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 Vital Decosterstraat 67A – bus 1
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N° 451-TEST
 NBN EN ISO 17025:2017
 EA MLA signatory

NOISE LAB
TEST REPORT Number A-2022LAB-072-1-44823_E

Customer : Studio Wae
 Gansstraat 170
 3582 EP Utrecht
 Nederland

Contacts : **Client :** Tynke Van den Heuvel
Noise lab : Els Meulemans

Tests : Measurement of sound absorption in the reverberation room

Product name : "The better Wae" Circular wall tiles

Normative references:
NBN EN ISO 354:2003

Acoustics - Measurement of sound absorption in a reverberation room

NBN EN ISO 11654:1997
 NBN ISO 9613-1:1996

Acoustics - Sound absorbers for use in buildings - Rating of sound absorption

Acoustics - Attenuation of sound during propagation outdoors -
 part 1 : Calculation of the absorption of sound by the atmosphere

ISO 12999-2:2020

Acoustics - Determination and application of measurement uncertainties in building acoustics
 Part 2: Sound absorption

To perform the above measurements, the laboratory of Daidalos Peutz is accredited by BELAC, "The Belgian Accreditation Body", under the certificate nr N°451-TEST. The activities covered by this accreditation certificate are covered by the EA MLA. BELAC is a signatory of all existing multilateral agreements and recognition agreements of International Laboratory Accreditation Cooperation (ILAC). In this way, reports issued by BELAC accredited bodies are internationally accredited.

Date and reference of the request:	1/07/2022	2022LAB-072
Date of receipt of the specimen(s):	19/09/2022	1
Date of construction:	19/09/2022	
Date of tests:	19/09/2022	
Date of preparation of the test report:	12/10/2022	

The measurements were carried out at Daidalos Peutz Laboratory for Acoustics at Hooglede, see appendix 1
 This test report together with its annexes contains : 9 pages and must be multiplied only in its entirety

Technical Manager,

Paul Mees

Laboratory Engineer,

Els Meulemans

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MEASURING EQUIPMENT

Signal

Brüel & Kjaer - 4292 : Omni Power Sound Source

Microphone system:

Brüel & Kjaer - 4189-L-001 : 1/2" free field microphone prepolarized, inclusive 2669L TEDS

Brüel & Kjaer - 4189 : 1/2" free field microphone, 6Hz to 20kHz, prepolarized

Brüel & Kjaer - 2669 : 1/2" microphone preamplifier

Brüel & Kjaer - 4231 : Sound calibrator 94&114dB SPL-1000Hz, Fulfills IEC 60942(2003)Class1

Number of source positions:	2	(Different sound source positions at least 3m apart.
Number of microphone positions for each source position:	8	The measurements shall be made with different microphone positions
Number of measured decays curves:	3	which are at least 1,5m apart, 2m from any sound source and 1m from
Total number of measurements with different positions for microphone & source:	16	any room surface and the test specimen.)

Signal processing

Brüel & Kjaer - 2716C : Power amplifier

Brüel & Kjaer - 3050-A-6/0: Signal generator, 6-ch. Inputmodule LAN-XI

Brüel & Kjaer - 3160-A-042: Signal generator, 4/2-ch. Input/output module LAN-XI

Brüel & Kjaer : PULSE Labshop Version 13.5

A PC with all necessary software

Reverberation room

Dimensions of the room:	Total volume :	298,3 m ³
	Length:	9,99 m
	Width	4,97 m
	Height	5,98 m
	Volume door opening :	1,32 m ³
	Total area:	279,9 m ²
	$I_{\max} = 12,65 \text{ m} < 1,9 V^{1/6}$	

In order to improve the diffusivity, the use of diffusers is necessary

The test specimen shall have a maximum area of 15,62 m², which depends on the room volume

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TEST METHOD

The tests were conducted in accordance with the provisions of the test method EN ISO354:2003. A detailed description of the test set up has been given in the figures of annex 1 of this report.

The measurement method can be simply described as follows:

Essence of the test is in measuring of the reverberation time in the empty reflecting room and in the same room with the test sample inside it. The sound-absorption properties of a material depend on how the material is mounted during the test. Annex B of ISO 354:2003 specifies several different standard mountings that shall be used during a test for sound absorption. Normally a test specimen is tested using only one of the specified mountings.

From these reverberation times, the equivalent sound absorption area of the test specimen, is calculated by using Sabine's equation. Measurement is carried out in ranges of 1/3 octave and interval from 100Hz to 5000Hz.

