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REPORT N. 093-2019-CR Eng

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

Issue place and date: Cerea (VR), date 06/07/2019

Committee: ABITEX srl

Address committee: Via E. Fermi 9/11, 35010 Cadoneghe (PD) Italy

Sample delivery date: 05/09/2019

Sample provenance: ABITEX srl

Sample installation date: 05/09/2019

Sample installed in laboratory by: Z Lab S.r.l (sampling made by the committee)

Test date: 05/09/2019

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

Sampling denomination: The test sample is denominated "Horo"

Mounting Type: Mounting G -100

LAB N° 1416

PREPARED	VERIFIED	APPROVED
Sabato Di Filippo	Antonio Scofano	Antonio Scofano

Sample description

The test sample is composed of fabric denominated "Horo" .

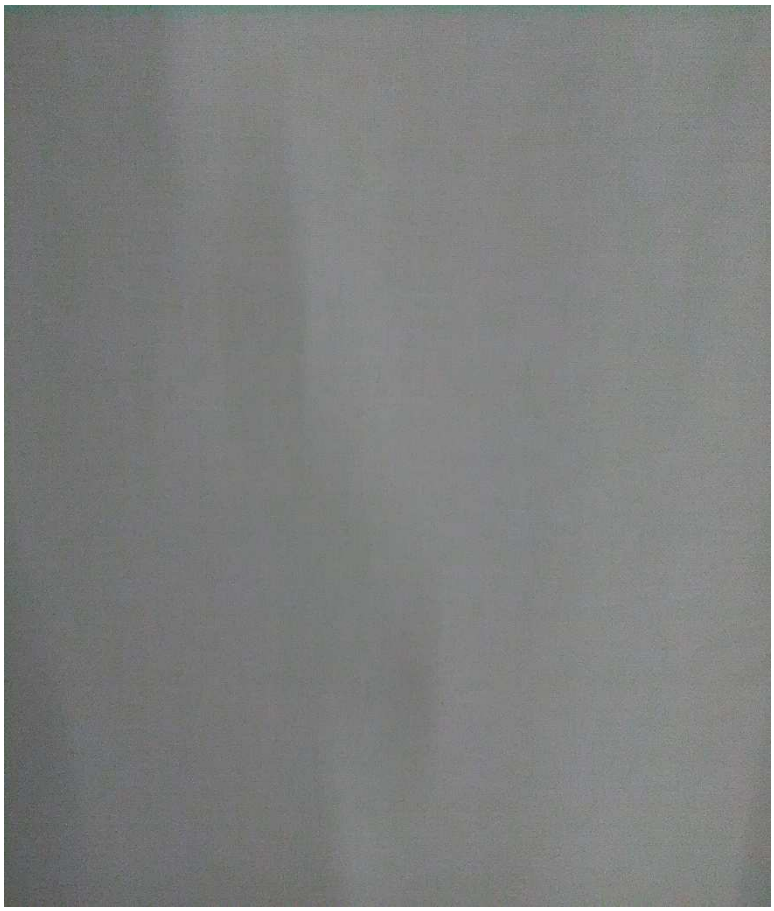


Figure 1_Sample detail

An extract of the technical data of the product is shown(*):

Article	HORO
Composition	100% polyester
Weight	± 550 gr/m²
Width	± 140 cm
More informations	www.abitex.eu

(*) nominal data provided by the sample manifacturer

Mounting conditions

The sample was installed in the reverberation chamber by laboratory employees.

The mounting type is G-100 in accordance with Annex B.5 of UNI EN ISO 354.

The sample was mounted in two configurations:

CONFIGURATION 1 (Internal reference: 093-2019-CR): Curled fabric

CONFIGURATION 2 (Internal reference: 095-2019-CR): Tight fabric

The details of mounting for the configurations are:

- Distance from walls: 100 mm, and construction without closing frame;
- The sample was mounted at wooden guide directly installed under the ceiling.

