

ABSORPTION MEASUREMENTS FOR AKUSTIL AKUSOUND

CONCLUSIONS

The sound absorption for the wall absorber Akusound from Akustil has been measured according to the reverberation room method (SS-EN ISO 354:2003). The measurements have been evaluated according to SS-EN ISO 11654:1997 and SS 25269:2013. The results as weighted sound absorption coefficient and sound absorption class are presented in the table below for the applicable measurement. The results for sound absorption area according to SS 25269:2013 are presented as appendices to this report.

Measurement protocol/Test object	Mounting	α_w	Absorption class
M1 Akusound	A (direct fixing)	1.0	A

1. CLIENT

Akustil Sweden AB, Box 303, 511 24 Kinna, SWEDEN
Contact: Inge Svensson, +46 102 06 68 40, info@akustil.se.

2. ASSIGNMENT

To measure the sound absorption coefficient and sound absorption area for the wall absorber Akusound from Akustil according to SS-EN ISO 354:2003. The measurements shall be evaluated according to SS-EN ISO 11654:1997 and SS 25269:2013 where applicable. The sound absorption for three combinations of absorbers shall also be calculated.

3. TEST OBJECTS

The Akusound wall absorber is based on a 50 mm polyester fleece sound absorber with a density of 72-80 kg/m³. The absorber is wrapped in wool fabric and has a thin frame that creates an airgap of 10 mm behind the absorber.

Akusound was measured for sound absorption area in three different sizes and as a large area of 10 m² for the absorption coefficient. An extra measurement was also performed with the absorber flipped upside down to investigate the influence of the wool fabric.

Akusound measured for sound absorption coefficient

Akusound 50x50 and 50x100 were combined to an area of 10 m² and placed directly on floor.



Figure 1: Akusound 10 m²

Akusound measured for sound absorption area/object

5-6 absorbers of each size were placed directly on the floor for measurement of the sound absorption area/object.



Figure 2: Akusound 20x100.



Figure 3: Akusound 50x50.



Figure 4: Akusound 50x100.

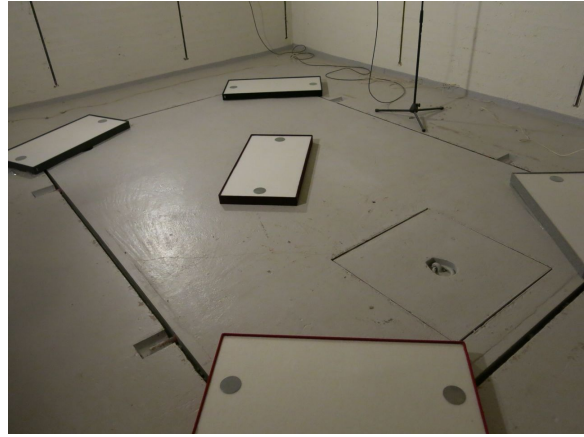


Figure 5: Akusound 50x100 upside down.

4. MEASUREMENT PROCEDURE

The absorption measurements were performed according to the standard SS-EN ISO 354:2003. The measurements were made with three speaker positions and four microphone positions. The results for absorption coefficient were evaluated according to SS-EN ISO 11654:1997. The results for sound absorption area were evaluated according to SS 25269:2013. The test specimen area fulfils the requirements in SS-EN ISO 354:2003.

The measurements were performed by Johan Jernstedt 2016-09-09 in Akustikverkstan's reverberation room in Skultorp, Skövde, Sweden. More information on the test facilities can be found in Appendix 2.

5. MEASUREMENT EQUIPMENT

Table 1 lists the equipment used during the measurements. The equipment fulfils class 1 according to SS-EN 61672-1, 60942 and 61260. Date for the latest calibration is available in the instrument journal of Akustikverkstan.

Instrument	Manufacture and type	Serial number	Internal designation
Measurement computer	HP ZBook		DA02
Front end	National Instruments NI 9234	1918620/190DB0B	AN05
Microphone	Roga MI-17	592	MI04
Microphone	Roga MI-17	593	MI05
Microphone	Roga MI-17	594	MI06
Microphone	Roga MI-17	595	MI07
Speaker	IMA Kub 1	8	HÖ7
Speaker	IMA Kub 1	9	HÖ8
Speaker	IMA Kub 1	10	HÖ9
Equalizer	Monacor MEQ-2152	-	Lab
Amplifier	Denon POA-2200	-	Lab

Table 1: Equipment used during the measurements.

6. RESULTS

The weighted sound absorption coefficient and sound absorption class for Akusound is presented in Table 2. Detailed measurement results for all test specimens are available in the measurement protocols belonging to this report 16-199-M1 to M5. The results are only valid for the tested samples.

Measurement protocol/Test object	Mounting	α_w	Absorption class
M1 Akusound	A (direct fixing)	1.0	A

Table 2: Results according to SS-EN ISO 11654:1997 for Akusound.

