National Research Council Canada | Conseil national de recherches Canada

NRC-CNRC

Client Report

B-3135.3

Airborne and Impact Sound Transmission Measurements Performed on Specimen B3135-3

for

Rendered by Manufacturer and Released to:
Acoustical Surfaces, Inc.
123 Columbia Court North
Chaska, MN 55318

02 September 1999

Institute for Research in Construction IRC

Airborne and Impact Sound Transmission Measurements Performed on Specimen B3135-3

Author

J.A. Birta

Quality Assurance

A.C.C. Warnock

Approved

M.R. Atif
Director, Indoor Environment

Report No: B-3135.3
Report Date: September 2 1999
Contract No: B-3135
Reference: Agreement dated March 22 1999
Program: Indoor Environment

9 pages
Copy No. 4 of 4 copies

INTRODUCTION

Airborne and impact sound transmission measurements were performed on a wood joist floor assembly with a topping which comprised 6 mm ceramic tiles and 38 mm gypsum concrete. For report purposes, this specimen is identified Specimen B3135-3. A complete description of the floor assembly is outlined in this report (see Specimen Description Section).

FACILITIES AND EQUIPMENT

The acoustics floor test facility comprises two reverberation rooms with a moveable test frame between the two rooms. Both rooms have a volume of 175 m^3.

Measurements are controlled by a desktop PC-type computer interfaced to a Norwegian Electronics type 830 real time analyser. Each room has a calibrated Bruel & Kjaer condenser microphone cartridge-type 4166 that is moved under computer control to nine positions used for the acoustical measurements. Each room has four loudspeakers driven by separate amplifiers and noise sources. To increase the randomness of the sound field, there are also fixed diffusing panels in each room.

TEST PROCEDURE

Airborne Sound Transmission Loss

Airborne sound transmission measurements were conducted in accordance with the requirements of ASTM E90-90, "Standard Method for Laboratory Measurement of Airborne Sound Transmission Loss of Building Partitions", and of ISO 140/III 1978(E), "Laboratory Measurement of Airborne Sound Insulation of Building Elements".

The Sound Transmission Class (STC) was determined in accordance with ASTM E413-87, "Classification for Rating Sound Insulation". The Weighted Sound Reduction Index (R_w) was determined in accordance with ISO 717, "Rating of Sound Insulation in Buildings and of Building Elements, Part 1: Airborne Sound Insulation in Buildings and of Interior Building Elements".

One-third octave band sound pressure levels were measured for 32 seconds at each microphone position and then averaged to get the average sound pressure level in the room. Five sound decays were averaged to get the reverberation time at each microphone position in the receiving room. These times were averaged to get the spatial average reverberation times for the room.

The space average sound pressure levels of both the source and receiving rooms and the spatial average reverberation times of the receiving room were used to calculate sound transmission loss values.

Airborne sound transmission loss tests were performed in the forward (receiving room is the lower room) and reverse (receiving room is the upper room) directions. Results presented in this report are the average of the tests in these two directions.

A complete description of the test procedure, information on the flanking limit of the facility and reference specimen test results are available on request.

The measured temperature and relative humidity in the upper chamber during testing was 28.7°C and 43.6%, respectively. The measured temperature and relative humidity in the lower chamber during testing 25.2°C and 58.6%, respectively.

TEST PROCEDURE

Impact Sound Transmission

Impact sound transmission measurements were made in accordance with ASTM E492-90, "Standard Test Method for Laboratory Measurement of Impact Sound Transmission Through Floor-Ceiling Assemblies Using the Tapping Machine". This test used the standard tapping machine and the prescribed four impact positions on the floor. The Impact Insulation Class (IIC) was determined in accordance with ASTM E989-89, "Standard Classification for Determination of Impact Insulation Class (IIC)".

These measurements are also in accordance with ISO 140-6, "Laboratory Measurements of Impact Sound Insulation of Floors", except that the tapping machine positions are not randomly selected. This difference is believed to be insignificant. The Weighted Normalized Impact Sound Pressure Level ($L_{n,w}$) was determined in accordance with ISO 717, "Rating of Sound Insulation in Buildings and of Building Elements - Part 2: Impact Sound Insulation".

One-third octave band sound pressure levels were measured for 32 seconds at each microphone position in the receiving room and then averaged to get the average sound pressure level in the room. Five sound decays were averaged to get the reverberation time at each microphone position in the receiving room. These times were averaged to get the spatial average reverberation times for the room.

The space average sound pressure levels and the spatial average reverberation times of the receiving room were used to calculate impact transmission values. For impact sound transmission, the lower room is the receiving room.

A complete description of the test procedure is available on request.

MOUNTING OF SPECIMEN

The test specimen was mounted in the IRC acoustical floor test opening which measures 4.70 m x 3.78 m. The area used for the calculations of impact transmission and airborne sound transmission loss was 17.85 m^2.

