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ABSORPTION MEASUREMENTS FOR PLANT WALL FROM BY FAUX

CONCLUSIONS

The sound absorption has been measured for plant wall from By Faux 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	α_w	Absorption Class
M1	Sound absorbing plant wall	0.60(H)	C
M3	Plant wall (without sound absorbing panel)	0.25(H)	E
M4	Sound absorbing plant wall – 1 sound absorber/ plant panel	0.50(H)	D
M5	Sound absorbing plant wall – 1 elevated sound absorber/ plant	0.55(H)	D

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

Measurement protocol	Test object name from client	N_{10}
M2	Sound absorbing plant wall – 3 panels as group	7.1

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

Detailed results of sound absorption area are presented in the separate measurement protocols 3368-M1 to M5.

1. CLIENT

By Faux, Kobbegårdsvägen 7, 436 34 Västra Frölunda
Contact: Linda Forsberg, linda@byfaux.se, +46 731 588 139

2. ASSIGNMENT

To measure the sound absorption coefficient and sound absorption area for Plant Wall from By Faux 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

The plant wall consists of modules with artificial plants attached to a metal wire grid with dimensions 800 x 800 mm. The total dimensions with plants were estimated to 830 x 830 mm.

The thickness of the plant panel is 70 mm as minimum, but some flower petals stick out up to 130 mm from the panel surface. The weight of each plant panel was 8,5 kg.

The plant panels are mounted with a bracket, creating 45 mm distance to the wall. In all measurements, the panels were supported by 45 mm wooden studs placed on the floor, creating the same distance.

For the sound absorbing version of plant wall, sound absorbing panels are placed behind the plant panels. The dimensions of the sound absorbing panels are 500 x 500 x 35 mm and are made of a mix of recycled PET fibers, virgin PET fibers and recycled textiles.

In measurements M1, M2 and M5, the sound absorbing panels were placed on distances creating an 8 mm air gap between the sound absorbers and floor. In M4, the sound absorbers were placed directly on the floor.

The surface area covered by sound absorbing panels varied according to table 3.

15 plant panels have a total surface area of 10.3 m^2. 12 plant panels have a total surface area of 8.3 m^2.

The setup for measurement protocol M4 and M5 each sound absorbing panel where centred under one plant panel. The setup in M1 – M3 all sound absorbing panels were butted together for each row.

Test object name from client	Plant wall panels	Sound absorbing panels	Elevation of sound absorbing panel	Measurement protocol
Sound absorbing plant wall – 1 sound absorber/ plant panel	15	15	0	M4
Sound absorbing plant wall – 1 elevated sound absorber/ plant panel	15	15	8 mm	M5
Sound absorbing plant wall	12	15	8 mm	M1
Plant wall (without sound absorbing panel)	12	0	0	M3
Sound absorbing plant wall – 3 panels as group	3	4	8 mm	M2

Table 3: Tested objects presented in tested order.

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 Joachim Schubert 2023-12-18 in Akustikverkstan's reverberation room in Skultorp, Skövde, Sweden. More information on the test facilities can be found in Appendix 2.

5. RESULTS

Result for weighted sound absorption coefficient α_w is given in table 1. Result as N_{10}-values are given in table 2.

Detailed measurement results for all test objects are available in the measurement protocols 3368-M1 to 3368-M2 attached as appendices to this report. The results are only valid for the tested sample.

6. COMMENTS AND INTERPRETATIONS

6.1 N10-value

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 average of the sound absorption area for the three 1/3 octave bands within 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 m^2 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.

6.2 Surface coverage ratio of sound absorber

Using one 500 x 500 mm sound absorbing panel per 830 x 830 plant panel gives a surface coverage ratio of 36%. This ratio was increased to 45% in measurement M1 by using 15 sound absorbing panels for 12 plant panels. The intended ratio for the product of 4 sound absorbing panels for 3 plant panels is 48%.

6.3 Deviations from measurements standard

Result for weighted sound absorption coefficient α_w for measurements M1 and M3 are based on 8.3 m^2, which is less than the 10 m^2 stipulated in SS-EN ISO 354:2003. The reason is that only 15 sound absorbing panels was available during the test for increasing surface coverage.

