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

NOISE LAB

REPORT Number A-2021LAB-025-11-14-44260_E

Customer : Carpentier
 Abeeldreef 15
 B-8760 Meulebeke
 Belgium

Contacts : Client : Dhr. Kristof Carpentier
 Noise lab : Els Meulemans

Tests : Measurement of sound absorption in the reverberation room

Product / series name : HOTWOOD PINE FINE LINE/ Profile name: CV3 40/20 with QuickClip Acoustic - CBQC-A - 5 mm spacing

Reference norm :
NBN EN ISO 354:2003 **Acoustics - Measurement of sound absorption in a reverberation room**

NBN EN ISO 11654:1997 Acoustics - Sound absorbers for use in buildings - Rating of sound absorption
 NBN ISO 9613-1:1996 Acoustics - Attenuation of sound during propagation outdoors -

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:	15/02/2021	2021LAB-025
Date of receipt of the specimen (s):	5/03/2021	
Date of construction:	5/03/2021	until 5/03/2021
Date of tests:	5/03/2021	until 5/03/2021
Date of preparation of the report:	4/02/2022	

This test report together with its annexes contains 10 pages and must be multiplied only in its entirety.

Technical Manager,

Paul Mees

Laboratory Engineer,

Els Meulemans

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MEASURING EQUIPMENT

Sound Sources

Brüel & Kjaer - 4292 : Omni Power Sound Source (+ Behringer iNuke NU3000DSP power amplifier)

Microphones and recording

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

A PC with all necessary software

Reverberation room

Dimensions of the room:	Volume :	298,31 m³
	Length:	9,99 m
	Width:	4,97 m
	Height:	5,98 m
	Volume door opening:	1,32 m³
	Total area:	279,9 m²
	$I_{\max} = 12,65 \text{ m} < 1,9 V^{1/3}$	

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 can be found in the standard.

The measurement method can be simply described as follows:

The reverberation time of the room is determined in 2 situations:

- an empty reflecting room
- a reflecting room with the test sample inside, which is mounted following the different prescriptions specified in the standard

By adding the test sample inside the room, the reverberation time will be shorter. The reduction of reverberation time is a reference for the amount of added absorption.

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_2, A_1 = the equivalent sound absorption area of respectively the empty reverberation room and the room containing a test specimen [m^2]
 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, T_2 = the reverberation time, in seconds, of the empty reverberation room resp. with test specimen in [s]
 m_1, m_2 = the power attenuation coefficient, in reciprocal metres, calculated according to ISO 9613-1:1993
 A_T = The equivalent sound absorption area of the test specimen in square metres
 S = the area, in square metres, covered by the test specimen
 α_s = the sound absorption coefficient

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 parentheses, 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 C423-09a. 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 $k=2$

$$U = u \cdot k$$

with 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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1. α_s

SOUND ABSORPTION COEFFICIENT

EN ISO 354:2003
 EN ISO 11654:1997
 ISO 12999-2:2020

Acoustics - Measurement of sound absorption in a reverberation room
 Acoustics - Sound absorbers for use in buildings - Rating of sound absorption
 Acoustics - Determination and application of measurement uncertainties in building acoustics - Part 2: Sound absorption

