AKOESTIEK EN BOUWFYSICA
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PEUTZ

Report

Hunter Douglas aluminium elements ceiling in relation to concrete core activation (CCA) - Climatic chamber and acoustic test

Report number BA 1164-2E-RA d.d. 6 september 2010

Principal:	Hunter Douglas Europe B.V. - Rotterdam
Report number:	BA 1164-2E-RA
Date:	6 september 2010
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1. INTRODUCTION

At the request of Hunter Douglas a climatic chamber test has been performed. Purpose of the test was to determine the loss of thermal power radiated by the thermally activated concrete slabs (concrete core activation (CCA)) due to the acoustic suspended ceiling. Acoustic measurements have also been performed to determine the absorption coefficient of the aluminium Luxalon 30BXD ceiling.

The test was performed in the period between June and August 2010 in the building physics laboratory and the acoustical laboratory of Peutz B.V. in Mook (the Netherlands).

The present report successively addresses:
– the experimental set-up used for the climatic research (chapter 2);
– the method followed for the thermal measurements (chapter 3);
– the results of the climate chamber measurements (chapter 4);
– the acoustic measurements in the laboratory (chapter 5);
– the findings of the study (chapter 6).

The results are summarized as follows:
By applying a suspended ceiling the cooling capacity delivered by the concrete core activation is reduced. By applying a full aluminium profile ceiling, consisting of Hunter Douglas panels type Luxalon 30BXD (with 30 mm spacing), the coverage rate is 50%. The reduction in cooling capacity of the ceiling in the tested configuration is approximately 23%.

The effective absorption coefficient α_w for a complete ceiling is 0.60 (H). Averaged over the octave bands from 500 - 4000 Hz (this is the main contribution of speech), the sound absorption is 0.77.

2. TEST SET UP CLIMATIC CHAMBER

2.1. Introduction

In the application of concrete core activation (CCA) cooling or heating capacity is delivered to the room by the concrete floor.

To improve the acoustics a suspended sound absorbing ceiling is installed under the concrete floor. It is expected that this barrier will reduce the cooling and heating capacity of the concrete core activation.
Depending on the degree of reduction of the thermal capacity, additional measures are required to achieve a comfortable indoor climate. The aim of the climatic research is to quantify the reduction of the cooling and heating capacity due to a suspended ceiling.

2.2. Test chamber

Within the measuring room a test chamber was built with the dimension l x w x h = 5,6 x 3,6 x 2,7 m^3, see figure 1. The test chamber has concrete floors fitted with piping (at the top of the concrete floor) that simulate the concrete core activation.
In the test chamber a raised floor was already present, the clearance to the concrete floor is 2.7 meters.

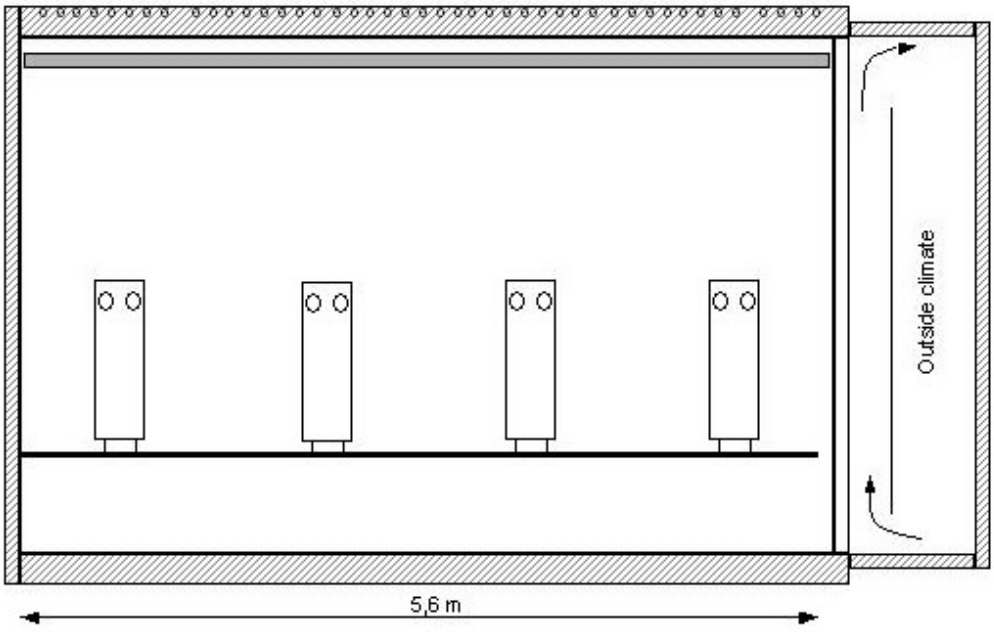

Figure 1 *section test chamber*

Regarding the façade, the existing façade is used, constructed of aluminium profiles and HR ++-glazing.
The temperature in the outdoor environment during the summer measurements was similar to the room temperature.

2.3. Suspended ceiling

After the reference measurement (table 1, variant 1) was conducted in the chamber without the suspended ceiling, the suspended ceiling was hung from the existing ceiling using omega profiles and a Flamco mounting construction already present.

In the test chamber a Hunter Douglas (Luxalon 30BXD) ceiling was mounted with a cavity of approximately 75 mm from the existing ceiling. The suspended ceiling consists of perforated U-profiles filled with sealed mineral wool strips. The profiles are 30 mm wide, 60 mm high and the distance between them is 30 mm. The profile surface is completely perforated, corresponding to a perforation rate of 23%.

Measurements were performed with the whole ceiling covered, corresponding to an effective coverage rate of approximately 50%. The perforated U-profiles were first mounted with the topside open (table 1, variant 2).

Next, measurements were performed with the topside of the U-profiles closed with a perforated aluminium strip (table 1, variant 3).

In the following photo's the two different ceiling profiles are shown.

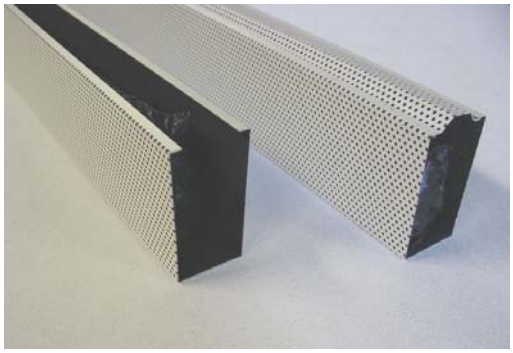

Figure 2 *ceiling profiles*

2.4. Lighting

No specific lighting is included in the ceiling. During the measurement (working) lighting was present in the test chamber. The power of the lights were accounted for in the measurement results.

3. MEASUREMENT METHOD THERMAL MEASUREMENTS

3.1. Introduction

Because the activation of the concrete in the test chamber is not representative for the concrete core activation in a specific project, it can only be determined what the relative capacity reduction is due to the suspended ceiling. The surface temperature of the bottom of the concrete was set to 20°C.

The activation of the concrete floor under the raised floor is not part of the investigation. The surface temperature of the floor is set to the room temperature.

3.2. Measuring points

Four measuring masts were placed in the room, measuring air temperatures at 0.1, 0.6, 1.1, 1.7 and 2.5 meters above the floor. Also at 1.1 meters height the blackglobe radiation temperature was determined. In figure 3 the location of the measuring masts are given.

