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Fabric SECRET

Measurement of sound absorption in a reverberation room according to EN ISO 354

Test Report No. M102794/08

Client:

Consultant:

Date of report:

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Création Baumann AG Bern-Zürichstrasse 23 CH – 4901 Langenthal

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Certified quality management system according to ISO 9001 Accredited testing laboratory according to ISO/IEC 17025 Müller-BBM GmbH HRB Munich 86143 VAT Reg. No. DE812167190

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1 Task

On behalf of the company Création Baumann AG, CH – 4901 Langenthal, the sound absorption of the fabric type Secret had to be measured according to EN ISO 354 [1] in the reverberation room. The fabric was tested in a flat and a 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. 2003-05
- [2] EN ISO 11654: Acoustics Sound absorbers for use in buildings Rating of sound absorption. 1997-04
- [3] ISO 9613-1: Acoustics; Attenuation of sound during propagation outdoors; part 1: calculation of the absorption of sound by the atmosphere. 1993-06
- [4] ASTM C 423-09a: Standard Test Method for Sound Absorption and Sound Absorption Coefficients by the Reverberation Room Method. Revision: 09a. 2009-10
- [5] EN 29053: Acoustics Materials for acoustical applications Determination of airflow resistance. 1993-03

3 Test object and test assembly

3.1 Test object

The tested material is described by the manufacturer as follows:

- manufacturer Création Baumann
- type Secret
- material 100 % PLF Trevira CS

The testing laboratory has measured as follows:

| - | thickness: | <i>t</i> = 0.75 mm |
|---|---|------------------------------------|
| - | air flow resistance acc. to EN 29053 [5]: | <i>R</i> _S = 606 Pa⋅s/m |
| | | |

- area specific mass: $m'' = 308 \text{ g/m}^2$

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 object was installed in a flat (G-150) and a folded arrangement.

The mounting details are as follows:

- distance to the wall 150 mm
- fixed directly underneath the ceiling, suspended from a metal rail, height 50 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 G-150
 - mounting type G-150 according to EN ISO 354 [1] section 6.2.1 and appendix B.5 of EN ISO 354 [1]
 - test object made of one fabric panel (height corresponds to panel width) width x height = 3.56 m x 3.07 m
 - total dimensions of the test surface (starting at the lower border of the metal rail): width x height = 3.56 m x 3.02 m = 10.75 m²
- b) folded arrangement
 - 100 % folded
 - test object made of two fabric panels (height corresponds to panel width) width x height = 3.56 m x 3.07 m
 - total dimensions of the test surface (starting at the lower border of the metal rail): width x height = 3.56 m x 3.02 m = 10.75 m²

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

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 onethird-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 onethird-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.

This test report may only be published and copied as a whole including all of its appendixes. The publishing of extracts requires the prior written consent of Müller-BBM GmbH.

Effiller

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Durch die DAkkS Deutsche Akkreditierungsstelle GmbH nach DIN EN ISO/IEC 17025 akkreditiertes Prüflaboratorium. Die Akkreditierung gilt für die in der Urkunde aufgeführten Prüfverfahren.

Sound absorption coefficient ISO 354 Measurement of sound absorption in reverberation rooms

