EUSKO JAURLARITZA GOBIERNO VASCO

EMPLEGU ETA GIZARTE POLITIKETAKO SAILA
Etxebizitza, Zuzendaritza
Eraikuntzaren Kalitate Kontrolerako Laborategia

DEPARTAMENTO DE EMPLEO Y POLÍTICAS SOCIALES
Dirección de Vivienda
Laboratorio de Control de Calidad de la Edificación

AKUSTIKA ARLOA kudeatzailea:
ÁREA DE ACÚSTICA gestionada por:
tecnalia

Tests Report Nº 90.8106.0–IN–CT–09/ 17 E

Laboratory measurements of sound insulation

TEST SPECIMEN: Reinforced concrete floating slab, with air gap.

APPLICANT: APLICACIONES MECÁNICAS DEL CAUCHO, S.A.

USED STANDARDS: EN ISO 140-3: 1995.
EN ISO 140-8: 1997.

TEST DATES: June 24th and 26th, 2.009.
TEST REPORT DATE: July 14th, 2.009.
TRANSLATION DATE: January 10th, 2.014.

Signature

tecnalia Inspiring Business

María José de Rozas

Acoustics Laboratory Manager

The technical-owned of the ENAC Nº4/LE456 accreditation fall to Fundación Tecnalia Research & Innovation, the same way as the technical signatures of this report.

The installations where are performed the measurements according ENAC Nº4/LE456 accreditation belong to the Acoustics Area of Laboratory for Quality Control in Buildings of the Basque Country Government.

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THIS REPORT CONTAINS:

Total number of pages: 15.

Pages of ANNEX: 2.

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. Uncertainties of measurements complies the recommendations of EN 20140-2:1993.

This document is a copy in PDF of the original Report, for request of our client.

INDEX

1.- AIM

This report shows the **reduction of impact sound pressure level** and **sound reduction improvement index** provided by a reinforced concrete floating slab with air gap.

2.- APPLICANT

COMPANY: APLICACIONES MECÁNICAS DEL CAUCHO, S.A.

ADDRESS: Industrialdea, Zona A, Nº 35
20159 ASTEASU (Guipúzcoa)

PERSON OF CONTACT: Mr. D. Jon Irazustabarrena.

3.- TEST SPECIMEN CONSTRUCTION AND TEST EXECUTION PLACE

The test specimen was mounted in the Laboratory for Quality Control in Buildings of the Basque Country Government located at:

Aguirrelanda Street, Nº 10
01013 Vitoria – Gasteiz (Alava – Spain)

The tests were performed in the vertical transmission rooms of the Acoustic Area of the laboratory by *TECNALIA´s* staff.

The materials for the construction of the specimen were selected and delivered by the applicant. The construction of the floor was made by applicant´s employers, supervised by *TECNALIA´s* staff, and finished on May 14th, 2.009.

4.- TEST STANDARDS AND PROCEDURES

- **EN ISO 140-3:1995:** "Acoustics - Measurement of sound insulation in buildings and of building elements. Part 3: Laboratory measurements of airborne sound insulation of building elements."
- **EN ISO 140-8:1997**: "Acoustics - Measurement of sound insulation in buildings and of building elements. Part 8: Laboratory measurements of the reduction of transmitted impact noise by floor coverings on a heavyweight floor."
- **EN ISO 140-16:2006**: "Acoustics. Measurement of sound insulation in buildings and of building elements. Laboratory measurement of the sound reduction index improvement by additional lining".
- **EN ISO 717-2:1996:** "Acoustics - Rating of sound insulation in buildings and of building elements. Part 2: Impact sound insulation."
- **TECNALIA´s internal procedures.** According to ENAC accreditation No 4/LE456 (ENAC: Spanish National Accreditation Body)".

5.- TEST ARRANGEMENT

5.1.- Previous considerations

To obtain the improvement in impact and airborne sound insulation, floating slab was built on a heavyweight floor of 15 cm width with reinforced concrete (normalized slab according to EN ISO 140-8).

The improvement of airborne sound insulation is obtained testing the airborne sound insulation of the heavyweight floor as the insulation of the whole specimen composed of floating covering + heavyweight floor, according to EN ISO 140-3. These results allow the calculation of the sound reduction improvement index (Δ**R**) provided by the covering, according to EN ISO 140-16.

The reduction of impact sound pressure level is obtained according to EN ISO 140-8.

5.2.- Description of the sample

The tested sample consists on a reinforced concrete floating slab (100 mm thick) that was raised 25 mm with a shock absorber system (photos and figures 1-3).