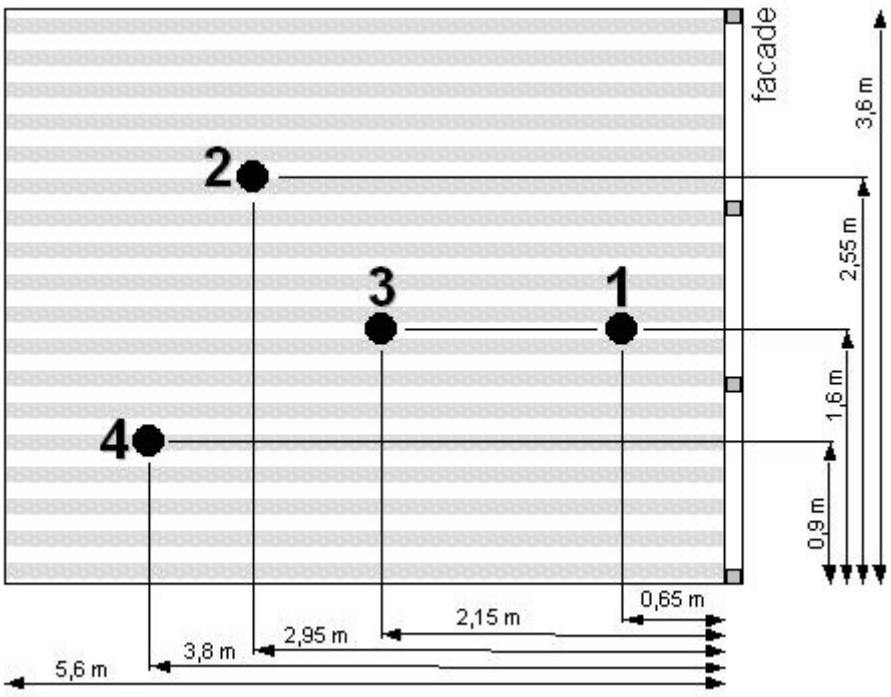

Figure 3 *Location of measuring masts*

The surface temperatures of the concrete and air temperatures were measured between the suspended ceiling and the concrete ceiling. Simultaneously relevant wall surface temperatures, and installation parameters etc. were measured. The data was recorded with a data log system and is presented in chapter 4.

3.3. Power measurement

The measuring room is heated by means of electric heating elements, evenly distributed over the area, according to DIN EN 14240, stabilizing the room temperature. By the introduced electric power the desired room temperature is controlled.

This quantity of electrical power is compared to the situations were a suspended ceiling was installed. At the same conditions (room temperature, concrete-surface temperature, etc.) the difference in the amount of heat input is a measure of the difference in thermal power delivered from the ceiling. The accuracy of these power measurements is 1-2%.

First a reference measurement, without suspended ceiling, was conducted. The amount of (electric) power needed to maintain the desired room temperature, given the set concrete surface temperature, was measured.

4. RESULTS CLIMATE CHAMBER

The results of the measurements are given in the table below. The measurements started with a reference measurement without a suspended ceiling in the test chamber, these results are shown in the third column (variant 1). The desired room temperature was 25°C, the surface temperature of the concrete was 20°C.

In variant 2, the room had a suspended ceiling, consisting of U-profiles with the topside open. Variant 3 was measured while the topsides of the profiles were closed by means of an aluminium strip.

The measurements were performed with the whole ceiling covered, corresponding to an effective coverage rate of approximately 50%.

Table 1 *Measurement results*

description	**unit**	**variant 1**	**variant 2**	**variant 3**
coverage	%	0	50	50
power heating elements	W	741	563	554
power (work) lighting	W	98	98	98
total power supplied	W	839	661	652
$T_{room\ average}$	°C	25.34	25.04	25.12
$T_{radiation\ room}$ average 1.1 m	°C	24.95	25.04	25.06
$T_{CCA\ ceiling}$	°C	20.11	20.05	20.00
$\Delta T_{radiation\ average}$ - $T_{CCA\ ceiling}$	K	4.84	4.99	5.06
power per K	W/K	173	132	129
specific power	$W/m^2.K$	8.6	6.6	6.4
difference electric power versus reference measurement	W %		-178 -21	-187 -22
difference specific power to reference measurement	$W/m^2.K$ %		-2.0 -23	-2.2 -26

Surface room: 3.6 x 5.6 = 20.2 m^2
Variant 1: measurement base without suspended ceiling
Variant 2: suspended ceiling (Luxalon 30BXD) topside open
Variant 3: suspended ceiling (Luxalon 30BXD) topside closed

A clear downward airflow of cool air between the profiles was observed.

5. ACOUSTIC MEASUREMENTS

The measurements were performed according to ISO 354 in the reverberation chamber of the Laboratory of Acoustics of Peutz bv Mook (the Netherlands). The characteristics of the reverberation room are given in the annex to this report (report A 2025-2E). In the annex, the full results of multiple variants are given. The ceiling that corresponds to ceiling variant 6, used in the climate chamber, is presented.

Through reverberation measurements the reverberation time of the room is defined for two situations:

- Where the reverberation chamber is empty;
- Where the material to be examined is placed in the reverberation chamber.

By introducing test material to be tested, the reverberation time in the reverberation chamber generally shortens. The reduction of the reverberation time is a measure of the amount of absorption introduced.

Calculations and measurements are carried out in 1/3 octave bandwidth from 100 to 5000 Hz, according to the standards. From these values, the third band octave values are calculated.

The weighted sound absorption coefficient is determined according to ISO 11654, the α_w-Value of this ceiling is 0.60 (H). Averaged over the octave bands from 500 - 4000 Hz (this is the main contribution of speech), the sound absorption is 0.77. See appendix for full results.

6. ASSESSMENT AND CONCLUSIONS

By applying a suspended ceiling, manufacturer Hunter Douglas type Luxalon 30BXD, with a cavity of approximately 75 mm between the concrete floor and ceiling, the cooling capacity delivered by the concrete core activation (CCA) is reduced.

By applying a full Luxalon 60BD ceiling (with 30 mm spacing), the effective coverage rate is 50%. The reduction of the cooling capacity for this examined ceiling configuration is approximately 23%.

The effective absorption coefficient α_w for a complete ceiling is 0.60 (H). Averaged over the octave bands from 500 - 4000 Hz (this is the main contribution of speech), the sound absorption is 0.77.

Mook,

This report contains:
10 pages
1 annex (report A 2025-2E)

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Report

Laboratory for Acoustics
Determination of the sound absorption (reverberation room method) of **ceiling panels type Luxalon 30 BD and type Luxalon 30 BXD, manufacturer Hunter Douglas**

Report number A 2025-2E-RA d.d. 6 September 2010

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Report number:	A 2025-2E-RA
Date:	6 September 2010
Ref.:	TS/HvH/HT/A 2025-2E-RA

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1. INTRODUCTION

At the request of Hunter Douglas Europe B.V. based in Rotterdam (The Netherlands), laboratory measurements of the sound absorption (reverberation room method) were carried out on

Ceiling panels type Luxalon 30 BD and type Luxalon 30BXD,
manufacturer Hunter Douglas

in the Laboratory for Acoustics of Peutz bv, at Mook, The Netherlands (see figure 1).

