

## Laboratory for Acoustics

*Determination of the sound absorption  
(reverberation room method) of a wooden  
linear ceiling/wall system, manufacturer  
Derako International*





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*Determination of the sound absorption (reverberation room method) of a wooden linear ceiling/wall system, manufacturer Derako International*

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

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## 1 Introduction

At the request of Derako International based in 't Zand (The Netherlands), laboratory measurements of the sound absorption (reverberation room method) were carried out on a:

**wooden linear ceiling / wall system  
manufacturer Derako International**

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

The present report is a translation of report A 1079-1 date Marz 25, 2002

## 2 Standards and guidelines

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

ISO 354:1985 <sup>1</sup>	Acoustics - Measurement of sound absorption in a reverberation room
NOTE:	this international standard has been accepted within all EU-countries as European standard EN ISO 20354:1993
ISO 354:1985/Amd.1:1997	Acoustics - Measurement of sound absorption in a reverberation room AMENDMENT 1: Test specimen mountings for sound absorption tests

Various other related norms:

ISO 11654:1997	Acoustics - Sound absorbers for use in buildings - Rating of sound absorption
ASTM C423-09a	Standard Test Method for Sound Absorption and Sound Absorption Coefficients by the Reverberation Room Method

<sup>1</sup> 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 construction

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

Manufacturer;	Derako International
Type;	wooden open slats system
Material;	spruce
Dimensions slats;	w x h = 92 x 16 mm
Slot width;	19 mm

The slots are at the cavity site sealed with non woven tissue. The measurements have been carried out on (see also figure 2 and 3);

1. ceiling / wall system as described, with a building height of 200 mm
2. idem 1, with mineral wool against the slats. Applied mineral wool;

Manufacturer;	Rockwool
Type;	501
Thickness:	20 mm
Mass;	approximately 90 kg/m <sup>3</sup>

*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

The ceiling / wall system to be measured (see chapter 3) are mounted on a support structure at a distance of 200 mm above the floor of the reverberation room, the facing side of the panels was up (Type E-200 mounting according to ISO 354:1985). The sides of the set-up were enclosed by 18 mm thick plastic covered chip wood 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 4 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  $m^2$

$$A_1 = \frac{55,3 V}{c T_1} \quad [m^2] \quad (1)$$

in which:

- $V$  = the volume of the reverberation room [ $m^3$ ]  
 $T_1$  = the reverberation time in the empty reverberation room [sec.]  
 $c$  = the speed of sound in the air, in m/s, calculated according to [m/s]

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

in which:

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

In the same manner the equivalent sound absorption  $A_2$  for the room with the test specimen is calculated according to formula 3, also expressed in  $m^2$

$$A_2 = \frac{55,3 V}{c T_2} \quad [m^2] \quad (3)$$

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]

The equivalent sound absorption  $A$  of the test specimen has been calculated according to formula 4 and is expressed in  $m^2$

$$A = A_2 - A_1 \quad (4)$$

When the test specimen consists of one plane with an area between 10 and 12  $m^2$  the sound absorption coefficient  $\alpha_s$  has to be calculated according to formula 5:

$$\alpha = \frac{A}{S} \quad (5)$$

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 0,17 as a maximum. For the frequency range 250 to 4000 Hz the repeatability  $r$  is 0,08 as a maximum.



## 4.3 Results

The results of the measurements are given in table 1 and in figure 4. 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.

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 "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.

