PEUTZ

Laboratory for Acoustics

TESTING
RvA L 334

Determination of the sound insulation and the sound absorption (reverberationroom method) of a facade type ***Metfiber ECO Wall Sound 100mm,*** *manufacturer Metecno Bausysteme GmbH*

Report number A 2651-2E-RA-001 d.d. March 17, 2014

Laboratory for Acoustics

*Determination of the sound insulation and sound absorption (reverberation room method) of a facade type **Metfiber ECO Wall Sound 100 mm** manufacturer Metecno Bausysteme GmbH*

Principal	Metecno Bausysteme GmbH Am Amselberg, 1 D-99444 BLANKENHAIN Germany
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1 Introduction

At the request of Metecno Bausysteme GmbH based at Blankenhain (Germany) sound insulation and sound absorption measurements have been carried out on a facade type

Metfiber *ECO* Wall Sound 100 mm
manufactured by Metecno Bausysteme GmbH

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

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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**: **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 and guidelines

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

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

ISO 10140-2:2010	Acoustics - Laboratory measurements of sound insulation of building elements – Part 2: Measurement of airborne sound insulation
N.B.	The standard ISO 10140-2 is in all countries of the EU accepted as European Standard EN ISO 10140-2:2010

Various other related norms:

ISO 10140-1:2010	Acoustics - Laboratory measurements of sound insulation of building elements – Part 1: Application rules for specific products
N.B.	The standard ISO 10140-1 is in all countries of the EU accepted as European Standard EN ISO 10140-1:2010
ISO 10140-4:2010	Acoustics - Laboratory measurements of sound insulation of building elements – Part 4: Measurement procedures and requirements
N.B.	The standard ISO 10140-4 is in all countries of the EU accepted as European Standard EN ISO 10140-4:2010
ISO 10140-5:2010	Acoustics - Laboratory measurements of sound insulation of building elements – Part 5: Requirements for test facilities and equipment
N.B.	The standard ISO 10140-5 is in all countries of the EU accepted as European Standard EN ISO 10140-5:2010
ISO 140-2:1991	Acoustics - Measurement of sound insulation of building elements - Part 2: Determination, verification and application of precision data
N.B.	The standard ISO 140-2 is accepted as European standard EN 20140-2:1993 in all countries of the EU
ISO 717-1:2013	Acoustics - Rating of sound insulation in buildings and of building elements - Part 1: Airborne sound insulation
N.B.	The standard ISO 717-1 is accepted as European Norm EN ISO 717-1:2013 in all countries of the EU

Sound absorption

ISO 354:2003[1]	Acoustics Measurement of sound absorption in a reverberation room
N.B.	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

1 According to this norm, the report should include for each measurement the mean reverberation times T1 end 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 following data have been provided by the principal, supplemented by observations in the laboratory where applicable.

Construction tested:
facade type **Metfiber *ECO* Wall Sound 100 mm** manufactured by Metecno Bausysteme GmbH.
Sandwich construction with the following composition:

- perforated metal sheet thickness 0,6 mm, perforation rate 32,7% (triangle pattern, hole diameter 3,0 mm, c.t.c. 5,0 mm)
- glass wool thickness 100 mm, density about 55 kg/m^3
- (closed) metal sheet thickness 0,6 mm

Width elements approximately 1000 mm. Mass approximately 15,4 kg/m^2 (weighted).

See figure 4 for a drawing of the tested construction supplied by the principal.

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 sound insulation

4.1 Method

The tests were conducted in accordance with the provisions of the test method ISO 10140-2 in the Laboratory for Acoustics of Peutz bv in Mook. A detailed description of the test set up has been given in figures 1 and 2 of this report.

The client built the facade construction in to the test opening D (c. 4300 x 2800 mm) between testing rooms 1 and 2, using 4 complete elements (width 1000 mm) and a fixing part (width 280 mm). The joints between the elements and the test opening were securely closed with sealant. No extra sealing is used on the the joints between the elements.

In one of the rooms (the so-called sending room) loudspeakers generate broadband noise.

In this sending room as well as in the adjacent room (the "receiving room") the resulting sound pressure level is measured by means of a continuous rotating boom, so the (time- and space-) averaged sound pressure level is determined.

The reverberation time of the receiving room is also measured.

The instruments and the method used meet the requirements of ISO 10140-5.

As allowed by the test method the test procedure is repeated reversing the sending and receiving rooms. The reported value of each sound insulation is the arithmetic average of the two results.