For this type of measurements the Laboratory for Acoustics has been accredited by the Dutch "Stichting Raad voor Accreditatie" (RvA).
The RvA is member of the EA MLA[1]

1 **EA MLA**: **E**uropean **A**ccreditation Organisation **M**ulti**L**ateral **A**greement: http://www.european-accreditation.org

EA: "*Certificates and reports issued by bodies accredited by MLA and MRA members are considered to have the same degree of credibility, and are accepted in MLA and MRA countries.*"

2. STANDARDS

The measurements have been carried out according to the Quality Manual of the Laboratory for Acoustics aswell as:

ISO 354:2003[2]	Acoustics Measurement of sound absorption in a reverberation room
NOTE:	this international standard has been accepted within all EU-countries as European Norm EN ISO 354:2003

Various other related norms:

EN ISO 11654:1997	Acoustics Sound absorbers for use in buildings Rating of sound absorption
ASTM C423-08a	Standard Test Method for Sound Absorption and Sound Absorption Coefficients by the Reverberation Room Method

2 According to this norm, the report should include for each measurement the mean reverberation times T1 and T2 at each frequency. Because these figures are not relevant for judging the quality of the product being tested, but merely for judging the accuracy of the calculations, they have been omitted in this report. It is possible of course to reproduce those figures at any time if the principal requests this.

3. TESTED CONSTRUCTION

The data presented here have been received from the principal or obtained by own observations.

Perforated Luxalon 30 BD Panels

Width:	ca. 30 mm
Height:	ca. 39 mm
Perforation:	equilateral triangle pattern
	Ø1,5 mm;
	c.t.c distance: 3,0 mm;
	perf. rate: ca. 23%
Material thickness:	ca. 0,65 mm
	Acoustic fleece on the inside
Mass:	ca. 125 gr/m^1

Perforated luxalon 30 BXD panels

Width:	ca. 32 mm
Height:	ca. 61 mm
Perforation:	equilateral triangle pattern
	Ø1,5 mm;
	c.t.c distance: 3,0 mm;
	perf. rate: ca. 23%
Material thickness:	ca. 0,65 mm
	Acoustic fleece on the inside
Mass:	ca. 185 gr/m^1

'Cover'

This cover can be attached to a panel, so a closed duct is obtained.

Rumble aluminium strip	Width:	ca. 32 mm
	Perforation:	equilateral triangle pattern
		Ø1,5 mm;
		c.t.c distance: 3,0 mm;
		perf. rate: ca. 23%
	Material thickness:	ca. 0,65 mm
	Acoustic fleece on the inside	
	Mass:	ca. 40 gr/m^1

Absorbing material

Sealed Glasswool, ca. 22 kg/m^3, height ca. 40 mm, width ca. 25 mm. Thickness foil ca. 0,02 mm

Attachment

Carriers

The panels were attached to aluminium Omega-strips — Height: ca. 30 mm; Width: ca. 60 mm; thickness: ca. 1 mm

Bracket

The attachment is made with profiled brackets — Height: ca. 15 mm; Width: ca. 30 mm; Thickness: ca. 1 mm

Total height (carriers + brackets) is ca. 37 mm

Fig.1; attached panels (30BXD)

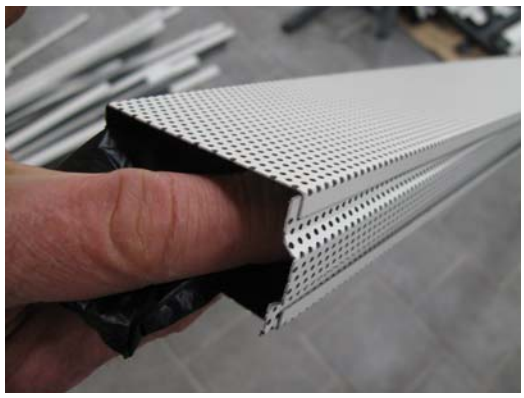

Fig. 2; Panel + cover

Variants:

The following variants are measured:

1. Luxalon 30 BD panels, glasswool, no cover, joint width 20 mm, total height 104 mm;
2. Luxalon 30 BD panels, glasswool, with cover, joint width 20 mm, total height 104 mm;
3. Luxlon 30 BXD panels, glasswool, no cover, joint width 45 mm, total height 136 mm;
4. Luxalon 30 BXD panels, glasswool, with cover, joint width 45 mm, total height 136 mm;
5. Luxalon 30 BXD panels, without glasswool, no cover, joint width 30 mm, total height 136 mm;
6. Luxalon 30 BXD panels, glasswool, no cover, joint width 30 mm, total height 136 mm.

The results as presented here relate only to the tested items and laboratory conditions as described in this report. The laboratory can make no judgement about the representativity of the tested samples.

4. MEASUREMENTS

The ceiling panels to be measured (see chapter 3) are mounted on a support structure above the floor of the reverberation room, the facing side of the panels was up (Type E-200 mounting according to ISO 354:2003.
The sides of the set-up were enclosed by 18 mm thick plastic covered chipwood board and sealed by tape.

4.1. Method

The tests were conducted in accordance with the provisions of the test method ISO 354 in the reverberation room of “Peutz bv" in Mook (the Netherlands) (see figure 1). The relevant data regarding the reverberation room are given in figure 2 of this report.

By means of reverberation measurements the reverberation time of the room is measured under two conditions:
– when the reverberation room is empty
– when the construction under test is inside the reverberation room

In general, once material is placed into the reverberation room a lower reverberation time will result.

The difference in reverberation times is a measure of the amount of absorption brought into the room.

Measurements and calculations were carried out in 1/3-octave bandwidth from 100 to 5000 Hz, according to the norms. Where applicable the octave values have been calculated from these 1/3-octave values.

From the reverberation measurements in the empty reverberation room the equivalent sound absorption A1 is calculated (per frequency band) according to formula 1 and expressed in m^2

$$A_1 = \frac{55{,}3\,V}{c\,T_1} - 4\,V\,m_1 \qquad (1)$$

in which :

V	=	the volume of the reverberation room	[m^3]
T_1	=	the reverberation time in the empty reverberation room	[sec.]
m_1	=	"power attenuation coefficient" in the empty room, calculated according to formula	[m^{-1}]
c	=	the speed of sound in the air, in m/s, calculated according to	[m/s]

$$c = 331 + 0{,}6t \qquad (2)$$

in which :

t = the temperature; this formula is valid for temperatures between 15 and 30 ºC [°C]

$$m = \frac{\alpha}{10 \log (e)} \quad (3)$$

in which :

α = "attenuation coefficient" according to ISO 9613-1

In the same manner the equivalent sound absorption A2 for the room with the test specimen is calculated according to formula 4, also expressed in m^2

$$A_2 = \frac{55{,}3V}{c\,T_2} - 4\,V\,m_2 \quad (4)$$

in which :

c and V have the same definition as in formula 1 and

T_2 = the reverberation time of the reverberation room with the test specimen placed inside [sec]

m_2 = "power attenuation coefficient" in the room with the test specimen placed inside, calculated according to formula 3 [m^{-1}]

The equivalent sound absorption A of the test specimen has been calculated according to formula 5 and is expressed in m^2

$$A = A_2 - A_1 \quad (5)$$

When the test specimen consists of one plane with an area between 10 and 12 m^2 the sound absorption coefficient α_S has to be calculated according to formula 6:

$$\alpha = \frac{A}{S} \quad (6)$$

in which:

S = the area of the test specimen [m^2]

4.2. Accuracy

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

When:

- two tests are performed on identical test material
- within a short period of time
- by the same person or team

- using the same instrumentation
- under unchanged environmental conditions
the probability will be 95% that the difference between the two test results will be less than or equal to r.

In order to evaluate the repeatability r for the sound absorption measurements performed in the reverberation room of “Peutz bv" in Mook (the Netherlands) eight series of measurements have been carried out according to ISO 354:1985 annex C. From the results of those measurements the repeatability r has been calculated. It was found that for the frequency range from 100 to 200 Hz and at 5000 Hz the repeatability r is 0,21 as a maximum. For the frequency range 250 to 4000 Hz the repeatability r is 0,09 as a maximum.

