

TEST REPORT N.325694

Measurement in reverberation room of the equivalent sound absorption area "A_{obj}" of paneling

Purpose of testing: Eggboard 1600x800

Standard: UNI EN ISO 354:2003

Place of testing: Istituto Giordano S.p.A. - Via Erbosa, 78 - 47043 Gatteo (FC) - Italia

Order number and date: 66761, 05/06/2015

Date sample received: 05/06/2015

Date of testing: 17/06/2015

Purpose of testing

Measurement in reverberation room of the equivalent sound absorption area "A_{obj}" of paneling in accordance with standard *UNI EN ISO 354:2003*.

Sample name

The test sample is called "EGGBOARD MATRIX 1600 × 800".

Description of sample

The sample is a panelling, realized by the combination of No. 8 modular boards, tested in No. 2 configurations that differ from the height of test sample from the reverberation room floor. The test sample has the physical characteristics in the following table.

Larghezza nominale del pannello modulare <i>Nominal width of the modular board</i>	795 mm
Lunghezza nominale del pannello modulare <i>Nominal length of the modular board</i>	1595 mm
Spessore nominale del pannello modulare <i>Nominal thickness of the modular board</i>	56 mm
Peso misurato del pannello modulare <i>Measured weight of the modular board</i>	16,70 kg/m ²
Dimensioni misurate del campione nella configurazione n. 1 <i>Test sample measured dimensions in configuration No. 1</i>	3190 mm × 3195 mm
Altezza misurata dal pavimento del campione nella configurazione n. 1 <i>Test sample measured height from floor in configuration No. 1</i>	500 mm
Superficie acustica utile del campione nella configurazione n. 1 (3190 mm × 3195 mm) <i>Effective acoustic surface of test sample in configuration No. 1 (3190 mm × 3195 mm)</i>	10,19 m ²
Dimensioni misurate del campione nella configurazione n. 2 <i>Test sample measured dimensions in configuration No. 2</i>	3190 mm × 3195 mm
Altezza misurata dal pavimento del campione nella configurazione n. 2 <i>Test sample measured height from floor in configuration No. 2</i>	800 mm
Superficie acustica utile del campione nella configurazione n. 2 (3190 mm × 3195 mm) <i>Effective acoustic surface of test sample in configuration No. 2 (3190 mm × 3195 mm)</i>	10,19 m ²

More specifically, each modular panel is constituted by:

- lower board with sinusoidal section made by polyester and clad by 100 % polyester Trevira CS;
- upper flat board made by polyester and clad by 100 % polyester Trevira CS;
- matrix light;
- indirect light;
- steel frame.

The sample is manufactured by the Customer and it was mounted in reverberation room by Istituto Giordano staff on a supporting steel structure, nominal section 50 mm × 40 mm and nominal thickness 0,6 mm.

3. Drawings of sample

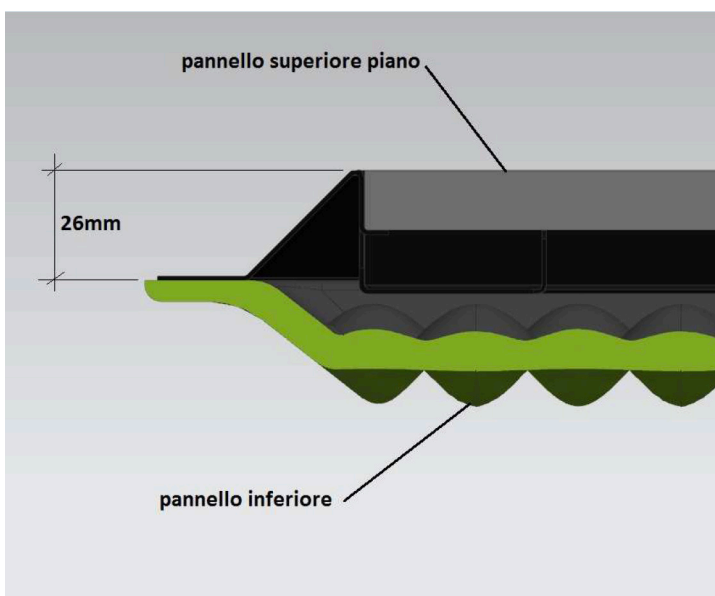
Technical drawings of the Eggboard Matrix light fixture. The top view shows a rectangular panel with a width of 795 mm and a length of 1270 mm. The side view shows a thickness of 56 mm. The perspective view shows the fixture suspended by three cables. A callout '5' points to the frame. A callout '3' points to the matrix light, and '1' points to the sound absorbing panel. A callout '4' points to the indirect light, and '2' points to the sound absorbing panel.

