
Requested by maxit Oy Ab
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Order Jorma Mäkipää, e-mail 17.10.2006

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Task **Determination of impact and airborne sound insulation – maxit Comfort Floor**

Specimen Construction materials of maxit Comfort Floor were delivered to VTT by maxit Oy to be used in a measurement of the reduction of transmitted impact noise and the reduction of sound insulation on a heavy weight standard floor. The following information was reported or measured:

Floor 4350	Fibre reinforced self-levelling screed
Floor 4945	Glass fibre mesh in the slab
Floor 4940	Geotextile (polypropylene filter cloth)
Floor 4960	Soft strips (cellular plastic)
Floor 4900	Rail plate (aluminium covered EPS slab, 35 mm)
Floor 4901	Corner plate (aluminium covered EPS slab, 20 mm)
Floor 4902	Adjustment plate (EPS slab, 20 mm)
Floor 4903	Pipe clamp
Heating pipe	Polyethylene, outside/inside diameter of pipe: 15/10 mm
Laminate flooring (lock)	HDF core with melamine impregnated overlay, tongue-and-groove joint without glue, 7 mm, 6.6 kg/m ²
Parquet underlay	Polyethylene foam, 2 mm
Cushioned vinyl flooring	Thickness 2,5 mm, $\Delta L_w = 19$ dB (loose)
Clinker flooring	Clinker 7 x 99 x 99 mm (normal fastening)

The specimen was received: 18th October 2006

Mounting and measuring

The EPS slabs (35 or 20 mm), heating pipes (c/c 280 mm) and geotextile were mounted by the customer onto a 160 mm concrete test slab. The screed slab (30 mm, 51 kg/m²) was cast onto it to accomplish a floating floor. The area of the test floor was 11.6 m².

The impact sound insulation measurements of the floating floor with and without different floor coverings were carried out with a load (21 kg/m²) [1]. The impact sound pressure levels were measured in the reverberation room below the test floor using a moving microphone. After removing the sample, the impact sound pressure levels for the bare concrete test slab were measured at the same tapping machine positions (five positions).

The airborne sound insulation measurements were carried out without the floor covering and with the laminate or clinker flooring (without the loading).

Mounting and casting:	18.10.2006
Mounting of laminate flooring:	09.11.2006
Measurements with floor coverings:	10.11.2006
Mounting of clinker flooring:	10.-15.11.2006
Measurements:	16.11.2006

Methods and equipment

The normalized impact sound pressure level L_n and the reduction of sound pressure level (improvement of impact sound insulation) ΔL were measured according to the standard *EN ISO 140-8:1998* [1]. The single-number quantity for the sample ΔL_w is calculated according to *EN ISO 717-2:1996* [2].

The measured ΔL values were used to predict the weighted normalised impact sound pressure levels in practice (in buildings) $L'_{n,w}$ for concrete floor slabs (used for example in Finland) with the floating top floor. The bare concrete floors were as follows:

- 160, 200 and 240 mm concrete (385, 480 and 575 kg/m²) and
- hollow core slabs 300, 375 and 500 kg/m²

The sound level values of the bare concrete floors in practice are given in sound isolation guides [3] [4].

The sound reduction index R was measured in accordance with *SFS-EN ISO 140-3:1995* [5] and the weighted sound reduction index R_w was determined in accordance with *SFS-EN ISO 717-1:1996* [6]. The sound reduction improvement index ΔR and the direct difference of the weighted sound reduction indices $\Delta R_{w, \text{direct}}$ (compared to the bare 160 mm concrete test slab) was calculated from measured results.

Measuring equipment and reverberation rooms:

Condenser microphone	B&K (Brüel&Kjær) 4943
Microphone preamplifier	B&K 2669
Rotating microphone boom	B&K 3923
Power amplifier	Yamaha MX-1000
Loudspeakers	Sinmarc V121L
Real-time analyser	Norsonic 830
Sound calibrator	B&K 4228
Tapping machine	B&K 3204

The construction thickness of the concrete wall and floor of the impact sound measuring room is 0.25 m. The floor dimensions are 3.05 m and 3.90 m and the height is 4.70 m. The volume is 56 m³. The dimensions of the concrete test slab are 3.05 m and 3.90 m and thickness is 160 mm

The construction thickness of the concrete walls and floors of the airborne sound measuring room is also 0.25 m. The floor dimensions of the sending room are 3.05 m and 3.90 m and the height is 4.70 m. The volume is 56 m³. The floor dimensions of the receiving room are 5.00 m and 6.50 m and the height is 4.00 m. The volume is 130 m³.

Results

The weighted normalized impact sound pressure levels $L'_{n,w}$ for different types of the slabs and the weighted reduction of impact sound pressure level ΔL_w are presented in Table 1.

The reduction of impact sound pressure level ΔL in third octave bands for the floating sample (maxit Comfort Floor) is shown in Appendix 1.

The results of the airborne sound insulation measurements are shown in Table 2 and in Appendix 2.

