

## **SOUND ABSORPTION MEASUREMENTS FOR WALL ABSORBERS FROM JOHANSON DESIGN ACCORDING TO SS-EN ISO 354:2003, SS-EN ISO 11654:1997 AND SS 25269:2013**

This report is the English version of report 15-052-R1, dated 2015-03-23.

### ABSTRACT

The sound absorption for a number of wall absorbers from Johanson Design has been measured according to the reverberation room method (SS-EN ISO 354:2003) and evaluated where applicable according to SS-EN ISO 25269:2013 and SS-EN ISO 11654:1997. The results as weighted sound absorption coefficient with sound absorption class and the sound absorption area for groups of objects are presented in the tables below.

Test object	$\alpha_w$	Absorption class
1. Leaves	0,6(MH)	C
2. Frequency wall 40 mm	0,7(MH)	C
3. Frequency wall 80 mm	1,0	A
4. Frequency wall 120 mm	1,0	A

Test object	$A_{obj}$ [m <sup>2</sup> Sabine]						
	63 Hz	125 Hz	250 Hz	500 Hz	1 kHz	2 kHz	4 kHz
5. Leaves, group of 4 objects	0,0	0,1	0,4	1,1	1,4	1,4	1,4
6. Beehive rectangular, group of 6 objects	0,0	0,1	0,5	1,1	1,5	1,4	1,4
7. Moon, group of 4 objects	0,0	0,1	0,4	0,9	1,4	1,4	1,5
8. Cropfield, group of 4 objects	0,0	0,1	0,3	0,7	1,3	1,6	1,5
9. Pebble, group of 4 objects	0,0	0,1	0,5	1,0	0,9	0,9	1,0

## 1. CUSTOMER



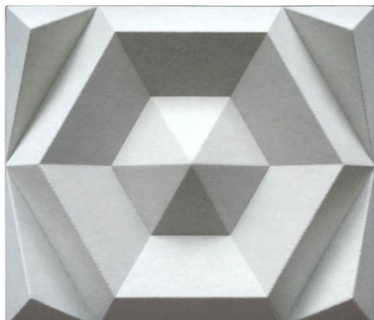
Johanson Design, Anders Anderssons Väg 7, 285 35 Markaryd  
Contact: Dan Johanson, 0709-22 09 10, dan@johansondesign.se.

## 2. ASSIGNMENT

To measure sound absorption coefficient and area for a number of wall absorbers from Johanson Design in different configurations according to SS-EN ISO 354:2003 and evaluate the results according to SS-EN ISO 11654:1997 and SS 25269:2013 where applicable.

## 3. TEST OBJECT

Johanson Design has two types of wall absorbers in their product portfolio. One type consists of an approximately 4 mm thick shell of pressed polyester felt. The other type consists of foam with textile. Images of the test setup are found in appendix 3.

Test object		Measurement protocol
1. Leaves, 600x600x66 mm, 28 object, 10 m <sup>2</sup>		15-052-M1
2. Leaves, 600x600x66 mm, three groups of 4 objects		15-052-M5
2. Frequency wall 40 mm, 10 m <sup>2</sup>		15-052-M2
3. Frequency wall 80 mm, 10 m <sup>2</sup>		15-052-M3
4. Frequency wall 120 mm, 10 m <sup>2</sup>		15-052-M4
Frequency wall is a textile covered foam absorber where each unit measures 400x400, 800x400 or 800x800 mm, with a thickness of 40, 80 or 120 mm. The measurements were made without the backing MDF board, which is a part of the product.		
5. Beehive rectangular, 550x475x75 mm, three groups of 6 objects.		15-052-M6

6. Moon, 0,36 m<sup>2</sup>, height 80 mm.  
three groups of 4 objects.

15-052-M7



7. Cropfield, 600x600x45 mm,  
three groups of 4 objects.

15-052-M8



8. Pebble, 600x600x65 mm,  
three groups of 4 objects.

15-052-M9



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Table 1: Test objects used for the measurements.