N	DESCRIPTION	MATERIAL
1	Esthetic sound absorbing panel	Polyester
2	Sound absorbing panel	Polyester
3	Matrix Light	
4	Indirect Light	
5	Frame	Steel

FINAL CODE	DESCRIPTION
M3101W21	Eggboard Matrix DIR/IND 1600x800 3000K BC
M3101W91	Eggboard Matrix DIR/IND 1600x800 3000K GRO
M3101W51	Eggboard Matrix DIR/IND 1600x800 3000K VDE
M3101N21	Eggboard Matrix DIR/IND 1600x800 4000K BC
M3101N91	Eggboard Matrix DIR/IND 1600x800 4000K GRO
M3101N51	Eggboard Matrix DIR/IND 1600x800 4000K VDE

PROVVISORIO		VISCO	28 Apr. 2015
DESCRIZIONE MESS/IND/AN/IND/AN DESCRIZIONE		DESCRIZIONE MESS/IND/AN/IND/AN	DESCRIZIONE
EGGBOARD MATRIX DIR/IND 1600x800			
Artemide			
DESCRIZIONE MESS/IND/AN/IND/AN		TREATMENT MESS/IND/AN/IND/AN	TREATMENT
1/1		A2	
VISCO			
			M3101XXX

4. Key



Simbolo Symbol	Descrizione Description
1	Pannello inferiore Lower board
2	Pannello superiore Upper board
3	Matrice luminosa Light matrix
4	Luce indiretta Indirect light
5	Telaio in acciaio Steel frame

5. Photograph of sample in configuration No. 1



6. Photograph of sample in configuration No. 2



7. Normative references

The test was carried out in accordance with standard *UNI EN ISO 354:2003 dated 01/12/2003 "Acoustics - Measurement of sound absorption in a reverberation room"*.

8. Test apparatus

The following equipment was used to carry out the test:

- Behringer "EPX2000" 2000 W power amplifier;
- Behringer "DEQ2496" digital $1/3$ - octave equaliser;
- 2 omnidirectional speakers;
- 01 dB-Stell "Symphonie" 2-channel real-time analyser;
- 01 dB-Stell "Cal21" acoustic calibrator for microphone calibration;
- G.R.A.S. Sound & Vibration type "4192" $1/2$ " microphone;
- G.R.A.S. Sound & Vibration type "2669" microphone preamplifier;
- Kern "VB 150 K 50LM" electronic platform scale;
- Sola "Tri-Matic 5m/19mm" metric tape measure;
- Bosch "DLE 50 Professional" laser rangefinder;
- Delta Ohm "HD206-2" thermo-hygrometer;
- Brüel & Kjær "UZ001" barometer;
- complementary accessories.

9. Test method

The test was carried out using detailed internal procedure PP016 revision 8 dated 11/06/2013 "*Measurement of sound absorption in a reverberation room (interrupted noise method)*".

The test environment consists of a parallelepiped-shaped reverberation room with a rectangular base and the following size specifications:

Dimensioni in pianta <i>Plan-view dimensions</i>	8,111 m × 6,744 m
Altezza "H" <i>Height "H"</i>	4,003 m
Superficie di base "S_b" <i>Base surface area "S_b"</i>	54,7 m ²
Superficie totale "S_t" <i>Total surface area "S_t"</i>	228,3 m ²
Volume della camera <i>Volume of the room</i>	218,9 m ³
Volume utile della camera "V" <i>Net volume of room "V"</i>	218,8 m ³

All surfaces of the test room were treated in such a way as to produce maximum sound reverberation; in addition, 14 slightly-curved diffusing elements having an overall surface area, including both faces, of approx. 40 m² were arranged and oriented randomly.

After at least 12 hours of conditioning inside the measurement environment, the sample was installed in the center of the reverberant room floor. It was also verified that sample's sides were not parallel to the reverberant room walls, at a distance of at least 1 m from them, as well as for the microphone positions.

The test involves measuring reverberation times of the empty reverberation room "T₁" and reverberation room containing the specimen "T₂" in order to determine the equivalent sound absorption area "a" of the sample; the reverberation time "T" corresponds to the time taken in seconds for the sound pressure level to decay 60 dB after the sound has stopped.

Measurements were taken in 1/3 -octave bands within the range 100 Hz to 5000 Hz using the interrupted noise method.

