

Müller-BBM Building Solutions GmbH
Helmut-A.-Müller-Straße 1 - 5
82152 Planegg

Telephone +49(89)3540486 0

www.mbbm-bso.com

Dipl.-Ing. (FH) Dominik Reif
Telephone +49(89)3540486 49
dominik.reif@mbbm-bso.com

2023-11-13
B102794/50 Version 1 RFD/STY

Vertical Blinds ACOUSTIC STRIPES

Measurement of sound absorption
according to DIN EN ISO 354

Test Report No. **B102794/50**

Client:	Création Baumann AG Bern-Zürich-Strasse 23 4901 Langenthal Switzerland
Consultant:	Dipl.-Ing. (FH) Dominik Reif
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Delivery of the test objects:	2023-07-31
Date of measurement:	2023-08-15
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Müller-BBM Building Solutions GmbH
HRB Munich 278753
VAT No. DE355267779

Managing Directors:
Stefan Schierer, Elmar Schröder

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test facility and test equipment

1 Task

On behalf of the company Création Baumann AG, CH-4901 Langenthal, the sound absorption of the vertical blinds ACOUSTIC STRIPES had to be measured according to DIN EN ISO 354 [1] in the reverberation room. The vertical blinds were tested as a curtain in an open, semi-open and closed arrangement with a distance of 150 mm to the reflective wall. As ordered by the customer, the blinds were also tested hanging freely in the reverberation room.

2 Basis

This test report is based on the following documents:

- [1] DIN EN ISO 354: Acoustics – Measurement of sound absorption in a reverberation room (ISO 354:2003); German version EN ISO 354:2003. 2003-12
- [2] DIN EN ISO 11654: Acoustics – Sound absorbers for use in buildings – Rating of sound absorption (ISO 11654:1997); German version EN ISO 11654:1997. 1997-07
- [3] ASTM C 423-22: Standard Test Method for Sound Absorption and Sound Absorption Coefficients by the Reverberation Room Method. Revision: 22. 2022-03
- [4] ISO 9613-1: Acoustics – Attenuation of sound during propagation outdoors – Part 1: calculation of the absorption of sound by the atmosphere. 1993-06
- [5] DIN EN ISO 5084: Textiles – Determination of thickness of textiles and textile products (ISO 5084:1996); German version EN ISO 5084: 1996. 1996-10
- [6] DIN EN ISO 9053-1: Acoustics – Determination of airflow resistance – Part 1: Static airflow method (ISO 9053-1:2018); German version EN ISO 9053-1:2018. 2019-03
- [7] DIN EN ISO 12999-2: Acoustics – Determination and application of measurement uncertainties in building acoustics – Part 2: Sound absorption (ISO 12999-2:2020); German version EN ISO 12999-2:2020. 2020-11

3 Test object and test assembly

3.1 Test object

The tested blinds are described by the manufacturer as follows:

- Manufacturer Création Baumann
- Article: ACOUSTIC STRIPES
- Composition 100 % PLF

The following parameters were determined by the testing laboratory on the basis of a circular sample ($\varnothing = 100$ mm) from the test material:

- Thickness acc. to DIN EN ISO 5084 [5] (3 positions, pressure 1.00 kPa, pressure-foot 2000 mm²): $d = 7.5$ mm
- Specific airflow resistance according to DIN EN ISO 9053-1 [6]: $R_s = 926$ Pa·s/m
- Area specific mass: $m'' = 1847$ g/m²

3.2 Test assemblies

The installation of the test objects in the reverberation room was carried out by employees of the testing laboratory. The test objects were tested in an open (opening angle 90°), a semi-open (opening angle 45°) and closed (opening angle 0°) arrangement in the reverberation room.

3.2.1 Vertical blinds in front of the wall of the reverberation room (Appendix A, pages 1, 2 and 3)

For the test assembly of the blinds in front of the wall of the reverberation room, the blinds were mounted as follows:

- Mounting type G-150 according to DIN EN ISO 354 [1], section 6.2.1, and appendix B of DIN EN ISO 354 [1]
- Distance to the rear wall 150 mm (= distance from the center of the ceiling rail to the rear wall of the reverberation room)
- Fitting in a standard ceiling rail ($h = 28$ mm), with load-bearing wooden construction ($h = 50$ mm)
- 10 mm distance from the blinds to the floor of the reverberation room
- Test object made of 40 lamellas ($w \times h = 127$ mm x 2380 mm), distance between the lamella suspension points approx. 107 mm
- Total dimension of the test surface (starting at the lower border of the load-bearing wooden construction incl. ceiling rail) $w \times h = 4,28$ m x 2.41 m = 10.31 m²
- Measurement without enclosing frame

3.2.2 Vertical blinds hanging freely in the reverberation room (Appendix A, pages 4 a/b, 5 a/b and 6 a/b)

In addition, the blinds were tested hanging freely in the reverberation room. The standard ceiling rail with the blinds was suspended from a load-bearing wooden construction ($h = 50 \text{ mm}$), supported on two steel props. The distance between the lamellas and the walls of the reverberation room was $> 2 \text{ m}$.

For the test assembly of the blinds hanging freely in the reverberation room, the following construction features were given:

- Blinds hanging freely in the reverberation room
- Test object made of 40 lamellas,
distance between the lamella suspension points approx. 107 mm
- 10 mm distance from the blinds to the floor of the reverberation room
- Total dimensions of the test surface
(starting at the lower border of the load-bearing wooden construction
incl. ceiling rail)
 $2 \times w \times h = 4.28 \text{ m} \times 2.41 \text{ m} = 20.63 \text{ m}^2$

The photographs in Appendix B show details of the test arrangements.

4 Test method

The measurements were executed according to DIN EN ISO 354 [1].

The test procedure, the test stand and the test equipment used for the measurements are described in Appendix C.

5 Evaluation

5.1 Vertical blinds in front of the wall of the reverberation room

The sound absorption coefficient α_s was determined in one-third octave bands between 100 Hz and 5000 Hz according to DIN EN ISO 354 [1].

In addition, the following characteristic values were determined according to DIN EN ISO 11654 [2].

- Practical sound absorption coefficient α_p in octave bands
- Weighted sound absorption coefficient α_w as single value

The weighted sound absorption coefficient α_w is determined from the practical sound absorption coefficients α_p in the octave bands of 250 Hz to 4000 Hz.

According to ASTM C 423 [3] the following characteristic values were determined:

- Noise reduction coefficient *NRC* as single value
Arithmetical mean value of the sound absorption coefficients in the four one-third octave bands 250 Hz, 500 Hz, 1000 Hz and 2000 Hz; mean value rounded to 0.05.
- Sound absorption average *SAA* as single value
Arithmetical mean value of the sound absorption coefficients in the twelve one-third octave bands between 250 Hz and 2500 Hz; mean value rounded to 0.01.

5.2 Vertical blinds hanging freely in the reverberation room

The indication of a sound absorption coefficient does not correspond to the standard since DIN EN ISO 354 [1] does not provide a definition of the test area to be applied to test objects hanging freely in the reverberation room as is required for a comparable measurement of products.

Therefore, the equivalent absorption area A_{Obj} between 100 Hz and 5000 Hz according to DIN EN ISO 354 [1] was determined for the blinds hanging freely in the reverberation room.

However, some test reports indicate sound absorption coefficients that are formed by referring the equivalent sound absorption area A_{Obj} to a more or less randomly selected test surface. The sound absorption coefficient is indicated in this test report for comparison reasons with existing test certificates of fabrics hanging freely in the reverberation room in which only the sound absorption coefficient is stated. The viewing surface on both sides of the blinds was used as test area for the determination of the sound absorption coefficient.