In ISO 140-3 the airborne sound insulation of an object is defined as the "sound reduction index R" to be evaluated according to formula 1 and expressed in dB:

$$R = L_1 - L_2 + 10 \log\left(\frac{S}{A}\right) \qquad (1)$$

in which:

L_1 = sound pressure level in the sending room [dB]
L_2 = sound pressure level in the receiving room [dB]
S = area of the object to be tested [m^2]
A = equivalent sound absorption [m^2] in the receiving room according to:

$$A = \frac{0{,}16\,V}{T} \qquad (2)$$

in which:

V = volume of the receiving room [m^3]
T = reverberation time in the receiving room [s]

4.2 Accuracy

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

4.2.1 Repeatability r

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 insulation measurements performed in the laboratories of Peutz bv in Mook eight series of measurements have been carried out according to ISO 140-2. From the results of those measurements the repeatability r has been calculated. It was found that for the frequency range from 100 to 250 Hz the repeatability r is 2,0 dB as a maximum. For the frequency range 315 to 3150 Hz the repeatability r is 1,3 dB as a maximum.

The repeatability r regarding the single-figure rating R_w is 0,7 dB as a maximum. As ISO 717-1 prescribes rounding of the R_w-values to the nearest dB repeatability r of 1 dB is applicable for the R_w-value.

From these results it may be concluded that the repeatability r as found satisfies the demands of ISO 140-2.

4.2.2 Reproducibility R

When: - two tests are performed on identical test material - in different laboratories - by different person(s) - under different environmental conditions - the probability will be 95% that the difference between the two test results will be less than or equal to R.

In ISO 140-2 there is a statement on the reproducibility R to be expected, based on the results of various inter-laboratory tests. The reproducibility of the single figure rating R_w is about 3 dB.

4.3 Environmental conditions during the measurements

t4.1 *Environmental conditions during the measurements*

Measuring room	temperature [°C]	relative humidity [%]
1	15	57
2	16	55

4.4 Results

The results of the measurements are given in table 4.2 and in figure 5. In the table and graph the values of the insulation found are presented in 1/3 octave bands. From these values the

weighted sound reduction index R_w according to ISO 717-1 including the spectrum adaptation terms C and Ctr have been calculated and stated.

t4.2 Measurements results ***Metfiber ECO Wall Sound 100 mm***

	airborne sound insulation R [dB]	
record nr.	**#178**	
figure nr.	**5**	
frequency [Hz]	**1/3 oct.**	**1/1 oct.**
50	18,9	
63	18,2	17,7
80	16,4	
100	23,6	
125	21,5	22,1
160	21,5	
200	23,4	
250	25,7	25,2
315	27,3	
400	30,3	
500	32,3	31,9
630	33,9	
800	35,7	
1000	35,8	34,3
1250	32,3	
1600	30,0	
2000	35,0	33,4
2500	44,0	
3150	47,0	
4000	48,7	49,1
5000	54,8	
$R_w(C;C_{tr})$	34(-1;-3) dB	
$C_{100\text{-}5000};C_{tr,100\text{-}5000}$	(0;-3) dB	
$C_{50\text{-}3150};C_{tr,50\text{-}3150}$	(-1;-5) dB	
$C_{50\text{-}5000};C_{tr,50\text{-}5000}$	(0;-5) dB	

The results as presented here are based on a testing area of 12 m^2. In situations where different dimensions and/or method of mounting differ from the ones tested, different results may be found.

5 Measurements sound absorption

The panels to be measured (see chapter 3) have been placed directly on the floor of the reverberation room, with the perforated side facing the room (Type A mounting according to ISO 354:2003). The panels were put tight to each other. The sides of the setup were enclosed by 18 mm thick plastic covered chipwood board (see figure 6).

5.1 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 3 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

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

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]

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

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:

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

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

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^{-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]

5.2 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.

