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The transmission loss of 203 mm thick prestressed precast concrete hollowcore floors

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Canada

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The Transmission Loss of 203 mm Thick Prestressed Precast Concrete Hollowcore Floors

Canadian Precast/Prestressed Concrete Institute
Report A1-012467.2
28 March, 2018

National Research Council Canada
Conseil national de recherches Canada
Canada

Executive Summary

The transmission loss and impact insulation of floors comprised of 203 mm (8 in) thick precast/prestressed concrete hollowcores slabs were evaluated in the direct floor testing facility at the National Research Council.

The first floor of concrete hollowcore slabs had a mass per unit area of 269 kg/m^2 without grout and a mass per unit area of 273 kg/m^2 once the grout was applied between the slabs.

The second floor of concrete hollowcore slabs had a mass per unit area of 301 kg/m^2 without grout and a mass per unit area of 305 kg/m^2 once the grout was applied between the slabs. This floor was also tested with a 25.4 mm (1") underlayment which was poured directly onto the concrete hollowcore slabs and with a carpet and underpad on the underlayment.

The results of the measurements are summarized in Table 1.

Table 1: Summary of the sound transmission class (STC) ratings and the impact insulation class (IIC) ratings for the floors.

Floor	Topping	Carpet	STC	IIC
203 mm (8") concrete hollowcore slabs with grout - 273 kg/m^2	None	None	55	23
203 mm (8") concrete hollowcore slabs with grout - 305 kg/m^2	None	None	54	23
203 mm (8") concrete hollowcore slabs with grout - 305 kg/m^2	25.4 mm (1") underlayment poured directly on the concrete hollowcore slabs	None	55	25
203 mm (8") concrete hollowcore slabs with grout - 305 kg/m^2	25.4 mm (1") underlayment poured directly on the concrete hollowcore slabs	6 mm (1/4") carpet with an 8 mm (5/16") underpad	55	72

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1. Measurement Results

1.1 Hollowcore slabs 203 mm thick with a mass per unit area[1] of 273 kg/m^2

Client: Canadian Precast/Prestressed Concrete Institute

Specimen: 203 mm (8") thick floor comprised of four precast prestressed concrete hollowcore slabs with an average mass per unit area of 269 kg/m^2 grouted together.

Specimen ID: A1-012467-1X

Specimen Description:

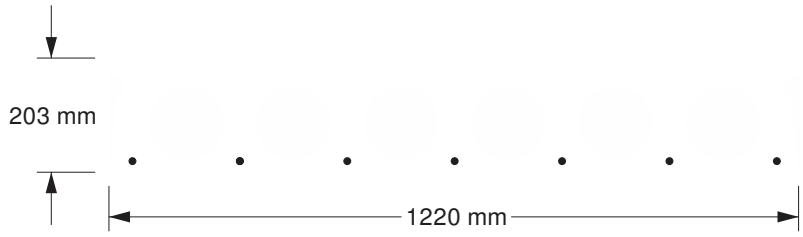


Figure 1: One 203 mm concrete hollowcore floor slab cross-section (nominal dimensions shown - not to size)

Bare hollowcore: Four 1212 mm wide x 3988 mm long x 201 mm thick (actual average values) concrete hollowcore slabs were grouted together to form a concrete hollowcore floor.

Grout: The edges were grouted with 75 kg of Sakrete Mortar Mix.

Perimeter: The perimeter between the specimen and the test frame was packed with sand.

Specimen Properties:

Element	Actual Average Thickness (mm)	Mass (kg)	Mass per unit area (kg/m^2)
203 mm thick concrete hollowcore slabs	201	5195	269
Sakrete mortar mix		75	4
Total		5270	273

Test Specimen Installation

- The test specimen was mounted in the NRC Construction acoustic floor test frame opening which measures 4.71 m x 3.79 m.
- The area used for the calculations of the airborne sound transmission loss was the specimen opening area of 17.85 m^2. The area used for mass per area for the floor elements is 19.32 m^2 (4.88 m x 3.96 m).

