NATIONAL TECHNICAL UNIVERSITY OF ATHENS

ACOUSTICS RESEARCH & SIMULATION LAB
School of Architecture

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Certificate of acoustic performance
Sound absorption coefficients laboratory test

a_w | Sound Absorption Class | NRC

ISO 354
Measurement of sound absorption in a reverberation room

ISO 11654
Sound absorbers for use in buildings - Rating of sound absorption

ASTM C423
Standard Test Method for Sound Absorption and Sound Absorption Coefficients by the Reverberation Room Method

Certificate Serial Number: *AWG WP aw 75-2023*

Total Pages: *14*

Contractor: *Alfa Wood Group AEBE*

Test Element Type: *Composite Soundabsorbing Panels*

Contractor's Test Element ID : *Alfa Sonic with Rockwool Backing*

Measurement Location: *NTUA Acoustics Laboratory - Zografou Campus, Athens-Greece*

Transaction Details: *1182612083 NBG iBank Electronic Payment*

Issue Date: *20 - 06 - 2023*

NOMENCLATURE

T20 - Reverberation Time

The time, in seconds, that would be required for the sound pressure level to decrease by 20 dB after the sound source has stopped.

T1 - Empty Chamber Reverberation Time

The reverberation time per 1/3 octave band of the test room prior to the installation of the test item and without the presence of people or other factors that can modify the reverberation time measurement results.

T2 - Reverberation Time with the test object installed

The reverberation time per 1/3 octave band of the test room after the installation of the test item and without the presence of people or other factors that can modify the reverberation time measurement results.

S - Surface Area

The area of the floor or wall covered by the test specimen in m^2.

a_s - 1/3 Octave Band Absorption Coefficient

The ratio of the equivalent sound absorption area of a test specimen divided by the area of the test specimen for the frequency range of 100 Hz - 5000 Hz .

a_{pi} - Practical Absorption Coefficient

Frequency-dependent value of the sound absorption coefficient which is based on measurements on 1/3 octave bands in accordance with ISO 354 and which is calculated in octave bands in accordance with ISO 11654:1997

a_w - Weighted Absorption Coefficient

The value of the shifted reference curve at 500 Hz, calculated using the method described in ISO 11654:1997 .

Absorption Class

The classification of the absorptive performance of the test item based on its weighted absorption coefficient.

NRC - Noise Reduction Coefficient

The arithmetic average, rounded to the nearest multiple of 0.05, of the absorption coefficients determined at the octave band centre frequencies of 250, 500, 1000 and 2000 Hz.

Mounting Type

Defines how the test item is arranged/fixed in the test room according to the methods described in Appendix B of ISO 354:2003

