



LURRALDE PLANGINTZA, ETXEBIZITZA
ETA GARRAIO SAILA

Etxebizitza, Lurzoru eta Arkitektura Zuzendaritza
Eraikuntzaren Kalitate Kontrolerako Laborategia

DEPARTAMENTO DE PLANIFICACIÓN
TERRITORIAL, VIVIENDA Y TRANSPORTES

Dirección de Vivienda, Suelo y Arquitectura
Laboratorio de Control de Calidad de la Edificación

AKUSTIKA ARLOA kudeatzailea:

ACOUSTICS AREA operated by

tecnalia

MEMBER OF BASQUE RESEARCH
& TECHNOLOGY ALLIANCE

Test Report No. B2021-LACUS-IN-159 A_En

Laboratory measurement of sound insulation

TEST SPECIMEN: ACOUSTIC SELF-SUPPORTING WALL LINING (SENOR+ChovA) EI120:

- SE-4800/TDM (HYBRID) (SENOR)
- SE-TAV-500/11A (SENOR)
- SE-TAV-500/11R (SENOR)
- SE-BEC-10X100 (SENOR)
- ChovANAPA 4cm PANEL 600 (ChovA)
- ViscoLAM AUTOADHESIVA (ChovA)
- 48 mm CHANNELS
- 46 mm STUDS
- 25 mm plasterboard

APPLICANT: SUSPENSIONES ELÁSTICAS DEL NORTE, S.L. (SENOR)
Polígono industrial El Garrotal, Parcela 10 - Módulos 4 y 5
14700 Palma del Río, Córdoba, España

USED STANDARDS: UNE-EN ISO 10140-1:2016 Annex G. "Acoustical linings. Improvement of airborne sound insulation".

UNE-EN ISO 10140-2:2011. "Acoustics. Laboratory measurement of sound insulation of building elements. Measurement of airborne sound insulation".

ORIGINAL REPORT ISSUE DATE: 11th March 2022

TRANSLATION DATE: 1st April 2022

Signature:

Technical Consultant

Susana Lopez de Aretxaga

The technical ownership of the ENAC Accreditation No. 4/LE456 falls to Fundación Tecnalia Research & Innovation, the same way as the technical signatures of this report. The test is performed by personnel of TECNALIA (Construction Lab_services Area).

Facilities where the measurements are carried out under the scope of ENAC Accreditation No. 4/LE456 belong to the Acoustics Area of the Building Quality Control Laboratory of the Basque Government, placed at Aguirrelanda No. 10, 01013 VITORIA-GASTEIZ (Spain).



THIS REPORT CONTAINS: Total number of pages: 14

This document concerns only and exclusively the test specimens and the moment and conditions in which those measurements were made.

The test specimen has been subjected to the test asked by the applicant, following the specified procedures in the used standards. Test results are detailed in the inside pages.

Uncertainty of measurement is available to the applicant.

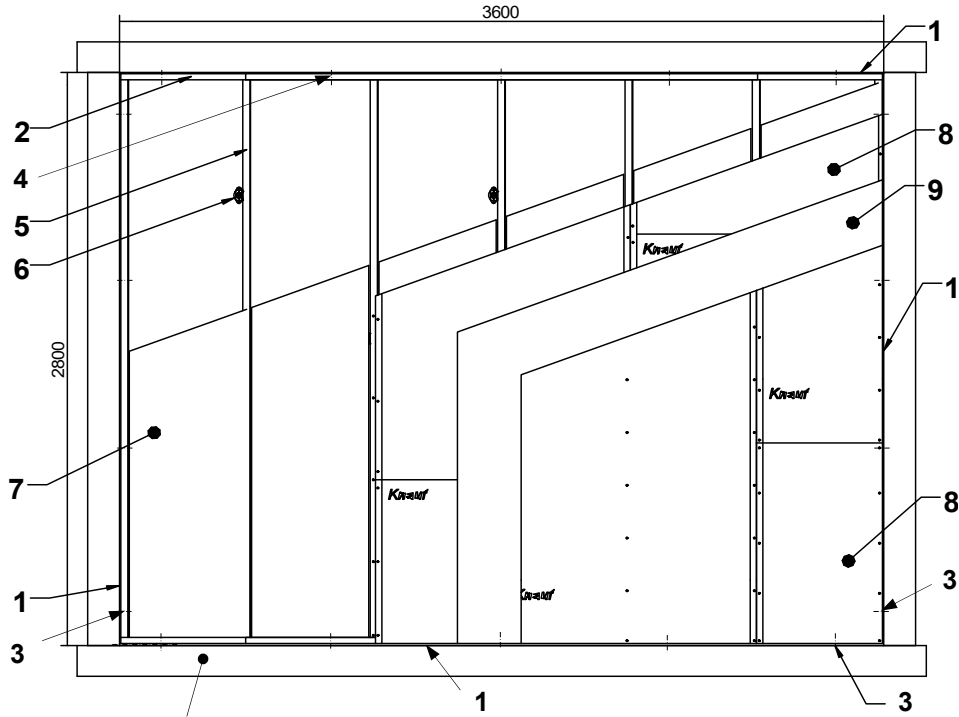
This document is the English version of the original report issued in Spanish, B2021-LACUS-IN-159 A (11th March 2022). In case of lawsuit, the original document will be taken as reference.

TECNALIA does not take responsibility for the information supplied by the applicant. This report may not be reproduced without the express authorization of FUNDACIÓN TECNALIA R&I, except when it is reproduced entirely.