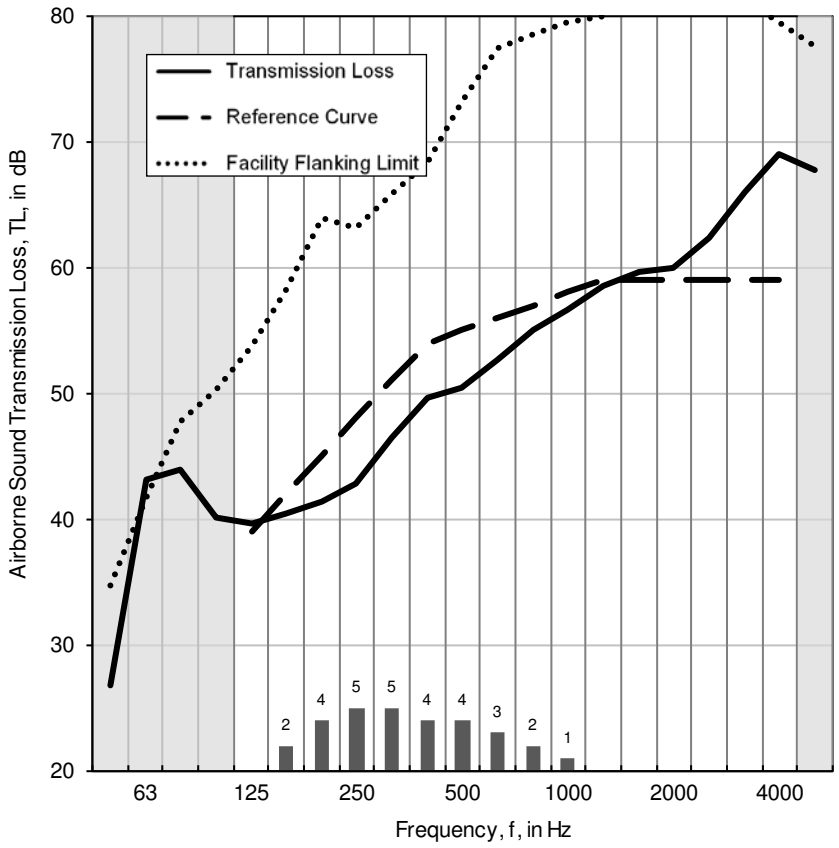
Airborne Sound Transmission Loss, *TL*, in Accordance with ASTM E 90

Client:	CPCI	Test ID:	TLF-18-008
Date of test:	13 February, 2018	Specimen ID:	A1-012467-1X

Area S of the test element:	17.85 m^2	**Mass per unit Area:**	273 kg/m^2

Room	Volume (m^3)	Air Temperature (°C)	Relative Humidity (%)
Upper	175.1	20.7 to 20.9	43.2 to 43.9
Lower	176.9	20.8 to 20.9	32.3 to 33.5

Frequency *f* (Hz)	*TL* one-third octave (dB)
50	27*
63	43*
80	44
100	40
125	40
160	40
200	41
250	43
315	46
400	50
500	51
630	53
800	55
1000	57
1250	59
1600	60
2000	60
2500	62
3150	66
4000	69
5000	68



Sum of Deficiencies	30 dB
Maximum Deficiency	5 dB at 250 Hz and 315 Hz
Sound Transmission Class (STC)	**55**

The solid line is the measured sound transmission loss for this specimen. The dashed line is the STC contour fitted to the measured values according to ASTM E413-16. The dotted line (may be above the displayed range) is 10 dB below the flanking limit established for this facility. For any frequency band where the measured transmission loss is above the dotted line, the reported value is potentially limited by flanking transmission via laboratory surfaces, and the true value may be higher than that measured. Bars at the bottom of the graph show deficiencies where the measured data are less than the reference contour as described in the fitting procedure for the STC, defined in ASTM E413-16. The shaded cells in the table and areas in the graph are outside the STC contour range.