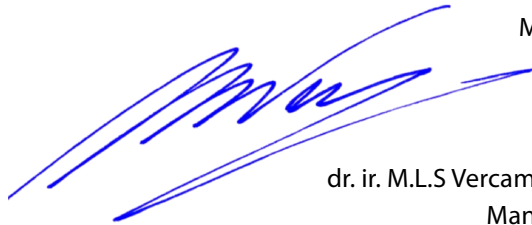
### t4.1 Measurements results

mineral wool figure nr.	sound absorption coefficient $\alpha_s$			
	none		20 mm	
	5		6	
frequency [Hz]	1/3 oct.	1/1 oct.	1/3 oct.	1/1 oct.
100	0,27		0,49	
125	0,19	0,29	0,46	0,57
160	0,42		0,76	
200	0,64		0,81	
250	0,74	0,71	0,85	0,83
315	0,76		0,84	
400	0,69		0,79	
500	0,62	0,59	0,76	0,76
630	0,47		0,73	
800	0,37		0,69	
1000	0,32	0,35	0,67	0,65
1250	0,36		0,58	
1600	0,27		0,52	
2000	0,25	0,25	0,47	0,47
2500	0,24		0,43	
3150	0,24		0,39	
4000	0,23	0,22	0,33	0,33
5000	0,20		0,28	
$\alpha_w$	0,30(LM)		0,50(LM)	
NRC	0,50		0,70	

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.



Th. Scheers  
Laboratory Supervisor



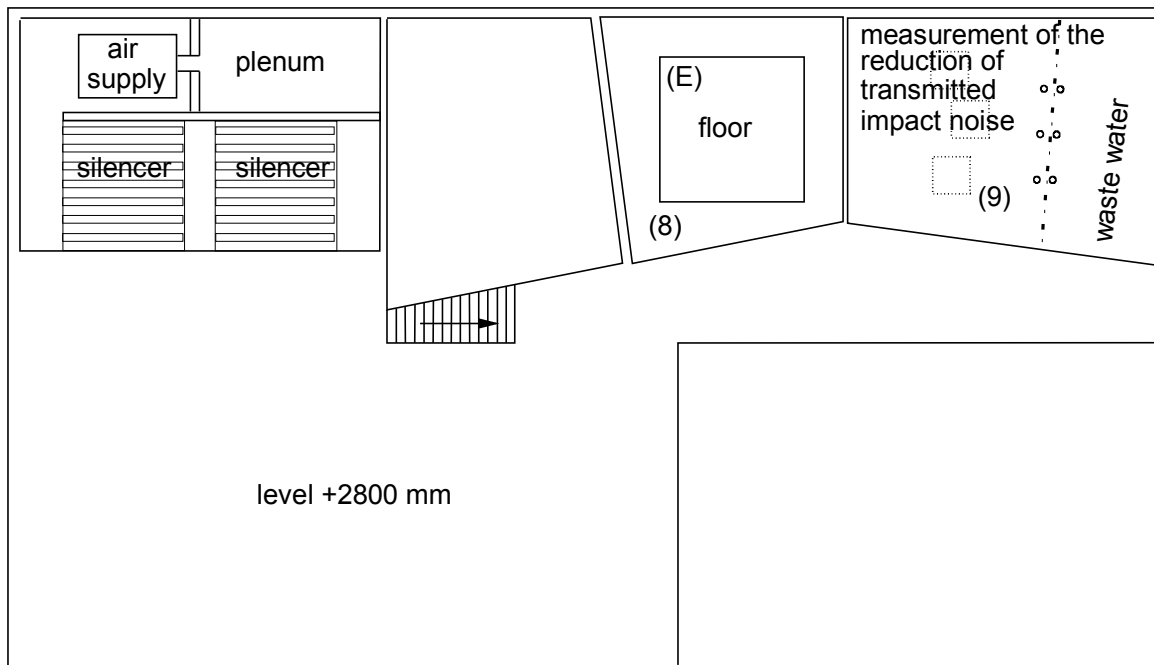
Mook,  
dr. ir. M.L.S Vercammen  
Manager

This report contains 10 pages and 6 figures.

