

## SOUND ABSORPTION FOR SPIEGEL PANEL

### CONCLUSIONS

The sound absorption has been measured for Spiegel Panel with three different heights according to the reverberation room method SS-EN ISO 354:2003. The measurements have been evaluated according to SS-EN ISO 11654:1997 and ISO 20189:2018.

Results are presented in table 1 and 2.

Measurement protocol	Test object	$\alpha_w$	Absorption Class
M1	Spiegel Panel High	1.00	A
M3	Spiegel Panel Medium	0.85(H)	B
M5	Spiegel Panel Low	0.50(MH)	D

Table 1: Results evaluated according to SS-EN ISO 11654:1997

Measurement protocol	Test object name from client	$N_{10}$
M3	Spiegel Panel High – Group of 6 panels as one object	4.4
M4	Spiegel Panel Medium – Group of 6 panels as one object	5.9
M6	Spiegel Panel Low – Group of 6 panels as one object	9.5

Table 2:  $N_{10}$ -value for the measured products.

Detailed results of sound absorption coefficient and sound absorption area are presented in the separate measurement protocols 3937-M1 to M6.

### 1 CLIENT

Flokk sp. z o.o., Górnicza 8, 62-700 Turek, Poland  
Contact: Daria Łuczak, daria.luczak@flokk.com, +48 785870903

### 2 ASSIGNMENT

To measure the sound absorption coefficient and sound absorption area for Spiegel Panel by OFFECCT for Flokk according to SS-EN ISO 354:2003. The measurements shall be evaluated according to SS-EN ISO 11654:1997 and ISO 20189:2018 where applicable.

### 3 TEST OBJECTS

Spiegel Panel is a pyramidic shaped sound absorber for walls and ceiling. The panel is made from fire retardant polyester needle felt with wall thickness 12 mm.

The base of the pyramid is 595 x 595 mm, and the heights and weights are shown in figure 1.

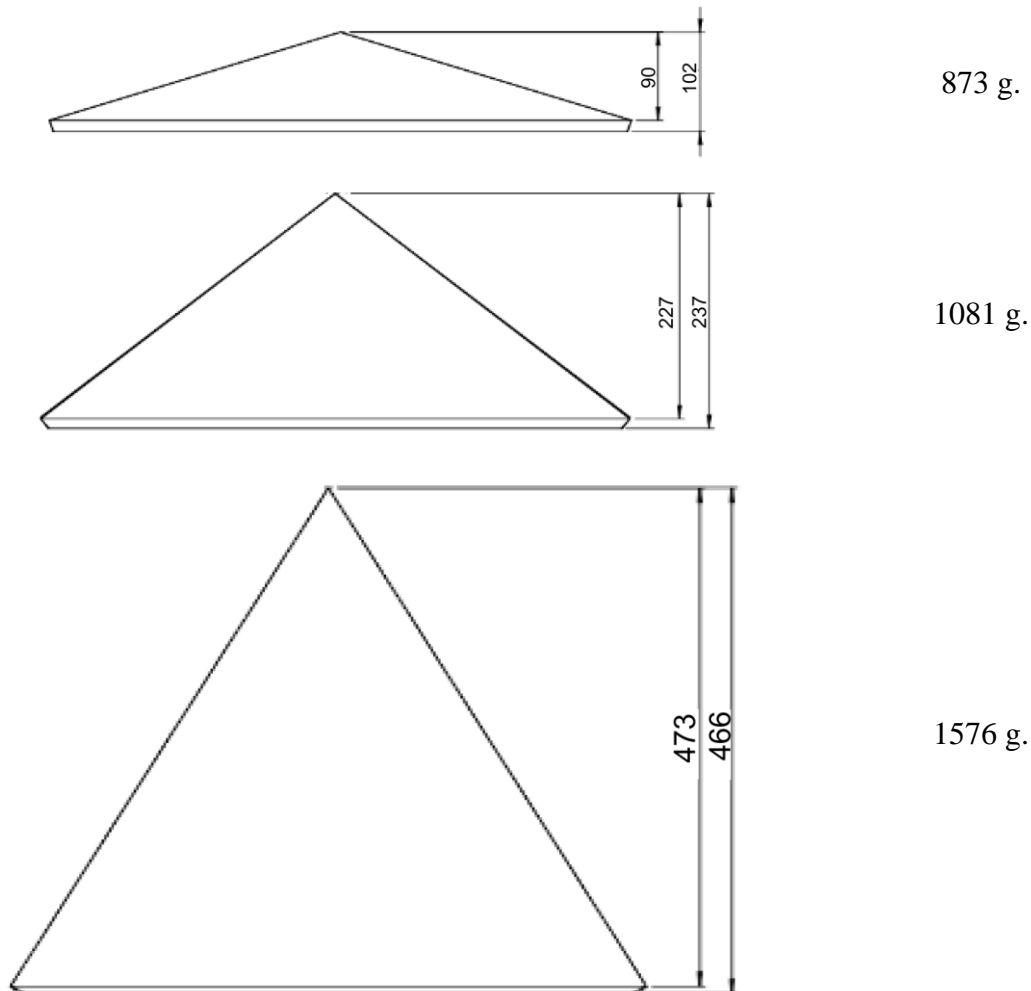


Figure 1. Spiegel Panel heights and weight. From top: low, medium, and high.

More photos of the test setups are available in Appendix 5.

### 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 sound absorption area were evaluated according to ISO 20189:2018. The results for sound absorption coefficient were evaluated according to SS-EN ISO 11654:1997.