#### 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 where applicable. 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 2015-03-20 in the Akustikverkstan reverberation room in Skultorp, Skövde, Sweden. During some of the measurements, the temperature was slightly below 15°C and the relative humidity was slightly below 50%, which are the limits according to SS-EN ISO 354:2003. The deviation is not expected to affect the results, as the situation was stable during the measurements.

#### 5. MEASUREMENT EQUIPMENT

Table 2 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.

<b>Instrument</b>	<b>Manufacture and type</b>	<b>Serial number</b>	<b>Internal designation</b>
Measurement computer	HP ZBook	2329	DA02
Front end	National Instruments NI 9234	195551B-01L-1918620	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 2: Equipment used during the measurements.

## 6. RESULTS

The weighted sound absorption coefficient and sound absorption class for the applicable measurements are listed in table 3 and displayed in figure 1. Detailed measurement results for all test specimens are available in the measurement protocols according to table 1. The results are only valid for the tested samples.

Test object	$\alpha_w$	Absorption class
1. Leaves	0,6(MH)	C
2. Frequency wall 40 mm	0,7(MH)	C
3. Frequency wall 80 mm	1,0	A
4. Frequency wall 120 mm	1,0	A

Table 3: Results according to SS-EN ISO 11654:1997 for the measured products.

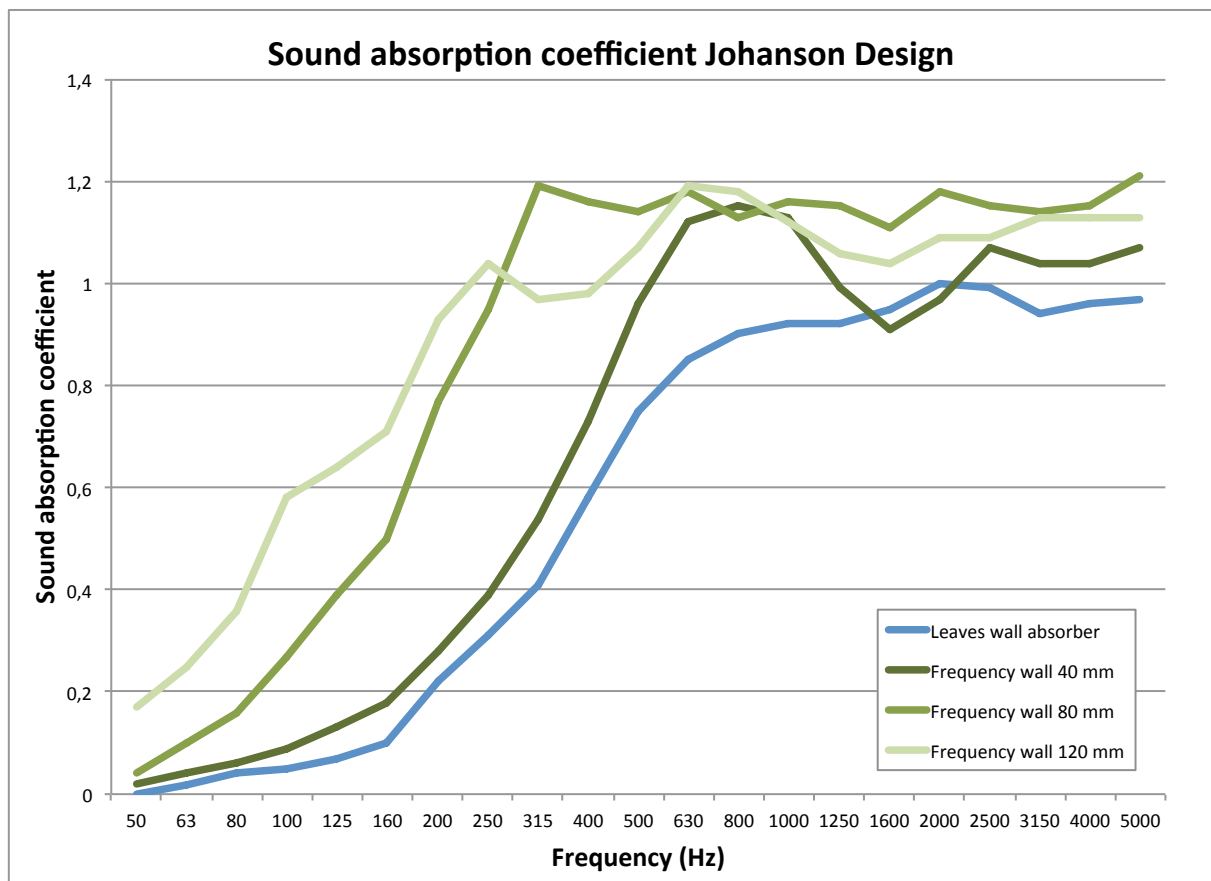


Figure 1: Measured sound absorption coefficient in third octave bands for Leaves and different thicknesses of Frequency wall.

The sound absorption area according to SS 25269:2013 is presented in table 4, figure 2 and 3 for the objects that were measured as separate groups of objects.

Test object	$A_{obj}$ [m <sup>2</sup> Sabine]						
	63 Hz	125 Hz	250 Hz	500 Hz	1 kHz	2 kHz	4 kHz
5. Leaves, group of 4 objects	0,0	0,1	0,4	1,1	1,4	1,4	1,4
6. Beehive rectangular, group of 6 objects	0,0	0,1	0,5	1,1	1,5	1,4	1,4
7. Moon, group of 4 objects	0,0	0,1	0,4	0,9	1,4	1,4	1,5
8. Cropfield, group of 4 objects	0,0	0,1	0,3	0,7	1,3	1,6	1,5
9. Pebble, group of 4 objects	0,0	0,1	0,5	1,0	0,9	0,9	1,0

Table 4: Sound absorption area for small groups of wall absorbers (1,44-1,57 m<sup>2</sup>, 4-6 objects).