The equivalent sound absorption area of the empty reverberation room, A_1 , in square metres, shall be calculated using the formula (1) :

$$A_1 = 55,3 V / (c_1 T_1) - 4V m_1 \quad [m^2] \quad (1)$$

The equivalent sound absorption area of the reverberation room containing a test specimen, A_2 , in square metres, shall be calculated using the formula (2) :

$$A_2 = 55,3 V / (c_2 T_2) - 4V m_2 \quad [m^2] \quad (2)$$

The equivalent sound absorption area of the test specimen, A_T , in square metres, shall be calculated using the formula (3) :

$$A_T = A_2 - A_1 = 55,3 V (1/c_2 T_2 - 1/c_1 T_1) - 4V(m_2 - m_1) \quad [m^2] \quad (3)$$

The sound absorption coefficient of a plane absorber or a specified array of test objects shall be calculated using the formula (4):

$$\alpha_s = A_T / S \quad (4)$$

whereas: A_1	=	<i>The equivalent sound absorption area of the empty reverberation room in square metres</i>
A_2	=	<i>The equivalent sound absorption area of the reverberation room containing a test specimen in square metres</i>
V	=	volume , in cubic metres, of the empty reverberation room [m^3]
c_1, c_2	=	the propagation speed of sound in air, in [m/s], calculated using the formula (in function of the temperature in the room during the test) $c = 331 + 0,6 t$ with $t =$ the air temperature in degrees Celsius for temperatures in the range of 15°C to 30°C
T_1	=	<i>the reverberation time, in seconds, of the empty reverberation room</i>
T_2	=	<i>the reverberation time, in seconds, of the reverberation room after the test specimen has been introduced</i>
m_1, m_2	=	<i>the power attenuation coefficient, in reciprocal metres, calculated according to ISO 9613-1:1993</i>
A_T	=	<i>The equivalent sound absorption area of the test specimen in square metres</i>
S	=	<i>the area, in square metres, covered by the test specimen</i>
α_s	=	<i>the sound absorption coefficient</i>

SPECIAL MEASUREMENT CONDITIONS

-
-
-
-
-

n/a

Cutting the samples into a rectangular measuring arrangement was not possible, because of the necessary re-use of the samples for sale

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RATING OF SOUND ABSORPTION

α_p PRACTICAL SOUND ABSORPTION COEFFICIENT

Frequency-dependent value of the sound absorption coefficient which is based on measurements on one-third-octave bands in accordance with ISO 354 and which is calculated in octave bands in accordance with the standard ISO 11654:1997.

The practical sound absorption coefficient, α_{pi} , for each octave band i , is calculated from the arithmetic mean value of the three one-third octave sound absorption coefficients within the octave. The mean value is calculated to the second decimal and rounded in steps of 0,05 and maximized to 1,00 for rounded mean values > 1,00

α_w WEIGHTED SOUND ABSORPTION COEFFICIENT

The weighted sound absorption coefficient is determined as a single number value from the practical sound absorption coefficients from 250 Hz to 4000 Hz. The practical sound absorption coefficient is calculated according to ISO 11654:1997.

Single-number frequency-independent value which equals the value of the reference curve at 500 Hz after shifting is as specified in the standard ISO 11654:1997.

SHAPE INDICATORS, L,M,H

Whenever a practical sound absorption coefficient α_{pi} exceeds the value of the shifted reference curve by 0,25 or more, one or more shape indicators shall be added, in parantheses, to the α_w value.

If the excess absorption occurs at 250 Hz, use the notation L.

If the excess absorption occurs at 500 Hz or 1000 Hz, use the notation M.

If the excess absorption occurs at 2000 Hz or 4000 Hz, use the notation H.

NRC NOISE REDUCTION COEFFICIENT

The NRC is a single-number index determined in a lab test and used for rating how absorptive a particular material is. This industry standard ranges from zero (perfectly reflective) to 1 (perfectly absorptive). It is simply the average of the mid-frequency sound absorption coefficients (250, 500, 1000 and 2000 Hertz) rounded to the nearest 5%.

SAA SOUND ABSORPTION AVERAGE

NRC is being replaced by the Sound Absorption Average (SAA), which is described in the current ASTM C423-17. The SAA is a single-number rating of sound absorption properties of a material similar to NRC, except that the sound absorption values employed in the averaging are taken at the twelve one-third octave bands from 200 Hz to 2500 Hz, inclusive, and rounding is to the nearest multiple of 0.01.