CONFIGURATION 1 details: Curled fabric

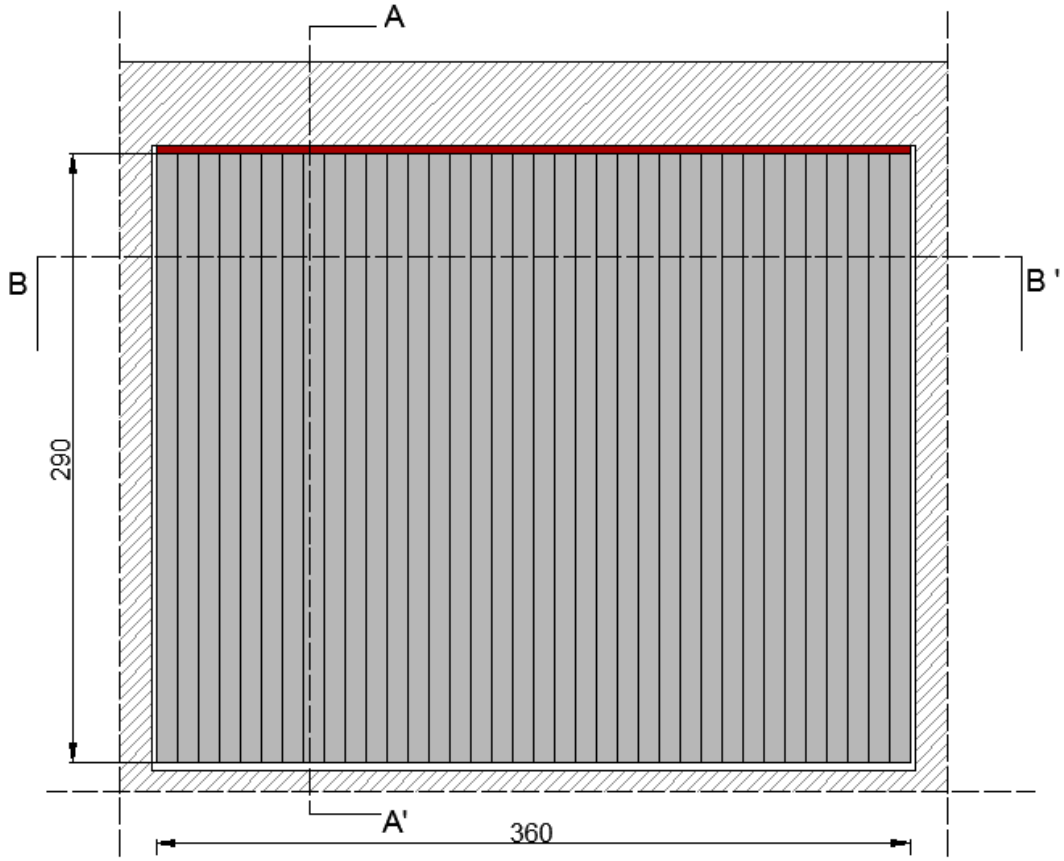
The test sample characteristics are listed below (**):

Length Structure (mm)	*Width Structure (mm)*	*Area (m^2)*	
2900	3600	10,44	

To obtain the 10.44 square meters of material, 2 portions of fabric have been placed side by side with an overlap of 20 mm union joints.

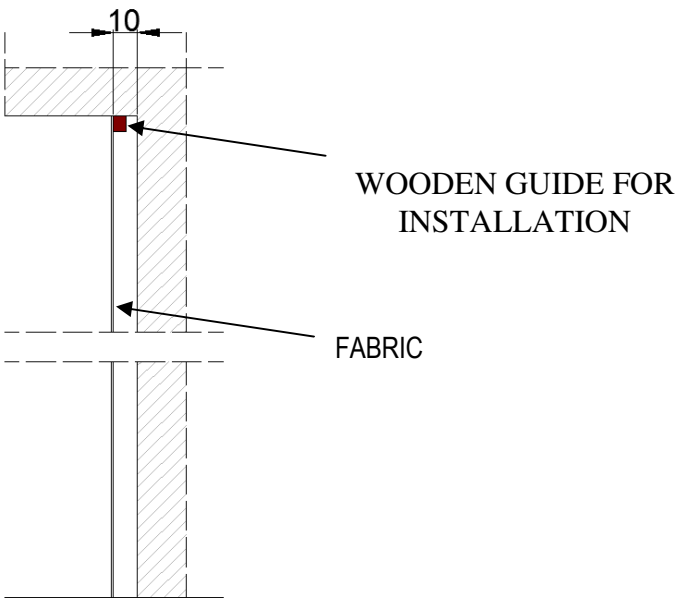
(*) nominal data provided by the sample manifacturer
(**) data measured by test element sampling

The drawings of the details of configuration 1 are shown in the following images:
(The measurements are shown in cm)

