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Bellaterra: 2nd of October, 2020

Report Number: 20/23054-1555

Client Reference: **GRANORTE – REVESTIMENTOS DE CORTIÇA, LDA.**
Av. Santiago num 68
4520-470 – Rio Meao (Portugal)

TEST REPORT

Requested test: Measurement of the sound absorption in a reverberation room, in accordance with the standard UNE-EN ISO 354:2004.

Test element: Veneered agglomerated cork tiles referenced ***CARIOCA.***

Date of test: 30th of July, 2020

Test carried out by: Cristian Torrente (Acoustics Laboratory – LGAI Technological Center)

Xavier Roviralta
Technical Manager of Acoustics
LGAI Technological Center S.A. (APPLUS)

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1.- SCOPE OF THE TEST

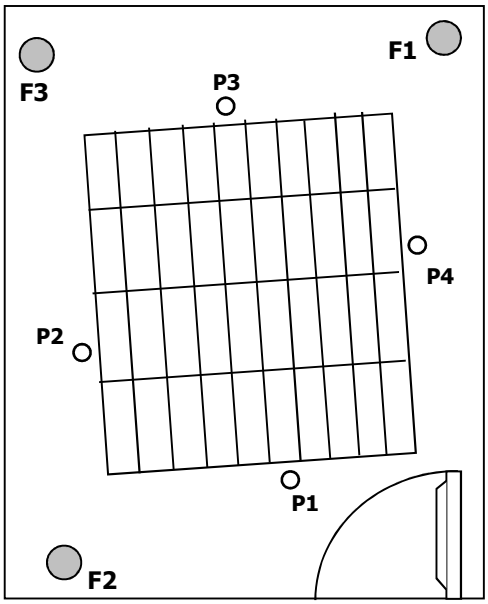
Measurement of the sound absorption, in accordance with the standard UNE-EN ISO 354:2004, of a veneered agglomerated cork tiles referenced ***CARIOCA***, 5,5 mm thickness.

2.- MEASUREMENT EQUIPMENT

The equipment used in the test is the following:

- Spectrum analyser id. no.: 170701 (Bruel&Kjaer mod. Pulse LAN-XI)
- Microphone calibrator id. no.: 171067 (Bruel&Kjaer mod. 4231)
- Diffuse field microphones id. no.: 171068, 103131, 170093 (Bruel&Kjaer mod. 4943), 170375 (G.R.A.S. mod 40AR)
- Sound sources id. no.: 103098 (AVM mod. DO12), 103124 and 170260 (CESVA mod. BP012)
- Noise generator id. no.: 103195 (Bruel&Kjaer mod. 1049)
- Power amplifier id. no.: 103097 (INTER mod. M700)
- Graphic equalizer id. no.: 170092 (INTER mod. EQ-9231)
- Thermo-hygrometer and barometer id. no.: 170680 (PCE mod. THB-40)
- Tape measurer id. no.: 103095 (Stanley mod. Powerlock)

3.- TEST PROCEDURE



Schematic sketch of test arrengement

The test is carried out in accordance with the standard UNE-EN ISO 354:2004, *'Measurement of sound absorption in a reverberation room'*; reverberation times of the room with and without test specimen are compared. The evaluation and rating is carried out in accordance with the standard UNE-EN ISO 11654:1998.

Around the room 4 microphones positions (P1 to P4, in figure) and 3 sound sources (F1, F2 and F3) positions are defined. Measurements are carried out exciting the room with pink or white noise and calculated from the measured reverberation times as specified in part 4.3.

4.- DEFINITIONS AND CLASSIFICATION

4.1. **Reverberation time.** Time, in seconds, that would be required for the sound pressure level to decrease by 60 dB after the sound source has stopped.

4.2. **Equivalent sound absorption area of a room.** Hypothetical area of a totally absorbing surface without diffraction effects which, if it were the only absorbing element in the room, would give the same reverberation time as the room under consideration.