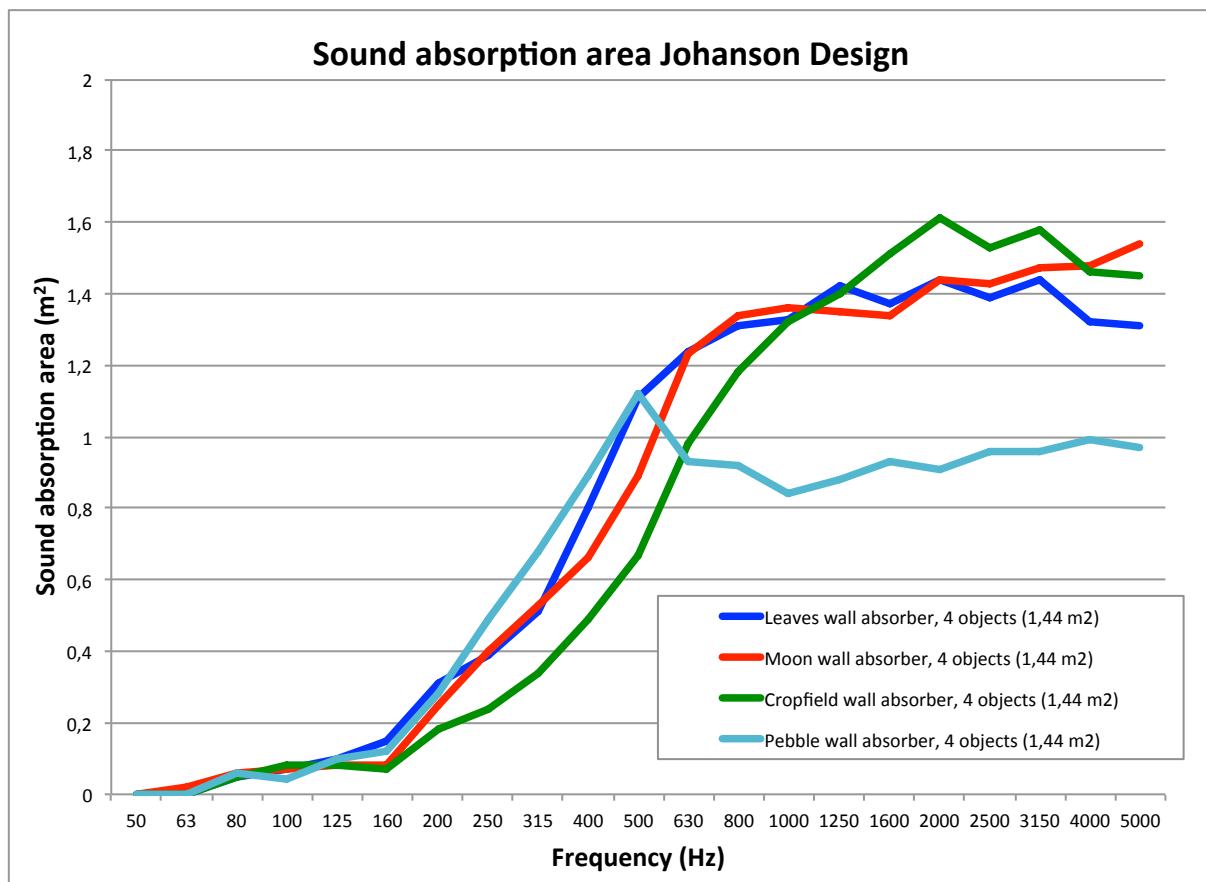


Figure 2: Sound absorption area for the groups of objects with similar area.

