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Noise barrier system Naturawall® unperforated plates

Measurement of the sound absorption coefficient in the reverberation room according to ISO 354

Test report No. M83397/03

Client:	Naturawall GbR Brombeerweg 10 83112 Frasdorf
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1 Task

On behalf of the company Naturawall GbR, 83112 Frasdorf, Germany, the sound absorption of the noise barrier system Naturawall® with unperforated plates is to be tested in the reverberation room according to DIN EN ISO 354 [1].

The results are to be evaluated according to ZTV-Lsw 06 [5] and DIN EN ISO 1793-1 [4].

2 References

This test report is based on the following documents:

- [1] DIN EN ISO 354 „Acoustics – Measurement of sound absorption in a reverberation room“. December 2003
- [2] DIN EN ISO 11654 „Acoustics – Sound absorbers for use in buildings – Rating of sound absorption“. July 1997
- [3] ISO 9613-1 „Acoustics; Attenuation of sound during propagation outdoors; Part 1: Calculation of the absorption of sound by the atmosphere“. June 1993
- [4] DIN EN 1793-1 „Road traffic reducing devices – Test method for determining the acoustic performance; Part 1: Intrinsic characteristics of sound absorption“. November 1997
- [5] ZTV-Lsw 06: Zusätzliche Technische Vertragsbedingungen und Richtlinien für die Ausführung von Lärmschutzwänden an Straßen. 2006

3 Test conditions and test object

3.1 Test conditions

The test objects were installed in the reverberation room by employees of the company Naturawall, Frasdorf on the day of the measurements.

The test objects were assembled in the reverberation room according to assembly type A, Appendix B.2 of DIN EN ISO 354 [1].

3.2 Test object

The tested noise barrier system Naturawall® consists of a V-shaped framework made of support profiles with metal plates suspended on both sides. During the installation, the framework and plates are filled with soil and planted, if required. The plates are made of galvanized steel sheet. The plates' structure is as follows:

- bent profile with the dimensions $B \times L \times H = 420 \text{ mm} \times 3000 \text{ mm} \times 25 \text{ mm}$,
- galvanized steel sheet, $t = 2,0 \text{ mm}$.

For the test, one half of the wall was reproduced lying on the reverberation room's floor. For this purpose, two lateral support profiles made of galvanized steel sheet were installed inclined above the reverberation room's floor and seven plates were connected to them. The cavities below and between the support profiles were filled with soil from an excavation. The filling depth was 630 mm on the front side, decreasing to 230 mm via the length of the installation. The plates were banked with soil on the backside. The soil was filled in without any mechanical compression and pressed on by hand.

The test set-up was enclosed laterally with a framework made of coated derived timber material boards with a thickness of 20 mm. The height of the framework was chosen according to the upper edge of the plates:

- along the longitudinal sides increasing from 400 mm to 800 mm,
- on the transverse sides 400 mm or 800 mm.

The joints between the framework and the reverberation room's floor were sealed with adhesive tape.

The size of the test area within the framework was $L \times B = 3820 \text{ mm} \times 3000 \text{ mm}$.

Appendix B shows pictures of the test set-up and Appendix C drawings from the client.

4 Test method

The measurements were carried out and evaluated according to DIN EN ISO 354 [1].

The test method, the test stand and the applied test equipment are described in Appendix D.

5 Evaluation

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

In order to evaluate the sound absorption properties of the noise barrier system, the single number rating DL_a was determined according to DIN EN 1793-1 [4], section 5.2, and the corresponding sound absorption class A0 to A4 was derived from that. Besides, the evaluation attributed to these classes according to ZTV-Lsw 06 [5] **Fehler! Verweisquelle konnte nicht gefunden werden.**, section 2.2 was assessed. The sound absorption classes and respective evaluations according to ZTV-Lsw 06 [5] are shown in Table 1 corresponding to the determined single number rating DL_a .

Table 1. Sound absorption classes according to DIN EN ISO 1793-1 [4] and evaluation according to ZTV-Lsw 06 [5].