The NRC and SAA results are not within the scope of the accreditation.

Test results related to tested object only. The test results should not be considered as material constants, the absorption depends not only on the material itself. The method of construction, the size of the material surface and its place in the room, affect the sound absorption characteristics of the test element.

ACCURACY

The accuracy of the absorption coefficients as calculated can be expressed in terms of repeatability of measured reverberation times (tests within one laboratory) and reproducibility (between various laboratories)

The expanded uncertainty under reproducibility conditions, U , is calculated in accordance to the standard ISO 12999-2 for the confidence level of 95%, used the coverage factor $k=2$

$$U = u \cdot k$$

met

u = uncertainty under reproducibility conditions

k = coverage factor ($k=2$ for a confidence level of 95%)

U = expanded uncertainty under reproducibility conditions

This standard specifies how to calculate :

- the uncertainty of sound absorption coefficients and equivalent sound absorption areas measured according to ISO 354

- the uncertainty of the practical and weighted sound absorption coefficients determined according to ISO 11654

The numbers given are derived from inter-laboratory measurements with different types of test specimens including suspended ceilings, mineral wool, foams.

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α_s

SOUND ABSORPTION COEFFICIENT

EN ISO 354:2003 Acoustics - Measurement of sound absorption in a reverberation room
 EN ISO 11654:1997 Acoustics - Sound absorbers for use in buildings - Rating of sound absorption
 ISO 12999-2:2020 Acoustics - Determination and application of measurement uncertainties in building acoustics - Part 2: sound absorption

Identification number of test element: 1 **Test date:** 19/09/2022

Name of test institute: Daidalos Peutz Laboratory of Acoustics, Hooglede, Belgium

Reverberation room: V = 298,3 m³ S_{tot} = 279,9 m²

Room conditions during measurements:

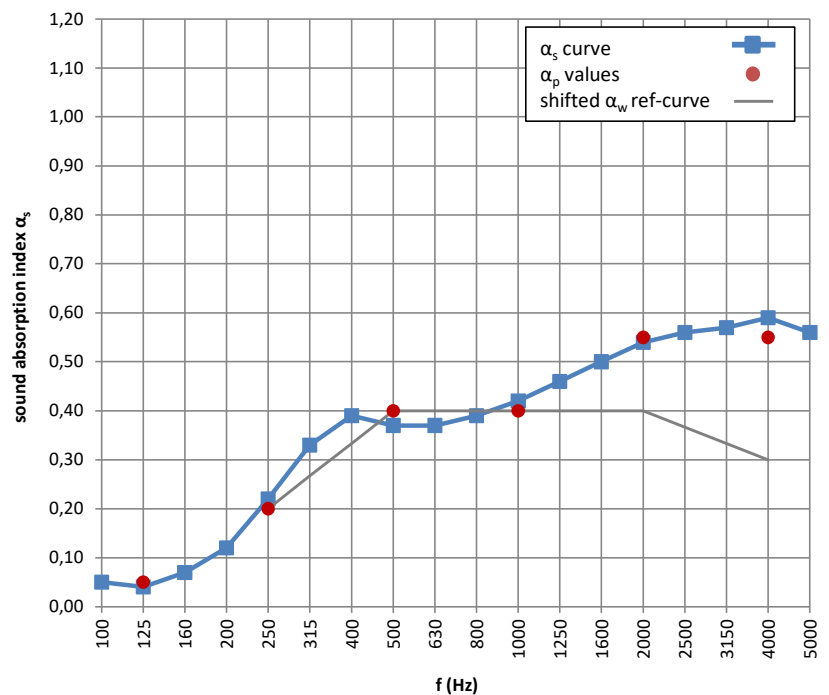
	Empty room	With testelement
Temperature:	T = 20,1	20,1 °C
Atmospheric pressure:	p = 101,9	102,0 kPa
Relative humidity :	h _r = 69	62 %

Type of test element: Plane absorber

Construction characteristics: Mounting type in line with ISO354 Annex B: Type A mounting (directly against a room surface)
 Area of test element: 10,83 m²
 Total thickness: 20-30 mm
 Number of layers, including air spaces: 1
 Connection of layers: The wall tiles were loosely laid side by side on the floor of the reverberation room.