The measurements were performed by Johan Jernstedt 2024-10-23 in Akustikverkstan's reverberation room in Skultorp, Skövde, Sweden. More information on the test facilities can be found in Appendix 2.

The equipment used is presented in Appendix 3.

## 5 RESULTS

Results for weighted sound absorption coefficients  $\alpha_w$  are given in table 1 on the first page. Results as N10-values are given in table 2.

Detailed measurement results for all test objects are available in the measurement protocols 3937-M1 to 3937-M6 attached to this report. The results are only valid for the tested samples.

## 6 COMMENTS AND INTERPRETATIONS

### 6.1 N10-value

The  $N_{10}$  value is a comparative value that applies to acoustic products with sound absorbing properties. *Kammarkollegiet*, the Swedish authority dealing with public purchasing, uses the value in their advice regarding purchasing of sound absorbers. The  $N_{10}$  value is calculated with the formula:

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

$A_{dim}$  is the average sound absorption area of the three 1/3 octave bands in the 500 Hz octave band. 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 m<sup>2</sup> 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.

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

Joachim Schubert

Reviewed by Johan Jernstedt, 2024-10-04

## APPENDIX 1: MEASURED REVERBERATION TIMES

f(Hz)	Empty 2024-10-23 (after)	M1: Spiegel panel High	M2: Spiegel panel High, 6 panels as object	M3: Spiegel panel Medium	M4: Spiegel panel Medium, 6 panels as object	M5: Spiegel panel Low	M6: Spiegel panel Low, 6 panels as object
50	8.10	5.38	6.47	6.65	7.29	7.57	7.73
63	8.48	5.16	6.57	6.49	7.49	7.58	7.96
80	8.14	4.42	6.18	5.97	7.22	7.40	7.84
100	7.69	3.82	5.46	5.76	6.63	6.94	7.30
125	7.14	2.91	3.98	4.12	5.16	5.66	6.44
160	5.58	2.46	3.16	3.11	4.03	4.36	5.02
200	5.81	2.25	3.07	2.81	3.78	4.11	4.95
250	5.30	2.19	2.99	2.53	3.50	3.67	4.42
315	5.46	2.17	3.06	2.45	3.52	3.47	4.28
400	5.29	2.26	3.22	2.49	3.57	3.31	4.20
500	4.73	2.06	2.84	2.34	3.19	2.87	3.61
630	4.32	1.81	2.57	1.99	2.85	2.42	3.19
800	4.66	1.85	2.73	1.98	2.97	2.34	3.24
1000	4.60	1.80	2.59	1.96	2.86	2.16	3.02
1250	4.13	1.71	2.44	1.88	2.66	1.95	2.73
1600	3.77	1.60	2.26	1.74	2.47	1.77	2.48
2000	3.38	1.47	2.10	1.60	2.28	1.63	2.34
2500	3.06	1.37	1.94	1.50	2.08	1.53	2.14
3150	2.62	1.24	1.72	1.35	1.84	1.41	1.90
4000	2.24	1.16	1.51	1.25	1.63	1.30	1.68
5000	1.81	1.02	1.31	1.09	1.40	1.13	1.44

Number of objects or test area (m <sup>2</sup> )	0	9.91	2	9.91	2	9.91	2
Temperature (°C)	20	20	20	20	20	20	20
RH (%)	49	49	49	49	49	49	49

## 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 m<sup>3</sup> and the total area of the walls, ceiling and floor is 209 m<sup>2</sup>. 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 m<sup>2</sup>, 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.

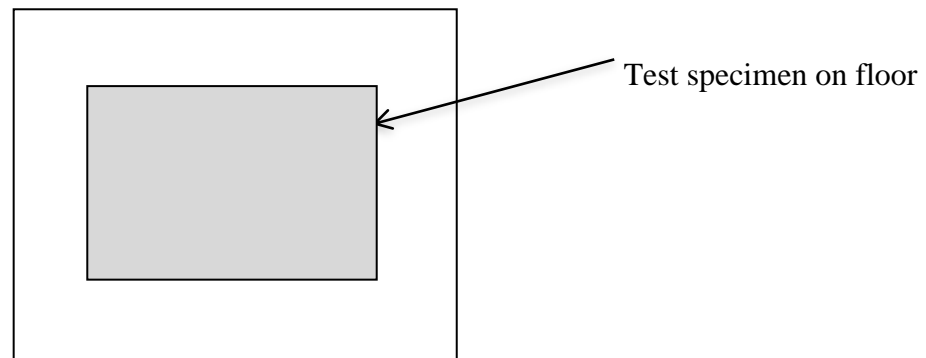


Figure A2.1: Plane drawing of the reverberation room with the positions of the test specimens.

### APPENDIX 3: MEASUREMENT EQUIPMENT

Table A3.1 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 A3.1: Equipment used during the measurements.

## APPENDIX 4: MEASUREMENT UNCERTAINTY

The uncertainties in the measured sound absorption coefficients have been estimated to the values in table A4.1. The uncertainty corresponds to one standard deviation. The uncertainty in measured sound absorption area is calculated from the actual test sample area multiplied by the uncertainty below.

<b>50 Hz</b>	<b>63 Hz</b>	<b>80 Hz</b>	<b>100 Hz</b>	<b>125 Hz</b>	<b>160 Hz</b>	<b>200 Hz</b>
± 0.10	± 0.08	± 0.07	± 0.06	± 0.05	± 0.04	± 0.03
<b>250 Hz</b>	<b>315 Hz</b>	<b>400 Hz</b>	<b>500 Hz</b>	<b>630 Hz</b>	<b>800 Hz</b>	<b>1 kHz</b>
± 0.03	± 0.03	± 0.03	± 0.03	± 0.03	± 0.03	± 0.03
<b>1.25 kHz</b>	<b>1.6 kHz</b>	<b>2 kHz</b>	<b>2.5 kHz</b>	<b>3.15 kHz</b>	<b>4 kHz</b>	<b>5 kHz</b>
± 0.03	± 0.03	± 0.03	± 0.03	± 0.03	± 0.03	± 0.03

Table A4.1: Measurement uncertainty for each third octave.