4.3. **Equivalent sound absorption area of the test specimen.** Difference between the equivalent sound absorption area of the reverberation room with and without the test specimen. To calculate this parameter the average reverberation time in the reverberation room is measured with and without the test specimen. From these reverberation times the equivalent sound absorption area, A_T, shall be calculated using the Sabine formula:

$$A_T = A_2 - A_1 = 55.3V\left(\frac{1}{c_2 T_2} - \frac{1}{c_1 T_1}\right) - 4V(m_2 - m_1)$$

where:

- c_1 and c_2 are the propagation speed of sound in air temperatures t_1 and t_2;
- V is the volume, in cubic metres, of the empty reverberation room;
- T_1 is the reverberation time, in seconds, of the empty reverberation room;
- T_2 is the reverberation time, in seconds, of the empty reverberation room after the test specimen has been introduced;
- m_1 and m_2 are the power attenuation coefficients, in reciprocal metres, of the empty reverberation room and with the test specimen, respectively. The value of m is calculated according to the International Standard ISO 9613-1:1993 using the climatic conditions that have been present during the measurement.

The value of m can be calculated from the attenuation coefficient, α, which is used in International Standard ISO 9613-1:1993 according to the formula:

$$m = \frac{\alpha}{10 \log(e)}$$

4.4. **Sound Absorption Coefficient**. The sound absorption coefficient, α_s, of a plane absorber (or an array of identical objects), shall be calculated using the formula:

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

where:

- A_T is the equivalent sound absorption area of the test specimen, in square meters;
- S is the area, in square meters, of the test specimen.

For discrete absorbers, the result should be expressed as equivalent sound absorption area per object, which is determined by dividing A_T by the number of objects tested, *n:*

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

4.5. **Practical sound absorption coefficient, α_p.** Value of sound absorption coefficient depending of frequency, based upon measurements of sound absorption according standard UNE-EN ISO 354:2004, and calculated using the formula:

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

where:

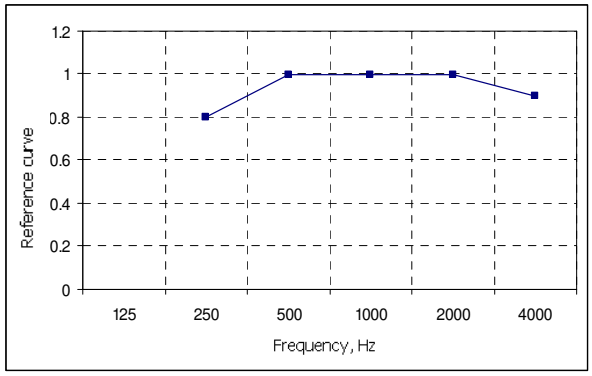
- α_{pi} is the practical sound absorption coefficient for the i^{th} octave band;
- α_{i1}, α_{i2} and α_{i3}, are the sound absorption coefficients of the corresponding third-octave band within the i^{th} octave band.

Values are given with 2 decimal and rounded in steps of 0,05 until a maximum value of α_{pi} = 1.00 in case of rounded average values > 1.00.

4.6. **Weighted sound absorption coefficient, α_w.** Single-number defined as the value of the reference curve, at the frequency of 500 Hz, after shifting it according to the method laid down.

To evaluate the results of a measurement, the reference curve is shifted in steps of 0.05 towards the curve of practical sound absorption, α_p, until the sum of the unfavourable deviations is as large as possible but no more than 0.10. An unfavourable deviation at a particular frequency occurs when the result of measurement is less than the reference curve. The set of reference values used for comparison with measurement results (reference curve) is specified in the table below:

Frequency (Hz)	Reference curve value
250	0,80
500	1,00
1000	1,00
2000	1,00
4000	0,90



4.7. **Shape indicators, L. M. H**. If a practical sound absorption coefficient, α_{pi}, exceeds the shifted reference curve value on 0.25 or more, a shape indicator will be added.
When excess happens at 250 Hz, indicator L is used. For 500 and 1000 Hz octave bands, indicator M is used. For 2000 Hz and 4000 Hz octave bands, indicator H is used.