The test utilised a pink-noise generator, power amplifier and two dodecahedral omnidirectional speakers, alternatively working for each one of the twelve microphone positions, such as to measure twelve decays in sound pressure level for each frequency band.

The equivalent sound absorption area "A_{obj}" was calculated using the following equations:

$$A_{obj} = \frac{A}{n}$$
$$A = A_2 - A_1 = 55,3 \cdot V \cdot \left(\frac{1}{c_2 \cdot T_2} - \frac{1}{c_1 \cdot T_1} \right) - 4 \cdot V \cdot (m_2 - m_1)$$
$$c_2 = 331 + 0,6 \cdot t_2$$
$$c_1 = 331 + 0,6 \cdot t_1$$

where:

A_{obj} = equivalent sound absorption area, in m²;

n = number of elements;

A = equivalent sound absorption area of the test sample, in square metres;

S = the area, in square metres, covered by the test sample;

A₂ = equivalent sound absorption area, in square metres, of the reverberation room after the test sample has been introduced;

A₁ = equivalent sound absorption area, in square metres, of the empty reverberation room;

V = effective volume, in cubic metres, of the empty reverberation room;

c₂ = propagation speed of sound in air, in metres per second, of the reverberation room after the test sample has been introduced;

T₂ = reverberation time, in seconds, of the reverberation room after the test sample has been introduced;

c_1 = propagation speed of sound in air, in metres per second, of the empty reverberation room;
 T_1 = reverberation time, in seconds, of the reverberation room that is empty except for the barriers bounding the sample;
 m_2 = sound power attenuation coefficient, in reciprocal metres, calculated according to standard *UNI ISO 9613-1:2006 dated 07/09/2006 "Acoustics - Attenuation of sound during propagation outdoors - Part 1: Calculation of the absorption of sound by the atmosphere"*, using the climatic conditions present in the reverberation room since the test sample was introduced;
 m_1 = sound power attenuation coefficient, in reciprocal metres, calculated according to standard *UNI ISO 9613-1:2006* using the climatic conditions present in the empty reverberation room during the measurement;
 t_2 = air temperature, in degrees Celsius, in the reverberation room after introducing the test sample;
 t_1 = air temperature, in degrees Celsius, in the empty reverberation room.

The test was performed immediately after completion of sample preparation.

10. Uncertainty of measurement

Uncertainty of measurement was determined in accordance with standard *UNI CEI ENV 13005:2000 dated 31/07/2000 "Guide to the expression of uncertainty in measurement"*, by calculating for each frequency the number of effective degrees of freedom " ν_{eff} " and expanded uncertainty "U" of the equivalent sound absorption area " A_{obj} ", using a coverage factor "k" representing a confidence level of 95 %.