4.3. Atmospheric conditions

The atmospheric conditions during the measurements are presented in table 1.

Table 1 environmental conditions during the measurements

Reverberation room	temperature [°C]	atmosperic pressure [kPa]	relative humidity [%]
Empty (variants 1 - 4)	16,9	101,6	45,2
Empty (variants 5 - 6)	17,0	99,5	46,3
Variant 1 - 6	17,1 – 17,6	99,6 – 101,5	49,5 – 52,9

4.4. Results

The results of the measurements are given in table 2 and 3 and in figure 4 to 9. The measurements were made in 1/3-octave bands. The results presented in octave-bands are the arithmetic average of the results of the three 1/3-octave bands belonging to that octaveband.

Table 2 Measurement results

	sound absorption coefficient α_s			
Variant	1		2	
Absorbing material	yes		yes	
Cover	no		yes	
Joint width [mm]	20		20	
Figure	4		5	
Record nr.	#159		#196	
frequency [Hz]	1/3 oct.	1/1 oct.	1/3 oct.	1/1 oct.
100	0,06		0,06	
125	0,12	0,10	0,10	0,09
160	0,12		0,11	
200	0,15		0,14	
250	0,26	0,27	0,26	0,25
315	0,40		0,36	
400	0,58		0,48	
500	0,71	0,69	0,57	0,56
630	0,79		0,63	
800	0,80		0,63	
1000	0,74	0,74	0,60	0,61
1250	0,68		0,60	
1600	0,66		0,67	
2000	0,75	0,78	0,79	0,78
2500	0,92		0,89	
3150	0,94		0,89	
4000	0,87	0,88	0,87	0,86
5000	0,83		0,83	
α_w	0,55(H)		0,55(H)	
NRC	0,60		0,55	

Table 3 Measurement results

	sound absorption coefficient α_s							
Variant	3		4		5		6	
Absorbing material	yes		yes		yes		yes	
Cover	no		yes		yes		no	
Joint width [mm]	45		45		30		30	
Figure	6		7		8		9	
Record nr.	#122		#83		#625		#626	
frequency [Hz]	1/3 oct.	1/1 oct.	1/3 oct.	1/1 oct.	1/3 oct.	1/1 oct.	1/3 oct.	1/1 oct.
100	0,05		0,05		0,03		0,06	
125	0,09	0,08	0,09	0,08	0,04	0,05	0,07	0,09
160	0,11		0,11		0,09		0,13	
200	0,15		0,16		0,11		0,16	
250	0,24	0,25	0,26	0,26	0,20	0,21	0,31	0,30
315	0,36		0,35		0,33		0,44	
400	0,46		0,43		0,47		0,57	
500	0,54	0,53	0,52	0,50	0,56	0,58	0,68	0,66
630	0,60		0,56		0,71		0,72	
800	0,58		0,53		0,69		0,69	
1000	0,57	0,57	0,54	0,56	0,61	0,60	0,66	0,67
1250	0,55		0,60		0,49		0,65	
1600	0,67		0,73		0,51		0,75	
2000	0,84	0,77	0,85	0,80	0,72	0,66	0,90	0,85
2500	0,81		0,81		0,74		0,91	
3150	0,85		0,85		0,70		0,89	
4000	0,82	0,84	0,83	0,84	0,78	0,77	0,90	0,91
5000	0,84		0,84		0,84		0,93	
α_w	0,55(H)		0,50(H)		0,50(H)		0,60(H)	
NRC	0,55		0,55		0,50		0,65	

From those values the following one-figure ratings have been calculated and stated :

– the "weighted sound absorption coefficient α_w" according to ISO 11654

– the "Noise Reduction Coefficient NRC" according to ASTM-C423, being the average of the absorption coefficients (1/3 octave values) at the frequencies of 250, 500, 1000 and 2000 Hz, rounded to the nearest 0,05.

The sound absorption coefficient of a material is not a material property. Is should be taken into account that the sound absorption of a construction depends on the dimensions, the way of mounting of the material and its position in the room.

Mook,

Th. Scheers
Laboratory Supervisor

ir. M.L.S. Vercammen
Manager

This report contains:
12 pages,
9 figures

LABORATORY FOR ACOUSTICS

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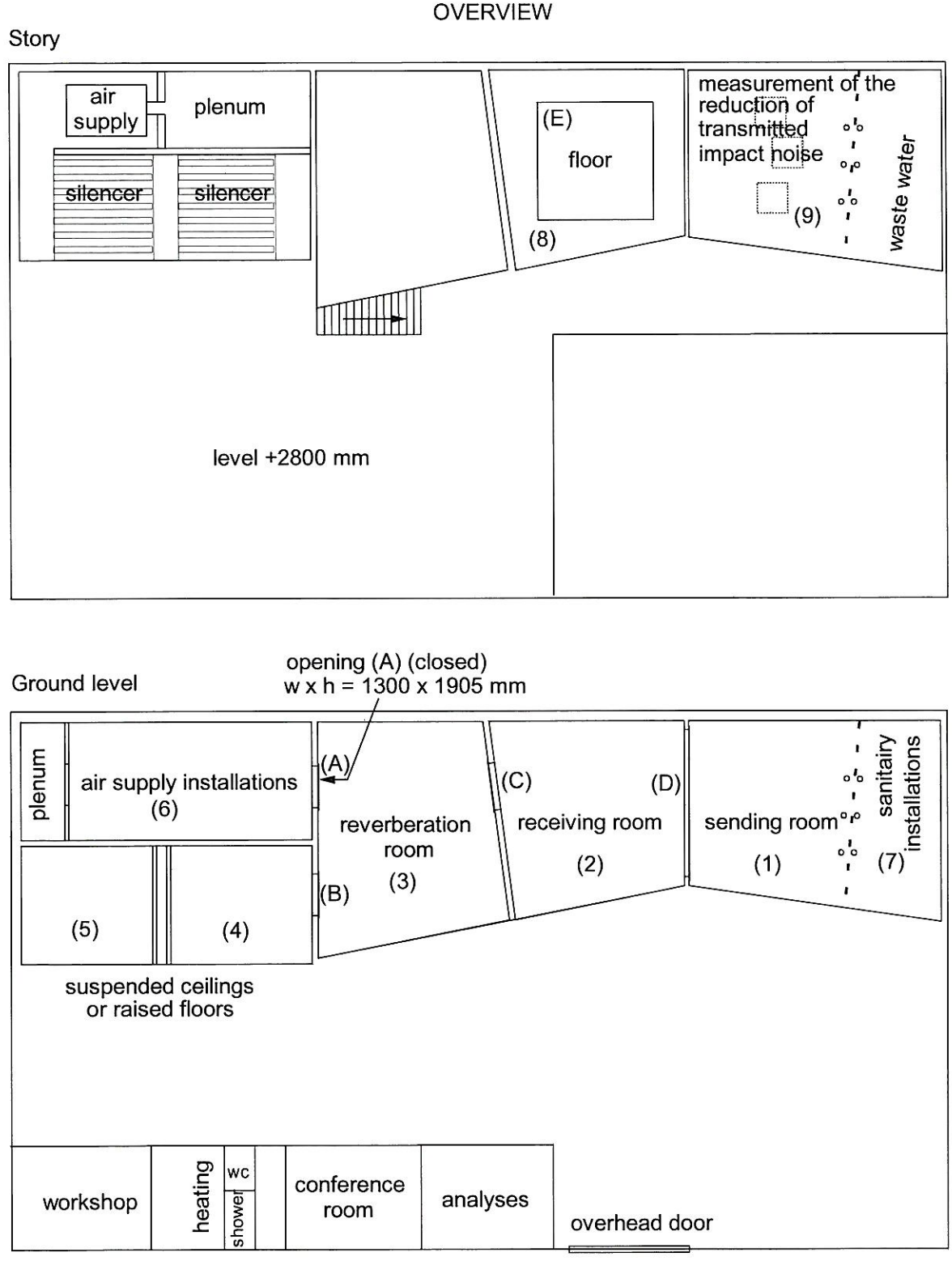
OVERVIEW