This approach was based on the specifications for the testing of partition walls in ASTM C 423-22 [3].

6 Measurement results

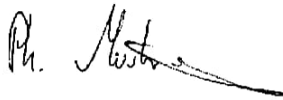
The sound absorption coefficients α_s in one-third octave bands, the practical sound absorption coefficients α_p in octave bands and the single values (α_w , *NRC* und *SAA*) are indicated in the test certificates in Appendix A, pages 1, 2, 3, 4 b, 5 b, and 6 b.

The equivalent absorption areas A_{obj} are indicated in the test certificates in Appendix A, pages 4 a, 5 a, and 6 a.

Information on the measurement uncertainties are given in Appendix C. Measurement uncertainties were not considered for attribution of the classes of sound absorption according to DIN EN ISO 11654 [2].

7 Remarks

The test results exclusively relate to the investigated subjects and conditions described.



M.Eng. Philipp Meistring
(Responsible for technical content)



Dipl.-Ing. (FH) Dominik Reif
(Project Manager)

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Sound absorption coefficient ISO 354

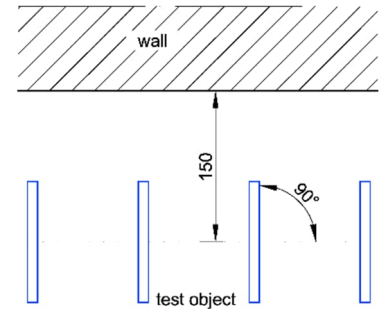
Measurement of sound absorption in reverberation rooms

Client: Cr ation Baumann AG
Bern-Z rich-Strasse 23, CH - 4901 Langenthal

Test specimen: ACOUSTIC STRIPES, open - opening angle 90 

Mounting of test object:

- Test set-up type G-150 according to DIN EN ISO 354
- Testing area width x height = 4.28 m x 2.41 m
- 150 mm distance between blinds and wall of reverberation room
- 40 lamellas, distance between the lamellas approx. 107 mm
- Set-up without enclosing frame



Test object:

Manufacturer information:

- Article: ACOUSTIC STRIPES
- Composition: 100 % PLF

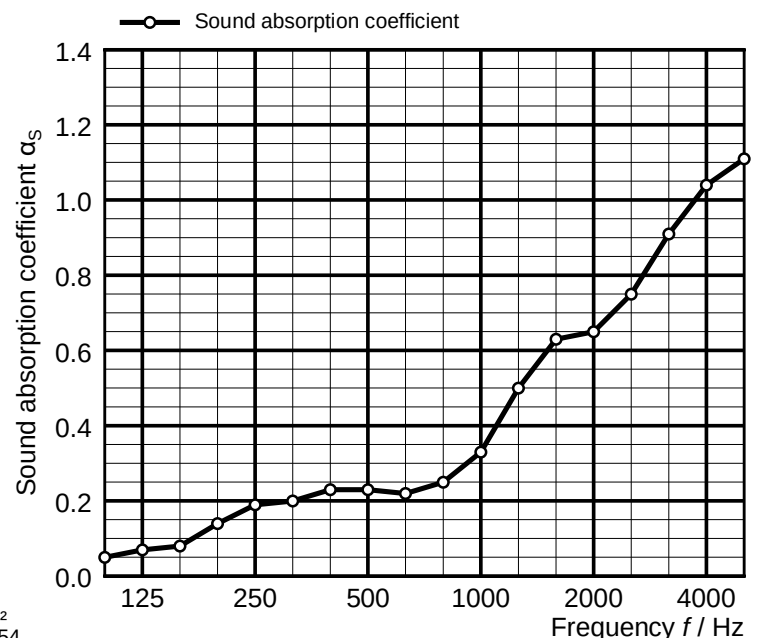
Values determined by the test laboratory:

- Thickness of lamellas $d = 7.5$ mm
- Area specific mass $m'' = 1847$ g/m²
- Specific airflow resistance according to DIN EN ISO 9053-1 $R_S = 926$ Pa s/m

Room: Hallraum E
Volume: 199.60 m³
Size: 10.31 m²
Date of test: 2023-08-15

	θ [�C]	r, h [%]	B [kPa]
without specimen	25.3	55.0	95.3
with specimen	25.2	55.4	95.3

Frequency [Hz]	α_s 1/3 octave	α_p octave
100	0.05	0.05
125	0.07	
160	0.08	
200	0.14	0.20
250	0.19	
315	0.20	
400	0.23	0.25
500	0.23	
630	0.22	
800	0.25	0.35
1000	0.33	
1250	0.50	
1600	0.63	0.70
2000	0.65	
2500	0.75	
3150	0.91	1.00
4000	1.04	
5000	1.11	



◦ Equivalent sound absorption area less than 1.0 m²
 α_s Sound absorption coefficient according to ISO 354
 α_p Practical sound absorption coefficient according to ISO 11654

Rating according to ISO 11654:
Weighted sound absorption coefficient
 $\alpha_w = 0.35$ (H)
Sound absorption class: D

Rating according to ASTM C423:
Noise Reduction Coefficient $NRC = 0.35$
Sound Absorption Average $SAA = 0.36$

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Appendix A

Page 1

Sound absorption coefficient ISO 354

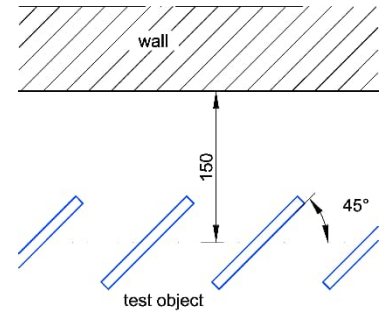
Measurement of sound absorption in reverberation rooms

Client: Cr ation Baumann AG
Bern-Z rich-Strasse 23, CH - 4901 Langenthal

Test specimen: ACOUSTIC STRIPES, semi-open - opening angle 45 

Mounting of test object:

- Test set-up type G-150 according to DIN EN ISO 354
- Testing area width x height = 4.28 m x 2.41 m
- 150 mm distance between blinds and wall of reverberation room
- 40 lamellas, distance between the lamellas approx. 107 mm
- Set-up without enclosing frame



Test object:

Manufacturer information:

- Article: ACOUSTIC STRIPES
- Composition: 100 % PLF

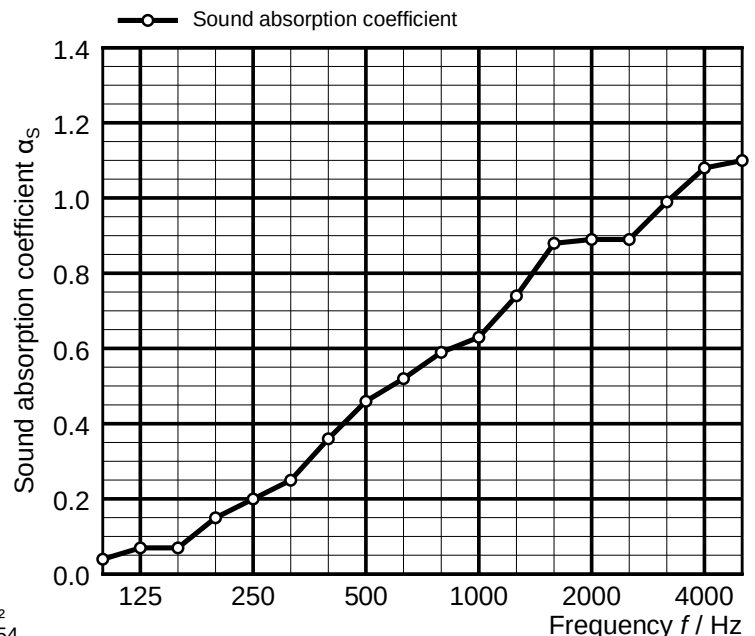
Values determined by the test laboratory:

- Thickness of lamellas $d = 7.5$ mm
- Area specific mass $m'' = 1847$ g/m²
- Specific airflow resistance according to DIN EN ISO 9053-1 $R_S = 926$ Pa s/m

Room: Hallraum E
Volume: 199.60 m³
Size: 10.31 m²
Date of test: 2023-08-15

	θ [�C]	$r. h.$ [%]	B [kPa]
without specimen	25.3	55.0	95.3
with specimen	25.3	55.6	95.3

Frequency [Hz]	α_s 1/3 octave	α_p octave
100	0.04	0.05
125	0.07	
160	0.07	
200	0.15	0.20
250	0.20	
315	0.25	
400	0.36	0.45
500	0.46	
630	0.52	
800	0.59	0.65
1000	0.63	
1250	0.74	
1600	0.88	0.90
2000	0.89	
2500	0.89	
3150	0.99	1.00
4000	1.08	
5000	1.10	



◦ Equivalent sound absorption area less than 1.0 m²
 α_s Sound absorption coefficient according to ISO 354
 α_p Practical sound absorption coefficient according to ISO 11654

Rating according to ISO 11654:
Weighted sound absorption coefficient
 $\alpha_w = 0.45$ (H)
Sound absorption class: D

Rating according to ASTM C423:
Noise Reduction Coefficient $NRC = 0.55$
Sound Absorption Average $SAA = 0.55$

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Appendix A

Page 2

Sound absorption coefficient ISO 354

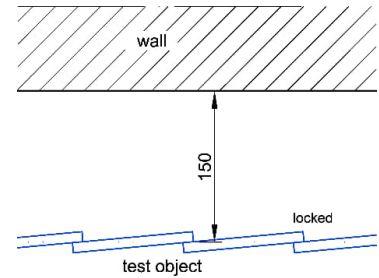
Measurement of sound absorption in reverberation rooms

Client: Cr ation Baumann AG
Bern-Z rich-Strasse 23, CH - 4901 Langenthal

Test specimen: ACOUSTIC STRIPES, closed - opening angle 0 

Mounting of test object:

- Test set-up type G-150 according to DIN EN ISO 354
- Testing area width x height = 4.28 m x 2.41 m
- 150 mm distance between blinds and wall of reverberation room
- 40 lamellas, distance between the lamellas approx. 107 mm
- Set-up without enclosing frame



Test object:

Manufacturer information:

- Article: ACOUSTIC STRIPES
- Composition: 100 % PLF

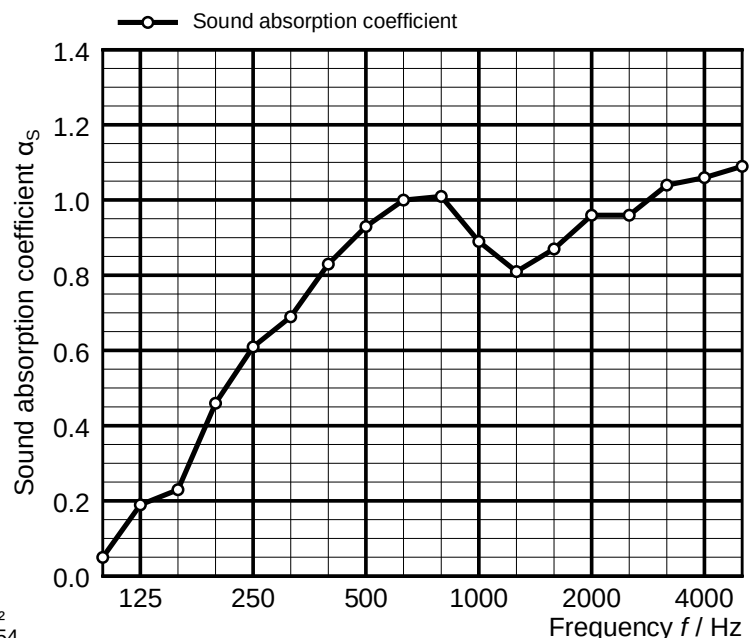
Values determined by the test laboratory:

- Thickness of lamellas $d = 7.5$ mm
- Area specific mass $m'' = 1847$ g/m²
- Specific airflow resistance according to DIN EN ISO 9053-1 $R_S = 926$ Pa s/m

Room: Hallraum E
Volume: 199.60 m³
Size: 10.31 m²
Date of test: 2023-08-15

	θ [�C]	$r. h.$ [%]	B [kPa]
without specimen	25.3	55.0	95.3
with specimen	25.3	55.8	95.3

Frequency [Hz]	α_s 1/3 octave	α_p octave
100	0.05	
125	0.19	0.15
160	0.23	
200	0.46	
250	0.61	0.60
315	0.69	
400	0.83	
500	0.93	0.90
630	1.00	
800	1.01	
1000	0.89	0.90
1250	0.81	
1600	0.87	
2000	0.96	0.95
2500	0.96	
3150	1.04	
4000	1.06	1.00
5000	1.09	



  Equivalent sound absorption area less than 1.0 m²
 α_s Sound absorption coefficient according to ISO 354
 α_p Practical sound absorption coefficient according to ISO 11654

Rating according to ISO 11654:
Weighted sound absorption coefficient
 $\alpha_w = 0.90$
Sound absorption class: A

Rating according to ASTM C423:
Noise Reduction Coefficient $NRC = 0.85$
Sound Absorption Average $SAA = 0.84$

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Appendix A

Page 3

Equivalent sound absorption area ISO 354

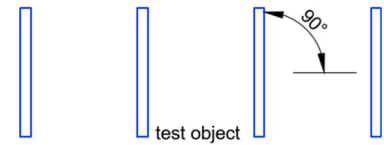
Measurement of sound absorption in reverberation rooms

Client: Cr ation Baumann AG
Bern-Z rich-Strasse 23, CH - 4901 Langenthal

Test specimen: ACOUSTIC STRIPES, open - opening angle 90  -
hanging freely in the reverberation room

Mounting of test object:

- Testing area 2 x width x height = 2 x 4.28 m x 2.41 m
- Blinds hanging freely in the reverberation room
- 40 lamellas, distance between the lamellas approx. 107 mm
- Set-up without enclosing frame



Test object:

Manufacturer information:

- Article: ACOUSTIC STRIPES
- Composition: 100 % PLF

Values determined by the test laboratory:

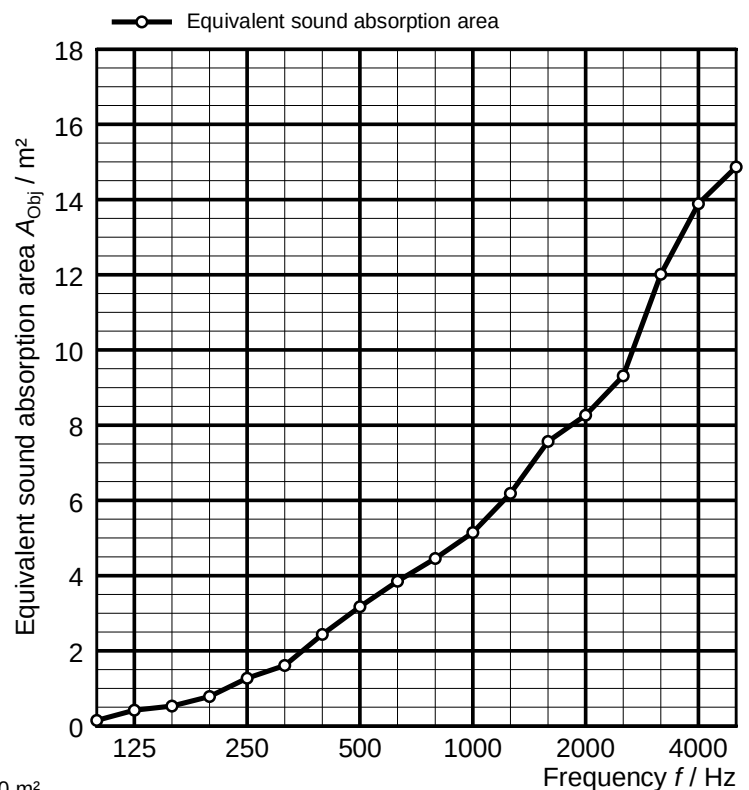
- Thickness of lamellas $d = 7.5$ mm
- Area specific mass $m'' = 1847$ g/m²
- Specific airflow resistance according to DIN EN ISO 9053-1 $R_S = 926$ Pa s/m