11. Environmental conditions during test

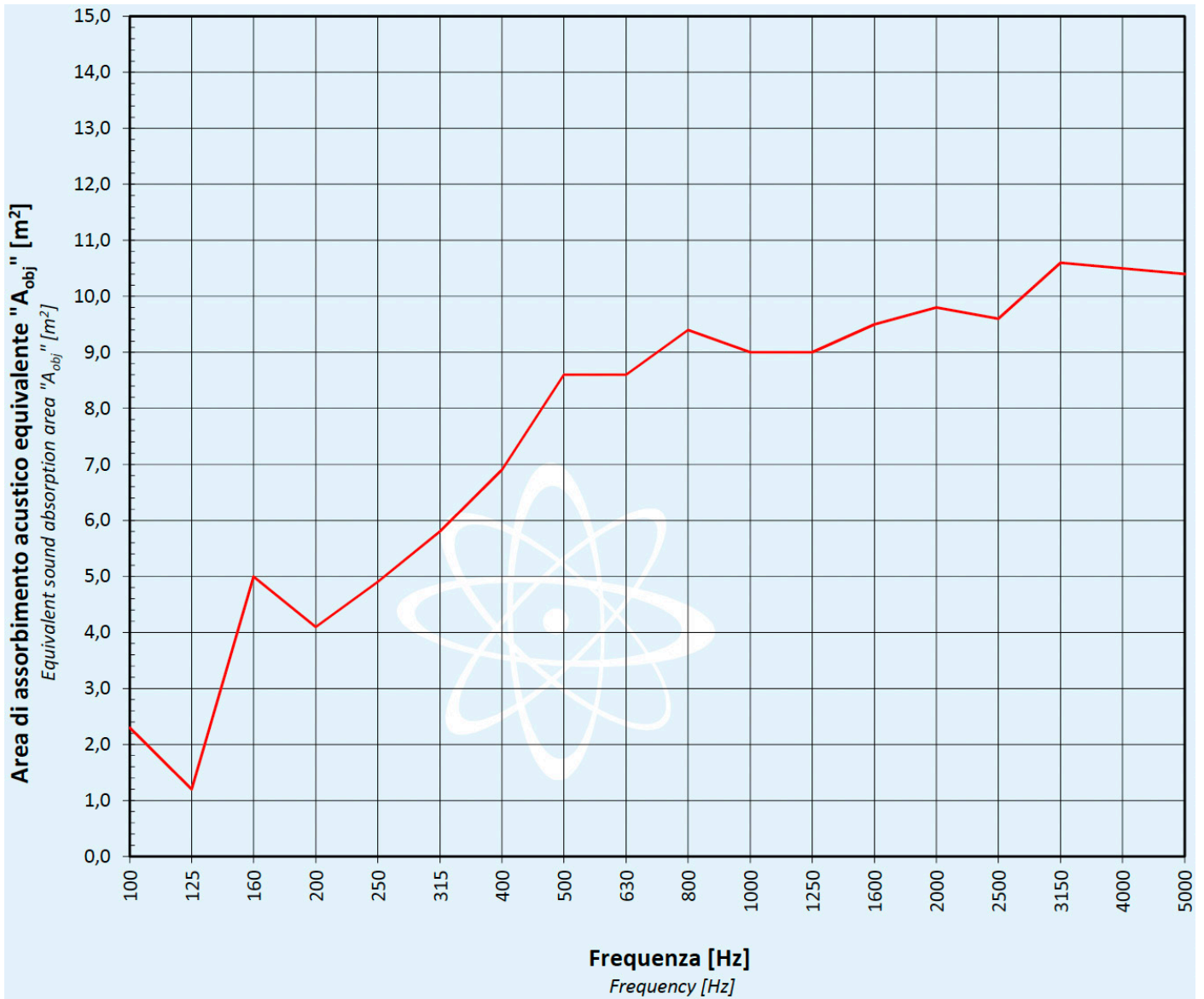
	Prova senza campione <i>Test without sample</i>	Prova con campione configurazione n. 1 <i>Test with sample configuration No. 1</i>	Prova con campione configurazione n. 2 <i>Test with sample configuration No. 2</i>
Data di esecuzione <i>Test date</i>	17/06/2014	17/06/2014	17/06/2014
Pressione atmosferica <i>Atmospheric pressure</i>	101300 Pa	101300 Pa	101300 Pa
Temperatura media <i>Average temperature</i>	25,6 °C	25,7 °C	25,5 °C
Umidità relativa media <i>Average relative humidity</i>	43,7 %	44,0 %	42,1 %

12. Test results

Configurazione n. 1 <i>Configuration No. 1</i>	Altezza dal pavimento: 500 mm <i>Height from floor: 500 mm</i>
Numero di oggetti <i>Number of objects</i>	1
Volume della camera riverberante "V" <i>Volume of reverberation room "V"</i>	218,8 m ³

Frequenza <i>Frequency</i> [Hz]	T₁ [s]	T₂ [s]	A_{obj} [m ²]	v_{eff}	k	U [m ²]
100	7,22	4,91	2,3	14	2,00	0,7
125	7,08	5,73	1,2	19	2,00	0,4
160	7,97	3,74	5,0	20	2,00	0,4
200	8,01	4,11	4,1	13	2,00	0,4
250	7,84	3,74	4,9	13	2,00	0,4
315	7,50	3,34	5,8	12	2,00	0,5
400	7,46	3,01	6,9	12	2,00	0,4
500	6,73	2,54	8,6	12	2,00	0,5
630	5,56	2,34	8,6	15	2,00	0,3
800	5,02	2,14	9,4	12	2,00	0,6
1000	5,00	2,18	9,0	13	2,00	0,3
1250	4,55	2,09	9,0	13	2,00	0,7
1600	4,24	1,97	9,5	14	2,00	0,3
2000	3,89	1,86	9,8	15	2,00	0,4
2500	3,55	1,80	9,6	22	2,00	0,2
3150	3,13	1,61	10,6	19	2,00	0,2
4000	2,75	1,51	10,5	19	2,00	0,2
5000	2,30	1,37	10,4	18	2,00	0,4

