THE INSTITUTE OF POWER ENGINEERING
THERMAL DIVISION
"ITC" in Łódź
93-208 Łódź, ul. Dąbrowskiego 113
www.itc.edu.pl, e-mail: itc@itc.edu.pl

ITC Topic: 04230029

Registration no: 8764

Job title

Determination of acoustic properties of MARBET lamella panels on felt

Authors:
mgr inż. Patrick Gaj
mgr inż. Kamil Wójciak
dr inż. Joanna Kopania

Manager:
inż. Włodzimierz Pryczek

Branch Manager:
dr inż. Jacek Karczewski

Making the facility available for testing	Start of work	Completion of work
September 2023.	September 2023.	September 2023.

pages 9 figures: 2 charts: - tables: 4 literature items: 3

Issue date
07.09.2023.

Distribution list

1. IEn OTC "ITC", CITE	1 copy
2. MARBET Sp. z o.o.	2 copies

TABLE OF CONTENTS

1 Introduction 1

2 Scope of testing 1

3 Method of measurement 1

4 Literature 4

5 Test of WOODLINE lamella panels on felt 5

1 Introduction

The job was ordered by *MARBET Sp. z o.o* . under the topic 04230029.

The testing involved measuring sound absorption in a reverberation chamber and calculating sound absorption coefficient of WOODLINE lamella panels on felt manufactured by Marbet sp. z o.o.

2 Scope of testing

The scope of the testing included:

- sound absorption measurements in a reverberation chamber
- calculation of the sound absorption

coefficient for the items presented in this report.

3 Method of measurement

Test method: according to EN ISO 354:2005 'Acoustics - Measurement of sound absorption in a reverberation chamber'.

The test station and test room met the requirements of EN ISO 354:2005 'Acoustics - Measurement of sound absorption in a reverberation chamber'.

The test samples were subjected to a minimum of 24 hours of acclimation in the reverberation chamber before the measurements began. The components supplied for testing were installed on the floor in the Laboratory's right-hand reverberation chamber.

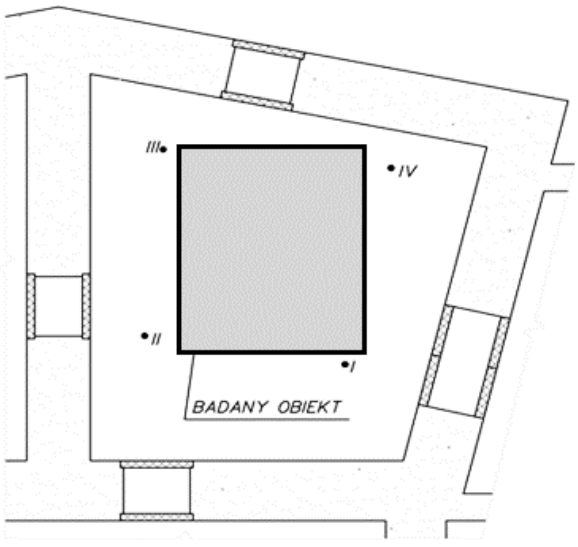


Figure 1. Tested sample installation sketch

Test station

Test site		right-hand reverberation chamber
Technical data	volume	245,6 m^3
	total surface area of partitions	235,0 m^2
	limiting planes	non-parallel
	additional distractors	none
Sample installation method		the tested components were placed on the floor of the reverberation chamber, none of the sides (edges) were additionally secured

Measuring apparatus

Name		Type	Manufacturer	Manufacturer no.
Measuring set Nor140	meter	Nor140	Norsonic	1407332
	condenser microphone	Nor1225	Norsonic	358181
	preamplifier	Nor1209	Norsonic	21954
Loudspeaker array	loudspeaker set 24Ω	special set	Tonsil	-
	power amplifier	LV 103	MMF	1540/35
calibrator		Nor1256	Norsonic	125626714
microphone swivel arm		Nor265	Norsonic	29487
barometer		HD 9908T	Delta OHM	11002854
thermohygrometer		HD 2717T.D0	Delta OHM	11032846
Tape measure		30 m	Richter	2134

Method of determining the reverberation sound absorption coefficient

Two series of chamber reverberation time measurements were made:

- time T_1 empty chamber reverberation, s,
- time T_2 reverberation time of the chamber with installed panels, s. The analysis of the test results included the calculation of:
- the average reverberation time for empty chamber T_1 and for the chamber with the tested sample T_2 in accordance with EN ISO 354:2005,
- determination of the equivalent sound-absorbing surface area for empty chamber A1, m2 according to:

$$A_1 = \frac{55{,}3 \cdot V}{c_1 \cdot T_1} - 4 \cdot V \cdot m_1$$

where:

  - V - volume of the reverberation chamber, m3,
  - c_1 - speed of sound in air, at a given temperature, m/s,
  - T_1 - reverberation time of empty reverberation chamber, s,
  - V - volume of empty reverberation chamber, m2,
  - m_1 - power damping factor, 1/m, from the relation:

$$m1 = \frac{\alpha}{10 \cdot \lg(e)}$$

where:

    - α - damping factor, due to absorption by the atmosphere, determined in accordance with PN-ISO 9613-1:2000, dB/m.

- determination of the equivalent sound-absorbing surface for empty chamber A1,m^2 according to:

$$A_2 = \frac{55{,}3 \cdot V}{c_2 \cdot T_2} - 4 \cdot V \cdot m_2$$

- of the equivalent sound absorption area of the tested material A_T m^2, from the relationship:

$$A_T = A_2 - A_1$$

- of the sound absorption coefficient α_w from the formula:

$$\alpha_w = \frac{A_T}{S}$$

where:

  - S - test sample area, m^2.

On the basis of the tests carried out in accordance with section 5 of EN ISO 11654:1999, the sound absorption coefficient αw , the shape indicator and the sound absorption class were determined in accordance with Annex B of the aforementioned standard.

4 Literature

1) EN ISO 354:2005 'Acoustics - Measurement of sound absorption in a reverberation chamber',
2) EN ISO 11654:1999 'Acoustics - Sound-absorbing products for use in buildings - Sound absorption coefficient',
3) PN-ISO 9613-1:2000 'Acoustics - sound dumping during propagation in an open space - Calculation of sound absorption by the atmosphere'.

5 Test of WOODLINE lamella panels on felt

Date of measurement: 04.09.2023 r.

Name/type	MARBET WOODLINE	
One sample length	mm	2700
One sample width	mm	300
One sample surface area	m²	0.810
Number of samples to be tested	pcs.	13
Total surface area	m²	10.53

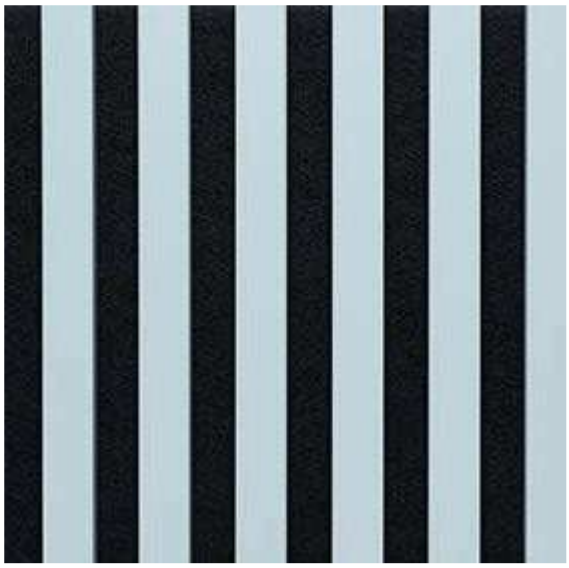


Figure 2. Photo (close-up) of the tested item.

Table 1

Environmental conditions

		Chamber with the tested item		Empty chamber	
		Before measurement	After measurement	Before measurement	After measurement
Air temperature	*°C*	21.2	21.3	21.1	21.2
Atmospheric Pressure	*hPa*	1000	1000	1000	1000
Relative humidity	*%*	53.0	52.8	52.3	52.2

Table 2

Characteristics of chamber reverberation time

$f_{śr}$	Average reverberation time of empty chamber T_1	Standard reverberation time deviation $\varepsilon_{20}(T_1)$	Average reverberation time of the chamber with tested item T_2	Standard reverberation time deviation $\varepsilon_{20}(T_2)$
Hz	*s*			
100	4.688	0.357	4.566	0.352
125	4.727	0.321	4.600	6.246
160	4.209	0.267	4.183	6.522
200	4.249	0.240	3.984	6.714
250	4.734	0.227	4.257	7.142
315	4.693	0.201	4.379	7.692
400	5.017	0.185	4.181	7.846
500	5.148	0.167	4.308	8.367
630	4.741	0.143	3.816	8.517
800	4.348	0.122	3.282	8.568
1000	4.151	0.106	2.901	8.617
1250	3.675	0.089	2.366	8.482
1600	3.138	0.073	1.883	8.374
2000	3.358	0.068	1.821	8.560
2500	3.492	0.062	1.786	8.877
3150	3.298	0.053	1.793	9.560
4000	2.987	0.045	1.813	10.458
5000	2.481	0.037	1.710	11.251
6300	1.994	0.029	1.503	11.801
8000	1.452	0.022	1.200	12.120
10000	1.014	0.017	0.888	12.055