No. of test report:	A1-012467.2	Signature:	See signature page
Name of test institute:	National Research Council	Date:	28 March 2018

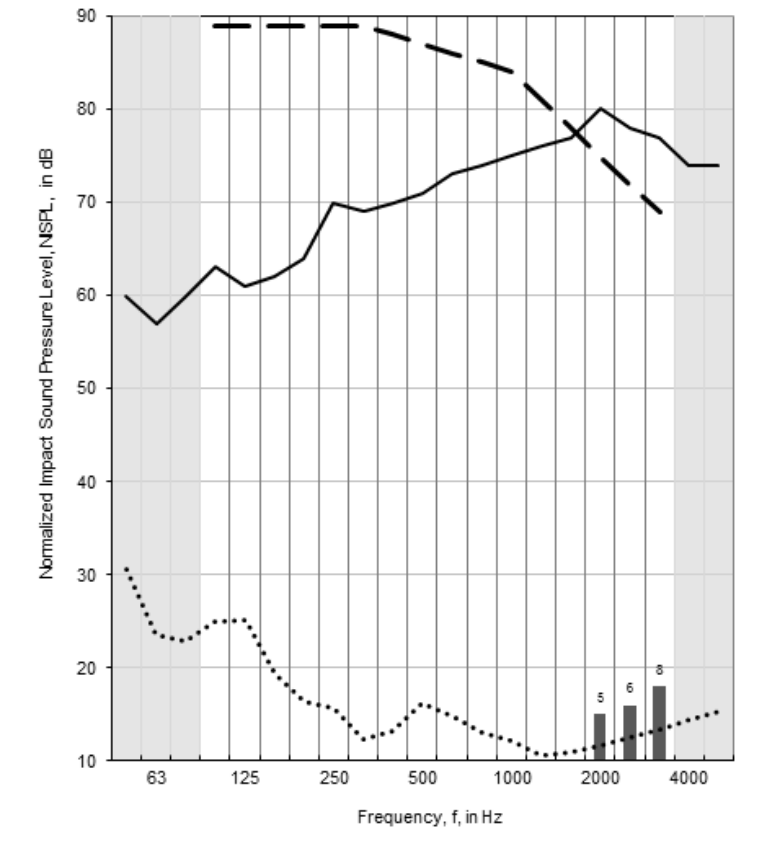
Normalized Impact Sound Pressure Levels in Accordance with ASTM E 492

Client:	CPCI	Test ID:	IIF-18-008
Date of test:	13 February, 2018	Specimen ID:	A1-012467-1X

Area S of the test element:	17.85 m^2	**Mass per unit Area:**	273 kg/m^2

Room	Volume (m^3)	Air Temperature (°C)	Relative Humidity (%)
Upper	175.1	21.9 to 21.9	34.5 to 35.3
Lower	176.9	20.3 to 20.3	27.6 to 27.6

Frequency *f* (Hz)	*NISPL* one-third octave (dB)
50	60
63	57
80	60
100	63
125	61
160	62
200	64
250	70
315	69
400	70
500	71
630	73
800	74
1000	75
1250	76
1600	77
2000	80
2500	78
3150	77
4000	74
5000	74



Sum of Positive Differences	19 dB
Maximum Positive Difference	8 dB at 3150 Hz
Impact Insulation Class (IIC)	**23**

The solid line is the measured normalized impact sound pressure level (NISPL) for this specimen. The dashed line is the IIC contour fitted to the measured values according to ASTM E989-06. The dotted line is the background sound level measured in the receiving room during this test (may be below the displayed range). For any frequency where measured NISPL is less than 10 dB above the dotted line, the reported values were adjusted as noted below. Bars at bottom of graph show positive differences; where the measured data are greater than the reference contour as defined in ASTM E989-06. Shaded cells in the table and areas in the graph are outside the IIC contour range.

No. of test report:	A1-012467.2	Signature:	See signature page
Name of test institute:	National Research Council	Date:	28 March 2018

1.2 Hollowcore slabs 203 mm thick with a mass per unit area[1] of 305 kg/m^2

Client: Canadian Precast/Prestressed Concrete Institute

Specimen: 203 mm (8") thick floor comprised of four precast prestressed concrete hollowcore slabs with an average mass per unit area of 301 kg/m^2 grouted together.

