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2019-10-29
M102794/40 RFD/STY

Curtain SIGMACOUSTIC

Measurement of sound absorption according to EN ISO 354

Test Report No. M102794/40

Client:	Création Baumann AG Bern-Zürich-Straße 23 4901 Langenthal Switzerland
Consultant:	Dipl.-Ing. (FH) Dominik Reif
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1 Task

On behalf of the company Création Baumann AG, CH-4901 Langenthal, the sound absorption of the fabric SIGMACOUSTIC had to be measured according to EN ISO 354 [1] in the reverberation room. The fabric was tested as a curtain in a flat and folded arrangement with a distance of 150 mm to the reflective wall.

2 Basis

This test report is based on the following documents:

[1] EN ISO 354: Acoustics – Measurement of sound absorption in a reverberation room. 2003-12

[2] EN ISO 11654: Acoustics – Sound absorbers for use in buildings – Rating of sound absorption. 1997-07

[3] ASTM C 423-17: Standard Test Method for Sound Absorption and Sound Absorption Coefficients by the Reverberation Room Method. Revision 17: 2017-02

[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] EN ISO 9053-1: Acoustics – Determination of airflow resistance. Part 1: Static airflow method (ISO 9053-2:2018); German Version EN ISO 9053-1:2018. March 2019

3 Test object and test assembly

3.1 Test object

The tested material is described by the manufacturer as follows:

- Manufacturer Création Baumann
- Type SIGMACOUSTIC
- Material 100 % PLF (Trevira CS)

The testing laboratory has measured as follows:

- Thickness: d = 0.88 mm
- Specific air flow resistance acc. to EN ISO 9053-1 [5]: R_s = 317 Pa·s/m
- Area specific mass: m'' = 253 g/m²

3.2 Test assembly

The installation of the test objects was carried out by employees of the test laboratory at the reverberation room of Müller-BBM. The test objects were installed in a flat (G-150) and folded arrangement.

Both test assemblies were mounted as follows:

- Distance to the wall 150 mm (= distance between rail and wall)
- Fixed directly underneath the ceiling of the reverberation room, suspended from a metal rail (height 60 mm)
- Construction without enclosing frame
- Fabric arranged with front side acc. to manufacturer's mark towards the reverberation room

The mounting details for the tested arrangements are as follows:

a) Flat arrangement

- Mounting type G-150 according to EN ISO 354 [1], section 6.2.1, and appendix B of EN ISO 354 [1]
- Test object made of one fabric panel, height 3.09 m
- Total dimensions of the test surface (starting at the lower border of the metal rail): width x height = 3.50 m x 3.03 m = 10.61 m^2

b) Folded arrangement

- 100 % fabric addition
- Test object made of two fabric panels, height 3.09 m,
  fabric overlap approx. 20 mm at the joints
- Total dimensions of the test surface (starting at the lower border of the metal rail): width x height = 3.49 m x 3.03 m = 10.57 m^2

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

4 Execution of the measurements

The measurements were executed according to 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

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

In addition, the following characteristic values were determined according to 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 423-17 [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.

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.

7 Remarks

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

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(Project Manager)

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(Responsible)

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Sound absorption coefficient ISO 354

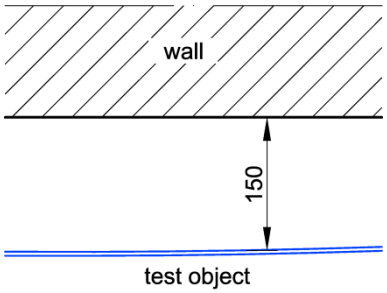
Measurement of sound absorption in reverberation rooms

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

Test specimen: SIGMACOUSTIC, flat arrangement, 150 mm distance to the wall

Mounting (set-up type G-150 according to EN ISO 354):

- Testing area width x height = 3.50 m x 3.03 m
- 150 mm distance between fabric and wall of reverberation room
- Fabric hanging in flat arrangement
- Construction without enclosing frame



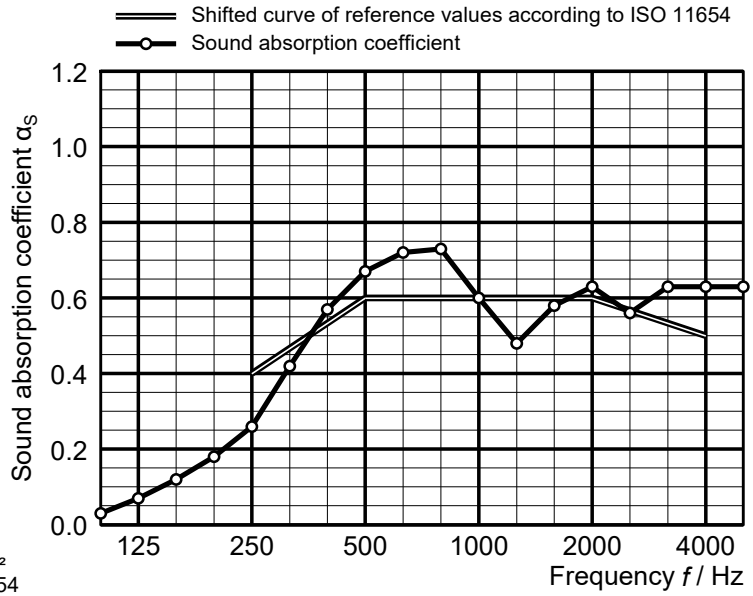
Material details:

- Fabric made of 100 % PLF (Trevira CS)
- Thickness d = 0.88 mm
- Area specific mass m'' = 253 g/m²
- Air flow resistance acc. to ISO 9053-1 R_S = 317 Pa s/m

Room: Hallraum E
Volume: 199.60 m³
Size: 10.61 m²
Date of test: 2019-08-21

	θ [°C]	*r. h.* [%]	*B* [kPa]
without specimen	21.7	61.5	96.3
with specimen	21.8	61.4	96.2

Frequency [Hz]	α_S 1/3 octave	α_p octave
100	◦ 0.03	
125	◦ 0.07	0.05
160	0.12	
200	0.18	
250	0.26	0.30
315	0.42	
400	0.57	
500	0.67	0.65
630	0.72	
800	0.73	
1000	0.60	0.60
1250	0.48	
1600	0.58	
2000	0.63	0.60
2500	0.56	
3150	0.63	
4000	0.63	0.65
5000	0.63	



◦ 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:	Rating according to ASTM C423:
Weighted sound absorption coefficient α_w = 0.60	**Noise Reduction Coefficient *NRC* = 0.55**
Sound absorption class: C	**Sound Absorption Average *SAA* = 0.53**

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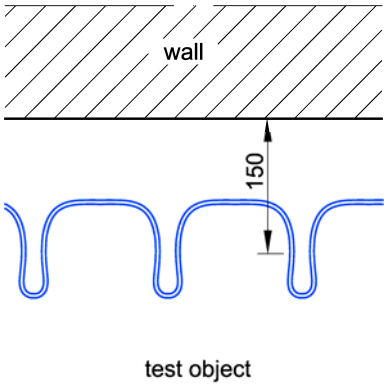
Sound absorption coefficient ISO 354

Measurement of sound absorption in reverberation rooms

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

Test specimen: SIGMACOUSTIC, folded arrangement, 100 % fabric addition
(150 mm distance to the wall)



test object

Mounting:

- Testing area width x height = 3.49 m x 3.03 m
- 150 mm distance between fabric and wall of reverberation room
- Fabric hanging in folded arrangement with 100 % fabric addition
- Construction without enclosing frame

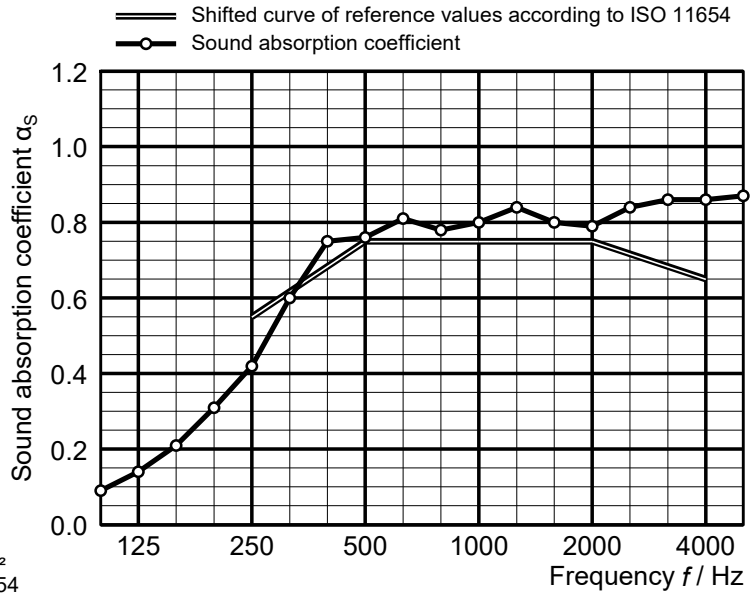
Material details:

- Fabric made of 100 % PLF (Trevira CS)
- Thickness d = 0.88 mm
- Area specific mass m'' = 253 g/m²
- Air flow resistance acc. to ISO 9053-1 R_S = 317 Pa s/m

