

## Laboratory for Acoustics



*Determination of the sound absorption (reverberation room method) of ceiling panels type Nittobu Graphite Soprano B, manufacturer Hecht & Efraim*



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Principal	Hecht & Efraim Ltd. 16 st. Hakishor 5886701 HOLON ISRAEL
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BTW NL004933837B01 KvK: 12028033

mook – zoetermeer – groningen – düsseldorf – dortmund – berlijn – leuven – parijs – lyon

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## 1 Introduction

At the request of Hecht & Efraim Ltd. based in HOLON (ISRAEL), laboratory measurements of the sound absorption (reverberation room method) were carried out on:

**ceiling panels type Nittobu Graphite Soprano B ,  
manufacturer Hecht & Efraim**

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

## 2 Standards and guidelines

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

EN-ISO 354:2003 <sup>1, 2</sup>	Acoustics Measurement of sound absorption in a reverberation room
ISO 11654:1997	Acoustics Sound absorbers for use in buildings Rating of sound absorption
ASTM C423-17	Standard Test Method for Sound Absorption and Sound Absorption Coefficients by the Reverberation Room Method

1



For these type of measurements the Laboratory for Acoustics has been accredited by the Dutch Accreditation Council (RvA).

The RvA is member of the EA MLA (**EA MLA: European Accreditation Organisation MultiLateral Agreement**: <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 According to this norm, the report should include for each measurement the mean reverberation times  $T_1$  and  $T_2$  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 constructions

The data presented here were taken from the information supplied by the principal. The density of the materials as reported is derived from the actual weighing by the laboratory staff of the materials under test.

The following ceiling panels have been tested.

Type	Nittobu Graphite Soprano B	<p><i>view side</i></p>  <p><i>rear side</i></p> 
Manufacturer	Hecht & Efraim Ltd.	
Material	Glass wool	
Finish front	smooth black painted glass-tissue	
Finish rear	glass-tissue	
Panel sizes:	1200 mm x 600 mm	
Thickness:	40 mm	
Mass:	4,58 kg/m <sup>2</sup> (weighted)	

*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. The test report ahead is valid as long as the tested constructions and/or materials are unchanged.*

## 4 Measurements

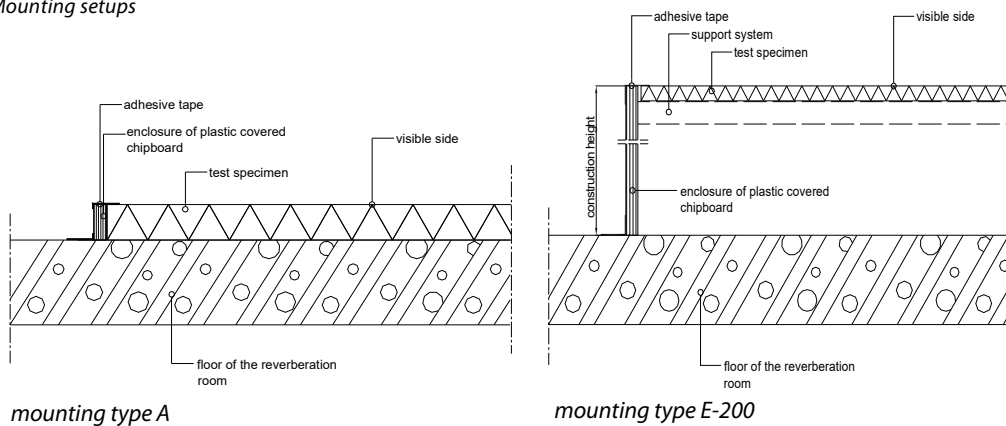
### 4.1 Mounting set-up

The panels to be measured (see chapter 3) have been measured in following 3 different measurement set-ups:

1. directly on the floor of the reverberation room;
2. on a (unfilled) 20 mm air cavity;
3. on a support structure with a total construction height of 200 mm (160 mm cavity).

Set-up 1 and 2 are according to mounting type A and set-up 3 is according to mounting type E-200 according to ISO 354:2003. The facing side of the panels was up. The sides of the set-up were enclosed by 18 mm thick plastic covered chip-wood board and sealed by tape.

