUND ABSORPTION IN A REVERBERATION ROOM ACCORDING TO EN-ISO 354:2003

TESTEN RvA L 334

principal: Smit Visual

#5; PET-felt thickness 9 mm with 100 mm cavity





volume reverberation room: 214 m^3

surface area sample: 10,8 m^2

heigth of the construction: 109 mm

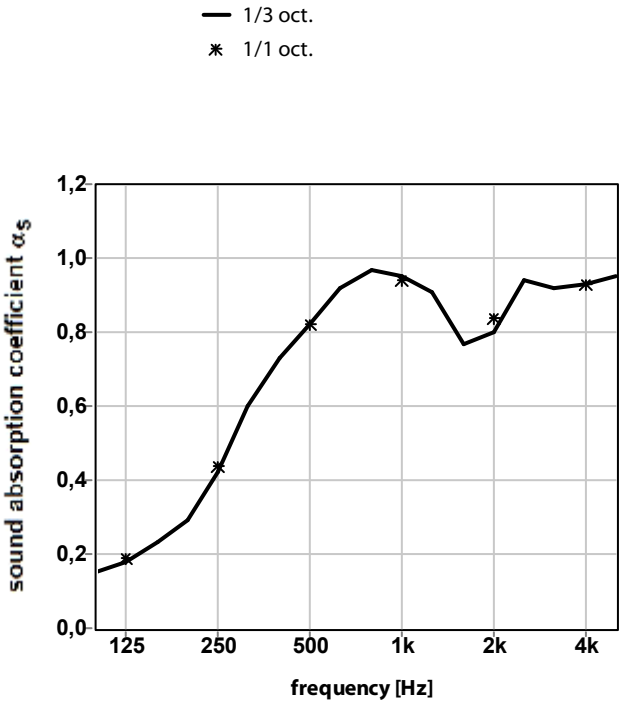
measured at: Peutz Laboratory for Acoustics

signal: broad-band noise

bandwidth: 1/3 octave

α_w (ISO 11654) = 0,75(H)

SAA (ASTM - C423) = 0,76



	0,15	0,29	0,73	0,97	0,77	0,92
1/3 oct.	0,18	0,42	0,82	0,95	0,80	0,93
	0,23	0,60	0,92	0,91	0,94	0,95
1/1 oct.	**0,19**	**0,44**	**0,82**	**0,94**	**0,84**	**0,93**

Mook, measured at 07-05-2024

Absorb, versie 5.10.4 / 5.10.5 mode 7, PM: JK, file: a4576 E#:1-36 F#:185-220 A#:221 T_1 = 17,4 °C T_2 = 18,0 °C p_1 = 101,2 kPa p_2 = 101,5 kPa h_1 = 58,5 % h_2 = 62,4 %

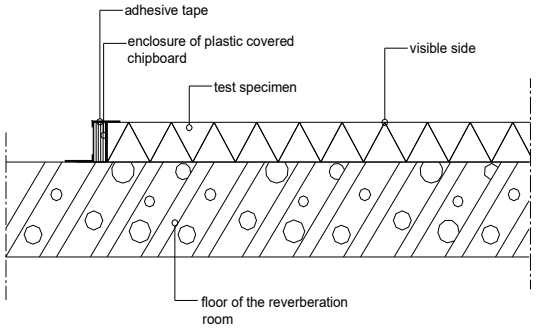
A 4576-2E-RA-001 I:DA8E710B\ REMKO

MEASUREMENT OF SOUND ABSORPTION IN A REVERBERATION ROOM
ACCORDING TO EN-ISO 354:2003

TESTEN
RvA L 334

principal: Smit Visual

#2; PET-felt thickness 18 mm



volume reverberation room: 214 m^3

surface area sample: 10,8 m^2

heigth of the construction: 18 mm

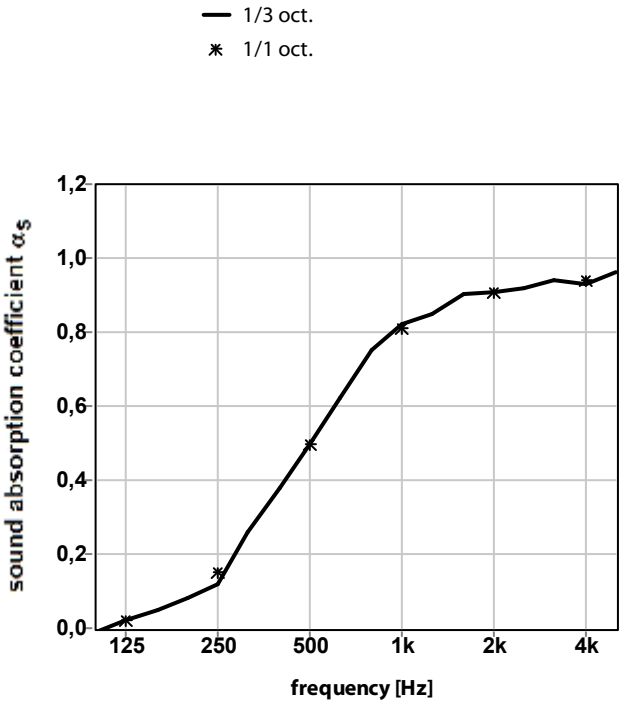
measured at: Peutz Laboratory for Acoustics

signal: broad-band noise

bandwidth: 1/3 octave

α_w (ISO 11654) = 0,45(MH)