5.3 Environmental conditions during the measurements

t5.1 *Environmental conditions during the measurements*

reverberation room	temperature [°C]	barometric pressure [kPa]	relative humidity [%]
empty	16	99,7	55
with facade	16	99,8	55

5.4 Results

The results of the measurements are given in table 5.2 and in figure 6. 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 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.

t5.2 *Measurements results* ***Metfiber ECO Wall Sound 100 mm***

	sound absorption coefficient α_s	
record nr.	**#75**	
figure nr.	**6**	
frequency [Hz]	**1/3 oct.**	**1/1 oct.**
100	0,41	
125	0,66	0,60
160	0,72	
200	0,78	
250	0,90	0,87
315	0,92	
400	0,96	
500	0,95	0,95
630	0,93	
800	0,93	
1000	0,98	0,96
1250	0,97	
1600	0,95	
2000	0,99	0,98
2500	0,99	
3150	0,96	
4000	0,97	0,97
5000	0,97	
α_w	1,00	
NRC	0,95	

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

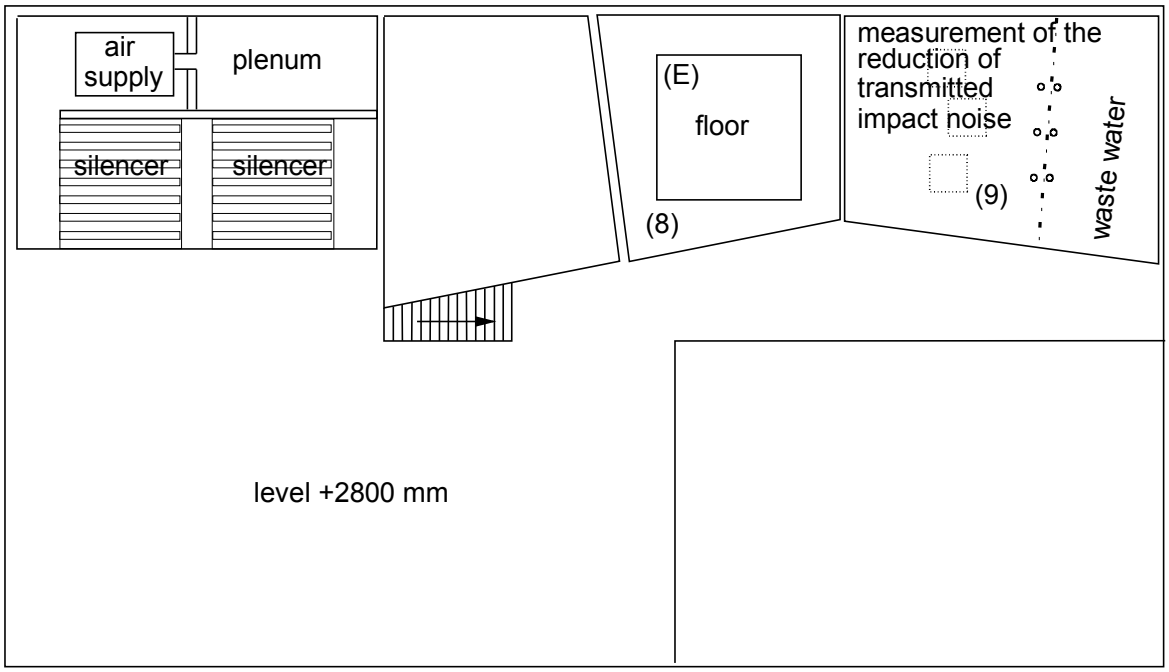
dr. ir. M.L.S Vercammen
Manager

This report contains 14 pages and 6 figures.