	θ [�C]	$r. h.$ [%]	B [kPa]
without specimen	25.3	55.0	95.3
with specimen	25.3	58.1	95.2

Room: Hallraum E
Volume: 199.60 m³
Date of test: 2023-08-15

Frequency [Hz]	A_{Obj} 1/3 octave [m ²]
100	� 0.2
125	� 0.4
160	� 0.5
200	� 0.8
250	1.3
315	1.6
400	2.4
500	3.2
630	3.9
800	4.5
1000	5.1
1250	6.2
1600	7.6
2000	8.3
2500	9.3
3150	• 12.0
4000	• 13.9
5000	• 14.9

-   Equivalent sound absorption area less than 1.0 m²
- Equivalent sound absorption area greater than 12.0 m²



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Appendix A

Page 4 a

Sound absorption coefficient ISO 354

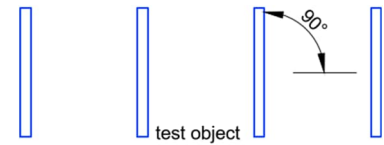
Measurement of sound absorption in reverberation rooms

Client: Création Baumann AG
Bern-Zürich-Strasse 23, CH - 4901 Langenthal

Test specimen: ACOUSTIC STRIPES, open - opening angle 90° - hanging freely in the reverberation room

Mounting of test object:

- Testing area 2 x width x height = 2 x 4.28 m x 2.41 m
- Blinds hanging freely in the reverberation room
- 40 lamellas, distance between the lamellas approx. 107 mm
- Set-up without enclosing frame



Test object:

Manufacturer information:

- Article: ACOUSTIC STRIPES
- Composition: 100 % PLF

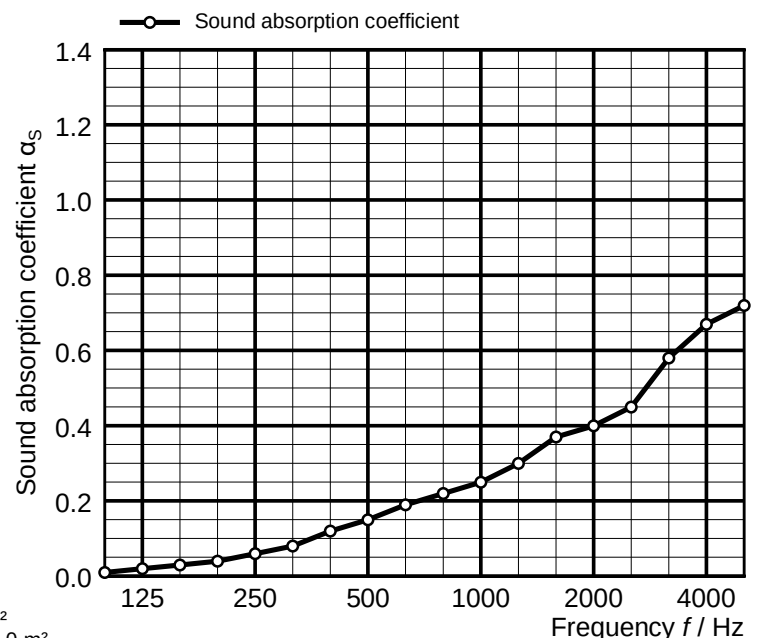
Values determined by the test laboratory:

- Thickness of lamellas $d = 7.5$ mm
- Area specific mass $m'' = 1847$ g/m²
- Specific airflow resistance according to DIN EN ISO 9053-1 $R_S = 926$ Pa s/m

Room: Hallraum E
Volume: 199.60 m³
Size: 20.63 m²
Date of test: 2023-08-15

	θ [°C]	$r. h.$ [%]	B [kPa]
without specimen	25.3	55.0	95.3
with specimen	25.3	58.1	95.2

Frequency [Hz]	α_s 1/3 octave	α_p octave
100	◦ 0.01	0.00
125	◦ 0.02	
160	◦ 0.03	
200	◦ 0.04	0.05
250	0.06	
315	0.08	
400	0.12	0.15
500	0.15	
630	0.19	
800	0.22	0.25
1000	0.25	
1250	0.30	
1600	0.37	0.40
2000	0.40	
2500	0.45	
3150	• 0.58	0.65
4000	• 0.67	
5000	• 0.72	



◦ Equivalent sound absorption area less than 1.0 m²
• Equivalent sound absorption area greater than 12.0 m²
 α_s Sound absorption coefficient according to ISO 354
 α_p Practical sound absorption coefficient according to ISO 11654

Rating according to ISO 11654:
Weighted sound absorption coefficient
 $\alpha_w = 0.25$ (H)
Sound absorption class: E

Rating according to ASTM C423:
Noise Reduction Coefficient NRC = 0.20
Sound Absorption Average SAA = 0.22

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Appendix A

Page 4 b

Equivalent sound absorption area ISO 354

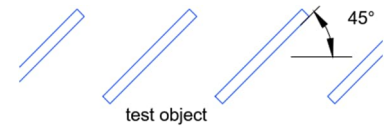
Measurement of sound absorption in reverberation rooms

Client: Cr ation Baumann AG
Bern-Z rich-Strasse 23, CH - 4901 Langenthal

Test specimen: ACOUSTIC STRIPES, semi-open - opening angle 45  -
hanging freely in the reverberation room

Mounting of test object:

- Testing area 2 x width x height = 2 x 4.28 m x 2.41 m
- Blinds hanging freely in the reverberation room
- 40 lamellas, distance between the lamellas approx. 107 mm
- Set-up without enclosing frame



Test object:

Manufacturer information:

- Article: ACOUSTIC STRIPES
- Composition: 100 % PLF

Values determined by the test laboratory:

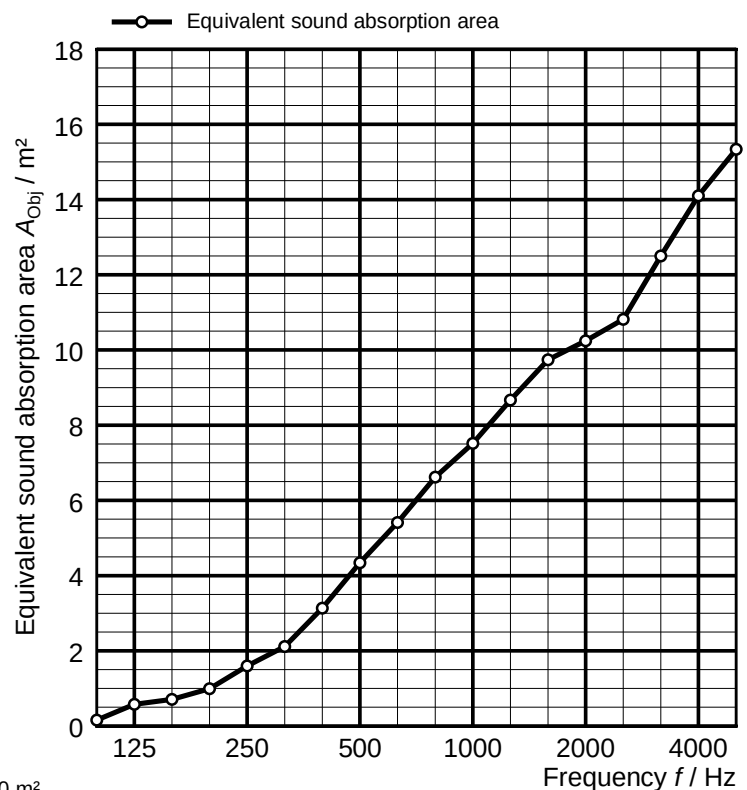
- Thickness of lamellas $d = 7.5$ mm
- Area specific mass $m'' = 1847$ g/m²
- Specific airflow resistance according to DIN EN ISO 9053-1 $R_S = 926$ Pa s/m