SAA (ASTM - C423) = 0,59



	-0,01	0,08	0,38	0,75	0,90	0,94
1/3 oct.	0,02	0,12	0,50	0,82	0,91	0,93
	0,05	0,26	0,62	0,85	0,92	0,96
1/1 oct.	**0,02**	**0,15**	**0,50**	**0,81**	**0,91**	**0,94**

Mook, measured at 07-05-2024

Absorb, versie 5.10.4 / 5.10.5 mode 7, PM: JK, file: a4576 E#:1-36 F#:74-109 A#:110 T_1 = 17,4 °C T_2 = 17,6 °C p_1 = 101,2 kPa p_2 = 101,4 kPa h_1 = 58,5 % h_2 = 58,8 %

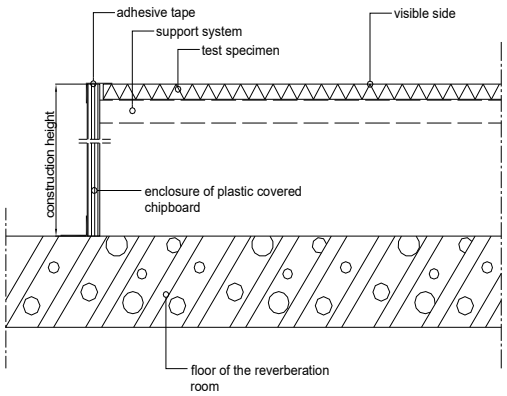
A 4576-2E-RA-001 (DA8E710B) REMKO

MEASUREMENT OF SOUND ABSORPTION IN A REVERBERATION ROOM ACCORDING TO EN-ISO 354:2003

TESTEN RvA L 334

principal: Smit Visual

#3; PET-felt thickness 18 mm with 50 mm cavity



volume reverberation room: 214 m^3

surface area sample: 10,8 m^2

heigth of the construction: 68 mm

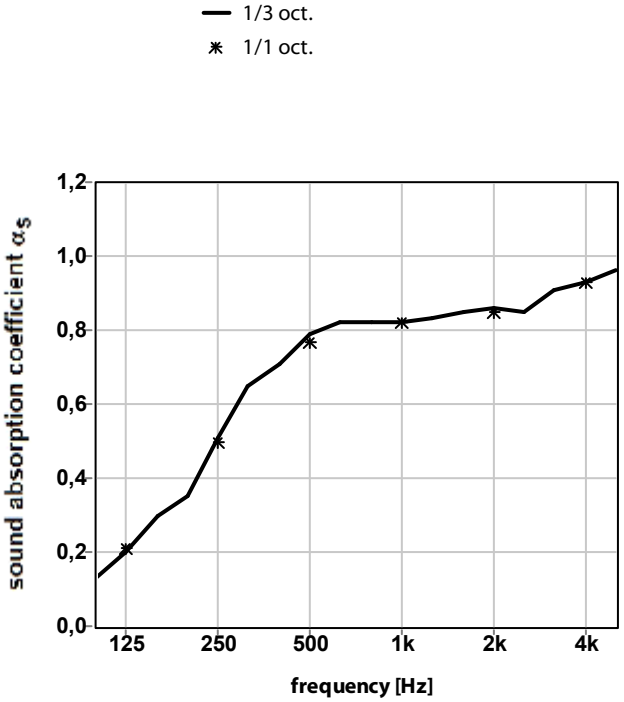
measured at: Peutz Laboratory for Acoustics

signal: broad-band noise

bandwidth: 1/3 octave

α_w (ISO 11654) = 0,75(H)

SAA (ASTM - C423) = 0,74



	0,13	0,35	0,71	0,82	0,85	0,91
1/3 oct.	0,20	0,51	0,79	0,82	0,86	0,93
	0,30	0,65	0,82	0,83	0,85	0,96
1/1 oct.	**0,21**	**0,50**	**0,77**	**0,82**	**0,85**	**0,93**