TEST OPENINGS (w x h in mm)
(B) 1000 x 2200
(C) 1500 x 1250
(D) 4300 x 2800
(E) 4000 x 4000

0 1 2 3 4 5 m
scale

PEUTZ bv
Lindenlaan 41, 6584 AC MOLENHOEK (LB)

REVERBERATION ROOM

The reverberation room meets the requirements of ISO 354:2003.

additional data:

volume : 214 m^3

total area S_t (walls, floor and ceiling) : 219 m^2

diffusion: by the shape of the room and by adding 6 curved and 2 flat reflecting elements with a total area of approx. 13 m^2 a sufficient diffusion has been gained.

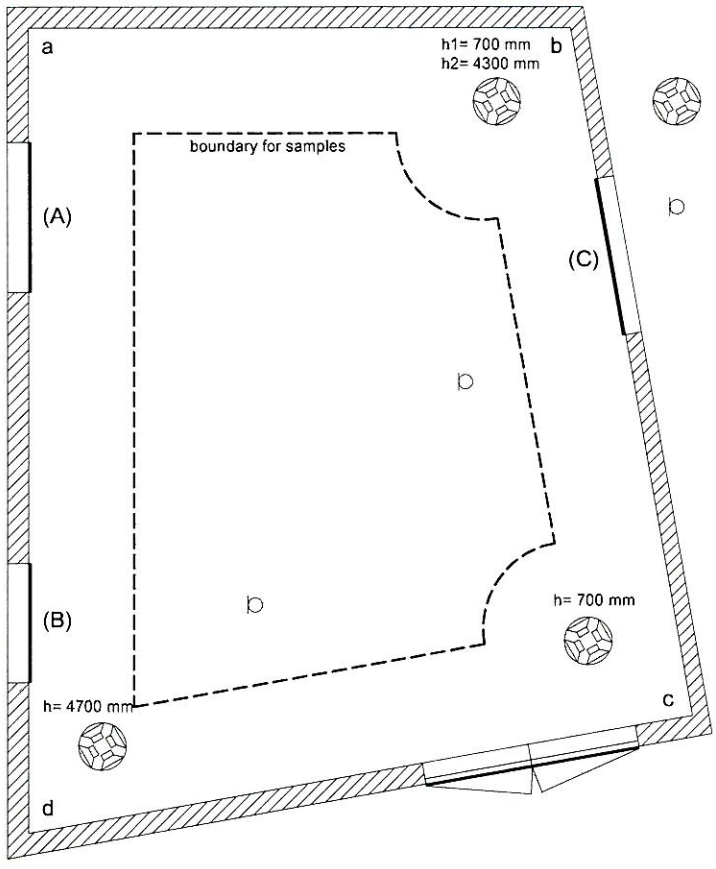
reverberation time of the empty reverberation room during measurements of 19-03-2010

frequency (1/1 oct.)	125	250	500	1000	2000	4000	Hz
reverberation time	9,32	7,88	8,22	6,82	4,54	2,67	sec.

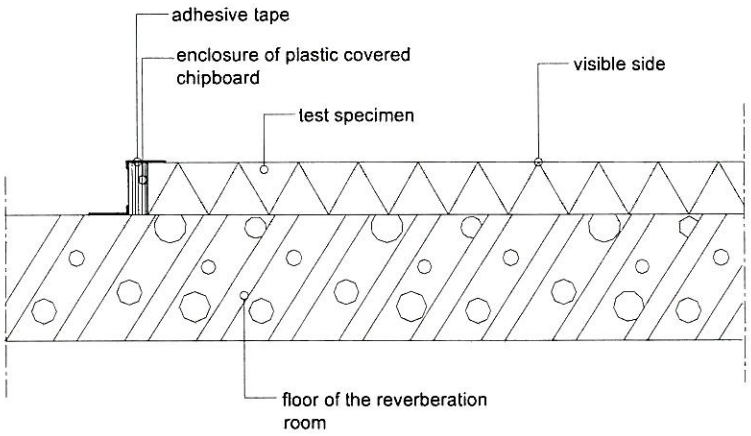
repeatibility r (1/1 oct.) c.f. ISO 354:1985 annex C (see chapter 4.2 of this report).

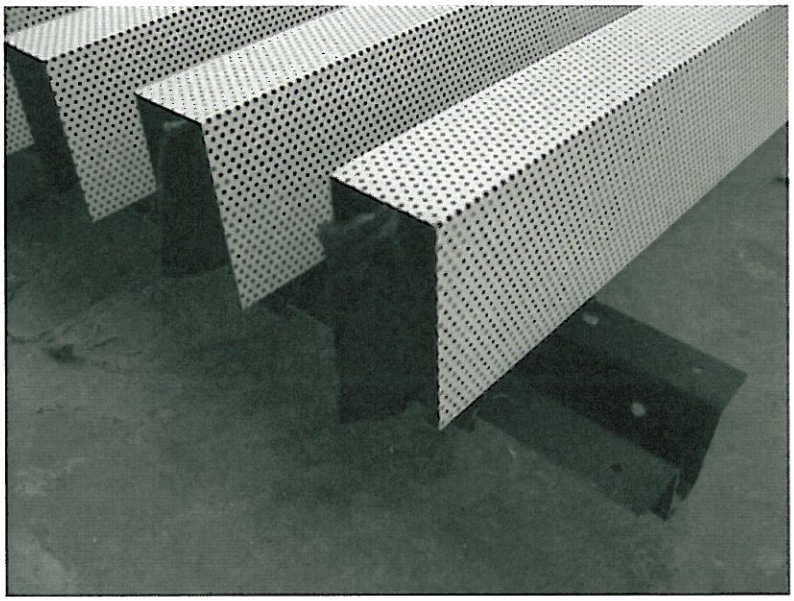
r bij hoge α	0,13	0,04	0,04	0,02	0,02	0,08	-
r bij lage α	0,09	0,02	0,01	0,02	0,02	0,04	-

plan



Measurement set-up





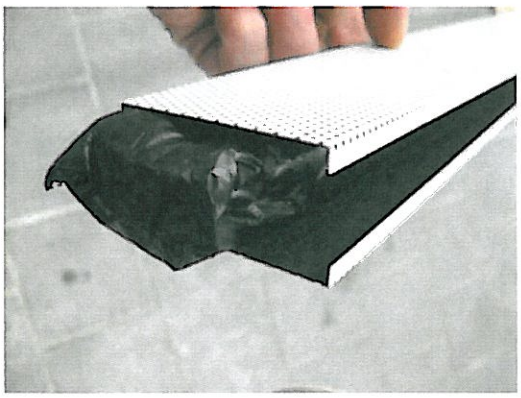
PEUTZ

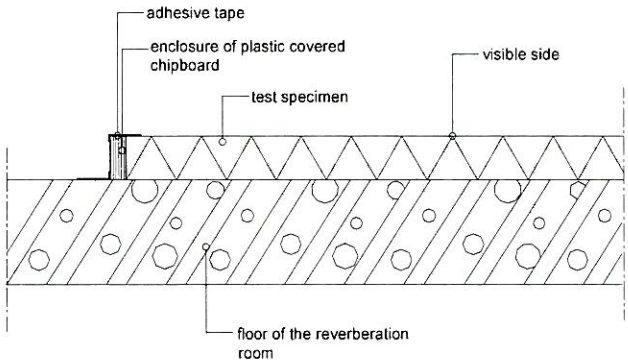
MEASUREMENT OF SOUND ABSORPTION IN A REVERBERATION ROOM ACCORDING TO ISO 354:2003

TESTING RvA L 334

principal: Hunter Douglas Europe B.v.