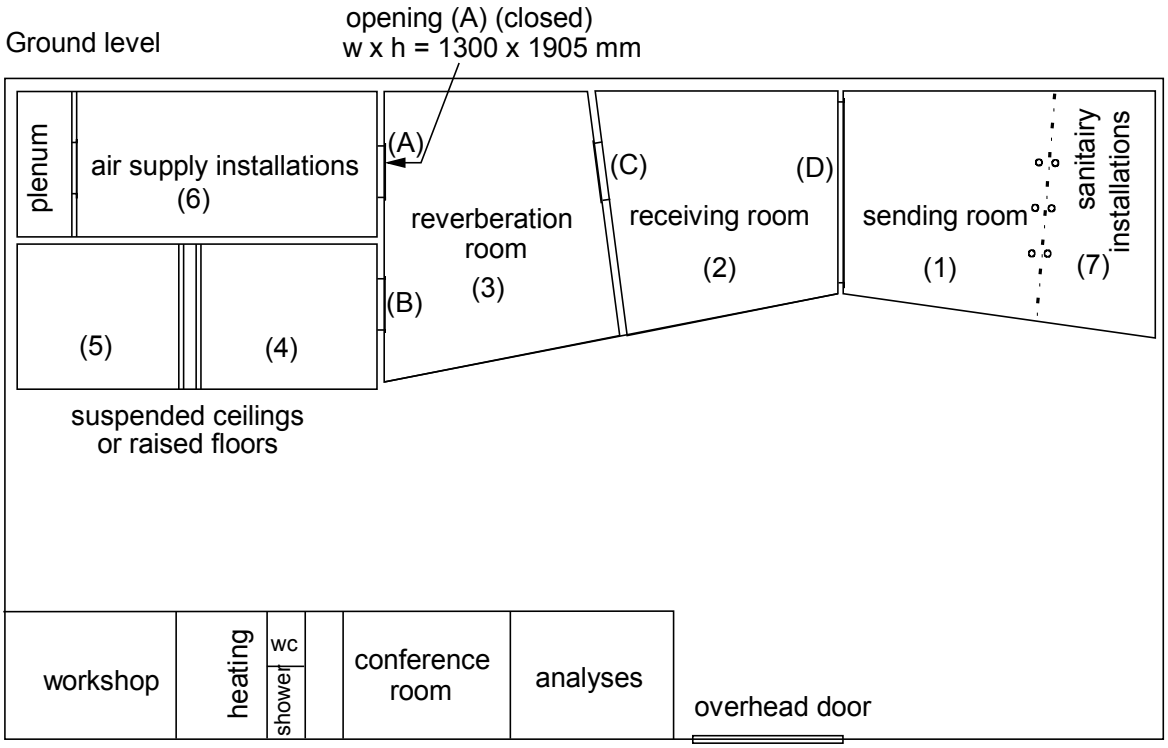
PEUTZ bv
Lindenlaan 41, NL-6584 AC MOLENHOEK (LB), THE NETHERLANDS

OVERVIEW

Story



Ground level



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

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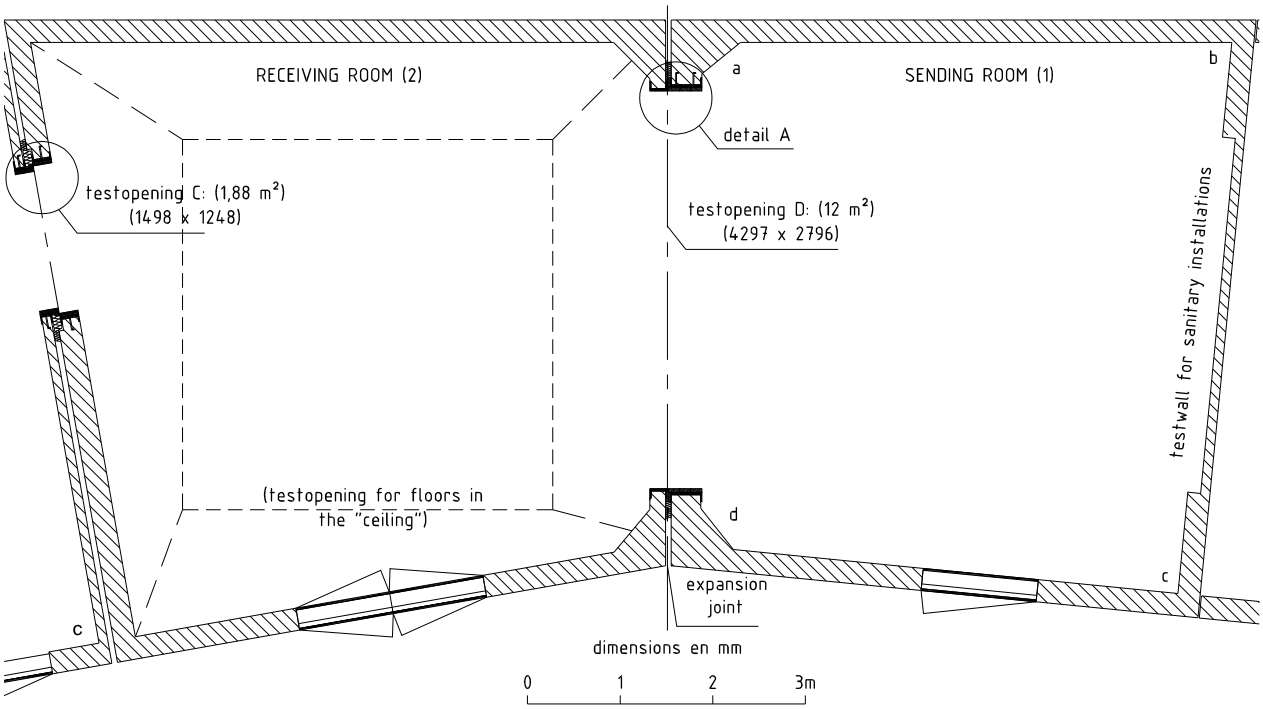
SOUND INSULATION TEST FACILITIES