## APPENDIX 5: PHOTOS OF THE TEST SET UP



Figure A5:1: Spiegel Panel High, ~10 m<sup>2</sup>.

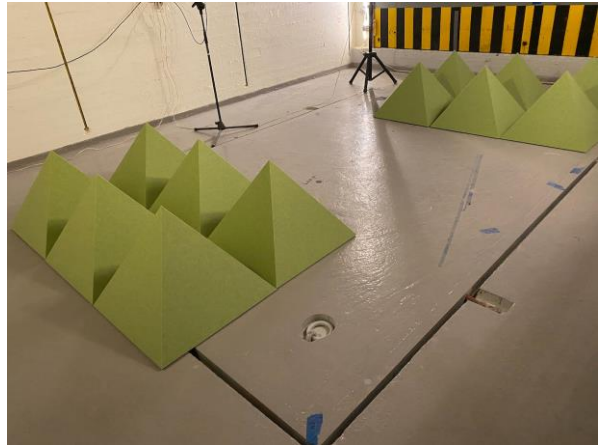


Figure A5:2: Spiegel Panel High. Two objects of 6 pieces.

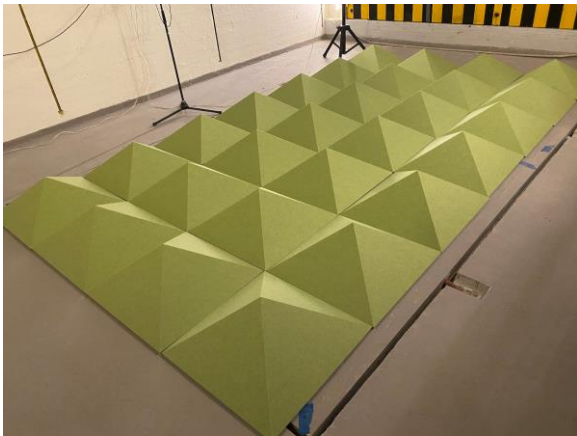


Figure A5:3: Spiegel Panel Medium, ~10 m<sup>2</sup>.

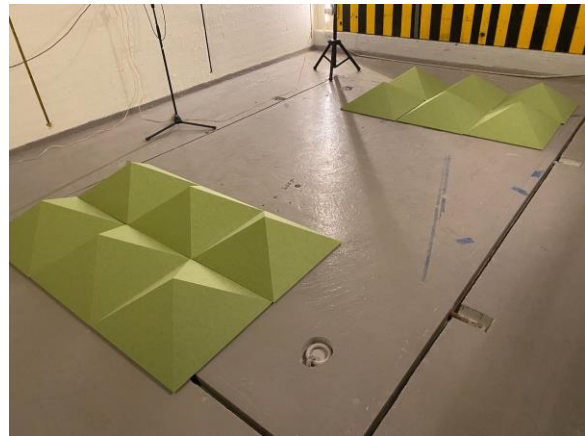


Figure A5:4: Spiegel Panel Medium. Two objects of 6 pieces.



Figure A5:5: Spiegel Panel Low, ~10 m<sup>2</sup>.

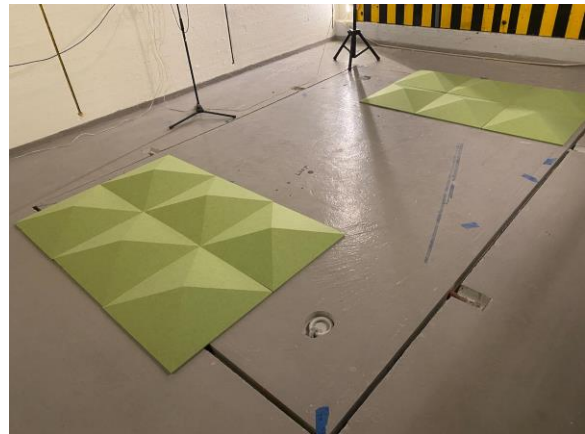


Figure A5:6: Spiegel Panel Low. Two objects of 6 pieces.