| Measurement of sound absorption in reverberation rooms Client: Création Baumann AG Bern-Zürichstrasse 23, CH - 4901 Langenthal Test specimen: SECRET, flat arrangement | | | | | | | | | | | |
|---|--|---|---|--------------|----------------|--------------------------|------------------|-------------------------------|----------------------------------|-------------------------------|---|
| total dime clear dist flat arran | type G- ensions ance to gement | | | = 3.56 r | n x 3.07 | 7 m | | wall | 150 | | |
| thickness | ver 100% s <i>t</i> = 0.75 | 6 PLF Trevir 5 mm ss app. <i>m</i> " = | | | | | | test ob | ject | | - |
| air flow re | esistanc | e: <i>R</i> _S = 606 | Pa s/m | | | | | | | | |
| | | | | | | | | | | | |
| | | | | | | | | | | | |
| Room: Hal | | | | _ | r. h. [%] | | | | | | |
| olume: 19 /olume: 19 | | 3 | without specimen with specimen | 19.8 19.8 | 44.7 46.3 | 94.5 94.5 | | | | | |
| Frequency [Hz] | α _s /3 octave | α_p octave | = | | | of referer ption coef | | es accord | ding to IS | SO 1165 | 4 |
| | ◦ 0.01 | 0.05 | | | | | | | | | _ |
| 125 160 | 0.10 0.11 | 0.05 | _ي 1.2 | | | | | | | | _ |
| 200 | 0.22 | | | | | | | | | | |
| 250 | 0.36 0.53 | 0.35 | 흥 1.0 🛏 | | | | | | | | _ |
| 315 | 0.00 | | .≓ ⊢ | | | | | | | | |
| 315 400 | 0.67 | | peffi | | | | | | | | |
| 400 500 | 0.81 | 0.75 | n coeffi | | | | | | | | _ |
| 400 500 630 | 0.81 0.84 | 0.75 | 8.0 coeffi | | | | | | | | |
| 400 500 | 0.81 | 0.75 | sorption coeffi | | | | | | | | |
| 400 500 630 800 1000 1250 | 0.81 0.84 0.78 0.63 0.62 | | absorption coeffi | | | | | | | | |
| 400 500 630 800 1000 1250 1600 | 0.81 0.84 0.78 0.63 0.62 0.71 | 0.70 | absorption coeffi | | | | | | | | |
| 400 500 630 800 1000 1250 | 0.81 0.84 0.78 0.63 0.62 | | 9.0 bind absorption | | | | | | | | |
| 400 500 630 1000 1250 1600 2000 | 0.81 0.84 0.78 0.63 0.62 0.71 0.69 | 0.70 | Sound absorption coefficiency 0.6 | | | | | | | | |
| 400 500 630 1000 1250 1600 2000 2500 3150 4000 | 0.81 0.84 0.78 0.63 0.62 0.71 0.69 0.69 0.71 0.72 | 0.70 | 0.2 | | | | | | | | |
| 400 500 630 1000 1250 1600 2000 2500 3150 4000 5000 | 0.81 0.84 0.78 0.63 0.62 0.71 0.69 0.69 0.71 0.72 0.72 | 0.70 0.70 0.70 | 0.2 | 25 | 250 | 500 | 10 | | 2000 | 400 | |
| 400 500 630 800 1000 1250 1600 2000 2500 3150 4000 5000 Equivalent s s Sound abs | 0.81 0.84 0.78 0.63 0.62 0.71 0.69 0.69 0.71 0.72 0.72 0.72 sound abso | 0.70 0.70 0.70 0.70 orption area less perficient accord orption coefficie | 0.2 0.0 12 0.0 12 0.0 12 0.0 12 12 0.0 12 12 12 12 12 12 12 12 12 12 12 12 12 | 25 | | | | F | reque | ncy f / | |
| 400 500 630 1000 1250 1600 2000 2500 3150 4000 5000 Equivalent s s Sound abs p Practical s | 0.81 0.84 0.78 0.63 0.62 0.71 0.69 0.69 0.71 0.72 0.72 sound abso sorption co ound abso sorption co ound abso | 0.70 0.70 0.70 0.70 orption area less perficient accord proption coefficient according to pund absorp | 0.2 0.0 12 0.0 0.0 12 0.0 0.0 10 0.0 0.0 10 0.0 0.0 0.0 0.0 0 | | Rat | ing acco | ording | F to AST | Freque | ncy f / 3: | |
| 400 500 630 1000 1250 1600 2000 2500 3150 4000 5000 Equivalent s s Sound abs p Practical s | 0.81 0.84 0.78 0.63 0.62 0.71 0.69 0.69 0.71 0.72 0.72 sound absc orption co ound absc Rating hted so | 0.70 0.70 0.70 0.70 orption area less sefficient accord orption coefficie according to | 0.2 0.0 15 0.554 0.165 0.165 0.1654 0.1655 1.0 0.0 0.1655 1.0 0.0 0.1655 1.0 0.0 0.0 0.1655 1.0 0.0 0.0 0.0 0.0 0.0 0.0 0.0 | No | Rat oise Re | | ording I Coef | F to AST ficient | Frequer M C42 NRC = | ncy f/ 3: • 0.60 | |

Sound absorption coefficient ISO 354 Measurement of sound absorption in reverberation rooms