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

Joachim Schubert
Reviewed by Staffan Andersson, 2023-12-27

APPENDIX 1: MEASURED REVERBERATION TIMES

f(Hz)	Empty room	M1, Sound absorbing plant wall	M2, Sound absorbing plant wall – 3 panels as group	M3, Plant wall (without sound absorbing panel)	M4, Sound absorbing plant wall – 1 sound absorber/ plant panel	M5, Sound absorbing plant wall – 1 elevated sound absorber/ plant
50	8.53	7.82	8.01	7.92	7.86	7.84
63	8.96	8.05	8.34	8.26	7.99	7.96
80	8.06	7.25	7.58	7.50	7.11	7.15
100	7.33	6.61	6.85	6.89	6.53	6.45
125	7.04	5.73	6.21	6.26	5.46	5.54
160	5.50	4.48	4.85	4.97	4.39	4.32
200	5.65	3.98	4.57	4.82	3.99	3.90
250	5.57	3.85	4.39	4.69	3.82	3.74
315	5.51	3.53	4.17	4.64	3.47	3.47
400	5.30	3.21	3.86	4.37	3.16	3.10
500	4.79	2.80	3.32	3.93	2.74	2.68
630	4.34	2.46	3.02	3.43	2.34	2.29
800	4.71	2.51	3.12	3.54	2.38	2.34
1000	4.63	2.51	3.10	3.49	2.32	2.31
1250	4.10	2.35	2.91	3.24	2.22	2.22
1600	3.69	2.24	2.73	2.98	2.13	2.11
2000	3.29	1.99	2.44	2.59	1.95	1.94
2500	2.93	1.85	2.19	2.26	1.76	1.74
3150	2.42	1.62	1.92	1.95	1.55	1.56
4000	1.97	1.40	1.62	1.63	1.34	1.34
5000	1.58	1.17	1.36	1.31	1.13	1.13

Number of test objects / test area	0	8.3	2	8.3	10.3	10.3
Temp (°C)	17.0	17.4	17.3	17.4	17.8	17.8
RH (%)	43	43	43	43	41	41

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^3 and the total area of the walls, ceiling and floor is 209 m^2. 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^2, 2.6 x 3.85 m) according to figure A2.1. The mounting area consists of a concrete slab that can be lowered up to 700 mm below the floor.

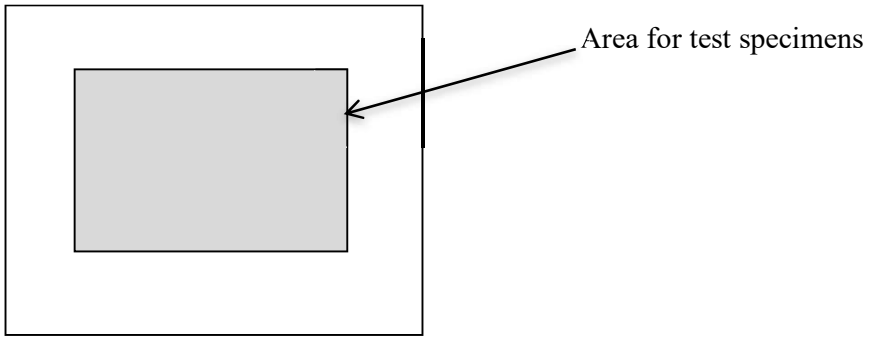


Figure A2.1: Plane drawing of the reverberation room with the test specimen put on the mounting area.

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 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 A4.1: Measurement uncertainty for each third octave.

APPENDIX 5: PHOTOS OF THE TEST OBJECT AND TEST SET-UP

Figure A5.1: Backside of plant panel with 800 x 800 mm metal wire grid.

Figure A5.2: Sound absorbing panels directly on the floor in test setup for measurement M4.

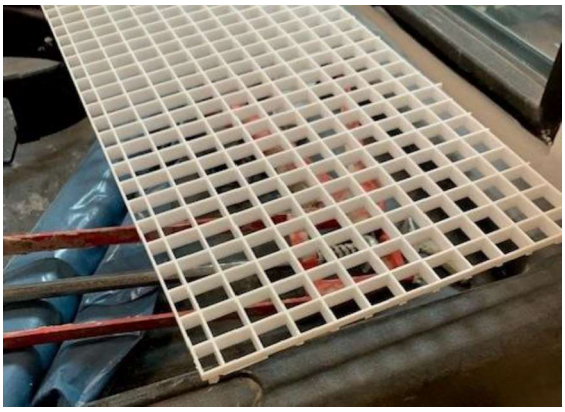


Figure A5.3: 8 mm thick plastic grid used to create 8 mm distance between floor and sound absorber in measurements M1-M2 and M5.