# Spiegel Panel High

SOUND ABSORPTION COEFFICIENT ACCORDING TO SS-EN ISO 354:2003 AND SS-EN ISO 11654:1997

Measurement of sound absorption coefficient in a reverberation room



Report number:  
**3937-M1**  
Date  
**2024-11-04**

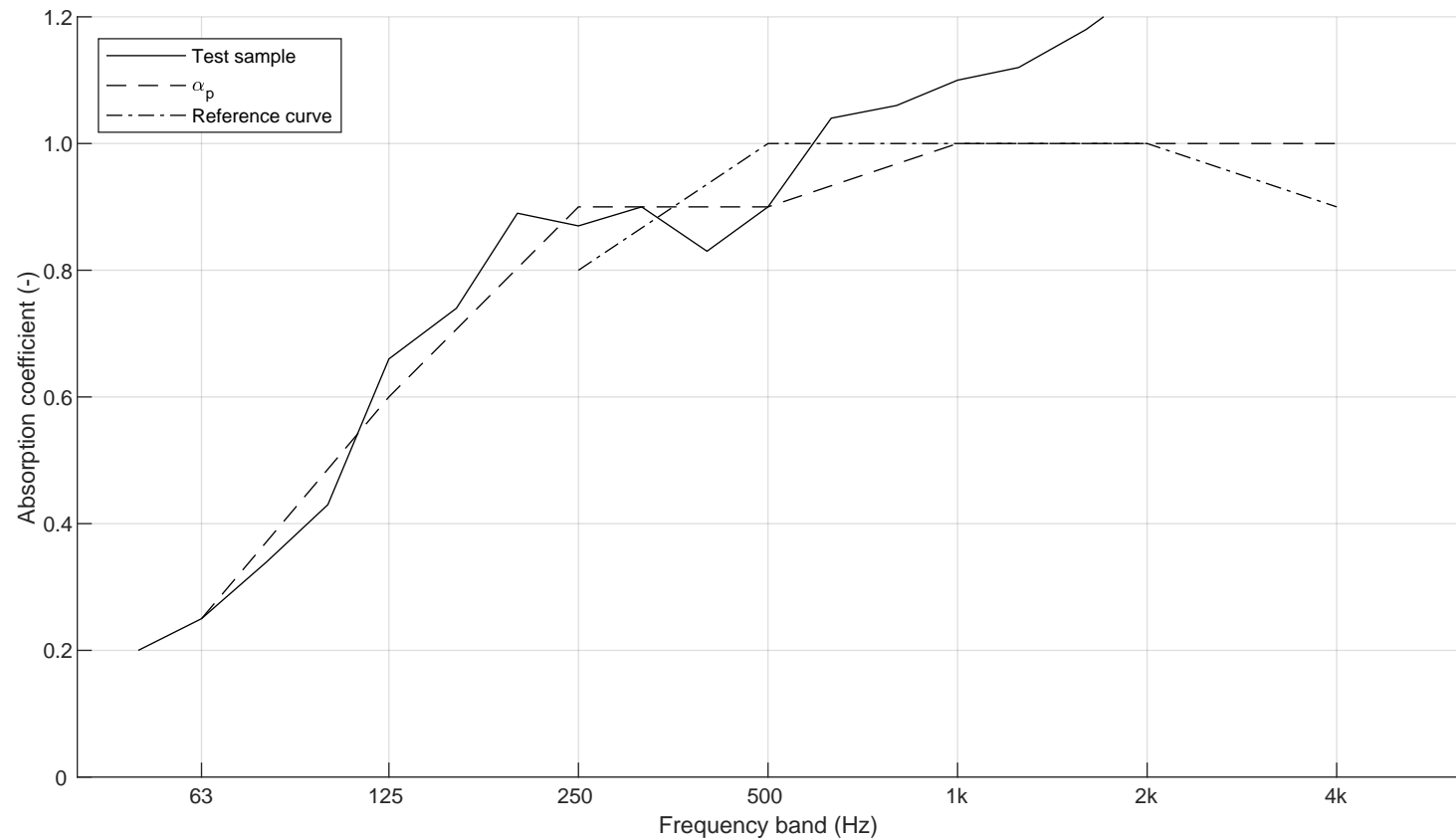
Frequency f [Hz]	Sound absorption coefficient	
	$\alpha_s$	$\alpha_p$
50	0.20	
63	0.25	0.25
80	0.34	
100	0.43	
125	0.66	0.60
160	0.74	
200	0.89	
250	0.87	0.90
315	0.90	
400	0.83	
500	0.90	0.90
630	1.04	
800	1.06	
1000	1.10	1.00
1250	1.12	
1600	1.18	
2000	1.25	1.00
2500	1.31	
3150	1.39	
4000	1.36	1.00
5000	1.40	

Client: Flokk  
 Manufacturer: OFFECCT  
 Product identification: Spiegel Panel High

Description of test specimen: Pyramid shaped sound absorber made of 12 mm needle felt.  
 Square base with dimensions 595x595 mm and height of 473 mm.  
 Tested directly on the floor.

Reverberation room volume: 200 m<sup>3</sup>  
 Temperature: 20.0 °C (empty: 20.0 °C)  
 Air humidity: 49 % (empty: 49 %)  
 Air pressure: 100.6 kPa (empty: 100.6 kPa)  
 Size of specimen: 9.91 m<sup>2</sup>