#1, Luxalon 30 BD Panels; Glasswool, no cover, Joint width 20 mm





volume reverberation room: 214 m^3

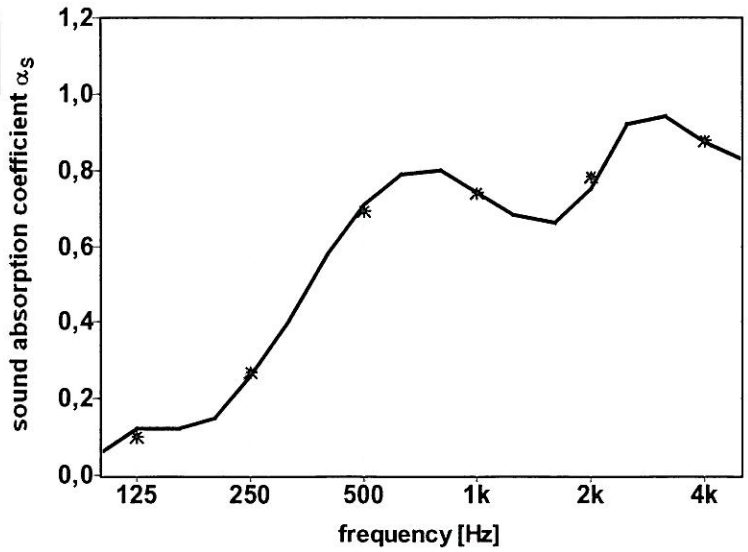
surface area sample: 12 m^2

heigth of the construction: 0,104 m

measured at: laboratory conditions

signal: broad-band noise

bandwidth: 1/3 octave



	0,06	0,15	0,58	0,80	0,66	0,94
1/3 oct.	0,12	0,26	0,71	0,74	0,75	0,87
	0,12	0,40	0,79	0,68	0,92	0,83
1/1 oct.	**0,10**	**0,27**	**0,69**	**0,74**	**0,78**	**0,88**

α_w (ISO 11654) = 0,55(H)

NRC (ASTM - C423) = 0,60

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Mook, 19-03-2010

Absorb, versie 5.6.1 mode 7, file: a2025 E#:11-46 F#:123-158 A#:159 T_1 = 16,9 °C T_2 = 17,5 °C p_1 = 101,6 kPa p_2 = 101,5 kPa h_1 = 45,2 % h_2 = 53,1 %

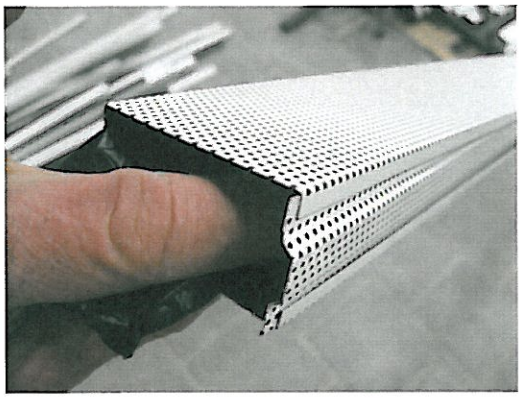
PEUTZ

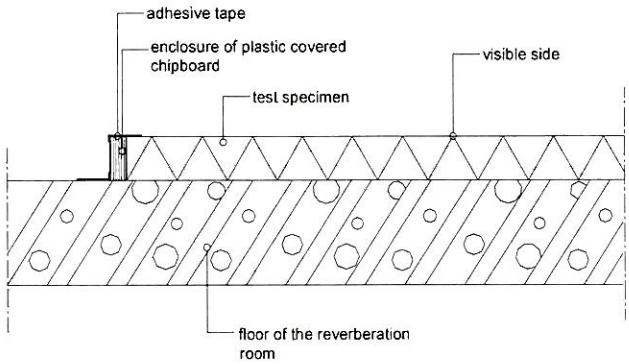
MEASUREMENT OF SOUND ABSORPTION IN A REVERBERATION ROOM ACCORDING TO ISO 354:2003

TESTING RvA L 334

principal: Hunter Douglas Europe B.v.

#2, Luxalon 30 BD Panels; glasswool, with cover, joint width 20 mm





volume reverberation room: 214 m³

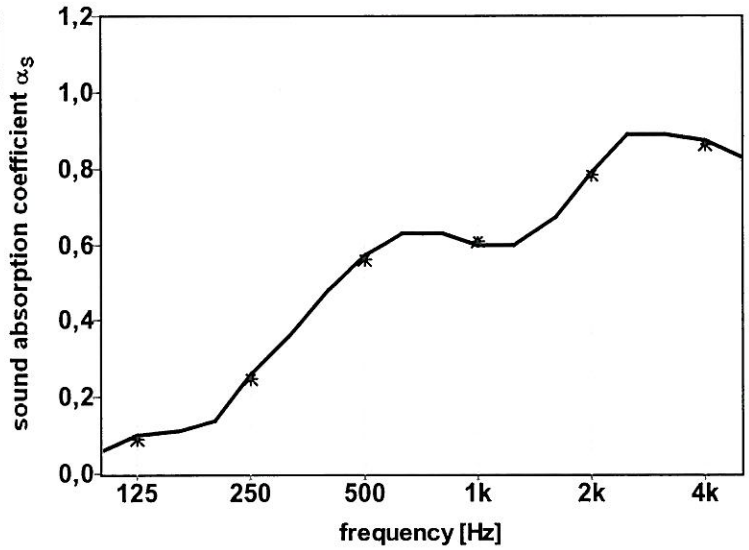
surface area sample: 12 m²

heigth of the construction: 0,104 m

measured at: laboratory conditions

signal: broad-band noise

bandwidth: 1/3 octave



α_w **(ISO 11654) = 0,55(H)**

NRC (ASTM - C423) = 0,55

	0,06	0,14	0,48	0,63	0,67	0,89
1/3 oct.	0,10	0,26	0,57	0,60	0,79	0,87
	0,11	0,36	0,63	0,60	0,89	0,83
1/1 oct.	**0,09**	**0,25**	**0,56**	**0,61**	**0,78**	**0,86**

Mook, 19-03-2010

Absorb, versie 5.6.1 mode 7, file: a2025 E#:11-46 F#:160-195 A#:196 T_1 = 16,9 °C T_2 = 17,6 °C p_1 = 101,6 kPa p_2 = 101,5 kPa h_1 = 45,2 % h_2 = 52,9 %

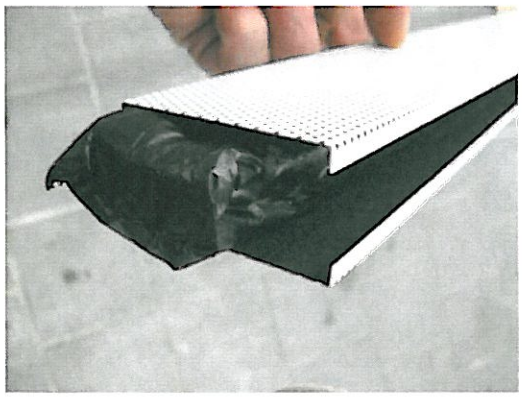
PEUTZ

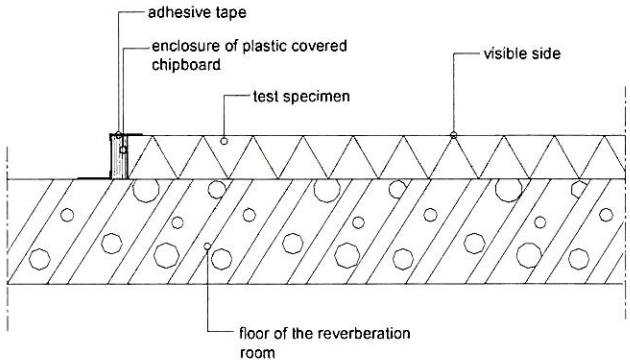
MEASUREMENT OF SOUND ABSORPTION IN A REVERBERATION ROOM ACCORDING TO ISO 354:2003

TESTING RvA L 334

principal: Hunter Douglas Europe B.v.