SPECIMEN DESCRIPTION

Construction on the floor assembly began on 25-May-99. The airborne sound transmission loss tests were performed on 14-Jun-99. The floor assembly comprised the following elements, listed from top to bottom.

Table 1: Element breakdown of Specimen B3135-3.

Element	Surface weight (kg/m^2)	Mass (kg)
6 mm ceramic tiles	15.6	294.5
38 mm gypsum concrete	70.1	1378.4
0.05 mm vapour barrier	0.04	0.9
8 mm Duracoustic	3.0	60.8
19 mm plywood	8.5	170.3
38 mm x 235 mm wood joists (including headers, trimmers and cross bridging), 406 mm oc		248.7
152 mm glass fibre batts	1.7	30.6
13 mm resilient channels, 610 mm oc		8.3
15.9 mm fire-rated gypsum board	11.1	196.4
TOTAL		**2388.9**

Total thickness: 334.9 mm

Wood joists measuring 38 mm x 235 mm in depth, spaced 406 mm on center were installed in the test frame. The framing had 19 mm x 64 mm pieces of wood cross bridging at mid-span. Resilient channels were installed on the underside of the joists spaced 610 mm on center. A single layer of 15.9 mm fire-rated gypsum board was attached to the resilient channels. The gypsum board screws were spaced 305mm on center.

152 mm thick R20 glass fibre batts were installed in the joist cavities. Each batt measured 381 mm x 1194 mm x 152 mm.

19 mm plywood was installed on top of the joists with screws spaced 152 mm on center along the edges of each sheet and 305 mm on center in the field of each sheet.

Pieces of 8 mm thick shredded rubber material, identified by the client as "Duracoustic", were installed directly on top of the plywood subfloor. The "Duracoustic" was installed with the rubber side against the plywood. A 0.05 mm thick vapour barrier was laid on top of the "Duracoustic" layer. 38 mm of Duracap 2000 gypsum concrete was poured on top of the plywood subfloor on 26-May-99. Once the gypsum concrete had cured, the ceramic tiles were laid according to the manufacturer's instructions.

RESULTS

Results of the airborne sound transmission loss measurements of Specimen B3135-3 are given in Table 2 and Figure 1. Results of the impact sound transmission measurements of this floor construction are given in Table 3 and Figure 2.

Certain values in the tables are marked. The values marked "*" indicate that the measured background level was less than 5 dB below the combined receiving room level and background level. The reported values provide an estimate of the lower limit of airborne sound transmission loss or impact transmission. These values do not limit the single number ratings. The values marked "c" indicate that the measured background level was between 5 dB and 10 dB below the combined receiving room level and background level. The reported values have been corrected according to the procedure outlined in ASTM E90-97 or ASTM E492-90.

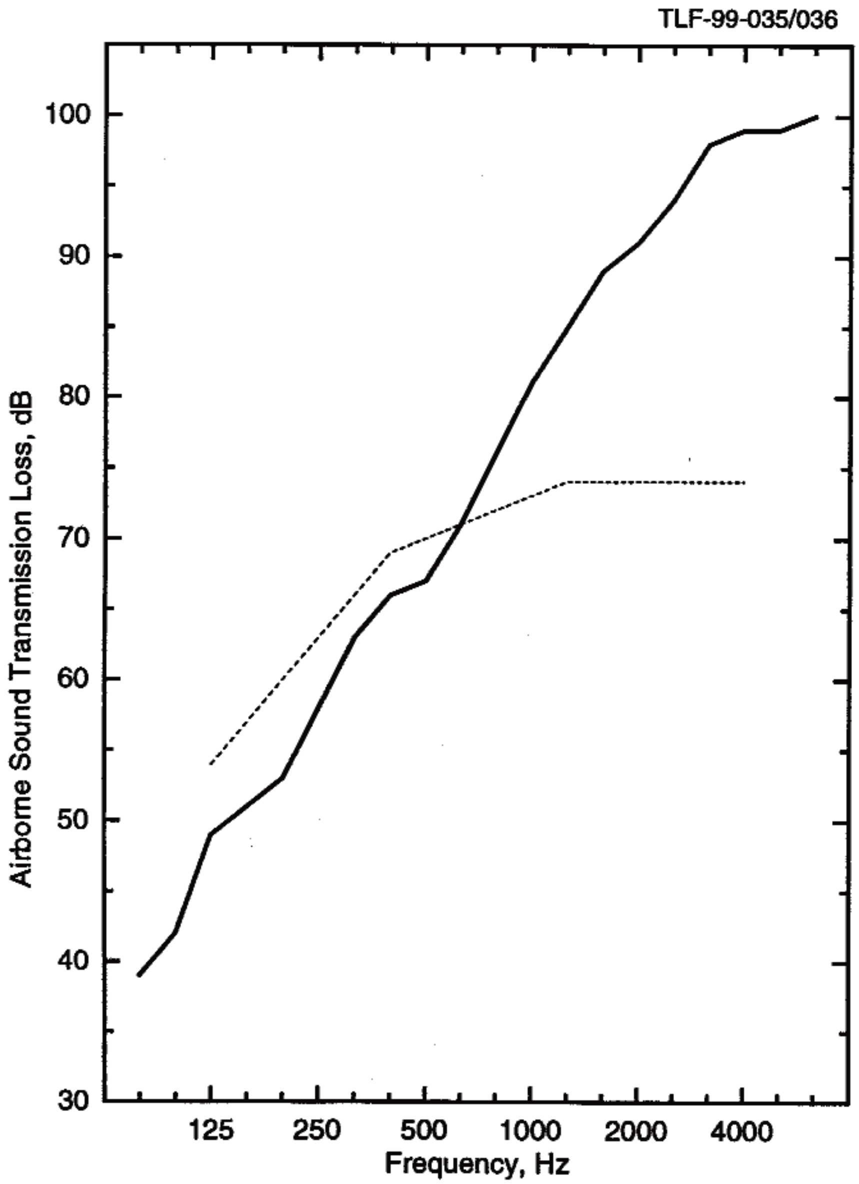
Table 2: Airborne sound transmission loss measurements of Specimen B3135-3, TLF-99-035/036.

