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REPORT N. 093-2017-CR ENG

UNI EN ISO 354:2003
ACOUSTIC ABSORPTION MEASUREMENT IN REVERBERATION ROOM

Issue place and date: Cerea (VR), 14/11/2017

Committee: Slalom S.r.l.

Address committee: Via Ernesto Rossi n°69, 20862 Arcore (MB), Italia

Sample delivery date: *09 and 10 October 2017*

Sample provenance: Slalom S.r.l.

Sample installation date: *11 October 2017*

Sample installed in laboratory by: *Committee /* (sampling made by the committee)

Test date: *11 October 2017*

Test location: Z Lab S.r.l. – Via Pisa, 5/7 – 37053 Cerea (VR) - Italia

Sampling denomination: Fabric for surface, wall ceiling furniture application, Model " Feltro 4.5 mm"
Mounting Type : A

LAB N° 1416

PREPARED	VERIFIED	APPROVED
Martina Ferrari	Antonio Scofano	Antonio Scofano

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The samples are kept for 30 days after the end of the test.

Sample description

The test sample is composed of fabric for surface, wall, ceiling, furniture application. Model " Feltro 4.5 mm", mass 1200 gr/mtl.

Two panels of 1600 x 3600 mm size were placed in contact so as to form a surface area of more than 10 square meters.

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Mounting conditions

The specimen was laid inside the reverberation chamber.

The mounting type is A in accordance with Annex B.2 of UNI EN ISO 354.

The test sample characteristics are listed below (**):

n° panels	*Length (mm)*	*Width (mm)*	*Thickness (mm)*	*Dimension of single panel (mm)*	*Area of specimen (m^2)*
2	3600	3200	4.5	1600 x 3600	11.52

(*) nominal data provided by the sample manifacturer
(**) data measured by test element sampling

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Test sample illustrations





The test has been made as soon as the sample installation was completed.

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Standards references

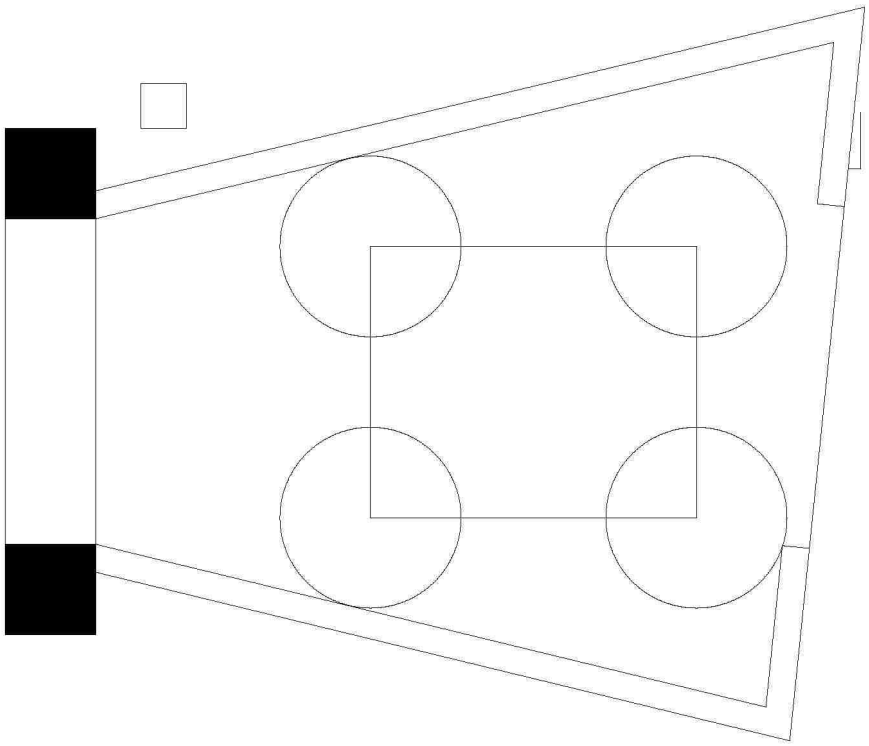
UNI EN ISO 354:2003	*Acoustic - Absorption measurement in reverberation room.*
UNI EN ISO 11654:1998	*Acoustics - acoustic absorbers for buildings - Rating of sound absorption.*
ASTM C423 – 09a	*Standard Test Method for sound absorption and sound absorption coefficients with reverberation room method.*

