Laboratory for Acoustics

TESTING
RvA L 334

Determination of the sound absorption (reverberation room method) of Mute Peak (wall panel), manufacturer: De Vorm

Report number A 4557-3E-RA-002 d.d. 03 June 2024

Laboratory for Acoustics

Determination of the sound absorption (reverberation room method) of Mute Peak (wall panel), manufacturer: De Vorm

Principal:	De Vorm Dijkgraaf 38 6921 RL DUIVEN The Netherlands
Report Number:	A 4557-3E-RA-002
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1 Introduction

At the request of De Vorm (based in Duiven, the Netherlands) laboratory measurements of the sound absorption (reverberation room method) were conducted on:

Mute Peak (wall panel),
Manufacturer: De Vorm

The measurements were performed at April 29th, 2024 in the Laboratory for Acoustics of Peutz bv, situated at Lindenlaan 41, 6584 AC in Molenhoek (the Netherlands). See Appendix 2.1 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:

EN-ISO 354:2003[1,2]	Acoustics - Measurement of sound absorption in a reverberation room
EN-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)
EN-ISO 12999-2:2020	Acoustics – Determination and application of measurement uncertainties in building acoustics – Part 2: Sound absorption

[1] For this type of measurements, the Laboratory for Acoustics has been accredited by the Dutch Accreditation Council (RvA).

The RvA is member of the EA MLA (**EA MLA**: **E**uropean **A**ccreditation Organization **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 construction

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

The following materials are investigated

type: material: thickness: manufacturer: dimensions (w x l): surface weight: mass:	Mute Peak PET Felt polyester fibres 6 mm De Vorm 790 x 2390 mm 3,22 kg/m^2 460 kg/m^3	
type: material: manufacturer: dimensions (w x l): thickness: surface weight: mass:	Rocksono Base Stone wool Rockwool 600 x 1200 mm 50 mm 1,78 kg/m^2 36 kg/m^3	

The results as presented here 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 sound absorption coefficient α_w

The results of the measurements are given in table t 4.2 and in 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.

t 4.1 Measurement results sound absorption coefficient α_w

variant nr.		α_w ± U (k=2)	NRC	SAA	Record nr.	Figure nr.
1	Mute Peak / directly on the floor	0,40(H) ± 0,07	0,45	0,43	#263	3.1
2	Mute Peak on top of an air cavity of 50 mm	0,65 ± 0,07	0,60	0,57	#300	3.2
3	Mute Peak on top of a 50 mm thick layer of stone wool	0,60(L) ± 0,07	0,65	0,63	#262	3.3
4	Mute Peak on top of a 100 mm thick layer of stone wool	0,60 ± 0,07	0,60	0,59	#337	3.4

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

4.2 Measurement set-up

The panels to be measured (see chapter 3) have been mounted directly on wooden beams (cavity of 50 mm / 100 mm) on the floor of the reverberation room, according to type A mounting (ISO 354:2003).

4.3 Method

The tests were conducted in accordance with the provisions of the test method EN-ISO 354:2003 in the reverberation room of "Peutz bv" in Mook (the Netherlands). The relevant data regarding the reverberation room are given in appendix 4.2 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_T of the total test specimens has been calculated according to formula 4.5 and is expressed in m^2

$$A_T = A_2 - A_1 \quad (4.5)$$

The equivalent sound absorption per single object has been calculated according to formula 4.6 and is expressed in m^2

$$A_{obj} = \frac{A_T}{n} \quad (4.6)$$

In which:
n = number of element during the test

In addition to the sound absorption area per object A_{obj} [m^2], the sound absorption coefficient α_S is calculated according to formula 4.7:

$$\alpha_s = \frac{A}{S} \quad (4.7)$$

In which:
S = the area of the test specimen [m^2]

4.4 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).

4.4.1 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 12999-2:2020, the repeatability related to the A_T depends on the measured value per 1/3-octave bands. The repeatability related to the single-digit value α_w ± is 0.04. For further explanation and measurement results provided with measurement uncertainty, see Appendix 1 of this report.