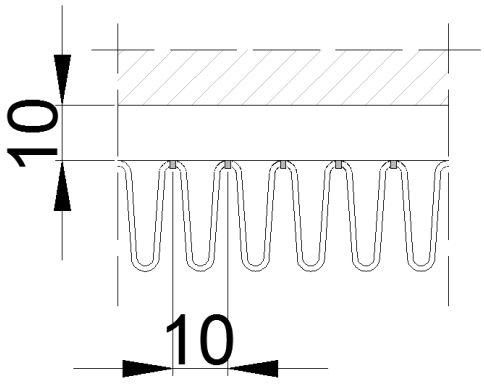


FABRIC

A-A Section



B-B' Section



CONFIGURATION 2 details: Tight fabric

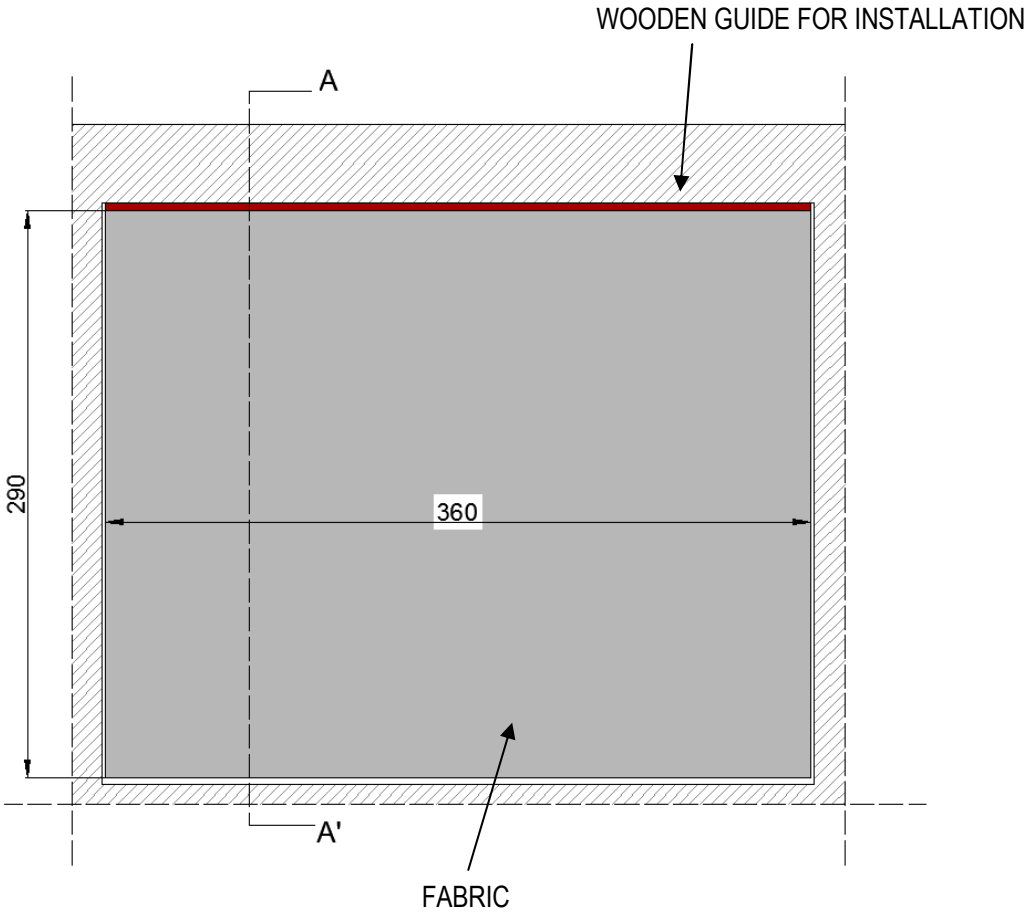
The test sample characteristics are listed below (**):

Length Structure (mm)	*Width Structure (mm)*	*Area (m^2)*	
2900	3600	10,44	

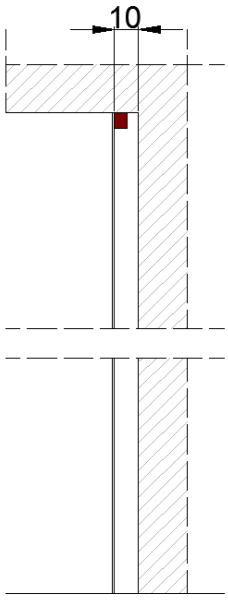
To obtain the 10.44 square meters of material, 2 portions of fabric have been placed side by side with an overlap of 20 mm union joints.

