BELGIAN BUILDING RESEARCH INSTITUTE

INSTITUTION RECOGNISED BY APPLICATION OF THE DECREE-LAW OF 30 JANUARY 1947

NOTIFICATION NUMBER 1136

BELAC N° 42-TEST

All tests in this report are executed according to the ISO 9001 certified Quality management system of the BBRI

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TEST REPORT

Laboratory	ACOUSTICS (AC)	O/References	631xB380 AC6642 Page 1 / 6

Requested by	INDETEX Rue du Mont Gallois 58 B-7700 MOUSCRON		
Date of the order	20-04-2015	**Samples identification**	2015-12-39/3
Date of the test	19-03-2015	**Date of reception of samples**	19-03-2015
Remark(s)	/	**Drafting date of the report**	30-04-2015
Tests carried out **Name of the product**	Measurement of the sound absorption coefficient in a reverberation room CORVO		
Reference standards	EN ISO 354:2003 Acoustics - Measurement of sound absorption in a reverberation room EN ISO 11654:1997 Acoustics - Sound absorbers for use in buildings - Rating of sound absorption		

This test report contains 6 pages. This test report may only be reproduced in its entirety.
Each page has a stamp of the laboratory (in red) and is initialised by the head of laboratory.
The results and findings are only valid for the tested samples.

☐ *No test sample*
☐ *Test sample(s) submitted to a destructive test*
☒ *Test sample(s) to be removed from our laboratories 30 calendar days after sending of the report, unless a written request is received by the demander of the test*

C.S.T.C. W.T.C.B.

Responsable engineer in charge of the test
ir. D. Wuyts

Technical responsable,
P. Huart

The head of the laboratory,
ir. D. Wuyts

MEASUREMENT UNCERTAINTIES and TEST CONFIGURATION

1 MEASUREMENT UNCERTAINTIES

Repeatability of measured reverberation times and calculated absorption coefficients

The standard deviation of the reverberation time T20 evaluated over a 20 dB decay range, can be estimated by the following formula (ISO 354:2003 - point 8.2.2.):

$$\varepsilon_{20}(T) = T * \sqrt{\frac{2.42 + 3.59 / N}{fT}}$$

T = the measured reverberation time [s]
f = the centre frequency of one-third-octave band [Hz]
N = the number of decay curves evaluated

The standard deviations are given in annex 2 of this test report.

Reproducibility of measured reverberation times and calculated absorption coefficients

The reproducibility of the absorption coefficient measurement is still subject of international research and is not known yet.

2 TEST CONFIGURATION

Signal

- Interrupted pink noise generated by two modules (non-correlated signals) Norsonic N850-MF1 belonging to the measurement system Norsonic NOR850 v.1.6
- 4 omni-directional tetrahedron shaped loudspeakers, each with 4 membranes BEYMA 6P200Fe, amplified by 2 amplifiers QSC RMX 2450
- The emitted broad-band noise between 50 Hz and 5000 Hz generates sound pressure levels that differ less than 6 dB in adjacent one-third octave bands in the test room in a measuring point.

Microphones and recording system

- Bruël & Kjaer - 4190: 2 microphones
- Bruël & Kjaer - 2669L: 2 preamplifiers for microphones
- Bruël & Kjaer - 2829: 2 current supplies for microphone
- Norsonic NOR850 v.1.6: Measurement system
- Number of source pair configurations: 2; distances between the different source positions at least 3 m
- The number of measurement positions per source configuration: 12; Distances between the different measurement positions at least 1.5 m, at least distanced 2 m from the sound source and at least 1m from any reflecting surface and of the
- Total number of measurements: 24

Signal analysis and processing

- Norsonic NOR850 v. 1.6: Measurement system
- Possibility to intervene by means of a graphical interface to determine the reverberation time from the decay curves

Reverberation room

- Volume of the reverberation room : 264.3 m³
- l_{max} = 12.10 m < $1.9V^{1/3}$ (=12.19 m)
- S_t = total surface (walls, floor, ceiling) = 267.1 m²
- Diffusors are present (± 34 m²)
- $(V / 200m^3)^{2/3}$= volume multiplication factor for spaces bigger than 200 m³ = 1.20
- Maximum surface for test elements in function of the volume = 14.45 m²

C.S.T.C. W.T.C.B. AC

α_S SOUND ABSORPTION COEFFICIENT - GELUIDABSORPTIECOEFFICIENT
COEFFICIENT D'ABSORPTION ACOUSTIQUE - SCHALLABSORPTIONKOEFFIZIENT