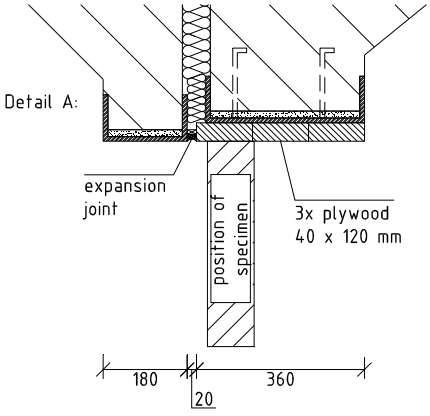
The testrooms meet the requirements of ISO 10140-5.
Additional data:
- volume of the receiving room: 111 m^3
- volume of the source room: 94 m^3
- area of the test specimen: 12,0 m^2

Both rooms are isolated for vibrations by using a so called room-in-room construction. Flanking transmission is thus minimized.

height: along the walls 2840 mm increasing to 2920 mm at the perimeter of the testopening for floors

height at a: 3055 mm
height at b: 3058 mm
height at c: 3052 mm
height at d: 3062 mm





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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.

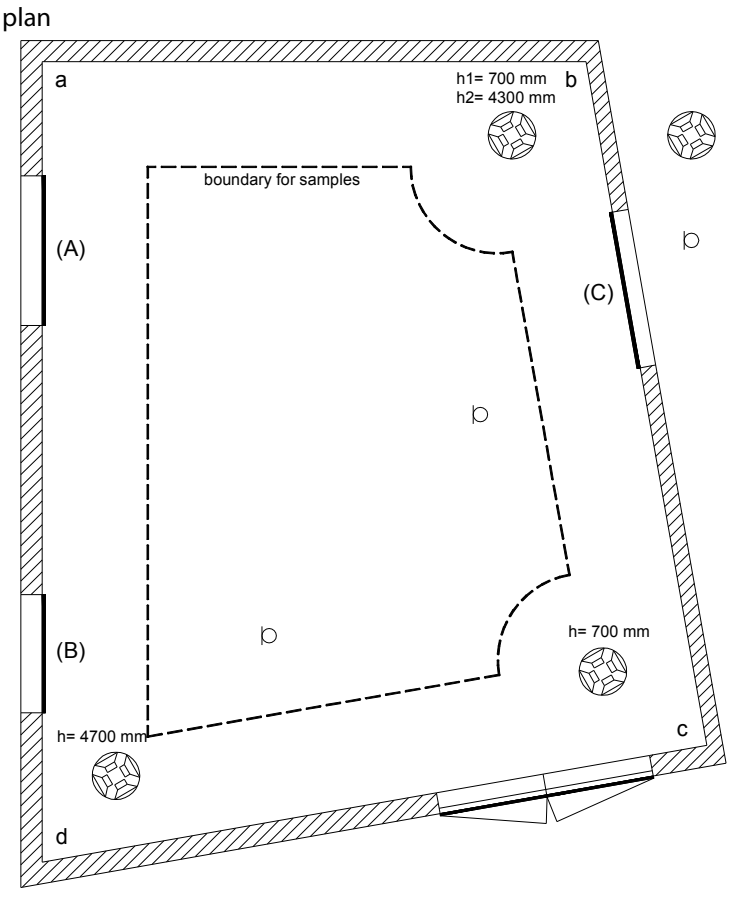
reverberation time of the empty reverberation room during measurements of 28-01-2014

frequency (1/1 oct.)	125	250	500	1000	2000	4000	Hz
Reverberation time	9,85	7,96	7,67	6,33	4,43	2,75	sec.