	θ [�C]	$r. h.$ [%]	B [kPa]
without specimen	25.3	55.0	95.3
with specimen	25.3	57.7	95.2

Room: Hallraum E
Volume: 199.60 m³
Date of test: 2023-08-15

Frequency [Hz]	A_{Obj} 1/3 octave [m ²]
100	� 0.2
125	� 0.6
160	� 0.7
200	� 1.0
250	1.6
315	2.1
400	3.1
500	4.3
630	5.4
800	6.6
1000	7.5
1250	8.7
1600	9.7
2000	10.2
2500	10.8
3150	• 12.5
4000	• 14.1
5000	• 15.3

-   Equivalent sound absorption area less than 1.0 m²
- Equivalent sound absorption area greater than 12.0 m²



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Appendix A

Page 5 a

Sound absorption coefficient ISO 354

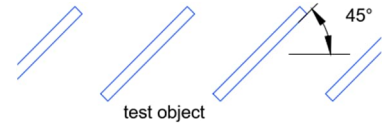
Measurement of sound absorption in reverberation rooms

Client: Cr ation Baumann AG
Bern-Z rich-Strasse 23, CH - 4901 Langenthal

Test specimen: ACOUSTIC STRIPES, semi-open - opening angle 45  - hanging freely in the reverberation room

Mounting of test object:

- Testing area 2 x width x height = 2 x 4.28 m x 2.41 m
- Blinds hanging freely in the reverberation room
- 40 lamellas, distance between the lamellas approx. 107 mm
- Set-up without enclosing frame



Test object:

Manufacturer information:

- Article: ACOUSTIC STRIPES
- Composition: 100 % PLF

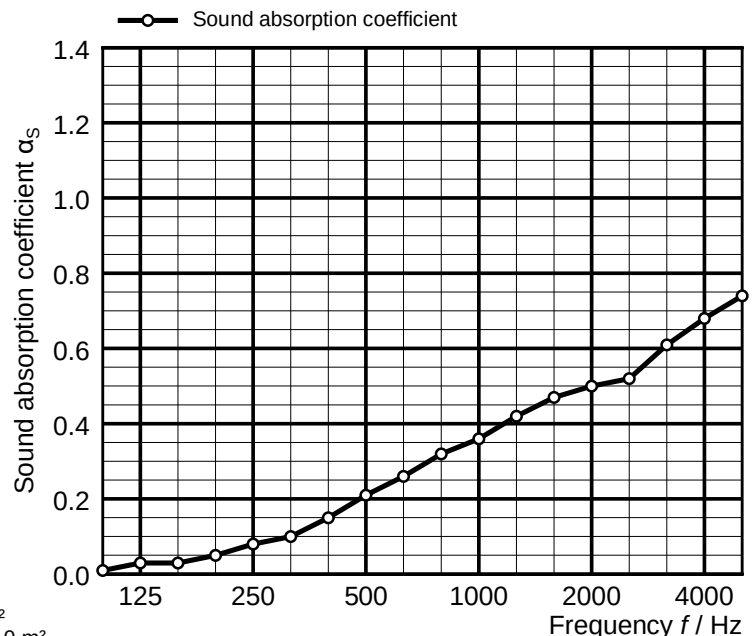
Values determined by the test laboratory:

- Thickness of lamellas $d = 7.5$ mm
- Area specific mass $m'' = 1847$ g/m²
- Specific airflow resistance according to DIN EN ISO 9053-1 $R_S = 926$ Pa s/m

Room: Hallraum E
Volume: 199.60 m³
Size: 20.63 m²
Date of test: 2023-08-15

	θ [�C]	$r. h.$ [%]	B [kPa]
without specimen	25.3	55.0	95.3
with specimen	25.3	57.7	95.2

Frequency [Hz]	α_s 1/3 octave	α_p octave
100	0.01	0.00
125	0.03	
160	0.03	
200	0.05	0.10
250	0.08	
315	0.10	
400	0.15	0.20
500	0.21	
630	0.26	
800	0.32	0.35
1000	0.36	
1250	0.42	
1600	0.47	0.50
2000	0.50	
2500	0.52	
3150	0.61	0.70
4000	0.68	
5000	0.74	



- Equivalent sound absorption area less than 1.0 m²
- Equivalent sound absorption area greater than 12.0 m²
- α_s Sound absorption coefficient according to ISO 354
- α_p Practical sound absorption coefficient according to ISO 11654

Rating according to ISO 11654:
Weighted sound absorption coefficient
 $\alpha_w = 0.30$ (H)
Sound absorption class: D

Rating according to ASTM C423:
Noise Reduction Coefficient $NRC = 0.30$
Sound Absorption Average $SAA = 0.29$

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Appendix A

Page 5 b

Equivalent sound absorption area ISO 354

Measurement of sound absorption in reverberation rooms

Client: Cr ation Baumann AG
Bern-Z rich-Strasse 23, CH - 4901 Langenthal

Test specimen: ACOUSTIC STRIPES, closed - opening angle 0  -
hanging freely in the reverberation room

Mounting of test object:

- Testing area 2 x width x height = 2 x 4.28 m x 2.41 m
- Blinds hanging freely in the reverberation room
- 40 lamellas, distance between the lamellas approx. 107 mm
- Set-up without enclosing frame



Test object:

Manufacturer information:

- Article: ACOUSTIC STRIPES
- Composition: 100 % PLF

Values determined by the test laboratory:

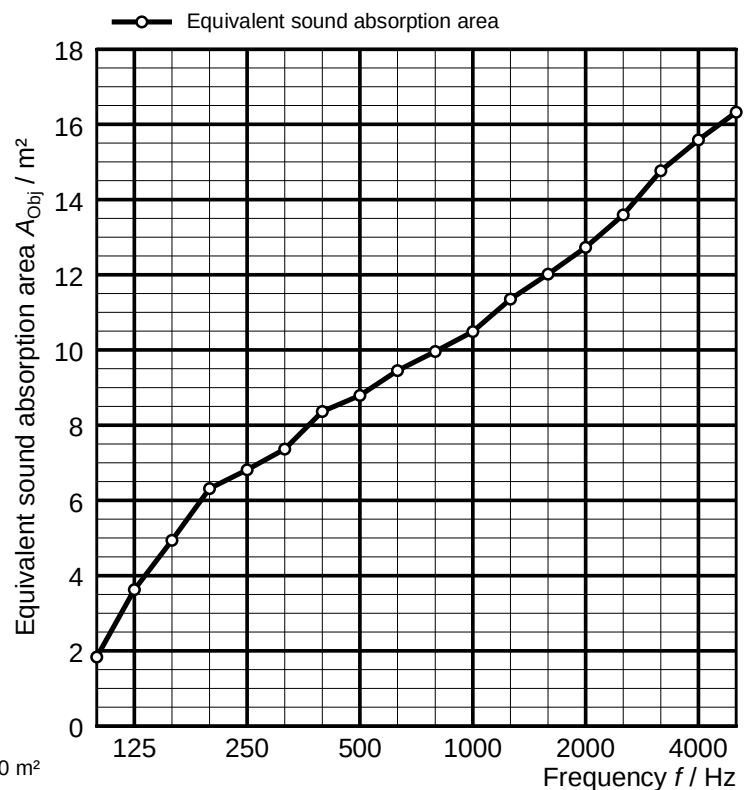
- Thickness of lamellas $d = 7.5$ mm
- Area specific mass $m'' = 1847$ g/m²
- Specific airflow resistance according to DIN EN ISO 9053-1 $R_S = 926$ Pa s/m