Test result: single number rating DL_a according to DIN EN 1793-1 [4]	Sound absorption class according to DIN EN 1793-1 [4]	Evaluation according to ZTV-Lsw 06 [5]
not tested	A0	--
$DL_a < 4$ dB	A1	not absorptive
$4 \text{ dB} \leq DL_a \leq 7$ dB	A2	absorptive
$8 \text{ dB} \leq DL_a \leq 11$ dB	A3	highly absorptive
$DL_a > 11$ dB	A4	

6 Test results

The sound absorption coefficients α_s in third-octave bands can be taken from the test certificate in Appendix A.

The measuring results determined for the noise barrier system Naturawall® with unperforated plates, evaluated according to DIN EN 1793-1 [4] and ZTV-Lsw 06 [5], are shown in Table 2.

Table 2. Evaluation according to DIN EN 1793-1 [4] and ZTV-Lsw 06 [5].

Test set-up	Evaluation according to DIN EN 1793-1 [4]		Evaluation according to ZTV-Lsw 06 [5]
	DL_a	Class	
Noise barrier system Naturawall® with unperforated plates	4 dB	A2	absorptive

7 Remarks

The determined test results exclusively refer to the conditions on the day of the measurements.

The absorptive properties of the tested noise barrier system are decisively determined by the composition and the degree of compression of the applied soil. Due to natural variations in the composition and a restricted reproducibility of the assembly conditions, only a reduced reproducibility of the measuring values is to be expected for the tested noise barrier system compared to systems with technically produced absorptive materials.

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M. Eng. Philipp Meistring

MÜLLER-BBM

Akkreditiertes Prüflaboratorium
nach ISO/IEC 17025



DGA-PL-2465.10

Schallabsorptionsgrad nach ISO 354

Messung der Schallabsorption in Hallräumen

Auftraggeber: Naturawall GbR, Brombeerweg 10, 83112 Frasdorf

Prüfgegenstand: Lärmschutzwandsystem Naturawall®
Lamellen ungelocht

Prüfaufbau (von oben nach unten):

- 170 mm Lamellen aus verzinktem Stahlblech $t = 2,0$ mm
7 Lamellen in seitliche Tragprofile aus Stahlblech eingehängt
Lamellen rückseitig mit Erde angebösch
- 230...630 mm Erde aus Aushub, darin: seitliche Tragprofile
- Hallraumboden

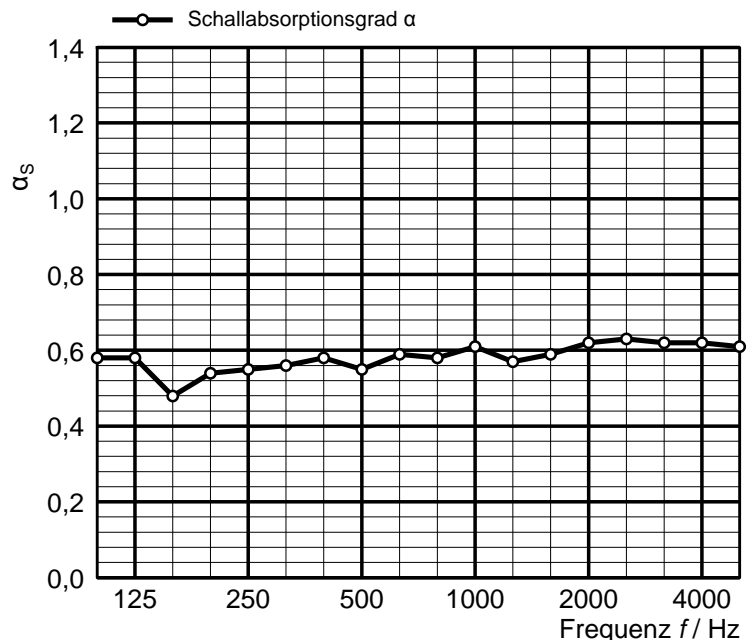
Der Prüfaufbau wurde seitlich mit einem Umfassungsrahmen aus 20 mm dicken, beschichteten Holzwerkstoffplatten eingefasst. Die Rahmenhöhe wurde entsprechend der Oberkante der Lamellen gewählt (entlang der Längsseiten von 400 mm auf 800 mm ansteigend, an den Querseiten 400 mm bzw. 800 mm). Die Fugen zwischen Rahmen und Hallraumboden wurden mit Klebeband abgedichtet. Die Erde wurde ohne maschinelle Verdichtungsmaßnahmen eingefüllt und handfest angedrückt.

