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Determination of impact and airborne sound insulation of wooden floors in a laboratory according to ISO 140-3 and 140-6.

(12 enclosures)

Client

Christian Berner AB and Getzner Werkstoffe.

Test object

Two types of wooden floors with four different types of upper floors.

The different upper floors where constructed as shown below (Figure 1-4).

Figure 1 – ***22 mm tongued and grooved board****.*

Figure 2 – called: ***P12***

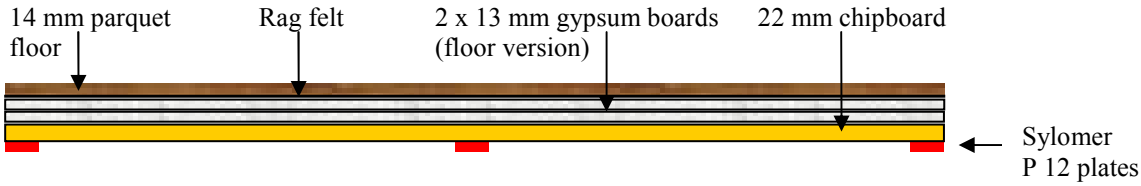


Figure 3 – called: ***L25***

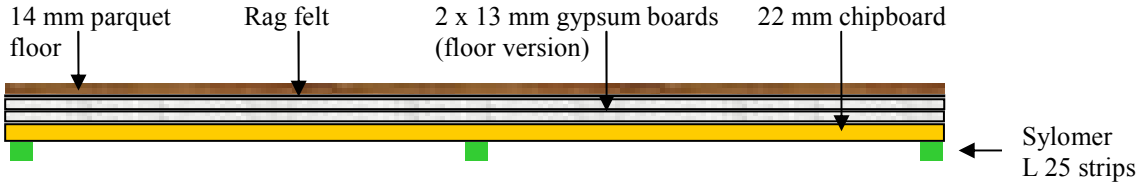
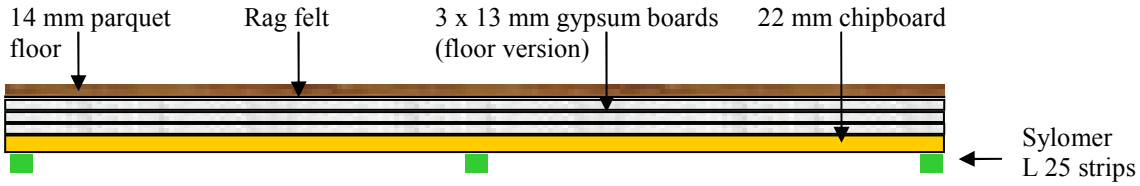


Figure 4 – called: ***L25 heavy***

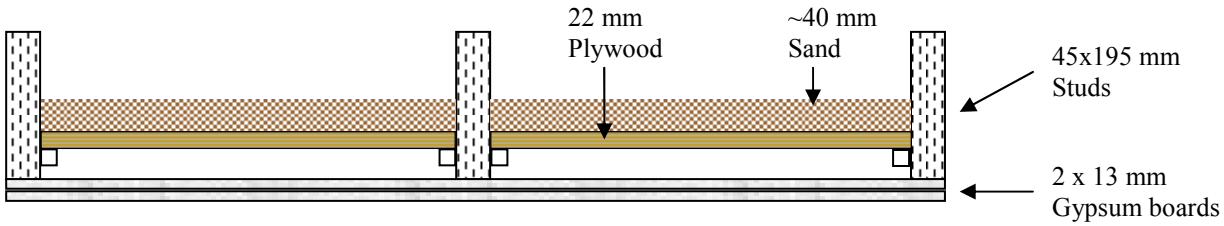


Note: The chipboard and the gypsum boards where glued together (Figure 2-4).

The two wooden floor structures where constructed like Figure 5 and 6.

*Figure 5 – The **empty version** of the wooden floor structure.*

*Figure 6 – The **sand version** of the wooden floor structure.*



Note: The mass of the sand was 80 kg/m^2 that resulted in a thickness of around 40 mm.

Arrival of test object

November 2006

Date of test

From November 28, 2006 to January 3, 2007.

Results

Weighted sound reduction index (R_w) and weighted normalized impact sound pressure level ($L_{n,w}$) are given in Table 1. The additional adaptation terms and a more detail results are given in enclosures 1-12.

The test results are valid for the tested specimen only.

Table 1 - Results

Type of upper floor and floor structure.	Weighted impact sound insulation ($L_{n,w}$) (dB)	$C_{I,50\text{-}2500}$ (dB)	Weighted airborne sound insulation (R_W) (dB)	$C_{50\text{-}3150}$ (dB)	Enclosure
Upper floor: 22 mm tongued and grooved board. Floor structure: Empty version	78	-4	39	-1	1-2
Upper floor: P12 Floor structure: Empty version	57	5	56	-3	3-4
Upper floor: L25 Floor structure: Empty version	57	5	57	-4	5-6
Upper floor: L25 heavy Floor structure: Empty version	52	8	58	-3	7-8
Upper floor: 22 mm tongued and grooved board. Floor structure: Sand version	77	-5	41	-1	9-10
Upper floor: L25 heavy Floor structure: Sand version	48	4	63	-3	11-12

Measurement method

The airborne sound insulation measurements have been performed according to the Swedish and International standard ISO 140-3.
The sound reduction index R has been determined according to

$$R = L_1 - L_2 + 10\lg\left(\frac{S}{A}\right)$$

where
L_1 is the average sound pressure level in the source room (dB),
L_2 is the average sound pressure level in the receiving room (dB),
S is the area of the test specimen (m²) and
A is the equivalent absorption area of the receiving room (m²).

The average sound pressure levels have been determined using a rotating microphone boom (radius >1,1 m) and a digital frequency analyser. A detailed description of the computerised measurement procedure is documented in the quality manual FEa QD 4 . A continuously moving loudspeaker has been used in the source room. During the measurement time of 128 s, the loudspeaker has moved up and down along a line across the room.

The impact sound insulation measurements have been performed according to ISO 140-6.
The adaptation terms of the impact sound insulation (C_I and $C_{I,50\text{-}2500}$) are defined in SS-EN ISO 717-2:96.

Evaluation

The results have been evaluated with respect to the weighted sound reduction index, R_w, according to the Swedish and International standard SS-EN ISO 717-1:96.

In the enclosures, R_w and the additional spectrum adaptation terms (C; C_{tr}), ($C_{50\text{-}3150}$;$C_{tr\ 50\text{-}3150}$) and ($C_{50\text{-}5000}$;$C_{tr\ 50\text{-}5000}$) according to SS-EN ISO 717-1:1996 are given. The spectrum adaptations terms are calculated in the 1/3 octave-bands 100-3150 Hz, 50-3150 and 50-5000 respectively and shall be added to the R_w values to obtain a summary value based on other noise spectra.

Measurement uncertainty

The measurement uncertainty for impact sound improvement according to ISO 140-6 is given in ISO 140/2:91(E) as given in Table 2. The reproducibility is an estimate of the range of results that may be expected if the test object is measured at different laboratories using different equipment, staff, reverberation rooms etc. The repeatability of measurements at the same laboratory using the same equipment etc is much more precise, i.e. the scatter of results is less. For airborne sound insulation improvement ISO 140/2 does not give any guidance. We estimate that the reproducibility for such measurements is equal to or better than the reproducibility for impact sound improvement given in Table 2.

Table 2 - Reproducibility

1/3 octave-band centre frequency (Hz)	Reproducibility (dB) ISO 140-3	Reproducibility (dB) ISO 140-6
100	9	5
125	8,5	4
160	6	3
200	5,5	3
250	5,5	3
315	4,5	3
400	4,5	3
500	4	2,5
630	3,5	2,5
800	3	2,5
1000	2,5	2,5
1250	3	2,5
1600	3,5	2,5
2000	3,5	2,5
2500	3,5	2,5
3150	3,5	2,5

Mounting

The wooden floor structures where built in SP:s sound insulation laboratory for floors (vertical measurements). The studs where placed directly on the edges of the test opening and can be seen in Figure 7. The mounting of the different upper floors can be seen in Figure 9-18. The joint between the upper floor and a the “real” floor in the laboratory was covered by several strips of gypsum boards and then sealed by tape (made of an elastic woven material) and model clay (see Figure 10).

Figure 7 – Placement of the studs in the test opening.

Figure 8 – Mounting of the ceiling consisting of two layers of 13 mm gypsum boards.

Figure 9 - Building of the first upper floor (22 mm tongued and grooved board) on the empty version of the wooden floor structure.

Figure 10 – Closing of the upper floor consisting of strips of gypsum board, tape and model clay.

Figure 11 –Upper floor 22 mm tongued and grooved board finished.

Figure 12 – Placement of the P12 sylomer.