Specimen ID: A1-012467-1F

Specimen Description:

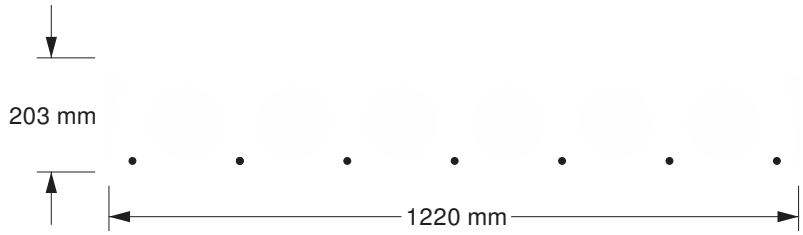


Figure 2: One 203 mm concrete hollowcore floor slab cross-section (nominal dimensions shown - not to size)

Bare hollowcore: Four 1210 mm wide x 3976 mm long x 203 mm thick (average values) concrete hollowcore slabs were grouted together to form a concrete hollowcore floor.

Grout: The edges were grouted with 75 kg of Sakrete Mortar Mix.

Perimeter: The perimeter between the specimen and the test frame was packed with sand.

Specimen Properties:

Element	Actual Average Thickness (mm)	Mass (kg)	Mass per unit area (kg/m^2)
203 mm thick concrete hollowcore slabs	203	5809	301
Sakrete mortar mix		75	4
Total		5884	305

Test Specimen Installation

- The test specimen was mounted in the NRC Construction acoustic floor test frame opening which measures 4.71 m x 3.79 m.
- The area used for the calculations of the airborne sound transmission loss was the specimen opening area of 17.85 m^2. The area used for mass per area for the floor elements is 19.32 m^2 (4.88 m x 3.96 m).

Airborne Sound Transmission Loss, *TL*, in Accordance with ASTM E 90

Client:	CPCI	Test ID:	TLF-18-081
Date of test:	11 December 2017	Specimen ID:	A1-012467-1F

Area S of the test element:	17.85 m^2	**Mass per unit Area:**	305 kg/m^2

Room	Volume (m^3)	Air Temperature (°C)	Relative Humidity (%)
Upper	175.1	19.6 to 19.7	37.7 to 37.8
Lower	176.9	21.0 to 21.0	39.4 to 39.5

Frequency *f* (Hz)	*TL* one-third octave (dB)
50	29*
63	42*
80	38
100	37
125	36
160	38
200	41
250	43
315	45
400	49
500	51
630	53
800	55
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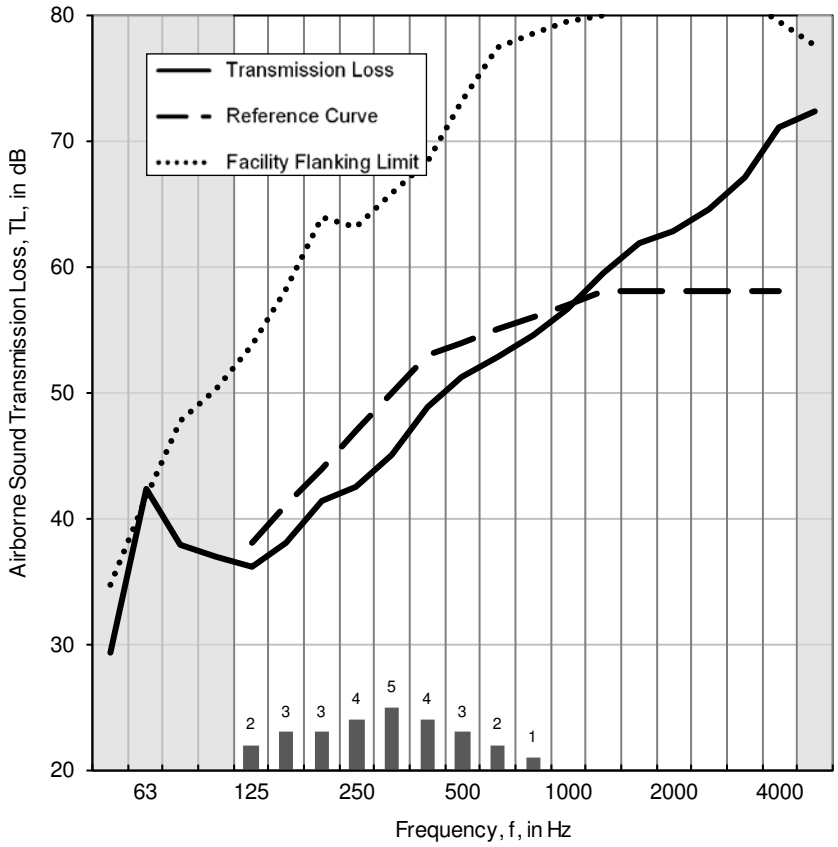
2000	63
2500	65
3150	67
4000	71
5000	72