Figure A5.3: 12 plant panels in test set-up M1 with a total surface of 8.3m^2. The set-up was used in M3.

Figure A5.4: 2 groups of 1x3 panels in test setup for M2.

Figure A5:5: 15 plant panels in test setup for M4 with a total surface area of 10.3 m^2. The same test set-up was used in M5.

Sound absorbing plant wall

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

Ackred. nr. 10445 Provning ISO/IEC17025

Report number: 3368-M1

Date 2023-12-20

Frequency f [Hz]	Sound absorption coefficient α_s	α_p
50	0.04	
63	0.05	0.05
80	0.05	
100	0.06	
125	0.13	0.10
160	0.16	
200	0.29	
250	0.31	0.35
315	0.40	
400	0.48	
500	0.58	0.60
630	0.69	
800	0.73	
1000	0.71	0.70
1250	0.71	
1600	0.69	
2000	0.78	0.75
2500	0.79	
3150	0.80	
4000	0.83	0.85
5000	0.87	

α_w = 0.60(H)

Absorption class = C

Client: By Faux

Manufacturer: By Faux

Product identification: Sound absorbing plant wall

Description of test specimen: Plant wall panels 800 x 800 mm mounted with a distance of 45 mm from floor. Sound absorbing panels 500 x 500 x 35 mm placed in the gap with 8 mm distance to the floor. 4 sound absorbers per 3 plant panels. 8.3 m^2 surface.

Reverberation room volume: 200 m^3

Temperature: 17.4 °C (empty: 17.0 °C)

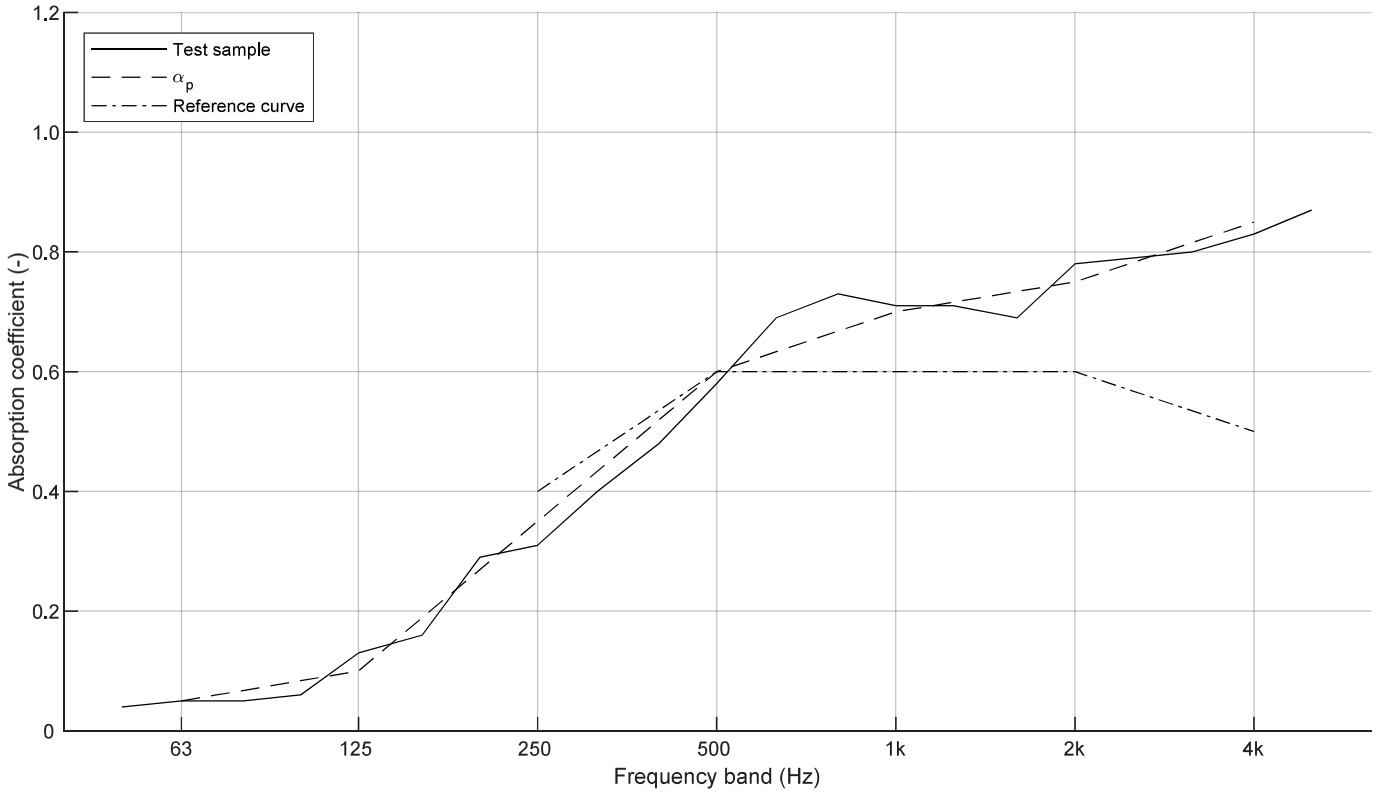
Air humidity: 43 % (empty: 43 %)