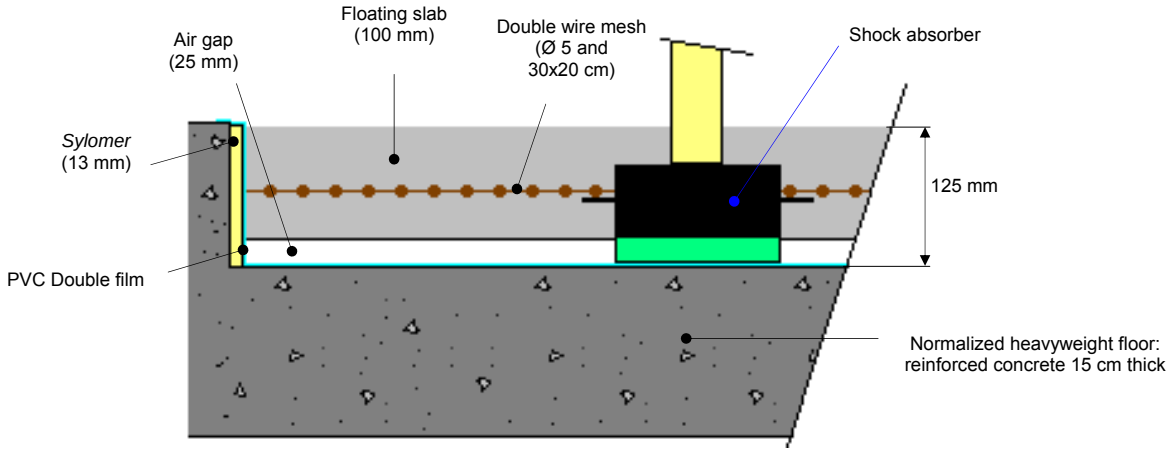


Figure 1: Sketch of floating slab on normalized floor

Floating slab: *HM-20-B 20* concrete reinforced with double wire mesh (Ø 5 mm and 30x20 cm).

The double wire mesh (one tied to the other) was posed over the shock absorbers (photo 4). These shock absorbers had the measured dimensions of 205 x 205 mm (figure 2) and were arranged as detailed in figure 3.

Sylomer of 13 mm thick was placed around the whole perimeter between the wall of the heavyweight floor and the floating slab.

Protective, double and transparent PVC film was placed to cover the *Sylomer* as well the surface of the heavyweight floor.

Once the concrete set, the slab was raised.

The dimensions of the sample were 4,2 m x 3,3 m (13,86 m^2).