	θ [�C]	$r. h.$ [%]	B [kPa]
without specimen	25.3	55.0	95.3
with specimen	25.3	57.8	95.2

Room: Hallraum E
Volume: 199.60 m³
Date of test: 2023-08-15

Frequency [Hz]	A_{Obj} 1/3 octave [m ²]
100	1.8
125	3.6
160	4.9
200	6.3
250	6.8
315	7.4
400	8.4
500	8.8
630	9.5
800	10.0
1000	10.5
1250	11.4
1600	• 12.0
2000	• 12.7
2500	• 13.6
3150	• 14.8
4000	• 15.6
5000	• 16.3

- Equivalent sound absorption area greater than 12.0 m²



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Appendix A

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Sound absorption coefficient ISO 354

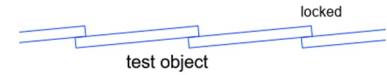
Measurement of sound absorption in reverberation rooms

Client: Cr ation Baumann AG
Bern-Z rich-Strasse 23, CH - 4901 Langenthal

Test specimen: ACOUSTIC STRIPES, closed - opening angle 0  -
hanging freely in the reverberation room

Mounting of test object:

- Testing area 2 x width x height = 2 x 4.28 m x 2.41 m
- Blinds hanging freely in the reverberation room
- 40 lamellas, distance between the lamellas approx. 107 mm
- Set-up without enclosing frame



Test object:

Manufacturer information:

- Article: ACOUSTIC STRIPES
- Composition: 100 % PLF

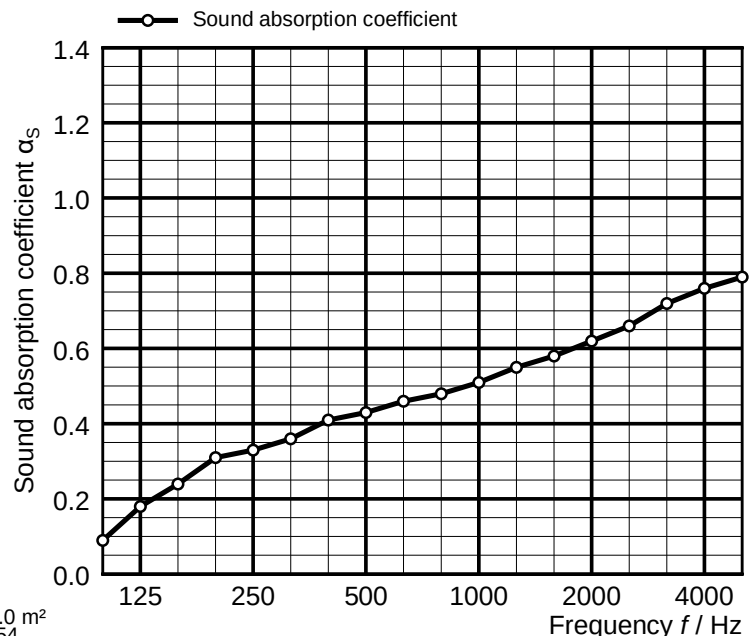
Values determined by the test laboratory:

- Thickness of lamellas $d = 7.5$ mm
- Area specific mass $m'' = 1847$ g/m²
- Specific airflow resistance according to DIN EN ISO 9053-1 $R_S = 926$ Pa s/m

Room: Hallraum E
Volume: 199.60 m³
Size: 20.63 m²
Date of test: 2023-08-15

	θ [�C]	$r. h.$ [%]	B [kPa]
without specimen	25.3	55.0	95.3
with specimen	25.3	57.8	95.2

Frequency [Hz]	α_s 1/3 octave	α_p octave
100	0.09	0.15
125	0.18	
160	0.24	
200	0.31	0.35
250	0.33	
315	0.36	
400	0.41	0.45
500	0.43	
630	0.46	
800	0.48	0.50
1000	0.51	
1250	0.55	
1600	• 0.58	0.60
2000	• 0.62	
2500	• 0.66	
3150	• 0.72	0.75
4000	• 0.76	
5000	• 0.79	



- Equivalent sound absorption area greater than 12.0 m²
- α_s Sound absorption coefficient according to ISO 354
- α_p Practical sound absorption coefficient according to ISO 11654

Rating according to ISO 11654:
Weighted sound absorption coefficient
 $\alpha_w = 0.50$ (H)
Sound absorption class: D

Rating according to ASTM C423:
Noise Reduction Coefficient $NRC = 0.45$
Sound Absorption Average $SAA = 0.48$

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Appendix A

Page 6 b

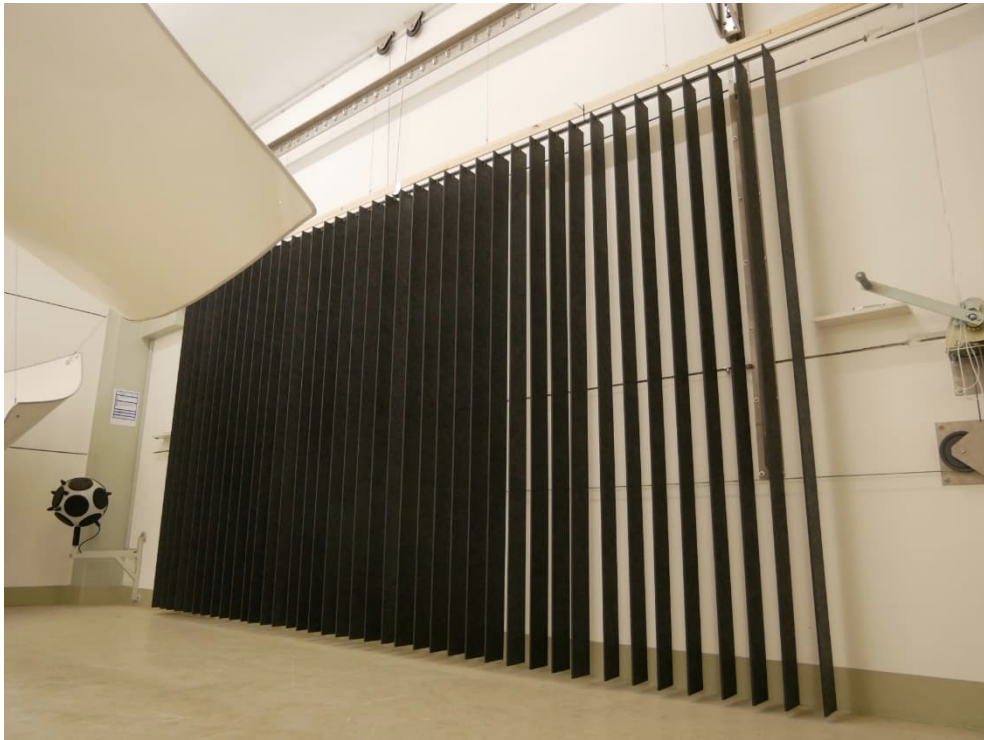
Vertical blinds ACOUSTIC STRIPES, Création Baumann

Figure B.1. Test object mounted in the reverberation room, opening angle 90° – open, 150 mm distance to the wall.