Test environment description

The test environment structure is made of reinforced concrete, wholly insulated from the laboratory through anti-vibration supports. In particular, this environment consists of a source room and a receiving room, both characterized by an irregularly-shaped volume, free of any parallel partition. The rooms are separated by a 100 cm thick test frame.

The dimensional data are listed below:

Average source room dimensions (L x W x H)	700 X 500 X 330 cm
Average receiving room dimensions (L x W x H)	770 X 560 X 370 cm



Reverberation room scheme.

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Test equipment and instruments

Instrument	Model	Serial number
Sound Level Meter	Bruel & Kjaer mod. 2250	3011945
Microphone	Bruel & Kjaer mod. 4189	3100355
Preamplifier	Bruel & Kjaer mod. ZC0032	26331
Calibrator	Bruel & Kjaer mod. 4231	2583667
Omnidirectional source	LOOK LINE KIT 103	AM.14019
Termohygrometer	DELTA OHM HD2301.0	09020599
Temperature and humidity sensor	DELTA OHM HP472AC R	09028736
Tape	STANLEY POWER LOCK 33-442	13/946
Microclimate with pressure gauge	DELTA OHM HD32.1	MSP430F4618

Environmental data during the test

	Reverberation room
Volume	161.3 m^3
Total surface	188.5 m^2
Average temperature during T_1	20.8 ± 1,0 °C
Average relative humidity during T_1	56 ± 2,0 %
Average temperature during T_2	21 ± 1,0 °C
Average relative humidity during T_2	58 ± 2,0 %
Sample surface	11.52 m^2

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Measurement method

The airborne sound insulation test between two rooms is based on the difference between the average sound pressure level in the source room (L_1) and the one detected in the receiving room (L_2). The acoustic source (which produces pink noise) has been operated within the source room in 3 different positions, while the microphone is located in 5 different positions, both in the source room and in the receiving room. Three measurements for each source-microphone combination have been performed, for a total of 45 measurements in the empty room and 45 measurements in the sample room. The integration time, for each measure, has been at least 10 s.

After the measurements, the reverberation time of both rooms is calculated in any frequency band by evaluating the arithmetic average of the total number of measured reverberation times. The average reverberation time for the empty room and for the sample room, respectively T_1 and T_2, is expressed with two significant digits.

The sample equivalent absorption area, A_T is then calculated using the formula:

$$A_T = A_2 - A_1 = 55{,}3 \cdot V \cdot \left(\frac{1}{c_2 T_2} - \frac{1}{c_1 T_1}\right) - 4 \cdot V \cdot (m_2 - m_1)$$

where:
c_1: is the sound speed in air at temperature t_1, in m/s;
c_2: is the sound speed in air at temperature t_2, in m/s;
V: is the empty room volume, in m^3;
T_1 e T_2: are the reverberation times for both the rooms;
m_1 e m_2: are attenuation coefficients, depending on climate rooms conditions during the test.

The acoustic absorption coefficient, α_s, of flat absorbers or of a set of objects is evaluated with the formula:

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

where:
S: is the sample area, in m^2.

According to UNI EN ISO 11654, is then possible to evaluate the practical absorption coefficient, α_{pi}, for any octave band i, through arithmetic average of the three absorption coefficients for any one-third octave band in the octave band of interest:

$$a_{pi} = \frac{a_{i1} + a_{i2} + a_{i3}}{3}$$

These values are used to evaluate the weighted acoustic absorption coefficient, α_w, starting from a reference curve. This curve is translated with steps of 0,05 towards the measured value, until the unfavorable differences sum is less or at least equal to 0,10. α_w is eventually evaluated as the reference curve value at 500 Hz.