| est spec Iounting mean dis | imen: : | | hstrasse 23, CH - 4901 folded arrangement 50 mm | go. | | | | all | |
|--|--|---|---|--------------|--------------|---------------|-----------------------|-----------------|-----------------------------------|
| folded ar | rangem | of the test s ent (100 %) enclosing f | | = 3.56 r | n x 3.02 | 2 m // | | 150 | |
| Material details: • single layer 100% PLF Trevira CS • thickness t = 0.75 mm • area specific mass app. m" = 308 g/m² | | | | | | | | | |
| air flow re | esistanc | e: R _S = 606 | ∂ Pa s/m | | | | test | object | |
| | | | | | | | | | |
| | | | | | | | | | |
| | | | | 1 | 1 | 1 1 | | | |
| oom: Hal | | | without an animan | _ | r. h. [%] | | | | |
| ize: 10.7 | | - | without specimen with specimen | 19.8 19.9 | 44.7 47.9 | 94.5 94.5 | | | |
| | α _s | α _p | | Chi | ftat aunia | | | | |
| [Hz] | /3 octave | octáve | 1.4 | | | of reference | e values acc cient | | 50 11654 |
| [Hz] | /3 octave | octave 0.15 | 1.4 | | | | | | 30 11654 |
| [Hz] 1 100 125 160 200 | /3 octave ○ 0.04 0.15 0.19 0.37 | 0.15 | 1.4 | | | | | | SO 11654 |
| [Hz] 1 100 125 160 200 250 | /3 octave | octave | 1.4 | | | | | | 50 11654 |
| [Hz] 1 100 125 160 200 | /3 octave ○ 0.04 0.15 0.19 0.37 | 0.15 | 1.4 | | | | | | 50 11654 |
| [Hz] 1 100 125 160 200 250 315 400 500 | /3 octave | 0.15 | 1.4 | | | | | | |
| [Hz] 1 100 125 160 200 250 315 400 | /3 octave 0.04 0.15 0.19 0.37 0.50 0.77 0.89 | 0.15 0.55 | 1.4 | | | | | | |
| [Hz] 1 100 125 160 200 250 315 400 500 630 800 1000 | /3 octave 0.04 0.15 0.19 0.37 0.50 0.77 0.89 0.93 0.97 0.89 0.94 | 0.15 0.55 | 1.4 | | | | | | |
| [Hz] 1 100 125 160 200 250 315 400 500 630 800 | /3 octave 0.04 0.15 0.19 0.37 0.50 0.77 0.89 0.93 0.97 0.89 | 0.15 0.55 0.95 | 1.4 | | | | | | |
| [Hz] 1 100 125 160 200 250 315 400 500 630 800 1000 1250 | /3 octave 0.04 0.15 0.19 0.37 0.50 0.77 0.89 0.93 0.97 0.89 0.94 0.94 0.96 | 0.15 0.55 0.95 | 1.4 | | | | | | |
| [Hz] 1 100 1 160 2 200 2 315 400 500 630 800 1000 1250 1600 2000 2 2000 2 | /3 octave 0.04 0.15 0.19 0.37 0.50 0.77 0.89 0.93 0.97 0.89 0.94 0.96 0.95 0.92 | 0.15 0.55 0.95 0.95 | 4.1 1.2 0.1 8.0 8.0 8.0 9.0 | | | | | | |
| [Hz] 1 100 1 160 2 200 2 315 400 500 6 630 800 1000 1 1250 1 | /3 octave 0.04 0.15 0.19 0.37 0.50 0.77 0.89 0.93 0.97 0.89 0.94 0.94 0.96 0.95 | 0.15 0.55 0.95 0.95 | 1.41.21.21.00.08.00.00.00.00.10.00.00.10.10.20.30.4 | | | | | | |
| [Hz] 1 100 1 160 2 250 3 315 400 500 630 800 1000 1250 1600 2000 2 3150 3 | /3 octave 0.04 0.15 0.19 0.37 0.50 0.77 0.89 0.93 0.97 0.89 0.94 0.96 0.95 0.92 0.94 | 0.15 0.55 0.95 0.95 0.95 | 1.4 1.2 1.2 1.0 8.0 8.0 0.0 0.0 0.0 | Southern | | ption coeffic | | | |
| [Hz] 100 125 160 200 250 315 400 500 630 800 1000 1250 1600 2500 3150 4000 2500 3150 4000 5000 2500 3150 4000 5000 2500 3150 4000 5000 2500 315 400 5000 2500 315 400 5000 5000 2500 315 400 5000 5000 2500 315 400 5000 500 500 500 500 500 5 | /3 octave | 0.15 0.55 0.95 0.95 0.95 0.95 0.95 0.95 | 1.4 1.2 1.2 1.0 1.0 0.8 0.6 0.4 0.2 0.0 12 0.6 0.4 0.2 0.0 12 0.8 0.4 0.2 0.0 12 0.8 0.4 0.2 0.0 12 0.8 0.4 0.2 0.1 1.0 0.4 0.4 0.4 0.4 0.4 0.4 0.4 0 | | 250 | 500 | | 2000 Freque | 4000 ncy f / H |
| [Hz] 100 125 160 200 250 315 400 500 630 800 1000 1250 1600 2000 2500 3150 4000 5000 2500 3150 4000 5000 2500 315 400 500 630 800 1000 1250 500 630 800 100 1000 1 | /3 octave 0.04 0.15 0.19 0.37 0.50 0.77 0.89 0.93 0.97 0.89 0.93 0.97 0.89 0.94 0.96 0.96 0.95 0.92 0.94 0.95 0.92 0.94 0.95 0.92 0.94 0.95 0.92 0.94 0.95 0.92 0.94 0.95 0.92 0.94 0.95 0.92 0.94 0.95 0.92 0.94 0.95 0.95 0.92 0.94 0.95 0.96 0.95 0.95 0.96 0.95 0.95 0.95 0.95 0.96 0.95 0.96 0.95 0.96 0.95 0.96 0.95 0.96 0.95 0.96 0.95 0.96 0.96 0.95 0.95 0 | 0.15 0.55 0.95 0.95 0.95 0.95 0.95 0.95 0.9 | 1.4 1.2 1.2 1.2 1.0 0.8 0.6 0.4 0.2 0.0 12 12 12 12 12 12 12 12 12 1.0 0.8 0.4 0.2 0.0 12 0.8 0.4 0.2 0.0 12 0.8 0.4 0.2 0.0 12 0.8 0.4 0.2 0.2 0.1 12 0.8 0.4 0.2 0.2 0.1 12 0.8 0.4 0.2 0.2 0.1 12 0.8 0.4 0.2 0.2 0.1 12 0.8 0.4 0.2 0.1 12 0.4 0.2 0.2 0.1 12 0.4 12 0.4 12 0.4 12 12 0.4 12 12 0.4 12 12 0.4 12 12 12 12 12 12 12 12 12 12 | Sources | 250 | ption coeffic | | 2000 Freques | 4000 ncy f / H 3: = 0.85 |