Mook, measured at 07-05-2024

Absorb, versie 5.10.4 / 5.10.5 mode 7, PM: JK, file: a4576 E#:1-36 F#:111-146 A#:147 T_1 = 17,4 °C T_2 = 17,9 °C p_1 = 101,2 kPa p_2 = 101,4 kPa h_1 = 58,5 % h_2 = 62,1 %

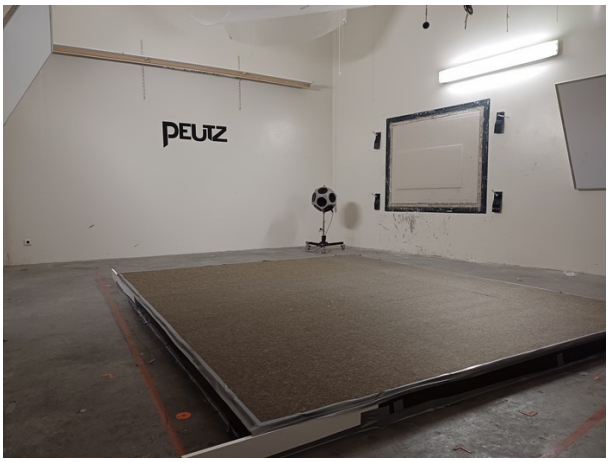
A 4576-2E-RA-001 (DA8E710B) REMKO

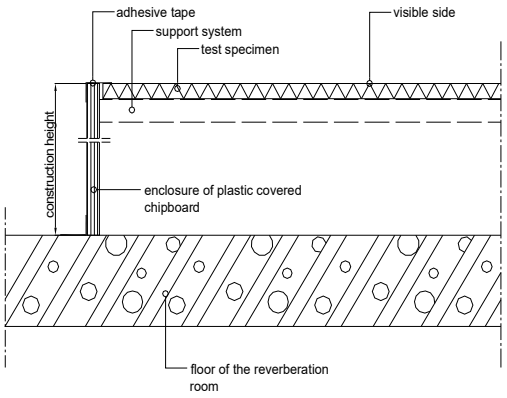
MEASUREMENT OF SOUND ABSORPTION IN A REVERBERATION ROOM
ACCORDING TO EN-ISO 354:2003

TESTEN
RvA L 334

principal: Smit Visual

#6; PET-felt thickness 18 mm with 100 mm cavity





volume reverberation room: 214 m^3

surface area sample: 10,8 m^2

heigth of the construction: 118 mm

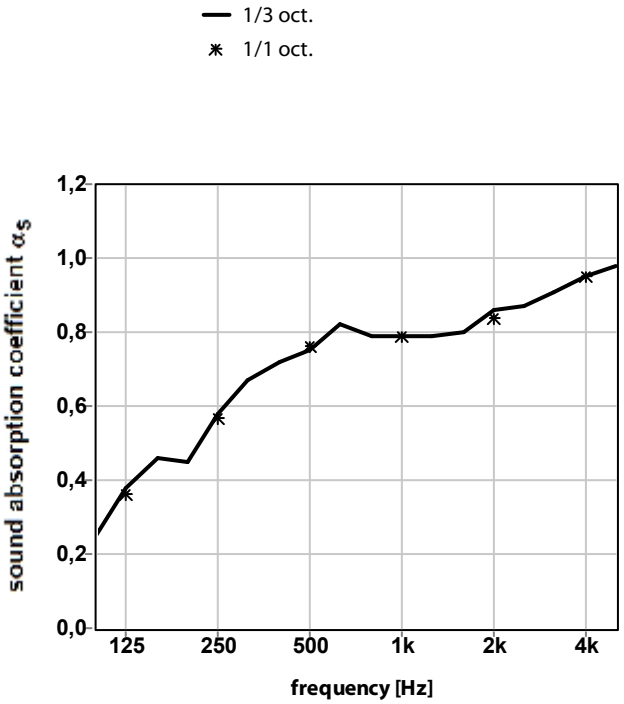
measured at: Peutz Laboratory for Acoustics

signal: broad-band noise

bandwidth: 1/3 octave

α_w (ISO 11654) = 0,80(H)

SAA (ASTM - C423) = 0,74



	0,25	0,45	0,72	0,79	0,80	0,91
1/3 oct.	0,38	0,58	0,75	0,79	0,86	0,95
	0,46	0,67	0,82	0,79	0,87	0,98
1/1 oct.	**0,36**	**0,57**	**0,76**	**0,79**	**0,84**	**0,95**

Mook, measured at 07-05-2024

Absorb, versie 5.10.4 / 5.10.5 mode 7, PM: JK, file: a4576 E#:1-36 F#:222-257 A#:258 T_1 = 17,4 °C T_2 = 17,9 °C p_1 = 101,2 kPa p_2 = 101,5 kPa h_1 = 58,5 % h_2 = 62,8 %

A 4576-2E-RA-001 (DA8E710B) REMKO