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

The drawings of the details of configuration 2 are shown in the following images:
(The measurements are shown in cm)



A-A Section



Sample images

Figura 2_ Reverberation chamber with Sample Configuration 1

Figura 3_ Reverberation chamber with Sample Configuration 2

Figura 4_ Detail "curled" fabric Configuration 1

The test was performed as soon as the preparation of the sample was completed.

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.*

Test environment description

The test structure is made of reinforced concrete, completely insulated from the floor of the laboratory with anti-vibration supports. It is made up of a reverberating room of irregular shape and free of partition parallel to each other.

The dimensional data are listed below:

Average reverberation room dimensions (L x W x H)	700 X 560 X 370 cm

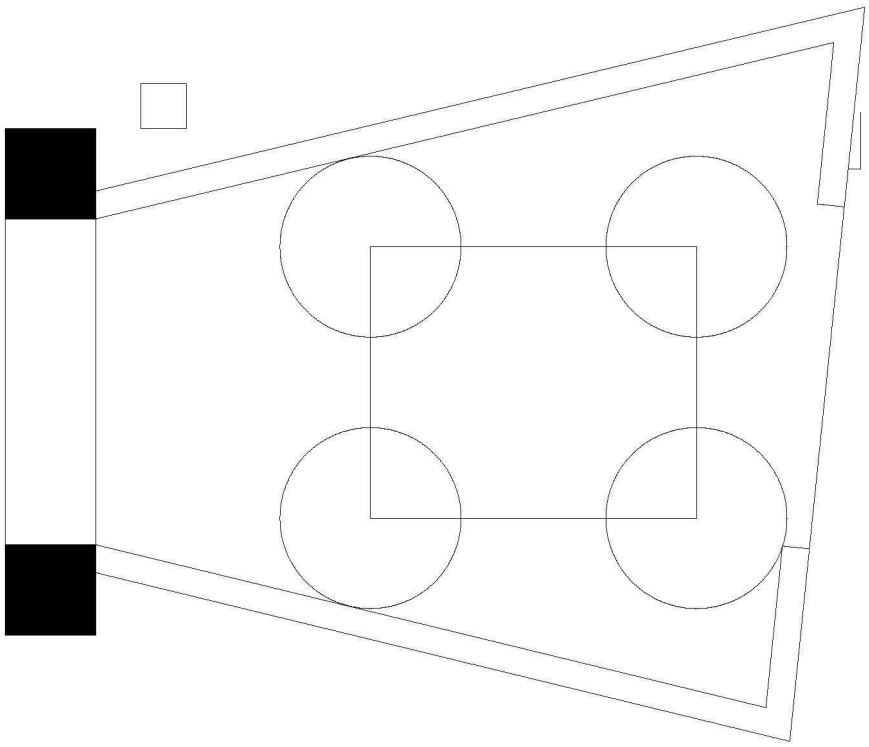


Figure 5_ Reverberation Room Scheme

Test equipment and instruments

Instrument	Model	Serial number
Sound Level Meter	Larson & Davis LD2900B	1080 CH1
Microphone	GRAS 40AQ	204027
Preamplifier	Larson & Davis PRM900C	1267
Calibrator	Larson & Davis CAL200	3852
Omnidirectional source	Bruel & Kjaer 2719 + 4292	2571776 + 14012
Termohygrometer	DELTA OHM HD35ED1NTV	16037651
Temperature and humidity sensor	DELTA OHM HD35ED1NTV	16037652
Tape	Stanley 33 - 442	13/946

Environmental data during the test

CONFIGURATION 1 (Referee 092-2019-CR)

	Reverberation room
Volume	161.3 m^3
Total surface	188.5 m^2
Average temperature during T_1	17.4 ± 1.0 °C
Average relative humidity during T_1	65.3 ± 2.0 %
Average temperature during T_2	17.4 ± 1.0 °C
Average relative humidity during T_2	65.3 ± 2.0 %
Sample surface	10.44 m^2

CONFIGURATION 2 (Referee 094-2019-CR)

	Reverberation room
Volume	161.3 m^3
Total surface	188.5 m^2
Average temperature during T_1	17.4 ± 1.0 °C
Average relative humidity during T_1	65.3 ± 2.0 %
Average temperature during T_2	17.4 ± 1.0 °C
Average relative humidity during T_2	65.3 ± 2.0 %
Sample surface	10.44 m^2