Measurement date: 2024-10-23  
 Measured by: Johan Jernstedt



$\alpha_w = 1.00$

Absorption class = A

# Spiegel Panel High - Group of 6

SOUND ABSORPTION AREA ACCORDING TO SS-EN ISO 354:2003 and ISO 20189:2018

Measurement of sound absorption area in a reverberation room



Report number:  
3937-M2  
Date  
2024-11-04

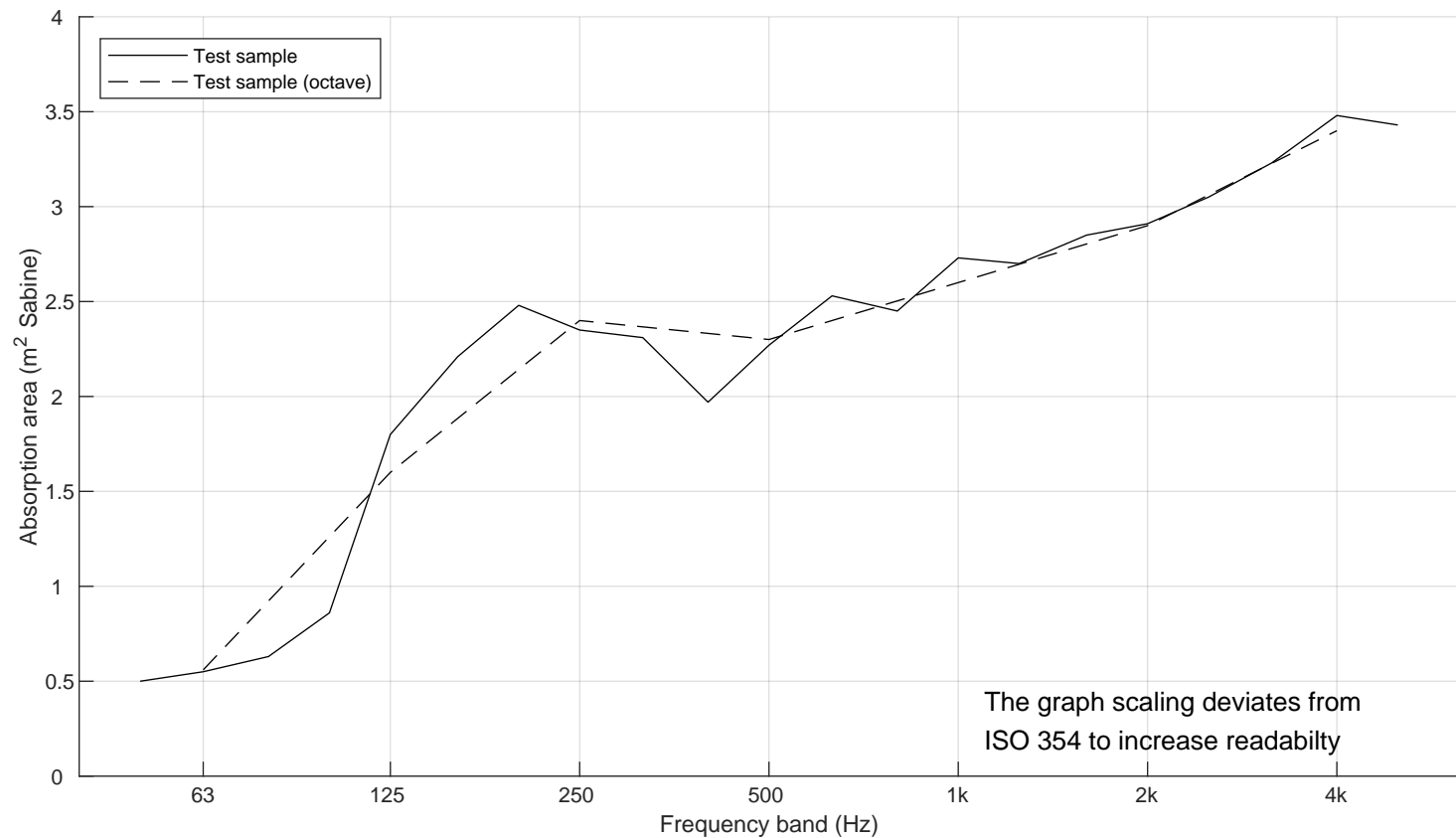
Frequency f [Hz]	Sound absorption area per object [m <sup>2</sup> Sabine]	
50	0.50	
63	0.55	0.56
80	0.63	
100	0.86	
125	1.80	1.6
160	2.21	
200	2.48	
250	2.35	2.4
315	2.31	
400	1.97	
500	2.27	2.3
630	2.53	
800	2.45	
1000	2.73	2.6
1250	2.70	
1600	2.85	
2000	2.91	2.9
2500	3.05	
3150	3.23	
4000	3.48	3.4
5000	3.43	

Client: Flokk  
 Manufacturer: OFFECCT  
 Product identification: Spiegel Panel High

Description of test specimen: Pyramid shaped sound absorber made of 12 mm needle felt.  
 Square base with dimensions 595x595 mm and height of 473 mm.  
 Tested directly on the floor.

Reverberation room volume: 200 m<sup>3</sup>  
 Temperature: 20.0 °C (empty: 20.0 °C)  
 Air humidity: 49 % (empty: 49 %)  
 Air pressure: 100.6 kPa (empty: 100.6 kPa)  
 Number of objects: 2