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

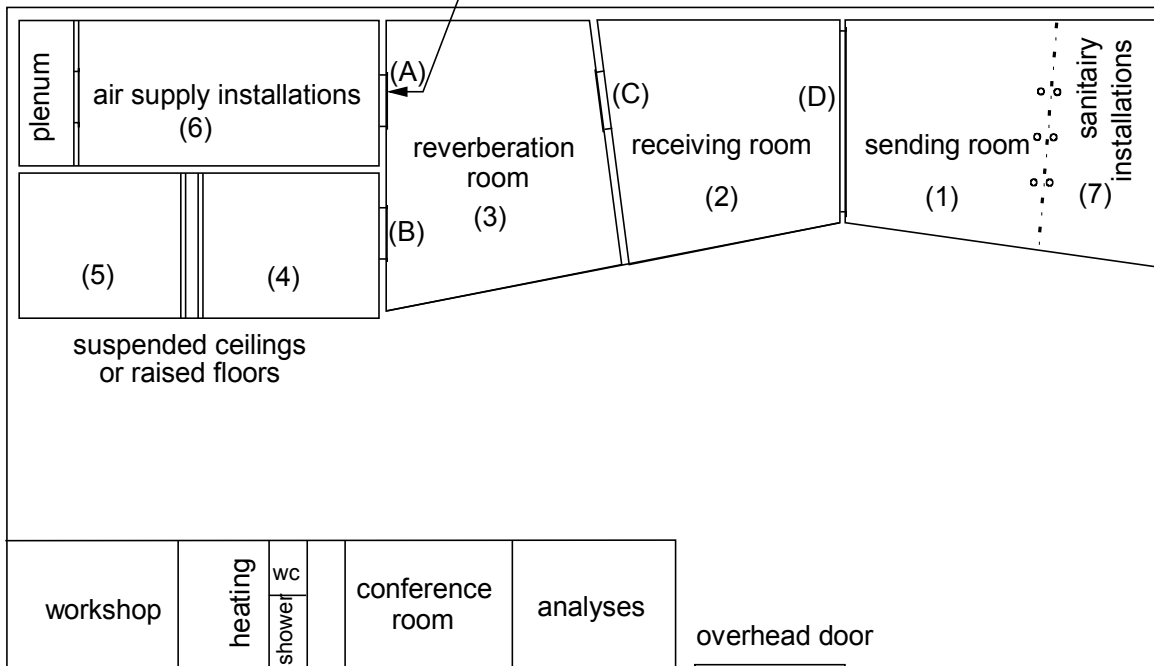
OVERVIEW

Story



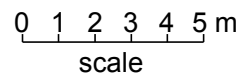
Ground level

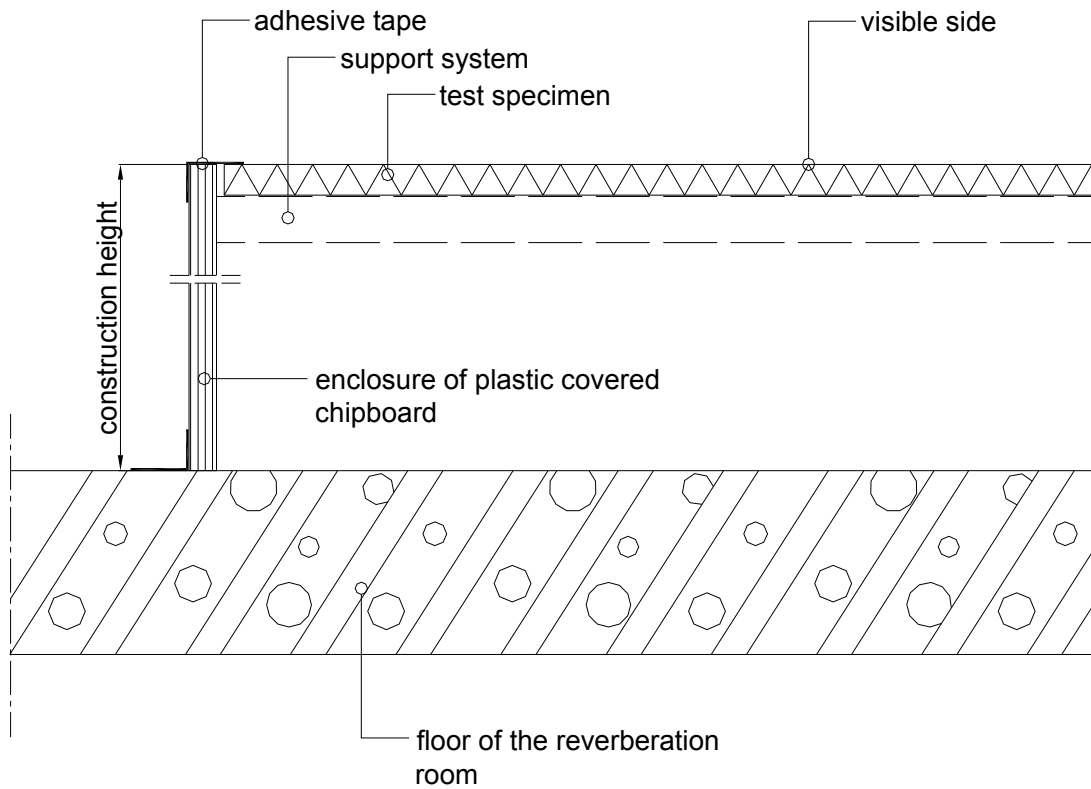
opening (A) (closed)  
w x h = 1300 x 1905 mm