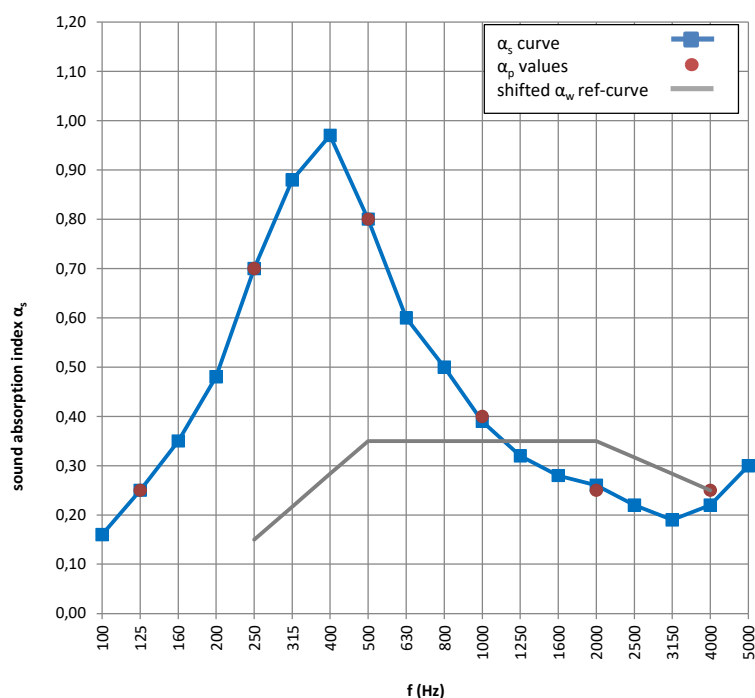
Identification number of test element: 14 **Test date:** 5/03/2021
Reverberation room: V = 298,3 m³ S_{tot} = 279,9 m²
Room conditions during measurements:
 Temperature: T = 18,9 °C
 Atmospheric pressure: p = 102,38 kPa
 Relative humidity: h_r = 47,4 %

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: 12,05 m²
 Total thickness: 113 mm
 Number of layers, including air spaces: 4
 Connection of layers:

The wooden profiles were mounted with the QuickClip® system on the aluminium joists for placement at 60cm intervals on the acoustic glass wool slab. These ceiling panels were mounted on a wooden frame to form the airgap and placed side by side on the floor of the room.

f(Hz)	T ₁ (s)	T ₂ (s)	α_s	$\pm U$ (k=2)
50				
63				
80				
100	11,24	7,82	0,16	$\pm 0,11$
125	9,30	5,86	0,25	$\pm 0,12$
160	9,47	5,18	0,35	$\pm 0,13$
200	10,13	4,58	0,48	$\pm 0,14$
250	9,67	3,59	0,70	$\pm 0,16$
315	10,04	3,13	0,88	$\pm 0,16$
400	9,32	2,85	0,97	$\pm 0,15$
500	9,13	3,24	0,80	$\pm 0,11$
630	9,43	3,89	0,60	$\pm 0,08$
800	9,51	4,34	0,50	$\pm 0,07$
1000	9,35	4,87	0,39	$\pm 0,06$
1250	8,45	5,01	0,32	$\pm 0,06$
1600	7,37	4,78	0,28	$\pm 0,05$
2000	6,40	4,43	0,26	$\pm 0,05$
2500	5,24	3,97	0,22	$\pm 0,04$
3150	4,22	3,39	0,19	$\pm 0,04$
4000	3,22	2,60	0,22	$\pm 0,04$
5000	2,51	2,00	0,30	$\pm 0,05$

f(Hz)	α_p	$\pm U$ (k=2)
125	0,25	
250	0,70	$\pm 0,11$
500	0,80	$\pm 0,08$
1000	0,40	$\pm 0,08$
2000	0,25	$\pm 0,08$
4000	0,25	$\pm 0,10$



$\alpha_w = 0,35$ (LM)* $\pm 0,07$ (k=2)

Sound absorption class: D

NRC = 0,55 **

SAA = 0,53 **

Requested by: Carpentier, Abeeldreef 15, B-8760 Meulebeke

TESTELEMET:

(short description by the manufacturer, details: see Annex 1)

HOTWOOD PINE FINE LINE / Profile name: CV3 40/20 with QuickClip Acoustic - CBQC-A - 5 mm spacing / Airgap of 50mm

* 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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2. α_s