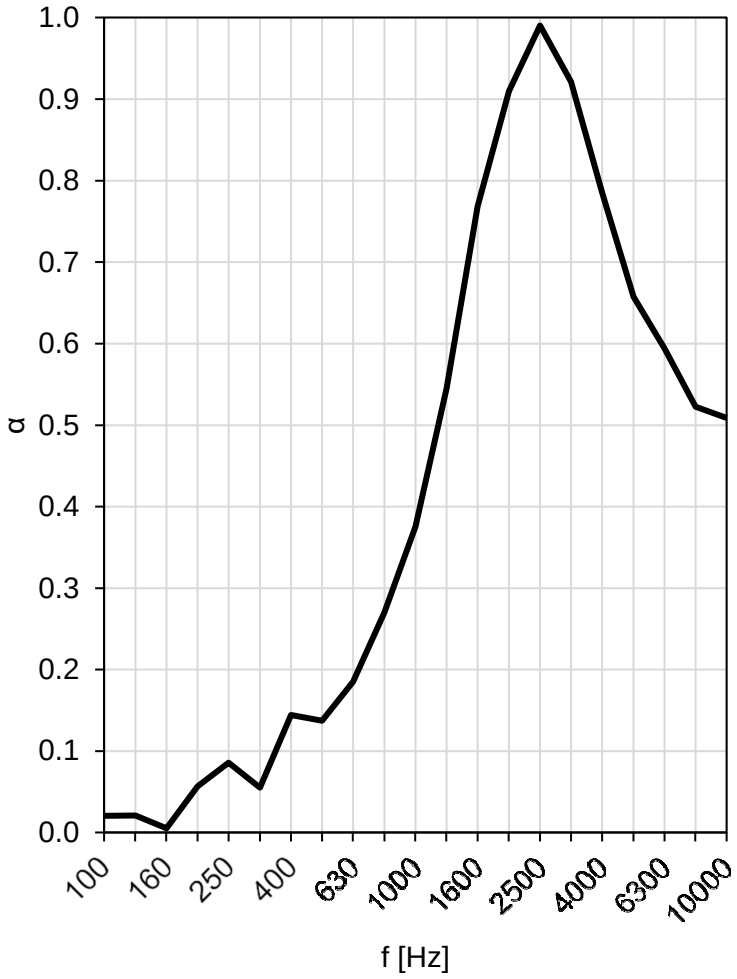
designations used in the table above,:

- T_1, T_2 - chamber reverberation times determined during the tests: without and with a sample, s,
- $\varepsilon_{20}(T_1)$, $\varepsilon_{20}(T_2)$ - standard deviation of reverberation time, determined in accordance with PN-EN ISO 354:2005, p. 8.2.2, dB.

Table 3

Characteristics of the reverberation sound absorption coefficient

$f_{śr}$	A_T	α_s
Hz	m^2	-
100	0.217	0.021
125	0.221	0.021
160	0.054	0.005
200	0.595	0.057
250	0.902	0.086
315	0.580	0.055
400	1.518	0.144
500	1.444	0.137
630	1.948	0.185
800	2.847	0.270
1000	3.957	0.376
1250	5.740	0.545
1600	8.091	0.768
2000	9.582	0.910
2500	10.429	0.990
3150	9.700	0.921
4000	8.268	0.785
5000	6.926	0.658
6300	6.254	0.594
8000	5.504	0.523
10000	5.359	0.509



designations used in the table above:

- A_T - equivalent sound absorption area of the test sample, m^2,
- α_S - test sample sound absorption coefficient, -.

Table 4

Sound absorption coefficient α_w

Sound absorption coefficient α_w	**0.25**
Shape determiner	**H**
Sound absorption class	**E**

The sound absorption coefficient, sound absorption index, shape indicator and sound absorption class do not depend on the dimensions of individual samples.