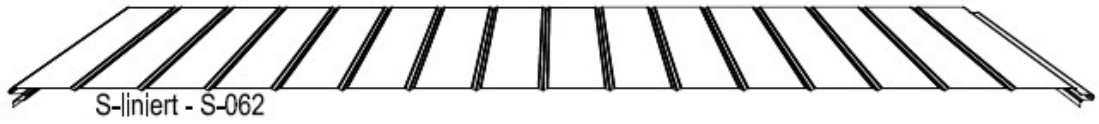
repeatibility r (1/1 oct.) c.f. ISO 354:1985 annex C (see chapter 5.2 of this report).

r at high α	0,13	0,04	0,04	0,02	0,02	0,08	-
r at low α	0,09	0,02	0,01	0,02	0,02	0,04	-

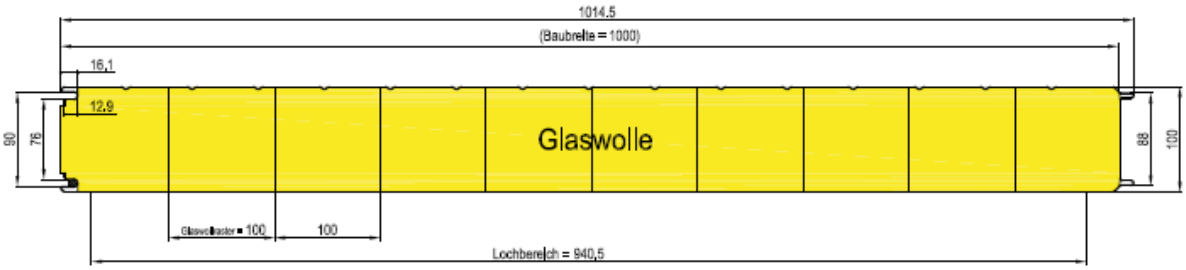
plan

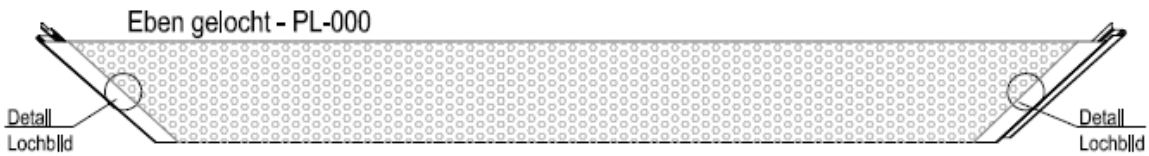


Absorb, versie 5.7.2 mode 7, PM: RA, file: a2651 E#:3-38 T_1 = 15,6 °C p_1 = 99,7 kPa h_1 = 54,5 %