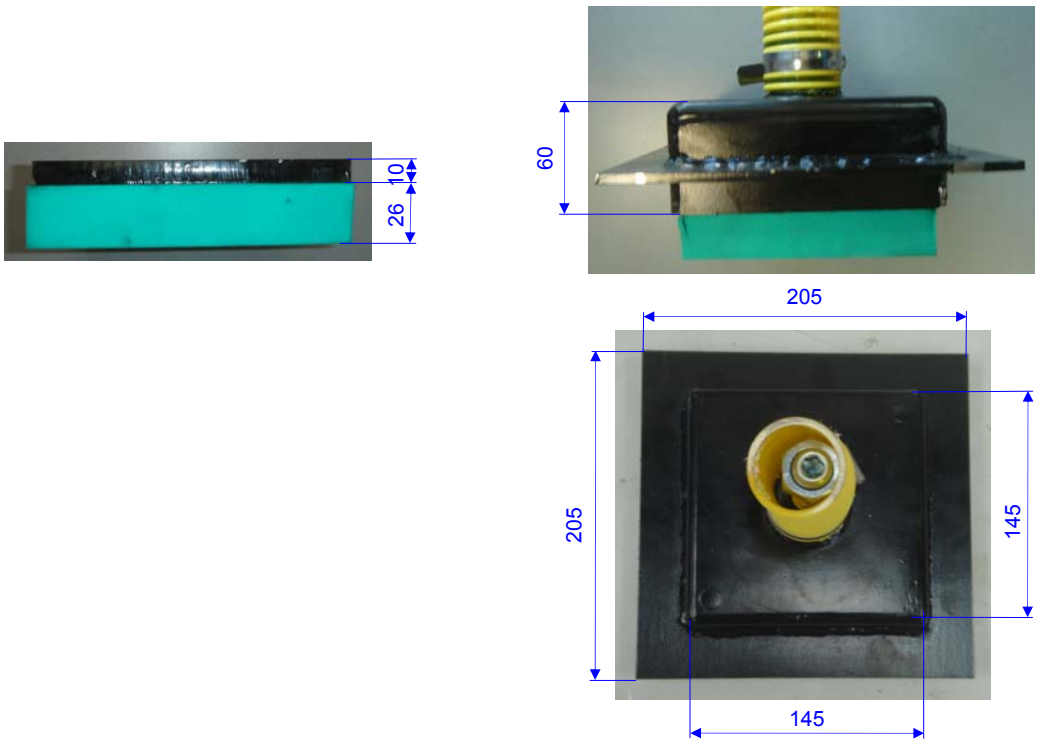


Figure 2: Shock absorbers *(cotes in mm)*

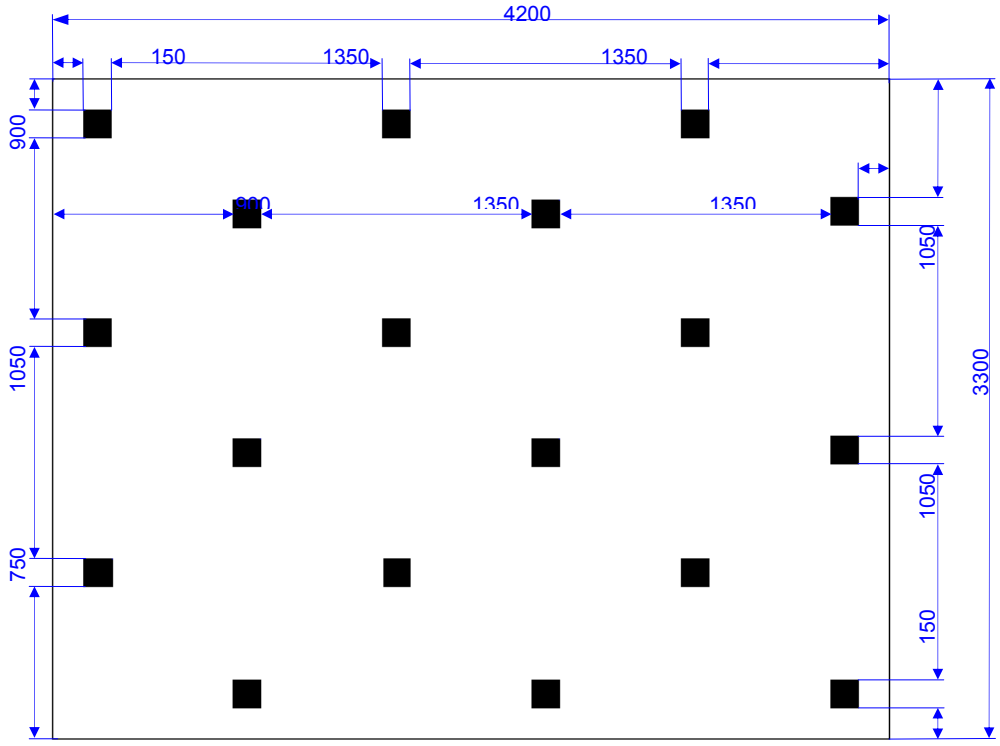


Figure 3: Arrangement of shock absorbers *(cotes in mm)*

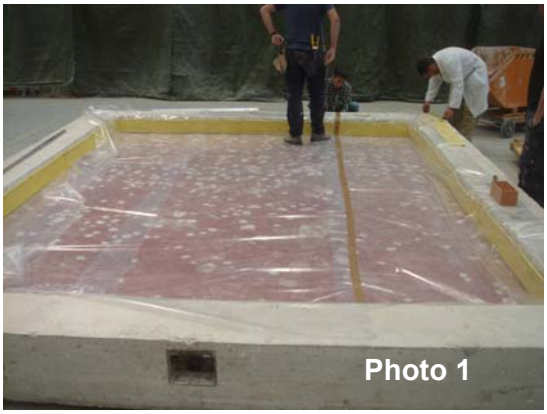
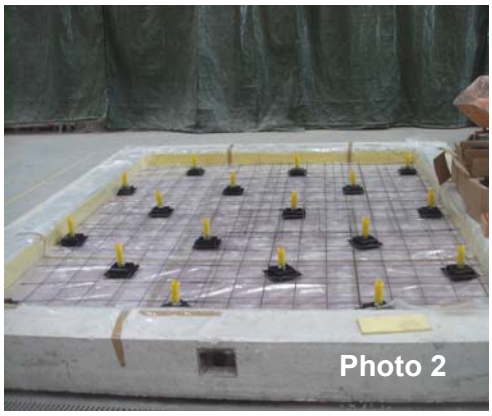
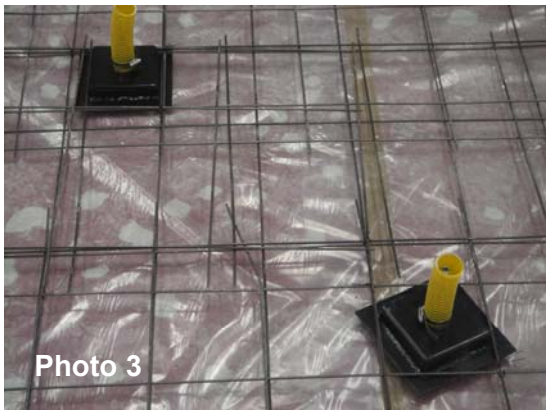
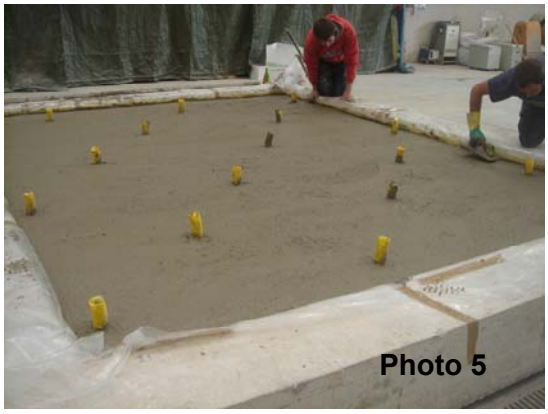


