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N° 451-TEST
 NBN EN ISO 17025:2017
 EA MLA signatory

NOISE LAB
TEST REPORT Number A-2023LAB-005-1-45008_E

Customer : Concordia Textiles
 Flanders-Fieldweg 37
 8790 Waregem
 Belgium

Contacts : **Client :** Rik Gekiere
Noise lab : Els Meulemans

Tests : Measurement of sound absorption in the reverberation room

Product name : Concordia AIR-tiles: type E-300 mounting (air cavity 280 mm)

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:	17/01/2023	2023LAB-005
Date of receipt of the specimen(s):	23/03/2023	1
Date of construction:	23/03/2023	
Date of tests:	23/03/2023	
Date of preparation of the test report:	19/04/2023	

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, Fulfils 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
	$l_{\max} = 12,65 \text{ m} < 1,9 V^{1/3}$	

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	=	<i>volume, in cubic metres, of the empty reverberation room [m³]</i>
c_1, c_2	=	<i>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)</i> $c = 331 + 0,6 t$ with $t =$ <i>the air temperature in degrees Celsius for temperatures in the range of 15°C to 30°C</i>
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

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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

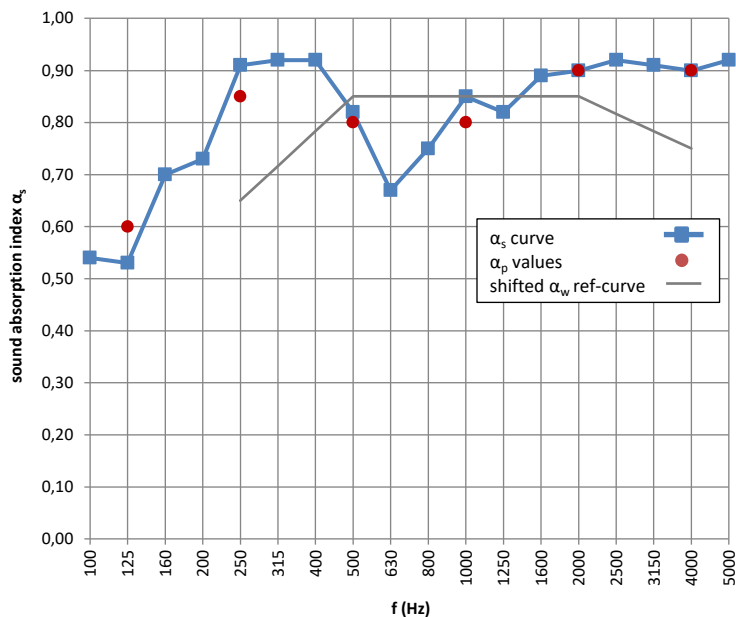
EN ISO 354:2003 Acoustics - Measurement of sound absorption in a reverberation room
 EN ISO 11654:1997 Acoustics - Sound absorbers for use in buildings - Rating of sound absorption
 ISO 12999-2:2020 Acoustics - Determination and application of measurement uncertainties in building acoustics - Part 2: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

Identification number of test element: 1 **Test date:** 23/03/2023
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:
 Temperature: T = 17,3 °C (Empty room) / 17,2 °C (With testelement)
 Atmospheric pressure: p = 99,9 kPa / 100,0 kPa
 Relative humidity: h_r = 58 % / 62 %

Type of test element: Plane absorber
Construction characteristics: Mounting type in line with ISO354 Annex B: Type E mounting (with an airspace)
 Area of test element: 10,56 m²
 Total thickness: 300 mm
 Number of layers, including air spaces: 2
 Connection of layers:
 1: AIR-tiles (ceiling tiles 20 mm) supported on ceiling grid
 2: Air cavity 280 mm

f(Hz)	T ₁ (s)	T ₂ (s)	α_s	$\pm U$ (k=2)
50				
63				
80				
100	10,36	4,67	0,54	$\pm 0,29$
125	8,33	4,26	0,53	$\pm 0,22$
160	8,06	3,61	0,70	$\pm 0,23$
200	8,80	3,67	0,73	$\pm 0,19$
250	9,36	3,28	0,91	$\pm 0,19$
315	9,37	3,26	0,92	$\pm 0,17$
400	8,69	3,18	0,92	$\pm 0,14$
500	8,61	3,39	0,82	$\pm 0,11$
630	8,92	3,88	0,67	$\pm 0,09$
800	8,82	3,60	0,75	$\pm 0,09$
1000	8,89	3,36	0,85	$\pm 0,10$
1250	8,21	3,34	0,82	$\pm 0,10$
1600	7,24	3,03	0,89	$\pm 0,10$
2000	6,37	2,84	0,90	$\pm 0,09$
2500	5,37	2,61	0,92	$\pm 0,09$
3150	4,36	2,37	0,91	$\pm 0,08$
4000	3,40	2,07	0,90	$\pm 0,08$
5000	2,65	1,77	0,92	$\pm 0,08$

f(Hz)	α_p	$\pm U$ (k=2)
125	0,60	
250	0,85	$\pm 0,13$
500	0,80	$\pm 0,08$
1000	0,80	$\pm 0,08$
2000	0,90	$\pm 0,08$
4000	0,90	$\pm 0,10$