DESCRIPTION OF THE MEASUREMENT PROCESS

The present report describes the process of measuring and assessing the sound absorption performance indices of the test item in subject.
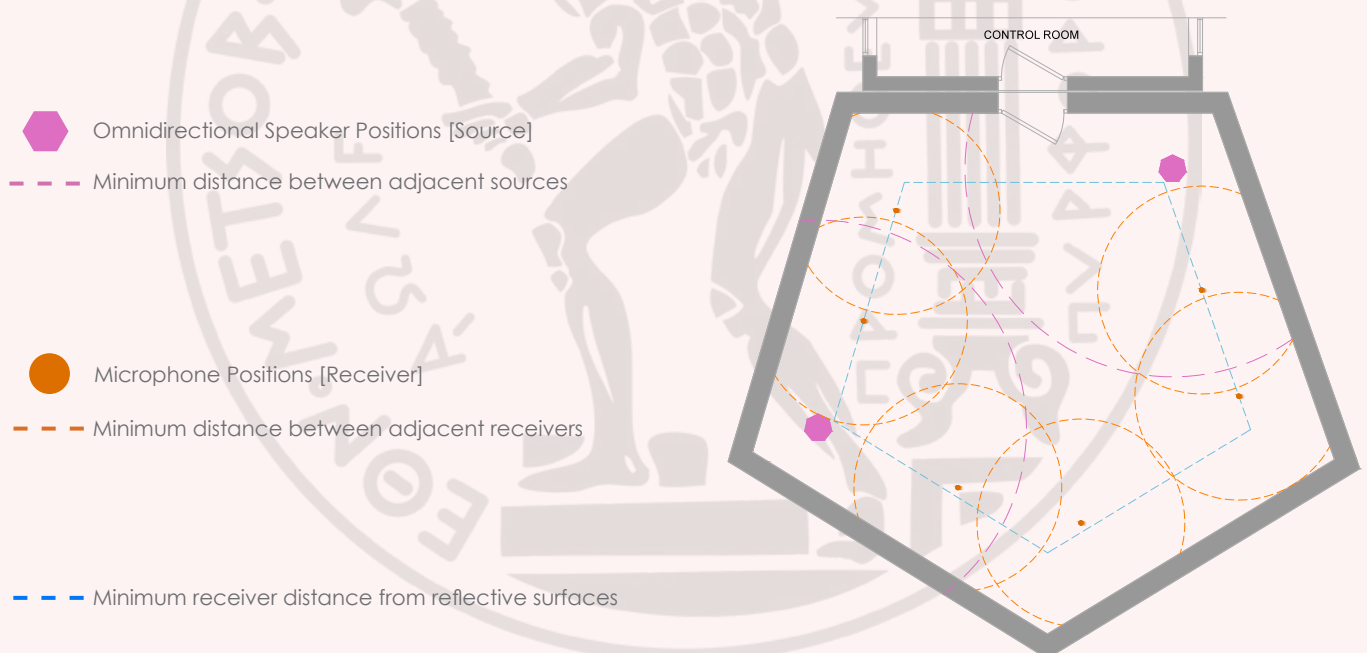
The measurements were carried out based on the guidelines of the International Organization for Standardization and in particular according to:

ISO 354

Measurement of sound absorption in a reverberation room

The acoustic tests were executed in the reverberation chamber of the Acoustics Laboratory - National Technical University of Athens, Greece.

The test room has a volume of 242.8 m³ and its floor plan is illustrated below·. The ceiling of the test room is relatively inclined, compared to the ground level. The diffuse field is further enhanced by the permanently installed ceiling diffusers. Additional diffusive elements are placed diametrically opposed two of the corners of the chamber in order to eliminate potential standing waves.

CONTROL ROOM

⬡ Omnidirectional Speaker Positions [Source]

– – – Minimum distance between adjacent sources

● Microphone Positions [Receiver]

– – – Minimum distance between adjacent receivers

– – – Minimum receiver distance from reflective surfaces

As depicted from the drawing above, an omnidirectional source (dodecahedron speaker) and a   point receiver (microphone) were placed into the reverberation chamber in order to achieve a combination of 12 measuring positions as directed by the ISO 354:2003. The measurements were executed in 1/3 octave band analysis (Lz Weighting) follwing the precision method.

For each receiver position the following parameters were sampled:

i) The average background sound pressure level of the test room [Sound Source Off]

ii) The reverberation time with the test item installed in the test room [Interrupted Noise Method]

iii) The reverberation time without the test item in the test room [Interrupted Noise Method]