4.8. **Absorption Classes**. Absorption classes A to E are another classification method described in the Standard UNE-EN ISO 11654:1998 and it is used in wide band applications. The single-number, α_w, is compared with values given in the table below:

Absorption class	α_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	0,15; 0,20; 0,25
Not classified	0,00; 0,05; 0,10

5.- UNCERTAINTY OF TEST

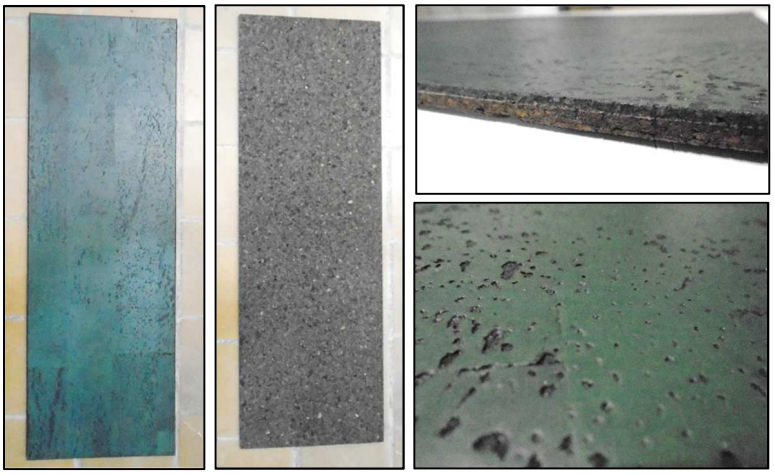
The uncertainty associated to the test has been calculated and is available to the petitioner. The expanded uncertainty has been calculated as the typical measurement uncertainty multiplied by a coverage factor k=2, which for a normal distribution corresponds to a coverage probability of approximately 95%.

For the weighted sound absorption coefficient, α_w, the calculated expanded uncertainty is $U(\alpha_w)$= ±0,058. For classification purposes shall be considered $U(\alpha_w)$= ±0,10.

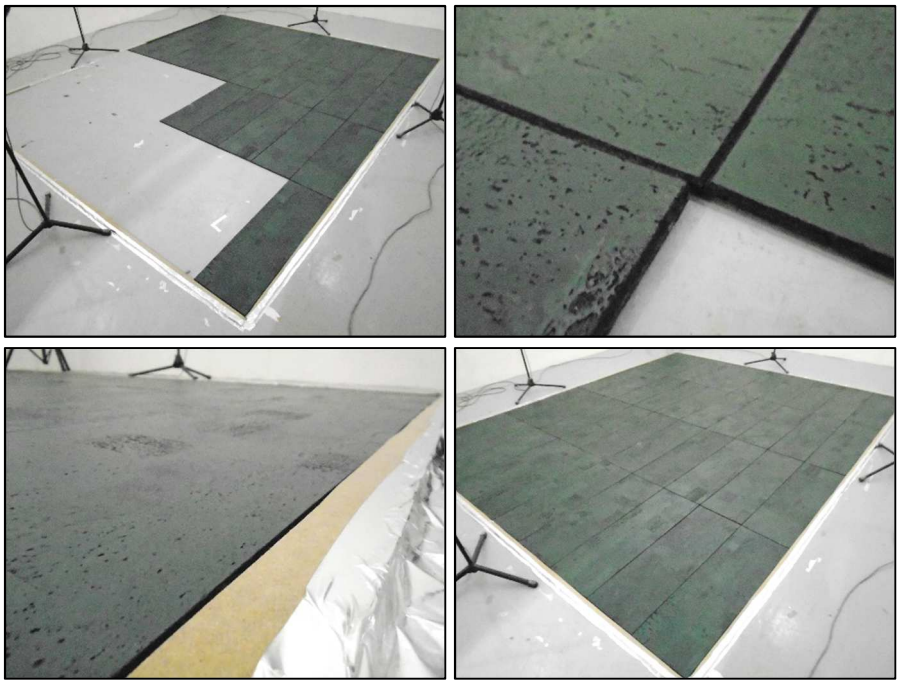
6.- TEST ELEMENT DESCRIPTION

The main characteristics of the test element are listed below. The references/models and the information indicated with *(*)* is provided by the test petitioner. LGAI Technological Center, S.A. is not responsible for the documentation and/or information provided for the petitioner.