Room: Hallraum E
Volume: 199.60 m³
Size: 10.57 m²
Date of test: 2019-08-21

	θ [°C]	*r. h.* [%]	*B* [kPa]
without specimen	21.7	61.5	96.3
with specimen	21.7	61.5	96.2

Frequency [Hz]	α_S 1/3 octave	α_p octave
100	◦ 0.09	
125	0.14	0.15
160	0.21	
200	0.31	
250	0.42	0.45
315	0.60	
400	0.75	
500	0.76	0.75
630	0.81	
800	0.78	
1000	0.80	0.80
1250	0.84	
1600	0.80	
2000	0.79	0.80
2500	0.84	
3150	0.86	
4000	0.86	0.85
5000	0.87	



◦ 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:	Rating according to ASTM C423:
Weighted sound absorption coefficient α_w = 0.75	**Noise Reduction Coefficient *NRC* = 0.70**
Sound absorption class: C	**Sound Absorption Average *SAA* = 0.71**

Curtain SIGMACOUSTIC, Création Baumann

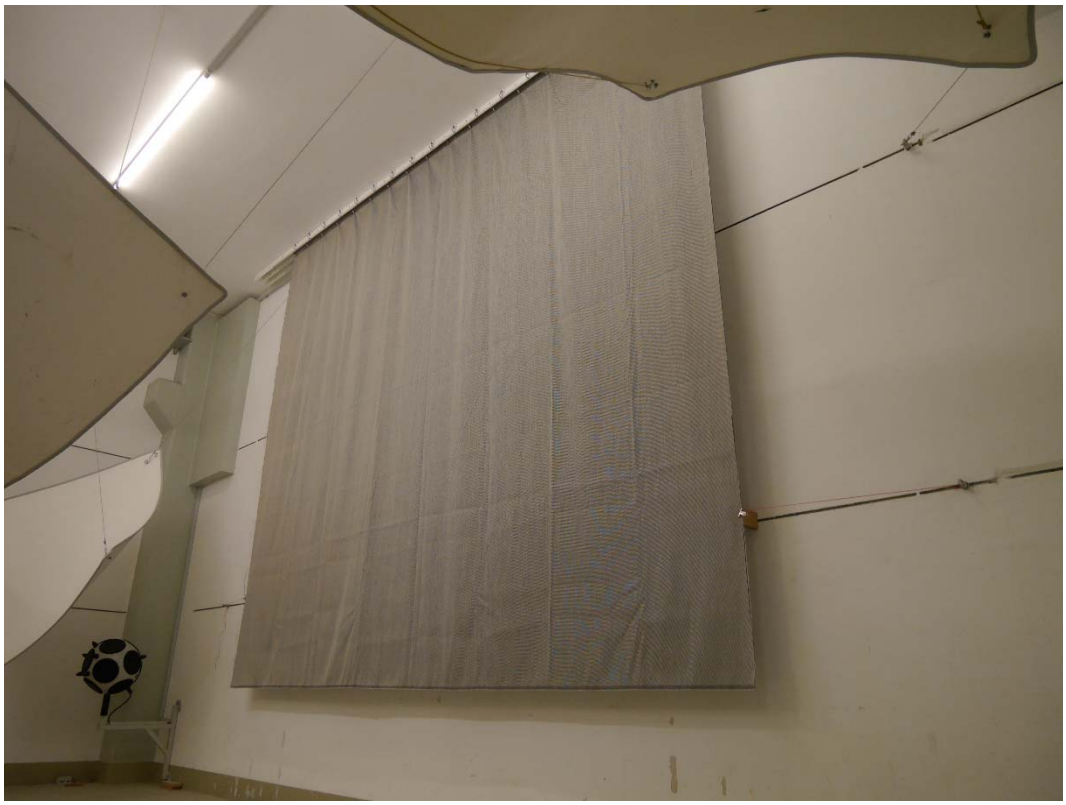


Figure B.1. Flat arrangement, test object mounted in the reverberation room.

Figure B.2. Folded arrangement, test object mounted in the reverberation room.

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

1 Measurand

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 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 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 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 EN ISO 354 [1].

2 Test procedure

2.1 Description of the reverberation room

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

The reverberation room has a volume of V = 199.6 m^3 and a surface of S = 216 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 m x 2.4 m and six composite sheet metal boards dimensioned 1.2 m x 1.2 m were suspended curved and irregularly.