Measurement date: 2024-10-23  
 Measured by: Johan Jernstedt



$N_{10} = 4.4$

# Spiegel Panel Medium

SOUND ABSORPTION COEFFICIENT ACCORDING TO SS-EN ISO 354:2003 AND SS-EN ISO 11654:1997

Measurement of sound absorption coefficient in a reverberation room



Report number:  
**3937-M3**  
Date  
**2024-11-04**

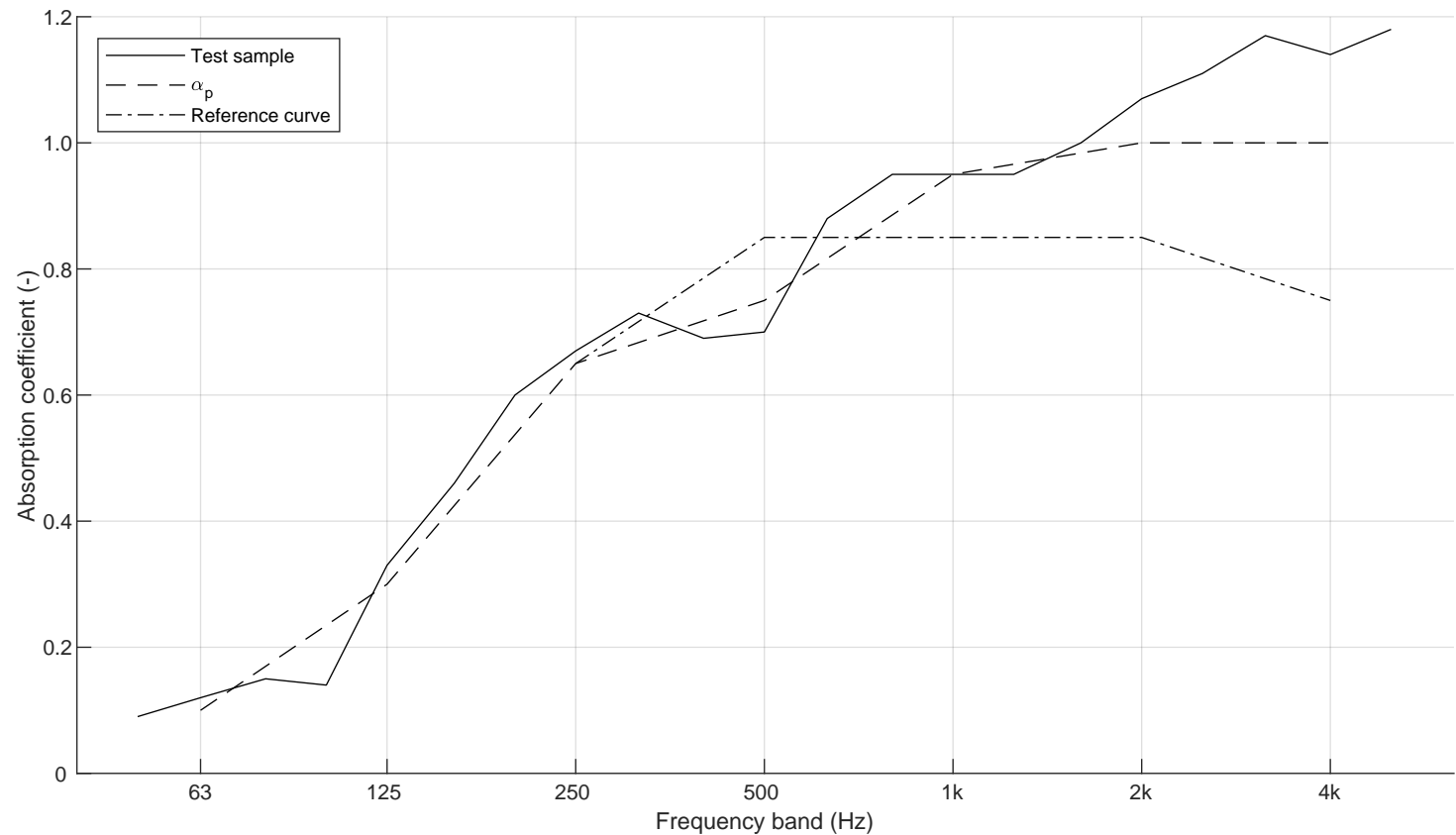
Frequency f [Hz]	Sound absorption coefficient	
	$\alpha_s$	$\alpha_p$
50	0.09	
63	0.12	0.10
80	0.15	
100	0.14	
125	0.33	0.30
160	0.46	
200	0.60	
250	0.67	0.65
315	0.73	
400	0.69	
500	0.70	0.75
630	0.88	
800	0.95	
1000	0.95	0.95
1250	0.95	
1600	1.00	
2000	1.07	1.00
2500	1.11	
3150	1.17	
4000	1.14	1.00
5000	1.18	

Client: Flokk  
 Manufacturer: OFFECCT  
 Product identification: Spiegel Panel Medium

Description of test specimen: Pyramid shaped sound absorber made of 12 mm needle felt.  
 Square base with dimensions 595x595 mm and height of 237 mm.  
 Tested directly on the floor.

Reverberation room volume: 200 m<sup>3</sup>  
 Temperature: 20.0 °C (empty: 20.0 °C)  
 Air humidity: 49 % (empty: 49 %)  
 Air pressure: 100.6 kPa (empty: 100.6 kPa)  
 Size of specimen: 9.91 m<sup>2</sup>