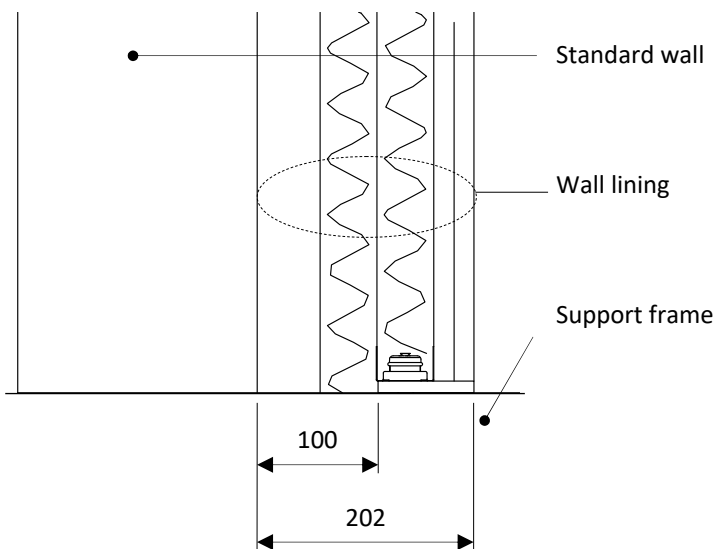
1. TEST SPECIMEN DESCRIPTION

The test specimen consists of a wall lining, with the following composition according to the information provided by the applicant:



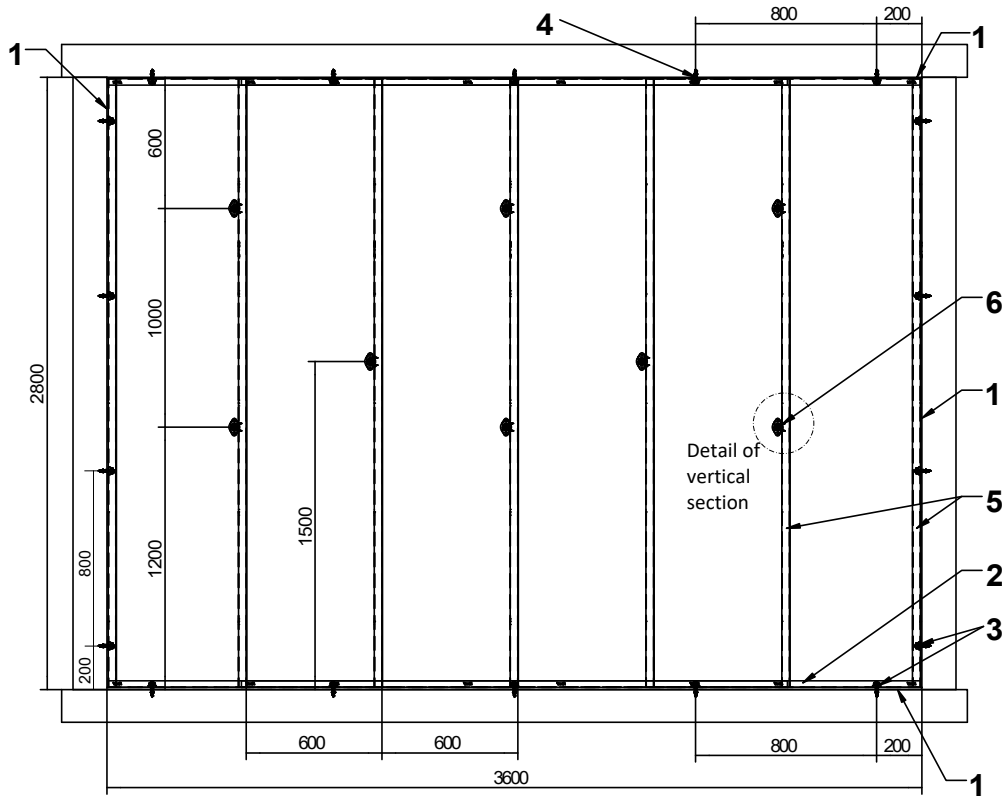
Reinforced concrete support frame (400x400 mm section)

Sketch 1 (cotes in mm)



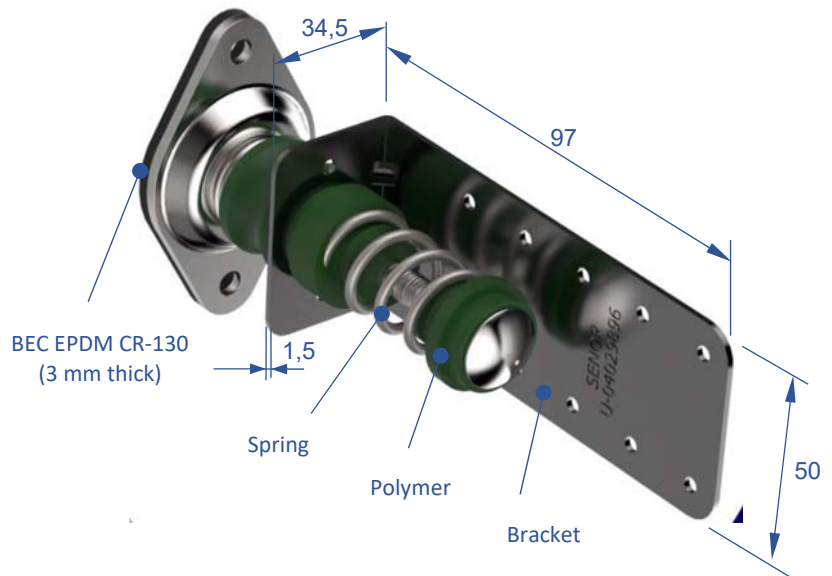
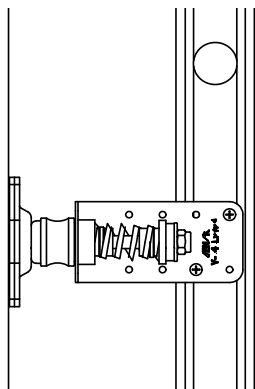
- 1. SE-BEC-10x100
- 2. 48/30 CHANNEL
- 3. SE-TAV-500/11A
- 4. SE-TAV-500/11R
- 5. C 48/35 STUD
- 6. SE-4800/TDM (HYBRID)
- 7. ChovANAPA 4cm PANEL 600 (2 units)
- 8. 25 mm plasterboard
- 9. ViscoLAM AUTOADHESIVA