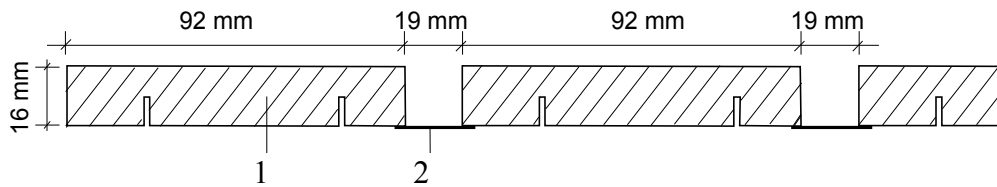
TEST OPENINGS (w x h in mm)

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

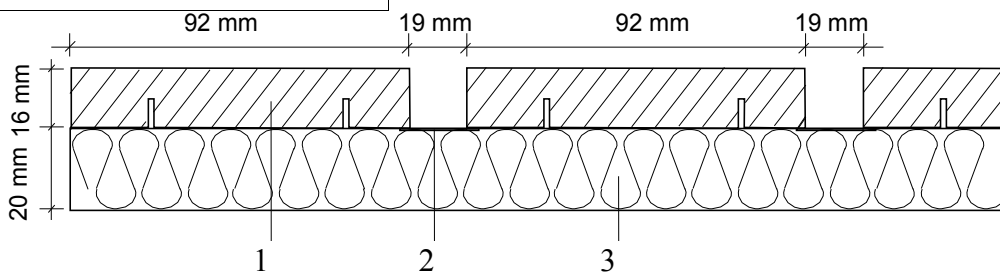




Detail variant 1; without mineral wool



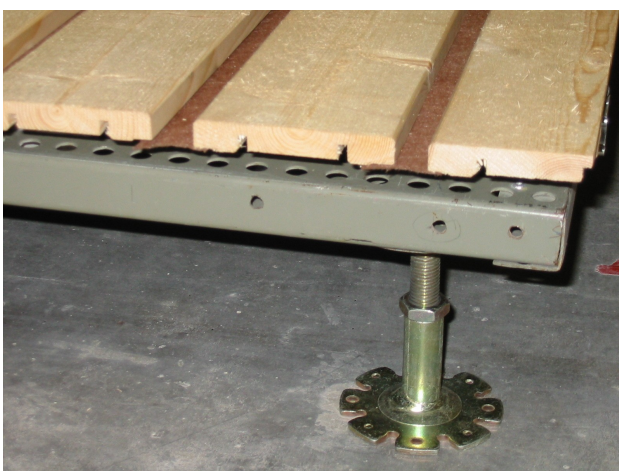
Detail variant 2; with mineral wool



- 1: slats
- 2: non woven tissue
- 3: 25 mm Rockwool 501



1; overview measurement set-up



2: detail variant 1 (without mineral wool)



3: detail variant 2 (with mineral wool)

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## REVERBERATION ROOM

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

additional data:

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

total area  $S_t$  (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.