Table 1. The weighted reduction of impact sound pressure level ΔL_w and the approximated weighted normalised impact sound pressure levels $L'_{n,w}$ for different concrete slabs and for hollow core slabs. The hollows have a circle or slightly elliptical shape. The volume of the room below the test floor is at most 50 m³ (ISO 140-8 and ISO 717-2).

slab	160/200/240 mm concrete slab	300/375/500 kg/m ² hollow core slab	ΔL_w
floor covering (loading 21 kg/m ²)	$L'_{n,w}$ [dB]	$L'_{n,w}$ [dB]	[dB]
maxit Comfort Floor	52/49/47	51/49/47	23
+ laminate flooring	47/44/42	44/42/40	27
+ vinyl flooring	47/44/42	44/42/40	26
+ clinker flooring	50/47/45	50/48/46	25

Table 2. The weighted sound reduction indices R_w and $\Delta R_{w, \text{direct}}$ (maxit Comfort Floor compared to the bare 160 mm concrete test slab). (ISO 140-3 and ISO 717-1).

Construction	R_w [dB]	$\Delta R_{w, \text{direct}}$
160 mm concrete slab	53	-
+ maxit Comfort Floor (without floor covering)	62	9
+ laminate flooring	62	9
+ clinker flooring	63	10

The results of the measurement are valid only for the measured samples.

Discussion of results

The weighted reduction of impact sound pressure level ΔL_w is 23-25 dB for maxit Comfort Floor with hard coverings fastened to the screed slab and 26-27 dB for other coverings. In buildings with ordinary concrete slabs the weighted normalised impact sound pressure level $L'_{n,w}$ is 51-40 dB and with hollow core slabs 51-40 dB.

The weighted sound reduction index R_w was 9-10 dB better compared to the test slab. The improvement of sound insulation must be estimated case-specific, because it depends on the sound insulation characters of the floor and on flanking transmissions. Usually in practice, the improvement of the airborne sound insulation is less than that measured in a laboratory.

Espoo, 28th December 2006

Pekka Sipari
Research Scientist

Reijo Heinonen
Research Engineer

References

- [1] ISO 140 - Part 8:1998: *Laboratory measurements of the reduction of transmitted impact noise by floor coverings on a heavyweight standard floor*
- [2] ISO 717: *Acoustics - Rating of sound insulation in buildings and of building elements - Part 2:1996: Impact sound insulation*
- [3] *Ympäristöopas 99: Ääneneristys rakennuksessa. Ympäristöministeriö 2003*
- [4] *Suomen Rakentamismääräyskokoelma: C5 - Ääneneristys - Ohjeet 1985*
- [5] ISO 140: *Acoustics - Measurement of sound insulation in buildings and of building elements - Part 3:1995 Laboratory measurements of airborne sound insulation of building elements.*
- [6] ISO 717: *Acoustics - Rating of sound insulation in buildings and of building elements - Part 1:1996: Airborne sound insulation*

APPENDICES DISTRIBUTION

3	
Customer	Original (2)
VTT	Original

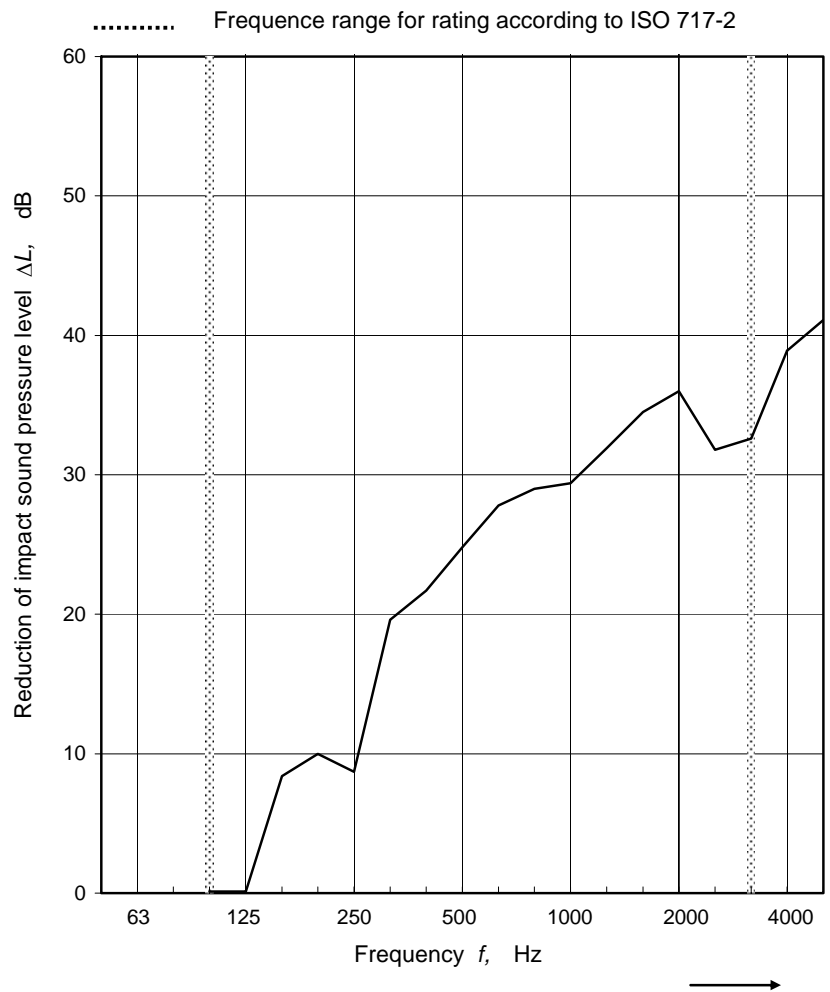
Product: maxit Comfort Floor without floor covering
 Manufacturer: maxit Oy Ab - maxit Group