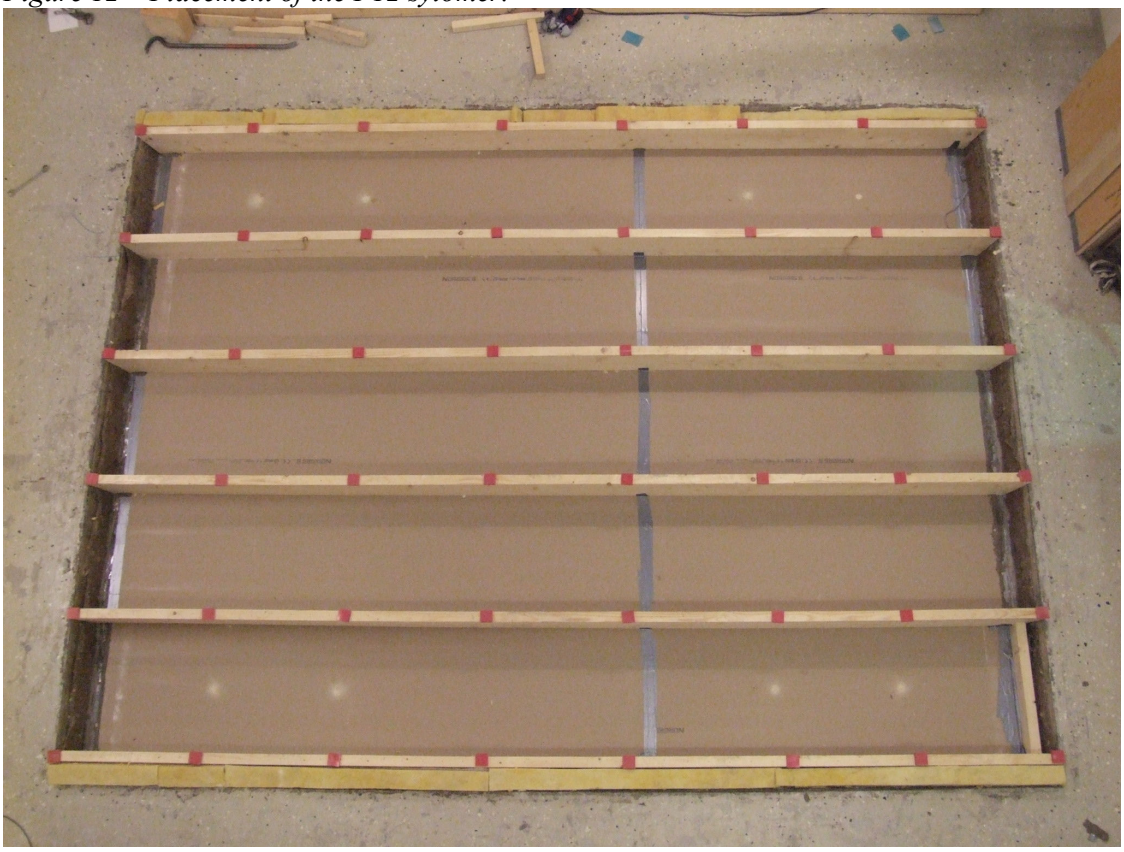


Figure 13 – Placement of the L25 sylomer.

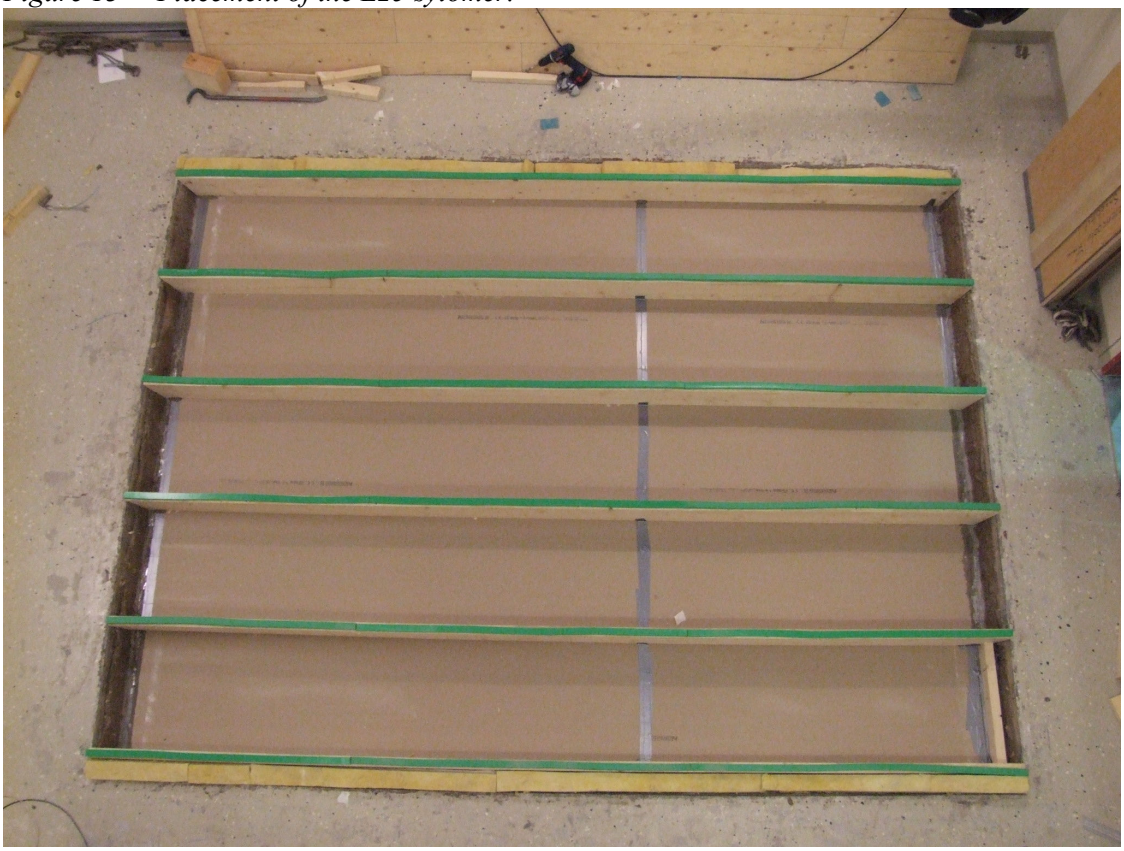


Figure 14 - Building of upper floor called P12 (with p12 sylomer) on the clean version of the wooden floor structure.

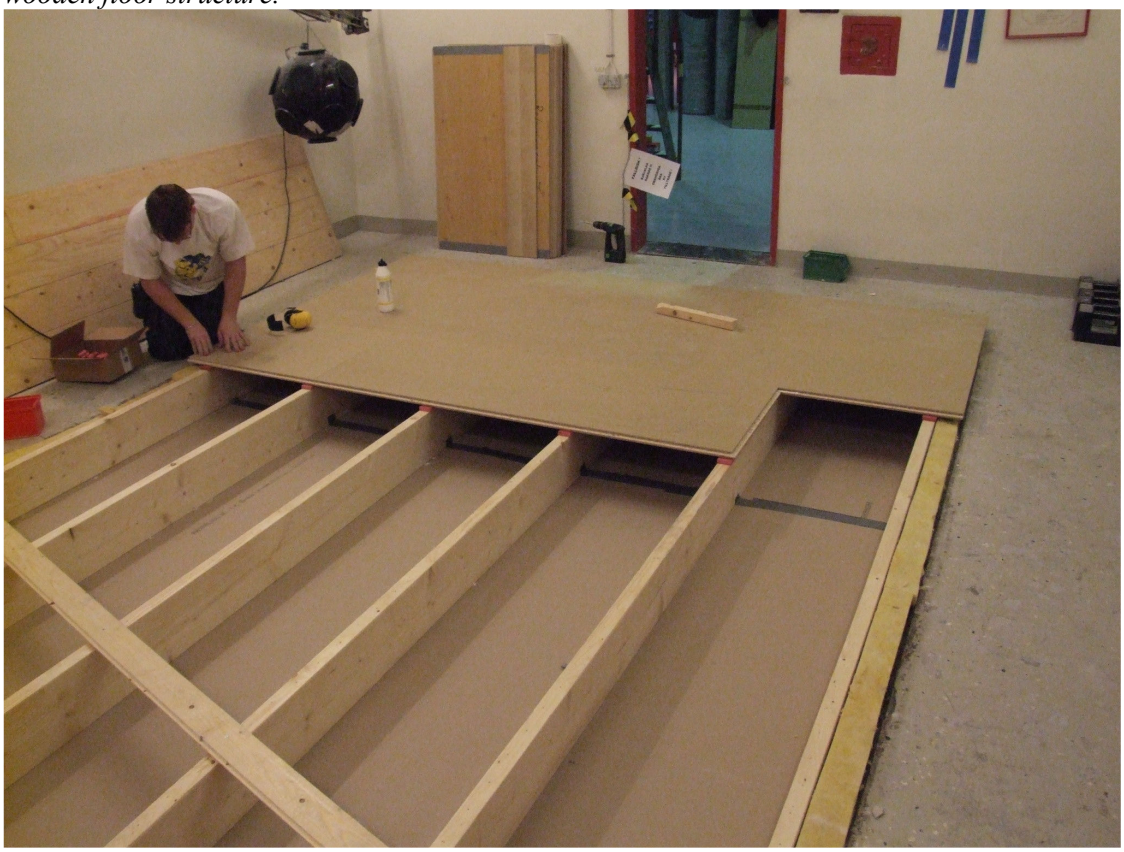


Figure 15 – Gluing of the gypsum boards for the upper floors P12, L25 and L25 heavy.

Figure 16 – Side view of the upper floor L25 heavy (3 layers of gypsum board).