ONE-THIRD OCTAVE EQUIVALENT SOUND ABSORPTION AREA CURVE "Aobj"*



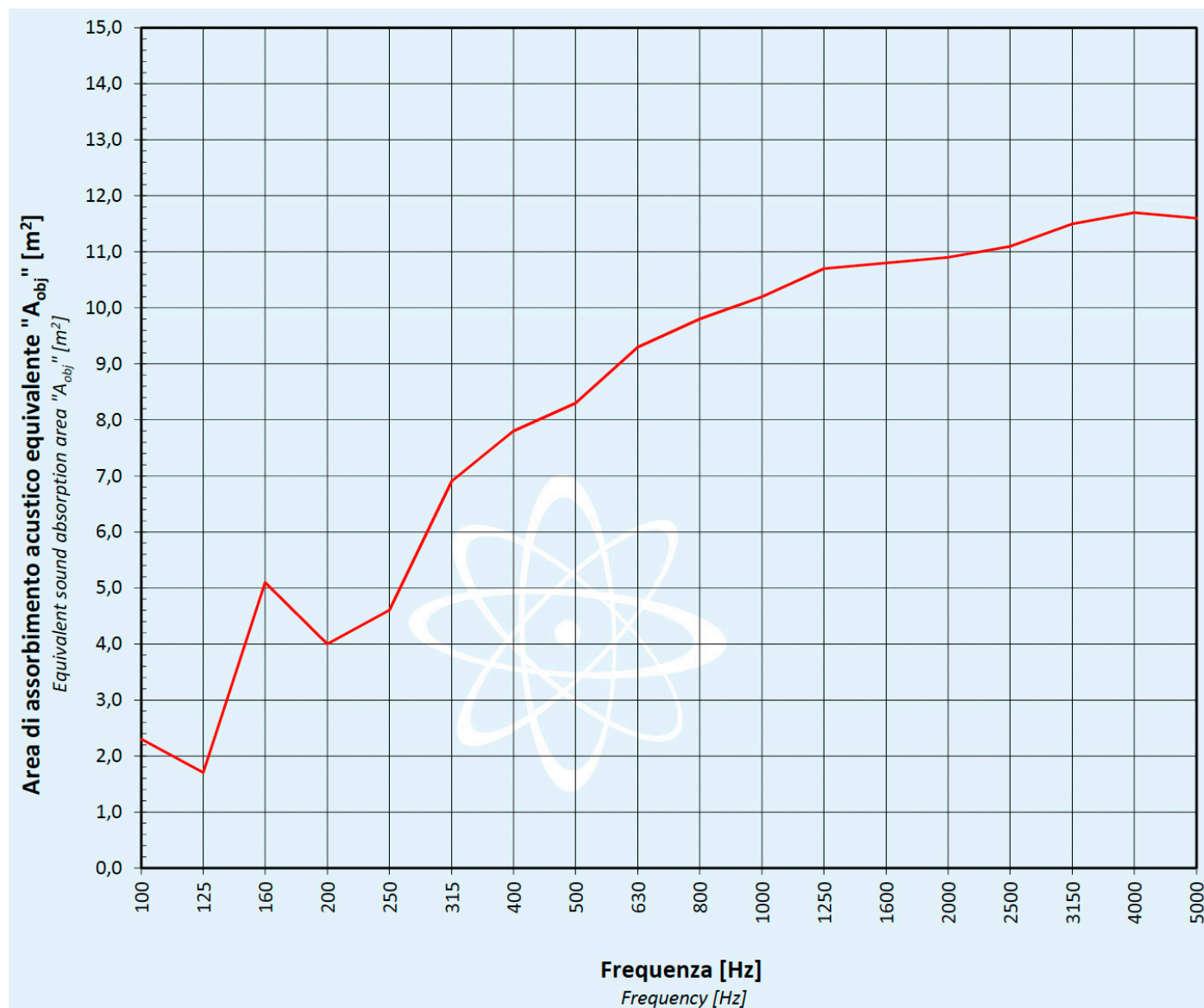
(*): Evaluation based on laboratory measurement results obtained by an engineering method.

