MÜLLER-BBM

Müller-BBM GmbH
Robert-Koch-Str. 11
82152 Planegg

Tel. +49(89)85602 0
Fax +49(89)85602 111

www.MuellerBBM.de

Dipl.-Phys. Elmar Schröder
Telephone +49(89)85602 145
Elmar.Schroeder@MuellerBBM.de

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M100047/05 srd/jre

Calmuc Sound Absorber, Article 9774, colour 75 black Manufacturer IBENA Textilwerke GmbH

Measurement of sound absorption acc. to EN ISO 354

Test Report No. M100047/05

Client:	IBENA Textilwerke GmbH Industriestraße 7 – 13 46395 Bocholt
Consultant:	Dipl.-Phys. Elmar Schröder
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1 Task

On behalf of the IBENA Textilwerke GmbH, 46395 Bocholt, Germany, the sound absorption of the fabric type Calmuc Sound Absorber, Article 9774, colour 75 black had to be measured according to EN ISO 354 [1] in the reverberation room. The fabric was tested in a flat arrangement with a distance to the reflecting wall of 200 mm.

2 Basis

This test report is based on the following documents:

[1] EN ISO 354 „Acoustics – Measurement of the sound absorption in a reverberation room.“ 2003

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

[3] ISO 9613-1 “Acoustics; Attenuation of sound during propagation outdoors; part 1: calculation of the absorption of sound by the atmosphere.” 1993

[4] ASTM C 423-09a: Standard Test Method for Sound Absorption and Sound Absorption Coefficients by the Reverberation Room Method. Revision: 09a

3 Test objects and measurement conditions

3.1 Measurement conditions

The installation of the test objects was carried out by employees of the test laboratory at the reverberation room of Müller-BBM. The test object was installed in a flat (G-200) arrangement.

The mounting details are as follows:

- mounting condition G-200 according to EN ISO 354, paragraph 6.2.1
- fabric hanging flat
- 200 mm distance between fabric and wall of the reverberation room
- mounting without circumferential frame
- testing area width x height = 3.50 m x 3.00 m
- fixed directly underneath the ceiling, suspended on a metal rail, height 50 mm

The figures in Appendix B show details of the test build-ups.

3.2 Test object

The tested material is described by the manufacturer as follows:

- manufacturer IBENA Textilwerke GmbH
- type Calmuc Sound Absorber, Article 9774, colour 75 black

Testing laboratory has measured as follows:

- area specific mass: m'' = 499 g/m²
- thickness: t = 0.4 mm
- air flow resistance acc. to EN 29053: R_S = 2409 Pa s/m

4 Execution of the measurements

The measurements were executed and evaluated 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 to the sound absorption coefficients 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 423-09a [4] 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* and *SAA* are indicated in the test certificates in Appendix A.

7 Remarks

The determined test results only refer to the test specimens and prevailing conditions on the day of measurements.

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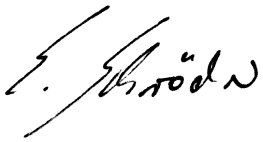


Dipl.-Phys. Elmar Schröder

MÜLLER-BBM
Accredited Testing Laboratory
according to DIN EN ISO/IEC 17025

Deutscher Akkreditierungs Rat
DAR

DGA-PL-2465.10

Sound absorption coefficient ISO 354

Measurement of sound absorption in reverberation rooms

Client: IBENA Textilwerke GmbH
Industriestraße 7-13, 46395 Bocholt, Germany

Test specimen: Calmuc Sound Absorber, Article 9774, colour 75 black

Description of the test object:

- Thickness d = 0.4 mm
- Specific airflow resistance according to EN 29053 R_S = 2409 Pa s/m
- Area specific mass m" = 499 g/m²
- Testing area widht x height = 3.50 m x 3.00 m

Details about the mounting conditions:

- Mounting condition G-200 according to EN ISO 354, paragraph 6.2.1
- Fabric hanging flat
- 200 mm distance between fabric and wall of the reverberation room
- Mounting without circumferential frame

