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Determination of sound absorption coefficients in a reverberation room according to ISO 354 and ISO 11654

(2 appendices)

Client

Konto Oy

Test object

“Painted” panels delivered by Konto Oy.

The panels were designated: “Konto Acoustic Panel”

The panels were 21-24 mm thick and had one painted surface which were turned against the room (upwards) during the test.

Arrival of test objects

October 17, 2011

Date of test

October 18, 2011

Results

The sound absorption coefficient (α_s) and the practical sound absorption coefficient (α_p) are given in enclosure 1-2. The weighted sound absorption coefficient (α_w) and the sound absorption classes have been calculated according to ISO 11654 and the results are given in table 1.

The results are valid for tested objects only.

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Table 1 – Summary of results

Test object:	ISO 11654		Enclosure
	Absorption class	α_w	
“Konto Acoustic Panel” Thickness: 21-24 mm. Mounting depth: 21-24 mm. Mass per square metre: 2,94 kg/m ²	D	0,55(MH)	1
“Konto Acoustic Panel” Thickness: 21-24 mm. Mounting depth: 200 mm. Mass per square metre: 2,94 kg/m ²	A	0,95	2

Measurement method

The measurements have been carried out according to ISO 354:2003, which SP is accredited for. The method is valid as European standard according to EN ISO 354 and as Swedish standard according to SS-EN ISO 354. The evaluation has been carried out according to ISO 11654, which SP is accredited for. The method is valid as European standard according to EN ISO 11654 and as Swedish standard according to SS-EN ISO 11654.

4 loudspeaker positions and 6 microphone positions have been used giving 24 different combinations for the reverberation time measurements. For the empty room 3 decays have been used for averaging the reverberation time and for the test objects 5 decays have been used, for each combination of loudspeaker and microphone.

The absorption coefficient α_s has been evaluated from:

$$\alpha_s = \frac{55.3 V}{c \cdot S} \left(\frac{1}{T_2} - \frac{1}{T_1} \right)$$

Where

- V= Volume of the reverberation room (m³)
- S = Area of the test object (m²)
- c = Speed of sound in air (m/s)
- c = 331 + 0.6t
- t = Temperature in the air (°C)
- T₁ = Reverberation time of the room without test object (s)
- T₂ = Reverberation time of the room with test object (s)

Measurement uncertainty

From a worldwide Round Robin, in which SP took part, with 23 participating laboratories from 11 countries, the following measurement uncertainty has been calculated:

Table 2

Frequencies (Hz)	Uncertainty
100-630	$\pm 0,15$
800-1250	$\pm 0,10$
1600-2500	$\pm 0,15$
3150-5000	$\pm 0,20$

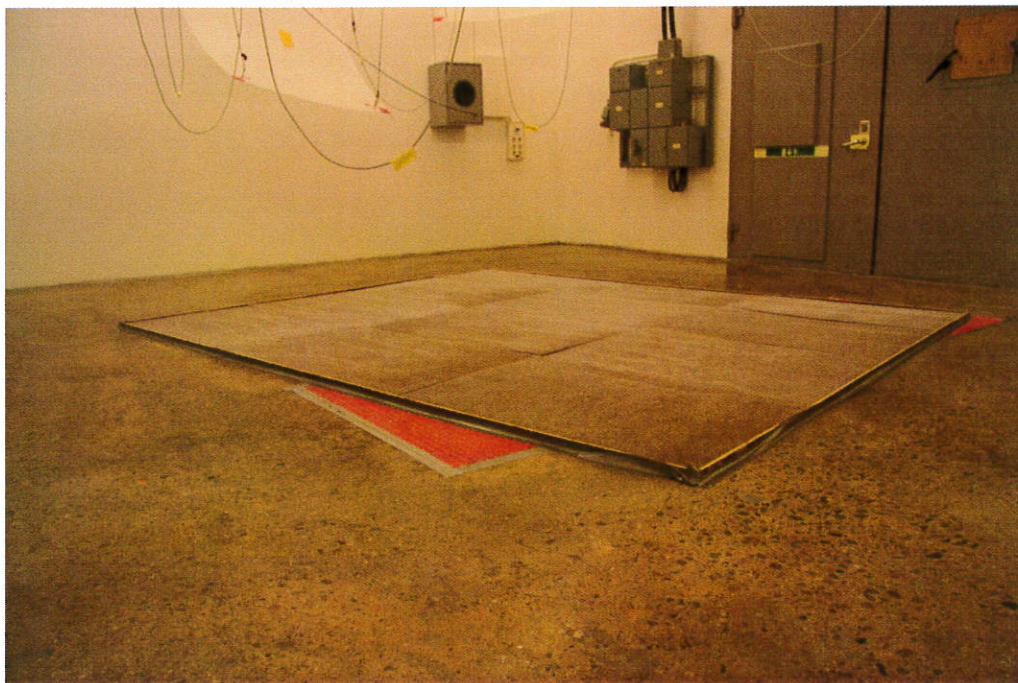
Test room

A reverberation room with the dimensions 7,64 m x 6,16 m x 4,25 m giving the volume 200 m³ and the total surface area 211 m² was used.