(Note: The dismantling of the test item has been completed within 10 minutes)
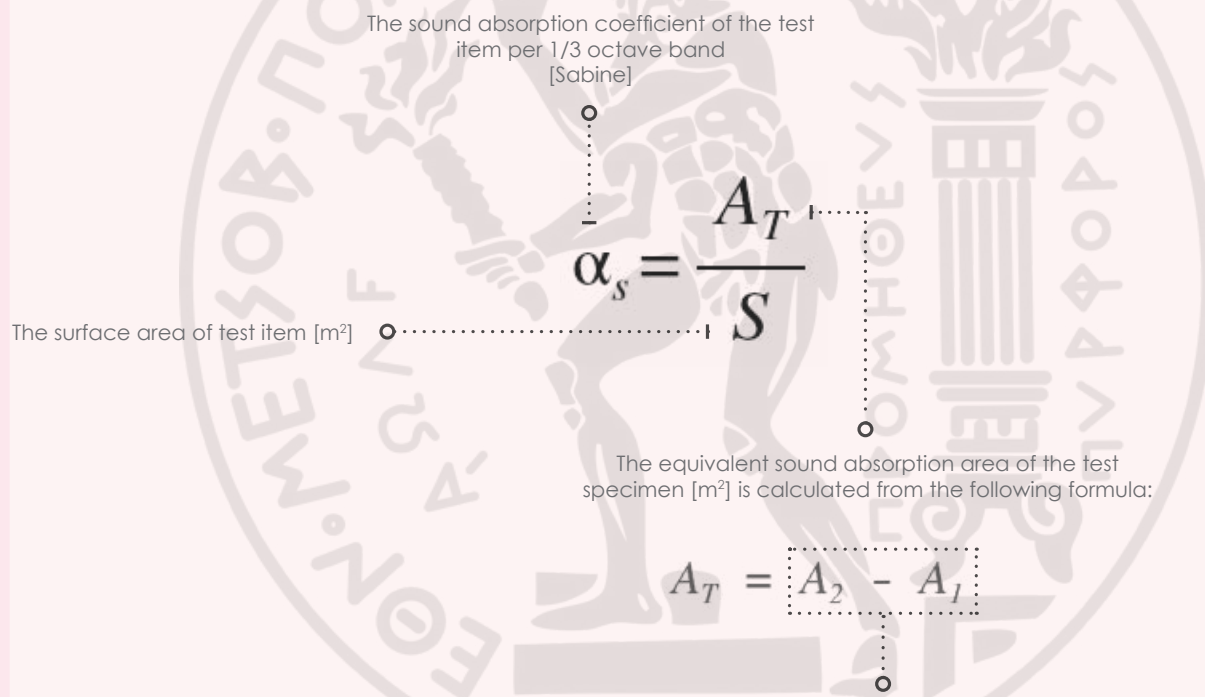
CALCULATION METHODOLOGY

Following the measurement procedure, the absorption coefficient per 1/3 octave band is calculated according to the method also described in:

ISO 354

Measurement of sound absorption in a reverberation room

The absorption curve of the test item was extracted from the 1/3 octave band values [a_s].

For the calculation of a_s for each 1/3 octave band between 100 Hz - 5000 Hz the following formula was used:

The sound absorption coefficient of the test item per 1/3 octave band [Sabine]

The surface area of test item [m²]

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

The equivalent sound absorption area of the test specimen [m²] is calculated from the following formula:

$$A_T = A_2 - A_1$$

The equivalent sound absorption area of the reverberation room w/o a test specimen (A1) and w/ the test item installed (A2) [m²] is calculated respectively as follows:

$$A_{1,2} = \frac{55,3\ V}{c_{1,2}\ T_{1,2}} - 4\ V\ m_{1,2}$$

The speed of sound [m/s] both before and after the installation of the test item is calculated respectively by the formula:

$$c = (331 + 0,6 t\,/°C)$$

The measured reverberation time for each case [Seconds]

The power attenuation coefficient, in reciprocal metres, calculated according to ISO 9613-1. It can be calculated from the attenuation coefficient, "a", which is used in ISO 9613-1 according to the formula:

$$m_{1,2} = \frac{a}{10\ log(e)}$$

RATING METHODOLOGY

After the completion of the calculations stage, the following ISO standard was used for rating and defining the absorption performance of the test item:

ISO 11654

Sound absorbers in buildings
Rating of sound absorption

The calculation of the a_w absorption coefficient was executed by shifting the reference curve, using the method described in paragraph 4.2 of the aforementioned ISO Standard.