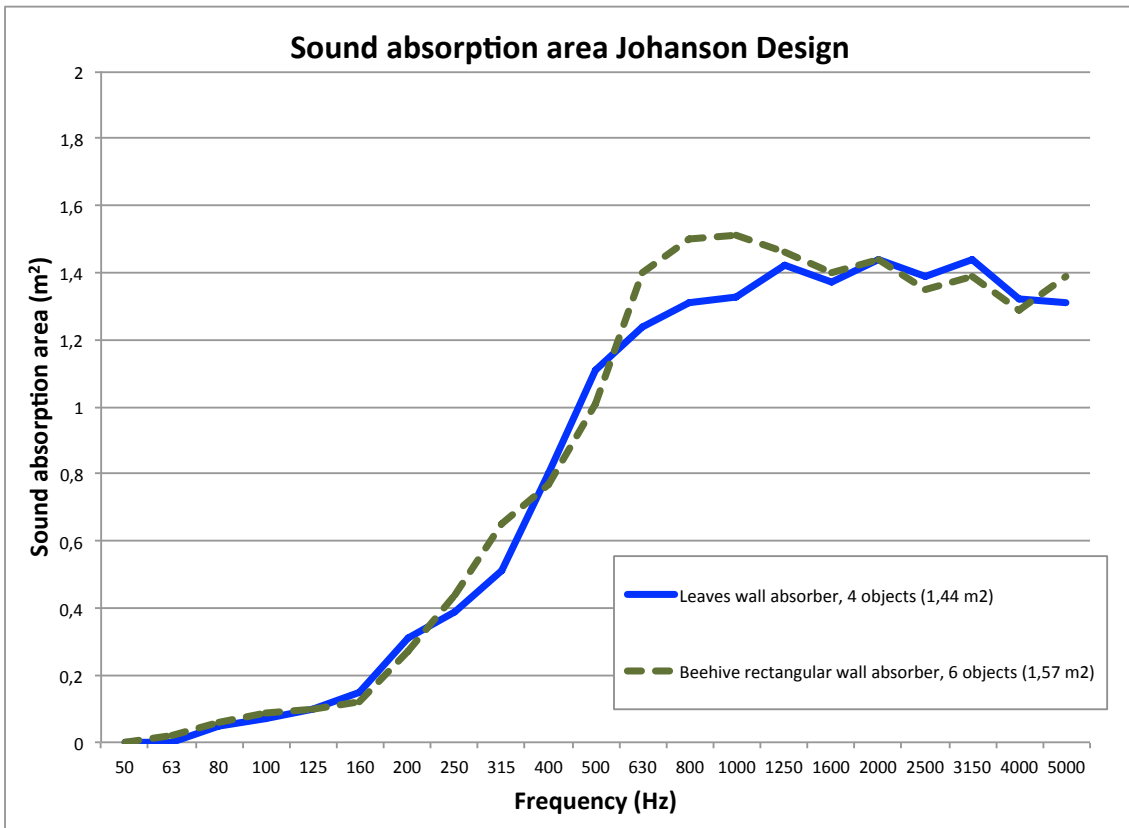


Figure 3: Sound absorption area for Beehive rectangular (6 objects, 1,57 m<sup>2</sup>) compared to Leaves (4 objects, 1,44 m<sup>2</sup>).

## 7. MEASUREMENT UNCERTAINTY

The uncertainties in the measured sound absorption coefficients have been estimated to the values in table 5. The uncertainty for the sound absorption area measurements is obtained by multiplying the value stated below with the actual size of the test object. The uncertainty corresponds to one standard deviation.

<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 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  
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Reviewed by Pontus Thorsson, 2015-03-25

## APPENDIX 1: MEASURED REVERBERATION TIMES

f (Hz)	Tom	Leaves	Frequency wall 40 mm	Frequency wall 80 mm	Frequency wall 120 mm
50	9.57	9.58	9.11	8.50	6.36
63	8.93	8.55	8.09	6.96	5.35
80	8.45	7.74	7.35	5.94	4.40
100	7.48	6.74	6.24	4.61	3.22
125	6.31	5.53	5.02	3.59	2.83
160	5.40	4.60	4.15	2.96	2.49
200	5.47	3.99	3.72	2.39	2.15
250	5.26	3.50	3.22	2.08	1.97
315	5.42	3.21	2.87	1.83	2.09
400	5.29	2.71	2.43	1.85	2.05
500	4.81	2.28	2.00	1.80	1.88
630	4.43	2.05	1.76	1.71	1.70
800	4.72	2.05	1.78	1.79	1.75
1k	4.53	1.99	1.77	1.74	1.78
1,25k	4.08	1.89	1.83	1.68	1.76
1,6k	3.69	1.77	1.82	1.64	1.70
2k	3.23	1.62	1.65	1.49	1.55
2,5k	2.82	1.52	1.47	1.41	1.44
3,15k	2.40	1.42	1.36	1.30	1.30
4k	2.01	1.26	1.22	1.17	1.17
5k	1.54	1.05	1.02	0.97	0.99
Test area (m <sup>2</sup> )	0.00	10.08	9.84	9.84	9.84
T (°C)	14.4	13.9	15.9	16.5	16.0
RH (%)	48.6	49.8	44.3	42.9	42.6