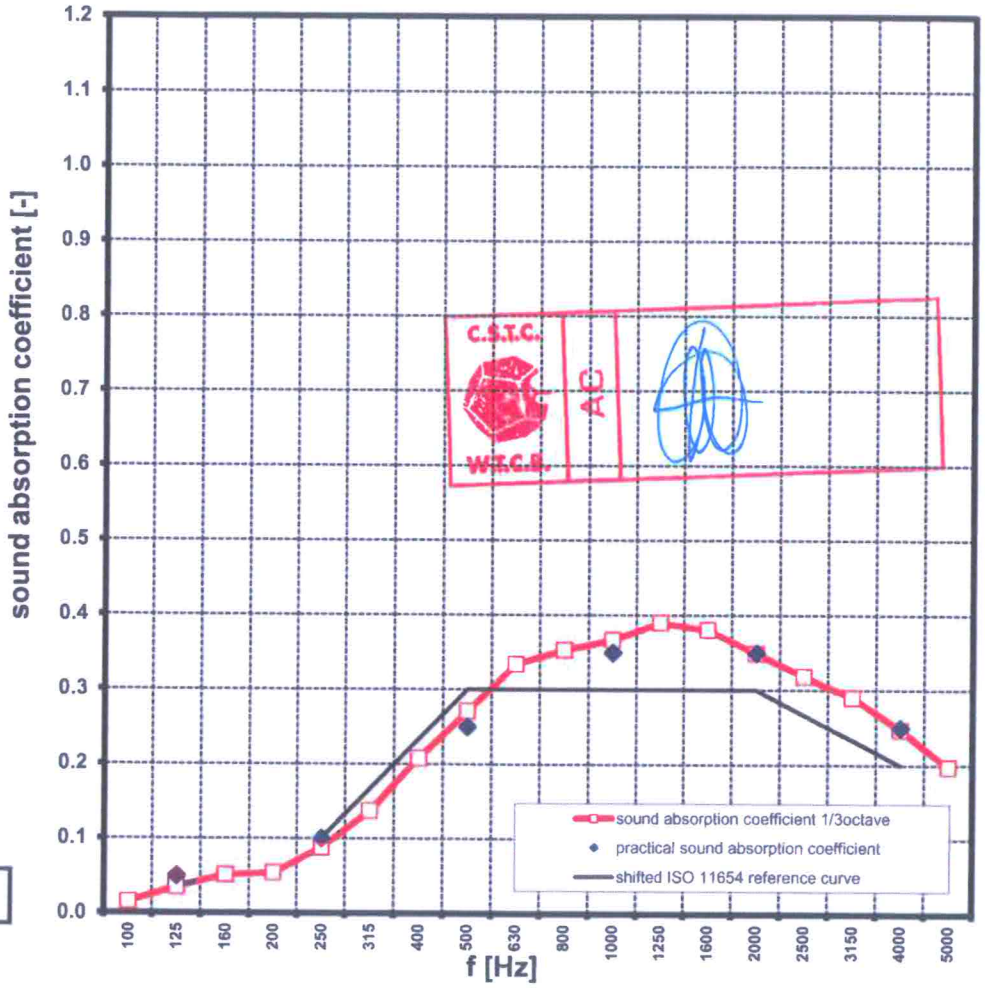
EN ISO 354:2003 Acoustics - Measurement of sound absorption in a reverberation room
EN ISO 11654:1997 Acoustics - Sound absorbers for use in buildings - Rating of sound absorption

Date / Datum: 19/03/2015
Reverberation room / Nagalmruimte / Salle réverbérante / Hallraum: **Alpha K2 :** V = 264.3 m³ S_t = 267.1 m²
Empty space /Lege ruimte / salle vide / Leere Hallraum: h_{r1} %H_2O = 45.8 % T_1 = 18.6 °C p_{a1} = 101.3 kPa
With testelement / Met testelement / Avec l'élément d'essai / Mit Testelementes: h_{r2} %H_2O = 39.6 % T_2 = 18.5°C p_{a2} = 101.3 kPa
N° test sample / N° testelement / N° de l'élément d'essai / Nr. Testelementes: 2015-12-39/3
Area of test element / Opp. testelement / Surf. de l'élément d'essai / Fläche des Testelementes: S = 10.40 m²

