Sound Absorption Testing

Carried out for

XSTONE Design Ltd

Report 105335/1

Compiled by Rebecca Hogg

27 June 2023

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Sound Absorption Testing

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QUALITY ASSURANCE

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1 INTRODUCTION

XSTONE Design Ltd commissioned BSRIA to carry out sound absorption testing in accordance with BS EN ISO 354:2003 in order to determine the sound absorption coefficients and sound absorption class of four material samples. This report details the test method and results obtained.

Tests were carried out at BSRIA's test facility located in Bracknell, Berkshire on 8th June 2023. John Sulzmann of XSTONE Design Ltd attended BSRIA to install the material samples and witness the testing. The installation configurations were specified by XSTONE Design Ltd.

The test method used to determine the sound absorption coefficients was taken from BS EN ISO 354:2003 "Acoustics – Measurement of sound absorption in a reverberation room".

The weighted sound absorption coefficient and class were then determined in accordance with BS EN ISO 11654:1997 "Acoustics – Sound absorbers for use in buildings – Rating of sound absorption".

2 ITEMS RECEIVED FOR TEST

XSTONE Design Ltd provided four material samples and the product details are given in Table 1. The material samples are shown in Figure 1 to Figure 4.

Table 1 Test Item Information

Product Name	Dimensions of exposed test sample (mm)		
	Length	Width	Depth
12mm ALTO (Recycled PET panels)	4000	2800	12
24mm ALTO (Recycled PET panels)	4000	2800	24
9mm XSTONE Acoustic	3900	2800	10
12mm XSTONE Acoustic	3900	2800	13

Figure 1 12mm ALTO (Recycled PET panels)

Figure 2 24mm ALTO (Recycled PET panels)

Figure 3 9mm XSTONE Acoustic

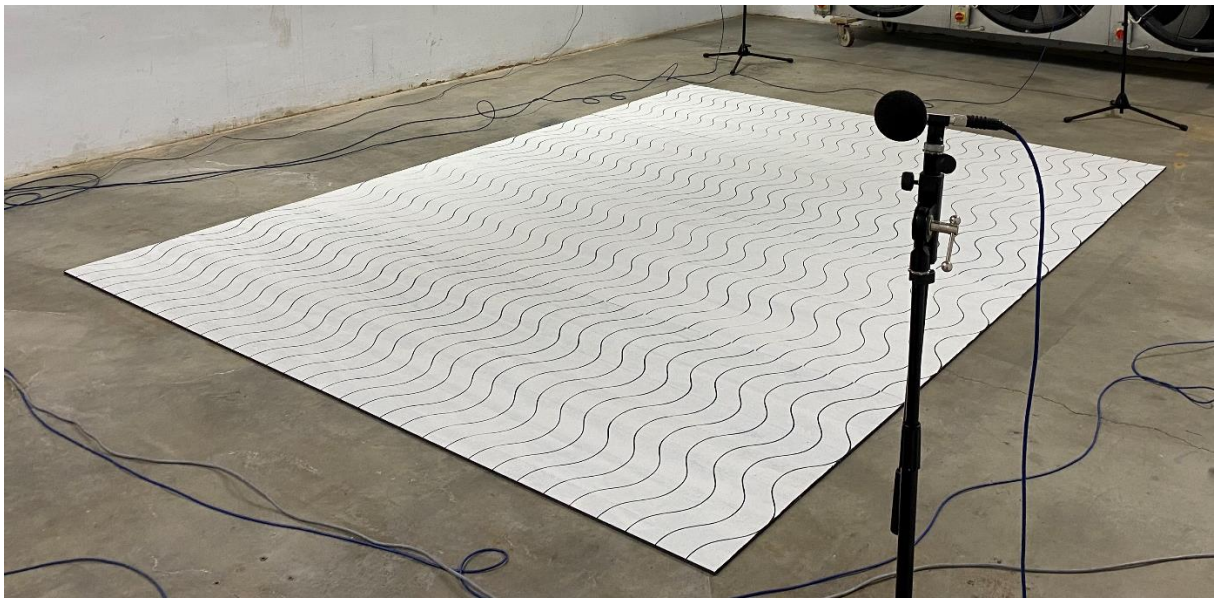


Figure 4 12mm XSTONE Acoustic

3 TEST METHODOLOGY

The objective of the sound absorption testing was to determine the sound absorption coefficients of the material sample in the configurations given in Table 2.

Table 2 Test Item Configuration

Test No.	Product Name	Number of Tiles	Mounting Configuration
1	12mm ALTO (Recycled PET panels)	4	Directly on floor (ISO 354:2003 Type A mounting)
2	24mm ALTO (Recycled PET panels)	4	Directly on floor (ISO 354:2003 Type A mounting)
3	9mm XSTONE Acoustic	4	Directly on floor (ISO 354:2003 Type A mounting)
4	12mm XSTONE Acoustic	4	Directly on floor (ISO 354:2003 Type A mounting)

A 210m^3 reverberation chamber was used to carry out the sound absorption testing and the instrumentation was installed as needed in the chamber. Eight diffusers were installed in the reverberation chamber and a drawing of the reverberation chamber is given in Appendix A. Each material sample was positioned in the chamber in accordance with the configuration given in Table 2. There were no fixings between the tiles and the sample edges were left exposed.