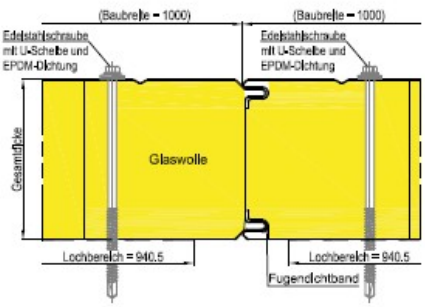


Gesamtdicke: 100

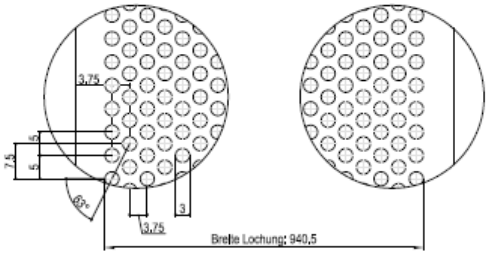




Detail



Detail Lochbild



MEASUREMENT OF THE SOUND INSULATION ACCORDING TO ISO 10140-2:2010

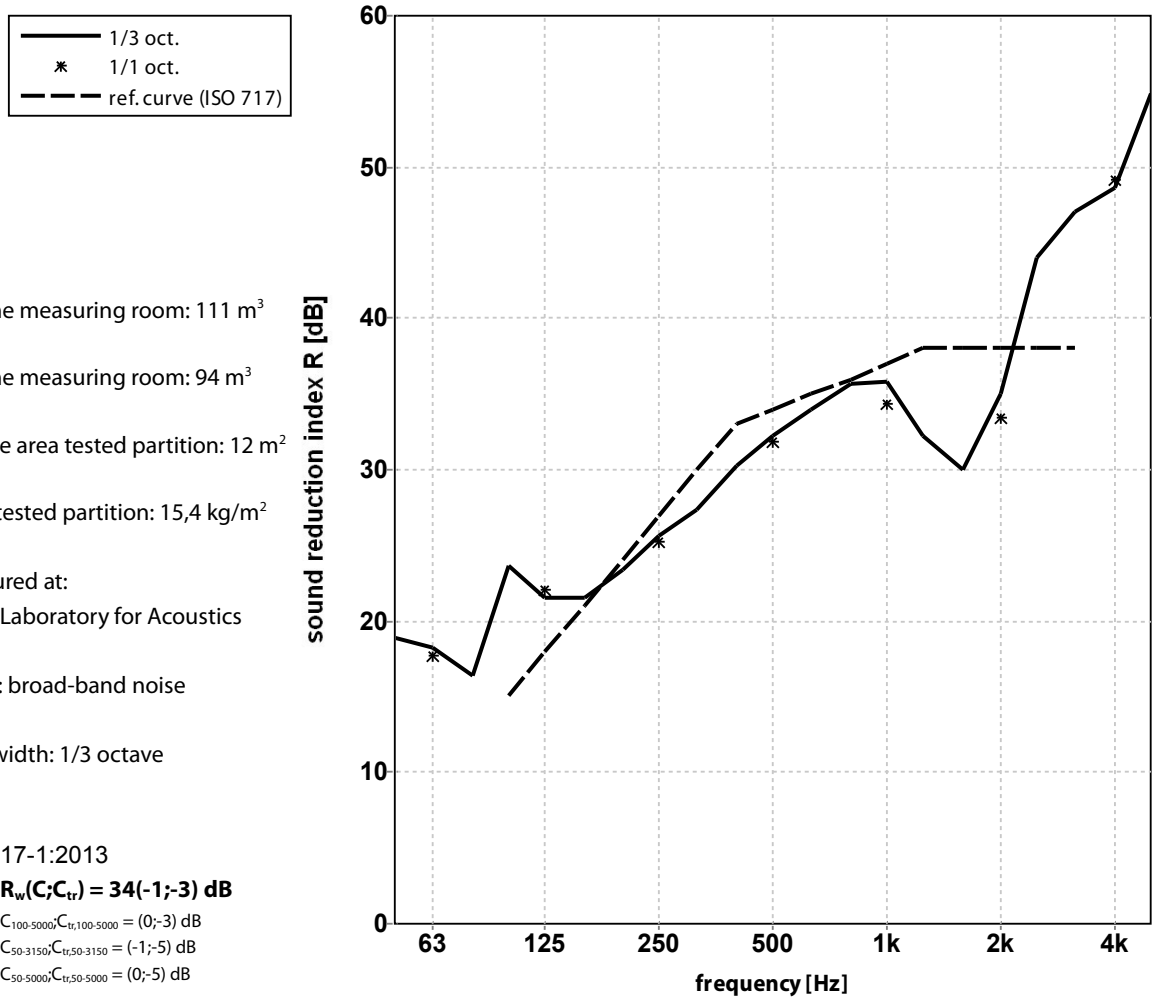
principal: Metecno Bausysteme GmbH

TESTING RvA L 334

Construction tested; facade type **Metfiber *ECO* Wall Sound 100 mm** manufactured by Metecno Bausysteme GmbH

Sandwich construction;

- perforated metal sheet thickness 0,6 mm, perforation rate 32,7 %
  (triangle pattern, hole diameter 3,0 mm, c.t.c. 5,0 mm)
- glass wool thickness 100 mm, density ca. 55 kg/m^3
- (closed) metal sheet thickness 0,6 mm



volume measuring room: 111 m^3

volume measuring room: 94 m^3

surface area tested partition: 12 m^2

mass tested partition: 15,4 kg/m^2

measured at:
Peutz Laboratory for Acoustics

signal: broad-band noise

bandwidth: 1/3 octave

ISO 717-1:2013

$R_w(C;C_{tr})$ = 34(-1;-3) dB

$C_{100\text{-}5000};C_{tr,100\text{-}5000}$ = (0;-3) dB
$C_{50\text{-}3150};C_{tr,50\text{-}3150}$ = (-1;-5) dB
$C_{50\text{-}5000};C_{tr,50\text{-}5000}$ = (0;-5) dB

	18,9	23,6	23,4	30,3	35,7	30,0	47,0	
1/3 oct.	18,2	21,5	25,7	32,3	35,8	35,0	48,7	dB
	16,4	21,5	27,3	33,9	32,3	44,0	54,8	
1/1 oct.	**17,7**	**22,1**	**25,2**	**31,9**	**34,3**	**33,4**	**49,1**	**dB**