Air pressure: 100.7 kPa (empty:100.6 kPa)

Size of specimen: 8.3 m^2

Measurement date: 2023-12-18

Measured by: Joachim Schubert



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Sound absorbing plant wall - 3 panels as group

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

Measurement of sound absorption area in a reverberation room

Ackred. nr. 10445
Provning
ISO/IEC17025

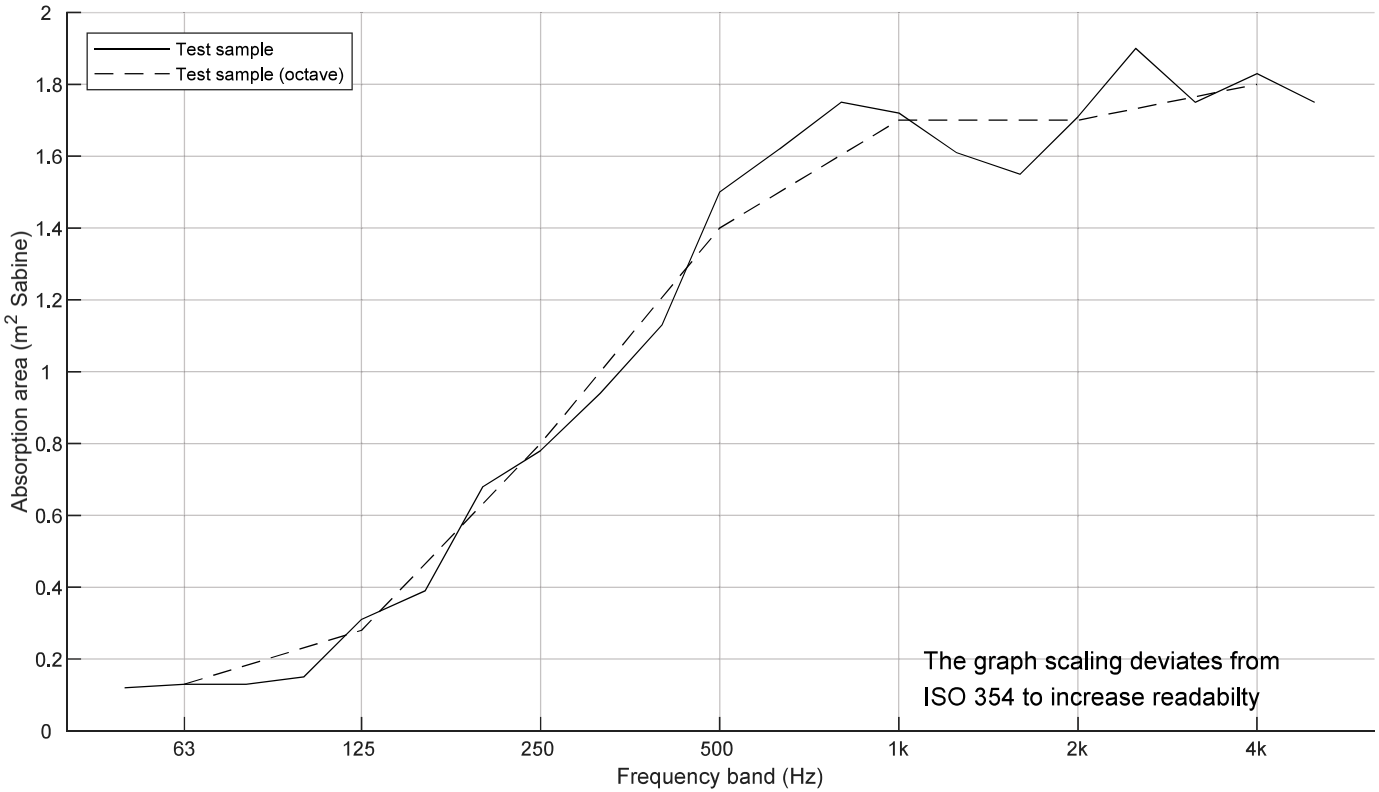
Report number:
3368-M2
Date
2023-12-20

Frequency f [Hz]	Sound absorption area per object [m^2 Sabine]	
50	0.12	
63	0.13	0.13
80	0.13	
100	0.15	
125	0.31	0.28
160	0.39	
200	0.68	
250	0.78	0.80
315	0.94	
400	1.13	
500	1.50	1.4
630	1.62	
800	1.75	
1000	1.72	1.7
1250	1.61	
1600	1.55	
2000	1.71	1.7
2500	1.90	
3150	1.75	
4000	1.83	1.8
5000	1.75	

N_{10} = 7.1

Client:	By Faux
Manufacturer:	By Faux
Product identification:	Sound absorbing plant wall - 3 panels as group
Description of test specimen:	Group of 3 plant wall panels 800 x 800 mm mounted with a distance of 45 mm from floor. 4 sound absorbing panels 500 x 500 x 35 mm placed in gap with 8 mm distance to the floor.