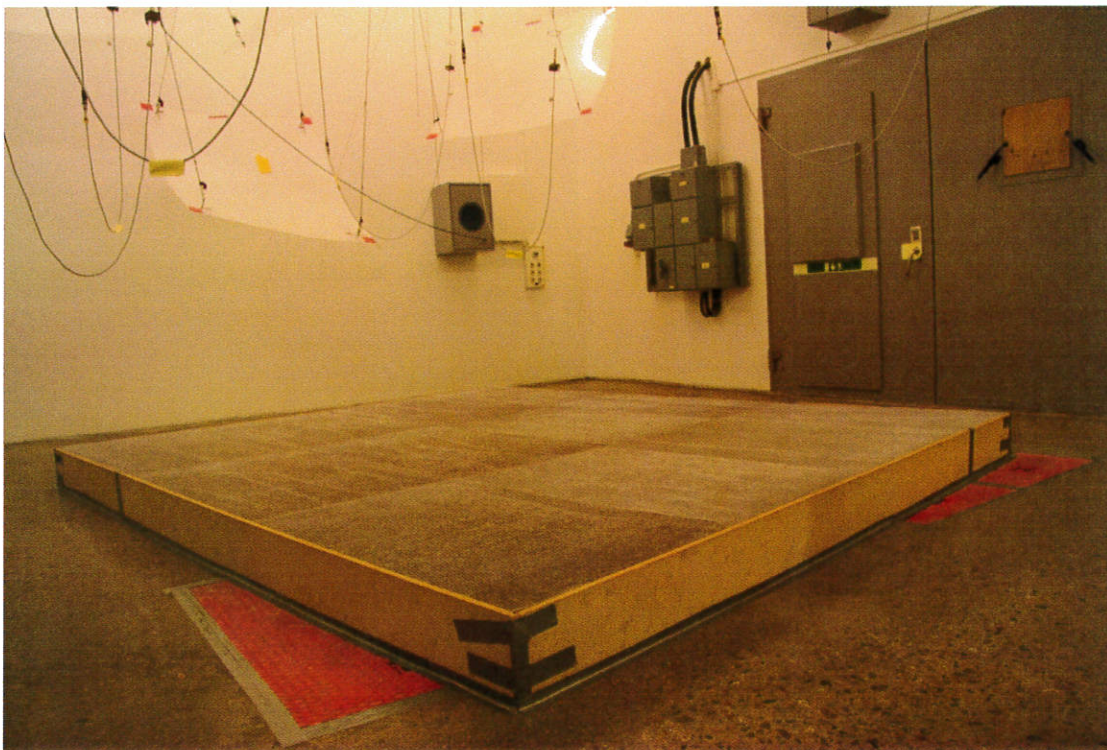
Mounting

The panels were placed on the floor in a frame with size 3 x 3,6 m. The edges were sealed with a wooden frame and a tape (made of an elastic woven material) to prevent air leakage. The mounting depth is the distance between the floor and the front surface (upper) of the test objects.