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Measured values

f [Hz]	T_1 [s]	T_2 [s]	A_T [m²]
Frequency	*Empty room reverberation time*	*Sample room reverberation time*	*Equivalent absorption area*
100	5.28	5.12	0.15
125	5.25	5.14	0.10
160	6.61	6.14	0.30
200	6.59	6.07	0.34
250	6.39	5.67	0.51
315	6.33	5.69	0.46
400	5.50	4.82	0.66
500	5.08	4.23	1.03
630	5.22	4.11	1.34
800	4.85	3.64	1.78
1000	4.21	3.01	2.46
1250	4.09	2.73	3.16
1600	4.18	2.58	3.85
2000	4.01	2.37	4.48
2500	3.64	2.14	5.00
3150	3.15	1.89	5.49
4000	2.63	1.65	5.86
5000	2.12	1.38	6.56

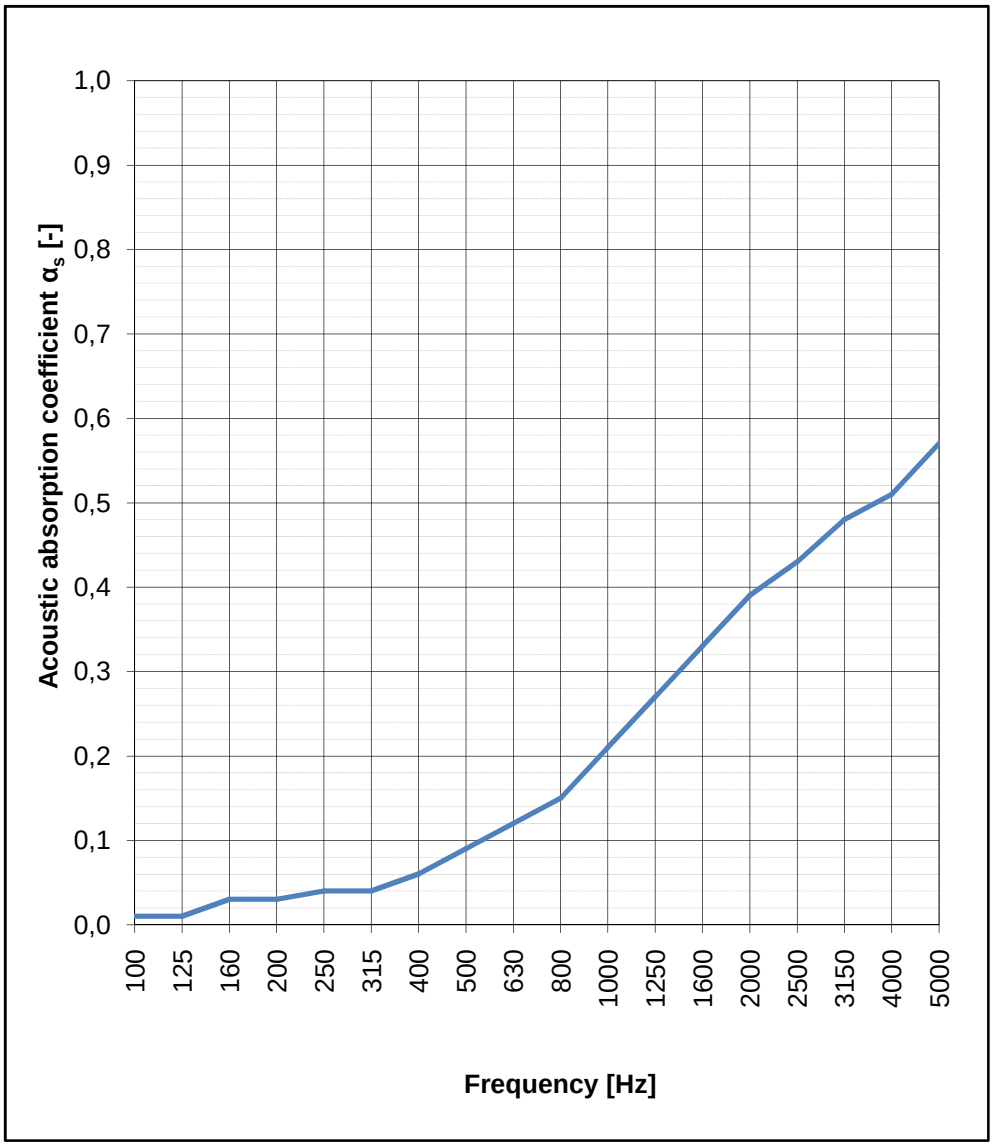
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Acoustic absorption calculation in reverberation room according to ISO 354