SOUND ABSORPTION COEFFICIENT

EN ISO 354:2003
 EN ISO 11654:1997
 ISO 12999-2:2020

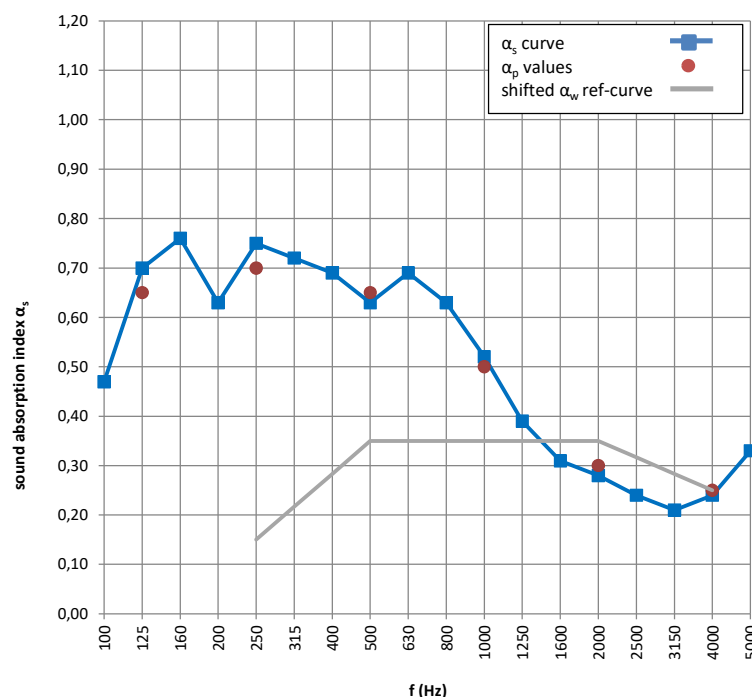
Acoustics - Measurement of sound absorption in a reverberation room
 Acoustics - Sound absorbers for use in buildings - Rating of sound absorption
 Acoustics - Determination and application of measurement uncertainties in building acoustics - Part 2: Sound absorption

Identification number of test element: 11
Reverberation room: V = 298,3 m³
Test date: 5/03/2021
Room conditions during measurements:
 Temperature: T = 18,9 °C (Empty space) / 18,3 °C (With testelement)
 Atmospheric pressure: p = 102,38 kPa
 Relative humidity: h_r = 47,4 % / 44 %

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: 12,05 m²
 Total thickness: 313 mm
 Number of layers, including air spaces: 4
 Connection of layers:

The wooden profiles were mounted with the QuickClip® system on the aluminium joists for placement at 60cm intervals on the acoustic glass wool slab. These ceiling panels were mounted on a wooden frame to form the airgap and placed side by side on the floor of the room.

f(Hz)	T ₁ (s)	T ₂ (s)	α_s	$\pm U$ (k=2)
50				
63				
80				
100	11,24	4,85	0,47	$\pm 0,26$
125	9,30	3,56	0,70	$\pm 0,28$
160	9,47	3,38	0,76	$\pm 0,24$
200	10,13	3,88	0,63	$\pm 0,17$
250	9,67	3,44	0,75	$\pm 0,17$
315	10,04	3,57	0,72	$\pm 0,14$
400	9,32	3,56	0,69	$\pm 0,11$
500	9,13	3,75	0,63	$\pm 0,09$
630	9,43	3,59	0,69	$\pm 0,09$
800	9,51	3,81	0,63	$\pm 0,08$
1000	9,35	4,23	0,52	$\pm 0,07$
1250	8,45	4,58	0,39	$\pm 0,06$
1600	7,37	4,62	0,31	$\pm 0,05$
2000	6,40	4,34	0,28	$\pm 0,05$
2500	5,24	3,87	0,24	$\pm 0,04$
3150	4,22	3,32	0,21	$\pm 0,04$
4000	3,22	2,56	0,24	$\pm 0,04$
5000	2,51	1,96	0,33	$\pm 0,05$



f(Hz)	α_p	$\pm U$ (k=2)
125	0,65	
250	0,70	$\pm 0,11$
500	0,65	$\pm 0,08$
1000	0,50	$\pm 0,08$
2000	0,30	$\pm 0,08$
4000	0,25	$\pm 0,10$