Measurement date: 2024-10-23  
 Measured by: Johan Jernstedt



$\alpha_w = 0.85(H)$

Absorption class = B

# Spiegel Panel Medium - Group of 6

SOUND ABSORPTION AREA ACCORDING TO SS-EN ISO 354:2003 and ISO 20189:2018

Measurement of sound absorption area in a reverberation room

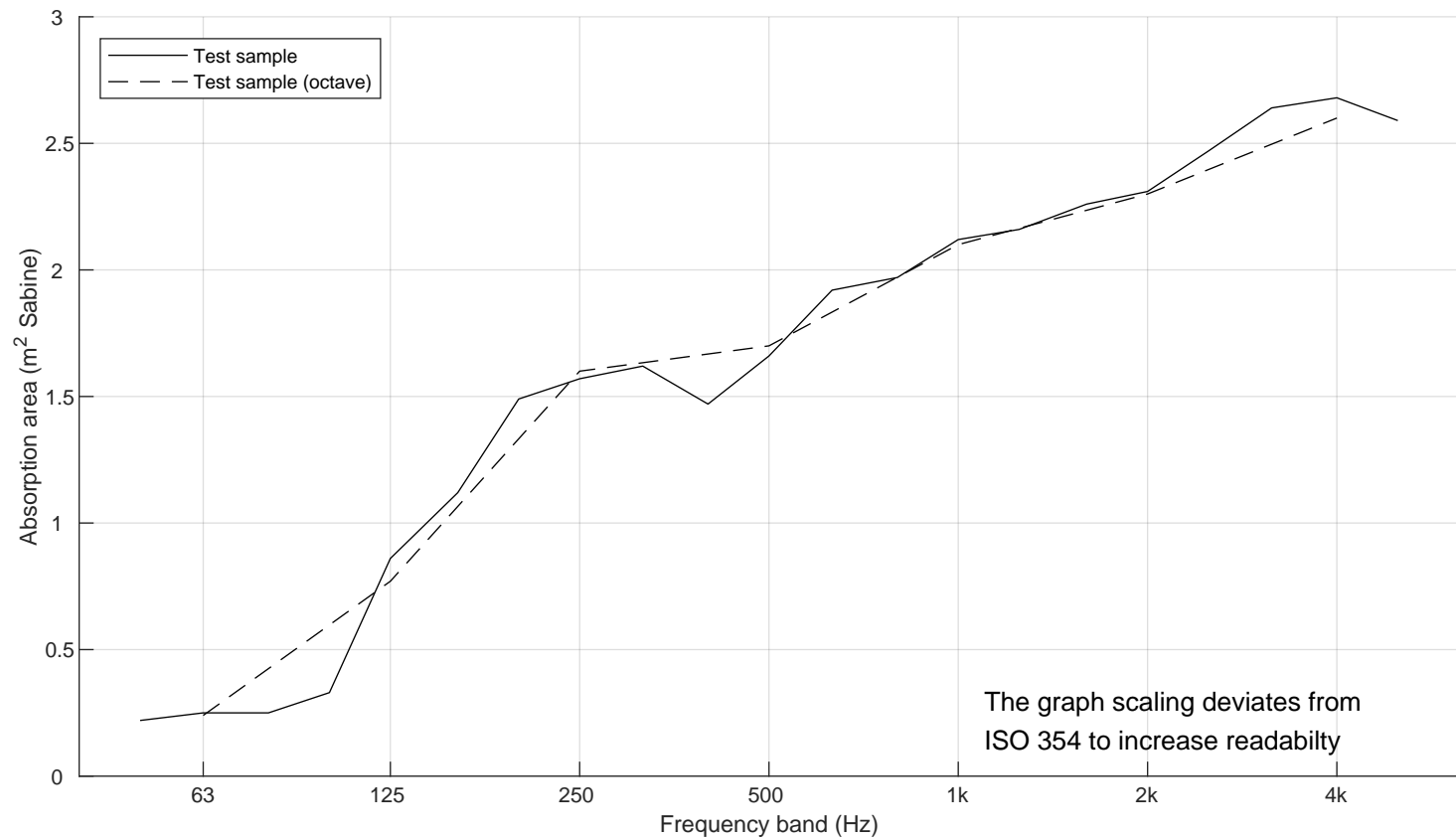


Report number:  
3937-M4  
Date  
2024-11-04

Frequency f [Hz]	Sound absorption area per object [m <sup>2</sup> Sabine]	
50	0.22	
63	0.25	0.24
80	0.25	
100	0.33	
125	0.86	0.77
160	1.12	
200	1.49	
250	1.57	1.6
315	1.62	
400	1.47	
500	1.66	1.7
630	1.92	
800	1.97	
1000	2.12	2.1
1250	2.16	
1600	2.26	
2000	2.31	2.3
2500	2.47	
3150	2.64	
4000	2.68	2.6
5000	2.59	

Client: Flokk  
 Manufacturer: OFFECCT  
 Product identification: Spiegel Panel Medium  
 Description of test specimen: Pyramid shaped sound absorber made of 12 mm needle felt. Square base with dimensions 595x595 mm and height of 237 mm. Tested directly on the floor.

Reverberation room volume: 200 m<sup>3</sup>  
 Temperature: 20.0 °C (empty: 20.0 °C)  
 Air humidity: 49 % (empty: 49 %)  
 Air pressure: 100.6 kPa (empty: 100.6 kPa)  
 Number of objects: 2  
 Measurement date: 2024-10-23  
 Measured by: Johan Jernstedt