Photo 1: Position of "*Sylomer*" in the perimeter and film of PVC on normalized heavyweight floor





Photos 2 and 3: Position of wire mesh and shock absorbers



Photos 4 and 5: Spill of concrete

Photo 6: Raising of concrete slab

Photo 7: View of sample in the test rooms

5.3.- Laboratory test facilities

The tests were performed in the vertical transmission rooms, composed of a source and a receiving room. The reception room is composed of an external and an internal concrete box, of 20 and 10 cm thick each one, disconnected by an anti-vibratory system and an air chamber 10 cm thick with fibreglass within.

The specimen was installed by moving away vertically the source room from the receiving one.

These rooms fulfill the standard **EN ISO 140-1:1997**.

A sketch of vertical transmission rooms is included in figure 4.

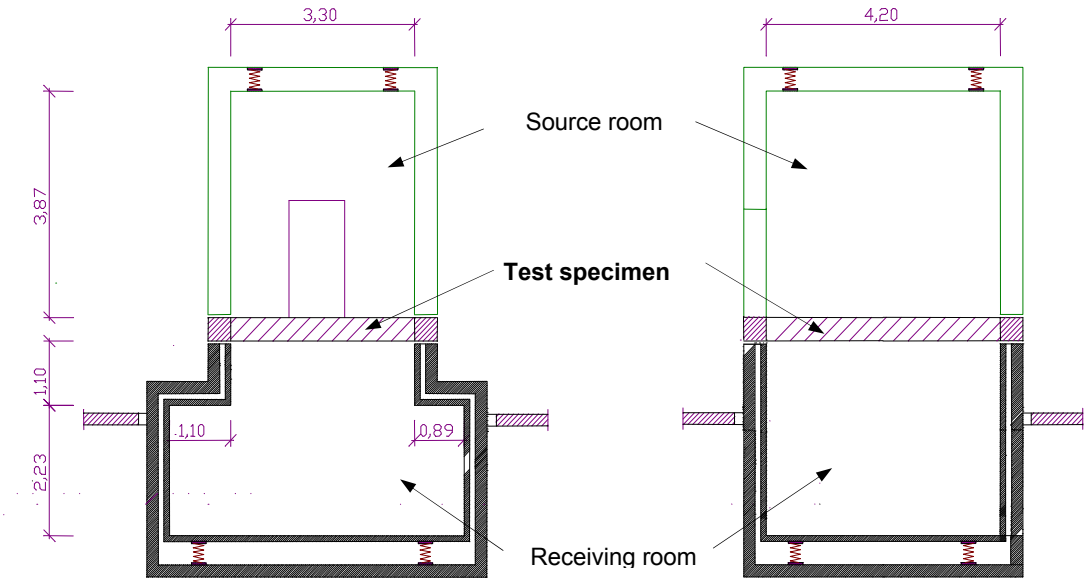


Figure 4: Sketch of the vertical transmission rooms

5.4.- Equipment

	Vertical sound room	Vertical reception room
Microphones	Brüel & Kjær 4943; Nº 2534064	Brüel & Kjær 4943; Nº 2534065
Preamplifiers	Brüel & Kjær 2669; Nº 1948764	Brüel & Kjær 2669; Nº 2025844
Sound sources	Brüel & Kjær 4296; Nº 2071427	BR 112 T/A
Booms	Brüel & Kjær 3923; Nº 2036584	Brüel & Kjær 3923; Nº 2036585
Tapping machine	Brüel & Kjær 3204; Nº 1362917	