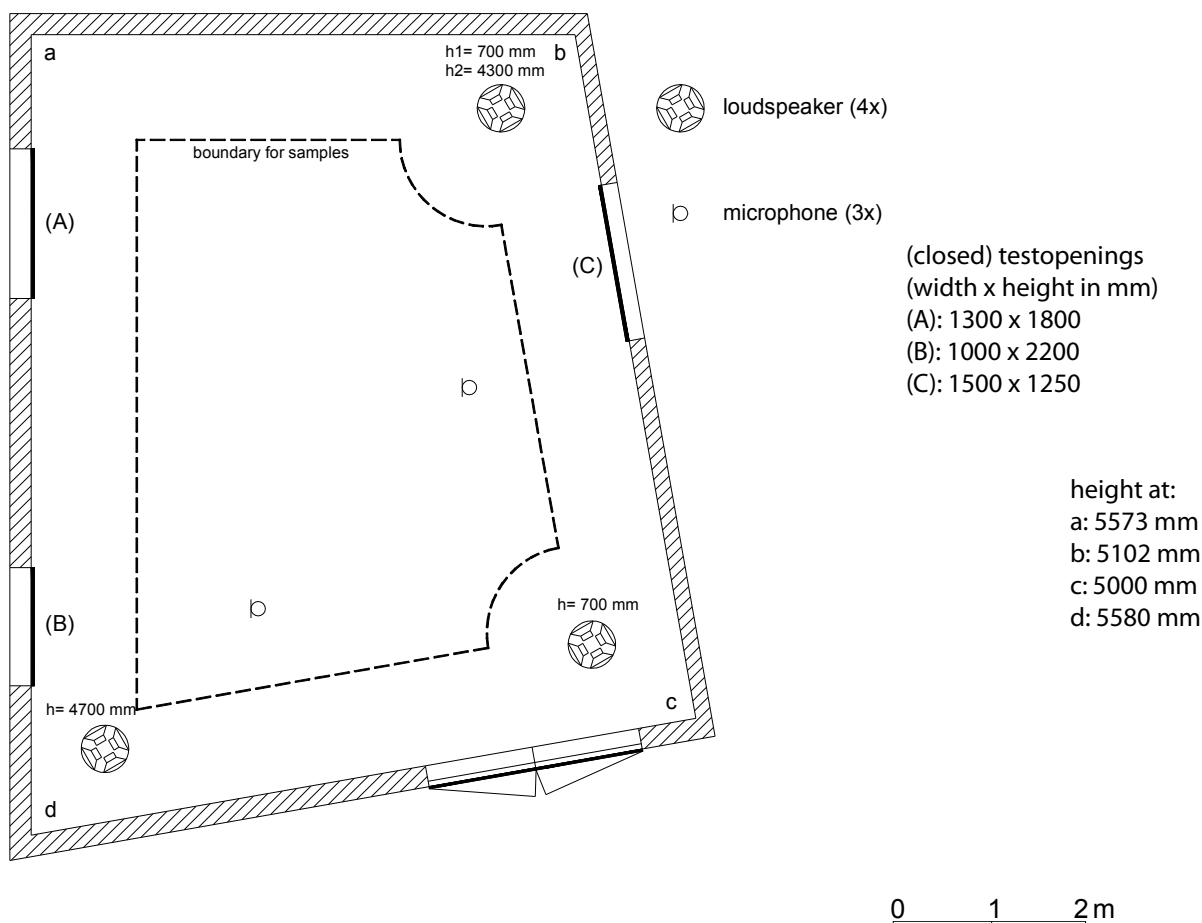
reverberation time of the empty reverberation room during measurements of 19-03-2002

frequency (1/1 oct.)	125	250	500	1000	2000	4000	Hz
reverberationtime	8,56	7,33	7,05	6,15	4,45	2,80	sec.