Sketch 2 (cotes in mm)

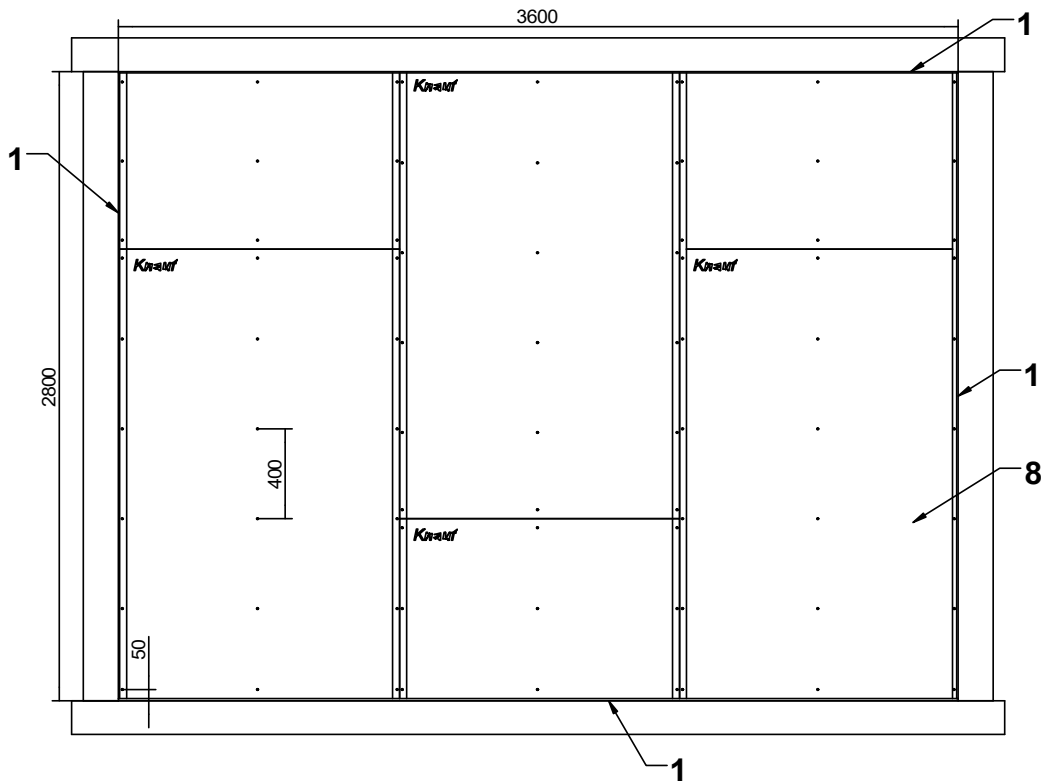


Detail of vertical section

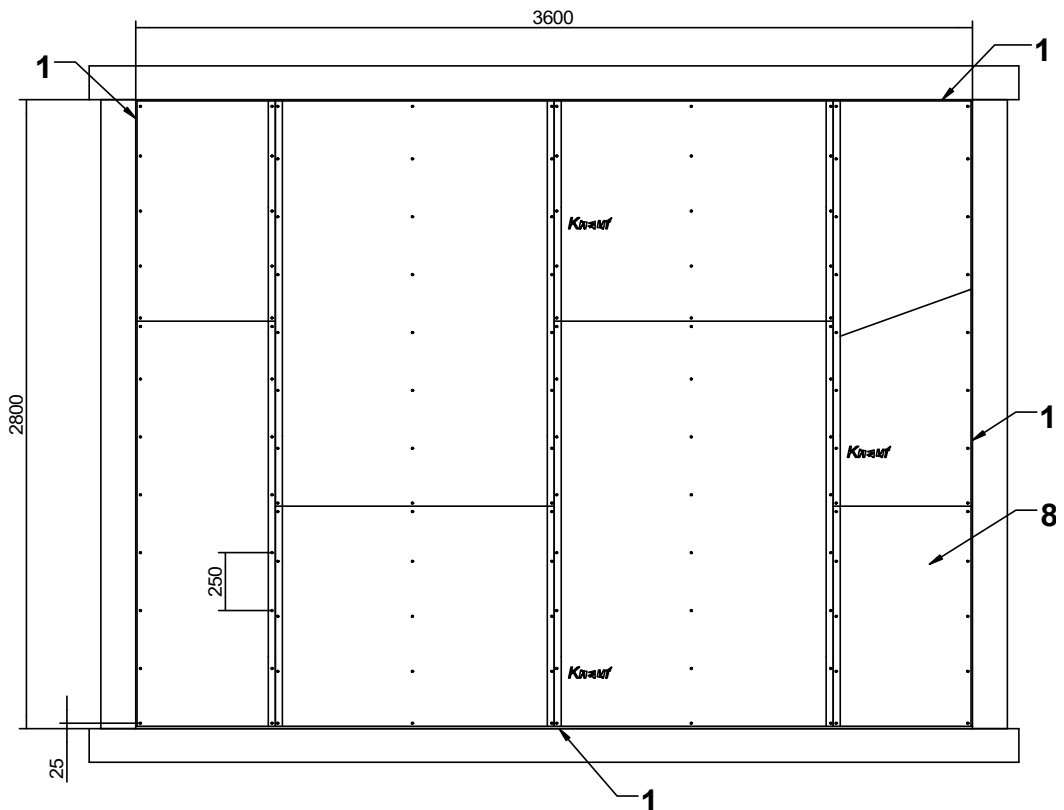
Detail of 4800/TDM acoustic hanger



Sketch 3 (cotes in mm)