The graph scaling deviates from ISO 354 to increase readability

$$N_{10} = 5.9$$

# Spiegel Panel Low

SOUND ABSORPTION COEFFICIENT ACCORDING TO SS-EN ISO 354:2003 AND SS-EN ISO 11654:1997

Measurement of sound absorption coefficient in a reverberation room



Report number:  
3937-M5  
Date  
2024-11-04

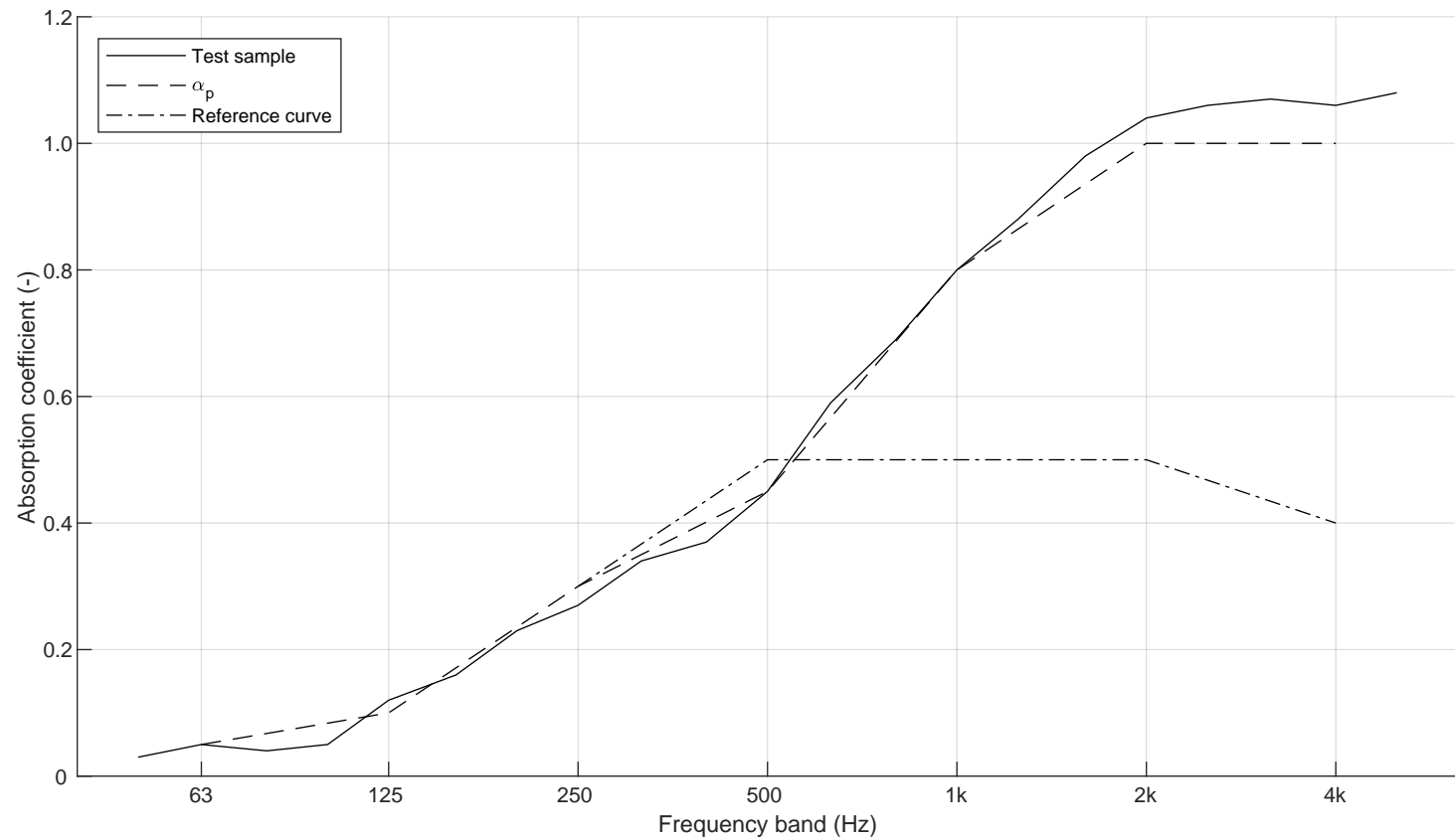
Frequency f [Hz]	Sound absorption coefficient	
	$\alpha_s$	$\alpha_p$
50	0.03	
63	0.05	0.05
80	0.04	
100	0.05	
125	0.12	0.10
160	0.16	
200	0.23	
250	0.27	0.30
315	0.34	
400	0.37	
500	0.45	0.45
630	0.59	
800	0.69	
1000	0.80	0.80
1250	0.88	
1600	0.98	
2000	1.04	1.00
2500	1.06	
3150	1.07	
4000	1.06	1.00
5000	1.08	

Client: Flokk  
 Manufacturer: OFFECCT  
 Product identification: Spiegel Panel Low

Description of test specimen: Pyramid shaped sound absorber made of 12 mm needle felt.  
 Square base with dimensions 595x595 mm and height of 102 mm.  
 Tested directly on the floor.

Reverberation room volume: 200 m<sup>3</sup>  
 Temperature: 20.0 °C (empty: 20.0 °C)  
 Air humidity: 49 % (empty: 49 %)  
 Air pressure: 100.6 kPa (empty: 100.6 kPa)  
 Size of specimen: 9.91 m<sup>2</sup>

Measurement date: 2024-10-23  
 Measured by: Johan Jernstedt



$\alpha_w = 0.50(\text{MH})$

Absorption class = D

# Spiegel Panel Low - Group of 6

SOUND ABSORPTION AREA ACCORDING TO SS-EN ISO 354:2003 and ISO 20189:2018

Measurement of sound absorption area in a reverberation room



Report number:  
**3937-M6**  
Date  
**2024-11-04**

Frequency f [Hz]	Sound absorption area per object [m <sup>2</sup> Sabine]	
50	0.09	
63	0.12	0.10
80	0.08	
100	0.11	
125	0.25	0.23
160	0.32	
200	0.48	
250	0.61	0.63
315	0.81	
400	0.79	
500	1.06	1.1
630	1.32	
800	1.52	
1000	1.82	1.8
1250	2.00	
1600	2.21	
2000	2.11	2.2
2500	2.26	
3150	2.32	
4000	2.42	2.3
5000	2.28	

Client: Flokk  
 Manufacturer: OFFECCT  
 Product identification: Spiegel Panel Low

Description of test specimen: Pyramid shaped sound absorber made of 12 mm needle felt.  
 Square base with dimensions 595x595 mm and height of 102 mm.  
 Tested directly on the floor.

Reverberation room volume: 200 m<sup>3</sup>  
 Temperature: 20.0 °C (empty: 20.0 °C)  
 Air humidity: 49 % (empty: 49 %)  
 Air pressure: 100.6 kPa (empty: 100.6 kPa)  
 Number of objects: 2  
 Measurement date: 2024-10-23  
 Measured by: Johan Jernstedt

$$N_{10} = 9.5$$