Pictures of the test object



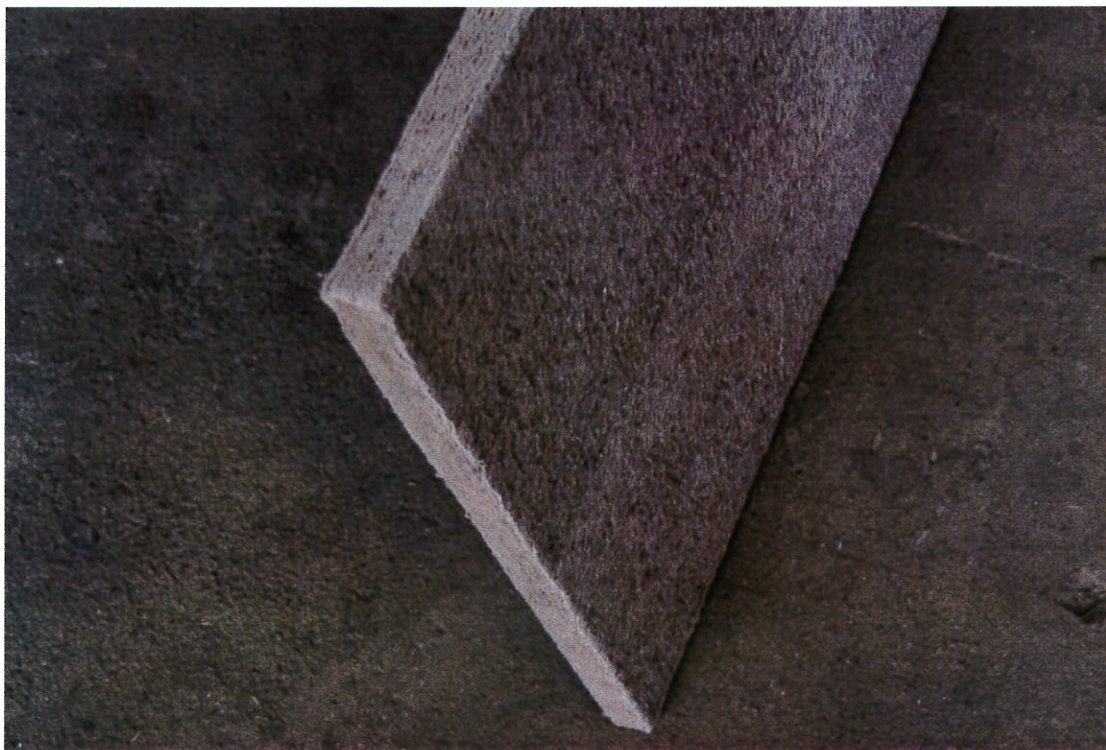
Picture 1 - Panels with mounting depth 21-24 mm (directly on the floor).



Picture 2 – The panels with mounting depth 200 mm



Picture 3 – The non painted side of a panel.



Picture 4 – The painted side of a panel.

List of instruments

Instrument	Manufacturer	Type	Serial no
Microphone	Brüel & Kjaer	4943	2479445
Microphone	Brüel & Kjaer	4943	2206273
Microphone	Brüel & Kjaer	4943	2206274
Microphone	Brüel & Kjaer	4943	2206276
Microphone	Brüel & Kjaer	4943	2206277
Microphone	Brüel & Kjaer	4943	2206278
Microphone Preamplifier	Brüel & Kjaer	2619	726624
Microphone Preamplifier	Brüel & Kjaer	2619	970948
Microphone Preamplifier	Brüel & Kjaer	2619	469905
Microphone Preamplifier	Brüel & Kjaer	2619	726792
Microphone Preamplifier	Brüel & Kjaer	2619	726825
Microphone Preamplifier	Brüel & Kjaer	2619	970968
Microphone Multiplexer	Norsonic	834	10050
Real-Time Analyzer	Norsonic	830	11533
Sound Level Calibrator	Brüel & Kjaer	4230	1411048
Programme	SP	Absorp 960627	
Power amplifier	PA1		
Noise generator	NG1 (white noise)		
Loudspeakers	SP	HGT2, HGT7, HGT4, HGTtak	
Hygrometer/ Temperature meter	Testo	615	502233

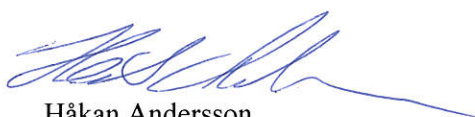
SP Technical Research Institute of Sweden
Energy Technology - Acoustics

Performed by

A blue ink signature of Joachim Stadig, written in a cursive style.

Joachim Stadig

Examined by

A blue ink signature of Håkan Andersson, written in a cursive style.