Reduction of impact sound pressure level

Measurement: ISO 140-8:1997 ENISO1408:1998 Date of test: 10 November 2006
 Rating: ISO 717-2:1996 ENISO7172:1996 Test slab: Concrete 160 mm

Mass per unit area: 52 kg/m² Loading: 21 kg/m²
 Curing time: h
 Air temp. in the source room: 20 °C
 Air humidity in the source room: 30 %
 Receiving room volume: 56 m³

Frequency <i>f</i> Hz	<i>L_{n,0}</i> Test slab 160 mm dB	ΔL One-third octave dB
50		
63		
80		
100	56,8	0,1
125	62,4	0,1
160	69,7	8,4
200	69,8	10,0
250	64,5	8,7
315	71,8	19,6
400	68,1	21,7
500	70,6	24,8
630	70,4	27,8
800	70,3	29,0
1000	69,7	29,4
1250	70,1	31,9
1600	71,3	34,5
2000	71,2	36,0
2500	70,4	31,8
3150	71,0	32,6
4000	68,8	38,9
5000	66,2	41,1



Rating according to ISO 717-2:

$\Delta L_w = 23$ dB

These results are based on test made with an artificial source under laboratory conditions (engineering method).

Product: maxit Comfort Floor and laminate flooring 7 mm
 Manufacturer: maxit Oy Ab - maxit Group

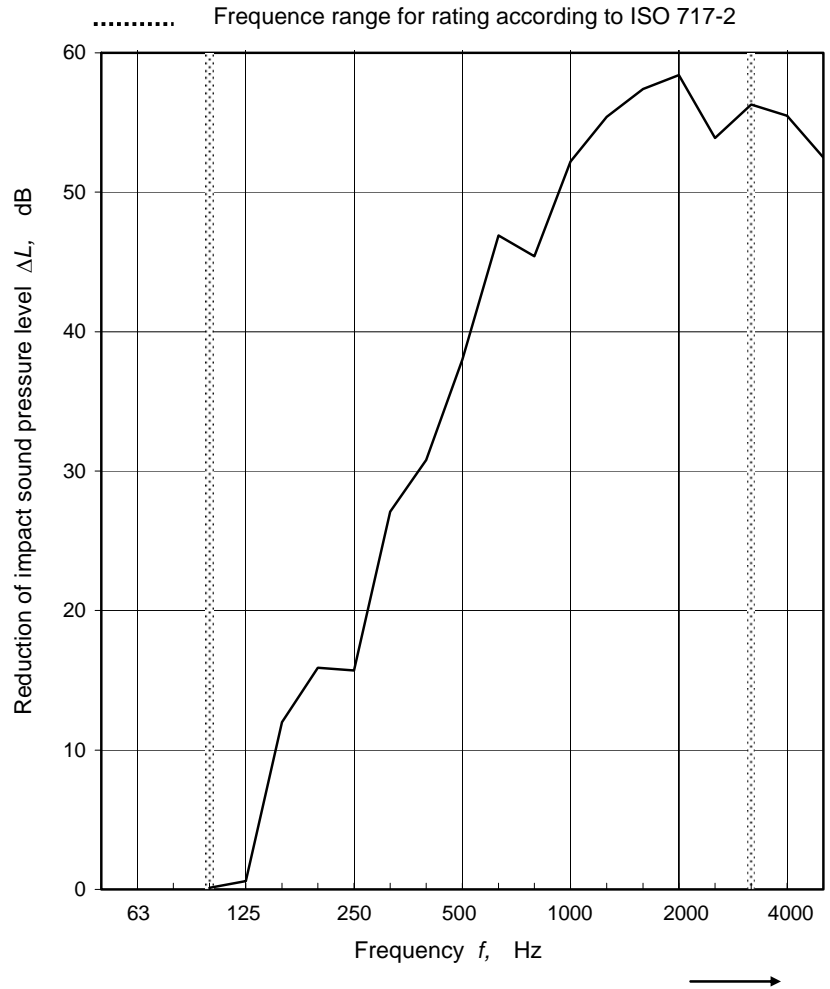
Reduction of impact sound pressure level

Measurement: ISO 140-8:1997 ENISO1408:1998 Date of test: 10 November 2006
 Rating: ISO 717-2:1996 ENISO7172:1996 Test slab: Concrete 160 mm

Mass per unit area: 58 kg/m² Loading: 21 kg/m²
 Curing time: h
 Air temp. in the source room: 20 °C
 Air humidity in the source room: 30 %
 Receiving room volume: 56 m³