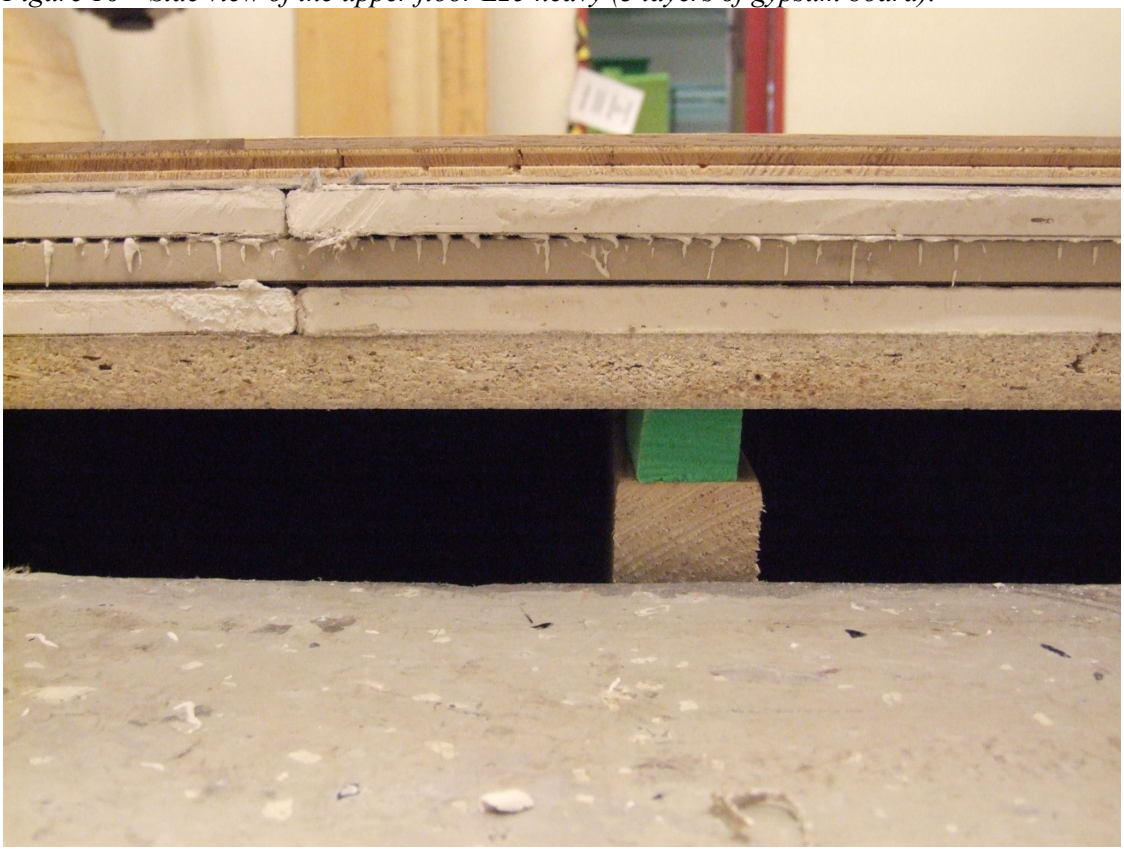


Figure 17 – Mounting of the parquet floor.

Figure 18 – Parquet floor finished..

Figure 19 – Building of the sand version of the wooden floor structure.

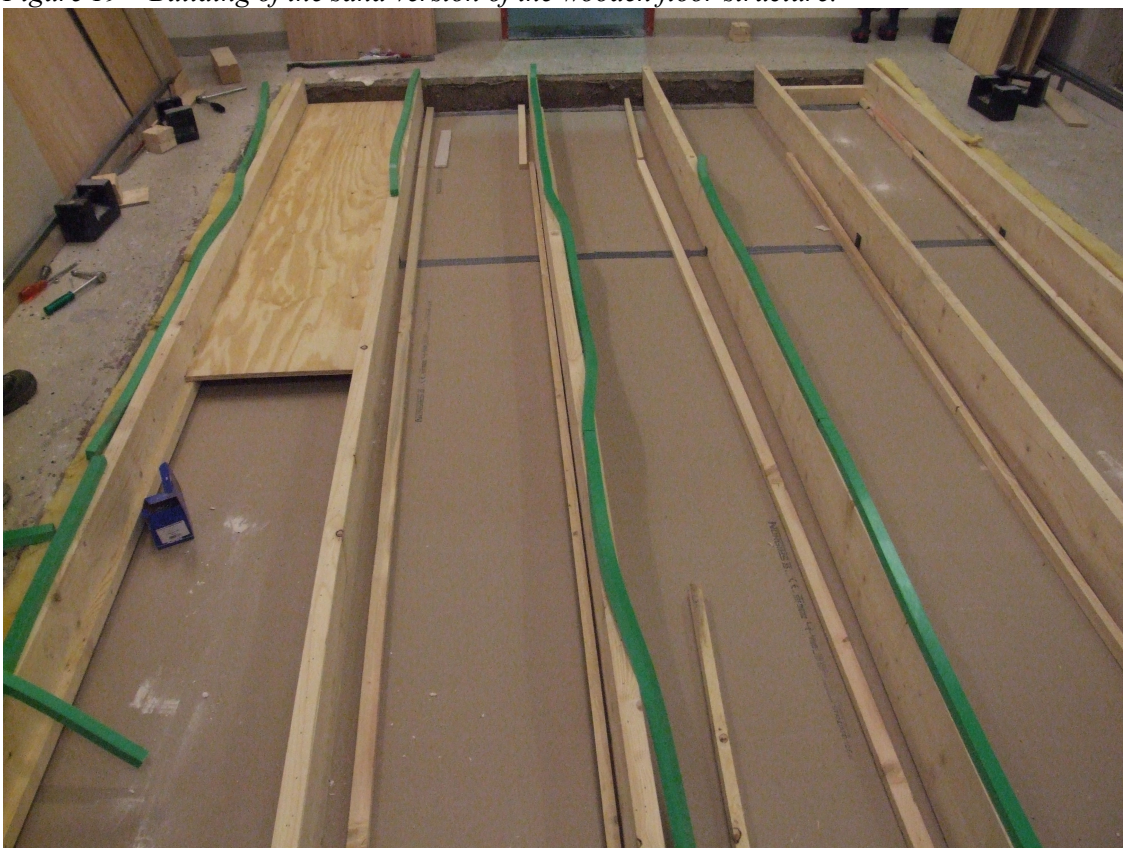


Figure 20 – Building of the sand version of the wooden floor structure.

Instrumentation

Instrument	Manufacturer	Type.	Serial no.
Real time analyzer	Norsonic	830	500338
Calibrator	Brüel & Kjaer	4230	500932
Tapping machine	Norsonic	211	503028
Microphone source room	Brüel & Kjær	4166	1011605
Microphone receiving room	Brüel & Kjær	4166	1072010
Microphone preamplifier source room	Brüel & Kjær	2619	970886
Microphone preamplifier receiving room	Brüel & Kjær	2619	726782
Microphone boom source room	Brüel & Kjær	3923	1419759
Microphone boom receiving room	Brüel & Kjær	3923	912304
Microphone power supply source room	Brüel & Kjær	2804	815268
Microphone power supply receiving room	Brüel & Kjær	2804	1445249
Loudspeaker source room	SP	Klot	-
Power amplifier	Lab. Gruppen	LAB 2000	

SP Sveriges Tekniska Forskningsinstitut SP Sveriges Tekniska Forskningsinstitut
Energy Technology – Acoustics

Hans Jonasson
Technical Manager

Karl Tillberg
Technical Officer

REPORT Enclosure 1

Acoustics 2007-02-01 P604997

Technical officier: Karl Tillberg

Determination of impact sound insolation in a laboratory according to ISO 140-6

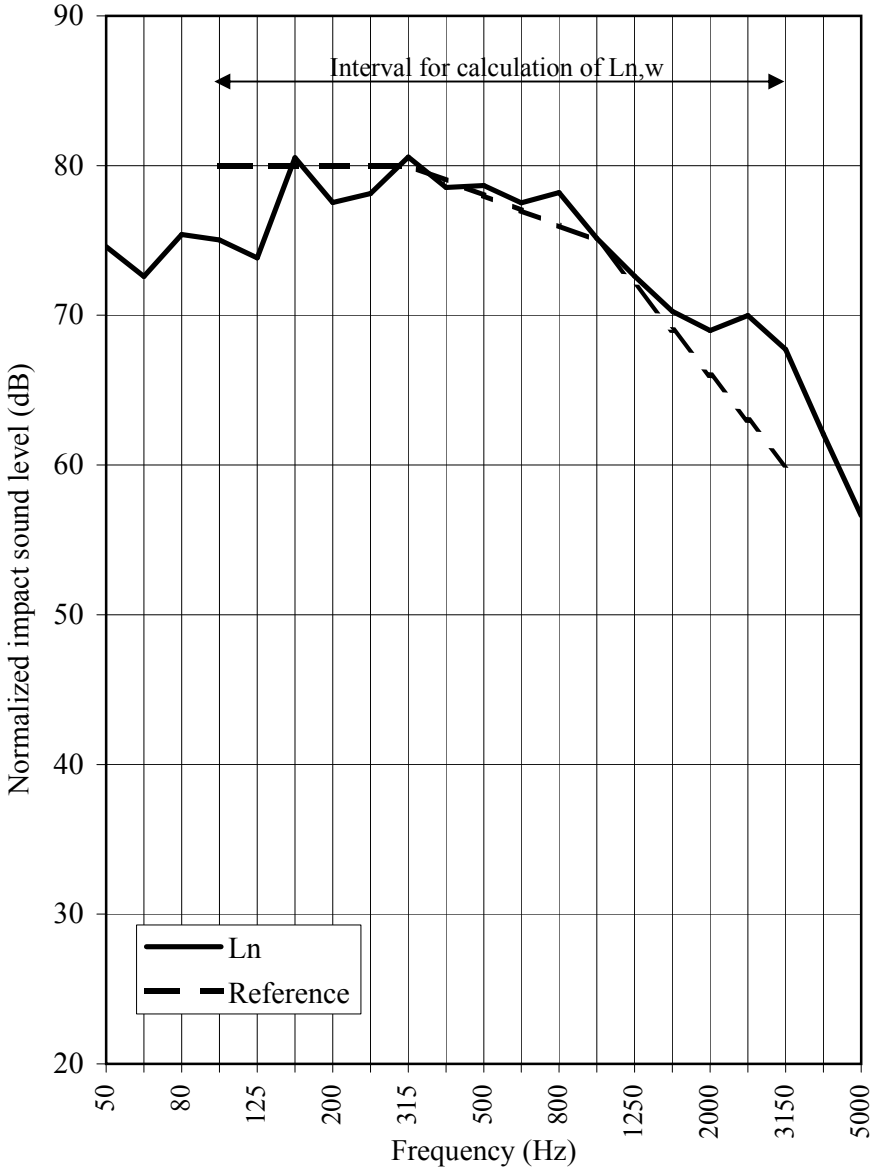
Client: Christian Berner AB and Getzner Werkstoffe