Sum of Deficiencies	27 dB
Maximum Deficiency	5 dB at 315 Hz
Sound Transmission Class (STC)	**54**

The solid line is the measured sound transmission loss for this specimen. The dashed line is the STC contour fitted to the measured values according to ASTM E413-16. The dotted line (may be above the displayed range) is 10 dB below the flanking limit established for this facility. For any frequency band where the measured transmission loss is above the dotted line, the reported value is potentially limited by flanking transmission via laboratory surfaces, and the true value may be higher than that measured. Bars at the bottom of the graph show deficiencies where the measured data are less than the reference contour as described in the fitting procedure for the STC, defined in ASTM E413-16. The shaded cells in the table and areas in the graph are outside the STC contour range.

No. of test report:	A1-012467.2	Signature:	See signature page
Name of test institute:	National Research Council	Date:	28 March 2018

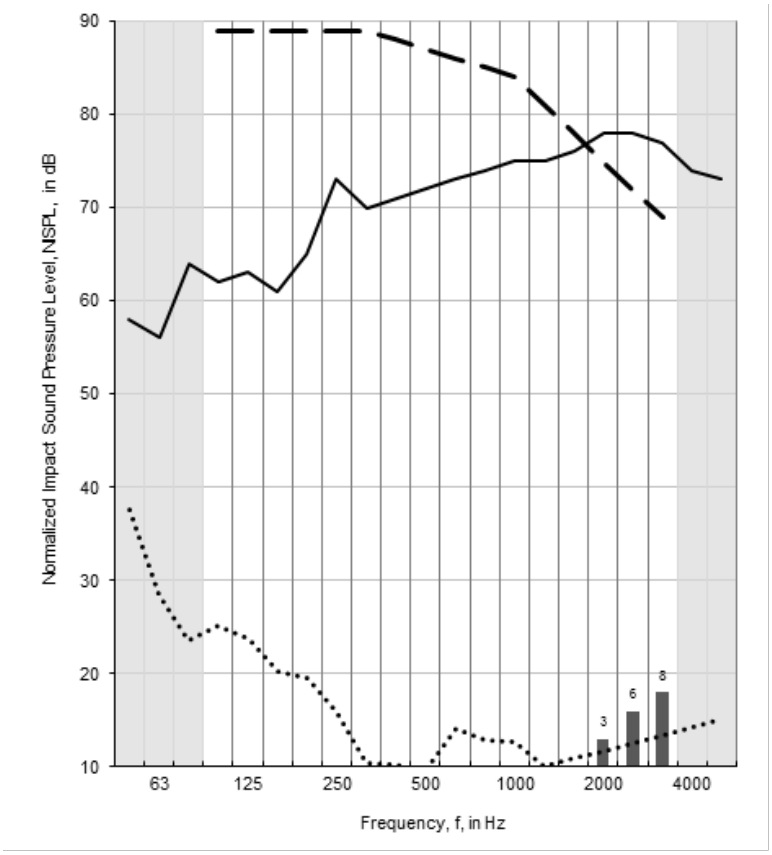
Normalized Impact Sound Pressure Levels in Accordance with ASTM E 492

Client:	CPCI	Test ID:	IIF-17-066
Date of test:	12 December, 2017	Specimen ID:	A1-004972-01F

Area S of the test element:	17.85 m^2	**Mass per unit Area:**	305 kg/m^2

Room	Volume (m^3)	Air Temperature (°C)	Relative Humidity (%)
Upper	175.1	20.0 to 20.1	36.3 to 37.2
Lower	176.9	21.0. to 21.0	39.4 to 39.5

Frequency *f* (Hz)	*NISPL* one-third octave (dB)
50	58
63	56
80	64
100	62
125	63
160	61
200	65
250	73
315	70
400	71
500	72
630	73
800	74
1000	75
1250	75
1600	76
2000	78
2500	78
3150	77
4000	74
5000	73