Where:
- T_1: Empty room reverberation time
- T_2: Room reverberation time with sample

Measurement method

The measurement of the sound absorption in the reverberation room is based on the principle of the difference between the reverberation times measured in the reverberation room in the presence of the material to be tested and in the empty reverberation room. The acoustic source, which produces pink noise, has been operated within the source room in 3 different positions, while the microphone is located in 4 different positions. Three measurements for each source-microphone combination have been performed, for a total of 36 measurements in the empty room and 36 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:

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

The mean value is calculated to the second decimal digit, rounded by 0.05 steps, and limited to αpi = 1.00 for rounded average values > 1.00.

The αpi values are used to calculate the αw weighted acoustic absorption coefficient starting from the reference curve which is translated at steps of 0.05 to the measured value until the sum of unfavorable deviations is less than or equal to 0.10. The αw weighted acoustic absorption coefficient is defined as the value of the reference curve transposed at 500 Hz.

If a practical acoustic absorption coefficient αpi exceeds the value of the referenced reference curve of 0.25 or more, add one or more shape gauges to the αw value by bringing them back into parentheses. If the excess absorption occurs at 250 Hz, the notion L is reported, if the excess occurs at 500 Hz or 1000 Hz, the indicator M is used, and if the excess occurs at 2000 Hz or 4000 Hz the notion H.

Measured values

Configuration 1 (Internal reference 093-2019-CR)

f [Hz]	T_1 [s]	T_2 [s]	A_T [m²]
Frequency	*Empty room reverberation time*	*Sample room reverberation time*	*Equivalent absorption area*
100	3.87	3.42	0.87
125	5.05	3.40	2.52
160	6.22	4.09	2.19
200	6.35	3.54	3.27
250	6.32	3.09	4.33
315	5.90	2.34	6.76
400	5.46	2.01	8.21
500	5.32	1.93	8.64
630	5.50	1.95	8.64
800	5.04	1.92	8.43
1000	4.46	1.89	7.94
1250	4.40	1.87	8.01
1600	4.59	1.99	7.42
2000	4.36	1.95	7.40
2500	3.98	1.83	7.73
3150	3.36	1.69	7.66
4000	2.83	1.59	7.19
5000	2.31	1.38	7.54

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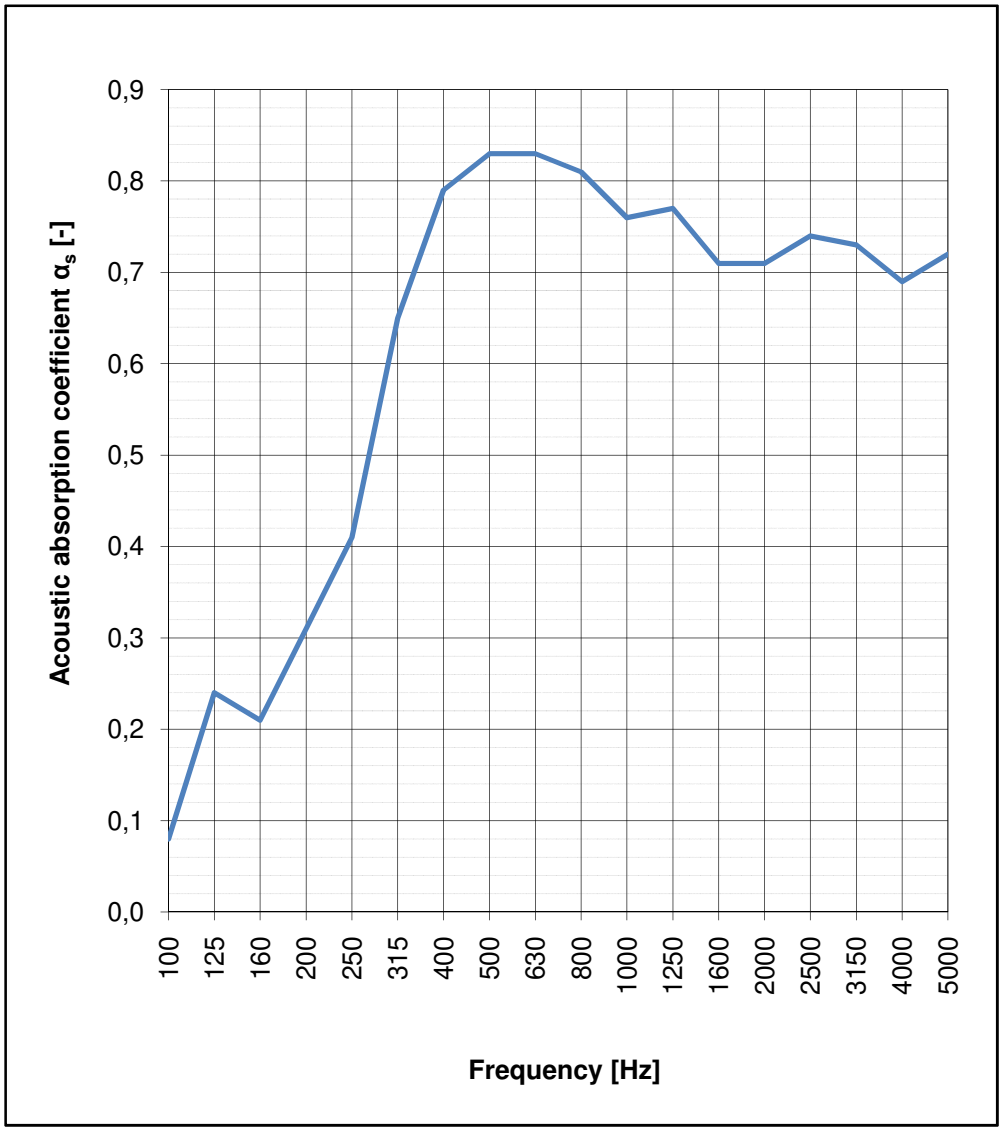
Acoustic absorption calculation in reverberation room according to UNI EN ISO 354:2003