7. COMMENTS AND INTERPRETATIONS

Kammarkollegiet, the Swedish authority dealing with public purchasing, has published advice regarding purchasing of sound absorbers. They define the value N_{10} according to the formula:

$$N_{10} = \frac{10}{A_{500}}$$

A_{500} is the sound absorption area at the 500 Hz octave band for the sound absorber. The N_{10} value is developed to be a single value metric for speech sound absorption and describes how many objects are needed to obtain 10 m² of sound absorption area in the 500 Hz octave band.

If the sound absorption is lower in any octave above 500 Hz, the lower value will be used instead.

Measurement protocol	Test object	N_{10}
M2	Akusound 20x100	33
M3	Akusound 50x50	33
M4	Akusound 50x100	17
M5	Akusound 50x100 upside down	14

Table 3: N_{10} -values for Akusound.

For Akusound, the sound absorption peaks at 500 Hz, which results in an N_{10} value calculated from the sound absorption at 2000 Hz. This sound absorption behaviour is in general an effect of high airflow resistivity in the top surface of the absorber. A measurement was performed with the 50x100 absorber turned upside down to investigate if the wool fabric had any influence on the sound absorption. A comparison between the measurements is made in Figure 6. The small differences results in an N_{10} -value of 14 instead of 17 if the absorber is turned upside down.

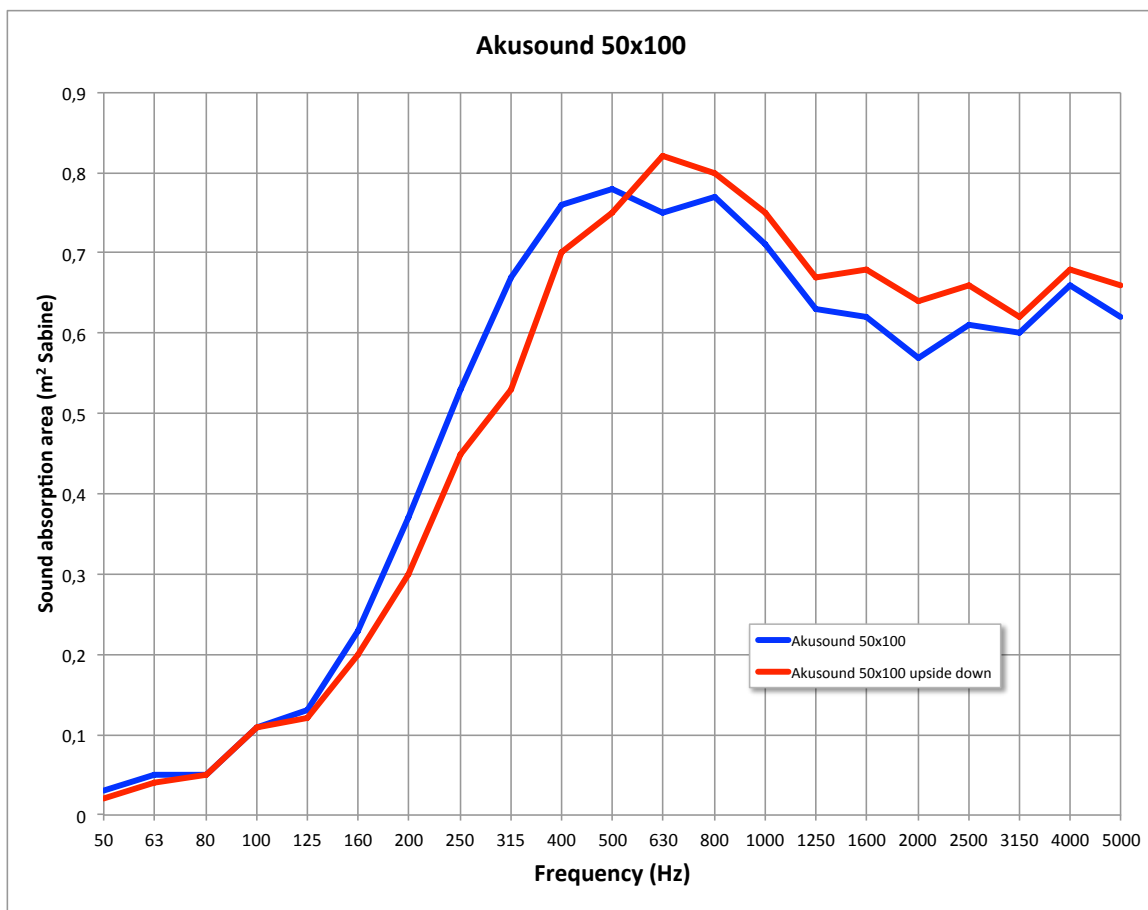


Figure 6: Sound absorption of Akusound 50x100, comparing normal mounting and upside down.

Both measurements show a decreased sound absorption at higher frequencies, which means that the wool fabric is not responsible alone for the decreased sound absorption at higher frequencies. It would be beneficial for the N_{10} -value if the airflow resistivity was decreased in the surface of the absorbers.