Frequency <i>f</i> Hz	<i>L_{n,0}</i> Test slab 160 mm dB	ΔL One-third octave dB
50		
63		
80		
100	56,8	0,1
125	62,4	0,6
160	69,7	12,0
200	69,8	15,9
250	64,5	15,7
315	71,8	27,1
400	68,1	30,8
500	70,6	38,0
630	70,4	46,9
800	70,3	45,4
1000	69,7	52,2
1250	70,1	55,4
1600	71,3	57,4
2000	71,2	58,4
2500	70,4	53,9
3150	71,0	56,3
4000	68,8	55,5
5000	66,2	52,5

minimum value
 minimum value
 minimum value
 minimum value



Rating according to ISO 717-2:
 $\Delta L_w = 27$ dB
 These results are based on test made with an artificial source under laboratory conditions (engineering method).

Product: maxit Comfort Floor and vinyl flooring
 Manufacturer: maxit Oy Ab - maxit Group

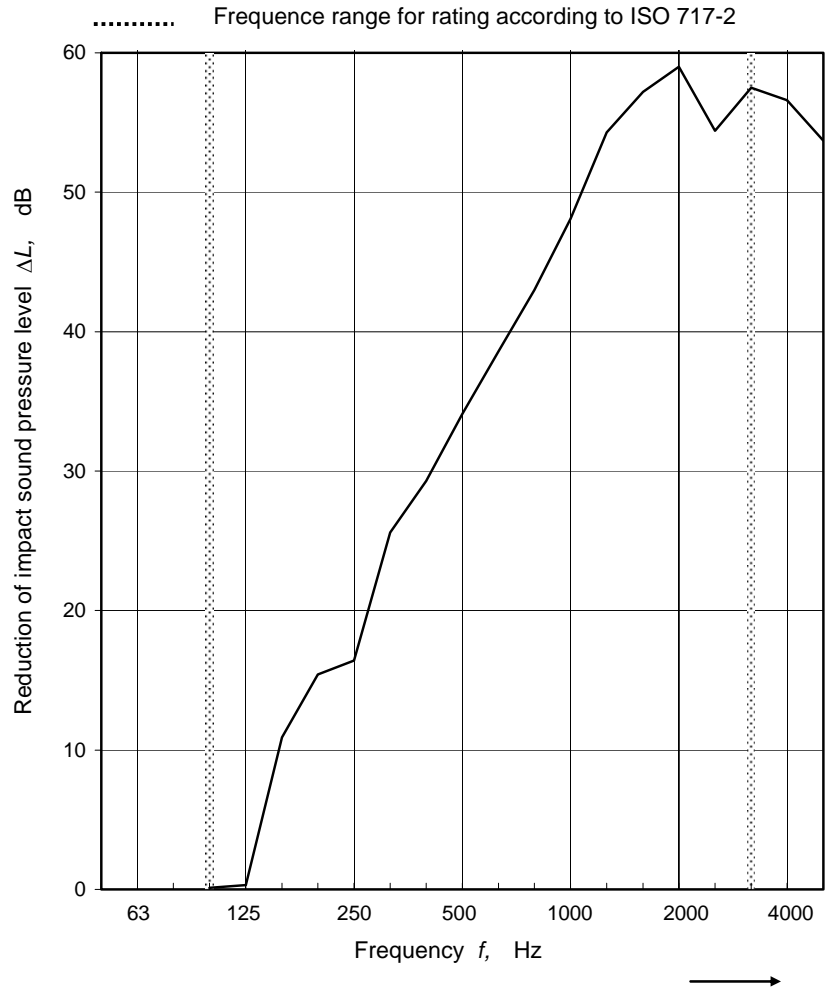
Reduction of impact sound pressure level

Measurement: ISO 140-8:1997 ENISO1408:1998 Date of test: 10 November 2006
 Rating: ISO 717-2:1996 ENISO7172:1996 Test slab: Concrete 160 mm

Mass per unit area: 53 kg/m² Loading: 21 kg/m²
 Curing time: h
 Air temp. in the source room: 20 °C
 Air humidity in the source room: 30 %
 Receiving room volume: 56 m³

Frequency <i>f</i> Hz	<i>L_{n,0}</i> Test slab 160 mm dB	ΔL One-third octave dB
50		
63		
80		
100	56,8	0,1
125	62,4	0,3
160	69,7	10,9
200	69,8	15,4
250	64,5	16,4
315	71,8	25,6
400	68,1	29,3
500	70,6	34,1
630	70,4	38,6
800	70,3	43,0
1000	69,7	48,1
1250	70,1	54,3
1600	71,3	57,2
2000	71,2	59,0
2500	70,4	54,4
3150	71,0	57,5
4000	68,8	56,6
5000	66,2	53,7

minimum value
 minimum value
 minimum value
 minimum value



Rating according to ISO 717-2:
 $\Delta L_w = 26$ dB

These results are based on test made with an artificial source under laboratory conditions (engineering method).