	Control room
Analyser	Brüel & Kjær 2144; Nº 1893979
Amplifier	LAB 300; Nº 970-967
Equalizer	Sony, SRP-E100; Nº 400238
Calibrator	Brüel & Kjær 4231; Nº 2061476
Atmospheric conditions meter	Testo 0560 4540 Nº 711.88490007GB

6.- TEST PROCEDURE AND EVALUATION

6.1.- Reduction of impact sound pressure level

The improvement of impact noise insulation of a sample is characterized by the **reduction of impact sound pressure level (ΔL)**.

The reduction of impact sound pressure level (ΔL) of the sample under test for the one-third-octave band is calculated from the difference of normalized impact sound pressure level of the standardized heavyweight floor without and with the floating slab, according the following formula:

$$\Delta L = L_{n,0} - L_n$$

$L_{n,0}$: Standardized impact sound pressure level of the standardized heavyweight floor, between 100 and 500 Hz.

L_n: Standardized impact sound pressure level of the standardized heavyweight floor with the floating slab, between 100 and 500 Hz.

The standardized impact sound pressure levels (L_n) for the one-third-octave band between 100 and 500 Hz, are obtained for each case ($L_{n,0}$ y L_n) according to the following formula:

$$L_n = L_i + 10 * \text{Log } A/A_0 \qquad \text{where,}$$

L_n: The normalized impact sound pressure level.

L_i: Impact sound pressure level.

A: Equivalent absorption area in the receiving room.

A_0: Reference equivalent absorption area (10 m^2).

For each case the measurement of sound pressure level (L_i) in a one-third-octave band was performed exciting the sample by a standard tapping machine, that was placed in different positions randomly distributed over the base floor without and with the floating slab.

The sound field in the receiving room was sampled using a moving microphone with a sweep radius of 1 m and a traverse period of 16 s during 32 s of measure.

The equivalent sound absorption area is evaluated from the reverberation time measured in the receiving room and determined using Sabine's formula:

$$A = 0.16 * V/T \qquad \text{where,}$$

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 using one position of the sound source and six different fixed microphone positions, at 60º in the microphone path.

Finally, background noise was measured in the receiving room in the one-third-octave band between 100 Hz to 5 KHz according the same sound field measurement in the receiving room.

All the testing equipment was calibrated just before and after every measurement.

6.2.- Sound reduction improvement index

The improvement of airborne sound insulation of a sample is characterized by the **Sound reduction improvement index (ΔR)**.

The sound reduction improvement index (ΔR) of the sample under test for each one-third-octave band is calculated according to **EN ISO 140-16**, as the difference between the sound reduction index of the normalized heavyweight floor with and without the floating slab, according to the following formula:

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

R_{with}: Sound reduction index of the heavyweight floor with floating slab, between 100 and 500 Hz.

$R_{without}$: Sound reduction index of the heavyweight floor without floating slab, between 100 and 500 Hz.

The sound reduction indexes (R) in one-third-octave band between 100 Hz and 500 Hz is calculated for each case (R_{with} and $R_{without}$) according to **EN ISO 140-3** standard using the following formula:

$$R=L_1-L_2+10*\text{Log } S/A \qquad \text{where,}$$

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.

For each case, the measurement of the average sound pressure levels L_1 and L_2 were performed emitting an equalized white noise (between 100 and 500 Hz) with a moving sound source.

The sound field in the source and receiving room were sampled using different fixed positions of microphone in the case of floating slab on standardized heavyweight floor and using a moving microphone with a sweep radius of 1 m and a traverse period of 16 s during 32 s of measure in the case of the standardized heavyweight floor.

The equivalent sound absorption area is evaluated from the reverberation time measured in the receiving room using Sabine's formula:

$$A=0.16*V/T$$ where,

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 using one position of the sound source and six different fixed microphone positions, at 60º in the microphone path.

Finally, background noise was measured in the receiving room in the one-third-octave band between 100 Hz to 5 KHz using different fixed positions of microphone in the case of floating slab on standardized heavyweight floor, and using a moving microphone with a sweep radius of 1 m and a traverse period of 16 s during 32 s of measure in the case of the standardized heavyweight floor.