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

$r$ bij hoge $\alpha$	0.13	0,04	0,04	0,02	0,02	0,08	-
$r$ bij lage $\alpha$	0,09	0.02	0.01	0.02	0.02	0,04	-

plan

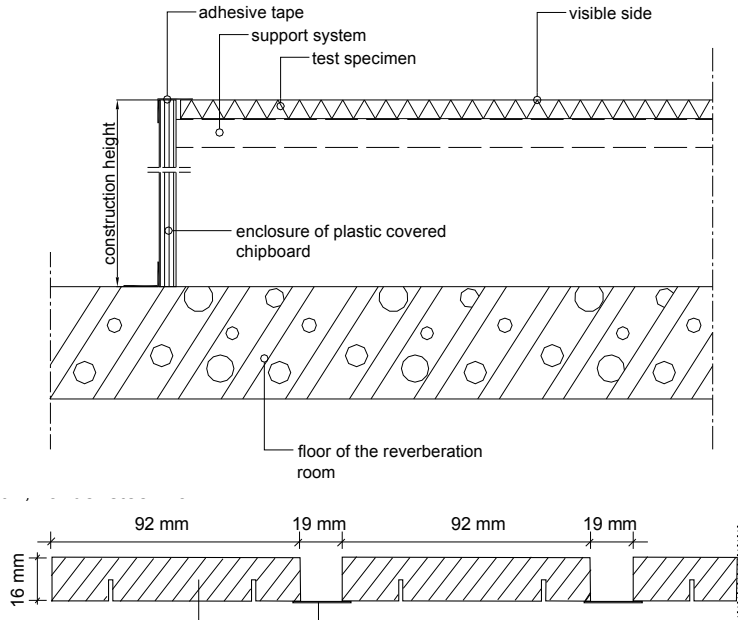


MEASUREMENT OF SOUND ABSORPTION IN A REVERBERATION ROOM  
ACCORDING TO ISO 354:1985

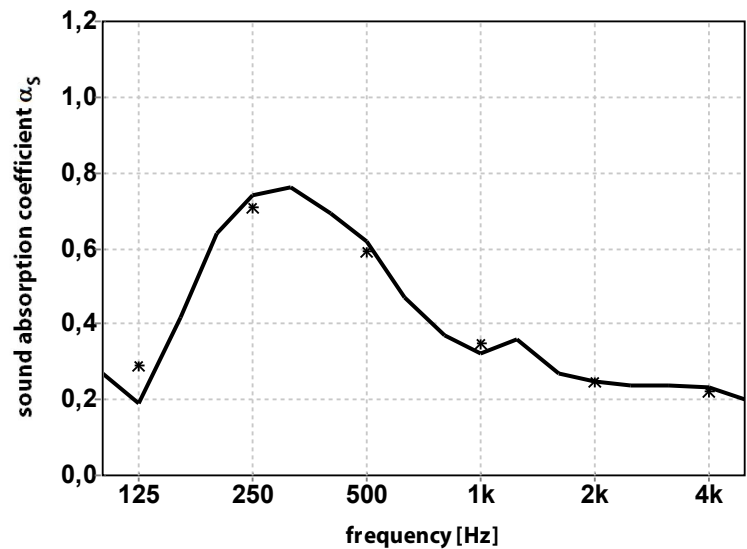


principal: Derako International

variant 1, without mineral wool



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  
 temperature: 17 °C



	0,27	0,64	0,69	0,37	0,27	0,24
1/3 oct.	0,19	0,74	0,62	0,32	0,25	0,23
	0,42	0,76	0,47	0,36	0,24	0,20
<b>alpha_w (ISO 11654) = 0,30(LM)</b>	<b>1/1 oct. 0,29</b>	<b>0,71</b>	<b>0,59</b>	<b>0,35</b>	<b>0,25</b>	<b>0,22</b>