Frequency (Hz)	Airborne Sound Transmission Loss (dB)	95% Confidence Limit[1]	Deviation Below the STC Contour
80	39	±2.7	
100	42	±2.1	
125	49	±1.4	5
160	51	±0.8	6
200	53	±0.8	7
250	58	±0.6	5
315	63	±0.4	3
400	66	±0.4	3
500	67	±0.4	3
630	71	±0.4	
800	76	±0.3	
1000	81	±0.3	
1250	85	±0.3	
1600	89	±0.3	
2000	91	±0.3	
2500	94	±0.3	
3150	98 c	±0.3	
4000	99 c	±0.3	
5000	99 c	±0.4	
6300	100 *	±0.4	
Sound Transmission Class (STC)[2] = 70			
Weighted Sound Reduction (R_W)[3] = 68			

[1] Acoustical measurement in rooms is a sampling process and as such has associated with it a degree of uncertainty. By correctly performing a number of measurements, the uncertainties can be reduced and upper and lower limits assigned to the probable error in the measurement. These limits are called confidence limits. Thus where a quantity (Q) has associated with it a confidence limit ±C, then one can say with 95% confidence that the true quantity is in the interval Q - C to Q + C.

[2] Sound Transmission Class (STC) calculated according to ASTM E413-94.

[3] Weighted Sound Reduction (R_w) calculated according to ISO 717.



Frequency (Hz)	Airborne Sound Transmission Loss (dB)	
80	39	
100	42	
125	49	
160	51	
200	53	
250	58	
315	63	
400	66	
500	67	
630	71	
800	76	
1000	81	
1250	85	
1600	89	
2000	91	
2500	94	
3150	98	c
4000	99	c
5000	99	c
6300	100	*