The sound absorber was classified using the following correlation matrix (Appendix B | ISO 11654:1997) :

SOUND ABSORPTION CLASS	a_w
A	0,90 | 0,95 | 1,00
B	0,80 | 0,85
C	0,60 | 0,65 | 0,70 | 0,75
D	0,30 | 0,35 | 0,40 | 0,45 | 0,50 | 0,55
E	0,25 | 0,20 | 0,15
Not Classified	0,10 | 0,05 | 0,00

In addition to the above, the Noise Reduction Coefficient was also calculated for the test element in subject, according to the stipulations delineated by the American Society for Testing and Materials (ASTM) and in particular as described in:

ASTM C423
Standard Test Method for Sound Absorption and Sound Absorption Coefficients by the Reverberation Room Method

The Noise Reduction Coefficient calculation formula is shown below:

$$NRC = \frac{[a_{s\,(250\ Hz)} + a_{s\,(500\ Hz)} + a_{s\,(1000\ Hz)} + a_{s\,(2000\ Hz)}]}{4}$$

MEASUREMENT EQUIPMENT

NTi XL2 Frequency Analyser

M2210 Class I Microphone

NTi Minirator MR-PRO Signal Generator

Bruel & Kjaer Type 4231 Sound Calibrator

Bruel & Kjaer Type 4292-L Omnipower Sound Source

Lab Gruppen - Lab 300 Sound Amplifier

Gitzo Tripods

Rotronic BL-1D Thermometer - Hygrometer-Atmospheric Pressure
(Precision 0.15 °C | 1.1 % RH | 0.3 hPa)

Bosch PLR 50 Professional Laser Range Finder

XLR & SPEAKON Cables

MEASUREMENT CONDITIONS

	Chamber w/o Test Item	Chamber w/ Test Item
Average Temp.	16.0 °C	16.0 °C
Relative Humidity	63.0 %	63.0 %
Atmospheric Pressure	99200 Pa	99200 Pa

TECHNICAL DESCRIPTION

According to the manufacturer's data sheet, the test item installed by the contractor consists of the following components:

The panels are made of a layer of black PET polyester (back side) 12 mm, density 203 kg/m³ on which 27 mm wide 700 kg/m³ and 10 mm thickness veneered strips of black MDF (L.A.F.) are placed. The strips are attached to the polyester sheet at a (nominal) distance of 13 mm from each other thus creating acoustic channels.
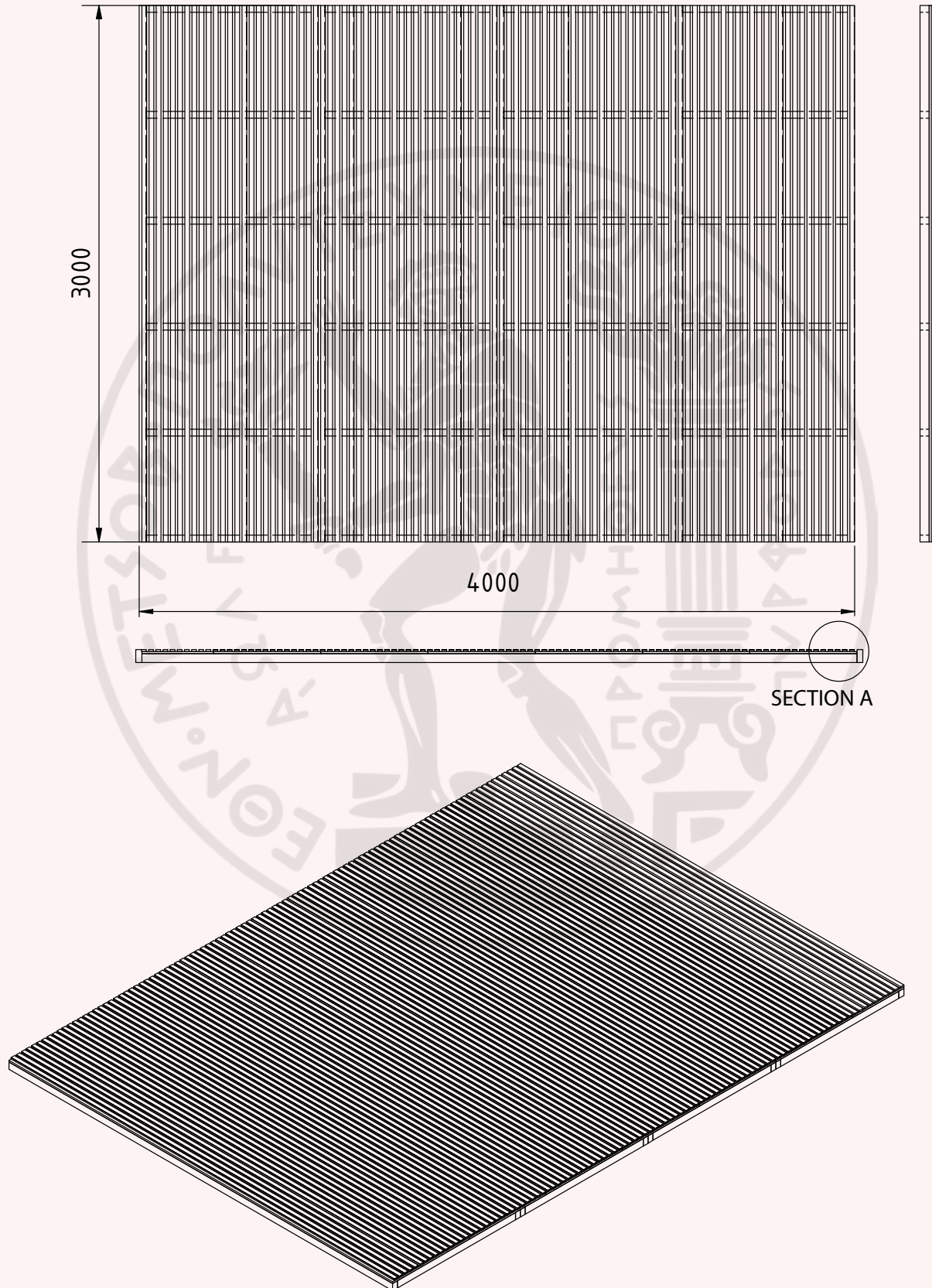
The panels have dimensions of 2400 x 600 x 22 mm or 3000 x 600 x 22 mm with a total thickness of 22 mm placing in between 40 kg/m³ 40 mm rockwool strengthening the sound absorption of the final product.
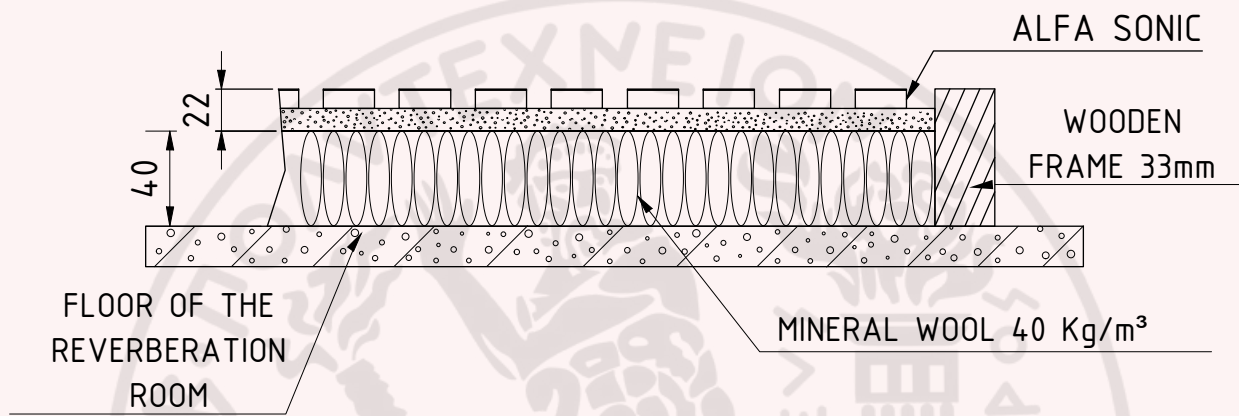
TECHNICAL DRAWINGS