8. MEASUREMENT UNCERTAINTY

The uncertainties in the measured sound absorption coefficients have been estimated to the values in table 5. The uncertainty corresponds to one standard deviation. The uncertainties for the sound absorption area measurement are concluded from the same values multiplied with the test specimen area.

50 Hz	63 Hz	80 Hz	100 Hz	125 Hz	160 Hz	200 Hz
± 0,10	± 0,08	± 0,07	± 0,06	± 0,05	± 0,04	± 0,03
250 Hz	315 Hz	400 Hz	500 Hz	630 Hz	800 Hz	1 kHz
± 0,03	± 0,03	± 0,03	± 0,03	± 0,03	± 0,03	± 0,03
1,25 kHz	1,6 kHz	2 kHz	2,5 kHz	3,15 kHz	4 kHz	5 kHz
± 0,03	± 0,03	± 0,03	± 0,03	± 0,03	± 0,03	± 0,03

Table 5: Measurement uncertainty for each third octave.

This report should always be used in its complete context, even though the measurement protocols may be used independently.

Johan Jernstedt
Master of Science, Civil engineering

Reviewed by Pontus Thorsson, 2016-09-23

APPENDIX 1: MEASURED REVERBERATION TIMES

f(Hz)	Empty room	Akusound 20x100	Akusound 50x50	Akusound 50x100	Akustil 50x100 upside down	Akusound, absorption coefficient
50	8.90	8.66	8.60	8.55	8.61	7.92
63	9.37	8.87	8.93	8.75	8.80	7.78
80	8.79	8.56	8.45	8.23	8.21	7.03
100	7.59	7.12	6.98	6.73	6.73	5.47
125	6.97	6.43	6.40	6.08	6.15	4.80
160	5.76	5.24	5.13	4.77	4.91	3.29
200	5.74	4.97	4.63	4.31	4.52	2.86
250	5.52	4.57	4.15	3.80	4.00	2.43
315	5.59	4.26	4.09	3.53	3.83	2.08
400	5.53	4.00	3.91	3.35	3.46	1.84
500	4.71	3.42	3.40	2.99	3.03	1.72
630	4.45	3.23	3.29	2.92	2.84	1.62
800	4.78	3.51	3.48	3.02	3.00	1.71
1000	4.60	3.43	3.43	3.03	2.99	1.70
1250	4.02	3.24	3.18	2.86	2.84	1.65
1600	3.86	3.12	3.04	2.80	2.74	1.66
2000	3.41	2.84	2.83	2.61	2.55	1.59
2500	3.14	2.65	2.63	2.42	2.38	1.55
3150	2.78	2.41	2.40	2.20	2.19	1.45
4000	2.38	2.09	2.07	1.91	1.91	1.29
5000	1.96	1.78	1.76	1.66	1.65	1.16

Number of test objects/test area	0	6	6	5	5	10.0 m ²
Temperature (°C)	16.0	19.3	17.3	18.0	17.0	17.0
RH (%)	72	63	68	67	71	70

APPENDIX 2: INFORMATION ABOUT THE REVERBERATION ROOM

The reverberation room is rectangular, measuring Length x Width x Height = 5,85 x 4,65 x 7,35 m. The room volume is 200 m³ and the total area of the walls, ceiling and floor is 209 m². There are 22 diffusors (size 0,775 x 1,25 m) randomly installed in the room. The reverberation time between 50 and 200 Hz is controlled with membrane absorbers on the walls.

The test specimen is put on the floor on the mounting area (10 m², 2,6 x 3.85 m) according to figure B2.1. The mounting area consists of a concrete slab that can be lowered up to 700 mm below the floor.

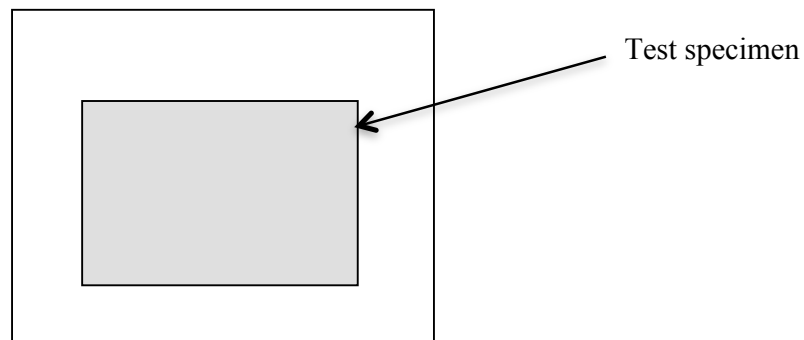


Figure B2.1: Plane drawing of the reverberation room with the test specimen put on the mounting area.