4.4.2 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 12999-2:2020, the reproducibility related to the A_T depends on the measured value per 1/3-octave bands. The reproducibility related to the single-digit value α_w ± is 0.07. For further explanation see Appendix 1 of this report.

4.5 Environmental conditions during the measurements

t 4.2 Environmental conditions during the measurements (March 29th, 2024)

Reverberation room	Temperature [°C]	relative humidity [%]	barometric pressure [kPa]
Empty	15,8	52,0	101,6
With objects	15,8 – 16,0	53,6 – 54,5	101,6

Mook,

R.T. Allan
Laboratory Supervisor

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

This report contains 13 pages and 3 appendices.

appendix 1	Measurement uncertainty	(3 pages)
appendix 2	Plans and sections	(2 pages)
appendix 3	Measurement results sound absorption coefficient α_w	(4 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 equivalent sound absorption area
Formula 1.1 was used to determine the standard deviation of the equivalent sound absorption area AT under reproducibility conditions.

$$\sigma_R = m\, A_T + n\, S \qquad (1.1)$$

In which:

A_T Equivalent sound absorption area in accordance with ISO 354
S Constant, S = 10 m^2
m, n Frequency-dependent numerical constants given in tabel I.1

t I.3 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 1.2 was used to determine the standard deviation of the equivalent sound absorption area A_T under repeatability conditions.

$$\sigma_r = 0{,}6\, \sigma_R \qquad (1.2)$$

Expanded uncertainty

The expanded uncertainty under reproducibility conditions, U, is calculated according to standard **Fout! Ongeldige koppeling.** for the 95% confidence level, with the coverage factor k=2. It is calculated according to formula 1.3:

$$U = u \cdot k \tag{1.3}$$

In which:

u uncertainty under reproducibility or repeatability conditions

k Coverage factor (k=2 for a 95% confidence level)

EXAMPLE

The reported equivalent sound absorption area A_T should be read as: A_T = 1,05 m^2 ± 0,38 (k=2).

Standard deviation for sound absorption coefficients

Formula 1.4 was used to determine the standard deviation of the sound absorption coefficient under reproducibility conditions.

$$\sigma_R = m\,\alpha_s + n \tag{1.4}$$

In which:

α_s sound absorption coefficient in accordance with ISO 354

m, n Frequency-dependent numerical constants given in tabel I.1

Standard deviation for the practical sound absorption coefficient

Formula 1.3 was used to determine the standard deviation of the practical sound absorption coefficient under reproducibility conditions.

$$\sigma_R = m\,\alpha_P + n \tag{1.3}$$

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

The reproducibility standard deviation of the weighted sound absorption coefficient, α_W, determined according to ISO 11654 is given by Formula 1.4

$$\sigma_R = 0{,}035 \quad (1.4)$$

The repeatability standard deviation of the weighted sound absorption coefficient, α_W, determined according to ISO 11654 is given by Formula 1.5

$$\sigma_r = 0{,}020 \quad (1.5)$$

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 1.6:

$$U = u \cdot k \quad (1.6)$$

In which:

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

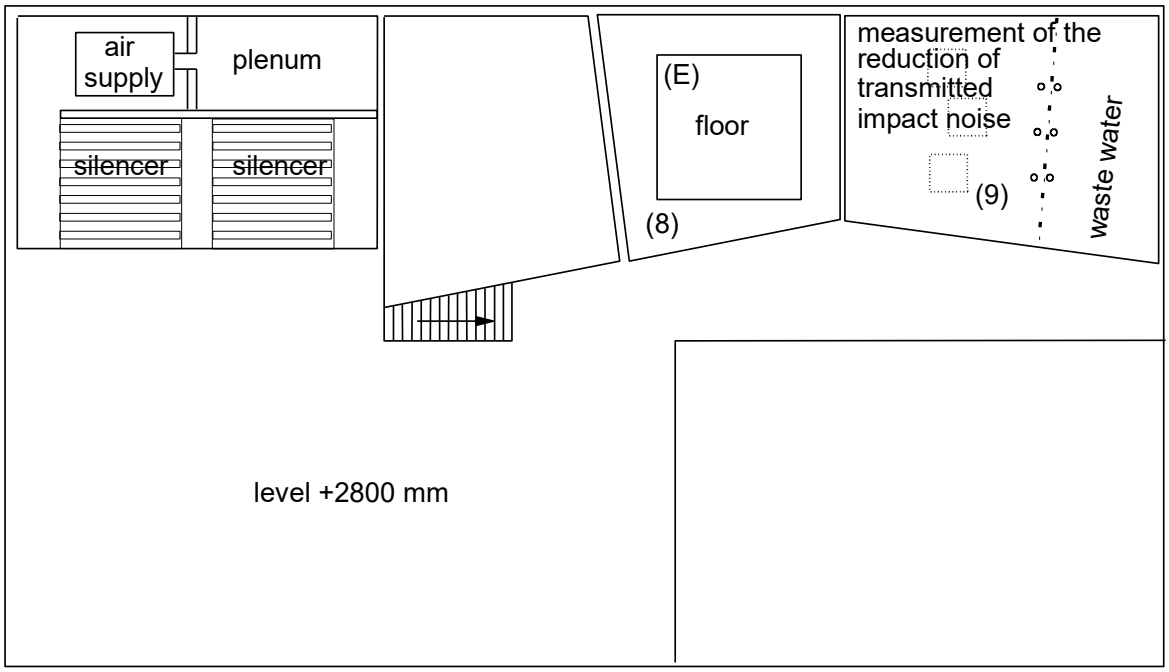
EXAMPLE

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

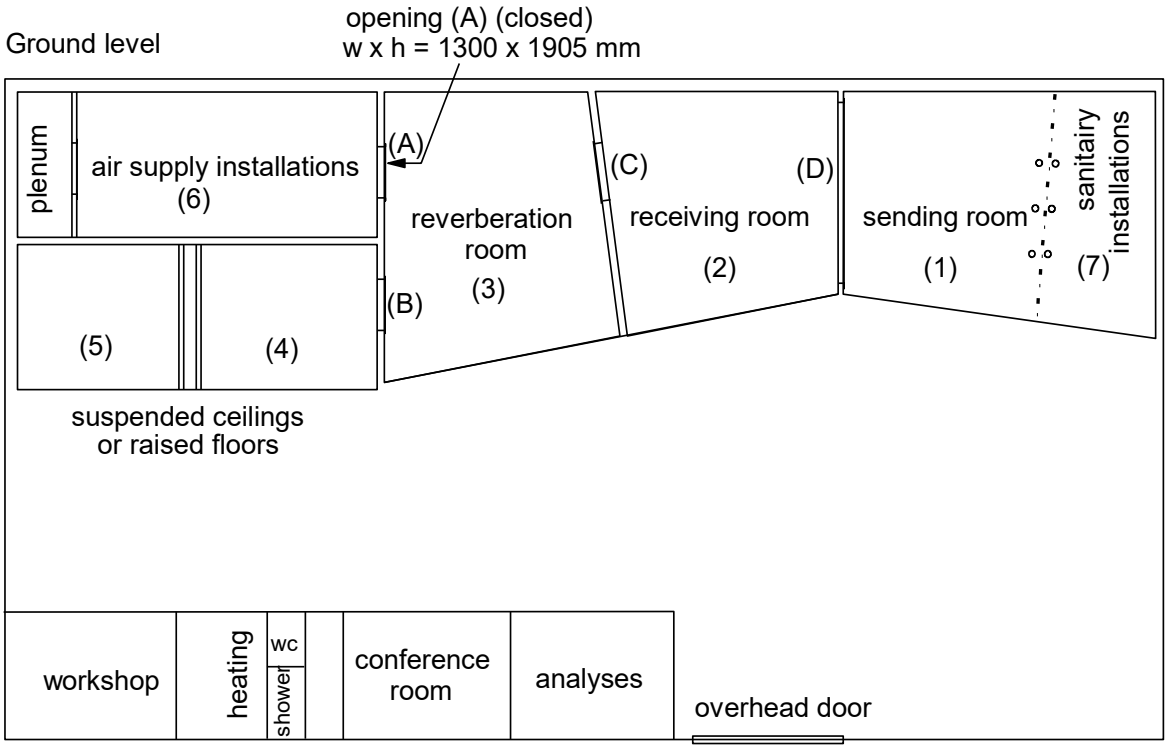
PEUTZ bv
Lindenlaan 41, NL-6584 AC MOLENHOEK (LB), THE NETHERLANDS