Measurement object: 22 mm tongued and grooved board + empty version of the floor structure

Measurement date: 2006-11-28

Sending room: Upper inpact sound insulation lab on SP
Receiving room: Lower inpact sound insulation lab on SP
Volume of R-room: 138 m^3

Results: Weighed impact sound level, $L_{n,w}$ and adaption terms, C_I & $C_{I,50\text{-}2500}$



Frequency (Hz)	Ln (dB)
50	74,6
63	72,6
80	75,4
100	75,0
125	73,8
160	80,5
200	77,5
250	78,1
315	80,6
400	78,5
500	78,7
630	77,5
800	78,2
1000	75,1
1250	72,6
1600	70,3
2000	69,0
2500	70,0
3150	67,7
4000	62,1
5000	56,6

$L_{n,w}$	**78**
C_I	-4
$C_{I,50\text{-}2500}$	-4
Sum. dev.	24,2
Max. dev.	7,7
Frequency	3150

Determination of sound insulation in a laboratory according to SS EN ISO 140-3:95

Client: Christian Berner AB and Getzner Werkstoffe Date of test: 2006-11-28

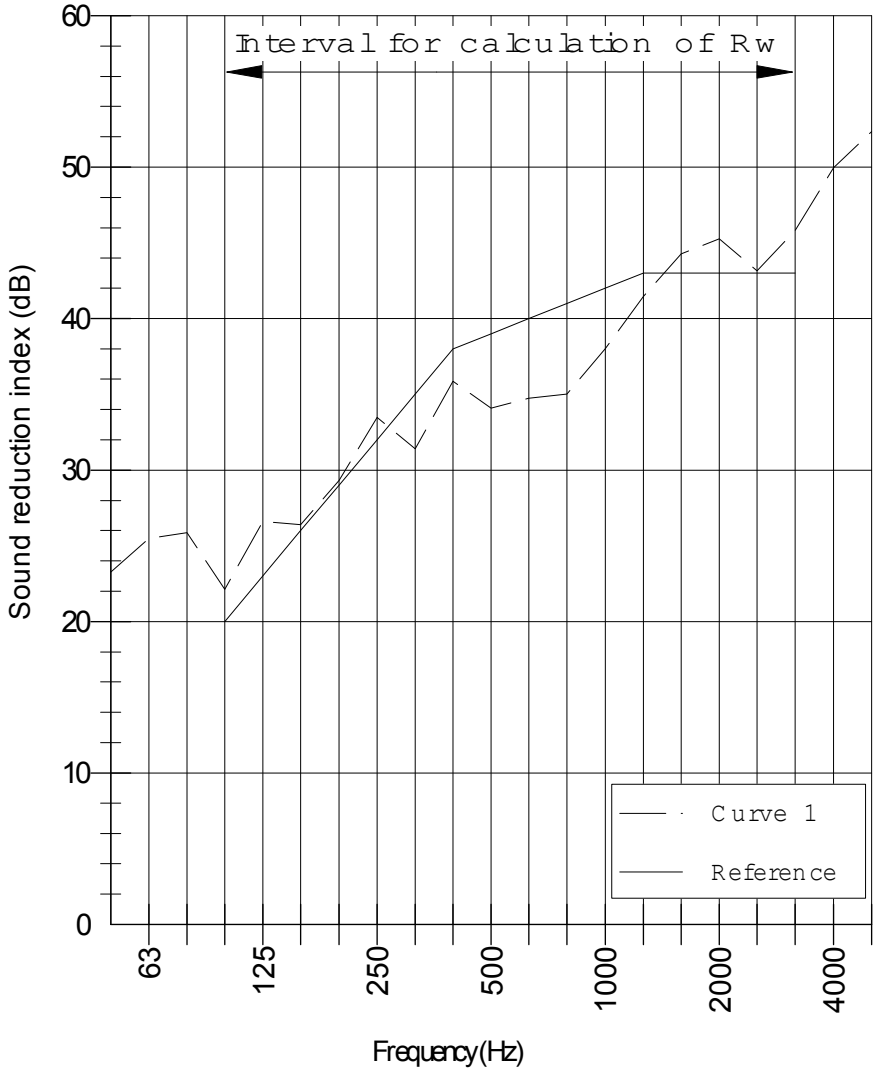
Test object: 22 mm tongued and grooved board + empty version of the floor structure

Temperature and humidity: 19 ° C resp. 47 % RH

Area of the test opening and module: 12,00 m^2, whole opening

Result: Curve 1 - Normal montage

Curve 2 - Reference Curve



Frecuency (Hz)	Curve 1 (dB)
50	23,3
63	25,5
80	25,9
100	22,1
125	26,6
160	26,4
200	29,3
250	33,5
315	31,4
400	35,9
500	34,1
630	34,8
800	35
1000	38
1250	41,5
1600	44,3
2000	45,3
2500	43,1
3150	45,8
4000	50
5000	52,4

Rw	39
(C; Ctr)	(-1;-4)
50-3150	(-1;-5)
50-5000	(0;-5)
Rmean	35,4
Sum. Dev.	27,3
Max. Dev.	6
Frequency	800

REPORT Enclosure 3

Acoustics 2007-02-01 P604997

Measurement personal: Karl Tillberg

Determination of impact sound insolation in a laboratory according to ISO 140-6

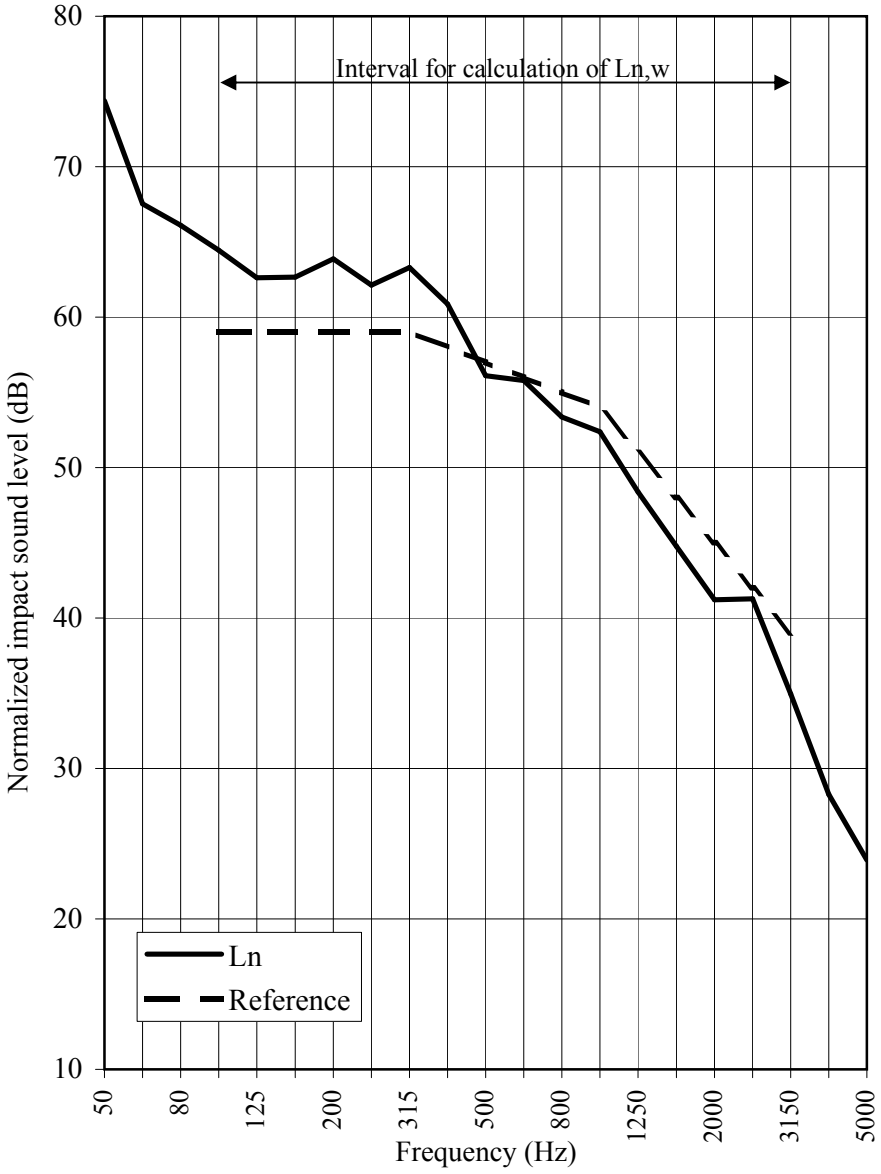
Client: Christian Berner AB and Getzner Werkstoffe

Measurement object: P12 + empty version of the floor structure

Measurement date: 2006-11-30

Sending room: Upper inpact sound insulation lab on SP
Receiving room: Lower inpact sound insulation lab on SP
Volume of R-room: 138 m^3

Results: Weighed impact sound level, $L_{n,w}$ and adaption terms, C_I & $C_{I,50\text{-}2500}$



Frequency (Hz)	Ln (dB)
50	74,4
63	67,5
80	66,1
100	64,4
125	62,6
160	62,7
200	63,9
250	62,1
315	63,3
400	60,9
500	56,1
630	55,8
800	53,4
1000	52,4
1250	48,4
1600	44,8
2000	41,2
2500	41,3
3150	35,0
4000	28,3
5000	23,9