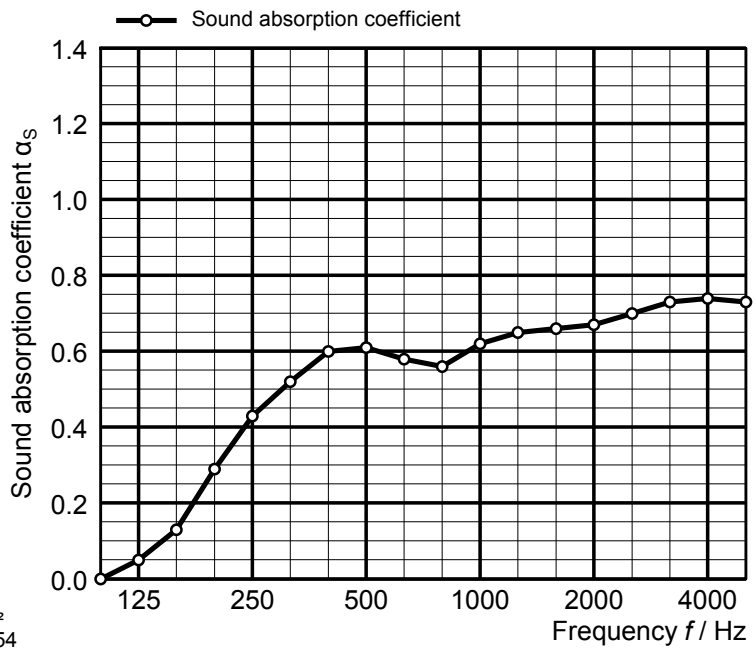
Room: E
Volume: 199.60 m³
Size: 10.50 m²
Date of test: 2012-03-15

	θ [°C]	r. h. [%]	B [kPa]
without specimen	20.4	34.0	96.3
with specimen	20.5	33.9	96.3

Accredited testing laboratory according to ISO/IEC 17025

DAP-PL-2465.10

Frequency [Hz]	α_S 1/3 octave	α_p octave
100	◦ 0.00	
125	◦ 0.05	0.05
160	0.13	
200	0.29	
250	0.43	0.40
315	0.52	
400	0.60	
500	0.61	0.60
630	0.58	
800	0.56	
1000	0.62	0.60
1250	0.65	
1600	0.66	
2000	0.67	0.70
2500	0.70	
3150	0.73	
4000	0.74	0.75
5000	0.73	



◦ 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 (*H*)	**Noise Reduction Coefficient *NRC* = 0.60**
Sound absorption class: C	**Sound Absorption Average *SAA* = 0.57**

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Planegg, 2012-03-20
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Calmuc Sound Absorber, Article 9774, colour 75 black

Figure B1. Test object mounted in the reverberation room

Figure B2. Distance of 200 mm between fabric and wall; without enclosing frame

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 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 dissipation was calculated according to ISO 9613-1 [3]. 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 (1.2 m x 2.4 m) and six composite sheet metal boards (1.2 m x 1.2 m) were suspended curved and irregularly.

Figure C1 shows the drawings of the reverberation room.