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

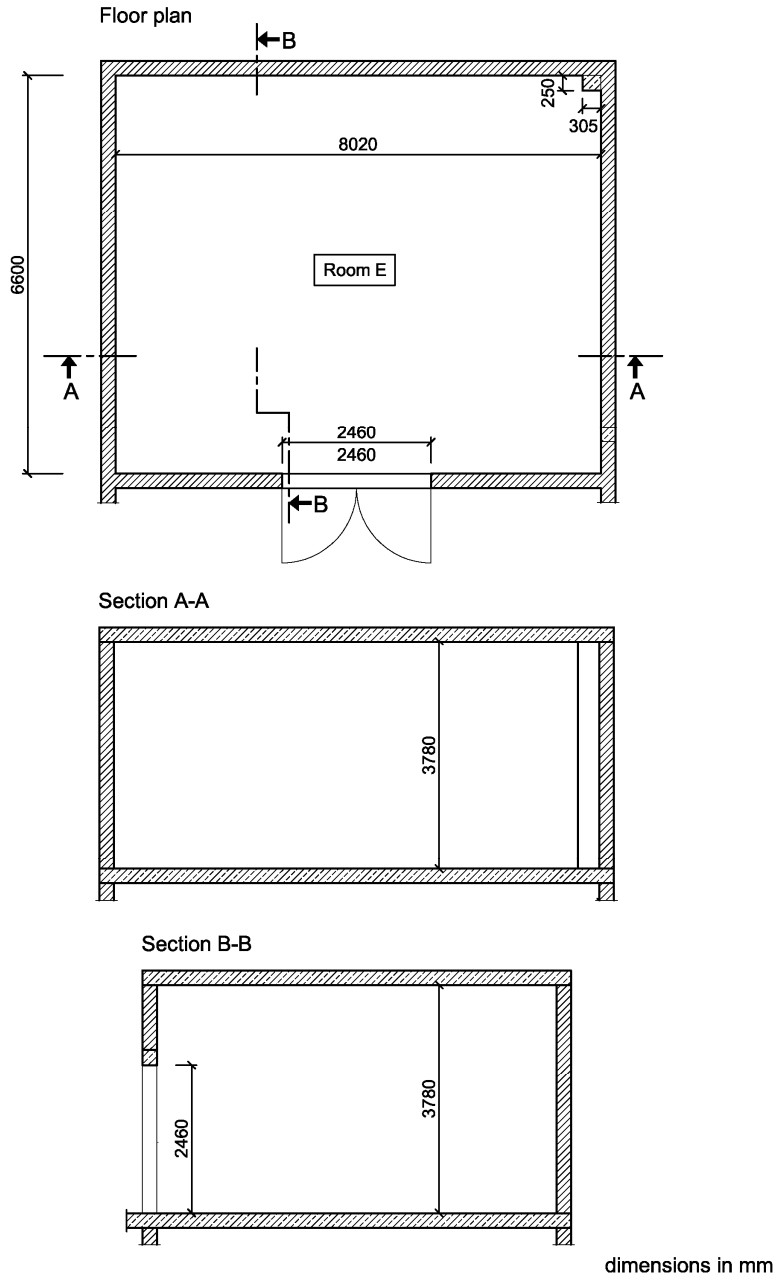


Figure C.1. Plan view and sections of the reverberation room.

2.2 Measurement of reverberation time

The determination of the impulse responses were 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 EN ISO 354 [1], using a linear regression for the calculation of the reverberation time T_{20} from the level of the backward integrated impulse response.

The determined reverberation times are indicated in Table C.1.

Table C.1. Reverberation times without and with test object.

Frequency *f* / Hz	Reverberation time *T* / s		
	T_1 (without test object)	T_2 (with test object)	
		Appendix A, Page 1 (flat)	Appendix A, Page 2 (folded)
100	5.12	4.84	4.47
125	5.10	4.59	4.16
160	5.45	4.45	3.94
200	5.27	4.01	3.41
250	5.27	3.64	3.05
315	5.06	2.96	2.53
400	5.33	2.65	2.31
500	5.29	2.43	2.27
630	5.18	2.32	2.18
800	4.83	2.23	2.15
1000	5.05	2.51	2.17
1250	5.20	2.86	2.14
1600	5.20	2.61	2.19
2000	5.01	2.45	2.17
2500	4.33	2.40	1.97
3150	3.61	2.07	1.78
4000	2.92	1.82	1.60
5000	2.46	1.63	1.45

2.3 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	09050048
Dodecahedron	Müller-BBM	DOD360A	372828
Dodecahedron	Müller-BBM	DOD360A	372829
Dodecahedron	Müller-BBM	DOD360A	372830
Dodecahedron	Müller-BBM	DOD360A	372831
Microphone	Microtech	M370	1355
Microphone	Microtech	M370	1356
Microphone	Microtech	M360	1786
Microphone	Microtech	M360	1787
Microphone	Microtech	M360	1788
Microphone	Microtech	M360	1789
Microphone power supply	MFA	IV80F	330364
Hygro-/Thermometer	Testo	Saveris H1E	01554624
Barometer	Lufft	Opus 10	030.0910.0003.9.4.1.30
Software for measurement and evaluation	Müller-BBM	Bau 4	Version 1.11