Akusound absorption coefficient

SOUND ABSORPTION COEFFICIENT ACCORDING TO ISO 354 AND ISO 11654

Measurement of sound absorption coefficient in a reverberation room



Report number:
16-199-M1
Date
2016-09-26

Frequency f [Hz]	Sound absorption coefficient	
	α_s	α_p
50	0.04	
63	0.07	0.05
80	0.09	
100	0.17	
125	0.21	0.25
160	0.42	
200	0.57	
250	0.74	0.75
315	0.98	
400	1.17	
500	1.19	1.00
630	1.27	
800	1.22	
1000	1.20	1.00
1250	1.16	
1600	1.10	
2000	1.09	1.00
2500	1.06	
3150	1.07	
4000	1.15	1.00
5000	1.15	

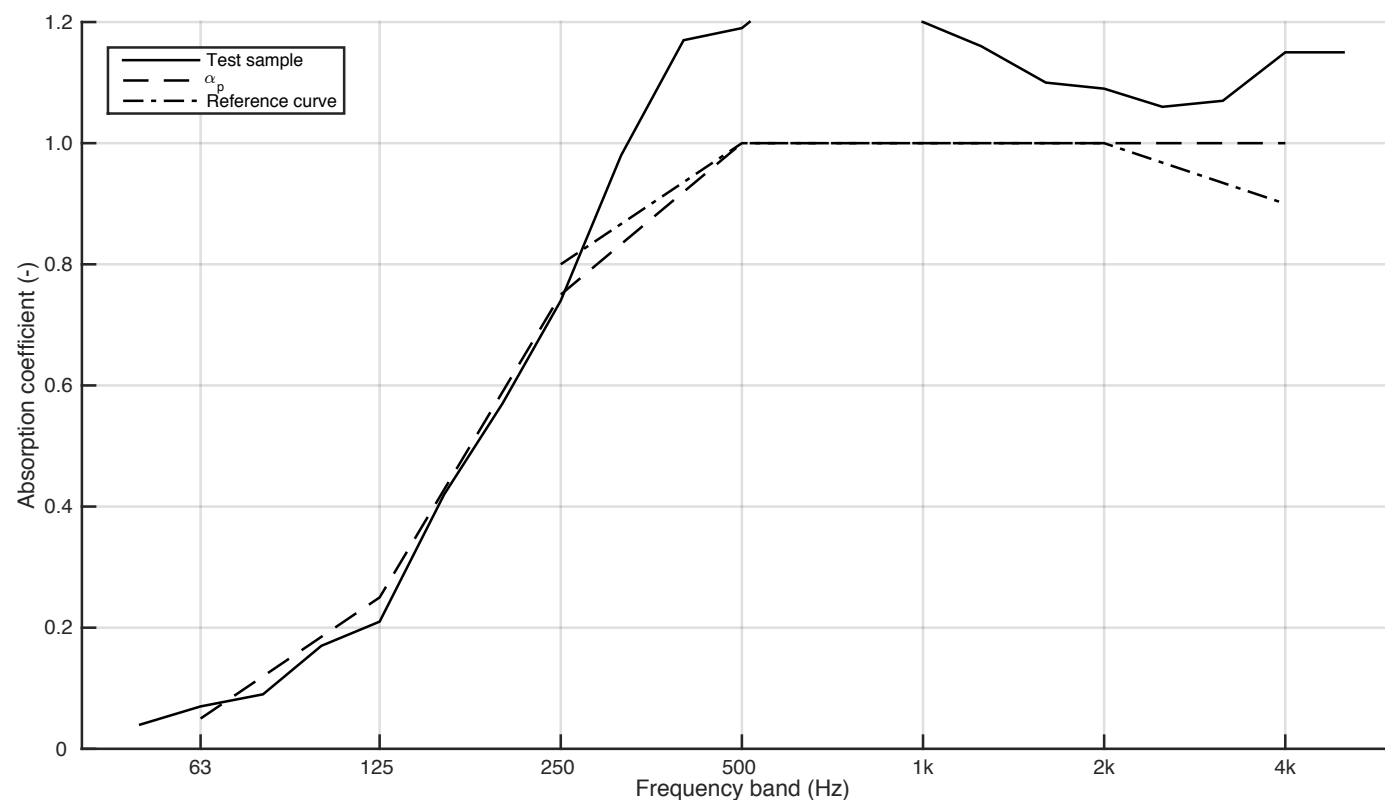
Client: Akustil
 Manufacturer: Akustil
 Product identification: Akusound

Description of test specimen: Akusound wall absorbers placed directly on floor.