Reverberation room volume:		200 m^3
Temperature:	17.3 °C	(empty: 17.0 °C)
Air humidity:	43 %	(empty: 43 %)
Air pressure:	100.6 kPa	(empty:100.6 kPa)
Number of objects:	2	
Measurement date:		2023-12-18
Measured by:		Joachim Schubert



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Plant wall (without sound absorbing panels)

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

Ackred. nr. 10445
Provning
ISO/IEC17025

Report number:
3368-M3
Date
2023-12-20

Frequency f [Hz]	Sound absorption coefficient α_s	α_p
50	0.03	
63	0.04	0.05
80	0.04	
100	0.03	
125	0.07	0.05
160	0.07	
200	0.12	
250	0.13	0.15
315	0.13	
400	0.15	
500	0.18	0.20
630	0.24	
800	0.27	
1000	0.27	0.25
1250	0.25	
1600	0.25	
2000	0.32	0.30
2500	0.40	
3150	0.40	
4000	0.43	0.45
5000	0.53	

α_w = 0.25(H)

Absorption class = E

Client: By Faux

Manufacturer: By Faux

Product identification: Plant wall (without sound absorbing panels)

Description of test specimen: Plant wall panels 800 x 800 mm mounted with a distance of 45 mm from floor. Without sound absorbing panels. 8.3 m^2 surface.

Reverberation room volume: 200 m^3

Temperature: 17.4 °C (empty: 17.0 °C)