Sketch 4 (cotes in mm). Interior layer



Sketch 5 (cotes in mm). Exterior layer



Description of materials and assembly details:

- SE-4800/TDM (HYBRID) (SEÑOR): Hybrid Acoustic Damper composed of “TC/GPN” triple polymeric core + metal helicoidal spring + high quality galvanized steel bracket, with BEC EPDM CR-130 strip (3 mm thick) in contact with the standard wall. Mechanically fixed at 2 points to studs and wall, according to Sketch 3.
- SE-TAV-500/11A (SEÑOR): Acoustic insulator for mechanical fixation of lower channel to frame. 5 insulators were used (placed every 800 mm).
- SE-TAV-500/11A (SEÑOR): Acoustic insulator for mechanical fixation of lateral channels to frame. 4 insulators were used (placed every 800 mm).
- SE-TAV-500/11R (SEÑOR): Acoustic insulator for mechanical fixation of upper channel to frame. 5 insulators were used (placed every 800 mm).
- SE-BEC-10x100 (SEÑOR): EPDM CR-130 Microcellular self-adhesive acoustic strip (10 mm thick x 10 cm wide), between perimeter channel and frame, adhered to frame.
- ChovANAPA 4cm PANEL 600 (ChovA): Polyester fiber (40 mm thick and 15 kg/m³). 2 layers, one inserted between studs and the other between standard wall and profiles.
- ViscoLAM AUTOADHESIVA (ChovA): High density viscoelastic membrane in roll (4 mm thick and 5,9 kg/m²).

Adhered to plasterboards of the interior layer. Sections butt jointed each other and against SE-BEC strip, with staggered joints with respect to plasterboards.

- 48/30 CHANNEL (KNAUF): 48 mm galvanized steel perimeter channel.
- C 48/35 STUD (KNAUF): 46 mm galvanized steel studs, every 600 mm, inserted in channels and mechanically fixed at 1 point to upper and lower channel.
- 25 mm plasterboard: Fire-proof laminated gypsum board KNAUF-DF 25 BA (25 mm thick and 20,6 kg/m²).

Assembly and mechanical fixation plasterboards-profile according to sketch 4 and 5. Plasterboards butt jointed each other and against SE-BEC-10x100 strip. Plasterboards of exterior layer with staggered joints with respect to the boards of interior layer. Sealing of exterior layer: joint tape and KNAUF Unik (30') joint compound between boards and KNAUF Unik (30') joint compound along perimeter between platerboards and SE-BEC strip.





Photos of mounting of wall lining



Photos of wall lining on wall in the test rooms

Material selected and delivered by SENOR, Asfaltos Chova, S.A (ChovA) and KNAUF; each company provided its material as indicated in the test specimen description.

Mounting in the test opening:

Lining mechanically fixed to standard wall built in a prefabricated concrete frame, 40 cm thick and internal dimensions of 2,8 m high by 3,6 m long.

Mounting performed by: SENOR

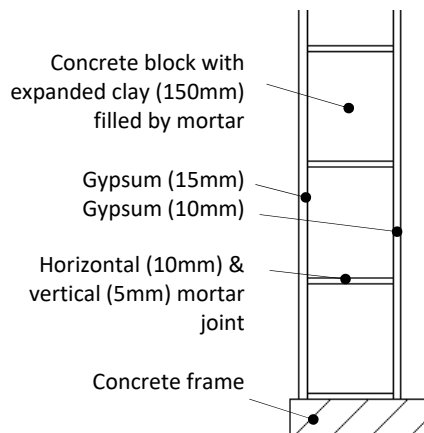
Mounting end date: 26th November 2021



Standard wall:

Lined filled block wall, of 300 kg/m² estimated superficial mass (*).

(*) Filling and mortar joints included.



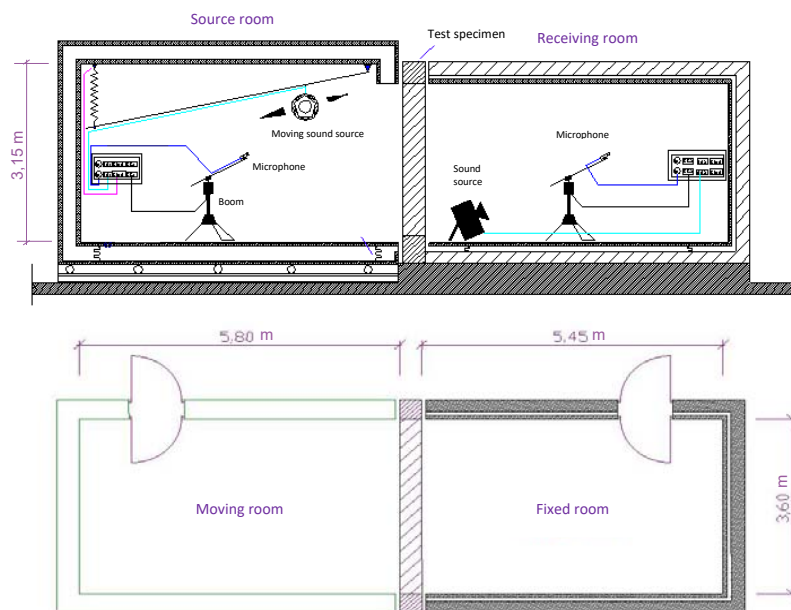
Block: 500 mm long x 190 mm high x 150 mm thick & 14,2 kg (estimated superficial mass: 149 kg/m²).