#### f1 Mounting setups



### 4.2 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  $A_1$  is calculated (per frequency band) according to formula 1 and expressed in  $m^2$

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

in which:

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

$$c = 331 + 0,6 t \quad (2)$$

in which:

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

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

in which:

- $\alpha$  = "attenuation coefficient" according to ISO 9613-1

In the same manner the equivalent sound absorption  $A_2$  for the room with the test specimen is calculated according to formula 4, also expressed in  $m^2$

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

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<sup>-1</sup>]

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<sup>2</sup> the sound absorption coefficient  $\alpha_s$  has to be calculated according to formula 6:

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

in which:

S = the area of the test specimen [m<sup>2</sup>]

### 4.3 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.

### 4.4 Environmental conditions during the measurements

#### t4.1 Environmental conditions during the measurements at May 6<sup>th</sup>, 2021

reverberation room	temperature [°C]	barometric pressure [kPa]	relative humidity [%]
empty	14,7	100,4	49,3
occupied	14,8-15,3	100,4	49,9-54,0

### 4.5 Results

The results of the measurements are given in table 4.2 and in figure 3 to 5. 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 octave band.

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

- the "weighted sound absorption coefficient  $\alpha_w$ " according to ISO 11654;
- the "Sound Absorption Average SAA" according to ASTM-C423, being the average of the absorption coefficients (1/3 octave values) at the frequencies of 200 Hz up to and including 2500 Hz, rounded to the nearest 0,01.

t4.2 Measurement results 40 mm Nittobu Graphite Soprano B panels

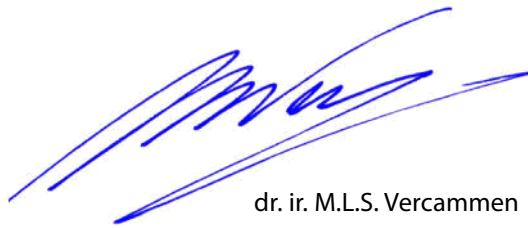
Variant nr.	sound absorption coefficient $\alpha_s$					
	1 0 mm #73 3		2 20 mm #110 4		3 160 mm #147 5	
Air cavity record nr. See figure						
frequency [Hz]	1/3 oct.	1/1 oct.	1/3 oct.	1/1 oct.	1/3 oct.	1/1 oct.
100	0,08		0,11		0,34	
125	0,16	0,17	0,22	0,24	0,43	0,47
160	0,28		0,38		0,64	
200	0,38		0,41		0,57	
250	0,59	0,59	0,68	0,64	0,71	0,70
315	0,80		0,84		0,83	
400	0,89		0,92		0,90	
500	0,91	0,92	0,92	0,92	0,89	0,88
630	0,95		0,92		0,85	
800	1,01		0,98		0,89	
1000	1,00	1,01	0,99	0,98	0,97	0,95
1250	1,02		0,98		1,00	
1600	1,02		1,01		1,02	
2000	1,02	1,02	1,00	1,00	1,05	1,03
2500	1,02		1,00		1,02	
3150	1,06		1,07		1,08	
4000	1,01	1,04	1,02	1,04	1,05	1,06
5000	1,04		1,04		1,04	
$\alpha_w$	0,90		0,90		0,95	
SAA	0,88		0,89		0,89	

The sound absorption coefficient of a material is not a material property. It 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