Six discrete microphone positions and two loudspeaker positions were selected in accordance with BS EN ISO 354:2003. A Nor850 Distributed Multi-Channel System with built-in signal generator were utilised to determine the reverberation times for the specific test environments. This arrangement was capable of producing sound pressure levels at least 10 dB higher than the ambient sound pressure levels in each frequency band of interest. The microphones were calibrated before and after the measurement period. The barometric pressure, ambient air dry bulb temperature and relative humidity were measured for each material sample setup. Table 3 provides calibration details for the instrumentation.

Table 3 Calibration details for instrumentation

Instrument	Manufacturer	Range	Units	BSRIA ID	Calibration Due
Temperature and humidity logger	Testo	0-30 0-100	°C %	1330	05/05/24
Nor850 Distributed Multi-channel System	Norsonic	0-130	dB	1400	21/11/24
Microphones & pre-amplifiers	Norsonic	0-130	dB	1401-1406	21/11/24
Acoustic calibrator Nor1251	Norsonic	114	dB	1407	21/11/23
Power amplifier Nor280	Norsonic	-35 - +0	dB	1408	N/A
Hemi-dodecahedron loudspeaker Nor275	Norsonic	0-120	dB	1409	N/A

The sound absorption coefficients were determined for one-third octave band frequencies between 100 Hz and 5 kHz. The material sample was considered a plane absorber and the results are expressed as sound absorption coefficient, α_s. The weighted sound absorption coefficient and class were then determined from the calculated results for each sample.

4 RESULTS

The thermal conditions in the reverberation chamber during the sound absorption measurements are given in Table 4, relating to the test numbers given in Table 2.

Table 4 Thermal conditions in reverberation chamber during measurements

Measured Quantity	Empty Room	Test 1	Test 2	Test 3	Test 4	Unit
Barometric Pressure	101	101	101	101	101	kPa
Dry Bulb Air Temperature	19.1	18.9	18.8	19.0	19.0	°C
Relative Humidity	51.0	49.8	50.7	50.1	50.0	%

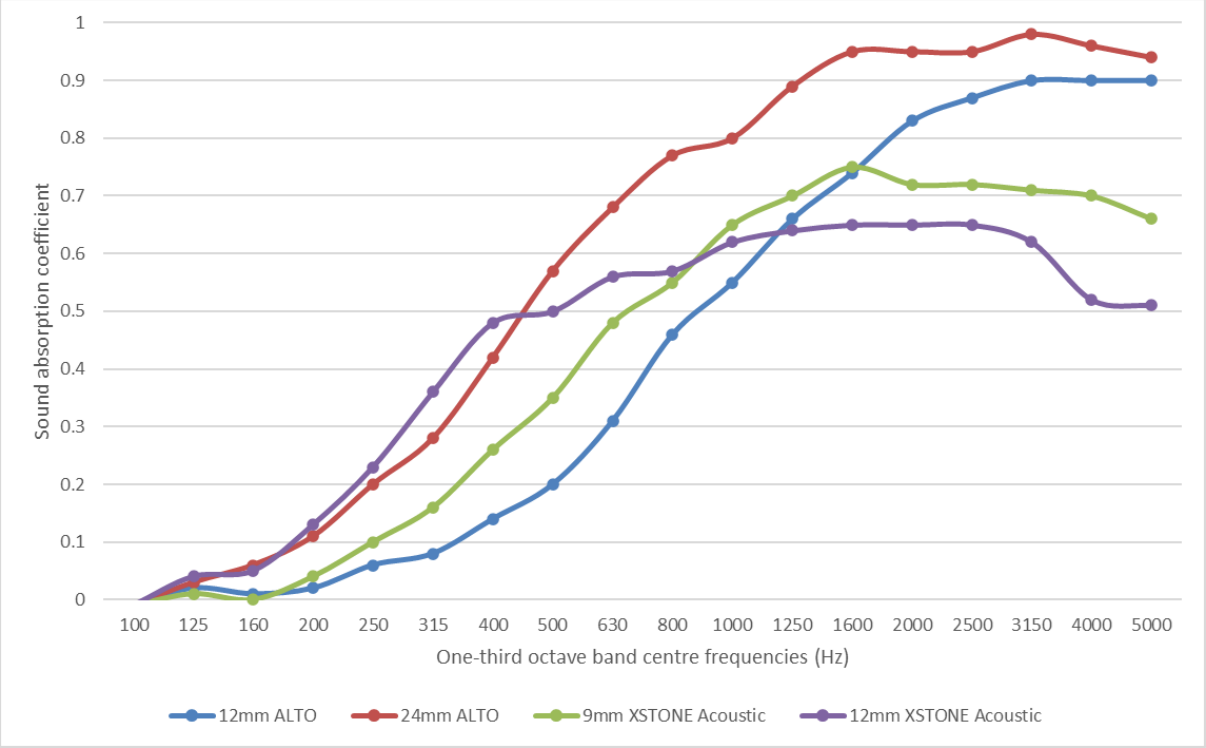
The calculated sound absorption coefficients are given in Table 5 and Figure 5. The surface area used in the calculations for the material sample directly on the floor of the chamber includes the edges of the test sample as these were exposed during testing.