Sketch and photos of standard wall

Standard basic element, 'Heavy wall', according to UNE-EN ISO 10140-5:2011, Annex B. Provided by the laboratory in its final condition. 10 mm gypsum side oriented to tested wall lining.

2. TEST FACILITIES

The test is performed in the horizontal transmission rooms, composed of a source and a receiving room. The receiving room is composed of a double concrete box of twenty and ten centimeters of thickness each one, acoustically disconnected and the source room, forty centimeters thick, is composed of a double box of metal frame and gypsum board, acoustically disconnected. The mobility of the source room allows the mounting of the test specimen into a frame outside, as well its subsequent installation between the test rooms. These rooms comply with the requirements of UNE-EN ISO 10140-5:2011.



Sketch of horizontal transmission rooms

3. EQUIPMENT AND TEST CONDITIONS

| | Source Room | Receiving Room |
|---------------|---------------------------------------|---------------------------------------|
| Microphones | Brüel & Kjær 4943; Serial No. 3188436 | Brüel & Kjær 4943; Serial No. 3188435 |
| Preamplifiers | Brüel & Kjær 2669; Serial No. 1948764 | Brüel & Kjær 2669; Serial No. 2025844 |
| Sound sources | Brüel & Kjær 4296; Serial No. 2071420 | CERWIN VEGA; No. 012446 |
| Booms | Brüel & Kjær 3923; Serial No. 2036584 | Brüel & Kjær 3923; Serial No. 2036591 |

| | Control Room |
|------------------------------|---------------------------------------|
| Analyser | Nor850-MF1; Serial No. 8501186 |
| Amplifier | LAB 300; Serial No. 970-967 |
| Equalizer | Sony, SRP-E100; Serial No. 400238 |
| Calibrator | Brüel & Kjær 4231; Serial No. 2061476 |
| Atmospheric conditions meter | Rotronic BL-1D; Serial No. A19060062 |

| Measurement uncertainty of atmospheric conditions: | |
|--|---------|
| Air temperature | ±0,5 °C |
| Air humidity | ±4 % |
| Atmospheric pressure | ±2 mbar |

4. TEST PROCEDURE AND EVALUATION

4.1 Determination of the sound reduction improvement index of a lining

The improvement of airborne sound insulation of a lining is characterized by the sound reduction improvement index (ΔR). For its determination, the measurement of airborne sound insulation is performed according to UNE-EN ISO 10140-2:2011, both for the basic element and basic element + lining.

The sound reduction improvement index (ΔR) of a lining placed on a basic element, for the one-third octave band from 100 Hz to 5 kHz, is obtained according to standard UNE-EN ISO 10140-1:2016 - Annex G, as the difference between the sound reduction indices of the basic element with and without the lining, as detailed in the equation:

$$\Delta R = R_{\text{with}} - R_{\text{without}}$$

R_{with} : Sound reduction index of the basic element with lining, from 100 to 5000 Hz

R_{without} : Sound reduction index of the basic element without lining, from 100 to 5000 Hz

4.2 Determination of the airborne sound insulation

The sound reduction index, R , for the one-third octave band from 100 Hz to 5 KHz is calculated according to UNE-EN ISO 10140-2:2011 using the following formula:

$$R = L_1 - L_2 + 10 \cdot \log S/A$$

L_1 : Average sound pressure level in the source room

L_2 : Average sound pressure level in the receiving room

S : Test specimen area

A : Equivalent sound absorption area in the receiving room

The measurement of the average sound pressure levels L_1 and L_2 is performed by emitting an equalized white noise, from 100 Hz to 5 kHz, using a moving omnidirectional sound source. The sound field in the source and receiving rooms is sampled using a moving microphone with a sweep radius of 1 m and a traverse period of 16 s during 32 s of measure, for the basic element and through six fixed positions of the microphone path, for the basic element with lining. Background noise in the receiving room for the one-third-octave band from 100 Hz to 5 KHz, is measured according to the same measurement process of sound field in the receiving room.

The equivalent sound absorption area from 100 Hz to 5 kHz, is evaluated from the reverberation time measured in the receiving room, using Sabine's formula:



$$A=0,16*V/T$$

- A: Equivalent sound absorption area in the receiving room
T: Reverberation time in the receiving room
V: Receiving room volume

Reverberation time in the receiving room is determined by using two positions of the sound source and three fixed microphone positions for each source position distributed at 120° in the microphone path.

Measuring chain is verified just before and after the execution of the test.

The guidelines indicated in the applicable internal procedures have been followed:

- PE.CM-AA-61-E: "Procedure for the determination of the airborne sound insulation into the horizontal and vertical transmission rooms".
- PE.MC-AA-06-M: "Procedure to manage the test specimens for acoustic tests in laboratory".

Standard UNE-EN ISO 10140-2:2011, together with the other UNE-EN ISO 10140-1:2016, UNE-EN ISO 10140-4:2011 and UNE-EN ISO 10140-5:2011, cancels and replaces UNE-EN ISO 140-3:1995. The measurement and evaluation process applied to the test specimen described in this report is according to the standard UNE-EN ISO 10140-2:2011 and complies with cancelled UNE-EN ISO 140-3:1995.