Reverberation room volume: 200 m³
 Temperature: 17.0 °C (empty: 16.0 °C)
 Air humidity: 70% (empty: 72%)
 Air pressure: 99.1 kPa (empty: 99.1 kPa)
 Size of specimen: 10 m²

Measurement date: 2016-09-09

Measured by: Johan Jernstedt



$\alpha_w = 1.00$

Absorption class = A

Akusound 20x100

SOUND ABSORPTION AREA ACCORDING TO ISO 354 AND SS 25269

Measurement of sound absorption area in a reverberation room



Report number:
16-199-M2
Date
2016-09-26

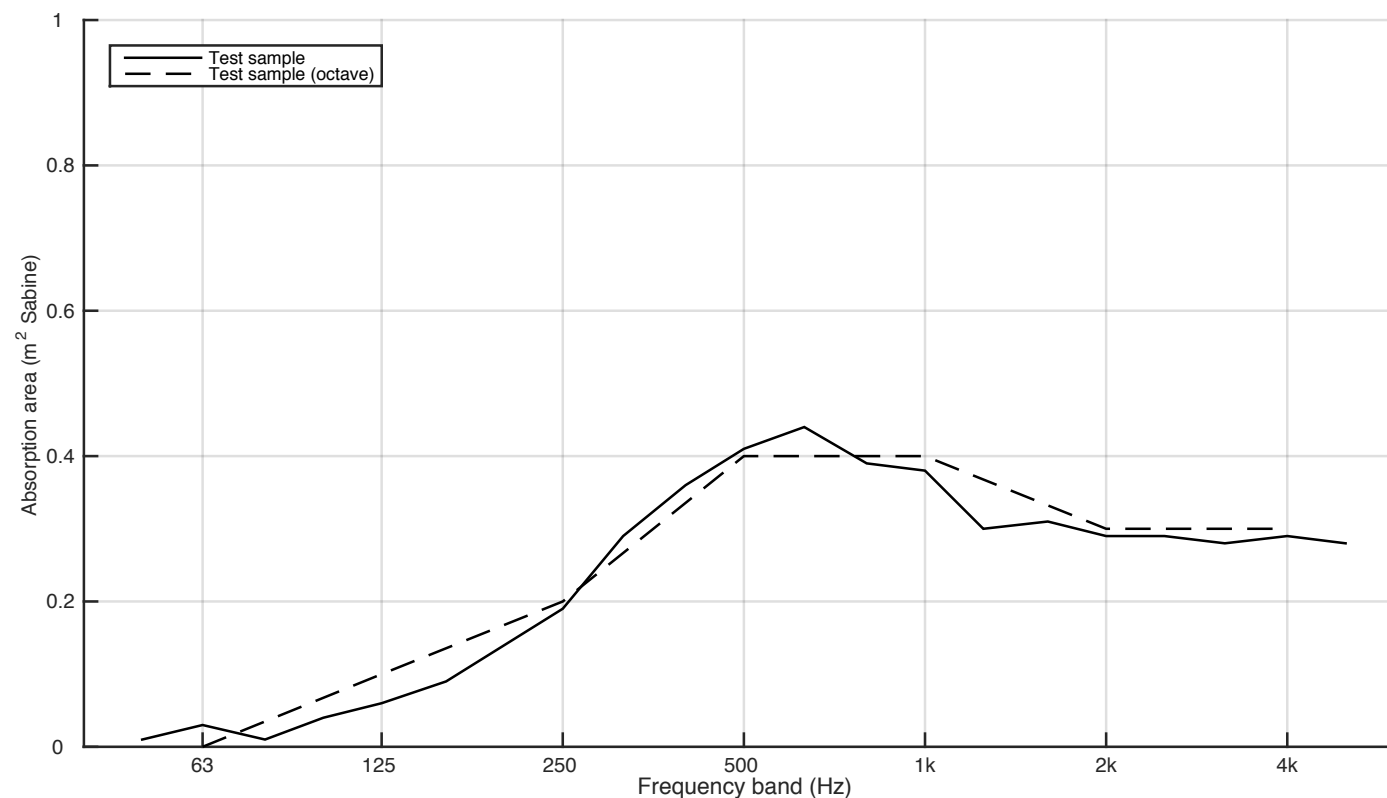
Frequency f [Hz]	Sound absorption area [m ² Sabine]	
50	0.01	
63	0.03	0.0
80	0.01	
100	0.04	
125	0.06	0.1
160	0.09	
200	0.14	
250	0.19	0.2
315	0.29	
400	0.36	
500	0.41	0.4
630	0.44	
800	0.39	
1000	0.38	0.4
1250	0.30	
1600	0.31	
2000	0.29	0.3
2500	0.29	
3150	0.28	
4000	0.29	0.3
5000	0.28	

Client: Akustil
 Manufacturer: Akustil
 Product identification: Akusound 20x100

Description of test specimen: Wall absorber 20x100x6 cm, sound absorption area for a single object placed directly on floor.
 The graph scaling deviates from ISO 354 to make it more readable as the actual size of each object is very small (0.2 square meter).