Sum of Positive Differences	17 dB
Maximum Positive Difference	8 dB at 3150 Hz
Impact Insulation Class (IIC)	**23**

The solid line is the measured normalized impact sound pressure level (NISPL) for this specimen. The dashed line is the IIC contour fitted to the measured values according to ASTM E989-06. The dotted line is the background sound level measured in the receiving room during this test (may be below the displayed range). For any frequency where measured NISPL is less than 10 dB above the dotted line, the reported values were adjusted as noted below. Bars at bottom of graph show positive differences; where the measured data are greater than the reference contour as defined in ASTM E989-06. Shaded cells in the table and areas in the graph are outside the IIC contour range.

No. of test report:	A1-012467.2	Signature:	See signature page
Name of test institute:	National Research Council	Date:	28 March 2018

1.3 Hollowcore slabs 203 mm thick with a mass per unit area[1] of 305 kg/m^2 with a topping of 25.4 mm (1") of floor underlayment poured directly on the slabs

Client: Canadian Precast/Prestressed Concrete Institute

Specimen: 203 mm (8") thick floor comprised of four precast prestressed concrete hollowcore slabs with an average mass per unit area of 301 kg/m^2 grouted together with a 25.4 mm (1") underlayment poured directly on the floor.

Specimen ID: A1-012467-2F

Specimen Description:

Figure 3: Floor of 203 mm thick precast concrete hollowcore slabs with a 25.4 mm underlayment poured directly on the floor.

Bare hollowcore: Four 1212 mm wide x 3988 mm long x 201 mm thick (average values) concrete hollowcore slabs were grouted together to form a hollowcore floor.

Grout: The edges were grouted with 75 kg of Sakrete Mortar Mix.

Perimeter: The perimeter between the specimen and the test frame was packed with sand.

Topping: 25.4 mm (1") underlayment poured directly on the floor. The underlayment had a mass per unit area of 37 kg/m^2 and a compressive strength of 1.02 to 1.32 kg/m^2 (3500 psi to 4500 psi).

Specimen Properties:

Element	Actual Average Thickness (mm)	Mass (kg)	Mass per unit area (kg/m^2)
203 mm thick concrete hollowcore slabs	203	5809	301
Sakrete mortar mix		75	4
25.4 mm underlayment	25	951	49
Total		5270	354

Test Specimen Installation

- The test specimen was mounted in the NRC Construction acoustic floor test frame opening which measures 4.71 m x 3.79 m.
- The area used for the calculations of the airborne sound transmission loss was the specimen opening area of 17.85 m^2. The area used for mass per area for the floor elements is 19.32 m^2 (4.88 m x 3.96 m).

Airborne Sound Transmission Loss, *TL*, in Accordance with ASTM E 90

Client:	CPCI	Test ID:	TLF-18-001
Date of test:	10 January, 2018	Specimen ID:	A1-012467-2F

Area S of the test element:	17.85 m^2	**Mass per unit Area:**	354 kg/m^2

Room	Volume (m^3)	Air Temperature (°C)	Relative Humidity (%)
Upper	175.1	24.6 to 24.7	30.5 to 30.8
Lower	176.9	22.0 to 22.0	36.3 to 36.7