OVERVIEW

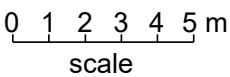
Story



Ground level



TEST OPENINGS (w x h in mm)
(B) 1000 x 2200
(C) 1500 x 1250
(D) 4300 x 2800
(E) 4000 x 4000



LABORATORY FOR ACOUSTICS

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 m2 a sufficient diffusion has been gained.

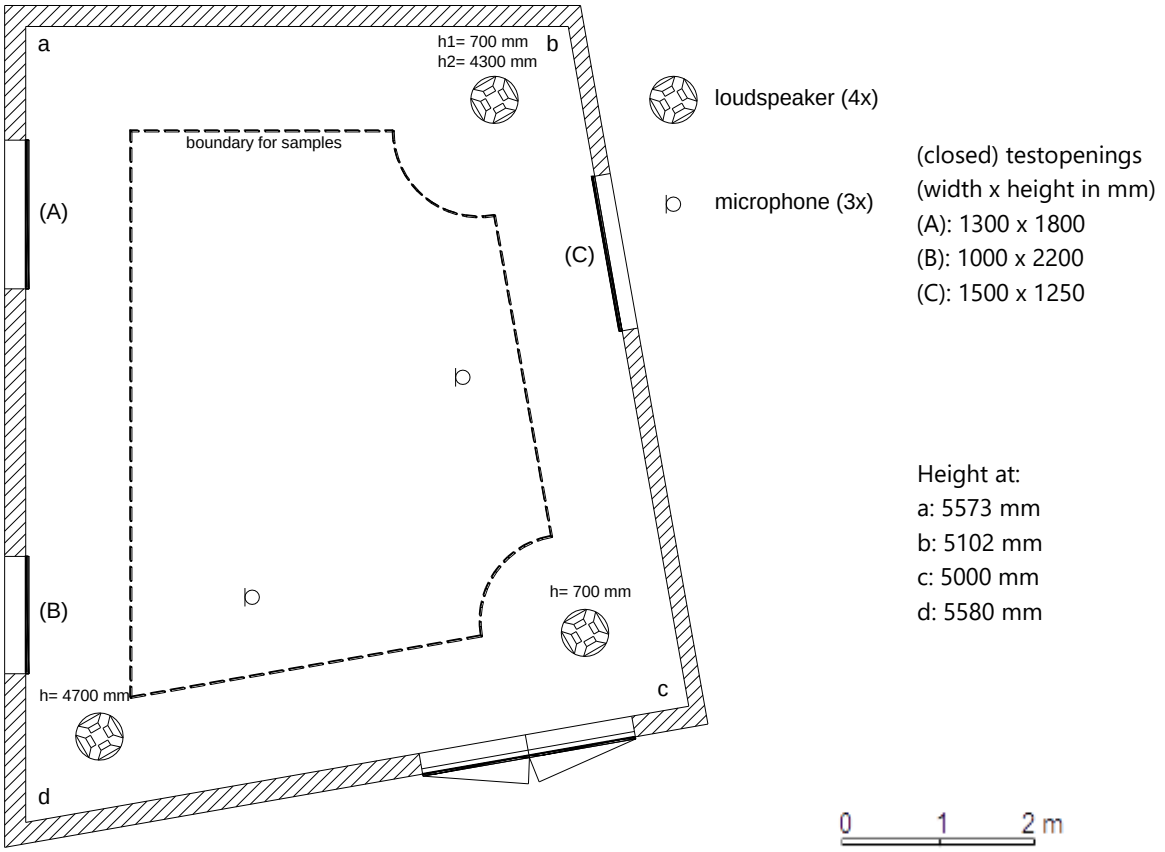
reverberation time of the empty reverberation room during measurements of 29-04-2024

frequency (1/1oct)	125	250	500	1000	2000	4000	Hz
reverberationtime	8,78	7,02	6,76	6,37	4,60	2,79	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 5.10.4 mode 7, file: a4557 E#:1-36 T_1 = 15,8 °C p_1 = 101,6 kPa h_1 = 52,0 %