5. RESULTS

The following results are presented:

B2021-159-M864 MRA: Sound reduction improvement index of *Lining on the standard basic element 'heavy wall'*:

- Sound reduction improvement index, ΔR , in decibels, for the one-third-octave band from 100 Hz to 5000 Hz, in table and graph.
- Weighted sound reduction improvement index, $\Delta R_{w,heavy}$, calculated according to UNE-EN ISO 10140-1:2016, Annex G, on the standard heavy wall.

$$\Delta R_{w,heavy} = R_{w,ref,with} - R_{w,ref,without}$$

$$R_{ref,with} = R_{ref,without} + \Delta R$$



$R_{ref,without}$ given in UNE-EN ISO 10140-5:2011, Annex B.

- A-weighted improvement of sound reduction indices $\Delta(R_w+C)_{heavy}$ and $\Delta(R_w+C_{tr})_{heavy}$, calculated in an equivalent way.
- A-weighted improvement of sound reduction indices $\Delta(R_w+C_{100-5000})_{heavy}$ and $\Delta(R_w+C_{tr,100-5000})_{heavy}$, calculated in an equivalent way.

Additionally, are presented:

- Sound reduction index of the standard wall with lining, R_{with} , for the one-third-octave band from 100 Hz to 5000 Hz.
- Sound reduction index of the standard wall without lining, $R_{without}$, for the one-third-octave band from 100 Hz to 5000 Hz.
- Global indices $R_w (C; C_{tr})$, R_A and $R_{A,tr}$ for the both elements mentioned above.

B2021-159-M864 RA: Airborne sound insulation of *Lining + 'heavy wall'*:

- Sound reduction index, R, for the one-third octave band from 100 to 5000 Hz, in table and graph.
- Global indices $R_w (C; C_{tr})$, R_A and $R_{A,tr}$.

The global indices $R_w (C; C_{tr})$, R_A and $R_{A,tr}$ for a test specimen are calculated as follows:

- R_w : Weighted sound reduction index, calculated according to UNE-EN ISO 717-1:2021, from the sound reduction index, R.
- C and C_{tr} : Spectrum adaptation terms from 100 to 3150 Hz, calculated according to UNE-EN ISO 717-1:2021, which are the values, expressed in decibels, to be added to the global magnitude value R_w to consider the characteristics of the pink noise spectrum (C) and traffic noise spectrum (C_{tr}), respectively.
- R_A and $R_{A,tr}$: Global indices calculated according to the expression of *Documento Básico "DB-HR Protección frente al ruido" - Código Técnico de la Edificación (CTE)*, from the sound reduction index, R, obtained by laboratory measurement:
 - R_A : A-weighted sound reduction index, from 100 to 5000 Hz, expressed to one decimal place.
 - $R_{A,tr}$: A-weighted sound reduction index for exterior traffic noise, from 100 to 5000 Hz, expressed to one decimal place.

The R_{with} value marked with * means that is greater than or equal to the indicated value, due to approaching in less than 15 dB to the R'_{max} of the test facilities. Likewise, the ΔR value marked with * means that is greater than or equal to the indicated value, due to the measurement limit of the R_{with} value marked with * on the same frequency. The global index marked with ** means that is greater than or equal to the indicated value, due to the frequency limit values marked with *.



Sound reduction improvement index of a lining on standard heavy wall according to UNE-EN ISO 10140-1:2016 Annex G

Laboratory measurements according to UNE-EN ISO 10140-2:2011

Result No.: B2021-159-M864 MRA

Test date: 30th November 2021

Applicant: SUSPENSIONES ELÁSTICAS DEL NORTE, S.L. (SEÑOR)

Test specimen: ACOUSTIC SELF-SUPPORTING WALL LINING (SEÑOR+ChovA) EI120:

- SE-4800/TDM (HYBRID) (SEÑOR)
- SE-TAV-500/11A (SEÑOR)
- SE-TAV-500/11R (SEÑOR)
- SE-BEC-10X100 (SEÑOR)
- ChovANAPA 4cm PANEL 600 (ChovA)
- ViscoLAM AUTOADHESIVA (ChovA)
- 48 mm CHANNELS
- 46 mm STUDS
- 25 mm plasterboard

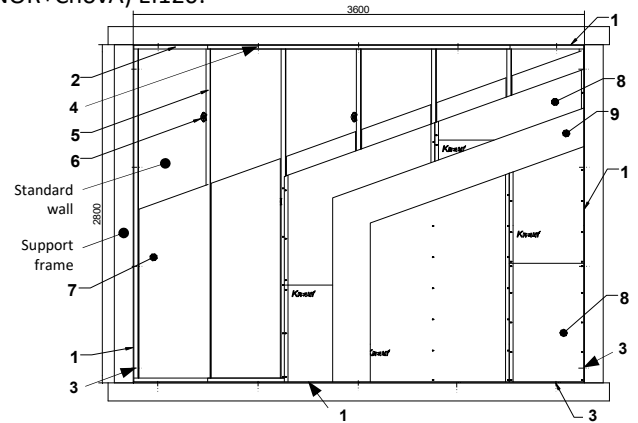
Standard heavy wall: Lined filled concrete block wall (300 kg/m²), tested on 16th November 2021 ($R_{w,without}$)