Product:
Manufacturer:

 maxit Comfort Floor and clinker flooring
maxit Oy Ab - maxit Group

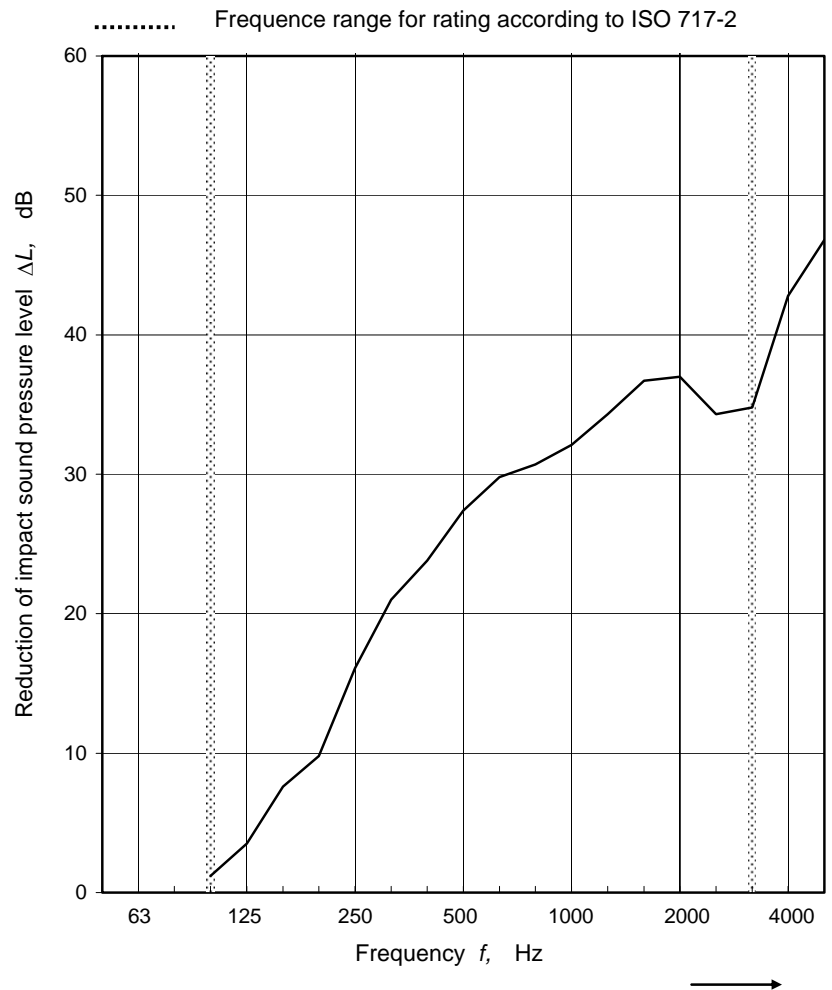
Reduction of impact sound pressure level

 Measurement: *ISO 140-8:1997 ENISO1408:1998*
Rating: *ISO 717-2:1996 ENISO7172:1996*

 Date of test: 16 November 2006
Test slab: Concrete 160 mm

 Mass per unit area: 72 kg/m² Loading: 21 kg/m²
Curing time: h
Air temp. in the source room: 20 °C
Air humidity in the source room: 28 %
Receiving room volume: 56 m³

Frequency <i>f</i> Hz	<i>L_{n,0}</i> Test slab 160 mm dB	ΔL One-third octave dB
50		
63		
80		
100	56,8	1,2
125	62,4	3,5
160	69,7	7,6
200	69,8	9,8
250	64,5	16,1
315	71,8	21,0
400	68,1	23,8
500	70,6	27,4
630	70,4	29,8
800	70,3	30,7
1000	69,7	32,1
1250	70,1	34,3
1600	71,3	36,7
2000	71,2	37,0
2500	70,4	34,3
3150	71,0	34,8
4000	68,8	42,8
5000	66,2	46,8



Rating according to ISO 717-2:

 $\Delta L_w = 25$ dB

These results are based on test made with an artificial source under laboratory conditions (engineering method).

Product: 160 mm test slab
 Manufacturer: VTT

Determination of sound reduction index

Test rooms: 5 and 2
 Date of test: 4.12.2006

Test specimen mounted by VTT VTT
 Description of test facility, test specimen and test arrangement:

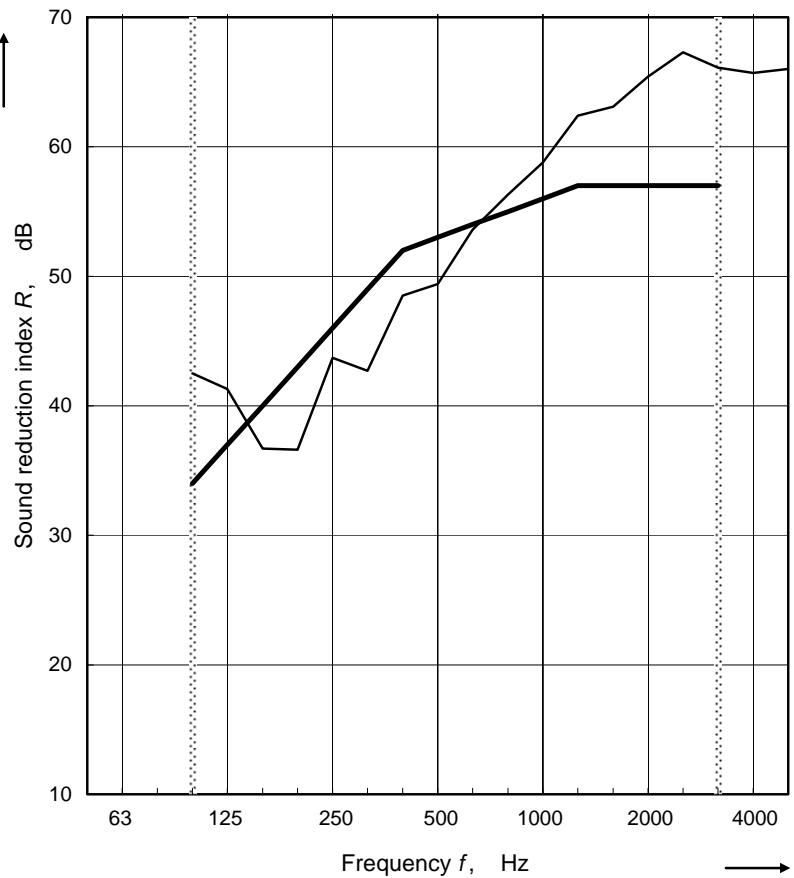
The test slab (3050x3900 mm) is between two reverberation rooms.

The airborne sound reduction index was determined by means of two channel sound pressure level measurement with two fixed sources and moving microphone booms.

Area S of test specimen: 11,9 m²
 Mass per unit area: 400 kg/m²
 Air Temp. In the test rooms: 20 °C
 Air humidity in the test rooms: 37 %
 Source room volume: 56 m³
 Receiving room volume: 131 m³

..... frequency range 100-3150 Hz
 ——— curve of reference values (ISO 717-1)

frequency <i>f</i> Hz	One-third octave <i>R</i> dB
50	
63	
80	
100	42,5
125	41,3
160	36,7
200	36,6
250	43,7
315	42,7
400	48,5
500	49,4
630	53,6
800	56,3
1000	58,8
1250	62,4
1600	63,1
2000	65,4
2500	67,3
3150	66,1
4000	65,7
5000	66,0



Rating according to ISO 717-1:
 $R_w (C; C_{tr}) = 53 (-1 ; -5) \text{ dB}; \quad C_{100-5000} = 0 \text{ dB} \quad C_{tr,100-5000} = -5 \text{ dB}$
 Evaluation based on laboratory measurement results obtained by an engineering method

Product: 160 mm test slab and **maxit Comfort Floor** (without floor covering)
 Manufacturer: maxit Oy Ab - maxit Group (160 mm test slab without maxit Comfort Floor: dash line)

Determination of sound reduction index

Test rooms: 5 and 2
 Date of test: 10.11.2006

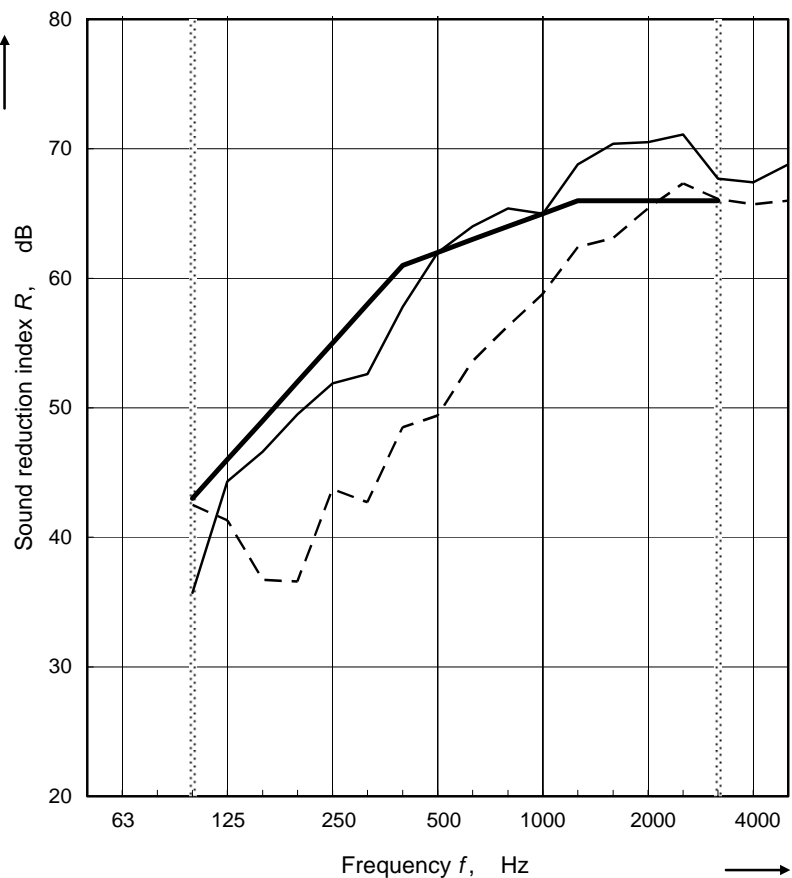
Test specimen mounted by: maxit Oy Ab
 Description of test facility, test specimen and test arrangement:

The test slab (3050x3900 mm) is between two reverberation rooms.
 The floating screed slab was 30 mm (51 kg/m²) on the test slab.
 The airborne sound reduction index was determined by means of two channel sound pressure level measurement with two fixed sources and moving microphone booms.