The technical drawings provided by the contractor are illustrated below:

3000

4000

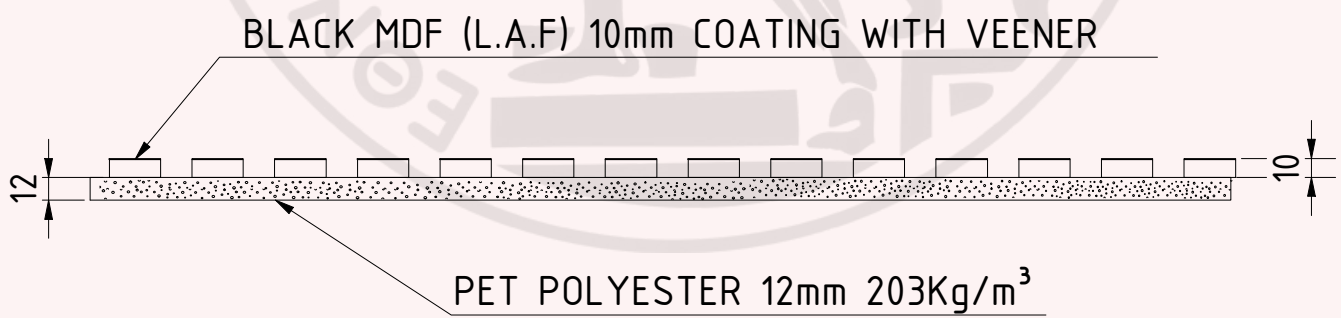SECTION A

TECHNICAL DRAWINGS

SECTION A

ALFA SONIC

WOODEN FRAME 33mm

22

40

FLOOR OF THE REVERBERATION ROOM

MINERAL WOOL 40 Kg/m³

SECTION ALFA SONIC

BLACK MDF (L.A.F) 10mm COATING WITH VEENER

12

10

PET POLYESTER 12mm 203Kg/m³

TEST SETUP - INSTALLATION WITHIN THE REVERB CHAMBER

Construction Process

TEST SETUP - INSTALLATION WITHIN THE REVERB CHAMBER

Overview

# TEST SETUP - INSTALLATION WITHIN THE REVERB CHAMBER

Surface close-up detail

REVERBERATION TIME CURVES

The RT60 curves of the chamber before (T1) and after (T2) the installation of the test item are illustrated in the following graph:

Frequency [Hz]	T1 [s]	T2 [s]
100	15.28	8.11
125	12.54	5.37
160	12.79	4.46
200	13.22	3.81
250	13.95	3.32
315	12.31	2.94
400	10.08	2.55
500	10.53	2.51
630	9.99	2.55
800	9.39	2.59
1000	8.71	2.65
1250	7.90	2.59
1600	6.72	2.49
2000	5.57	2.31
2500	4.37	2.04
3150	3.42	1.79
4000	2.66	1.56
5000	2.20	1.44
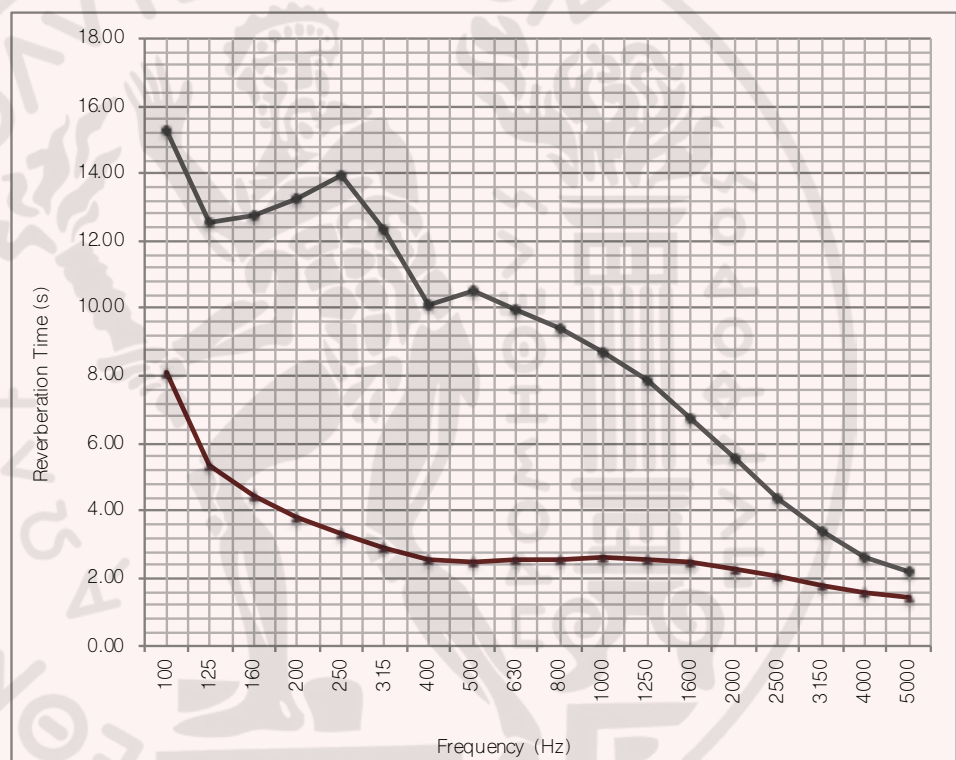
● **T1** - RT60 curve prior the installation of the test item [Empty Reverberation Chamber]

▲ **T2** - RT60 curve after the installation of the test item

MEASUREMENT RESULTS

The performance indices and spectral analysis for the predescribed test item are as follows :

Sound absorption according to ISO 354:2003
Measurement of sound absorption in a reverberation room

Client: Alfa Wood Group   Date of test: 10/3/2023

Object: Composite Sound Absorbing Panel | As per manufacturer's description & technical drawings [Attached]

Type-E60 Mounting

Room Volume:	242.8 m³	Specimen Area:	10.8 m²	
T1 Temperature:	16 °C	Humidity:	63 %	Pressure: 99.2 kPa
T2 Temperature:	16 °C	Humidity:	63 %	Pressure: 99.2 kPa

Freq f Hz	T1 RT s	T2 RT s	α_s	α_p
100	15.28	8.11	0.21	
125	12.54	5.37	0.39	0.40
160	12.79	4.46	0.53	
200	13.22	3.81	0.68	
250	13.95	3.32	0.84	0.80
315	12.31	2.94	0.95	
400	10.08	2.55	1.07	
500	10.53	2.51	1.11	1.00
630	9.99	2.55	1.07	
800	9.39	2.59	1.02	
1000	8.71	2.65	0.96	1.00
1250	7.90	2.59	0.95	
1600	6.72	2.49	0.92	
2000	5.57	2.31	0.92	0.95
2500	4.37	2.04	0.96	
3150	3.42	1.79	0.97	
4000	2.66	1.56	0.97	0.95
5000	2.20	1.44	0.88	

Sound Absorption Coefficient

Rating in accordance with ISO 11654:1997:
    α_w = 1.00   Class A

Rating in accordance with ASTM C423-17:
    NRC = 0.95   SAA = 0.95

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