All the testing equipment was calibrated just before and after every measurement

7.- RESULTS

7.1.- Reduction of impact sound pressure level

Annex I presents the following results of reduction of impact noise for the tested sample:

- The **reduction of impact sound pressure level, ΔL,** in the one-third-octave band between 100 Hz to 5 KHz, in table and graphic.

- The **weighted reduction impact sound pressure level (ΔL_w)**, according **EN ISO 717-2,** using the following formula:

$$\Delta L_w = L_{n,r,0,w} - L_{n,r,w} = 78 \text{ dB} - L_{n,r,w}$$ where,

$L_{n,r,0,w}$: The weighted normalized sound pressure level for reference floor without floating slab.

$L_{n,r,w}$: The weighted normalized sound pressure level for reference floor with floating slab.

- **The spectrum adaptation term for reduction of impact noise ($C_{I,\Delta}$)**, according to **EN ISO 717-2,** using the following formula:

$$C_{I,\Delta} = C_{I,r,0} - C_{I,r} = -11 \text{ dB} - C_{I,r}$$ where,

$C_{I,r,0}$: Spectrum adaptation term for the reference without the floating slab under test.

$C_{I,r}$: Spectrum adaptation term for the reference with the floating slab under test.

Additionally, the Annex I also presents:

- The normalized impact sound pressure level of the **standardized heavyweight floor with the floating slab**, L_n, between 100 and 500 Hz.

- The normalized impact sound pressure level of the **standardized heavyweight floor, $L_{n,0}$**, between 100 and 500 Hz.

- The global index, $L_{n,w}$ / $L_{n,0,w}$ for the **standardized** heavyweight floor with and without the sample.

7.2.- Reduction of airborne sound insulation

Annex II presents the following results for the sound reduction index improvement for the tested sample:

- The **sound reduction improvement index, ΔR,** in the one-third-octave band between 100 Hz to 5 KHz, in table and graphic.

- The **A-weighted sound reduction improvement indices**, ΔR_A, between 100 Hz to 5 KHz and using the following formula:

$$\Delta R_A = (R_{w,ref,with} + C_{ref,\ with,100\text{-}500}) - (R_{w,ref,without} + C_{ref,without,100\text{-}500}).$$

  This index is one of the acoustic parameters to determine the reduction of airborne sound insulation to the application of the Spanish Basic Building Regulation: **NBE-CA 88** "Acoustical Conditions in Buildings".

- The **weighted sound reduction improvement index ΔR_w**, calculated according to **EN ISO 140-16**, Annex A, from the sound reduction improvement index, ΔR.

- The **weighted sound reduction indexes, A,** between 100 Hz to 5 KHz, **$\Delta(R_w + C)$ and $\Delta(R_w + C_{tr})$, according to EN ISO 140-16**.

Additionally, the Annex II also presents:

- The sound reduction index of the **standardized heavyweight floor**, $R_{without,}$ between 100 and 500 Hz.
- The sound reduction index of the **floating slab on the standardized heavyweight floor**, $R_{with,}$ between 100 and 500 Hz.

- The global indeces **R_w (C, C_{tr}) for both elements.**

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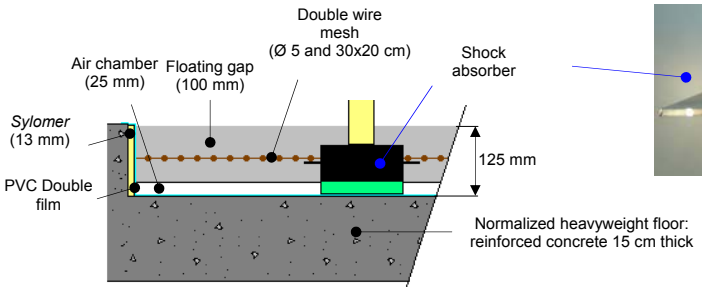
DEPARTAMENTO DE EMPLEO Y POLÍTICAS SOCIALES
Dirección de Vivienda
Laboratorio de Control de Calidad de la Edificación

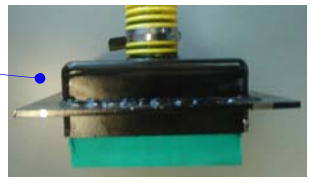
Reduction of Transmitted Impact Noise according to EN ISO 140-8:1998
Laboratory Measurements

Applicant: APLICACIONES MECÁNICAS DEL CAUCHO, S.A. **Test date:** June 24th, 2009.

Test specimen: Reinforced concrete floating slab, 100 mm thick, rised 25 mm by a shock absorber system, as detailed in the report.

Heavyweight floor: base floor of reinforced concrete, 15 cm thick, tested on June 26th, 2009 ($R_{without}$).