Area S of test specimen: 11,9 m²
 Mass per unit area: 452 kg/m²
 Air Temp. In the test rooms: 20 °C
 Air humidity in the test rooms: 30 %
 Source room volume: 56 m³
 Receiving room volume: 131 m³

..... frequency range 100-3150 Hz
 ——— curve of reference values (ISO 717-1)

frequency <i>f</i> Hz	One-third octave <i>R</i> dB	ΔR
50		
63		
80		
100	35,7	-6,8
125	44,3	3,0
160	46,6	9,9
200	49,5	12,9
250	51,9	8,2
315	52,6	9,9
400	57,8	9,3
500	62,0	12,6
630	64,0	10,4
800	65,4	9,1
1000	65,0	6,2
1250	68,8	6,4
1600	70,4	7,3
2000	70,5	5,1
2500	71,1	3,8
3150	67,7	1,6
4000	67,4	1,7
5000	68,8	2,8



Rating according to ISO 717-1:

$$R_w (C; C_{tr}) = 62 (-2; -8) \text{ dB}; \quad C_{100-5000} = -1 \text{ dB} \quad C_{tr,100-5000} = -8 \text{ dB}$$

Evaluation based on laboratory
 measurement results obtained
 by an engineering method

Product:
Manufacturer: maxit Oy Ab - maxit Group

160 mm test slab and **maxit Comfort Floor + laminate 7 mm**
(160 mm test slab without maxit Comfort Floor: dash line)

Determination of sound reduction index

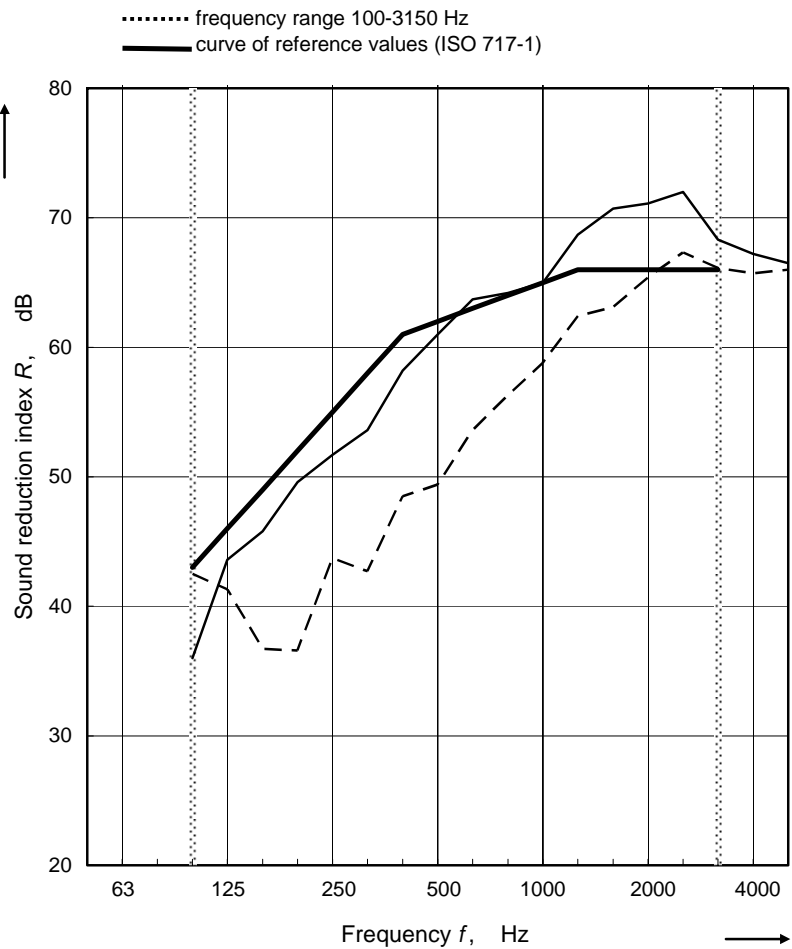
Test rooms: 5 and 2
Date of test: 10.11.2006

Test specimen mounted by: maxit Oy Ab
Description of test facility, test specimen and test arrangement:

The test slab (3050x3900 mm) is between two reverberation rooms.
The floating screed slab was 30 mm (51 kg/m²) on the test slab.
The airborne sound reduction index was determined by means of two channel sound pressure level measurement with two fixed sources and moving microphone booms.