Figure 2.2

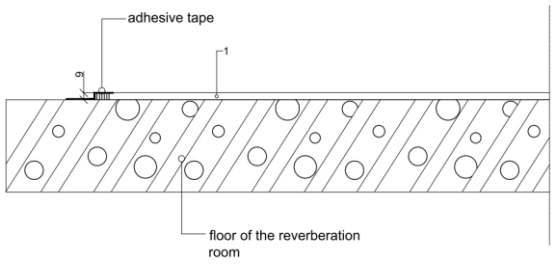
LABORATORY FOR ACOUSTICS

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

principal: De Vorm

TESTING RvA L 334

Variant 1: Mute Peak / directly on the floor



volume reverberation room
214 m³

surface area sample
11,5 m²

height of the construction
0,034 m

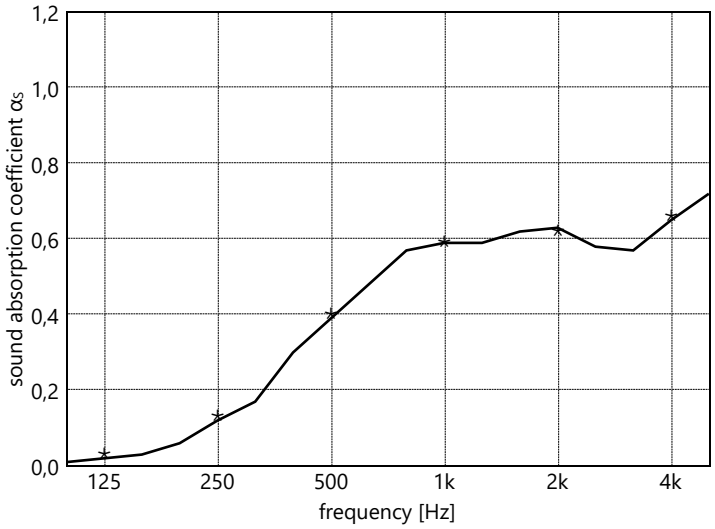
measured at
Peutz Laboratory for Acoustics

signal
broad-band noise

bandwidth
1/3 octave

α_w(ISO 11654) = 0,40(H)

SAA (ASTM - C423) = 0,43



	0,01	0,06	0,30	0,57	0,62	0,57
1/3 oct.	0,02	0,12	0,39	0,59	0,63	0,65
	0,03	0,17	0,48	0,59	0,58	0,72
1/1 oct.	**0,02**	**0,12**	**0,39**	**0,58**	**0,61**	**0,65**

——— 1/3 oct.

* 1/1 oct.

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Mook, measured at 29-04-2024

Absorb, versie 5.10.4 mode 7, PM: RA, file: a4557 E#:1-36 F#:189-224 A#:263 T_1= 15,8°C T_2= 16,2°C p_1= 101,6 kPa p_2= 101,7 kPa h_1= 52,0 % h_2= 57,0 %