f (Hz)	Leaves	Beehive rectangular	Moon	Cropfield	Pebble
50	9.80	9.74	9.69	9.92	10.27
63	8.91	8.77	8.79	8.94	8.87
80	8.14	8.08	8.08	8.13	8.03
100	7.12	7.01	7.09	7.05	7.24
125	5.96	5.95	6.01	6.01	5.93
160	5.01	5.07	5.17	5.20	5.07
200	4.72	4.79	4.84	4.99	4.77
250	4.41	4.32	4.39	4.69	4.23
315	4.31	4.08	4.27	4.61	4.04
400	3.80	3.82	3.98	4.25	3.67
500	3.22	3.30	3.44	3.68	3.20
630	2.93	2.81	2.94	3.15	3.20
800	3.00	2.84	2.97	3.10	3.35
1k	2.91	2.77	2.88	2.90	3.34
1,25k	2.65	2.62	2.69	2.65	3.04
1,6k	2.51	2.49	2.52	2.42	2.78
2k	2.26	2.25	2.25	2.16	2.51
2,5k	2.06	2.07	2.05	1.99	2.22
3,15k	1.81	1.82	1.80	1.75	1.94
4k	1.60	1.61	1.57	1.55	1.66
5k	1.29	1.27	1.25	1.25	1.32

Number of objects	3x4	3x6	3x4	3x4	3x4
T (°C)	15.1	16.1	15.6	16.4	16.0
RH (%)	46.3	44.0	45.3	42.3	42.6

## 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 according to figure B2.1. The mounting area consists of a concrete slab that can be lowered up to 700 mm below the floor.

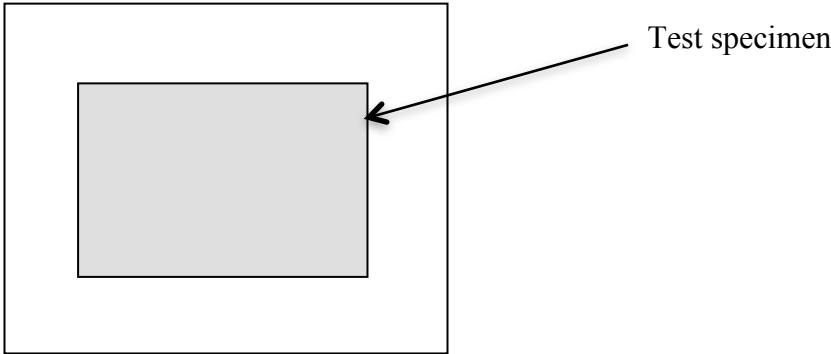


Figure B2.1: Plane drawing of the reverberation room with the test specimen put on the mounting area.

**APPENDIX 3: IMAGES**



Figure B3.1: Leaves during the measurement of sound absorption coefficient.



Figure B3.2: Frequency wall 40 mm during the measurement of sound absorption coefficient.



Figure B3-3: Frequency wall 80 mm during the measurement of sound absorption coefficient.



Figure B3.4: Frequency wall 120 mm during the measurement of sound absorption coefficient.



Figure B3.5: Leaves during the measurement of sound absorption area for groups of 4 objects.



Figure B3.6: Beehive rectangular during the measurement of sound absorption area for groups of 6 objects.



Figure B3.7: Moon during the measurement of sound absorption area for groups of 4 objects.



Figure B3.8: Cropfield during the measurement of sound absorption area for groups of 4 objects.

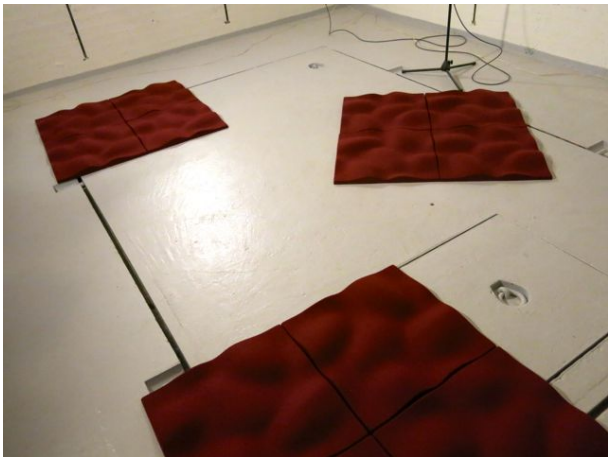


Figure B3.9: Pebble during the measurement of sound absorption area for groups of 4 objects.