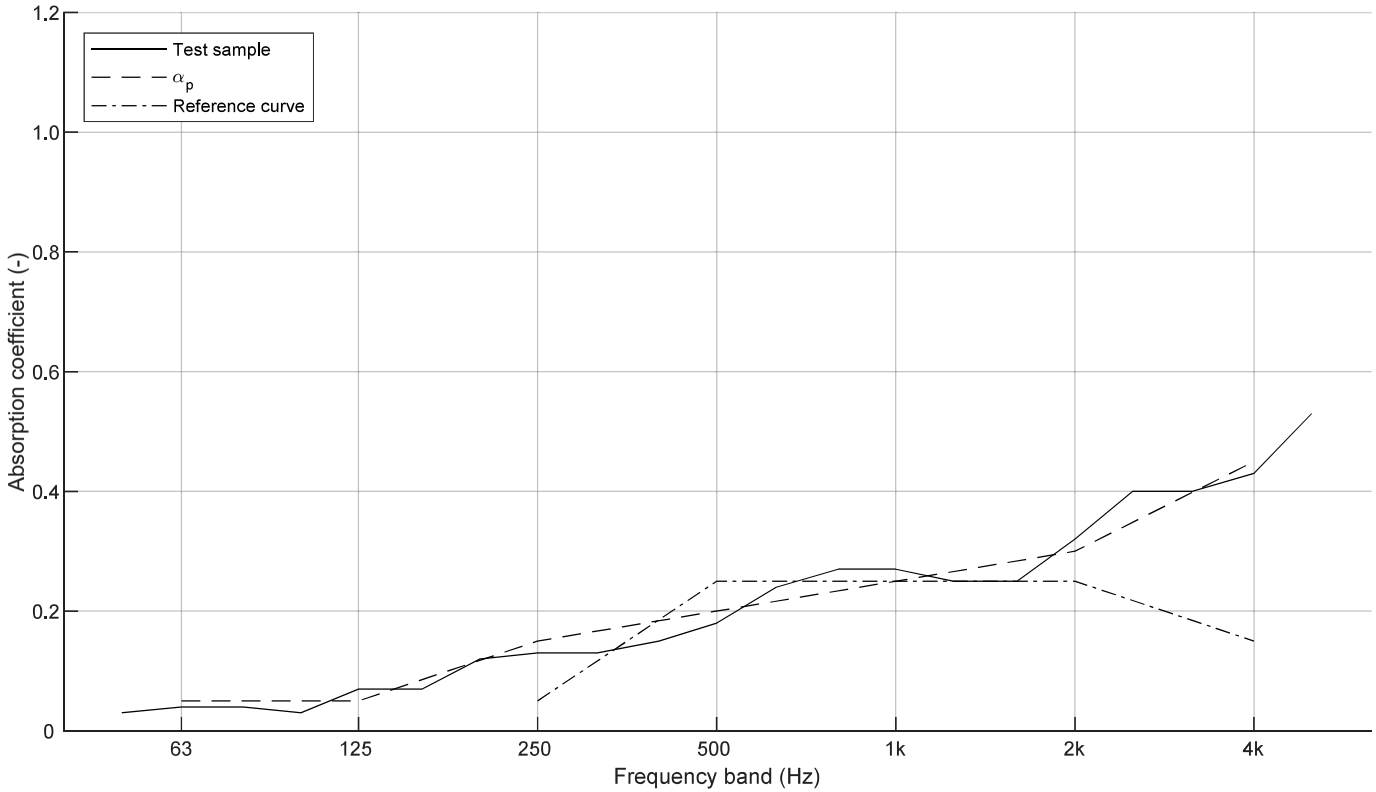
Air humidity: 43 % (empty: 43 %)

Air pressure: 100.6 kPa (empty:100.6 kPa)

Size of specimen: 8.3 m^2

Measurement date: 2023-12-18

Measured by: Joachim Schubert



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Sound absorbing plant wall - 1 sound absorber/ plant panel

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

Ackred. nr. 10445 Provning ISO/IEC17025

Report number: 3368-M4

Date 2023-12-20

Frequency f [Hz]	Sound absorption coefficient α_s	α_p
50	0.03	
63	0.04	0.05
80	0.05	
100	0.05	
125	0.13	0.10
160	0.14	
200	0.23	
250	0.26	0.25
315	0.33	
400	0.40	
500	0.49	0.50
630	0.62	
800	0.65	
1000	0.67	0.65
1250	0.64	
1600	0.62	
2000	0.65	0.65
2500	0.71	
3150	0.72	
4000	0.73	0.75
5000	0.76	

α_w = 0.50(H)

Absorption class = D

Client: By Faux

Manufacturer: By Faux

Product identification: Sound absorbing plant wall - 1 sound absorber/ plant panel

Description of test specimen: Plant wall panels 800 x 800 mm mounted with a distance of 45 mm from floor. Sound absorbing panel 500 x 500 x 35 mm placed in the gap directly on the floor. 1 sound absorber per plant panel.