f(Hz)	T ₁ (s)	T ₂ (s)	α_s	$\pm U$ (k=2)
50				
63				
80				
100	10,73	9,54	0,05	± 0,05
125	8,78	8,17	0,04	± 0,04
160	8,02	7,14	0,07	± 0,05
200	9,16	7,34	0,12	± 0,06
250	9,60	6,52	0,22	± 0,07
315	9,41	5,49	0,33	± 0,08
400	8,78	4,94	0,39	± 0,08
500	8,77	5,03	0,37	± 0,07
630	9,06	5,12	0,37	± 0,06
800	9,01	5,01	0,39	± 0,06
1000	8,90	4,81	0,42	± 0,06
1250	8,23	4,40	0,46	± 0,07
1600	7,38	4,01	0,50	± 0,07
2000	6,64	3,64	0,54	± 0,07
2500	5,71	3,26	0,56	± 0,06
3150	4,84	2,92	0,57	± 0,06
4000	3,88	2,49	0,59	± 0,07
5000	3,22	2,19	0,56	± 0,06

f(Hz)	α_p	$\pm U$ (k=2)
125	0,05	
250	0,20	± 0,06
500	0,40	± 0,08
1000	0,40	± 0,08
2000	0,55	± 0,08
4000	0,55	± 0,10



$\alpha_w = 0,40$ (H)* $\pm 0,07$ (k=2)
 Sound absorption class: D

NRC = 0,4 **
SAA = 0,39 **

* It is strongly recommended to use this single-number rating in combination with the complete sound absorption coefficient curve
 ** These results are not within the scope of the accreditation

Requested by: Studio Wae, Gansstraat 170, 3582 EP Utrecht

TESTELEMANT: (product name, for details see Annex 2)

"The better Wae" Circular wall tiles

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ANNEX 1: Description test items by manufacturer

The test sample description given by manufacturer is checked visually as good as possible by the laboratory.
 The correspondence between the test element and the commercialized product is the sole responsibility of the manufacturer

"The better Wae" Circular wall tiles

Material : 100% Production carpet tile waste : waste acoustic felt, carpettiles.
 Thickness : thinnest layer ca. 20 mm, thickest layer ca. 30 mm

shape : equilateral hexagon - radius = 25,5 mm - area = 0,167m²
 Ca. 6 tiles per sqm

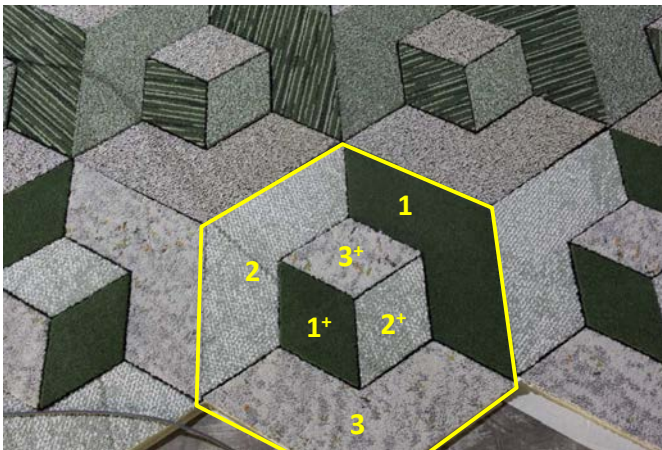


photo : test setup with indication of the different types of layers

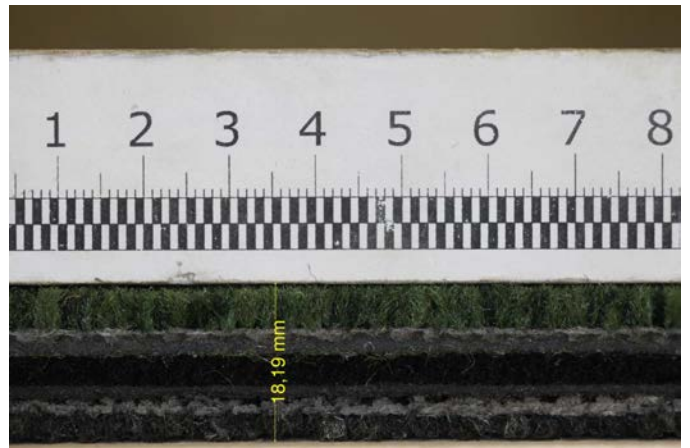


photo : section of layer 1 (dark green)



photo : section view with the different in height in the center of the tile
 (ca. 6mm higher for layer 1⁺)