$\alpha_w = 0,85$ * $\pm 0,07$ (k=2)
 Sound absorption class: B

NRC = 0,85 **
SAA = 0,84 **

Requested by: Concordia Textiles, Flanders-Fieldweg 37,8790 Waregem
TESTELEMENT: (product name, for details see Annex 2)

Concordia AIR-tiles: type E-300 mounting (air cavity 280 mm)

* 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

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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

Concordia AIR-tiles , type E-300 mounting

Technical information about the tiles:

The AIR-tiles are treated with a balanced recipe of Airmax 2.0 , FR and WR components

Material: 100% non-woven PES 20mm + 100% polyester acoustic textile with airmax 2.0

Dimensions: 600 x 600 mm

Thickness: 20 mm

Surface weight: 1.5 kg/m² (indicative measurement of the tile in the laboratory: ±1.305 kg/m², ±65.25 kg/m³)

Technical information about the suspension system:

Rockfon Chicago Metallic® T24 Hook 850 ceiling suspension system

24mm hook grid with a knuckle joint main runner and butt-cut cross tees

To improve retention of the tiles, Rockfon Hold Down Clips were used

The total height of the suspension ceiling = 300 mm (type E-300) with an airspace of 280 mm between the AIR tiles and the existing floor/ceiling

photo of test sample: Concordia Air-tiles

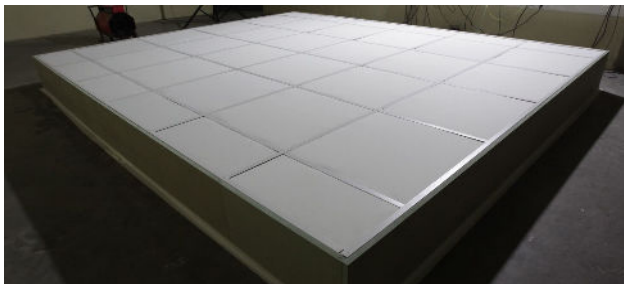
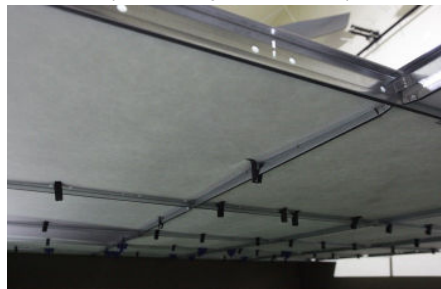


photo of the suspension ceiling and hold down clips



cross-section photo of the Air-tile



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ANNEX 2: Technical datasheet

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

Please request further information from **Concordia Textiles**

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

Description of the assembly or drawing or photo

The test object was installed as a type E mounting specified in Annex B of ISO 354:2003.
 First, 5 main runners with a length of ± 3.6 m were installed and attached to the perimeter of the test sample.
 Then the cross-tees were inserted, to form a grid.
 The ceiling tiles (600 mm x 600 mm) were laid in the grid. To improve retention of the tiles, Rockfon Hold Down Clips were used.
 The test sample was sealed along its entire perimeter with an acoustically reflective frame (2 x 18 mm MDF), with a surface density of at least 20 kg/m², as described in ISO 354:2003.
 The exposed surface of the MDF frame was flush with the exposed surface of the test sample (ceiling tiles).
 The perimeter frame was sealed at the bottom (frame/concrete floor) as well as at the top (frame/test specimen) with a non-sound absorbing tape.
 The length:width ratio of the test sample is 1:0.83. The defined area of the test sample exposed to sound = 10.56 m².

photo of the setup:

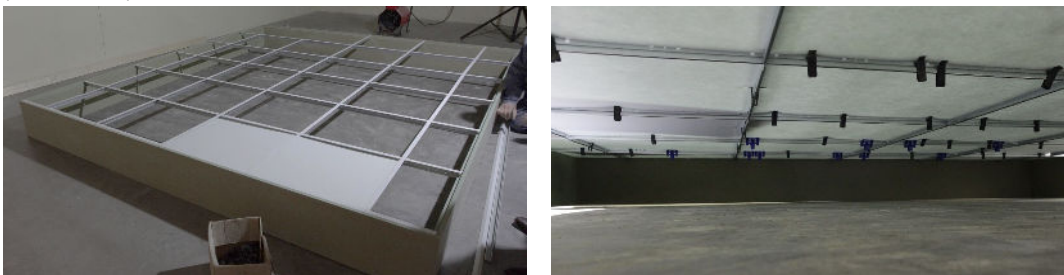
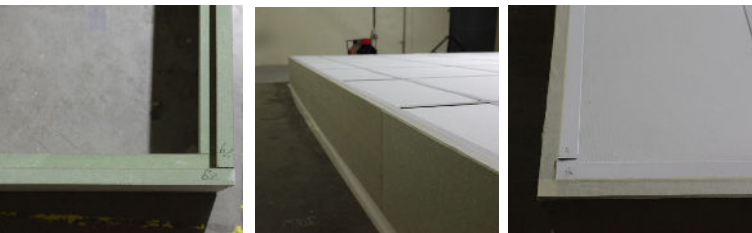


photo of measuring test sample:



edges taped with non-absorbent tape



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ANNEX 4: Sketch of the test room

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

The test room was built and finished according ISO 354.