$L_{n,w}$	**57**
C_I	0
$C_{I,50\text{-}2500}$	5
Sum. dev.	27,9
Max. dev.	5,4
Frequency	100

Enclosure 4

Determination of sound insulation in a laboratory according to SS EN ISO 140-3:95

Client: Christian Berner AB and Getzner Werkstoffe Date of test: 2006-11-30

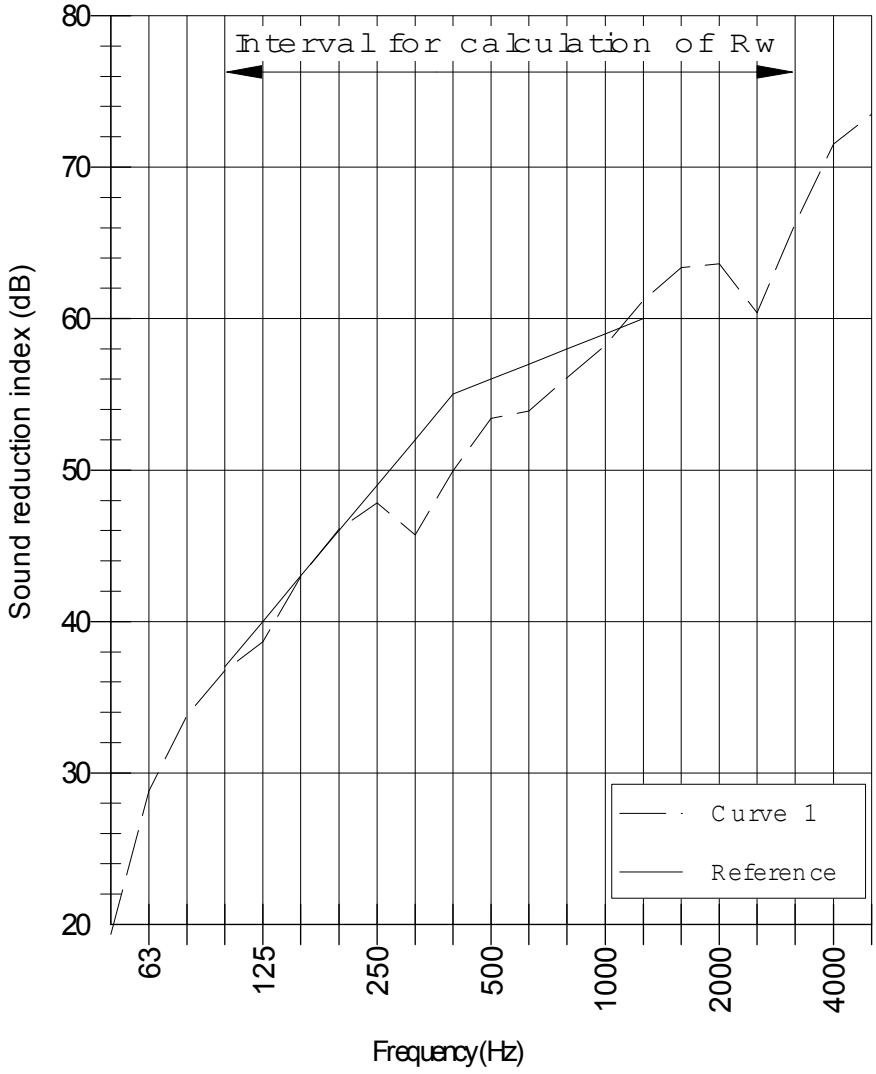
Test object: P12 + empty version of the floor structure

Temperature and humidity: 19 ° C resp. 49 % RH

Area of the test opening and module: 12,00 m^2, whole opening

Result: Curve 1 - Normal montage

Curve 2 - Reference Curve



Frecuency (Hz)	Curve 1 (dB)
50	19,3
63	28,8
80	33,8
100	36,7
125	38,7
160	43
200	46,1
250	47,8
315	45,7
400	49,9
500	53,4
630	53,9
800	56,1
1000	58,2
1250	61,2
1600	63,4
2000	63,6
2500	60,4
3150	66,2
4000	71,5
5000	73,5

Rw	56
(C; Ctr)	(-1;-5)
50-3150	(-3;-13)
50-5000	(-2;-13)
Rmean	52,8
Sum. Dev.	22,6
Max. Dev.	6,3
Frequency	315

REPORT Enclosure 5

Acoustics 2007-02-01 P604997

Technical officier: Karl Tillberg

Determination of impact sound insolation in a laboratory according to ISO 140-6

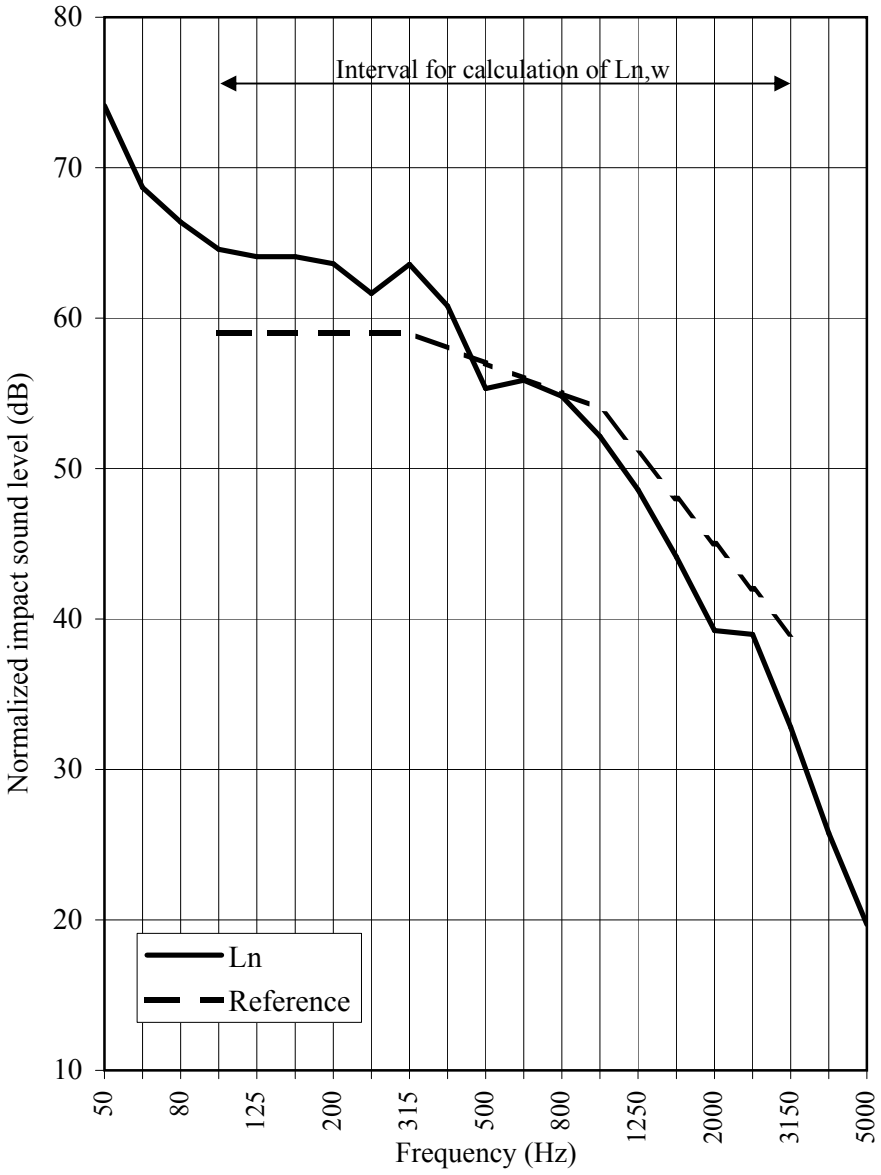
Client: Christian Berner AB and Getzner Werkstoffe

Measurement object: L25 + empty version of the floor structure

Measurement date: 2006-12-06

Sending room: Upper inpact sound insulation lab on SP
Receiving room: Lower inpact sound insulation lab on SP
Volume of R-room: 138 m^3

Results: Weighed impact sound level, $L_{n,w}$ and adaption terms, C_I & $C_{I,50\text{-}2500}$



Frequency (Hz)	Ln (dB)
50	74,1
63	68,7
80	66,4
100	64,6
125	64,1
160	64,1
200	63,6
250	61,6
315	63,6
400	60,8
500	55,3
630	55,9
800	54,8
1000	52,2
1250	48,6
1600	44,1
2000	39,2
2500	39,0
3150	32,8
4000	25,8
5000	≤ 19,7

$L_{n,w}$	**57**
C_I	0
$C_{I,50\text{-}2500}$	5
Sum. dev.	30,4
Max. dev.	5,6
Frequency	100

Enclosure 6

Determination of sound insulation in a laboratory according to SS EN ISO 140-3:95