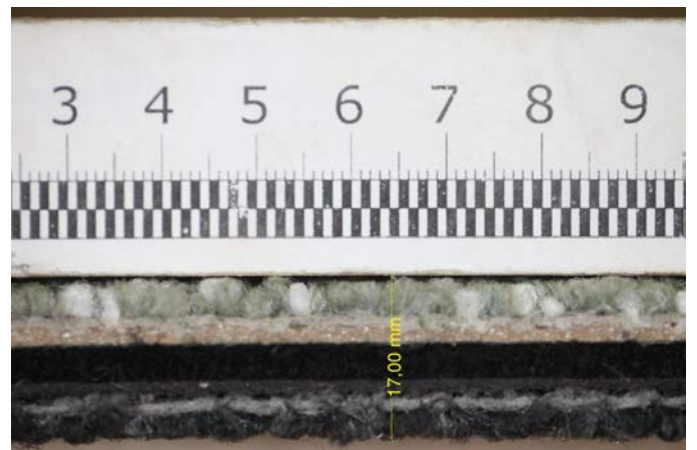


photo : section of layer 2 (middle green)

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ANNEX 2: Technical datasheet

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Further information can be obtained from the manufacturer

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ANNEX 3: photographs of the test element or the test arrangement

Description of the assembly or drawing or photo

The wall tiles were installed as a type A mounting specified in Annex B of ISO 354:2003
 The wall tiles were placed side by side, directly on the floor of the reverberation room

To prevent the side edges from absorbing sound, the perimeter of the sample was covered with a non sound absorbing tape.

The test specimen measures 65 x 0,1666m², surface area of 10,829m²

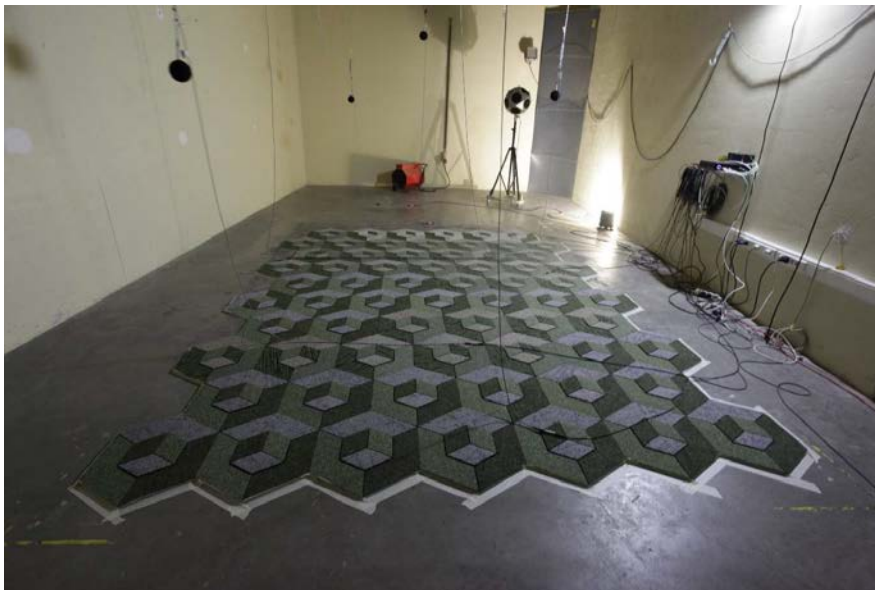


photo: test set-up in the reverberation room

Studio Wae: sample Polygon wall tiles
 Surface area : 10,83m²

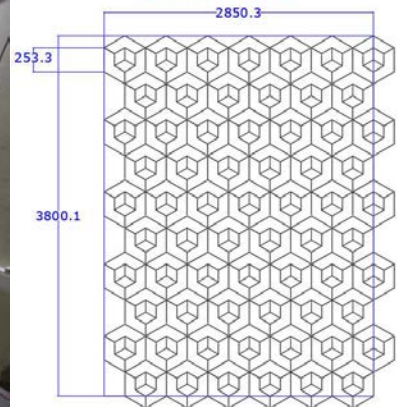


photo : detail of the perimeter of the test set-up



photo : backside of the wall tiles (the double-sided tape was not used for the mounting, the tiles were loosely laid on the floor of the reverberation room)

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ANNEX 4: Sketch of the test room

Daidalos Peutz Laboratory of Acoustics, Diksmuidesteenweg 17B/1, B-8830 Hooglede, Belgium

The test room was built and finished according ISO 354.

Reverberation Room (according EN ISO 354)