STC 70

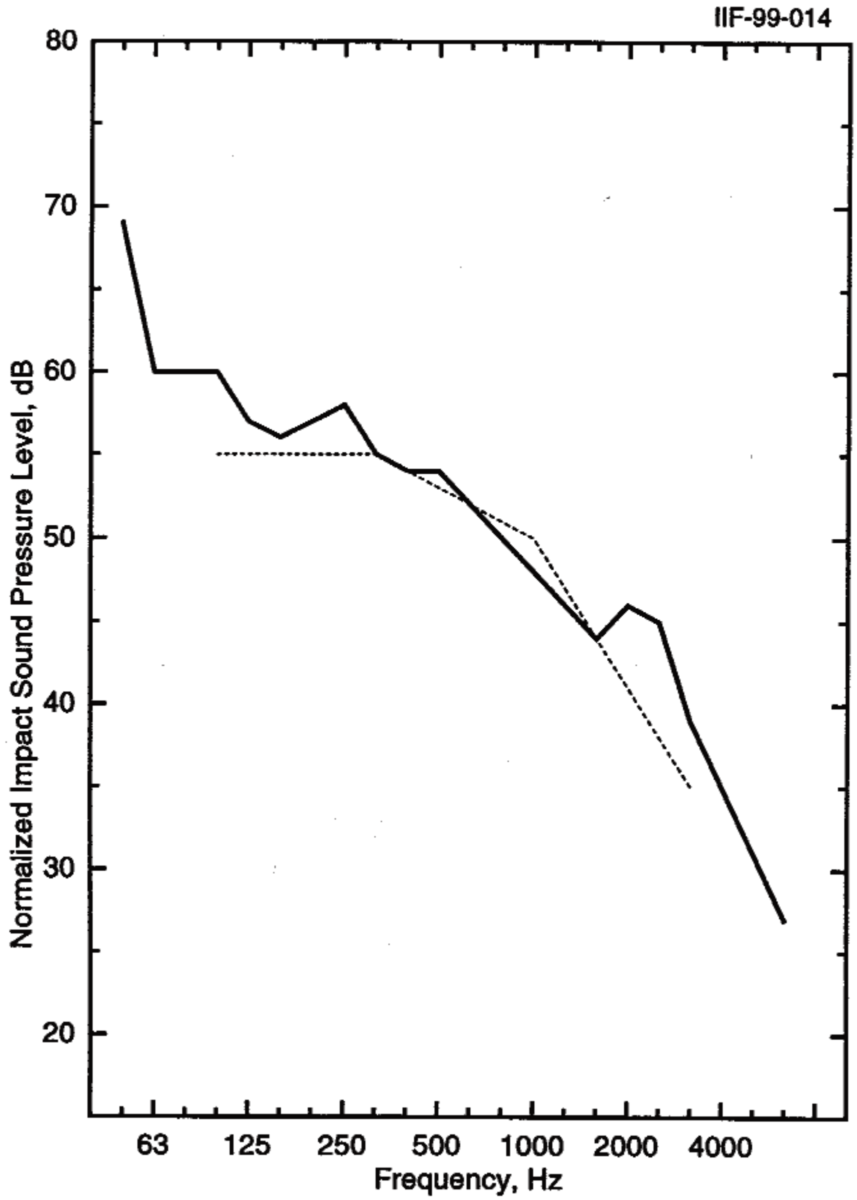
Figure 1: Airborne sound transmission loss measurements of a Specimen B3135-3. The solid line is the experimental data and the dotted line is the STC 70 contour.

Table 3: Impact sound transmission measurements of Specimen B3135-3, IIF-99-014.

Frequency (Hz)	Normalized Impact Sound Pressure Level (dB)	95% Confidence Limit[1]	Deviation Above the IIC Contour
50	69	±1.1	
63	60	±1.6	
80	60	±1.0	
100	60	±0.9	5
125	57	±0.7	2
160	56	±0.5	1
200	57	±0.4	2
250	58	±0.3	3
315	55	±0.3	
400	54	±0.3	
500	54	±0.2	1
630	52	±0.2	
800	50	±0.1	
1000	48	±0.1	
1250	46	±0.1	
1600	44	±0.1	
2000	46	±0.1	5
2500	45	±0.1	7
3150	39	±0.1	4
4000	35	±0.1	
5000	31	±0.1	
6300	27 c	±0.2	
Impact Insulation Class (IIC)[4] = 57			
Weighted Normalized Impact Sound Pressure Level ($L_{n,w}$)[5] = 53			

[4] Impact Insulation Class (IIC) calculated according to ASTM E989-89.

[5] Weighted Normalized Impact Sound Pressure Level ($L_{n,w}$) calculated according to ISO ISO 717.



Frequency (Hz)	Normalized Impact Sound Pressure Level (dB)	
50	69	
63	60	
80	60	
100	60	
125	57	
160	56	
200	57	
250	58	
315	55	
400	54	
500	54	
630	52	
800	50	
1000	48	
1250	46	
1600	44	
2000	46	
2500	45	
3150	39	
4000	35	
5000	31	
6300	27	c

IIC 57

Figure 2: Impact sound transmission measurements of Specimen B3135-3 The solid line is the experimental data and the dotted line is the IIC 57 contour.

NOTES ON THE SIGNIFICANCE OF TEST RESULTS

Sound Transmission Class And Weighted Sound Reduction Index

The Sound Transmission Class (STC) and Weighted Sound Reduction Index (R_w) are single-figure rating schemes intended to rate the acoustical performance of a partition element under typical conditions involving office or dwelling separation. The higher the value of either rating, the better the floor performance. Thus, the rating is intended to correlate with subjective impressions of the sound insulation provided against the sounds of speech, radio, television, music, office machines and similar sources of noise characteristic of offices and dwellings. In applications involving noise spectra that differ markedly from those referred to above (for example, heavy machinery, power transformers, aircraft noise, motor vehicle noise), the STC and R_w are of limited use. Generally, in such applications it is desirable to consider explicitly the noise spectra and the insulation requirements.

Impact Insulation Class And Weighted Normalized Impact Sound Pressure Level

The Impact Insulation Class (IIC) and the Weighted Normalized Impact Sound Pressure Level ($L_{n,w}$) are single-figure rating schemes intended to rate the effectiveness of floor-ceiling assemblies at preventing the transmission of impact sound from the standard tapping machine. The higher the value of the rating, the better the floor performance.