Sample description: Fabric for surface, wall ceiling furniture application, Model " Feltro 4.5 mm"
Mounting Type: A

Sample area: 11.52 m^2
Reverberation room volume: 161.3 m^3

f [Hz]	α_S [-]
Frequency	*Acoustic absorption coefficient values*
100	0.01
125	0.01
160	0.03
200	0.03
250	0.04
315	0.04
400	0.06
500	0.09
630	0.12
800	0.15
1000	0.21
1250	0.27
1600	0.33
2000	0.39
2500	0.43
3150	0.48
4000	0.51
5000	0.57



Evaluation based on laboratory measurement results by means of a technical method.

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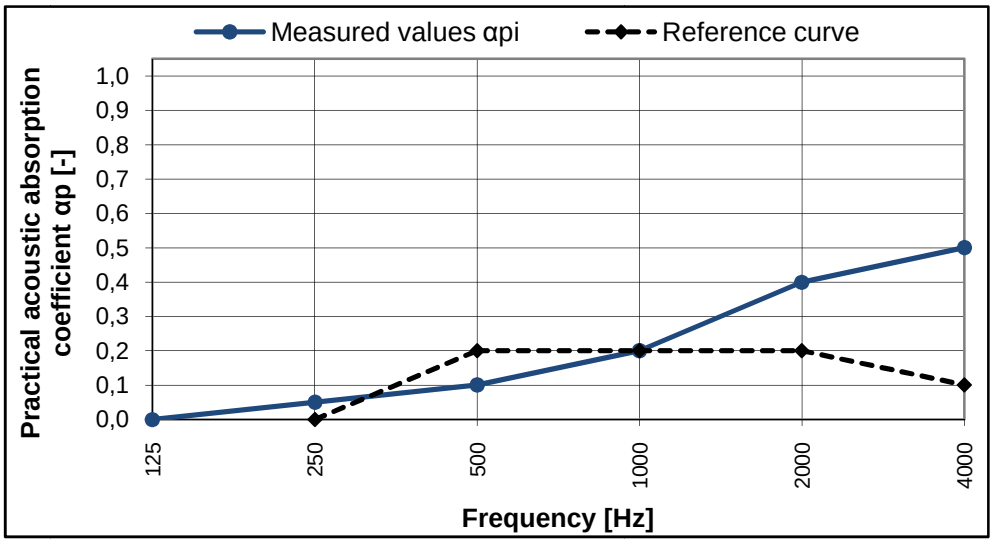
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Acoustic absorption calculation in reverberation room according to ISO 11654 and ASTM C423-09a

Sample description: Fabric for surface, wall ceiling furniture application, Model " Feltro 4.5 mm"
Mounting Type: A

Sample area: 11.52 m^2
Reverberation room volume: 161.3 m^3

f [Hz]	α_p [-]
Frequency	*Practical acoustic absorption coefficient values*
125	0,00
250	0,05
500	0,10
1000	0,20
2000	0,40
4000	0,50



STANDARD EVALUATION INDEX:

α_w	0.20 (H)	*Weighted acoustic sound absorption*	*UNI EN ISO 11654:1998*
NRC	0.20	*Noise Reduction Coefficient*	*ASTM C423 – 09a*

Evaluation based on laboratory measurement results by means of a technical method.

Laboratory Manager, Ing. Antonio Scofano

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