Client: Christian Berner AB and Getzner Werkstoffe Date of test: 2006-12-04

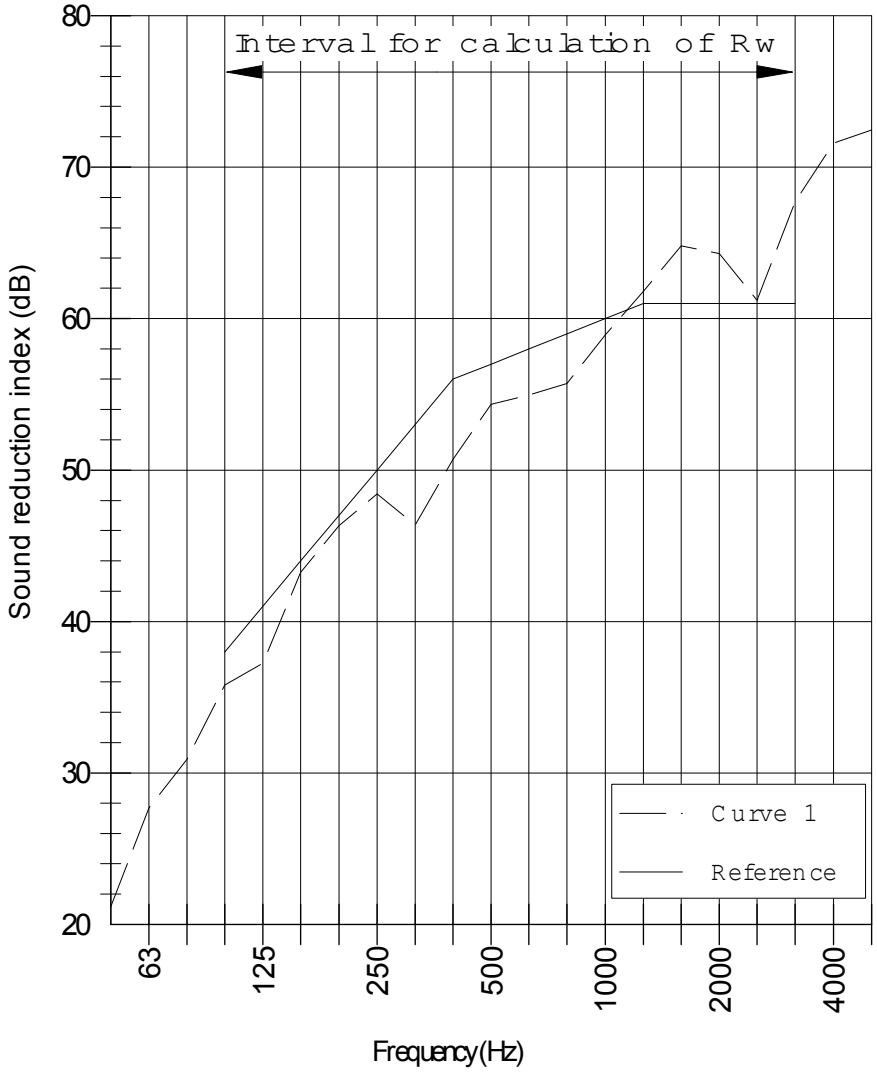
Test object: L25 + empty version of the floor structure

Temperature and humidity: 20 ° C resp. 45 % RH

Area of the test opening and module: 12,00 m^2, whole opening

Result: Curve 1 - Normal montage

Curve 2 - Reference Curve



Frecuency (Hz)	Curve 1 (dB)
50	21,2
63	27,7
80	30,9
100	35,8
125	37,3
160	43,2
200	46,4
250	48,4
315	46,4
400	50,7
500	54,3
630	55
800	55,7
1000	58,9
1250	61,8
1600	64,8
2000	64,3
2500	61,2
3150	67,7
4000	71,6
5000	72,4

Rw	57
(C; Ctr)	(-2;-6)
50-3150	(-4;-14)
50-5000	(-3;-14)
Rmean	53,2
Sum. Dev.	30,9
Max. Dev.	6,6
Frequency	315

REPORT Enclosure 7

Acoustics 2007-02-01 P604997

Technical officier: Karl Tillberg

Determination of impact sound insolation in a laboratory according to ISO 140-6

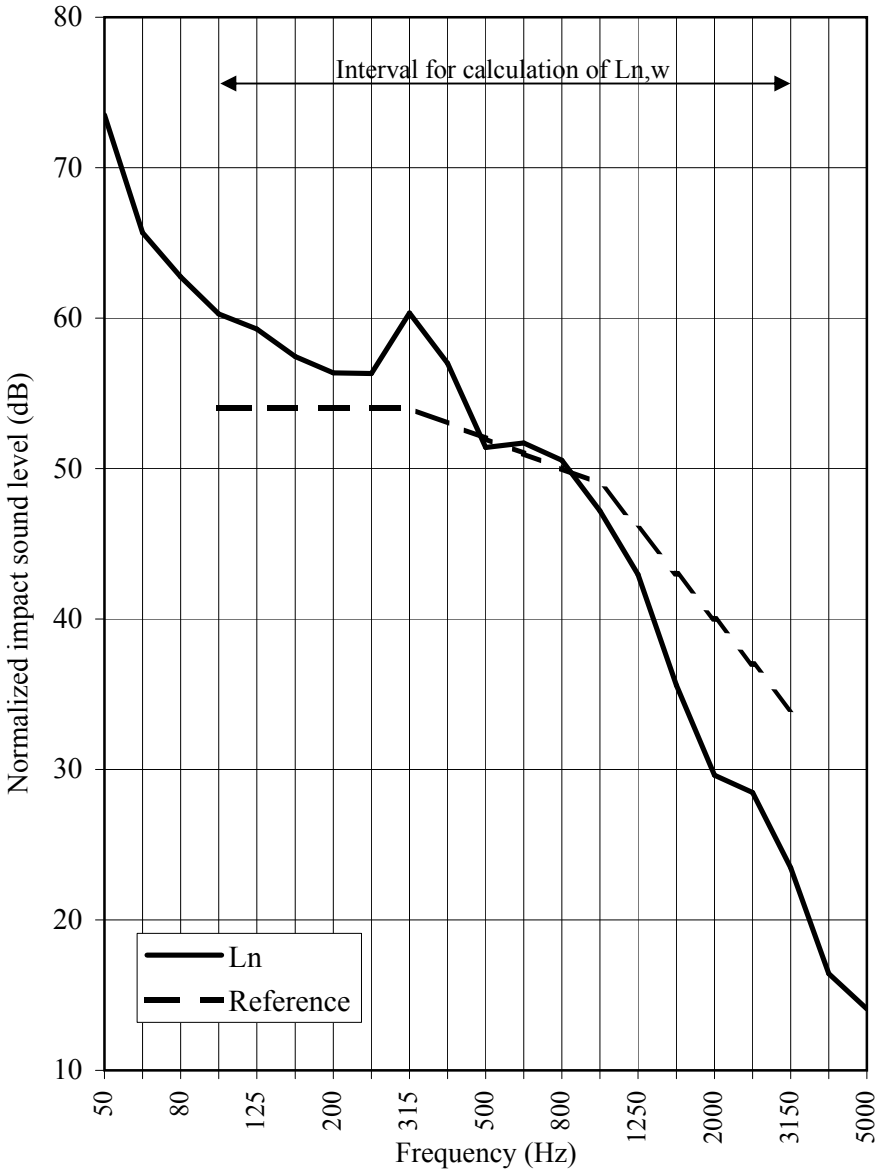
Client: Christian Berner AB and Getzner Werkstoffe

Measurement object: L25 heavy + empty version of the floor structure

Measurement date: 2006-12-06

Sending room: Upper inpact sound insulation lab on SP
Receiving room: Lower inpact sound insulation lab on SP
Volume of R-room: 138 m^3

Results: Weighed impact sound level, $L_{n,w}$ and adaption terms, C_I & $C_{I,50\text{-}2500}$



Frequency (Hz)	Ln (dB)
50	73,5
63	65,7
80	62,7
100	60,3
125	59,3
160	57,4
200	56,4
250	56,3
315	60,3
400	57,0
500	51,4
630	51,7
800	50,6
1000	47,2
1250	43,0
1600	35,6
2000	29,6
2500	28,5
3150	23,5
4000	≤ 16,4
5000	≤ 14,1

$L_{n,w}$	**52**
C_I	0
$C_{I,50\text{-}2500}$	8
Sum. dev.	31,3
Max. dev.	6,3
Frequency	315

Enclosure 8

Determination of sound insulation in a laboratory according to SS EN ISO 140-3:95

Client: Christian Berner AB and Getzner Werkstoffe Date of test: 2006-12-06

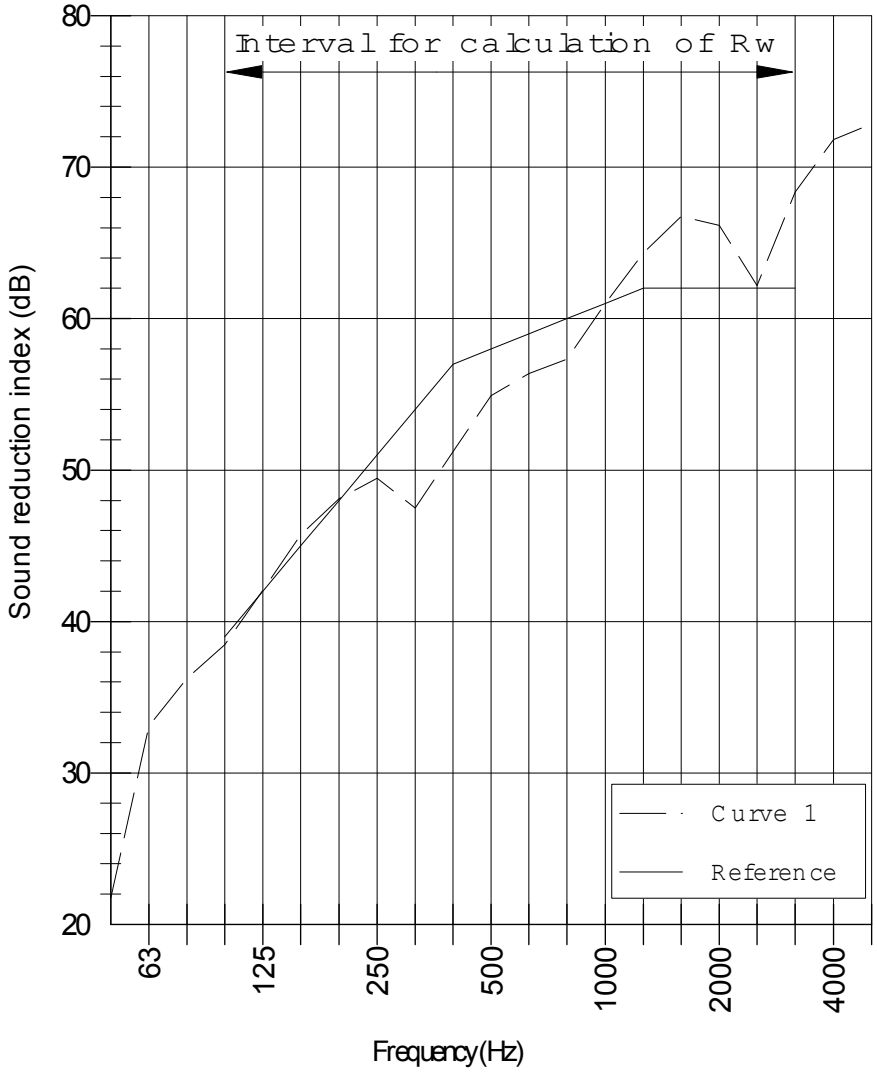
Test object: L25 heavy + empty version of the floor structure