$\alpha_w = 0,35$ (LM)* $\pm 0,07$ (k=2)
 Sound absorption class: D

NRC = 0,55 **
 SAA = 0,54 **

Requested by: Carpentier, Abeeldreef 15, B-8760 Meulebeke

TESTELEMANT:

(short description by the manufacturer, details: see Annex 1)

HOTWOOD PINE FINE LINE / Profile name: CV3 40/20 with QuickClip Acoustic - CBQC-A - 5 mm spacing / Airgap of 250mm

* 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*

HOTWOOD PINE FINE LINE/ Profile name: CV3 40/20 with QuickClip Acoustic - CBQC-A - 5 mm spacing

HOTWOOD PINE FINE LINE (Heat treated - PEFC certified) : thickness 20mm - width 40mm
 profile name : CV3 40/20 with QuickClip® Acoustic - CBQC-A- 5 mm spacing - thickness 18mm (12 mm rail + 6 mm clip)
 acoustic layer : 25mm glaswool Isover Climliner 602

Acoustic ceiling with QuickClip® covering in HOTWOOD PINE FINE LINE, PEFC certified, with dimensions: thickness 20mm; width 40mm, installed with invisible Grad fastening system.

On the back of the wood, a groove is provided measuring 5,8mm by 11,8mm where the clips (made of plastic polyoxymethylene) click perfectly into it. All plastic clips with an axis distance of 60mm are mounted before on a aluminum rail (black lacquered) with the following dimensions : thickness 12mm; width 55mm and length $\pm$ 3600 mm or more.

Equipped with suspension system (to be placed every 600mm) and glaswool Isover Climliner 602 with a thickness of 25mm.

The construction with the acoustic glaswool layer but without the airgap is 63 (20+18+25) mm.

see photos and sketches

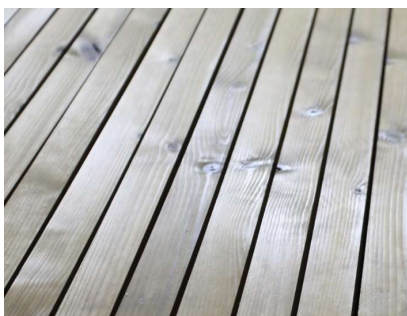
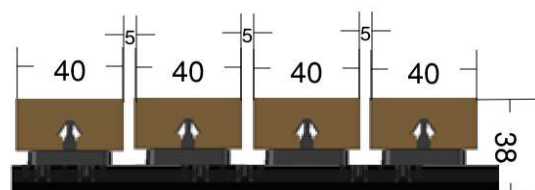
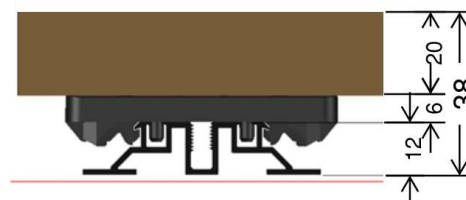


photo: front side Hotwood PINE FINE LINE CV3 40/20 QC - 5mm spacing



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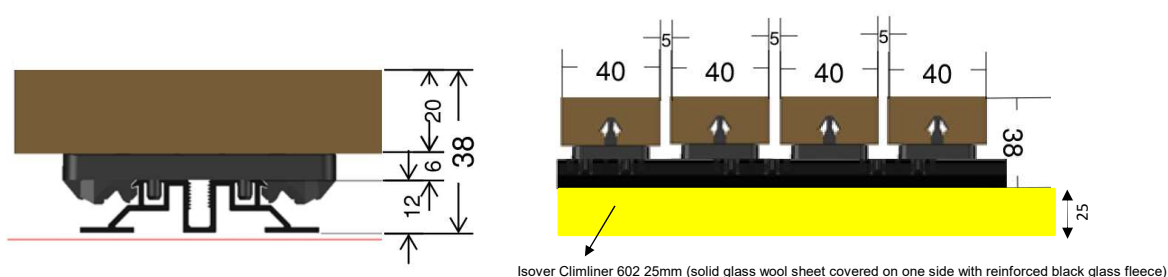