Estimated superficial mass: 48 kg/m²

Test specimen area: 10,08 m² T_{rooms} : 17,3 °C

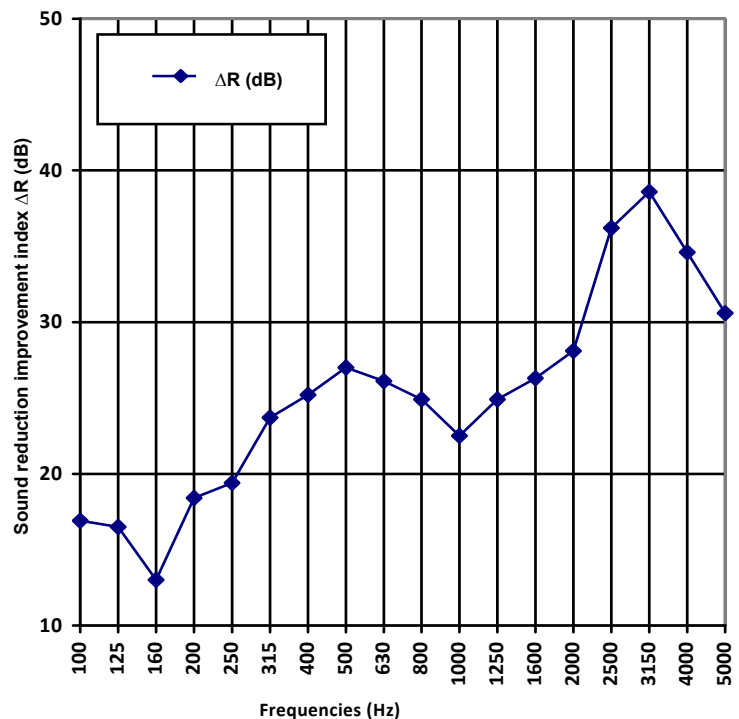
Source room volume: 65,1 m³ HR_{rooms} : 52 %

Receiving room volume: 55,2 m³ P_{rooms} : 967 mbar



1. SE-BEC-10x100
 2. 48/30 CHANNEL
 3. SE-TAV-500/11A
 4. SE-TAV-500/11R
 5. C 48/35 STUD
 6. SE-4800/TDM (HYBRID)
 7. ChovANAPA 4cm PANEL 600 (2 units)
 8. 25 mm plasterboard
 9. ViscoLAM AUTOADHESIVA
- Chamber wall - interior layer
plasterboards: 100 mm
Wall lining: 202 mm thick

| f (Hz) | $R_{w,with}$ (dB) | $R_{w,without}$ (dB) | ΔR (dB) |
|--------|-------------------|----------------------|-----------------|
| 100 | 49,6* | 32,7 | 16,9* |
| 125 | 49,0 | 32,5 | 16,5 |
| 160 | 50,3 | 37,3 | 13,0 |
| 200 | 54,7* | 36,3 | 18,4* |
| 250 | 56,4 | 37,0 | 19,4 |
| 315 | 62,0 | 38,3 | 23,7 |
| 400 | 66,3 | 41,1 | 25,2 |
| 500 | 70,2 | 43,2 | 27,0 |
| 630 | 72,5 | 46,4 | 26,1 |
| 800 | 74,6 | 49,7 | 24,9 |
| 1000 | 74,8 | 52,3 | 22,5 |
| 1250 | 79,5 | 54,6 | 24,9 |
| 1600 | 82,5 | 56,2 | 26,3 |
| 2000 | 84,2 | 56,1 | 28,1 |
| 2500 | 89,7* | 53,5 | 36,2* |
| 3150 | 91,3* | 52,7 | 38,6* |
| 4000 | 88,5* | 53,9 | 34,6* |
| 5000 | 85,1* | 54,5 | 30,6* |



| | |
|---|---|
| $R_{w(C; C_{tr})_{with}}$: 70(-3;-8) dB ** | $R_{w(C; C_{tr})_{without}}$: 48(-1;-4) dB |
| $R_{A,with}$: 68,3 dBA ** | $R_{A,without}$: 47,7 dBA |
| $R_{A,tr,with}$: 62,2 dBA ** | $R_{A,tr,without}$: 43,5 dBA |

Weighted indices according to UNE-EN ISO 10140-1:2016 Annex G:

$\Delta R_{w,heavy}$: 21 dB ** / $\Delta(R_w+C)_{heavy}$: 20 dBA ** / $\Delta(R_w+C_{tr})_{heavy}$: 19 dBA **

$\Delta(R_w+C_{100-5000})_{heavy}$: 20 dBA ** / $\Delta(R_w+C_{tr,100-5000})_{heavy}$: 19 dBA **

Evaluation based on laboratory measurement results obtained by an engineering method



* R' and $\Delta R \geq$ indicated value (measurement limit by approx. R'_{max}). ** Global Index \geq indicated value.
 R'_{max} 100 Hz: 59,8 dB; 200 Hz: 67,5 dB; 2500 Hz: 102,4 dB; 3150 Hz: 101,2 dB; 4000 Hz: 96,9 dB; 5000Hz: 94,1dB.