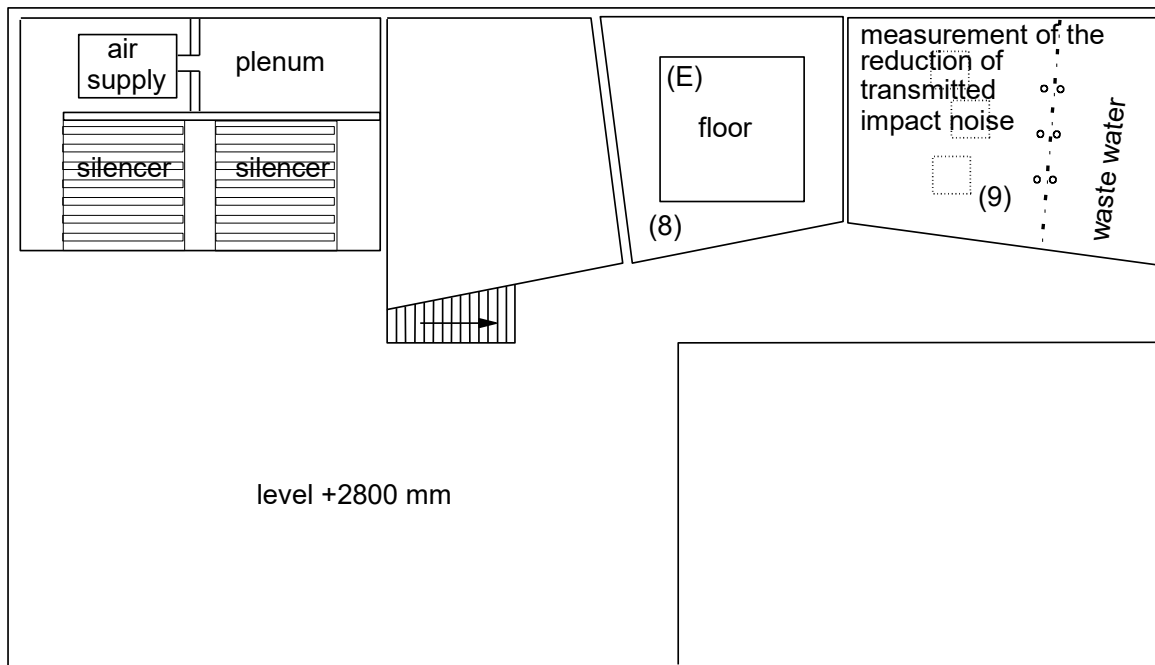
dr. ir. M.L.S. Vercammen  
Manager

This report contains 11 pages and 5 figures

PEUTZ bv  
Lindenlaan 41, NL-6584 AC MOLENHOEK (LB), THE NETHERLANDS

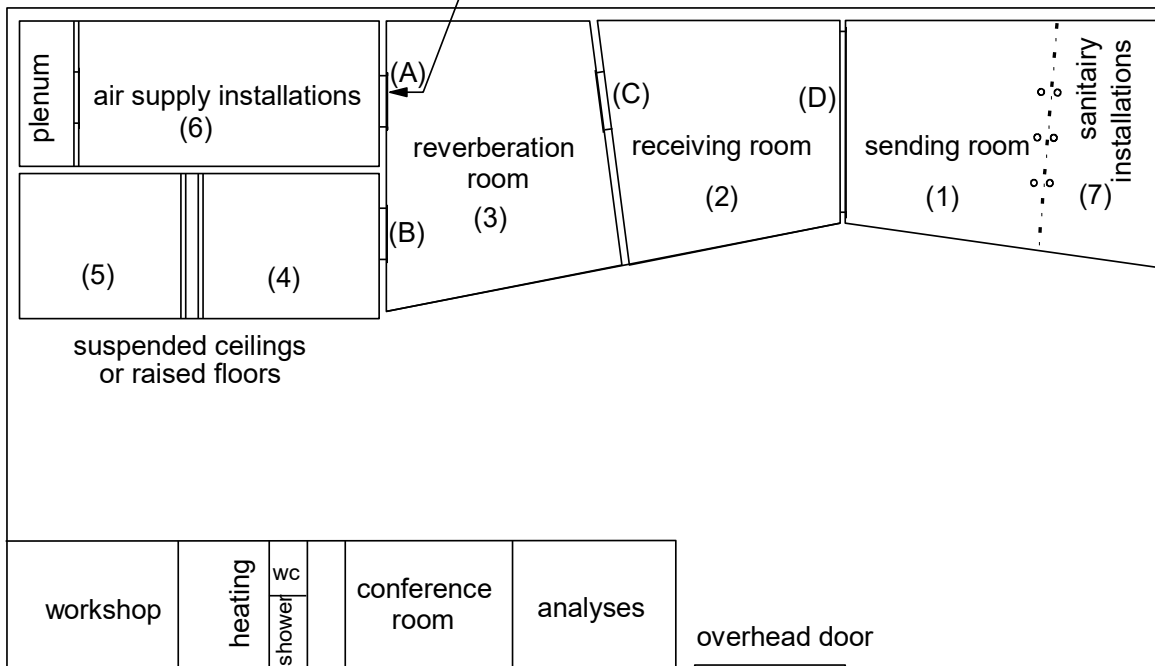
OVERVIEW

Story



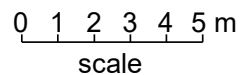
Ground level

opening (A) (closed)  
w x h = 1300 x 1905 mm



TEST OPENINGS (w x h in mm)

- (B) 1000 x 2200
- (C) 1500 x 1250
- (D) 4300 x 2800
- (E) 4000 x 4000



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<sup>3</sup>  
total area St (walls, floor and ceiling) : 219 m<sup>2</sup>

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<sup>2</sup> a sufficient diffusion has been gained.