A 4557-3E-RA-002 (BOA3026E7) REMKO

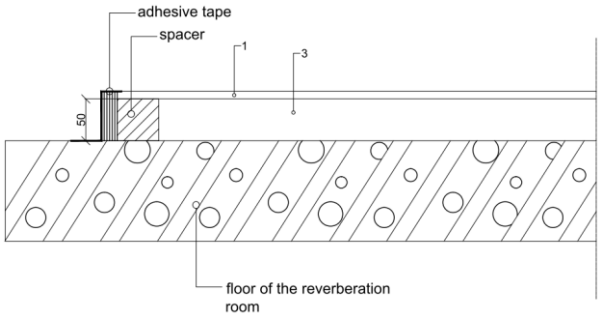
LABORATORY FOR ACOUSTICS

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

principal: De Vorm

TESTING RvA L 334

Variant 2: Mute Peak on top of an air cavity of 50 mm



volume reverberation room
214 m³

surface area sample
11,5 m²

height of the construction
0,084 m

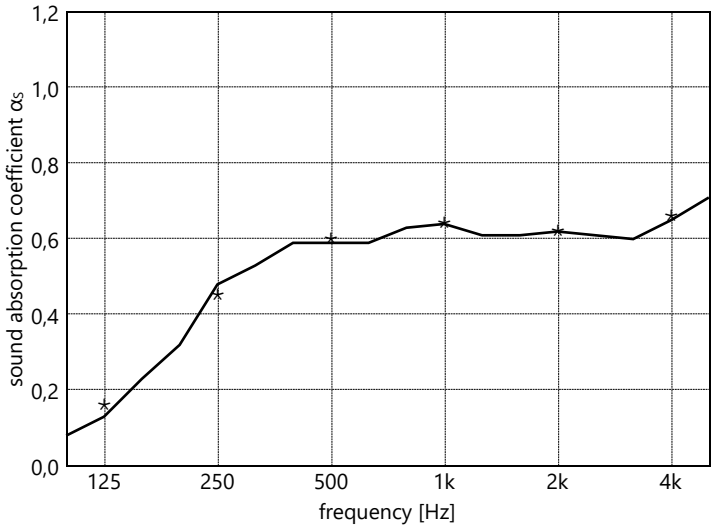
measured at
Peutz Laboratory for Acoustics

signal
broad-band noise

bandwidth
1/3 octave

α_w(ISO 11654) = 0,65

SAA (ASTM - C423) = 0,57



	0,08	0,32	0,59	0,63	0,61	0,60
1/3 oct.	0,13	0,48	0,59	0,64	0,62	0,65
	0,23	0,53	0,59	0,61	0,61	0,71
1/1 oct.	**0,15**	**0,44**	**0,59**	**0,63**	**0,61**	**0,65**

——— 1/3 oct.

* 1/1 oct.

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Mook, measured at 29-04-2024

Absorb, versie 5.10.4 mode 7, PM: RA, file: a4557 E#:1-36 F#:264-299 A#:300 T_1= 15,8°C T_2= 16,5°C p_1= 101,6 kPa p_2= 101,6 kPa h_1= 52,0 % h_2= 58,1 %

A 4557-3E-RA-002 /BOA3026E7/ REMKO

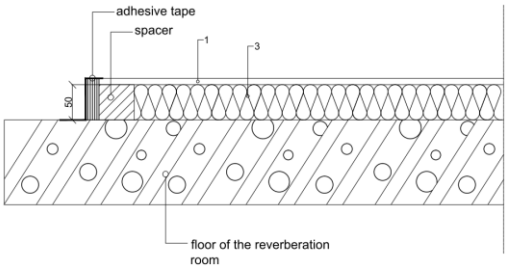
LABORATORY FOR ACOUSTICS

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

principal: De Vorm

TESTING RvA L 334

Variant 3: Mute Peak on top of a 50 mm thick layer of stone wool



volume reverberation room
214 m³

surface area sample
11,5 m²

height of the construction
0,084 m

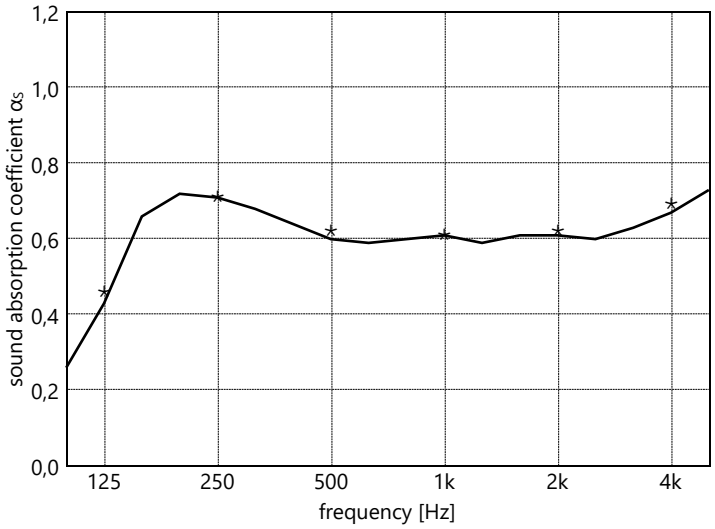
measured at
Peutz Laboratory for Acoustics

signal
broad-band noise

bandwidth
1/3 octave

α_w(ISO 11654) = 0,60(L)