Prüffläche (innerhalb Umfassungsrahmen): $L \times B = 3,82 \text{ m} \times 3,00 \text{ m}$

Raum: Hallraum E
Volumen: 199,60 m³
Prüffläche: 11,46 m²
Prüfdatum: 22.02.2011

	θ [°C]	r. h. [%]	B [kPa]
Ohne Probe	18,0	37,5	94,8
Mit Probe	17,6	41,1	95,0

Frequenz [Hz]	α_s Terz
100	0,58
125	0,58
160	0,48
200	0,54
250	0,55
315	0,56
400	0,58
500	0,55
630	0,59
800	0,58
1000	0,61
1250	0,57
1600	0,59
2000	0,62
2500	0,63
3150	0,62
4000	0,62
5000	0,61



Bewertung nach EN 1793-1:

Einzahl-Angabe zur Schallabsorption: $DL_a = 4$ dB

Gruppe der Schallabsorptionseigenschaften: A2

Noise barrier system Naturawall[®], unperforated plates



Figure B.1. Assembly of the test set-up: Framework with soil, inside: support profiles with the first plates.



Figure B.2. Test set-up in the reverberation room.

Noise barrier system Naturawall[®], unperforated plates



Figure B.3. Test set-up in the reverberation room.

Noise barrier system Naturawall[®], unperforated plates

(Manufacturer's drawing with scale, dimensions in mm)

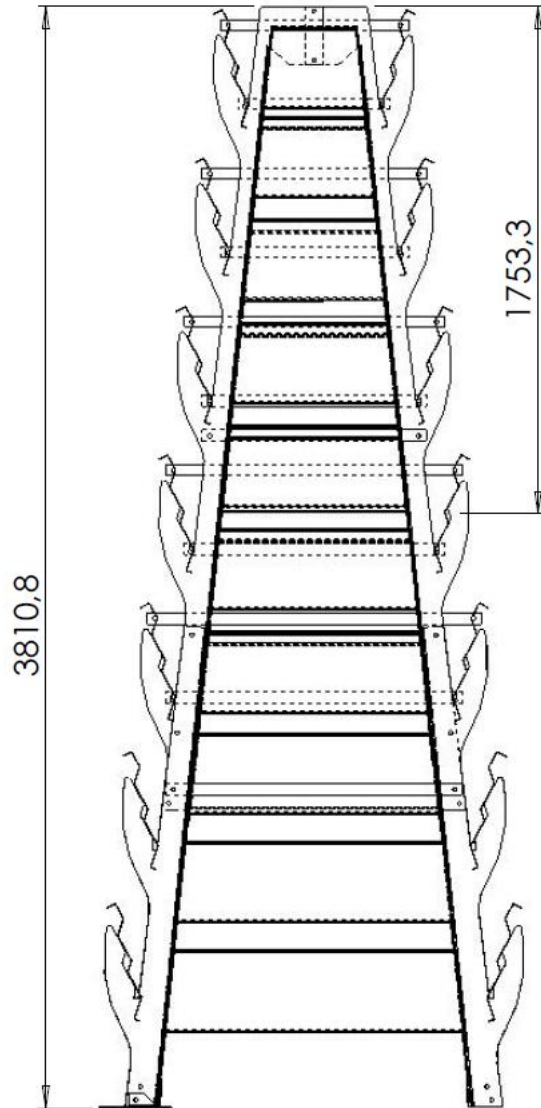


Figure C.1. Noise barrier wall system Naturawall[®]: wall section.