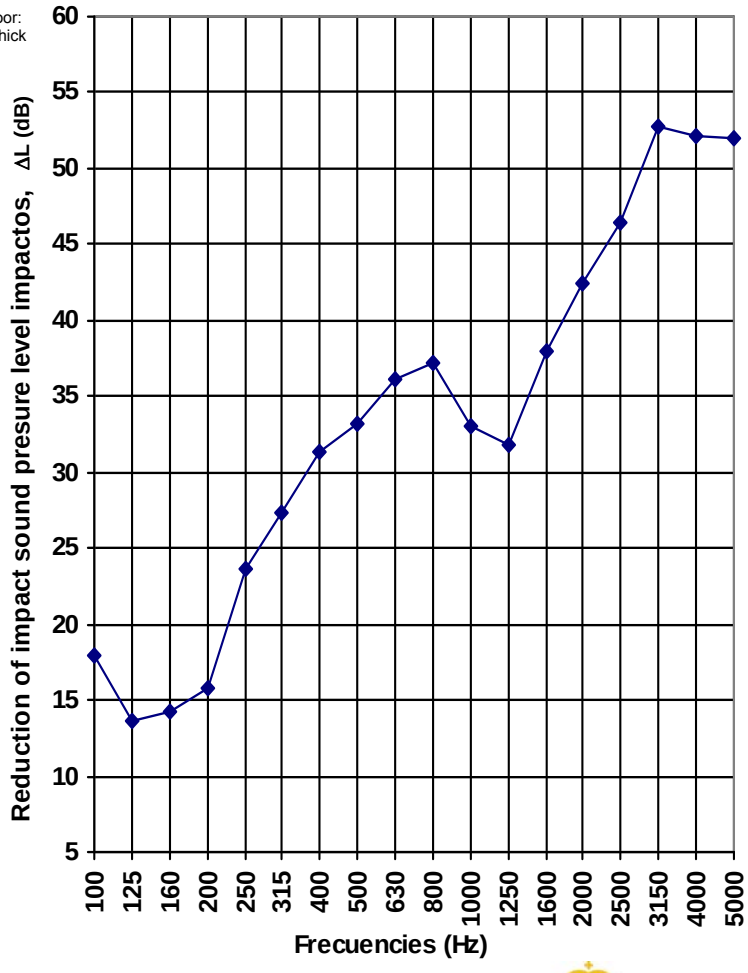




Receiving room volume: 64,7m^3
Test specimen area: 13,86 m^2 (3,3x4,2 m)
Estimated superficial mass: 250 kg/m^2

T_{rooms}: 17,3 ºC
HR_{rooms} : 77 %

f (Hz)	L_n (dB)	$L_{n,0}$ (dB)	ΔL (dB)
100	47,2	65,1	**17,9**
125	46,9	60,5	**13,6**
160	53,2	67,5	**14,3**
200	49,5	65,3	**15,8**
250	41,8	65,4	**23,6**
315	37,3	64,7	**27,4**
400	34,5	65,9	**31,4**
500	34,3	67,5	**33,2**
630	31,9	68,0	**36,1**
800	32,9	70,1	**37,2**
1000	37,3	70,4	**33,1**
1250	38,9	70,7	**31,8**
1600	32,5	70,5	**38,0**
2000	27,8	70,3	**42,5**
2500	22,9	69,3	**46,4**
3150	15,3·	68,1	**52,8·**
4000	14,1·	66,2	**52,1·**
5000	11,6·	63,6	**52,0·**
$L_{n,w}$ / $L_{n,0,w}$	41	76	



Weighted Reduction of impact noise according to EN ISO 717-2:1997 ΔL_w ($C_{I,\Delta}$): 34 (-11) dB

Results based on measurements with artificial source and under conditions of laboratory (engineering method).
· L_n ≤ showed value and ΔL ≥ showed value (measurement limits)

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Nº of result: B0910–17–M25 MRI
Date of report: July 14th, de 2.009
Date of translation: January 10th, 2.014

Signature:

Acoustics Area
Managed by tecnalia

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DEPARTAMENTO DE EMPLEO Y POLÍTICAS SOCIALES
Dirección de Vivienda
Laboratorio de Control de Calidad de la Edificación

Sound reduction improvement index according to EN ISO 140-16:2006
Laboratory Measurements according to EN ISO 140-3:1995

Applicant: APLICACIONES MECÁNICAS DEL CAUCHO, S.A. **Test date:** June 24th, 2009.