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SECRET, Création Baumann

Figure B1. Flat arrangement, test object mounted in the reverberation room.



Figure B2. 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 m²;
- S area covered by the test object in m^2 ;
- 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 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 $V = 199.6 \text{ m}^3$ 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 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 C1 shows the drawings of the reverberation room.

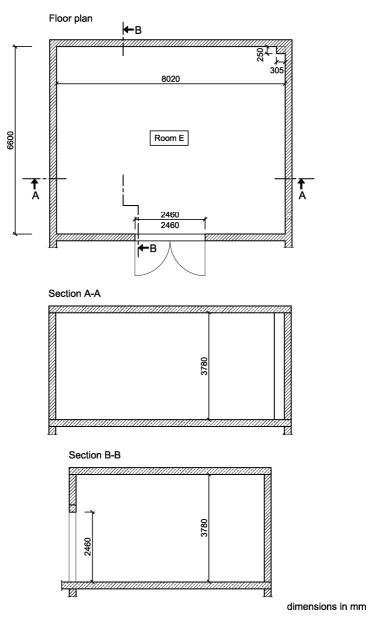


Figure C1. Plan view and sections of the reverberation room.

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 backward integrated impulse response.

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

| | Reverberation time <i>T</i> in s | | | | | |
|-----------|-------------------------------------|-----------------------------------|-----------------------|--|--|--|
| frequency | T (without | T ₂ (with test object) | | | | |
| in Hz | <i>T</i> ₁ (without test object) | Appendix A, page 1 | Appendix A, page 2 | | | |
| 100 | 4.81 | 4.75 | 4.51 | | | |
| 125 | 4.90 | 4.23 | 3.93 | | | |
| 160 | 5.33 | 4.46 | 3.96 | | | |
| 200 | 5.62 | 3.99 | 3.34 | | | |
| 250 | 5.24 | 3.22 | 2.78 | | | |
| 315 | 5.26 | 2.71 | 2.23 | | | |
| 400 | 5.42 | 2.46 | 2.07 | | | |
| 500 | 5.34 | 2.18 | 2.00 | | | |
| 630 | 5.22 | 2.11 | 1.94 | | | |
| 800 | 4.94 | 2.16 | 2.00 | | | |
| 1000 | 5.26 | 2.50 | 1.99 | | | |
| 1250 | 5.41 | 2.54 | 1.97 | | | |
| 1600 | 5.35 | 2.36 | 1.98 | | | |
| 2000 | 4.82 | 2.29 | 1.92 | | | |
| 2500 | 4.19 | 2.14 | 1.85 | | | |
| 3150 | 3.39 | 1.89 | 1.66 | | | |
| 4000 | 2.61 | 1.62 | 1.45 | | | |
| 5000 | 1.98 | 1.36 | 1.24 | | | |

Table C1. Reverberation times.

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2.3 List of test equipment

The test equipment used is listed in Table C2.

| Table C2. | List of test equipment. |
|-----------|-------------------------|
| | |

| Name | Manufacturer | Туре | 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 1.7 | |