Sample description: Fabric denominated "Horo"
Mounting Type: Mounting G-100 - Configuration 1 Curled Fabric

Sample area: 10.44 m^2
Reverberation room volume: 161.3 m^3

f [Hz]	α_S [-]
Frequency	*Acoustic absorption coefficient values*
100	0.08
125	0.24
160	0.21
200	0.31
250	0.41
315	0.65
400	0.79
500	0.83
630	0.83
800	0.81
1000	0.76
1250	0.77
1600	0.71
2000	0.71
2500	0.74
3150	0.73
4000	0.69
5000	0.72



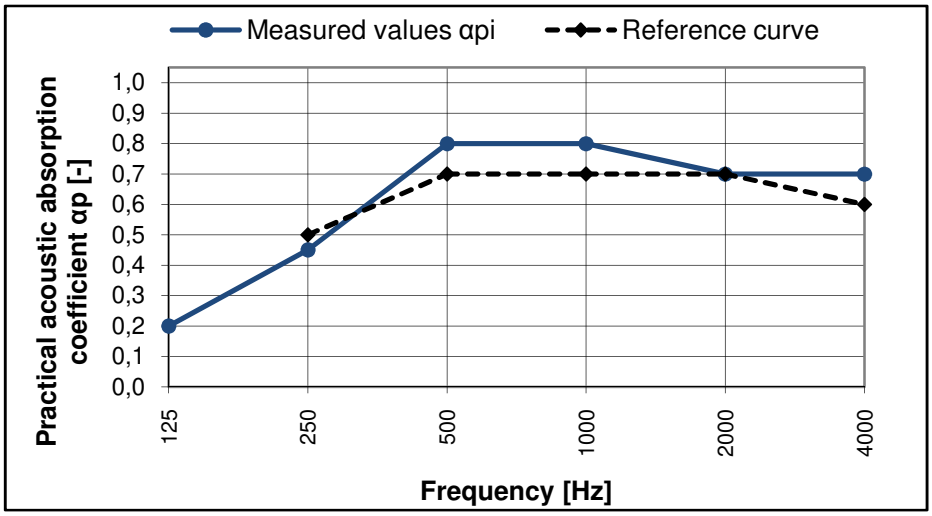
Evaluation based on laboratory measurement results by means of a technical method.