Frequency *f* (Hz)	*TL* one-third octave (dB)
50	34*
63	46*
80	42
100	38
125	38
160	37
200	42
250	43
315	46
400	49
500	52
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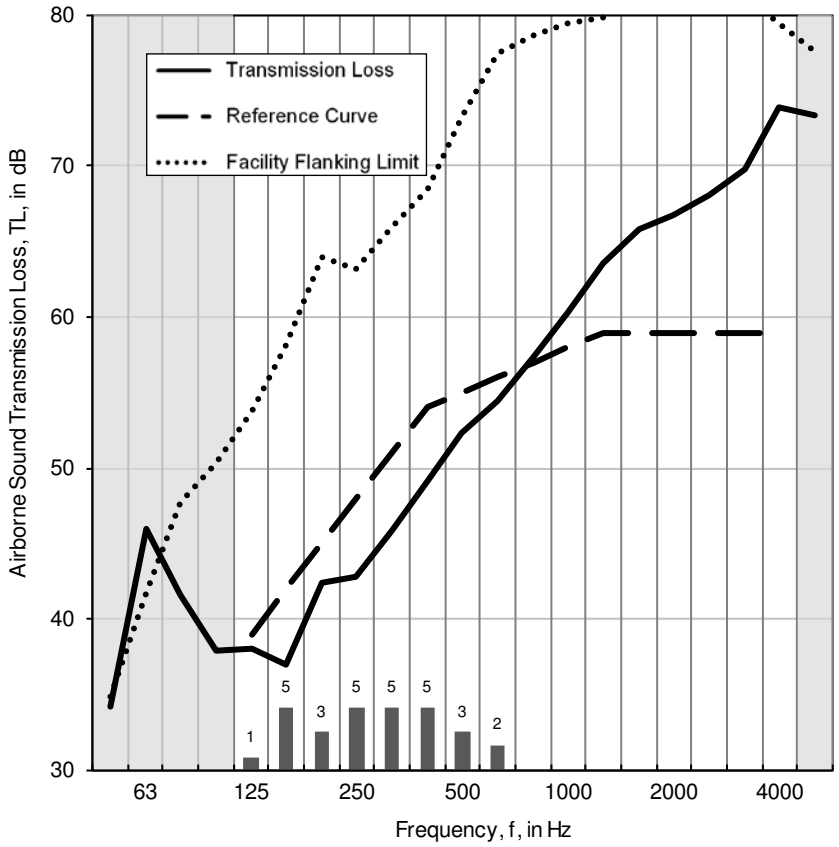
2000	67
2500	68
3150	70
4000	74
5000	73



Sum of Deficiencies	29 dB
Maximum Deficiency	5 dB
Sound Transmission Class (STC)	**55**

The solid line is the measured sound transmission loss for this specimen. The dashed line is the STC contour fitted to the measured values according to ASTM E413-16. The dotted line (may be above the displayed range) is 10 dB below the flanking limit established for this facility. For any frequency band where the measured transmission loss is above the dotted line, the reported value is potentially limited by flanking transmission via laboratory surfaces, and the true value may be higher than that measured. Bars at the bottom of the graph show deficiencies where the measured data are less than the reference contour as described in the fitting procedure for the STC, defined in ASTM E413-16. The shaded cells in the table and areas in the graph are outside the STC contour range.

No. of test report:	A1-012467.2	Signature:	See signature page
Name of test institute:	National Research Council	Date:	28 March 2018

Normalized Impact Sound Pressure Levels in Accordance with ASTM E 492

Client:	CPCI	Test ID:	IIF-18-001
Date of test:	10 January, 2018	Specimen ID:	A1-004972-02F

Area S of the test element:	17.85 m^2	**Mass per unit Area:**	354 kg/m^2

Room	Volume (m^3)	Air Temperature (°C)	Relative Humidity (%)
Upper	175.1	25.1 to 25.2	30.9 to 32.1
Lower	176.9	22.0 to 22.0	37.3 to 37.6

Frequency *f* (Hz)	*NISPL* one-third octave (dB)
50	53
63	55
80	61
100	62
125	62
160	61
200	65
250	70
315	78
400	70
500	70
630	71
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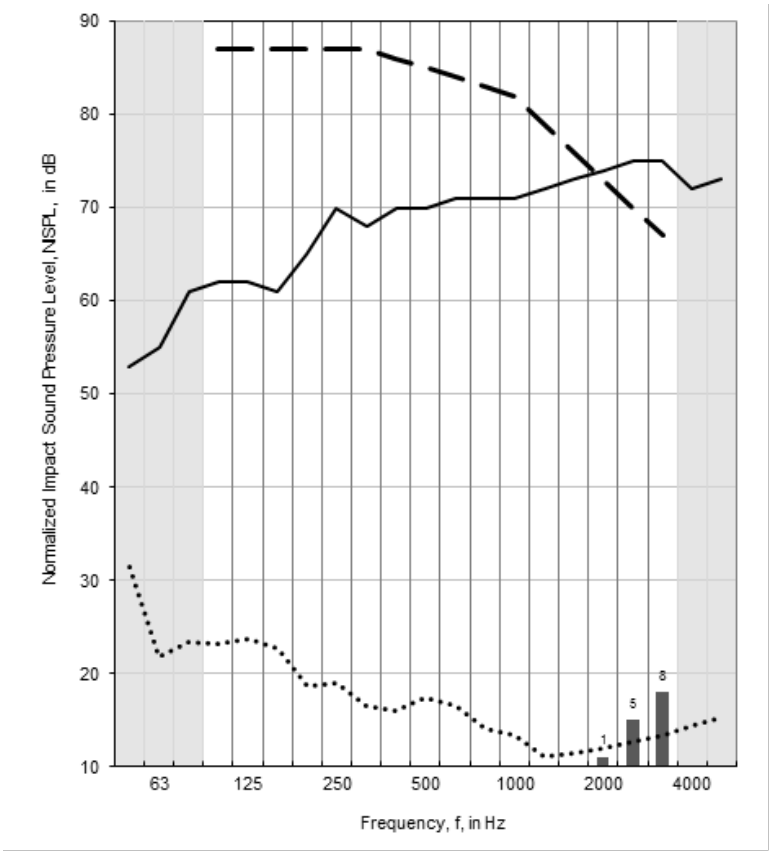
1600	73
2000	74
2500	75
3150	75
4000	72
5000	73