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ANNEX 2: Technical datasheets

*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*



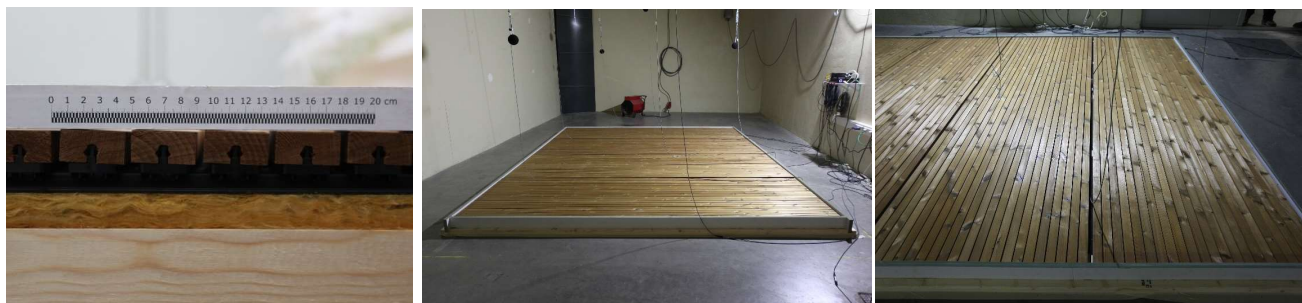
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ANNEX 3: Photographs of the test elements and/or the test arrangements

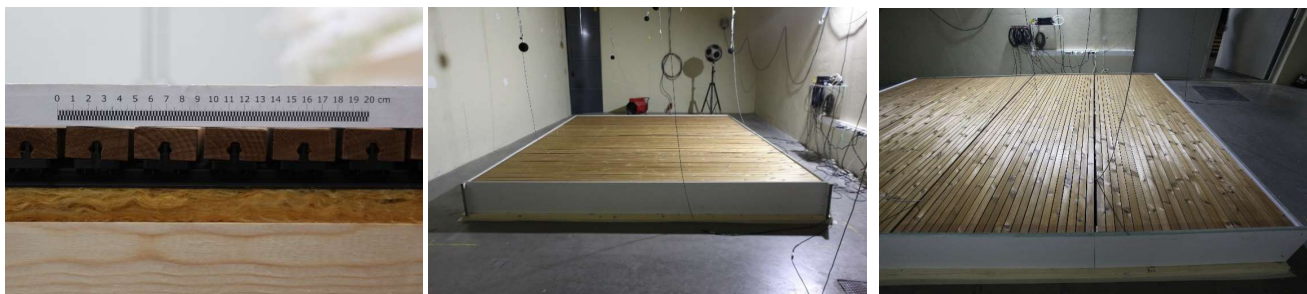
Description of the assembly and/or drawing and/or image

The wooden profiles (height 20mm) were mounted with the QuickClip® system on the aluminium joists (height 18mm) for placement at 60cm intervals on the acoustic glass wool slab with a thickness of 25mm.
 These ceiling panel with the dimensions of 3000 x 1000 mm and total height of 63mm was mounted on a wooden frame with a height of 50 or 250 mm to form an airspace behind it of respectively 50 or 250mm. Total test setup with a height of respectively 113 or 313 mm.
 The perimeter edge of the test specimen was covered with a wooden fixture with a surface density of at least 20kg/m². The joints between the fixture and the room surface were sealed with a tape to prevent air leakage between the enclosed space and the outside.

photographs : test setup 1 : HOTWOOD PINE FINE LINE / Profile name: CV3 40/20 with QuickClip Acoustic - CBQC-A - 5 mm spacing / Airgap of 50mm



photographs : test setup 2 : HOTWOOD PINE FINE LINE / Profile name: CV3 40/20 with QuickClip Acoustic - CBQC-A - 5 mm spacing / Airgap of 250mm



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ANNEX 4: Sketch of the test room

The test room was built and finished according ISO 354.