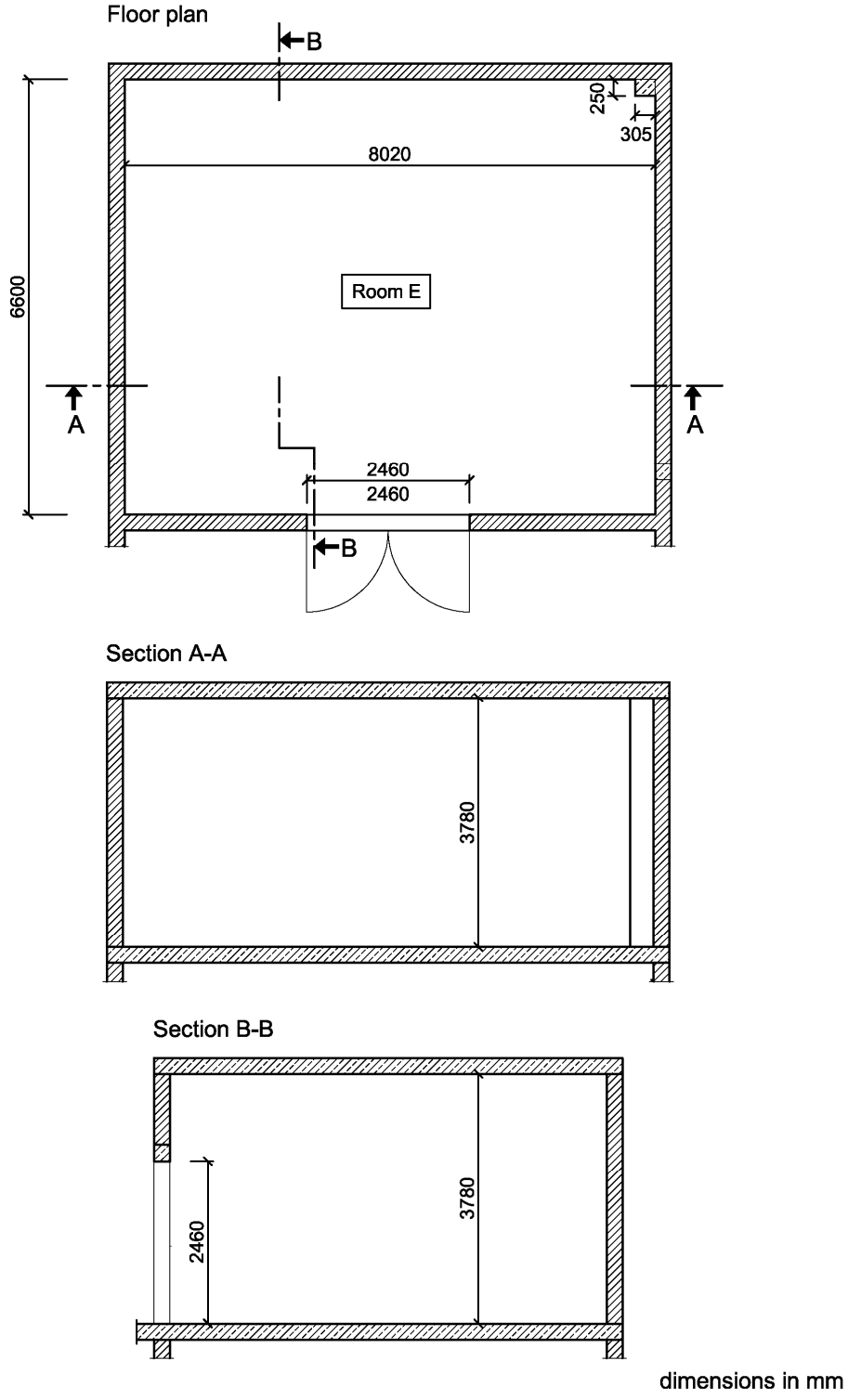

Figure C1. Plan view and sections of the reverberation room

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 a backward integrated impulse response.

The determined reverberation times in the reverberation room with and without test object are indicated in table C1.

Table C1. Reverberation times

Reverberation time *T* in s		
frequency in Hz	**T_1 (without test object)**	**T_2 (with test object)**
100	4,97	4,95
125	4,96	4,60
160	4,88	4,05
200	5,09	3,44
250	5,11	2,98
315	4,89	2,67
400	5,14	2,55
500	4,98	2,51
630	4,75	2,49
800	4,77	2,54
1000	5,10	2,51
1250	5,19	2,47
1600	5,04	2,41
2000	4,53	2,27
2500	3,81	2,04
3150	2,99	1,75
4000	2,25	1,46
5000	1,68	1,20

2.3 List of test equipment

The test equipment used is listed in table C2.

Table C2. List of test equipment

Name	Manufacturer	Type	Serial-No.
Sound card	RME	Multiface II	22460388
Amplifier	APart	Champ One	09070394
Dodecahedron	Müller-BBM	DOD130B	265201
Dodecahedron	Müller-BBM	DOD130B	265202
Dodecahedron	Müller-BBM	DOD130B	265203
Dodecahedron	Müller-BBM	DOD130B	265204
Microphone	Microtech	M360	1783
Microphone	Microtech	M360	1785
Microphone	Microtech	M360	1786
Microphone	Microtech	M360	1787
Microphone	Microtech	M360	1788
Microphone	Microtech	M360	1789
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 1.6