**NRC (ASTM - C423) = 0,50**

publication is permitted for the entire page only

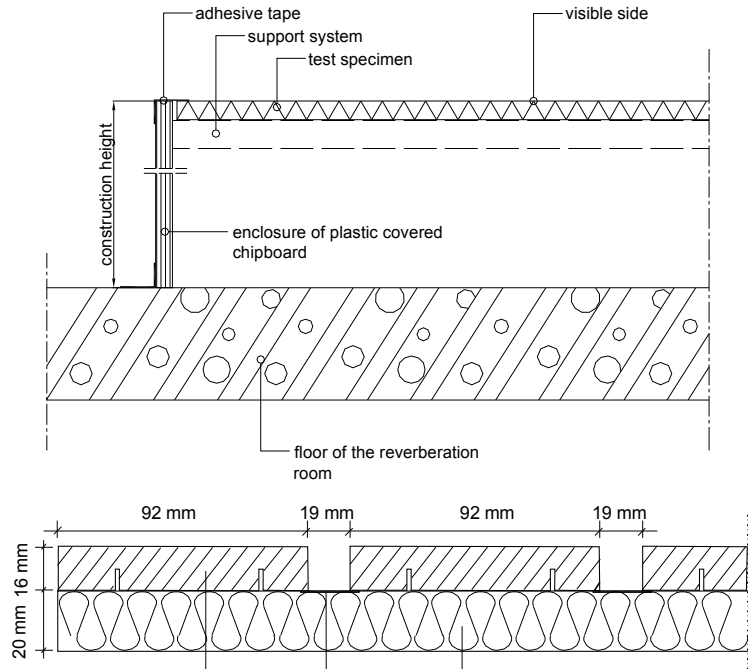
Mook, measured at 19-03-2002

**MEASUREMENT OF SOUND ABSORPTION IN A REVERBERATION ROOM  
ACCORDING TO ISO 354:1985**



principal: Derako International

variant 2; with mineral wool (20 mm)



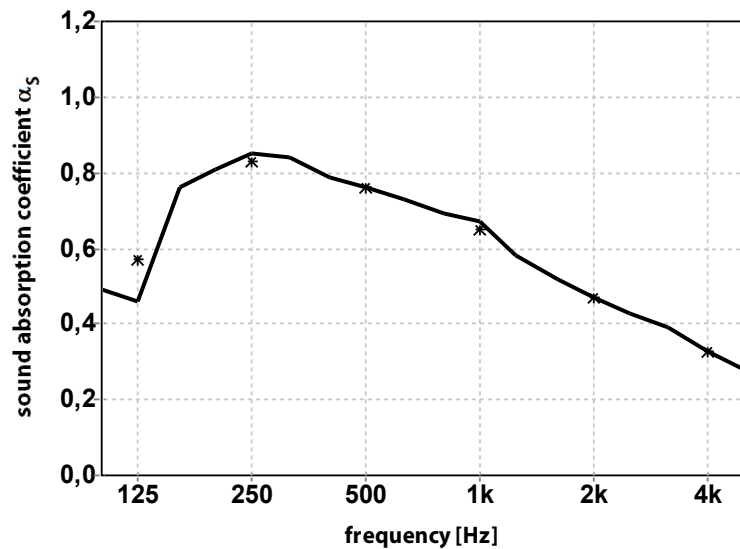
volume reverberation room: 214 m<sup>3</sup>  
 surface area sample: 10,8 m<sup>2</sup>  
 height of the construction: 0,200 m  
 measured at: Peutz Laboratory for Acoustics  
 signal: broad-band noise  
 bandwidth: 1/3 octave  
 temperature: 17 °C

relative humidity: 0 %

**$\alpha_w$  (ISO 11654) = 0,50(LM)**

**NRC (ASTM - C423) = 0,70**

publication is permitted for the entire page only



	0,49	0,81	0,79	0,69	0,52	0,39
1/3 oct.	0,46	0,85	0,76	0,67	0,47	0,33
	0,76	0,84	0,73	0,58	0,43	0,28
<b>1/1 oct.</b>	<b>0,57</b>	<b>0,83</b>	<b>0,76</b>	<b>0,65</b>	<b>0,47</b>	<b>0,33</b>

Mook, measured at 19-03-2002