Håkan Andersson

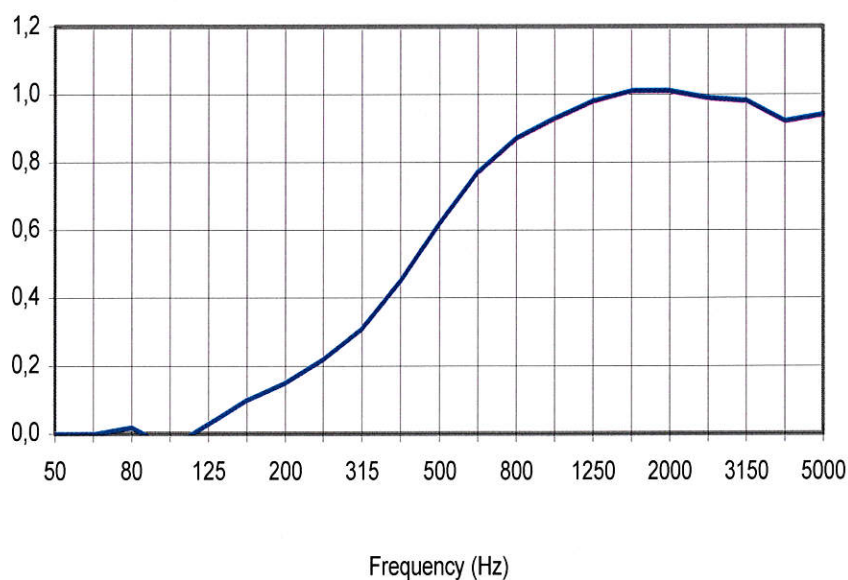
Appendices

Appendix 1

Measurement of sound absorption coefficient

Test	Measurement of sound absorption coefficient in a reverberation room according to EN ISO 354 and evaluation according to EN ISO 11654
Client	Konto Oy Mika Laitila
Object	Panels: Konto Acoustic Panel (painted) Thickness: 21-24 mm. Panel size: 1200 mm x 800 mm.
Date of test	October 18, 2011
Conditions	Mounting depth: 21-24 mm. Surface area: 10,8 m ² . Room volume: 200 m ³ . Temperature at measurement on object/in empty room: 21/ 21 °C. Relative humidity at measurement on object/in empty room: 80/ 80 %.
Result	Sound absorption class D . Weighted sound absorption coefficient $\alpha_w = 0,55(\text{MH})$.

Sound absorption coefficient



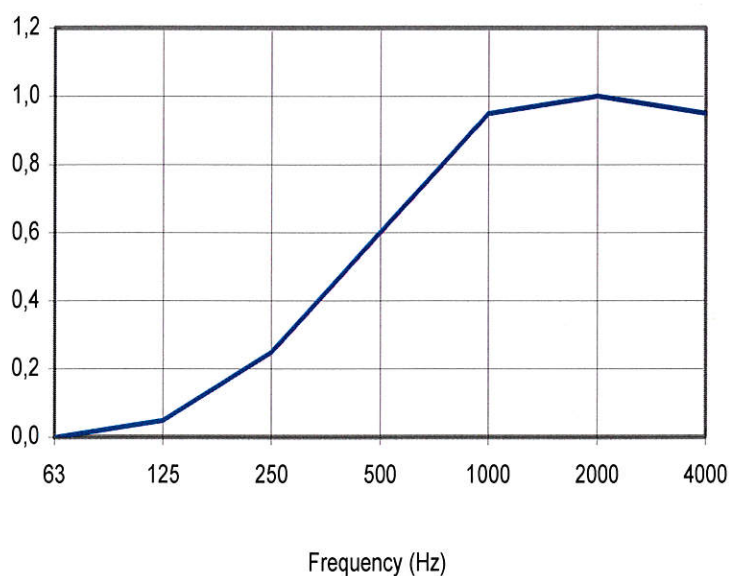
Frequency (Hz)	α_s
50	0,00
63	0,00
80	0,02
100	-0,04
125	0,03
160	0,10
200	0,15
250	0,22
315	0,31
400	0,45
500	0,62
630	0,77
800	0,87
1000	0,93
1250	0,98
1600	1,01
2000	1,01
2500	0,99
3150	0,98
4000	0,92
5000	0,94

Appendix 1

Measurement of sound absorption coefficient

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Client	Konto Oy Mika Laitila
Object	Panels: Konto Acoustic Panel (painted) Thickness: 21-24 mm. Panel size: 1200 mm x 800 mm.
Date of test	October 18, 2011
Conditions	Mounting depth: 21-24 mm. Surface area: 10,8 m ² . Room volume: 200 m ³ . Temperature at measurement on object/in empty room: 21/ 21 °C. Relative humidity at measurement on object/in empty room: 80/ 80 %.
Result	Sound absorption class D . Weighted sound absorption coefficient $\alpha_w = 0,55(\text{MH})$.