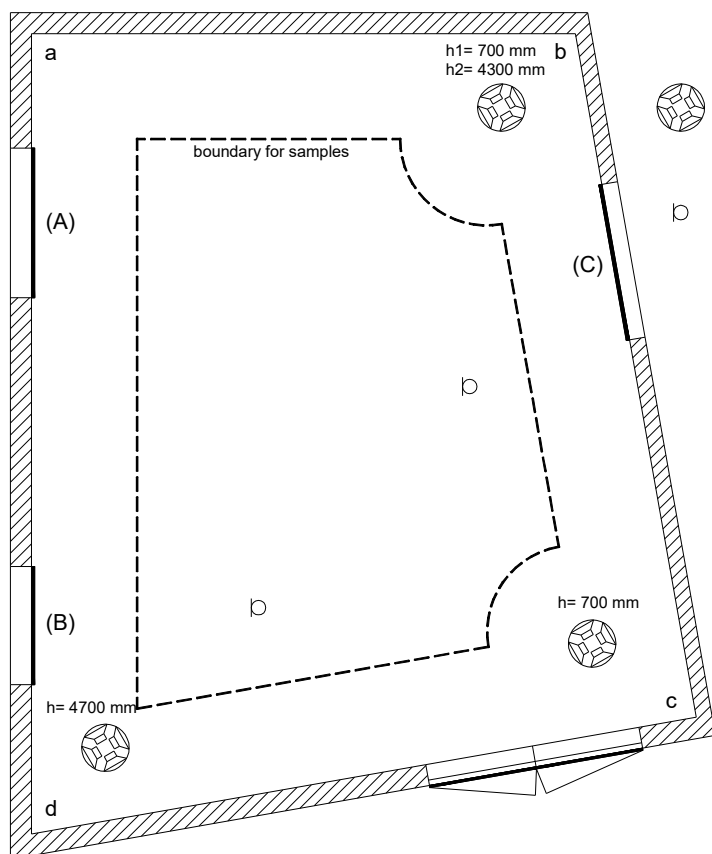
reverberation time of the empty reverberation room during measurements of 06-05-2021

frequency (1/1 oct.)	125	250	500	1000	2000	4000	Hz
reverberationtime	9,13	7,42	6,99	6,37	4,57	2,67	sec.

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

r at high $\alpha$	0,13	0,04	0,04	0,02	0,02	0,08	-
r at low $\alpha$	0,09	0,02	0,01	0,02	0,02	0,04	-

plan



loudspeaker (4x)

microphone (3x)

(closed) testopenings  
(width x height in mm)  
(A): 1300 x 1800  
(B): 1000 x 2200  
(C): 1500 x 1250

height at:  
a: 5573 mm  
b: 5102 mm  
c: 5000 mm  
d: 5580 mm

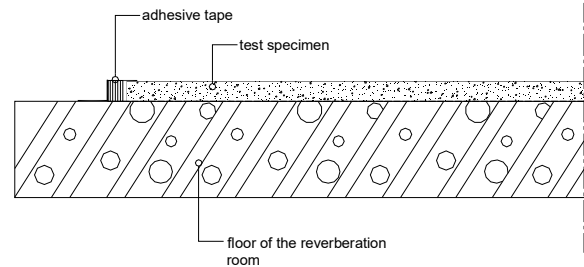
0 1 2 m

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



principal: Hecht & Efraim

Variant 1; 40 mm Nittobu Graphite Soprano B panels directly on the floor



Absorb, versie 5.9 mode 7, PM: JK, file: a3974 E#:1-36 F#:37-72 A#:73 T<sub>1</sub> = 14,7 °C T<sub>2</sub> = 14,8 °C p<sub>1</sub> = 100,4 kPa p<sub>2</sub> = 100,4 kPa h<sub>1</sub> = 49,3 % h<sub>2</sub> = 54,0 %