Temperature and humidity: 19,5 ° C resp. 45,8 % RH

Area of the test opening and module: 12,00 m^2, whole opening

Result: Curve 1 - Normal montage

Curve 2 - Reference Curve



Frecuency (Hz)	Curve 1 (dB)
50	21,8
63	33,1
80	36,2
100	38,5
125	42,1
160	45,7
200	48,1
250	49,5
315	47,5
400	51,2
500	54,9
630	56,4
800	57,3
1000	61
1250	64,3
1600	66,8
2000	66,2
2500	62,2
3150	68,3
4000	71,8
5000	72,9

Rw	58
(C; Ctr)	(-1;-5)
50-3150	(-3;-13)
50-5000	(-2;-13)
Rmean	55
Sum. Dev.	22,7
Max. Dev.	6,5
Frequency	315

REPORT Enclosure 9

Acoustics 2007-02-01 P604997

Technical officier: Karl Tillberg

Determination of impact sound insolation in a laboratory according to ISO 140-6

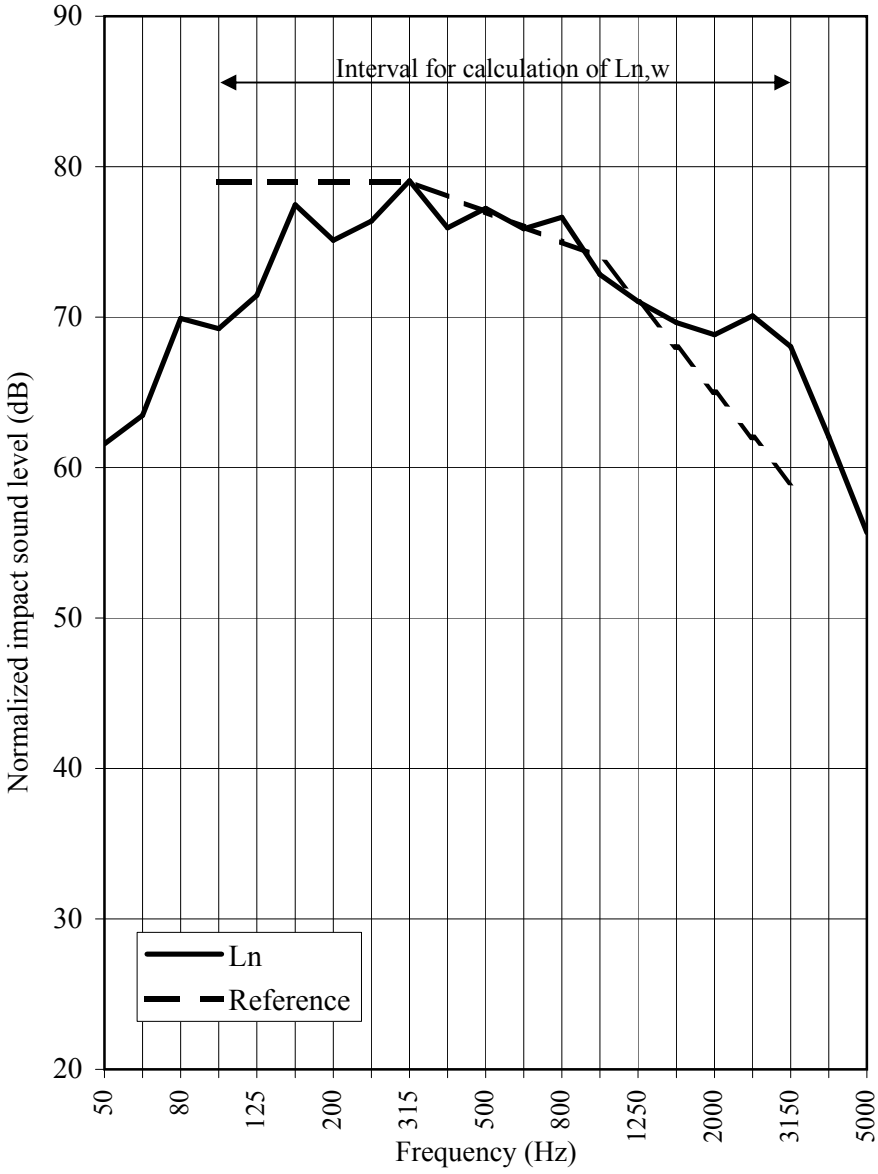
Client: Christian Berner AB and Getzner Werkstoffe

Measurement object: 22 mm tongued and grooved board + sand version of the floor structure

Measurement date: 2006-12-06

Sending room: Upper inpact sound insulation lab on SP
Receiving room: Lower inpact sound insulation lab on SP
Volume of R-room: 138 m^3

Results: Weighed impact sound level, $L_{n,w}$ and adaption terms, C_I & $C_{I,50\text{-}2500}$



Frequency (Hz)	Ln (dB)
50	61,6
63	63,5
80	69,9
100	69,2
125	71,4
160	77,5
200	75,1
250	76,4
315	79,1
400	75,9
500	77,2
630	75,9
800	76,6
1000	72,8
1250	71,0
1600	69,6
2000	68,8
2500	70,1
3150	68,1
4000	62,0
5000	55,7

$L_{n,w}$	**77**
C_I	-5
$C_{I,50\text{-}2500}$	-5
Sum. dev.	24,6
Max. dev.	9,1
Frequency	3150

Enclosure 10

Determination of sound insulation in a laboratory according to SS EN ISO 140-3:95

Client: Christian Berner AB and Getzner Werkstoffe Date of test: 2007-01-02

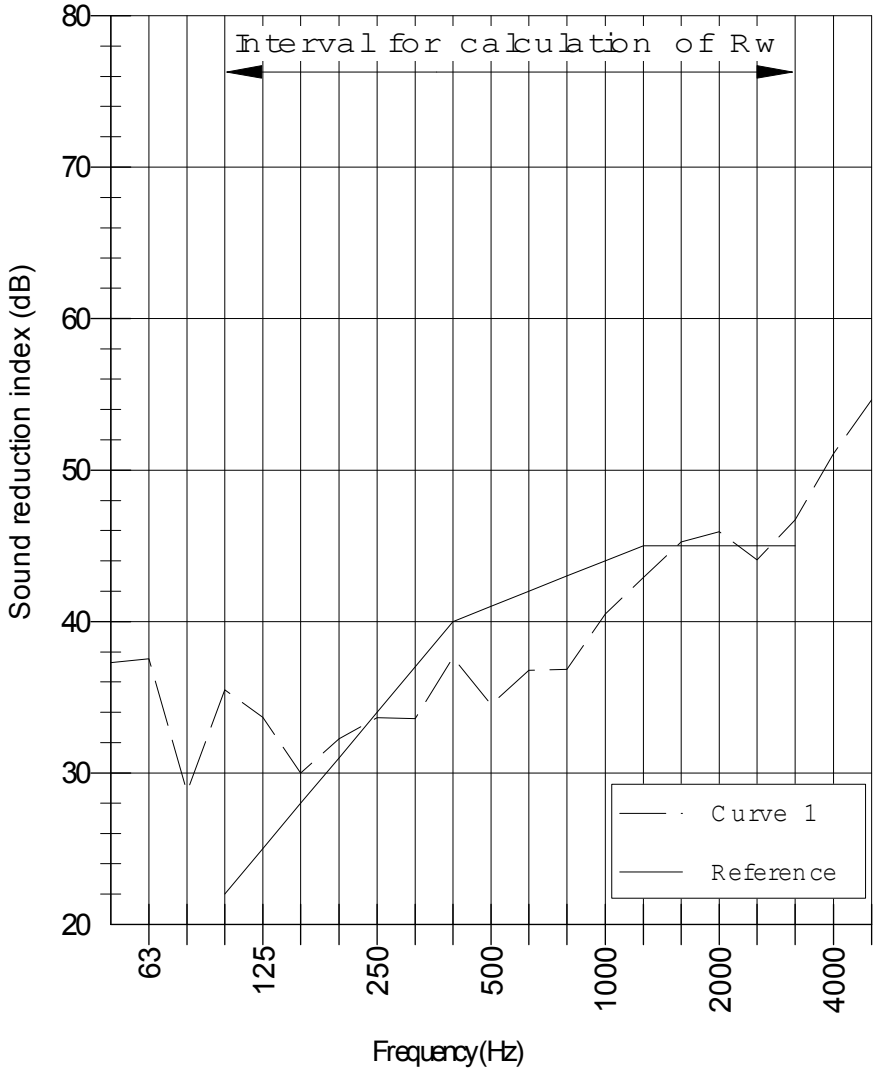
Test object: 22 mm tongued and grooved board + sand version of the floor structure