Reverberation room volume: 200 m^3

Temperature: 17.8 °C (empty: 17.0 °C)

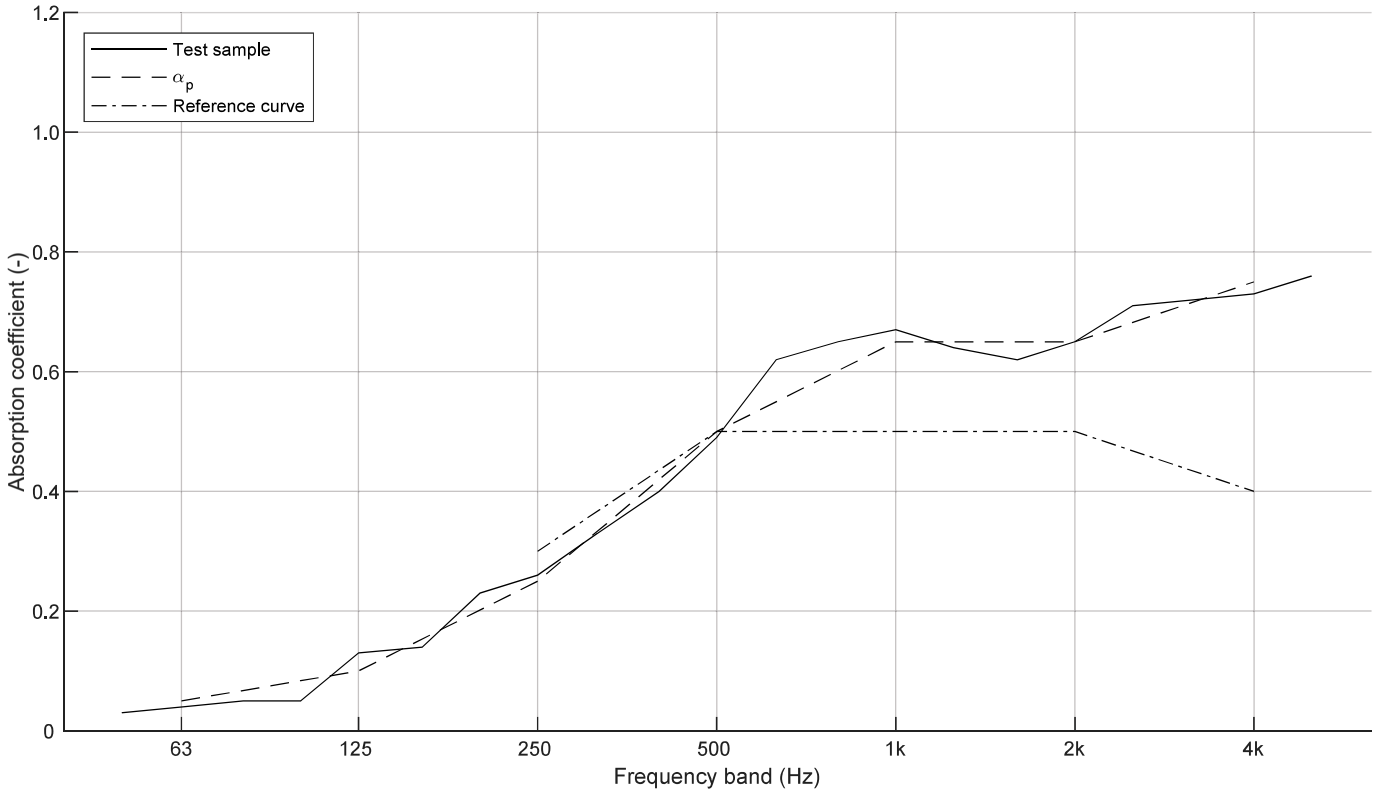
Air humidity: 41 % (empty: 43 %)

Air pressure: 100.7 kPa (empty:100.6 kPa)

Size of specimen: 10.3 m^2

Measurement date: 2023-12-18

Measured by: Joachim Schubert



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Sound absorbing plant wall - 1 elevated sound absorber/ plant panel

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

Ackred. nr. 10445 Provning ISO/IEC17025

Report number: 3368-M5

Date 2023-12-20

Frequency f [Hz]	Sound absorption coefficient α_s	α_p
50	0.03	
63	0.04	0.05
80	0.05	
100	0.06	
125	0.12	0.10
160	0.15	
200	0.25	
250	0.27	0.30
315	0.33	
400	0.42	
500	0.51	0.55
630	0.65	
800	0.67	
1000	0.68	0.65
1250	0.64	
1600	0.64	
2000	0.66	0.70
2500	0.73	
3150	0.71	
4000	0.74	0.75
5000	0.77	

α_w = 0.55(H)

Absorption class = D

Client: By Faux

Manufacturer: By Faux

Product identification: Sound absorbing plant wall - 1 elevated sound absorber/ plant panel

Description of test specimen: Plant wall panels 800 x 800 mm mounted with a distance of 45 mm from floor. One sound absorbing panel 500 x 500 x 35 mm placed in the gap with 8 mm distance to the floor. 1 sound absorber per plant panel.