#3, Luxalon 30 BXD Panels; glasswool, no cover, panel height 60 mm, joint width 45 mm





volume reverberation room: 214 m³

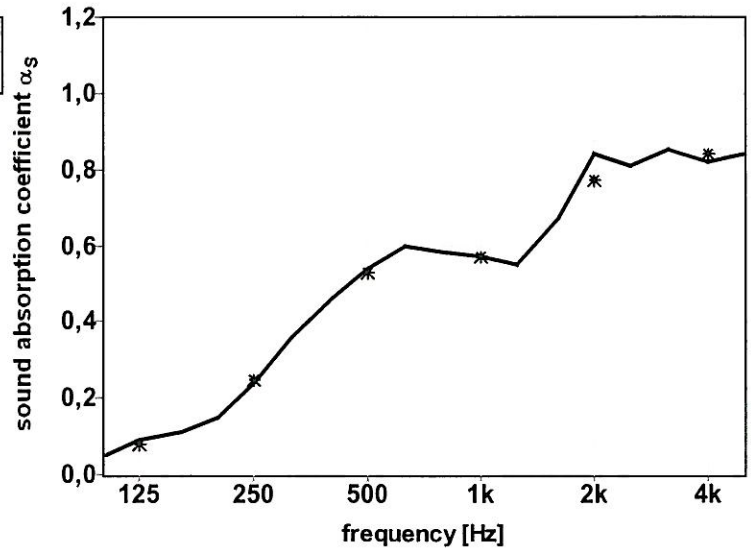
surface area sample: 12 m²

heigth of the construction: 0,136 m

measured at: laboratory conditions

signal: broad-band noise

bandwidth: 1/3 octave



	0,05	0,15	0,46	0,58	0,67	0,85
1/3 oct.	0,09	0,24	0,54	0,57	0,84	0,82
	0,11	0,36	0,60	0,55	0,81	0,84
1/1 oct.	**0,08**	**0,25**	**0,53**	**0,57**	**0,77**	**0,84**

α_w (ISO 11654) = 0,55(H)

NRC (ASTM - C423) = 0,55

Mook, 19-03-2010

Absorb, versie 5.6.1 mode 7, file: a2025 E#:11-46 F#:86-121 A#:122 T_1 = 16,9 °C T_2 = 17,4 °C p_1 = 101,6 kPa p_2 = 101,5 kPa h_1 = 45,2 % h_2 = 52,1 %

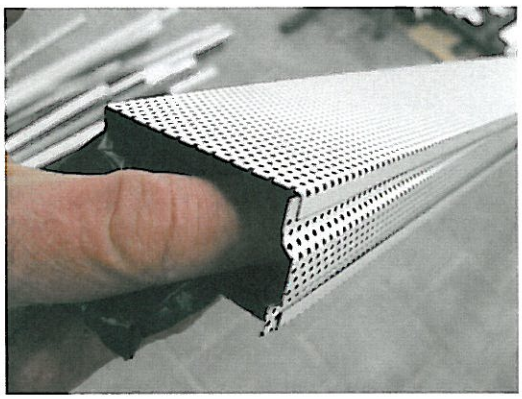
PEUTZ

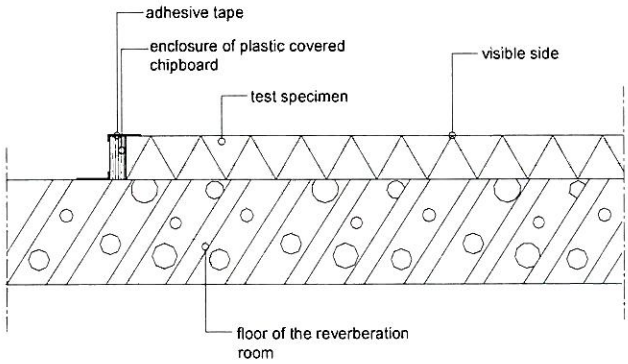
MEASUREMENT OF SOUND ABSORPTION IN A REVERBERATION ROOM ACCORDING TO ISO 354:2003

TESTING RvA L 334

principal: Hunter Douglas Europe B.v.

#4, Luxalon 30 BXD Panels; glasswool, with cover, panel height 60 mm, joint width 45 mm





volume reverberation room: 214 m³

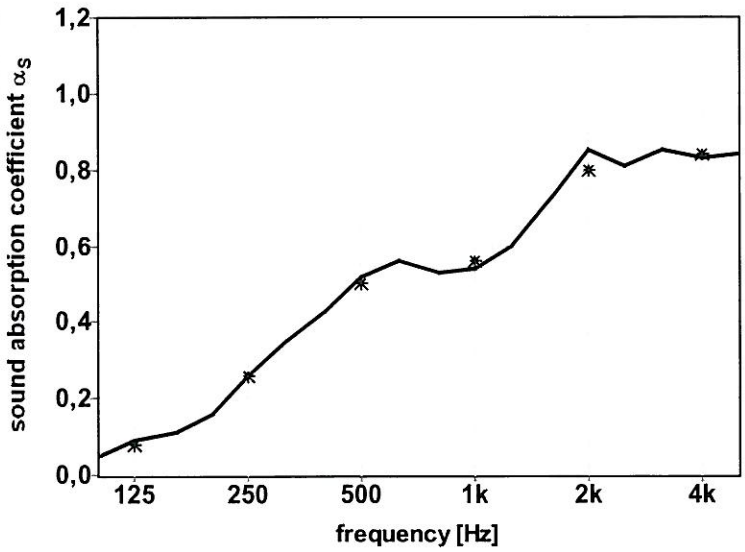
surface area sample: 12 m²

heigth of the construction: 0,136 m

measured at: laboratory conditions

signal: broad-band noise

bandwidth: 1/3 octave



α_w **(ISO 11654) = 0,50(H)**

NRC (ASTM - C423) = 0,55

	0,05	0,16	0,43	0,53	0,73	0,85
1/3 oct.	0,09	0,26	0,52	0,54	0,85	0,83
	0,11	0,35	0,56	0,60	0,81	0,84
1/1 oct.	**0,08**	**0,26**	**0,50**	**0,56**	**0,80**	**0,84**

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Mook, 19-03-2010

Absorb, versie 5.6.1 mode 7, file: a2025 E#:11-46 F#:47-82 A#:83 T_1 = 16,9 °C T_2 = 17,6 °C p_1 = 101,6 kPa p_2 = 101,5 kPa h_1 = 45,2 % h_2 = 52,0 %

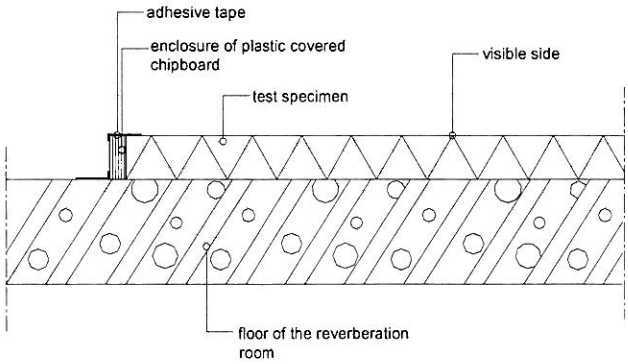
PEUTZ

MEASUREMENT OF SOUND ABSORPTION IN A REVERBERATION ROOM ACCORDING TO ISO 354:2003

TESTING RvA L 334

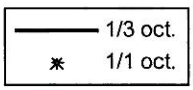
principal: Hunter Douglas Europe B.v.