Mook, 28-01-2014

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

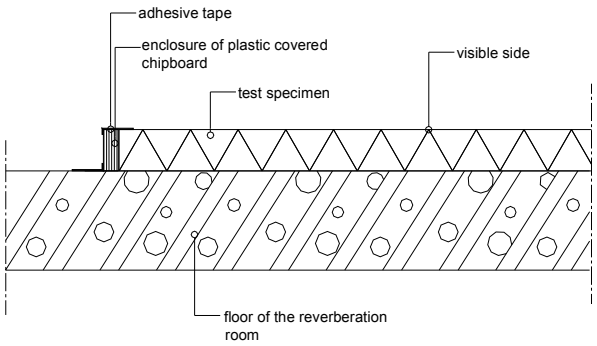
TESTING RvA L 334

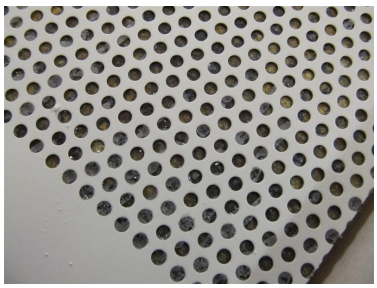
principal: Metecno Bausysteme GmbH

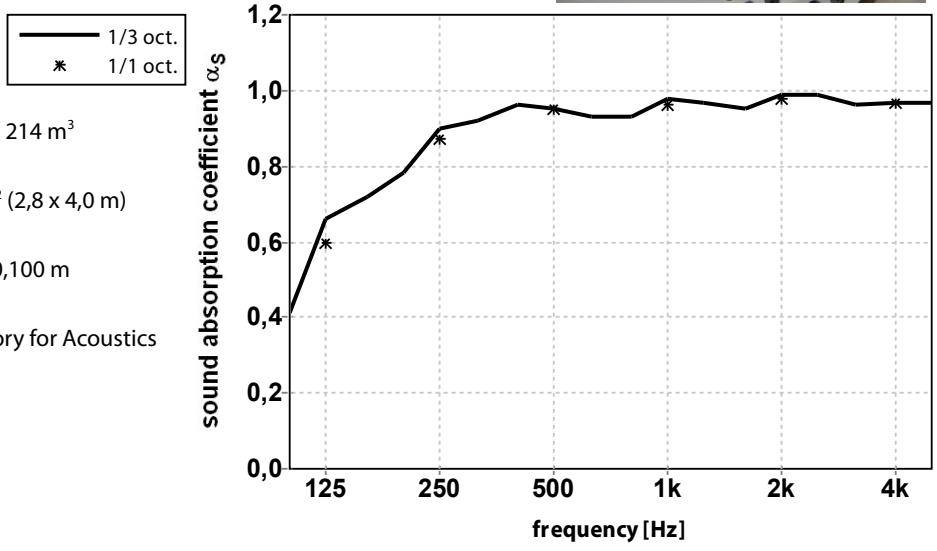
Construction; facade type **Metfiber Wall *ECO* Sound 100 mm** manufactured by Metecno Bausysteme GmbH

Sandwich construction:

- perforated metal sheet thickness 0,6 mm, perforation rate 32,7 %
  (triangle pattern, hole diameter 3,0 mm, c.t.c. 5,0 mm)
- glass wool thickness 100 mm, density abt. 55 kg/m^3
- (closed) metal sheet thickness 0,6 mm







volume reverberation room: 214 m^3

surface area sample: 11,2 m^2 (2,8 x 4,0 m)

heigth of the construction: 0,100 m

measured at: Peutz Laboratory for Acoustics

signal: broad-band noise

bandwidth: 1/3 octave

		0,41	0,78	0,96	0,93	0,95	0,96
	1/3 oct.	0,66	0,90	0,95	0,98	0,99	0,97
		0,72	0,92	0,93	0,97	0,99	0,97
	1/1 oct.	**0,60**	**0,87**	**0,95**	**0,96**	**0,98**	**0,97**

α_w (ISO 11654) = 1,00

NRC (ASTM - C423) = 0,95

publication is permitted for the entire page only

Mook, 28-01-2014

Absorb, versie 5.7.2 mode 7, PM: RA, file: a2651 E#:3-38 F#:39-74 A#:75 T_1 = 15,6 °C T_2 = 16,3 °C p_1 = 99,7 kPa p_2 = 99,8 kPa h_1 = 54,5 % h_2 = 55,4 %

A 2651-2E-RA-001 / 7B9BE47C / THEO