Applus test specimen no.	20/1555
Manufacturer	GRANORTE – REVESTIMENTOS DE CORTIÇA, LDA.
Model / Reference	***CARIOCA***
Supplied by	GRANORTE – REVESTIMENTOS DE CORTIÇA, LDA.
Date received	16-07-2020
Type of test specimen	Veneered agglomerated cork tiles
Test specimen area, *S*	10,77 m^2 – 2995 x 3595 mm
Test specimen thickness	Nominal thickness: 5,5 mm *(*)*
Test specimen composition	Veneered agglomerated cork tiles referenced ***CARIOCA*** to be used as wallcoverings within buildings, composed of: *(*)* - Natural cork veneer - Steamed toasted agglomerated cork - Waterbased paint - Waterbased lacquer as finishing Nominal dimensions: 900 x 300 mm *(*)* Nominal density: 310 kg/m^3 *(*)* Test specimen composed of 40 tiles (4 x 10 grid), installed without space between them.
Test arrangement	Type A mounting according to UNE-EN ISO 354:2004 Annex B. Test specimen installed on the reverberation room floor without adhesive.
Perimeter frame	MDF of 10 mm thickness. Sealed to the reverberation room floor with adhesive tape.
Sectional drawing	See figure 1
Test element assembling (carried out by/date)	Applus Laboratories – LGAI TC / 30-07-2020



Images 1 to 4 Test specimen details: *CARIOCA*



Images 5 to 8 Test specimen installation into the reverberation room

Image 9 Test specimen ready for the test

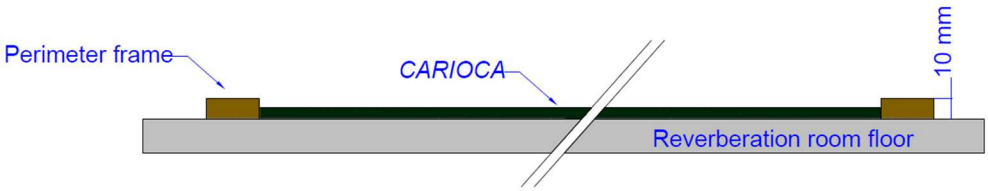


Figure 1 Sectional drawing

7.- TEST CONDITIONS

Reverberation room characteristics			
Shape:	Parallelepiped	Total surface area (S_t):	238,1 m^2
Dimensions:	7,835 × 4,956 × 6,271 m	Number of diffusers:	14
Volume (V):	243,5 m^3	Dimensions of diffuser:	1,5 m^2

Environmental conditions of reverberation room		
Room state:	Empty	With test specimen
Temperature:	24,1 ºC	24,2 ºC
Humidity:	71,0 %	68,1 %
Atmospheric Pressure:	1001,5 hPa	1001,0 hPa

8.- REVERBERATION TIMES AND EQUIVALENT SOUND ABSORPTION AREA

In the following table the reverberation time values of the test room without and with the test element are given, as well as the calculated equivalent sound absorption areas.

Frequency (Hz)	Reverberation time of the empty room, T_1 (s)	Reverberation time of the room with the test specimen, T_2 (s)	Equivalent sound absorption area, A_T (m^2)
100	14,93	14,70	0,0
125	11,72	11,52	0,1
160	10,74	10,52	0,1
200	11,74	10,95	0,2
250	12,23	11,20	0,3
315	11,54	10,80	0,2
400	10,57	9,85	0,3
500	10,01	9,24	0,3
630	9,49	8,57	0,4
800	8,80	7,63	0,7
1000	8,16	6,87	0,9
1250	7,34	5,57	1,7
1600	6,51	4,25	3,2
2000	5,82	3,81	3,5
2500	5,02	3,89	2,2
3150	4,33	3,70	1,5
4000	3,43	3,11	1,1
5000	2,78	2,59	0,9