Figure B.2. Test object mounted in the reverberation room, opening angle 45° – semi-open, 150 mm distance to the wall.

Vertical blinds ACOUSTIC STRIPES, Création Baumann

Figure B.3. Test object mounted in the reverberation room, opening angle 0° – closed, 150 mm distance to the wall.

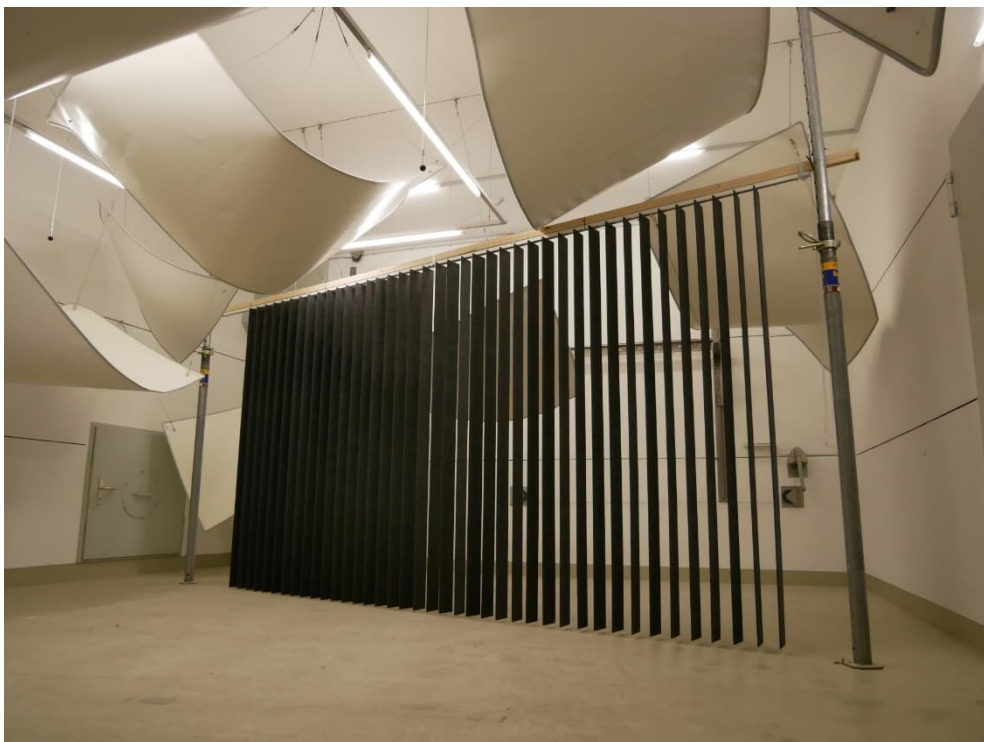


Figure B.4. Test object mounted in the reverberation room, opening angle 90° – open, hanging freely in the reverberation room.

Vertical blinds ACOUSTIC STRIPES, Création Baumann

Figure B.5. Test object mounted in the reverberation room, opening angle 45° – semi-open, hanging freely in the reverberation room.



Figure B.6. Test object mounted in the reverberation room, opening angle 0° – closed, hanging freely in the reverberation room.

Description of the test procedure for the determination of the sound absorption in a reverberation room

1 Measurand Sound Absorption Coefficient

The sound absorption coefficient α of the test object was determined. For this purpose the mean value of the reverberation time in the reverberation room with and without the test object was measured. The sound absorption coefficient was calculated using the following equation:

$$\alpha_s = \frac{A_T}{S}$$

$$A_T = 55,3 V \left(\frac{1}{c_2 T_2} - \frac{1}{c_1 T_1} \right) - 4 V (m_2 - m_1)$$

With:

- α_s sound absorption coefficient
- A_T equivalent sound absorption area of the test object in m²
- S area covered by the test object in m²
- V volume of the reverberation room in m³
- c_1 propagation speed of sound in air in the reverberation room without test object in m/s
- c_2 propagation speed of sound in air in the reverberation room with test object in m/s
- T_1 reverberation time in the reverberation room without test object in s
- T_2 reverberation time in the reverberation room with test object in s
- m_1 power attenuation coefficient in the reverberation room without test object in m⁻¹
- m_2 power attenuation coefficient in the reverberation room with test object in m⁻¹

The area covered by the test object was used as testing area.

The different dissipation during the sound propagation in the air was taken into account according to paragraph 8.1.2 of DIN EN ISO 354 [1]. The power attenuation coefficient was calculated according to ISO 9613-1 [4]. The climatic conditions during the measurements are indicated in the test certificates.

Information on the repeatability and reproducibility of the test procedure are given in DIN EN ISO 354 [1] and DIN EN ISO 12999-2 [7]. In [7] for the single-number α_w a standard deviation of reproducibility of $\sigma_R = 0.035$ is indicated. This value was determined from reproducibility data of the test method based on round robin tests and describes the reproducibility of test results that was determined in test laboratories for similar constructions. An aspired confidence level of 95 % results in a coverage factor of $k = 2.0$ and an expanded uncertainty of $U = \pm 0.07$ for the weighted sound absorption coefficient α_w .

2 Measurand Sound Absorption Area

The equivalent sound absorption area A_{Obj} of the test object was determined. For this purpose, the mean value of the reverberation time in the reverberation room with and without the test object was measured. The equivalent sound absorption area was calculated using the following equation:

$$A_{\text{Obj}} = \frac{A_T}{n}$$

$$A_T = 55,3 V \left(\frac{1}{c_2 T_2} - \frac{1}{c_1 T_1} \right) - 4 V (m_2 - m_1)$$

With:

- α_s sound absorption coefficient
- A_T equivalent sound absorption area of the test object in m^2
- S area covered by the test object in m^2
- V volume of the reverberation room in m^3
- c_1 propagation speed of sound in air in the reverberation room without test object in m/s
- c_2 propagation speed of sound in air in the reverberation room with test object in m/s
- T_1 reverberation time in the reverberation room without test object in s
- T_2 reverberation time in the reverberation room with test object in s
- m_1 power attenuation coefficient in the reverberation room without test object in m^{-1}
- m_2 power attenuation coefficient in the reverberation room with test object in m^{-1}

The different dissipation during the sound propagation in the air was taken into account according to paragraph 8.1.2 of DIN EN ISO 354 [1]. The power attenuation coefficient was calculated according to ISO 9613-1 [4]. The climatic conditions during the measurements are indicated in the test certificates.

Information on the repeatability and reproducibility of the test procedure are given in DIN EN ISO 354 [1] and DIN EN ISO 12999-2 [7].

3 Test procedure

3.1 Description of the reverberation room

The reverberation room complies with the requirements according to DIN EN ISO 354 [1].

The reverberation room has a volume of $V = 199,6 \text{ m}^3$ and a surface of $S = 216 \text{ m}^2$.

Six omni-directional microphones and four loudspeakers were installed in the reverberation room. In order to improve the diffusivity, six composite sheet metal boards dimensioned $1,2 \text{ m} \times 2,4 \text{ m}$ and six composite sheet metal boards dimensioned $1,2 \text{ m} \times 1,2 \text{ m}$ were suspended curved and irregularly.

Figure C.1 shows the drawings of the reverberation room.