Acoustic absorption calculation in reverberation room according to UNI EN ISO 11654:1998

Sample description: Fabric denominated "Horo"
Mounting Type: Mounting G-100 - Configuration 1 Curled Fabric

Sample area: 10.44 m^2
Reverberation room volume: 161.3 m^3

f [Hz]	α_p [-]
Frequency	*Practical acoustic absorption coefficient values*
125	0.20
250	0.45
500	0.80
1000	0.80
2000	0.70
4000	0.70



STANDARD EVALUATION INDEX:

α_w	0.70 CLASS C	*Weighted acoustic sound absorption coefficient* *Sound Absorption Class* **	*UNI EN ISO 11654:1998*

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

** Classification of acoustic absorbers: The unique αw evaluation index is used to calculate the absorption class according to the following table:

CLASS	α_w
A	0.9 - 0.95 - 1.00
B	0.8 - 0.85
C	0.6 - 0.65 - 0.7 - 0.75
D	da 0.3 a 0.55
E	0.15 - 0.2 - 0.25
NC	0.00 - 0.05 - 0.1

Configuration 2 (Internal reference 095-2019-CR)

f [Hz]	T_1 [s]	T_2 [s]	A_T [m²]
Frequency	*Empty room reverberation time*	*Sample room reverberation time*	*Equivalent absorption area*
100	3.87	3.38	0.98
125	5.05	3.54	2.22
160	6.22	4.22	2.00
200	6.35	4.40	1.82
250	6.32	3.34	3.68
315	5.90	2.64	5.47
400	5.46	2.27	6.71
500	5.32	2.08	7.66
630	5.50	2.00	8.33
800	5.04	1.99	7.92
1000	4.46	1.98	7.35
1250	4.40	2.25	5.66
1600	4.59	2.22	6.08
2000	4.36	2.13	6.26
2500	3.98	2.09	5.95
3150	3.36	1.86	6.24
4000	2.83	1.71	6.05
5000	2.31	1.54	5.63