Noise barrier system Naturawall[®], unperforated plates
(Manufacturer's drawing without scale)

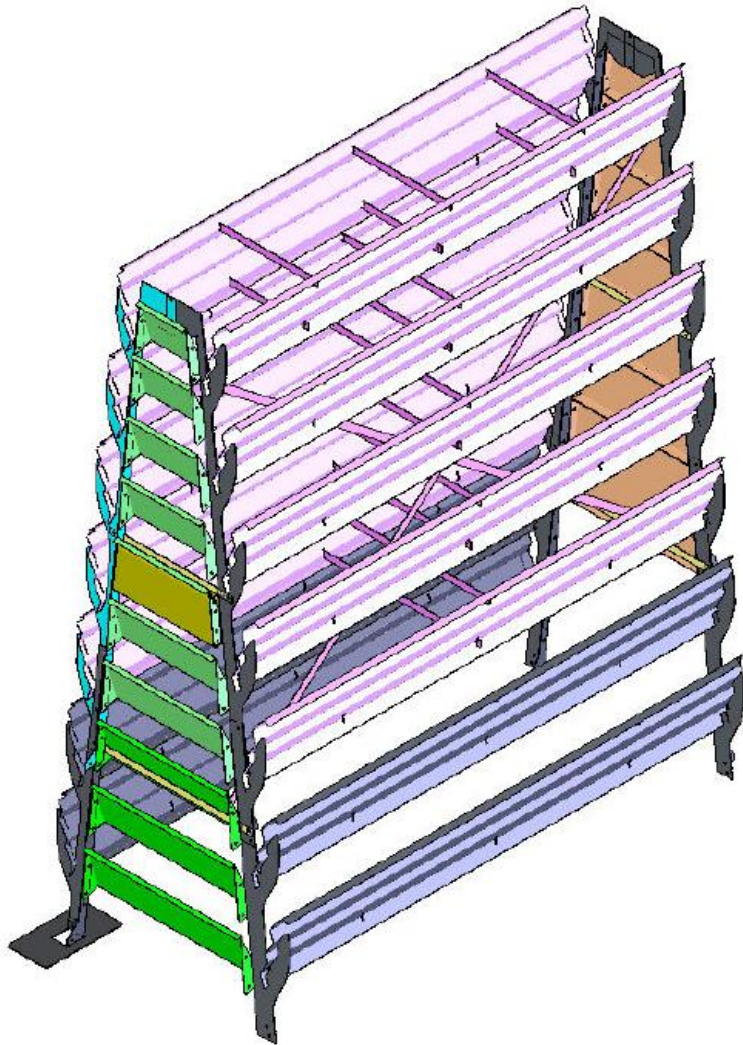


Figure C.2. Noise barrier wall system Naturawall[®]: Isometry.

Description of the test procedure to determine the sound absorption in a reverberation room

1 Measured quantity

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 determined. 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 sound velocity in air in the reverberation room without test object in m/s;
- c_2 sound velocity 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 air absorption coefficient in the reverberation room without test object in m^{-1} ;
- m_2 air absorption coefficient in the reverberation room with test object in m^{-1} .

As area of the test object, the area covered by the test object was applied.

The differing dissipation during the sound propagation in the air was taken into account according to section 8.1.2 of DIN EN ISO 354 [1]. The air absorption coefficient 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 is given in DIN EN ISO 354 [1].

2 Test procedure

2.1 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 $V = 199.6 m^3$ 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 with the dimensions 1.2 m x 2.4 m and six composite sheet metal boards with the dimensions 1.2 m x 1.2 m were suspended in the room curved and irregularly.

Figure D.1 shows drawings of the reverberation room.