Table 5 Sound absorption coefficients of sample, α_s

One-third octave band centre frequency (Hz)	Empty Room Reverberation Time, RT_{60} (sec)	12mm ALTO		24mm ALTO		9mm XSTONE Acoustic		12mm XSTONE Acoustic	
		RT_{60} (sec)	α_s	RT_{60} (sec)	α_s	RT_{60} (sec)	α_s	RT_{60} (sec)	α_s
100	5.27	5.39	-0.01	5.39	-0.01	5.37	-0.01	5.41	-0.01
125	6.47	6.22	0.02	6.04	0.03	6.29	0.01	5.98	0.04
160	6.48	6.38	0.01	5.75	0.06	6.41	0.00	5.81	0.05
200	5.47	5.29	0.02	4.53	0.11	5.12	0.04	4.45	0.13
250	5.19	4.73	0.06	3.85	0.20	4.42	0.10	3.75	0.23
315	5.61	4.89	0.08	3.64	0.28	4.31	0.16	3.37	0.36
400	6.19	4.82	0.14	3.30	0.42	4.04	0.26	3.14	0.48
500	6.24	4.39	0.20	2.84	0.57	3.63	0.35	3.09	0.50
630	5.84	3.65	0.31	2.48	0.68	3.04	0.48	2.83	0.56
800	5.46	2.97	0.46	2.25	0.77	2.77	0.55	2.71	0.57
1000	5.14	2.65	0.55	2.14	0.80	2.47	0.65	2.51	0.62
1250	4.94	2.35	0.66	1.98	0.89	2.32	0.70	2.44	0.64
1600	4.64	2.16	0.74	1.86	0.95	2.18	0.75	2.33	0.65
2000	4.17	1.93	0.83	1.77	0.95	2.10	0.72	2.21	0.65
2500	3.67	1.77	0.87	1.67	0.95	1.97	0.72	2.05	0.65
3150	3.03	1.58	0.90	1.51	0.98	1.78	0.71	1.87	0.62
4000	2.46	1.40	0.90	1.36	0.96	1.57	0.70	1.73	0.52
5000	2.10	1.27	0.90	1.25	0.94	1.43	0.66	1.54	0.51

Note 1: The sound absorption coefficient evaluated from reverberation time measurements can have values larger than 1.0 (e.g. because of diffraction effects), and α_s is not, therefore expressed as a percentage.
Note 2: The use of the subscript "s" is to avoid confusion with the sound absorption coefficient defined as the ratio of non-reflected-to-incident sound energy if a plane wave strikes a plane wall at a particular angle of incidence. A "geometric" sound absorption coefficient is always smaller than 1.0 and may therefore be expressed as a percentage.

Figure 5 Sound absorption coefficients of samples, α_s



The practical and weighted sound absorption coefficients and the rating class are given in Table 6. The practical sound absorption coefficients are rounded to the nearest 0.05 in accordance with BS EN ISO 11654:1997. Shape indicators are used in accordance with BS EN ISO 11654:1997, where the 250Hz frequency band is considered low frequency, the 500 Hz and 1kHz frequency bands are considered mid-frequency, and the 2 kHz and 4 kHz frequency bands are considered high frequency.

Table 6 Rating of sound absorption

One-third octave band centre frequency (Hz)	12mm ALTO	24mm ALTO	9mm XSTONE Acoustic	12mm XSTONE Acoustic
250	0.05	0.20	0.10	0.25
500	0.20	0.55	0.35	0.50
1000	0.55	0.80	0.65	0.60
2000	0.80	0.95	0.75	0.65
4000	0.90	0.95	0.70	0.55
Weighted sound absorption coefficient	0.25 (M,H)	0.5 (M,H)	0.35 (M,H)	0.5
Class	E	D	D	D

XSTONE Design Ltd has requested a comparison of the results between the 12mm ALTO and 9mm and 12mm XSTONE Acoustic samples. The results of the sound absorption testing show the 9mm and 12mm XSTONE Acoustic samples have a higher weighted sound absorption coefficient than the 12mm ALTO sample and are both a Class D material sample. The 9mm and 12mm XSTONE Acoustic samples had a higher sound absorption coefficient in the low and mid frequency bands (250 Hz to 1 kHz) and a lower sound absorption coefficient in the high frequency bands (2 kHz and 4 kHz) compared to the 12mm ALTO sample.

APPENDIX A: REVERBERATION CHAMBER DRAWING