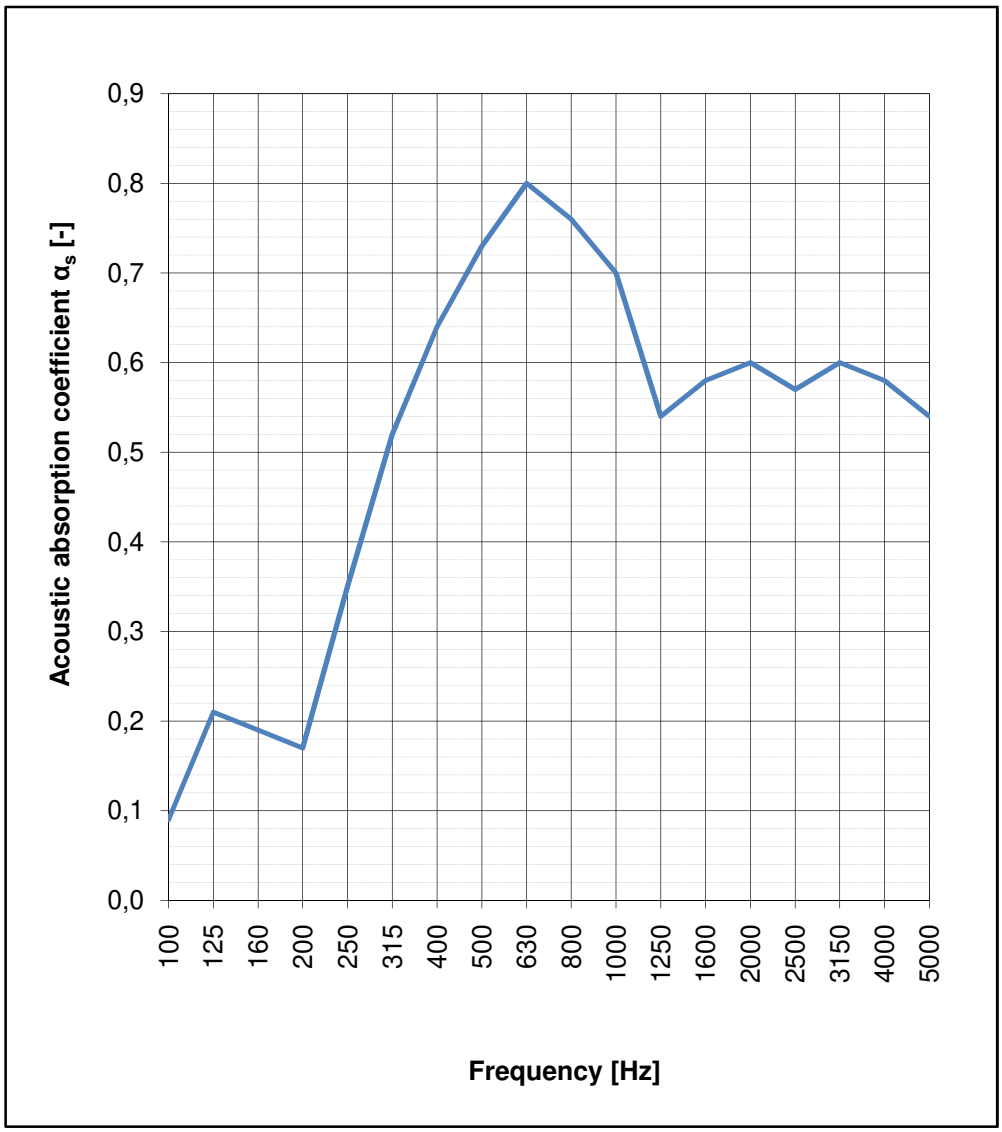
LAB N° 1416

Acoustic absorption calculation in reverberation room according to UNI EN ISO 354:2003

Sample description: Fabric denominated "Horo"
Mounting Type: Mounting G-100 - Configuration 2 Tight Fabric

Sample area: 10.44 m^2
Reverberation room volume: 161.3 m^3

f [Hz]	α_S [-]
Frequency	*Acoustic absorption coefficient values*
100	0.09
125	0.21
160	0.19
200	0.17
250	0.35
315	0.52
400	0.64
500	0.73
630	0.80
800	0.76
1000	0.70
1250	0.54
1600	0.58
2000	0.60
2500	0.57
3150	0.60
4000	0.58
5000	0.54



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

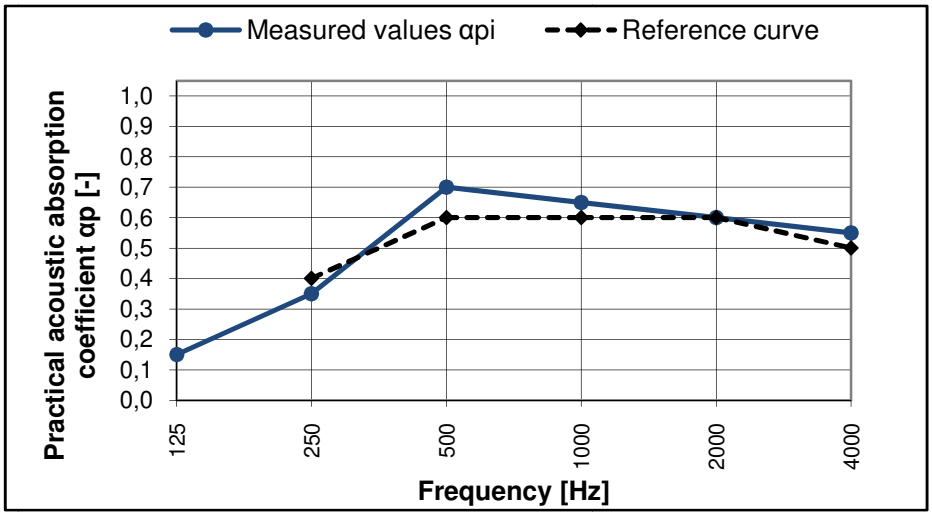
LAB N° 1416

Acoustic absorption calculation in reverberation room according to UNI EN ISO 11654:1998

Sample description: Fabric denominated "Horo"
Mounting Type: Mounting G-100 - Configuration 2 Tight Fabric

Sample area: 10.44 m^2
Reverberation room volume: 161.3 m^3

f [Hz]	α_p [-]
Frequency	*Practical acoustic absorption coefficient values*
125	0.15
250	0.35
500	0.70
1000	0.65
2000	0.60
4000	0.55



STANDARD EVALUATION INDEX:

α_w	0.60 CLASS C	*Weighted acoustic sound absorption coefficient* *Sound Absorption Class* **	*UNI EN ISO 11654:1998*

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

** Classification of acoustic absorbers: The unique αw evaluation index is used to calculate the absorption class according to the following table:

CLASS	α_w
A	0.9 - 0.95 - 1.00
B	0.8 - 0.85
C	0.6 - 0.65 - 0.7 - 0.75
D	da 0.3 a 0.55
E	0.15 - 0.2 - 0.25
NC	0.00 - 0.05 - 0.1

Laboratory Manager, Ing. Antonio Scofano