SAA (ASTM - C423) = 0,63



	0,26	0,72	0,64	0,60	0,61	0,63
1/3 oct.	0,43	0,71	0,60	0,61	0,61	0,67
	0,66	0,68	0,59	0,59	0,60	0,73
1/1 oct.	**0,45**	**0,70**	**0,61**	**0,60**	**0,61**	**0,68**

——— 1/3 oct.

* 1/1 oct.

publication is permitted for the entire page only

Mook, measured at 29-04-2024

Absorb, versie 5.10.4 mode 7, PM: RA, file: a4557 E#:1-36 F#:226-261 A#:262 T_1= 15,8°C T_2= 16,5°C p_1= 101,6 kPa p_2= 101,6 kPa h_1= 52,0 % h_2= 58,7 %

A 4557-3E-RA-002 /BOA3026E7/ REMKO

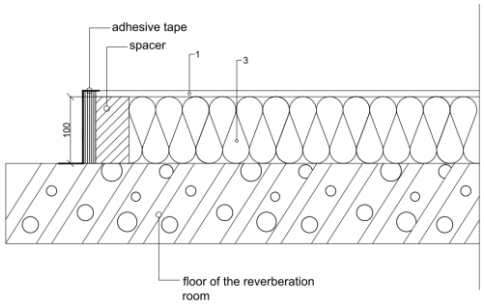
LABORATORY FOR ACOUSTICS

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

principal: De Vorm

TESTING RvA L 334

Variant 4: Mute Peak on top of a 100 mm thick layer of stone wool



volume reverberation room
214 m³

surface area sample
11,5 m²

height of the construction
0,134 m

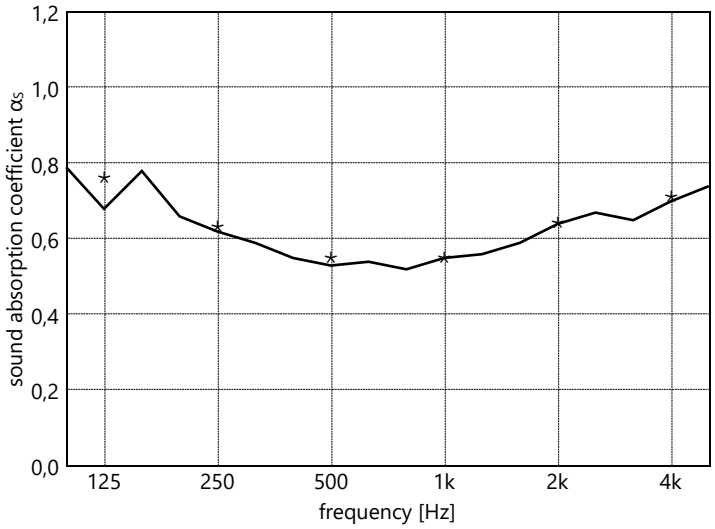
measured at
Peutz Laboratory for Acoustics

signal
broad-band noise

bandwidth
1/3 octave

α_w(ISO 11654) = 0,60

SAA (ASTM - C423) = 0,59



	0,79	0,66	0,55	0,52	0,59	0,65
1/3 oct.	0,68	0,62	0,53	0,55	0,64	0,70
	0,78	0,59	0,54	0,56	0,67	0,74
1/1 oct.	**0,75**	**0,62**	**0,54**	**0,54**	**0,63**	**0,70**

——— 1/3 oct.

* 1/1 oct.

publication is permitted for the entire page only

Mook, measured at 29-04-2024