Reverberation room volume: 200 m³
 Temperature: 19.3 °C (empty: 16.0 °C)
 Air humidity: 63% (empty: 72%)
 Air pressure: 99.1 kPa (empty: 99.1 kPa)
 Number of specimens: 6

Measurement date: 2016-09-09
 Measured by: Johan Jernstedt



$N_{10} = 33$

Akusound 50x50

SOUND ABSORPTION AREA ACCORDING TO ISO 354 AND SS 25269

Measurement of sound absorption area in a reverberation room



Report number:
16-199-M3
Date
2016-09-26

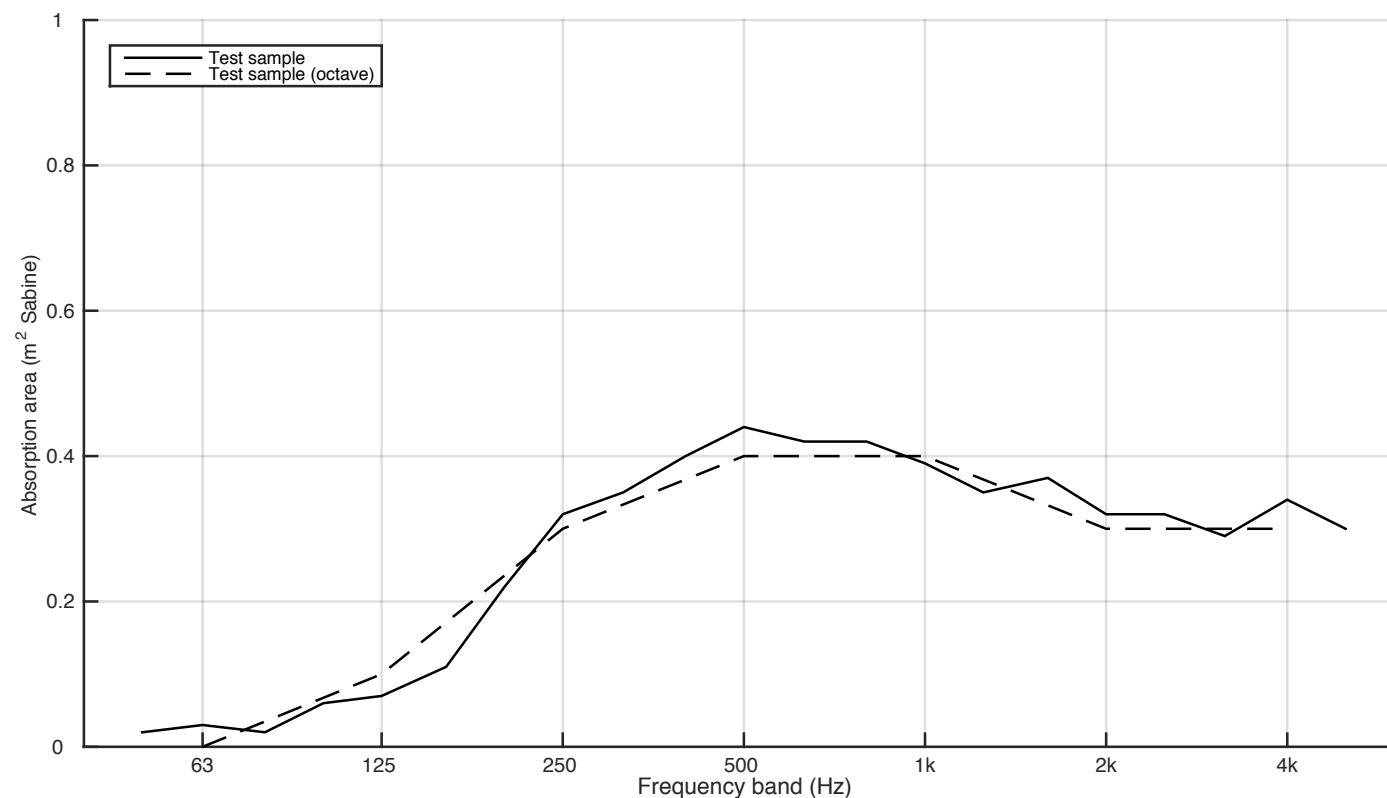
Frequency f [Hz]	Sound absorption area [m ² Sabine]	
50	0.02	
63	0.03	0.0
80	0.02	
100	0.06	
125	0.07	0.1
160	0.11	
200	0.22	
250	0.32	0.3
315	0.35	
400	0.40	
500	0.44	0.4
630	0.42	
800	0.42	
1000	0.39	0.4
1250	0.35	
1600	0.37	
2000	0.32	0.3
2500	0.32	
3150	0.29	
4000	0.34	0.3
5000	0.30	

Client: Akustil
 Manufacturer: Akustil
 Product identification: Akusound 50x50

Description of test specimen: Wall absorber 50x50x6 cm, sound absorption area for a single object placed directly on floor.
 The graph scaling deviates from ISO 354 to make it more readable as the actual size of each object is very small (0.25 square meter).