9.- RESULTS

Measurement of sound absorption according to UNE-EN ISO 354:2004

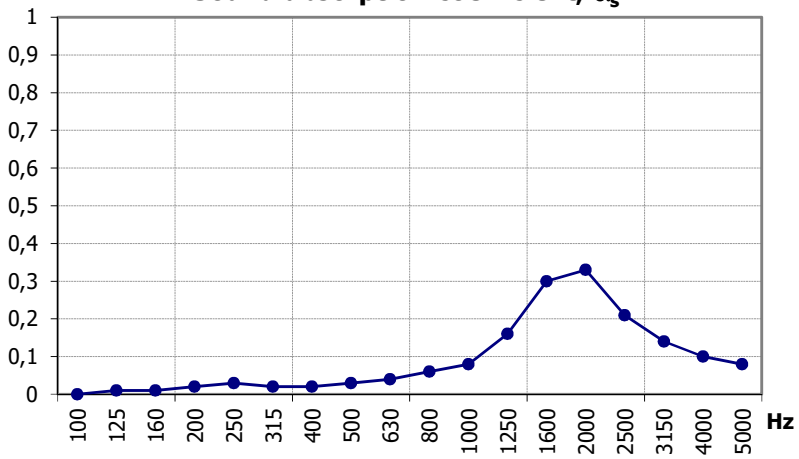
Client: GRANORTE – REVESTIMENTOS DE CORTIÇA, LDA.

Test specimen:
Veneered agglomerated cork tiles referenced ***CARIOCA,*** 5,5 mm thickness

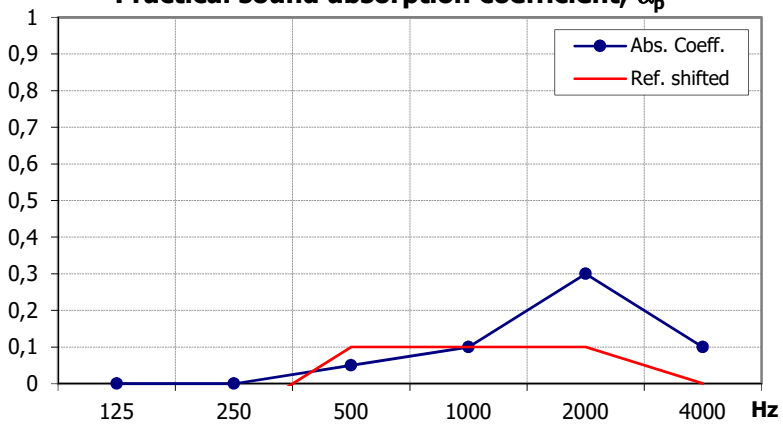
Test specimen area, *S*: 10,77 m² – 2995 x 3595 mm

Date of test: 30th of July, 2020

Sound absorption coefficient, α_s



Practical sound absorption coefficient, α_p



Sound abs. coefficient, α_s

Freq. (Hz)	α_s
100	0,00
125	0,01
160	0,01
200	0,02
250	0,03
315	0,02
400	0,02
500	0,03
630	0,04
800	0,06
1000	0,08
1250	0,16
1600	0,30
2000	0,33
2500	0,21
3150	0,14
4000	0,10
5000	0,08

Practical sound absorption coefficient, α_p

Freq. (Hz)	α_p
125	0,00
250	0,00
500	0,05
1000	0,10
2000	0,30
4000	0,10

Weighted sound absorption coefficient (UNE-EN ISO 11654:1998)

$\alpha_w = 0,10$ (-)

Absorption classes according to α_w (UNE-EN ISO 11654:1998)
A (>0,85)
B (0,80 to 0,85)
C (0,60 to 0,75)
D (0,30 to 0,55)
E (0,15 to 0,25)
Not classified (<0,15)

It is highly recommended to use the single number "weighted sound absorption coefficient" (α_w) together with frequency-dependent values of sound absorption coefficient.

The results reported in this document relate only to the sample, product or item delivered to LGAI Technological Center the appointed day having been tested under the conditions established in this document