volume reverberation room: 214 m<sup>3</sup>

surface area sample: 10,8 m<sup>2</sup>

height of the construction: 0,040 m

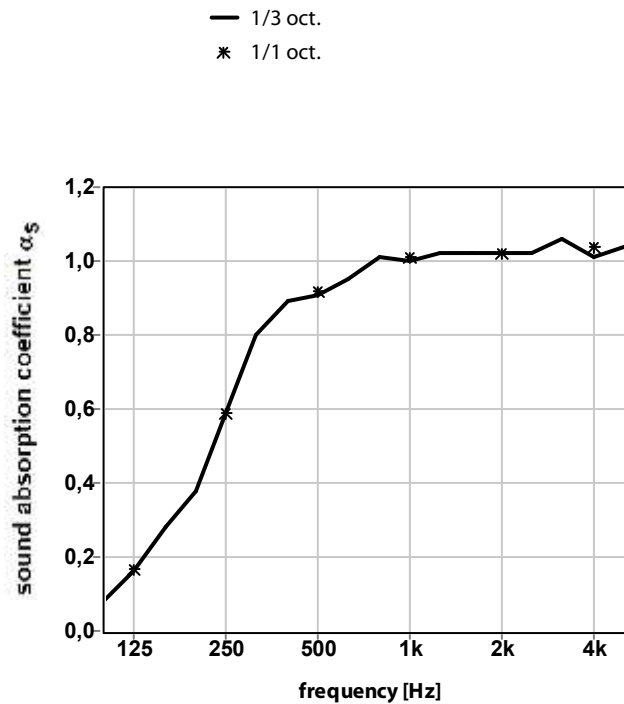
measured at: Peutz Laboratory for Acoustics

signal: broad-band noise

bandwidth: 1/3 octave

**$\alpha_w$  (ISO 11654) = 0,90**

SAA (ASTM - C423) = 0,88



	0,08	0,38	0,89	1,01	1,02	1,06
1/3 oct.	0,16	0,59	0,91	1,00	1,02	1,01
	0,28	0,80	0,95	1,02	1,02	1,04
1/1 oct.	0,17	0,59	0,92	1,01	1,02	1,04

publication is permitted for the entire page only

Mook, measured at 06-05-2021

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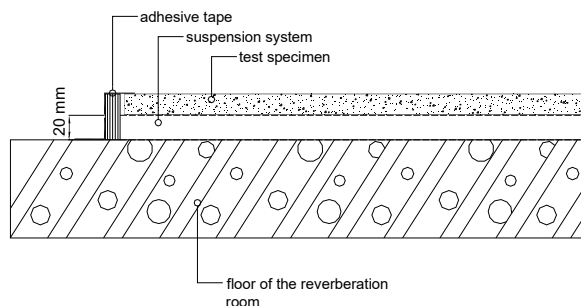
figure 3

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



principal: Hecht & Efraim

Variant 2; 40 mm Nittobu Graphite Soprano B panels on 20 mm cavity



Absorb, versie 5.9 mode 7, PM: JK, file: a3974 E#:1-36 F#:74-109 A#:110 T<sub>1</sub> = 14,7 °C T<sub>2</sub> = 15,3 °C p<sub>1</sub> = 100,4 kPa p<sub>2</sub> = 100,4 kPa h<sub>1</sub> = 49,3 % h<sub>2</sub> = 50,8 %

volume reverberation room: 214 m<sup>3</sup>

surface area sample: 10,8 m<sup>2</sup>

height of the construction: 0,060 m

measured at: Peutz Laboratory for Acoustics

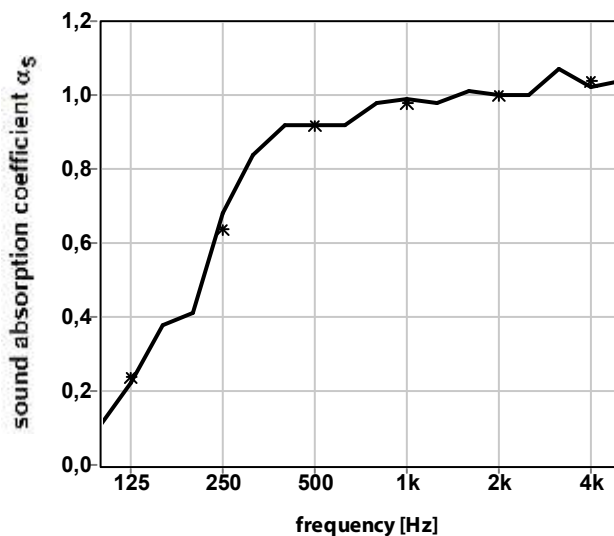
signal: broad-band noise

bandwidth: 1/3 octave

**$\alpha_w$  (ISO 11654) = 0,90**

SAA (ASTM - C423) = 0,89

— 1/3 oct.  
\* 1/1 oct.