Area S of test specimen: 11,9 m²
Mass per unit area: 458 kg/m²
Air Temp. In the test rooms: 20 °C
Air humidity in the test rooms: 30 %
Source room volume: 56 m³
Receiving room volume: 131 m³

frequency <i>f</i> Hz	One-third octave <i>R</i> dB	ΔR
50		
63		
80		
100	36,0	-6,5
125	43,6	2,3
160	45,8	9,1
200	49,6	13,0
250	51,7	8,0
315	53,6	10,9
400	58,2	9,7
500	61,0	11,6
630	63,7	10,1
800	64,2	7,9
1000	65,0	6,2
1250	68,7	6,3
1600	70,7	7,6
2000	71,1	5,7
2500	72,0	4,7
3150	68,3	2,2
4000	67,2	1,5
5000	66,5	0,5



Rating according to ISO 717-1:

$$R_w (C; C_{tr}) = 62 (-2; -8) \text{ dB};$$

$$C_{100-5000} = -1 \text{ dB}$$

$$C_{tr,100-5000} = -8 \text{ dB}$$

Evaluation based on laboratory
measurement results obtained
by an engineering method

Product:
Manufacturer: maxit Oy Ab - maxit Group

160 mm test slab and **maxit Comfort Floor + clinker 7 mm**
(160 mm test slab without maxit Comfort Floor: dash line)

Determination of sound reduction index

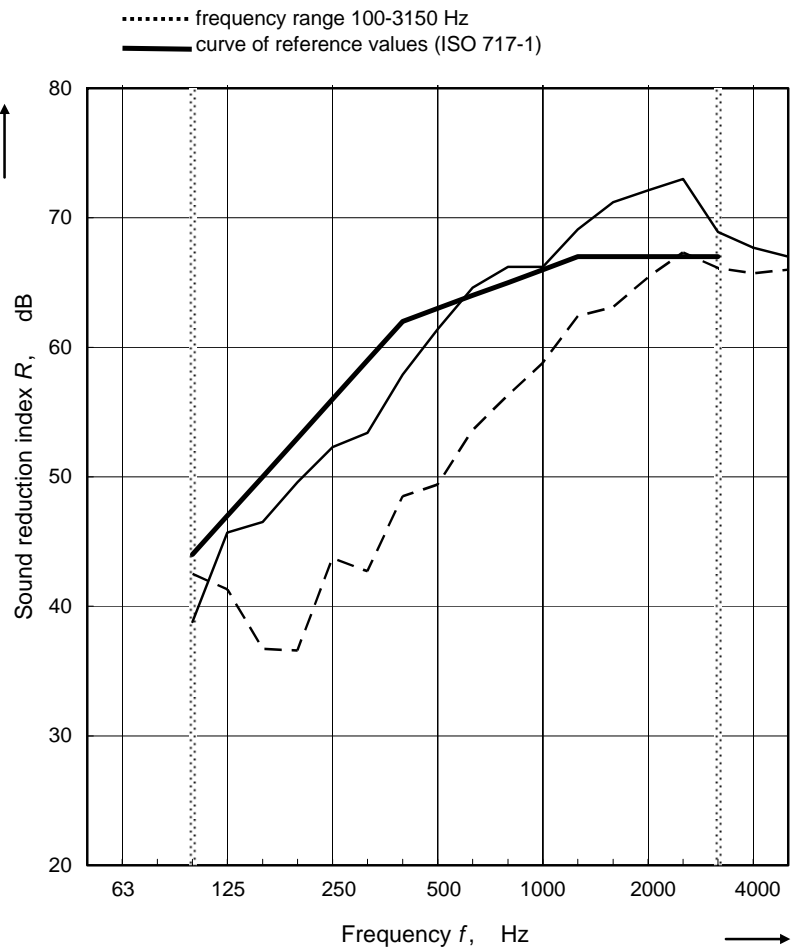
Test rooms: 5 and 2
Date of test: 16.11.2006

Test specimen mounted by: maxit Oy Ab
Description of test facility, test specimen and test arrangement:

The test slab (3050x3900 mm) is between two reverberation rooms.
The floating screed slab was 30 mm (51 kg/m²) on the test slab.
The airborne sound reduction index was determined by means of two channel sound pressure level measurement with two fixed sources and moving microphone booms.

Area S of test specimen: 11,9 m²
Mass per unit area: 472 kg/m²
Air Temp. In the test rooms: 20 °C
Air humidity in the test rooms: 28 %
Source room volume: 56 m³
Receiving room volume: 131 m³

frequency <i>f</i> Hz	One-third octave <i>R</i> dB	ΔR
50		
63		
80		
100	38,8	-3,7
125	45,7	4,4
160	46,5	9,8
200	49,6	13,0
250	52,3	8,6
315	53,4	10,7
400	57,9	9,4
500	61,4	12,0
630	64,6	11,0
800	66,2	9,9
1000	66,2	7,4
1250	69,1	6,7
1600	71,2	8,1
2000	72,1	6,7
2500	73,0	5,7
3150	68,9	2,7
4000	67,7	2,0
5000	67,0	1,0



Rating according to ISO 717-1:

$$R_w (C; C_{tr}) = 63 (-2; -7) \text{ dB};$$

$$C_{100-5000} = -1 \text{ dB}$$

$$C_{tr,100-5000} = -7 \text{ dB}$$

Evaluation based on laboratory
measurement results obtained
by an engineering method

maxit Comfort Floor