Reverberation room volume: 200 m^3

Temperature: 17.8 °C (empty: 17.0 °C)

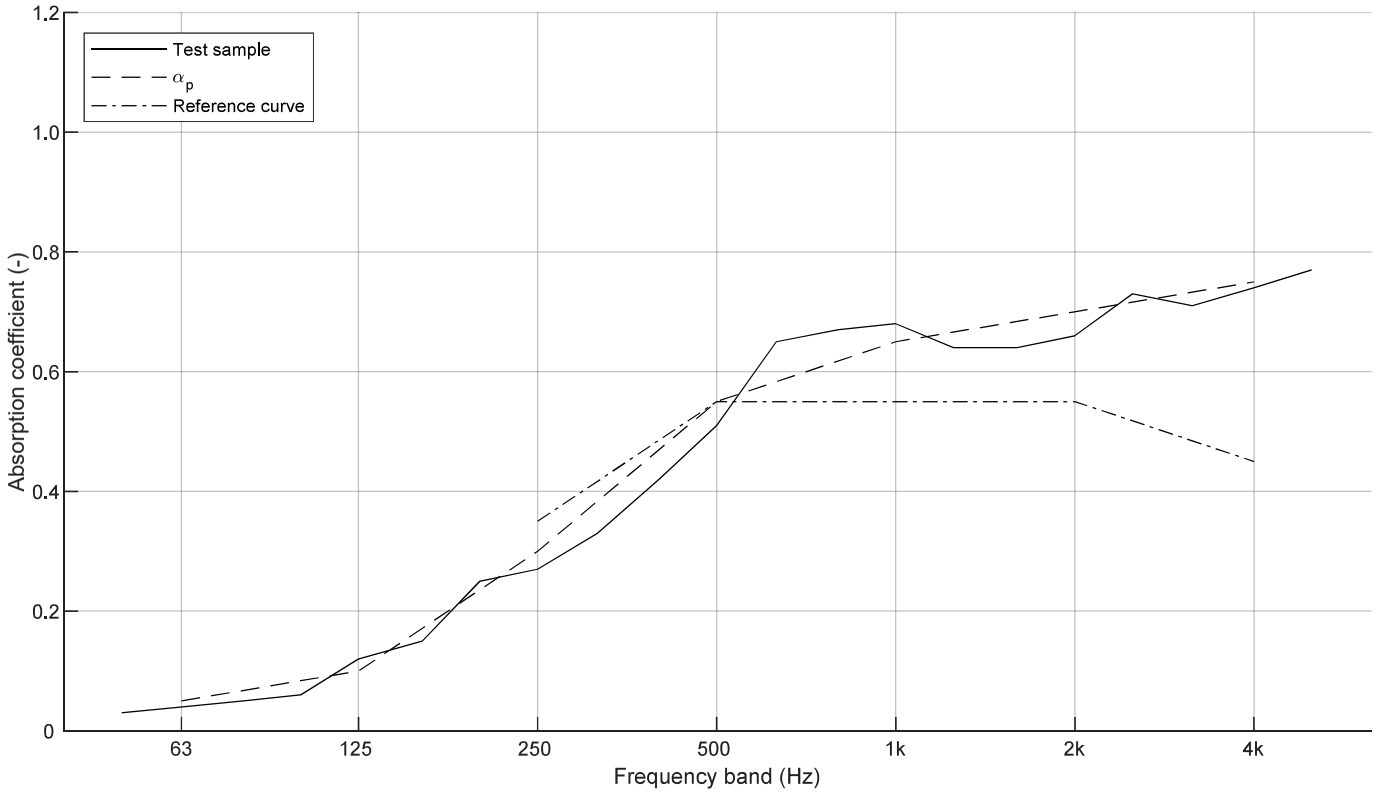
Air humidity: 41 % (empty: 43 %)

Air pressure: 100.7 kPa (empty:100.6 kPa)

Size of specimen: 10.3 m^2

Measurement date: 2023-12-18

Measured by: Joachim Schubert



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