	0,11	0,41	0,92	0,98	1,01	1,07
1/3 oct.	0,22	0,68	0,92	0,99	1,00	1,02
	0,38	0,84	0,92	0,98	1,00	1,04
1/1 oct.	<b>0,24</b>	<b>0,64</b>	<b>0,92</b>	<b>0,98</b>	<b>1,00</b>	<b>1,04</b>

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Mook, measured at 06-05-2021

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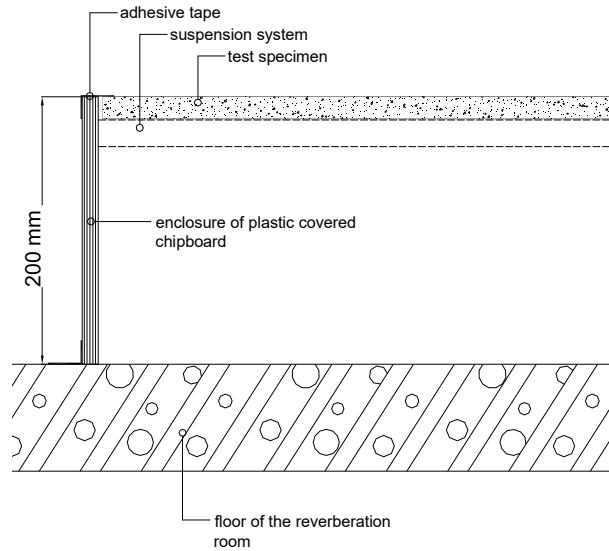
figure 4

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



principal: Hecht & Efraim

Variant 3; 40 mm Nittobu Graphite Soprano B panels on 160 mm cavity



Absorb, versie 5.9 mode 7, PM:JK, file: a3974 E#:1-36 F#:111-146 A#:147 T<sub>1</sub> = 14,7 °C T<sub>2</sub> = 15,3 °C p<sub>1</sub> = 100,4 kPa p<sub>2</sub> = 100,4 kPa h<sub>1</sub> = 49,3 % h<sub>2</sub> = 49,9 %  
 A3974-2E-RA-001 (E)BIBBIB THEO

volume reverberation room: 214 m<sup>3</sup>

surface area sample: 10,8 m<sup>2</sup>

height of the construction: 0,200 m

measured at: Peutz Laboratory for Acoustics

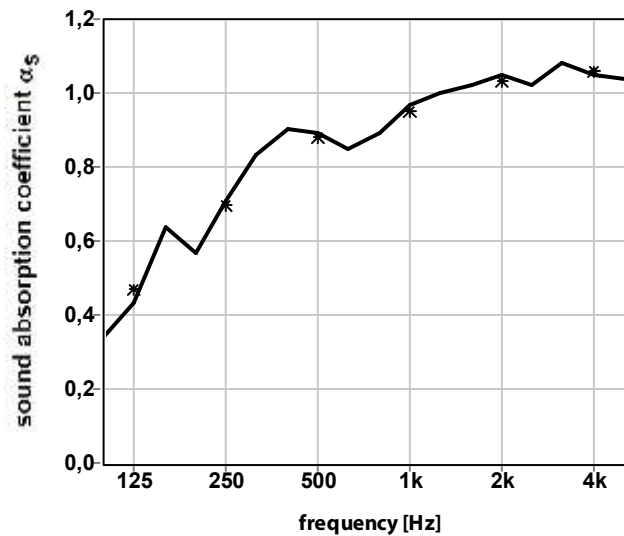
signal: broad-band noise

bandwidth: 1/3 octave

**$\alpha_w$  (ISO 11654) = 0,95**

SAA (ASTM - C423) = 0,89

— 1/3 oct.  
\* 1/1 oct.



	0,34	0,57	0,90	0,89	1,02	1,08
1/3 oct.	0,43	0,71	0,89	0,97	1,05	1,05
	0,64	0,83	0,85	1,00	1,02	1,04
1/1 oct.	<b>0,47</b>	<b>0,70</b>	<b>0,88</b>	<b>0,95</b>	<b>1,03</b>	<b>1,06</b>

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Mook, measured at 06-05-2021

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figure 5