#5, Luxalon 30 BXD Panels; no glasswool, no cover, panel height 60 mm, joint width 30 mm



volume reverberation room: 214 m^3

surface area sample: 10,4 m^2

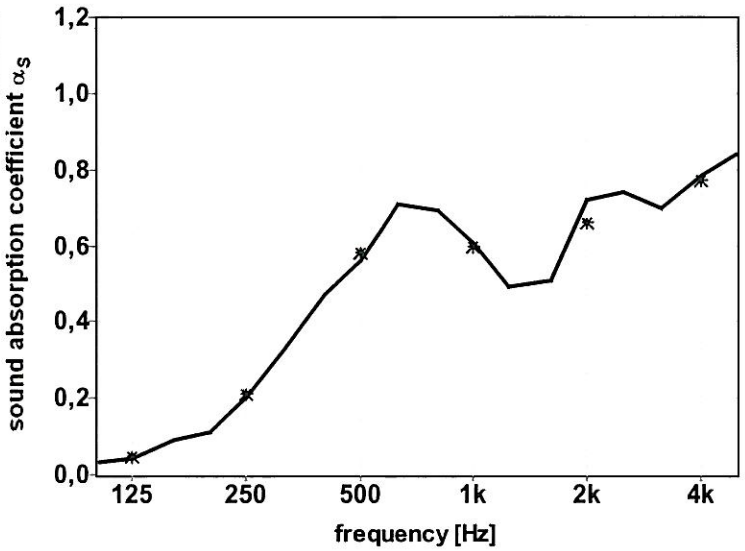


heigth of the construction: 0,136 m

measured at: laboratory conditions

signal: broad-band noise

bandwidth: 1/3 octave



α_w (ISO 11654) = 0,50(H)

NRC (ASTM - C423) = 0,50

	0,03	0,11	0,47	0,69	0,51	0,70
1/3 oct.	0,04	0,20	0,56	0,61	0,72	0,78
	0,09	0,33	0,71	0,49	0,74	0,84
1/1 oct.	**0,05**	**0,21**	**0,58**	**0,60**	**0,66**	**0,77**

Mook, 31-03-2010

Absorb, versie 5.6.1 mode 7, file: a2025 E#:589-624 F#:517-552 A#:625 T_1 = 17,0 °C T_2 = 17,1 °C p_1 = 99,5 kPa p_2 = 99,6 kPa h_1 = 46,3 % h_2 = 49,9 %

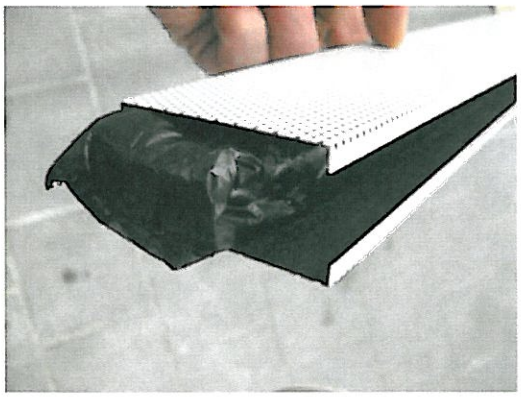
PEUTZ

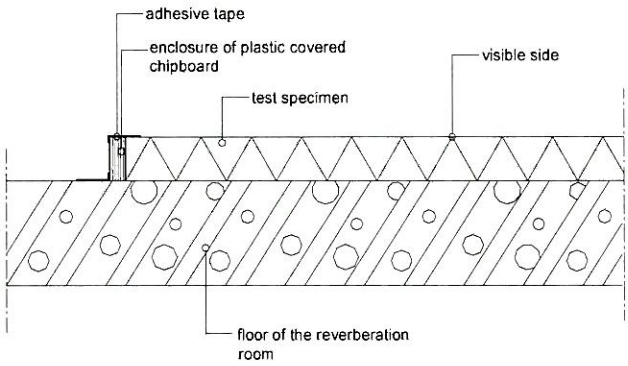
MEASUREMENT OF SOUND ABSORPTION IN A REVERBERATION ROOM ACCORDING TO ISO 354:2003

TESTING RvA L 334

Principal: Hunter Douglas Europe B.v.

#6, Luxalon 30 BXD Panels; glasswool, no cover, panel height 60 mm, joint width 30 mm





volume reverberation room: 214 m^3

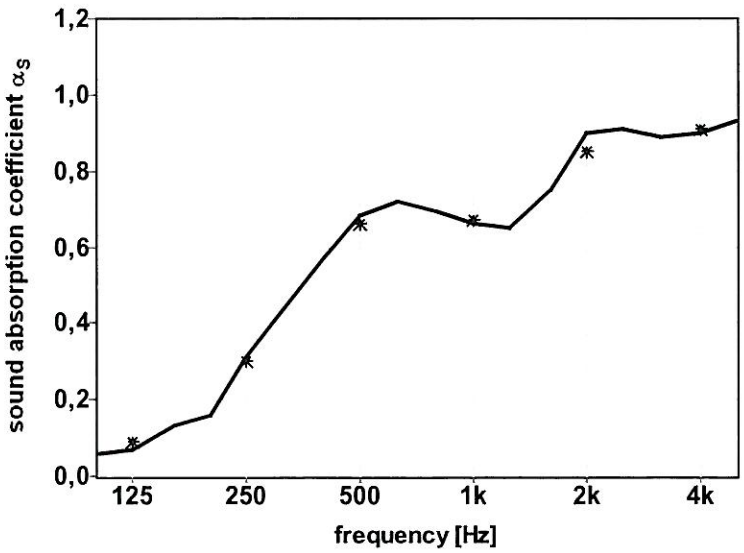
surface area sample: 10,4 m^2

heigth of the construction: 0,136 m

measured at: laboratory conditions

signal: broad-band noise

bandwidth: 1/3 octave



	0,06	0,16	0,57	0,69	0,75	0,89
1/3 oct.	0,07	0,31	0,68	0,66	0,90	0,90
	0,13	0,44	0,72	0,65	0,91	0,93
1/1 oct.	**0,09**	**0,30**	**0,66**	**0,67**	**0,85**	**0,91**

α_w (ISO 11654) = 0,60(H)

NRC (ASTM - C423) = 0,65

Mook, 31-03-2010

Absorb, versie 5.6.1 mode 7, file: a2025 E#:589-624 F#:553-588 A#:626 T_1 = 17,0 °C T_2 = 17,3 °C p_1 = 99,5 kPa p_2 = 99,5 kPa h_1 = 46,3 % h_2 = 49,5 %