Temperature and humidity: 18 ° C resp. 46 % RH

Area of the test opening and module: 12,00 m^2, whole opening

Result: Curve 1 - Normal montage

Curve 2 - Reference Curve



Frecuency (Hz)	Curve 1 (dB)
50	37,3
63	37,5
80	28,7
100	35,5
125	33,7
160	30
200	32,3
250	33,7
315	33,6
400	37,6
500	34,5
630	36,8
800	36,8
1000	40,5
1250	42,9
1600	45,2
2000	45,9
2500	44,1
3150	46,7
4000	51,1
5000	54,6

Rw	41
(C; Ctr)	(-1;-3)
50-3150	(-1;-4)
50-5000	(0;-4)
Rmean	38,1
Sum. Dev.	30,5
Max. Dev.	6,5
Frequency	500

REPORT Enclosure 11

Acoustics 2007-02-01 P604997

Technical officier: Karl Tillberg

Determination of impact sound insolation in a laboratory according to ISO 140-6

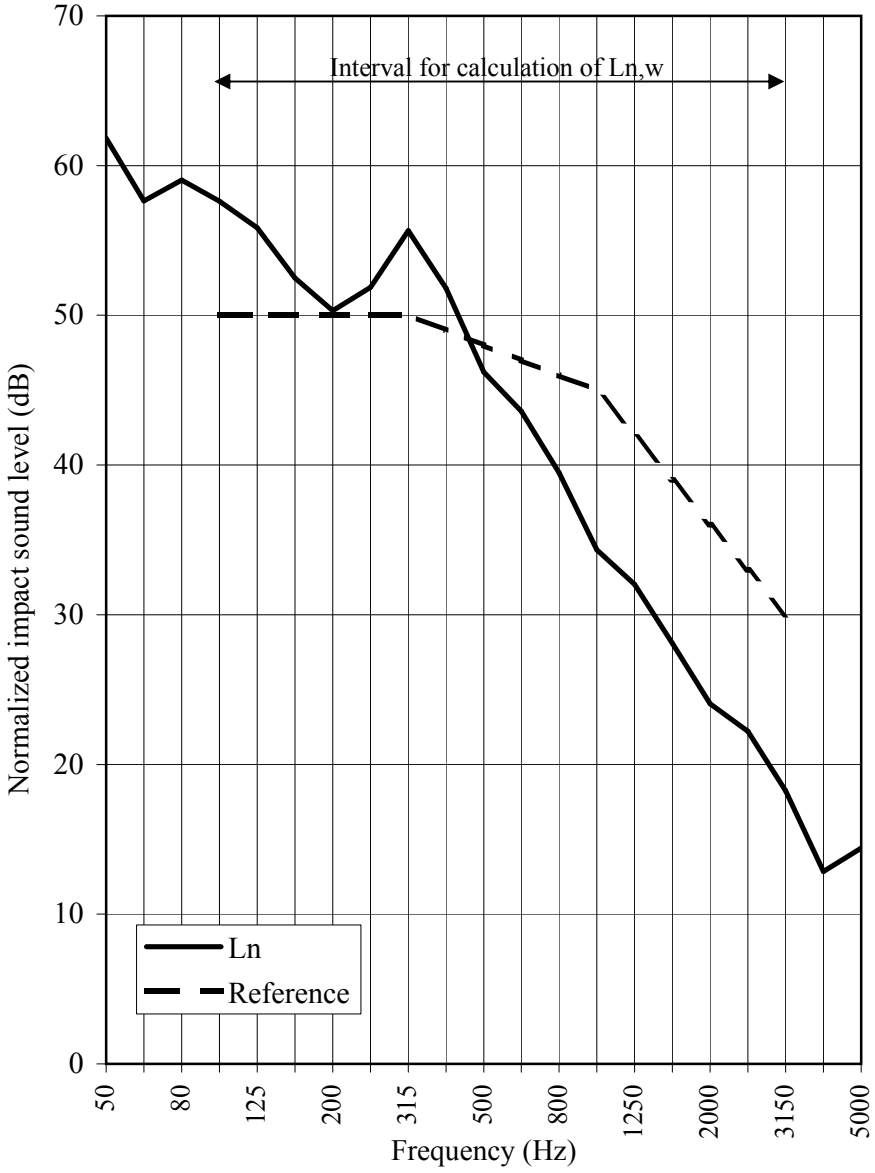
Client: Christian Berner AB and Getzner Werkstoffe

Measurement object: L25 heavy + sand version of the floor structure

Measurement date: 2006-12-06

Sending room: Upper inpact sound insulation lab on SP
Receiving room: Lower inpact sound insulation lab on SP
Volume of R-room: 138 m^3

Results: Weighed impact sound level, $L_{n,w}$ and adaption terms, C_I & $C_{I,50\text{-}2500}$



Frequency (Hz)	Ln (dB)
50	61,8
63	57,6
80	59,0
100	57,6
125	55,9
160	52,5
200	50,3
250	51,9
315	55,6
400	51,8
500	46,2
630	43,6
800	39,5
1000	34,3
1250	32,0
1600	28,1
2000	24,0
2500	22,2
3150	18,2
4000	≤ 12,9
5000	≤ 14,4

$L_{n,w}$	**48**
C_I	0
$C_{I,50\text{-}2500}$	4
Sum. dev.	26,6
Max. dev.	7,6
Frequency	100

Enclosure 12

Determination of sound insulation in a laboratory according to SS EN ISO 140-3:95

Client: Christian Berner AB and Getzner Werkstoffe Date of test: 2006-12-22

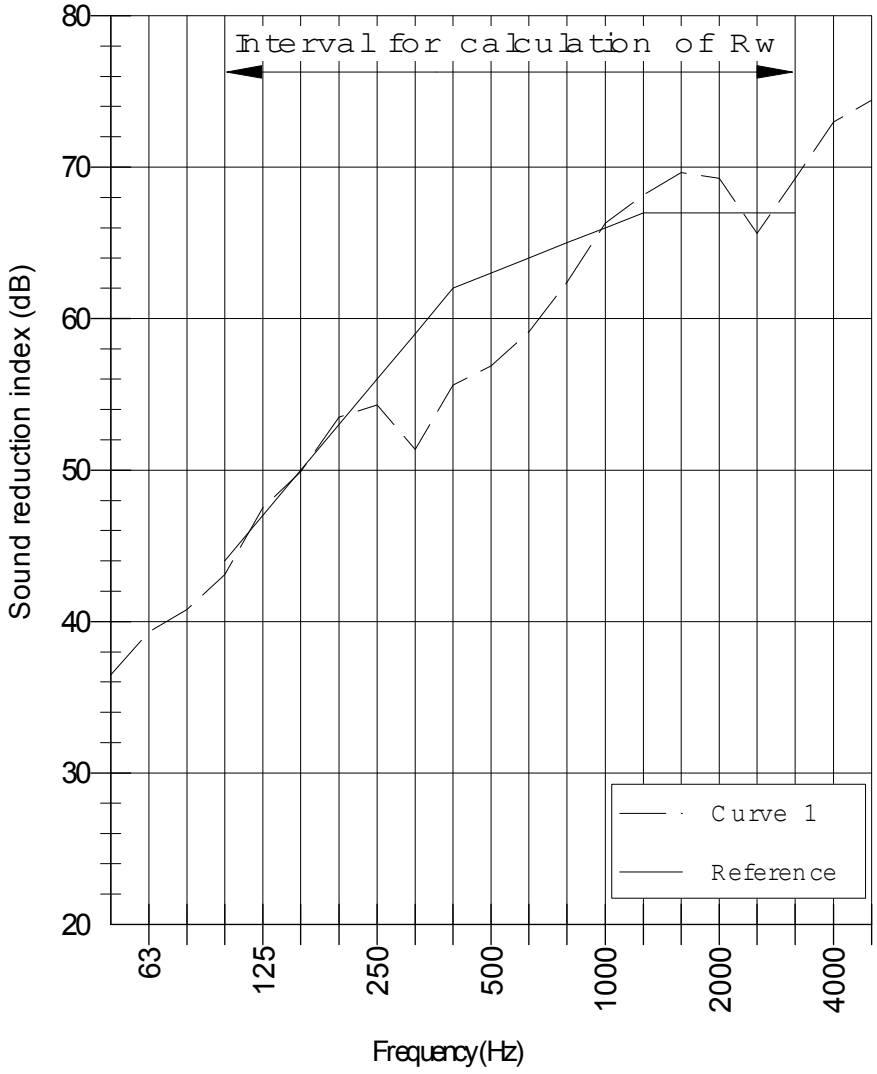
Test object: L25 heavy + sand version of the floor structure

Temperature and humidity: 18,3 ° C resp. 43 % RH

Area of the test opening and module: 12,00 m^2, whole opening

Result: Curve 1 - Normal montage

Curve 2 - Reference Curve



Frecuency (Hz)	Curve 1 (dB)
50	36,5
63	39,3
80	40,8
100	43,1
125	47,5
160	49,9
200	53,5
250	54,3
315	51,4
400	55,6
500	56,9
630	59,1
800	62,4
1000	66,3
1250	68,2
1600	69,7
2000	69,3
2500	65,6
3150	69,2
4000	73
5000	74,4

Rw	63
(C; Ctr)	(-2;-6)
50-3150	(-3;-9)
50-5000	(-2;-9)
Rmean	58,9
Sum. Dev.	31,7
Max. Dev.	7,6
Frequency	315