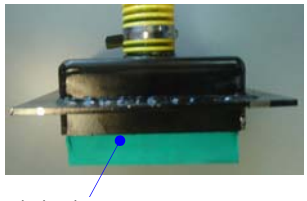
Test specimen: Floating floor covering of reinforced concrete, 100 mm thick, rised 25 mm by a shock absorber system, as detailed in the report.

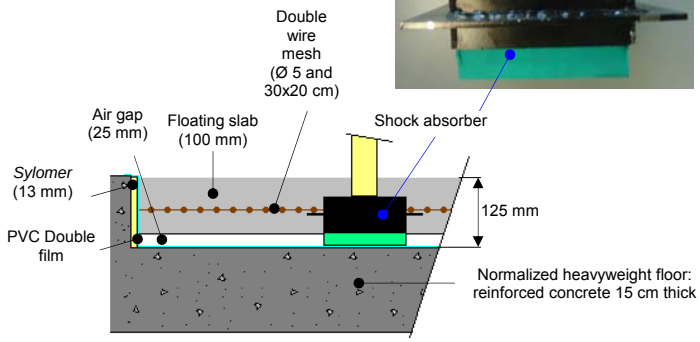
Heavyweight floor: base floor of reinforced concrete, 15 cm thick, tested on June 26th, 2009 ($R_{without}$).

Receiving room volume: 64,7m^3
Source room volume: 53,6 m^3

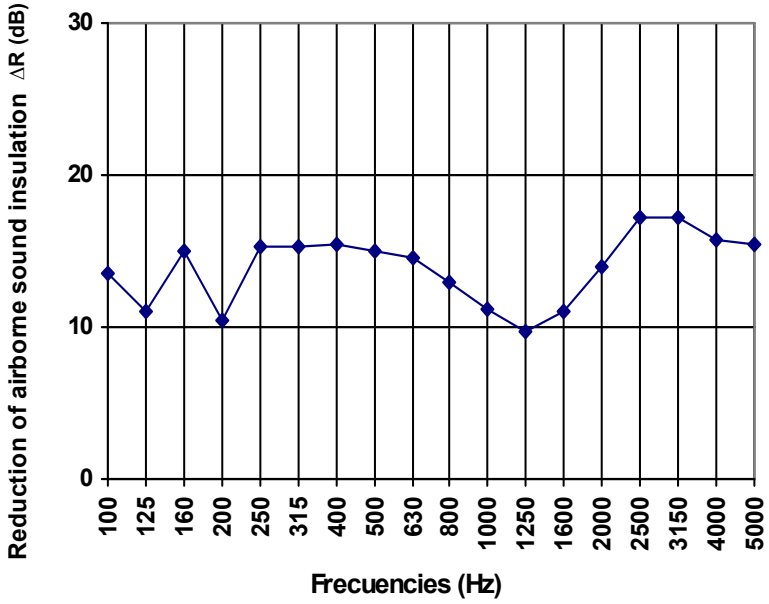
Test specimen area: 13,86 m^2 (3,3x4,2 m)
Estimated superficial mass: 250 kg/m^2

T_{rooms}: 17,3 ºC
HR_{rooms} : 77 %





f (Hz)	R_{with} (dB)	$R_{without}$ (dB)	ΔR (dB)
100	48,4·	34,8	**13,6**·
125	53,7·	42,6	**11,1**·
160	54,6·	39,6	**15,0**·
200	58,1·	47,6	**10,5**·
250	63,0	47,7	**15,3**
315	67,6·	52,3	**15,3**·
400	70,4·	54,9	**15,5**·
500	71,0·	56,0	**15,0**·
630	72,3·	57,7	**14,6**·
800	72,8	59,8	**13,0**
1000	72,0	60,8	**11,2**
1250	71,9	62,2	**9,7**
1600	74,9	63,8	**11,1**
2000	80,8·	66,8	**14,0**·
2500	87,5·	70,3	**17,2**·
3150	91,2·	74,1	**17,1**·
4000	91,9·	76,1	**15,8**·
5000	92,3·	76,9	**15,4**·
R_w (C; C_{tr})	72 (-2; -7)	58 (-2; -7)	
R_A	70,9	57,5	



Sound reduction improvement indices:

ΔR_A:	13	dBA
ΔR_w :	13	dB
$\Delta(R_w+C)$:	13	dBA
$\Delta(R_w+C_{tr})$:	13	dBA

Evaluation based on laboratory measurement results obtained by an engineering method.
· R_{with} and ΔR ≥ showed value (measurement limit)

ENAC ENSAYOS Nº 4 / LE 456

Nº of result: B0910–17–M25 MRA
Date of report: July 14th, de 2.009
Date of translation: January 10th, 2.014

Signature:

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