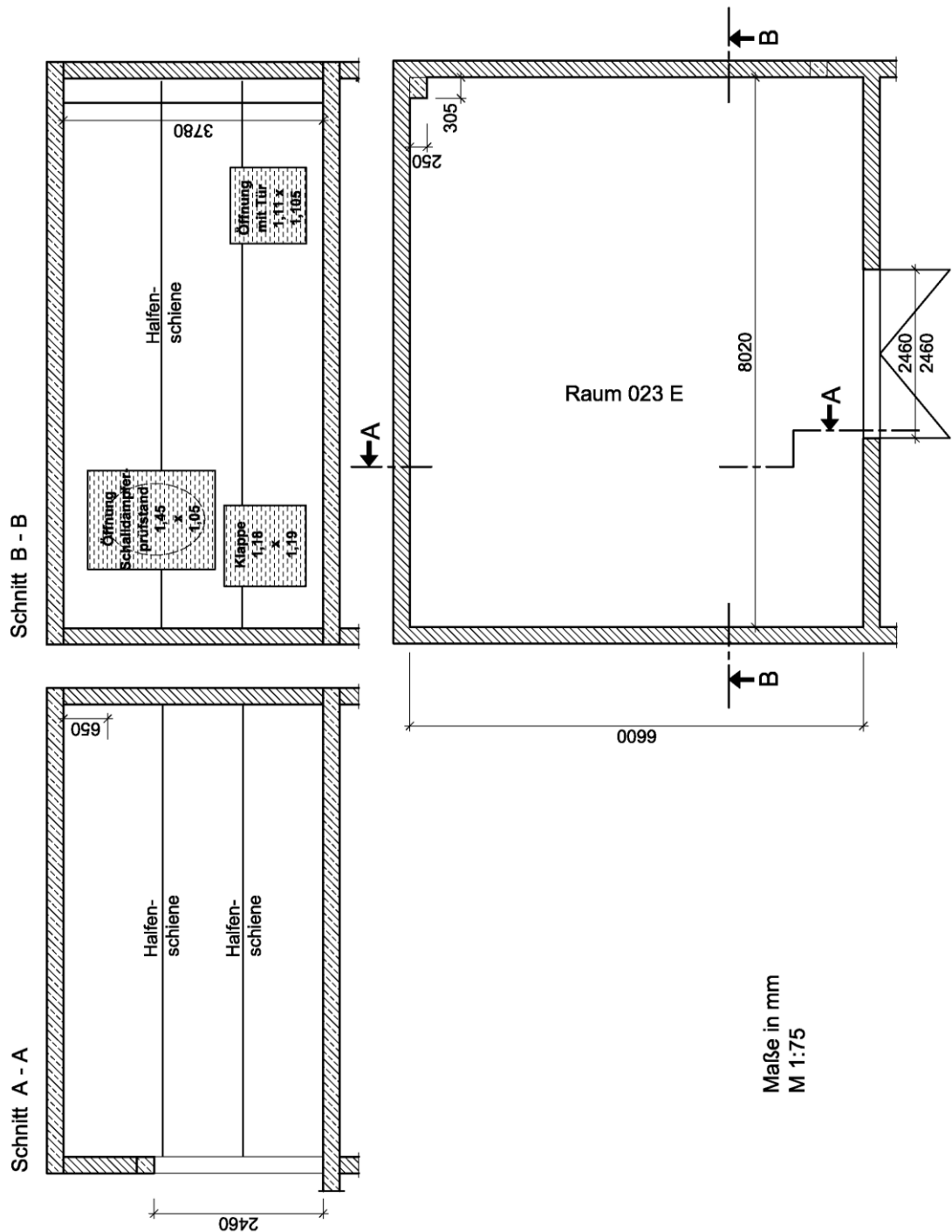


Figure D.1. Plan view and sections of the reverberation room.

2.2 Measurement of the 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 24 independent combinations of loudspeakers and microphones were measured each. 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 the backwards integrated impulse response.

The determined reverberation times are given in Table D1.

Table D.1. Reverberation times without and with test objects.

Frequency in Hz	Reverberation time T in s	
	T_1 (without test object)	T_2 (with test object)
100	5.22	2.51
125	4.73	2.39
160	4.77	2.62
200	5.12	2.60
250	5.20	2.58
315	5.04	2.52
400	5.53	2.58
500	5.58	2.67
630	5.45	2.55
800	5.39	2.56
1000	5.61	2.54
1250	5.52	2.61
1600	5.26	2.52
2000	4.60	2.32
2500	3.85	2.11
3150	2.98	1.84
4000	2.27	1.55
5000	1.70	1.28

2.3 List of test equipment

The applied test equipment is listed in Table D.2.

Table D.2. 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
Software for measurement and evaluation	Müller-BBM	Bau 4	Version 1.6