f [Hz]	T_1 [s]	T_2 [s]	α_S
50	7.15	6.75	0.03
63	**6.65**	**6.90**	**-0.02**
80	7.04	7.29	-0.02
100	5.94	5.80	0.02
125	**5.63**	**5.36**	**0.04**
160	5.40	5.05	0.05
200	5.32	4.97	0.05
250	**5.89**	**5.23**	**0.09**
315	6.02	5.02	0.14
400	6.05	4.64	0.21
500	**6.02**	**4.32**	**0.27**
630	5.98	4.03	0.33
800	5.88	3.91	0.35
1000	**5.83**	**3.83**	**0.37**
1250	5.76	3.70	0.39
1600	5.50	3.60	0.38
2000	**4.95**	**3.41**	**0.35**
2500	4.29	3.10	0.32
3150	3.66	2.76	0.29
4000	**3.00**	**2.36**	**0.25**
5000	2.36	1.93	0.20

f [Hz]	α_p
125	**0.05**
250	**0.10**
500	**0.25**
1000	**0.35**
2000	**0.35**
4000	**0.25**

α_w = **0.30** (/)
Acoustical absorption class: **D**



REQUESTED BY / AANVRAGER / DEMANDEUR / ANTRAGSTELLER:

INDETEX, Rue du Mont Gallois 58, B-7700 MOUSCRON

TEST ELEMENT / PROEFELEMENT / ELEMENT D'ESSAI / PRÜFMUSTER:

*(Short description by the manufacturer, details: see page 6 *** Beknopte beschrijving door het bedrijf, details: zie pag. 6 *** Description sommaire par l'entreprise, détails: voir page 6 *** Kurze Beschreibung durch den Hersteller, Details auf Seite 6*

NL: Geen nederlandse beschrijving beschikbaar

FR: Pas de description en Français disponible

GB: CORVO - Blackout Textile Fabric

D: Keine Deutsche Beschreibung verfügbar

ANNEX 1: MEASUREMENT METHOD AND SINGLE VALUE RATINGS

1. MEASUREMENT METHOD

The determination of the sound absorption coefficient follows the standard EN ISO 354 "Acoustics – Measurement of sound absorption in a reverberation room (ISO 354)". A detailed description of the measurement procedure can be found in this standard.

The measurement principle is as follows: The sound absorption coefficient of a test specimen can be derived from measurements of the reverberation time in a reverberation room. The reverberation time for a specified frequency band is defined as the time needed to decay 60 dB after switching off a sound source. First the reverberation time of the empty room is measured. This leads to a reverberation time spectrum T1. Then the test sample is fitted into the reverberation room over a sufficient area, in such a way that the mounting and detailling corresponds to a real practice. The reverberation times for this new situation lead to a second spectrum T2. According to the standard, the "Sabine" sound absorption coefficients for each frequency band can be obtained using the following formula:

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

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

A_1, A_2 = equivalent sound absorption area of the empty and the fitted room respectively [m²]
V = the volume of the reverberation room [m³]
c_1, c_2 = the speed of sound in the empty and the fitted room respectively [m/s]
T_1,T_2 = the reverberation time in the empty and the fitted room respectively [s]
m_1, m_2 = the power attenuation coefficient, in reciprocal metres, calculated according to ISO 9613-1 [1/m]
A_T = the equivalent sound absorption area of the test specimen [m²]
S = the area of the test specimen [m²]
α_s = the sound absorption coefficient of the specimen [-]

2. α_P PRACTICAL SOUND ABSORPTION COEFFICIENT

This is the sound absorption coefficient per octave band, deduced from third-octave band measurements according to the procedure in EN ISO 11654. It is calculated by taking the arithmetic average of the sound absorption coefficients of the three third-octave bands within the octave band. This average needs to be rounded to the nearest multiple of 0.05 and is limited to 1.

3. α_W SINGLE RATING

The single number rating (indicated by the subscript "w") procedure is explained in ISO 11654 "Acoustics - Sound absorbers for use in buildings - Rating of sound absorption". The calculation is based on the practical sound absorption coefficients, and is too complex to describe in a few lines here. We refer to the cited standard. More information can also be found on the following website: http://www.normen.be

4. FORM INDICATORS L, M, H

Each time a practical sound absorption coefficient exceeds the shifted reference curve by 0.25 or more, one or more form indicators (L, M, H) need to be added to the weighted sound absorption coefficient.

- if the excess happens in the 250 Hz band, the indicator "L" is added
- if the excess happens in the 500 Hz or 1000 Hz band, the indicator "M" is added
- if the excess happens in the 2000 Hz or 4000 Hz band, the indicator "H" is added

The form indicators indicate that, in one or more octave bands, the practical sound absorption coefficient is considerably higher than the value of the shifted reference curve. The interested parties are invited to study the absorption curve in detail.