Reverberation room volume: 200 m³
 Temperature: 17.3 °C (empty: 16.0 °C)
 Air humidity: 68% (empty: 72%)
 Air pressure: 99.1 kPa (empty: 99.1 kPa)
 Number of specimens: 6

Measurement date: 2016-00-09
 Measured by: Johan Jernstedt



$N_{10} = 33$

Akusound 50x100

SOUND ABSORPTION AREA ACCORDING TO ISO 354 AND SS 25269

Measurement of sound absorption area in a reverberation room



Report number:
16-199-M4
Date
2016-09-26

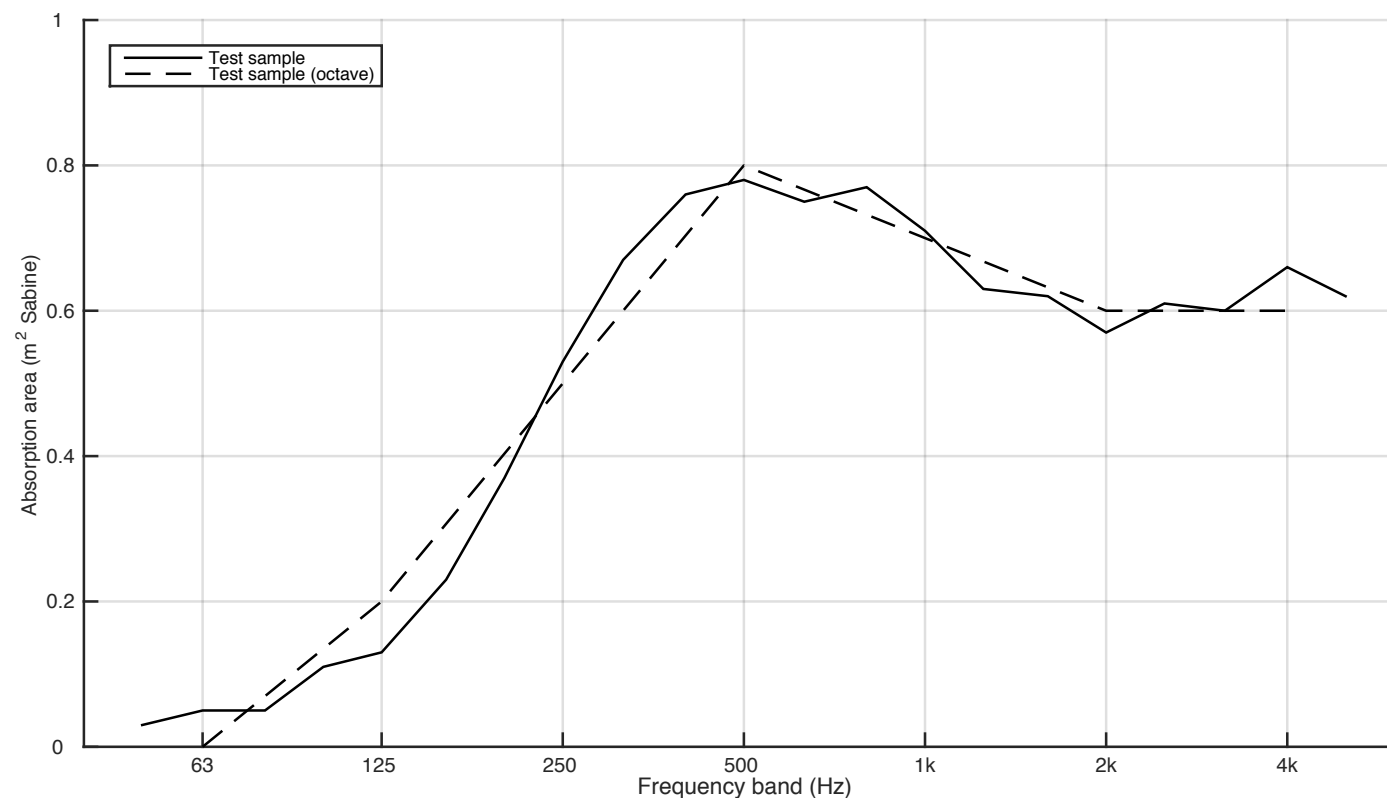
Frequency f [Hz]	Sound absorption area [m ² Sabine]	
50	0.03	
63	0.05	0.0
80	0.05	
100	0.11	
125	0.13	0.2
160	0.23	
200	0.37	
250	0.53	0.5
315	0.67	
400	0.76	
500	0.78	0.8
630	0.75	
800	0.77	
1000	0.71	0.7
1250	0.63	
1600	0.62	
2000	0.57	0.6
2500	0.61	
3150	0.60	
4000	0.66	0.6
5000	0.62	

Client: Akustil
 Manufacturer: Akustil
 Product identification: Akusound 50x100

Description of test specimen: Wall absorber 50x100x6 cm, sound absorption area for a single object placed directly on floor.
 The graph scaling deviates from ISO 354 to make it more readable as the actual size of each object is very small (0.5 square meter).