Airborne Sound Insulation according to UNE-EN ISO 10140-2:2011 Laboratory Measurements

Result No.: B2021-159-M864 RA

Test date: 30th November 2021

Applicant: SUSPENSIONES ELÁSTICAS DEL NORTE, S.L. (SEÑOR)

Test specimen: ACOUSTIC SELF-SUPPORTING WALL LINING (SEÑOR+ChovA) EI120:

- SE-4800/TDM (HYBRID) (SEÑOR)
 - SE-TAV-500/11A (SEÑOR)
 - SE-TAV-500/11R (SEÑOR)
 - SE-BEC-10X100 (SEÑOR)
 - ChovANAPA 4cm PANEL 600 (ChovA)
 - ViscoLAM AUTOADHESIVA (ChovA)
 - 48 mm CHANNELS
 - 46 mm STUDS
 - 25 mm plasterboard
- ON LINED BLOCK WALL.**

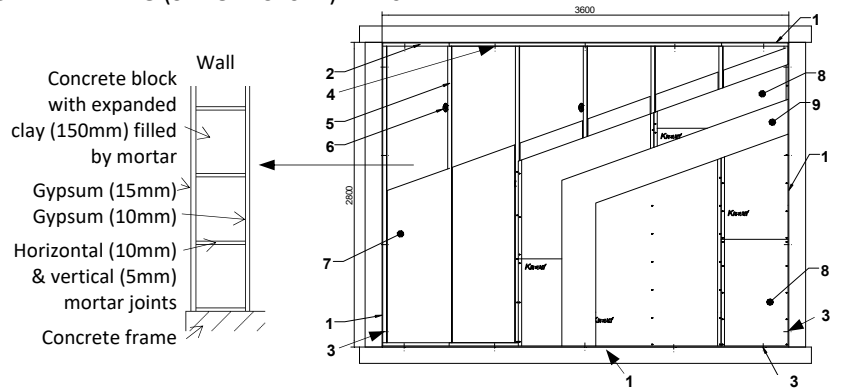
Estimated superficial mass: 348 kg/m²

Test specimen thickness: 377 mm

Test specimen area: 10,08 m² T_{rooms}: 17,3 °C

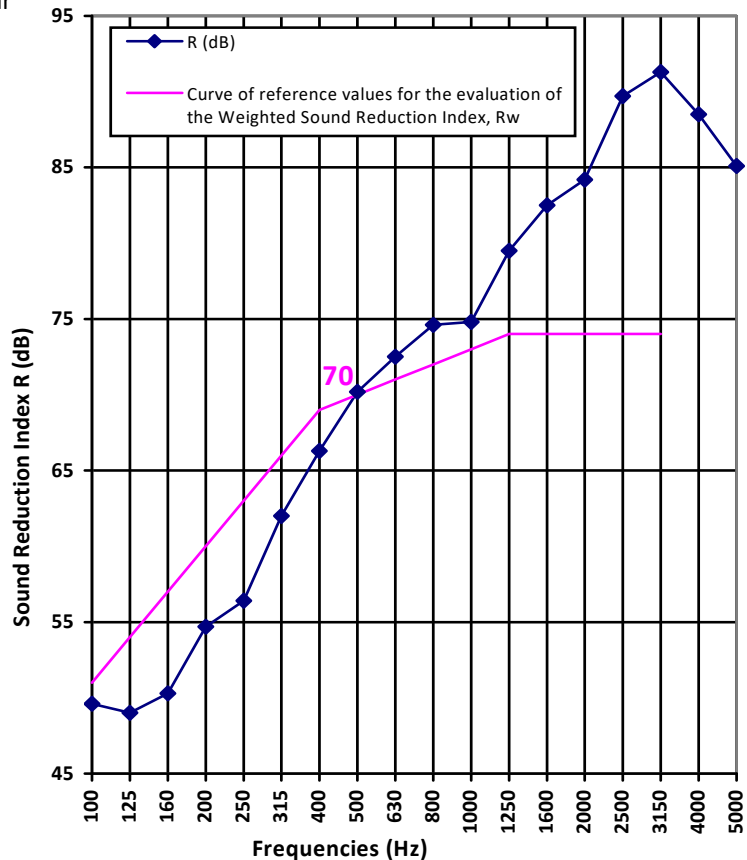
Source room volume: 65,1 m³ HR_{rooms}: 52%

Receiving room volume: 55,2 m³ P_{rooms}: 967 mbar



- | | | |
|-------------------|------------------------------------|-------------------------------|
| 1. SE-BEC-10x100 | 5. C 48/35 STUD | 9. ViscoLAM AUTOADHESIVA |
| 2. 48/30 CHANNEL | 6. SE-4800/TDM (HYBRID) | Chamber wall - interior layer |
| 3. SE-TAV-500/11A | 7. ChovANAPA 4cm PANEL 600(2units) | plasterboards: 100 mm |
| 4. SE-TAV-500/11R | 8. 25 mm plasterboard | Wall lining: 202 mm thick |

| f (Hz) | R (dB) |
|--------|--------|
| 100 | 49,6* |
| 125 | 49,0 |
| 160 | 50,3 |
| 200 | 54,7* |
| 250 | 56,4 |
| 315 | 62,0 |
| 400 | 66,3 |
| 500 | 70,2 |
| 630 | 72,5 |
| 800 | 74,6 |
| 1000 | 74,8 |
| 1250 | 79,5 |
| 1600 | 82,5 |
| 2000 | 84,2 |
| 2500 | 89,7* |
| 3150 | 91,3* |
| 4000 | 88,5* |
| 5000 | 85,1* |



Rating according to UNE-EN ISO 717-1:2021: R_w (C;C_{tr}): 70 (-3; -8) dB **

Rating according to CTE DB-HR: R_A: 68,3 dBA **

R_{A,tr}: 62,2 dBA **

Evaluation based on laboratory measurement results obtained by an engineering method



*R' ≥ indicated value (measurement limit by approx. R' max). ** Global Index ≥ indicated value.

R' max 100 Hz: 59,8 dB; 200 Hz: 67,5 dB; 2500 Hz: 102,4 dB; 3150 Hz: 101,2 dB; 4000 Hz: 96,9 dB; 5000 Hz: 94,1 dB.