C.S.T.C. W.T.C.B. AC

ANNEX 2: MEASUREMENT UNCERTAINTY

Uncertainty of the measured reverberation times

f (Hz)	T_1 (s)	ε_{20} (s)	T_2 (s)	ε_{20} (s)
50	7.2	0.61	6.8	0.59
63	6.6	0.52	6.9	0.53
80	7.0	0.48	7.3	0.48
100	5.9	0.39	5.8	0.39
125	5.6	0.34	5.4	0.33
160	5.4	0.29	5.0	0.28
200	5.3	0.26	5.0	0.25
250	5.9	0.25	5.2	0.23
315	6.0	0.22	5.0	0.20
400	6.0	0.20	4.6	0.17
500	6.0	0.18	4.3	0.15
630	6.0	0.16	4.0	0.13
800	5.9	0.14	3.9	0.11
1000	5.8	0.12	3.8	0.10
1250	5.8	0.11	3.7	0.09
1600	5.5	0.09	3.6	0.08
2000	4.9	0.08	3.4	0.07
2500	4.3	0.07	3.1	0.06
3150	3.7	0.05	2.8	0.05
4000	3.0	0.04	2.4	0.04
5000	2.4	0.03	1.9	0.03

ε_{20} = The standard deviation of the reverberation time T20 evaluated over a 20 dB decay range, can be estimated by the following formula (ISO 354:2003 - point 8.2.2.):

$$\varepsilon_{20}(T)=T\sqrt{\frac{2.42+3.59/N}{f\,T}}$$

T_1 = the reverberation time in the empty room [s]
T_2 = the measured reverberation time in the fitted room [s]
f = the centre frequency of one-third-octave band [Hz]
N = the number of decay curves evaluated

C.S.T.C. AC W.T.C.B.

Uncertainty of the measured sound absorption coefficients

f (Hz)	α	$\varepsilon(\alpha)$	$\delta_{95}(\alpha)$
50	0.03	0.07	0.03
63	-0.02	0.07	0.03
80	-0.02	0.05	0.02
100	0.02	0.07	0.03
125	0.04	0.06	0.03
160	0.05	0.06	0.02
200	0.05	0.06	0.02
250	0.09	0.05	0.02
315	0.14	0.04	0.02
400	0.21	0.04	0.02
500	0.27	0.04	0.02
630	0.33	0.04	0.01
800	0.35	0.03	0.01
1000	0.37	0.03	0.01
1250	0.39	0.03	0.01
1600	0.38	0.03	0.01
2000	0.35	0.03	0.01
2500	0.32	0.03	0.01
3150	0.29	0.03	0.01
4000	0.25	0.03	0.01
5000	0.20	0.04	0.02

$\varepsilon(\alpha)$ = standard deviation of the measured sound absorption coefficients

$$\varepsilon(\alpha)\cong\frac{55,3V}{cS}\sqrt{\left(\frac{\varepsilon_{20}(T_2)}{T_2^2}\right)^2+\left(\frac{\varepsilon_{20}(T_1)}{T_1^2}\right)^2}$$

T_1 = the reverberation time in the empty room [s]
T_2 = the measured reverberation time in the fitted room [s]
V = the volume of the reverberation room [m³]
c = average speed of sound for the empty and the fitted reverberation room [m/s]
S = the area of the test specimen [m²]

$\delta_{95}(\alpha)$ = 95% confidence limit on the measurement of the average sound absorption coefficient (=1.96 times the "standard error" or 1.96 times the "standard deviation of the mean"). If the same measurement would be repeated, the difference with the actual measurement would be smaller than this limit in 95% of the cases.

$$\delta_{95}(\alpha)=\frac{1,96\,\varepsilon(\alpha)}{\sqrt{N}}$$

N = the number of decay curves evaluated

ANNEX 3: DESCRIPTION OF THE TEST ARRANGEMENT

This description is given by the producer of the test element and is not guaranteed, but as good as possible and reasonable controlled, by the laboratory. The equivalence between the tested product in this report and the commercialised product is the sole responsability of the producer.

Dimensions	"mounted"	m^2	10.40
	"unfolded"	m^2	23.76
	height	m	2.70
	width (folded)	m	3.85
	width (unfolded)	m	8.80
Number of folds			16
Distance to wall	rail (dr)	mm	100
	Min. average (d1)	mm	20
	Max. average (d2)	mm	160