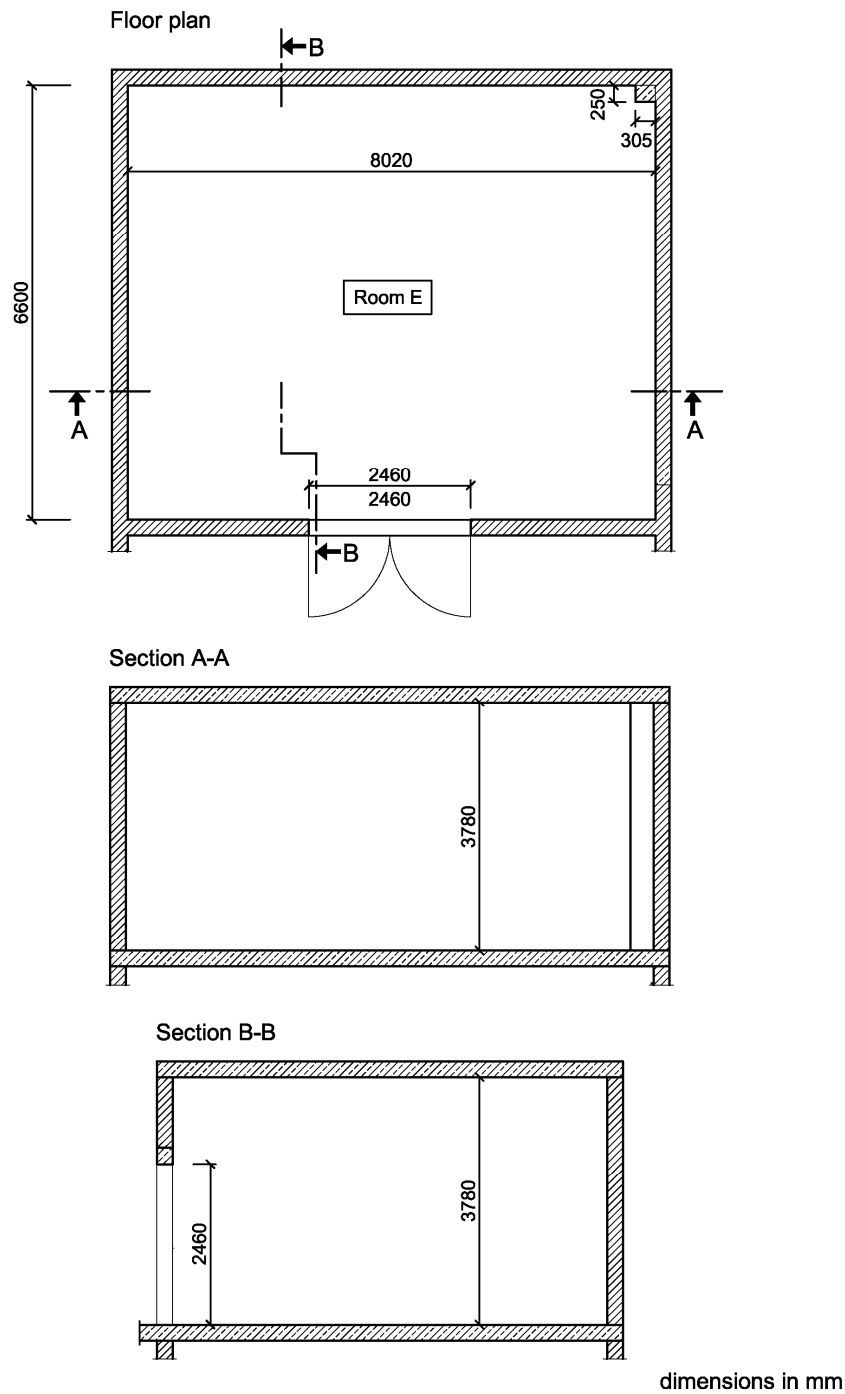


Figure C.1. Plan view and sections of the reverberation room.

3.2 Measurement of reverberation time

The determination of the impulse responses was carried out according to the indirect method. In all tests, a sinusoidal sweep with pink noise spectrum was used as test signal. In the reverberation room with and without test objects each 24 independent combinations of loudspeakers and microphones were measured. The reverberation time was evaluated according to DIN EN ISO 354 [1], using a linear regression for the calculation of the reverberation time T_{20} from the level of a backward integrated impulse response.

The determined reverberation times-are indicated in table C1.

Table C.1. Reverberation times without and with test objects (in front of wall of reverberation room).

Fre- quency f / Hz	Reverberation time T / s			
	T_1 (without test object)	T_2 (with test object)		
		Appendix A, page 1	Appendix A, page 2	Appendix A, page 3
100	5.71	5.20	5.30	5.21
125	6.30	5.53	5.56	4.53
160	6.21	5.37	5.41	4.24
200	5.21	4.23	4.13	2.94
250	5.68	4.20	4.16	2.69
315	5.43	4.03	3.78	2.46
400	5.47	3.88	3.33	2.21
500	5.36	3.82	2.99	2.05
630	5.12	3.76	2.76	1.92
800	4.87	3.50	2.52	1.88
1000	4.90	3.23	2.46	2.04
1250	5.02	2.77	2.28	2.17
1600	4.92	2.47	2.05	2.06
2000	4.72	2.37	2.01	1.91
2500	4.10	2.06	1.88	1.81
3150	3.50	1.72	1.65	1.61
4000	2.87	1.46	1.43	1.45
5000	2.46	1.31	1.31	1.32

Table C.1. Reverberation times without and with test objects (hanging freely in the reverberation room).

Fre- quency f / Hz	Reverberation time T / s			
	T_1 (without test object)	T_2 (with test object)		
		Appendix A, pages 4 a/b	Appendix A, page 5 a/b	Appendix A, page 6 a/b
100	5.71	5.55	5.55	4.29
125	6.30	5.81	5.65	3.67
160	6.21	5.63	5.46	3.17
200	5.21	4.62	4.48	2.56
250	5.68	4.63	4.42	2.57
315	5.43	4.26	3.99	2.41
400	5.47	3.86	3.55	2.25
500	5.36	3.49	3.10	2.16
630	5.12	3.16	2.74	2.03
800	4.87	2.90	2.42	1.93
1000	4.90	2.73	2.27	1.87
1250	5.02	2.54	2.12	1.80
1600	4.92	2.27	1.96	1.72
2000	4.72	2.12	1.88	1.64
2500	4.10	1.87	1.72	1.49
3150	3.50	1.51	1.48	1.34
4000	2.87	1.28	1.27	1.20
5000	2.46	1.15	1.13	1.10

3.3 List of test equipment

The test equipment used is listed in Table C.2.

Table C.2. List of test equipment

Name	Manufacturer	Type	Serial-No.
AD-/DA-converter	RME	Fireface 802	23811470
Amplifier	APart	Champ 2	17120171
Dodecahedron	Müller-BBM	DOD360A	372828
Dodecahedron	Müller-BBM	DOD360A	372829
Dodecahedron	Müller-BBM	DOD360A	372830
Dodecahedron	Müller-BBM	DOD360A	372831
Microphone	Microtech Gefell	M370	1355
Microphone	Microtech Gefell	M370	1356
Microphone	Microtech Gefell	M360	1786
Microphone	Microtech Gefell	M360	1787
Microphone	Microtech Gefell	M360	1788
Microphone	Microtech Gefell	M360	1789
Microphone power supply	MFA	IV80F	330364
Hygro-/Thermometer	Testo	Saveris H1E	01554624
Barometer	Lufft	Opus 10	057.0410.0003.9. 4.1.30
Thickness gauge	Hans Schmidt & Co GmbH	D-2000-C0913	2985
Scales	Kern	KB1200-2N	W1402353
Software for measurement and evaluation	Müller-BBM	Bau 4	Version 1.11