12. Test results

Configurazione n. 2 <i>Configuration No. 2</i>	Altezza dal pavimento: 800 mm <i>Height from floor: 800 mm</i>
Numero di oggetti <i>Number of objects</i>	1
Volume della camera riverberante "V" <i>Volume of reverberation room "V"</i>	218,8 m ³

Frequenza <i>Frequency</i> [Hz]	T₁ [s]	T₂ [s]	A_{obj} [m ²]	v_{eff}	k	U [m ²]
100	7,22	4,87	2,3	13	2,00	0,8
125	7,08	5,23	1,7	15	2,00	0,5
160	7,97	3,70	5,1	20	2,00	0,4
200	8,01	4,20	4,0	12	2,00	0,5
250	7,84	3,88	4,6	14	2,00	0,3
315	7,50	3,01	6,9	13	2,00	0,5
400	7,46	2,81	7,8	12	2,00	0,4
500	6,73	2,60	8,3	13	2,00	0,4
630	5,56	2,25	9,3	16	2,00	0,3
800	5,02	2,09	9,8	13	2,00	0,4
1000	5,00	2,03	10,2	13	2,00	0,4
1250	4,55	1,90	10,7	12	2,00	0,8
1600	4,24	1,84	10,8	14	2,00	0,3
2000	3,89	1,76	10,9	16	2,00	0,3
2500	3,55	1,67	11,1	14	2,00	0,4
3150	3,13	1,54	11,5	17	2,00	0,3
4000	2,75	1,43	11,7	16	2,00	0,3
5000	2,30	1,30	11,6	15	2,00	0,5

ONE-THIRD OCTAVE EQUIVALENT SOUND ABSORPTION AREA CURVE "Aobj"*



(*) Evaluation based on laboratory measurement results obtained by an engineering method.

ANNEX “A” TO TEST REPORT No. 325694

Place and date of issue: Bellaria-Igea Marina - Italia, 26/06/2015

Customer: ARTEMIDE S.p.A. - Corso Monforte, 19 - 20122 MILANO (MI) - Italia

Purpose: estimation of equivalent sound absorption area “a” and sound absorption coefficient “ α_s ” of modular board .

Sample name

The test sample is called “EGGBOARD MATRIX 1600 × 800”.

Calculation method

The equivalent sound absorption area of the modular board “a” can be estimated using the following relationship:

$$a = \frac{A_{obj}}{n}$$

where:

a = equivalent sound absorption area of the modular board, in m²;

A_{obj} = equivalent sound absorption area of the test sample, in m²;

n = number of modular boards, equal to 8.

The sound absorption coefficient “ α_s ” can be estimated using the following equations:

$$\alpha_s = \frac{A_{obj}}{S}$$

where :

α_s = sound absorption coefficient;

A_{obj} = equivalent sound absorption area of the test sample, in m²;

S = test sample area, in m².

The surface of the test sample was not doubled, because the lower face of the test sample is not completely sound absorbing and it is partially covered by the supporting structure.

The value of “ α_s ” must be considered as indicative.

Test results

Configurazione n. 1 <i>Configuration No. 1</i>	Altezza dal pavimento: 500 mm <i>Height from floor: 500 mm</i>
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Frequenza <i>Frequency</i> [Hz]	a [m ²]	α_s [-]
100	0,29	0,22
125	0,15	0,11
160	0,62	0,49
200	0,52	0,41
250	0,61	0,48
315	0,73	0,57
400	0,87	0,68
500	1,07	0,84
630	1,08	0,85
800	1,17	0,92
1000	1,13	0,89
1250	1,13	0,89
1600	1,19	0,93
2000	1,23	0,96
2500	1,20	0,94
3150	1,32	1,04
4000	1,31	1,03
5000	1,30	1,02

α_w (indicatore di forma); classe di assorbimento secondo UNI EN ISO 11654:1998 <i>α_w (shape indicator); sound absorption class</i> <i>according to UNI EN ISO 11654:1998</i>	0,80; B
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NOTE: The values of "α_s" must be considered as indicative.

Test results

Configurazione n. 2 <i>Configuration No. 2</i>	Altezza dal pavimento: 800 mm <i>Height from floor: 800 mm</i>
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Frequenza <i>Frequency</i> [Hz]	a [m ²]	α_s [-]
100	0,29	0,23
125	0,22	0,17
160	0,63	0,50
200	0,50	0,39
250	0,57	0,45
315	0,87	0,68
400	0,97	0,76
500	1,03	0,81
630	1,16	0,91
800	1,22	0,96
1000	1,28	1,00
1250	1,34	1,05
1600	1,34	1,05
2000	1,36	1,07
2500	1,38	1,09
3150	1,44	1,13
4000	1,46	1,14
5000	1,45	1,14

α_w (indicatore di forma); classe di assorbimento secondo UNI EN ISO 11654:1998 <i>α_w (shape indicator); sound absorption class</i> <i>according to UNI EN ISO 11654:1998</i>	0,80; B
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NOTE: The values of " α_s " must be considered as indicative.

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