Reverberation room volume: 200 m³
 Temperature: 18.0 °C (empty: 16.0 °C)
 Air humidity: 67% (empty: 72%)
 Air pressure: 99.1 kPa (empty: 99.1 kPa)
 Number of specimens: 5

Measurement date: 2016-09-09
 Measured by: Johan Jernstedt



$N_{10} = 17$

Akusound 50x100 upside down

SOUND ABSORPTION AREA ACCORDING TO ISO 354 AND SS 25269

Measurement of sound absorption area in a reverberation room



Report number:
16-199-M5
Date
2016-09-26

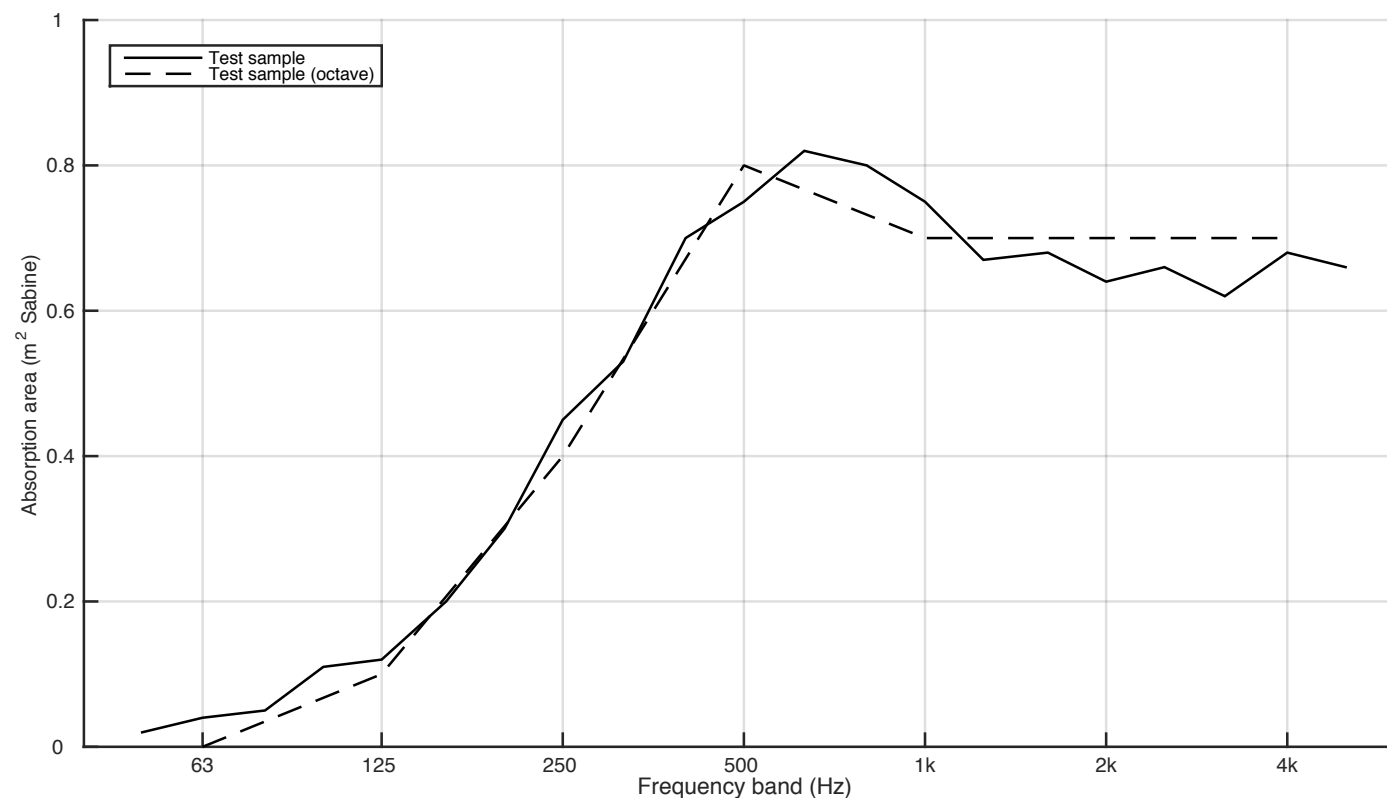
Frequency f [Hz]	Sound absorption area [m ² Sabine]	
50	0.02	
63	0.04	0.0
80	0.05	
100	0.11	
125	0.12	0.1
160	0.20	
200	0.30	
250	0.45	0.4
315	0.53	
400	0.70	
500	0.75	0.8
630	0.82	
800	0.80	
1000	0.75	0.7
1250	0.67	
1600	0.68	
2000	0.64	0.7
2500	0.66	
3150	0.62	
4000	0.68	0.7
5000	0.66	

Client: Akustil
 Manufacturer: Akustil
 Product identification: Akusound 50x100

Description of test specimen: Wall absorber 50x100x5 cm turned upside down, sound absorption area for a single object placed directly on floor.
 The graph scaling deviates from ISO 354 to make it more readable as the actual size of each object is very small (0.5 square meter).

Reverberation room volume: 200 m³
 Temperature: 17.0 °C (empty: 16.0 °C)
 Air humidity: 71 % (empty: 72 %)
 Air pressure: 99.1 kPa (empty: 99.1 kPa)
 Number of specimens: 5

Measurement date: 2016-09-09
 Measured by: Johan Jernstedt



$N_{10} = 14$