Practical sound absorption coefficient



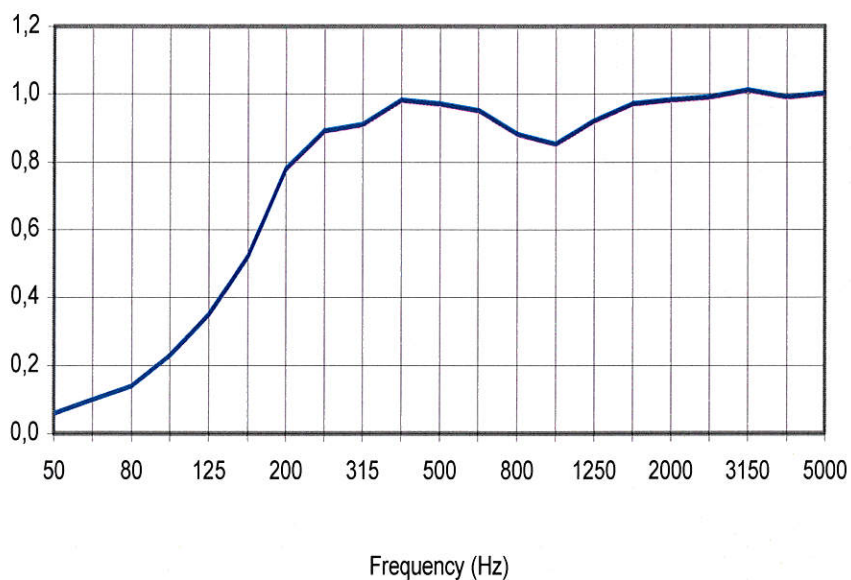
Frequency (Hz)	α_p
63	0,00
125	0,05
250	0,25
500	0,60
1000	0,95
2000	1,00
4000	0,95

Appendix 2

Measurement of sound absorption coefficient

Test	Measurement of sound absorption coefficient in a reverberation room according to EN ISO 354 and evaluation according to EN ISO 11654
Client	Konto Oy Mika Laitila
Object	Panels: Konto Acoustic Panel (painted) Thickness: 21-24 mm. Panel size: 1200 mm x 800 mm.
Date of test	October 18, 2011
Conditions	Mounting depth: 200 mm. Surface area: 10,8 m ² . Room volume: 200 m ³ . Temperature at measurement on object/in empty room: 21/ 21 °C. Relative humidity at measurement on object/in empty room: 80/ 80 %.
Result	Sound absorption class A . Weighted sound absorption coefficient $\alpha_w = \mathbf{0,95}$.

Sound absorption coefficient



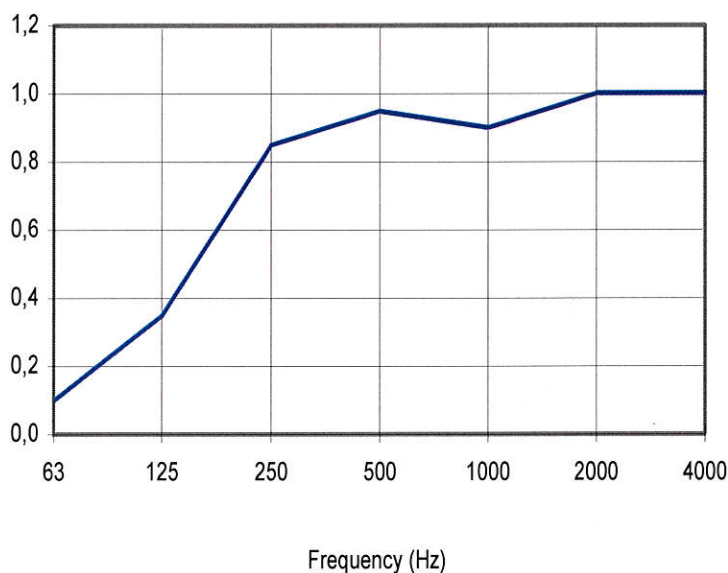
Frequency (Hz)	α_s
50	0,06
63	0,10
80	0,14
100	0,23
125	0,35
160	0,52
200	0,78
250	0,89
315	0,91
400	0,98
500	0,97
630	0,95
800	0,88
1000	0,85
1250	0,92
1600	0,97
2000	0,98
2500	0,99
3150	1,01
4000	0,99
5000	1,00

Appendix 2

Measurement of sound absorption coefficient

Test	Measurement of sound absorption coefficient in a reverberation room according to EN ISO 354 and evaluation according to EN ISO 11654
Client	Konto Oy Mika Laitila
Object	Panels: Konto Acoustic Panel (painted) Thickness: 21-24 mm. Panel size: 1200 mm x 800 mm.
Date of test	October 18, 2011
Conditions	Mounting depth: 200 mm. Surface area: 10,8 m ² . Room volume: 200 m ³ . Temperature at measurement on object/in empty room: 21/ 21 °C. Relative humidity at measurement on object/in empty room: 80/ 80 %.
Result	Sound absorption class A . Weighted sound absorption coefficient $\alpha_w = 0,95$.

Practical sound absorption coefficient



Frequency (Hz)	α_p
63	0,10
125	0,35
250	0,85
500	0,95
1000	0,90
2000	1,00
4000	1,00