Sum of Positive Differences	14 dB
Maximum Positive Difference	8 dB at 3150 Hz
Impact Insulation Class (IIC)	**25**

The solid line is the measured normalized impact sound pressure level (NISPL) for this specimen. The dashed line is the IIC contour fitted to the measured values according to ASTM E989-06. The dotted line is the background sound level measured in the receiving room during this test (may be below the displayed range). For any frequency where measured NISPL is less than 10 dB above the dotted line, the reported values were adjusted as noted below. Bars at bottom of graph show positive differences; where the measured data are greater than the reference contour as defined in ASTM E989-06. Shaded cells in the table and areas in the graph are outside the IIC contour range.

No. of test report:	A1-012467.2	Signature:	See signature page
Name of test institute:	National Research Council	Date:	28 March 2018

1.4 Hollowcore slabs 203 mm thick with a mass per unit area[1] of 305 kg/m^2 with a topping of 25.4 mm (1") of floor underlayment poured directly on the slabs and a short pile carpet with pad on the underlayment

Client: Canadian Precast/Prestressed Concrete Institute

Specimen: 203 mm (8") thick floor comprised of four precast prestressed concrete hollowcore slabs with an average mass per unit area of 301 kg/m^2 grouted together with a 25.4 mm (1") underlayment poured directly on the floor. A short pile carpet with pad was installed on the underlayment.

Specimen ID: A1-012467-3F

Specimen Description:

Figure 4: Floor of 203 mm thick precast concrete hollowcore slabs with a 25.4 mm underlayment poured directly on the floor. An 8 mm underpad and a 6 mm carpet were installed on the underlayment.

Bare hollowcore: Four 1212 mm wide x 3988 mm long x 201 mm thick (average values) concrete hollowcore slabs were grouted together to form a hollowcore floor.

Grout: The edges were grouted with 75 kg of Sakrete Mortar Mix.

Perimeter: The perimeter between the specimen and the test frame was packed with sand.

Topping: 25.4 mm (1") underlayment poured directly on the floor. The underlayment had a mass per unit area of 37 kg/m^2 and a compressive strength of 1.02 to 1.32 kg/m^2 (3500 psi to 4500 psi). 6 mm (1/4") carpet 0.62 kg/m (20 oz/yd) with standard 8 mm (5/16") underpad.

Specimen Properties:

Element	Actual Average Thickness (mm)	Mass (kg)	Mass per unit area (kg/m^2)
203 mm thick concrete hollowcore slabs	203	5809	301
Sakrete mortar mix		75	4
25.4 mm underlayment	25	951	49
8 mm underpad	8	16	0.8
6 mm carpet	6	41	2.1
Total		6892	357

Test Specimen Installation

- The test specimen was mounted in the NRC Construction acoustic floor test frame opening which measures 4.71 m x 3.79 m.
- The area used for the calculations of the airborne sound transmission loss was the specimen opening area of 17.85 m^2. The area used for mass per area for the floor elements is 19.32 m^2 (4.88 m x 3.96 m).

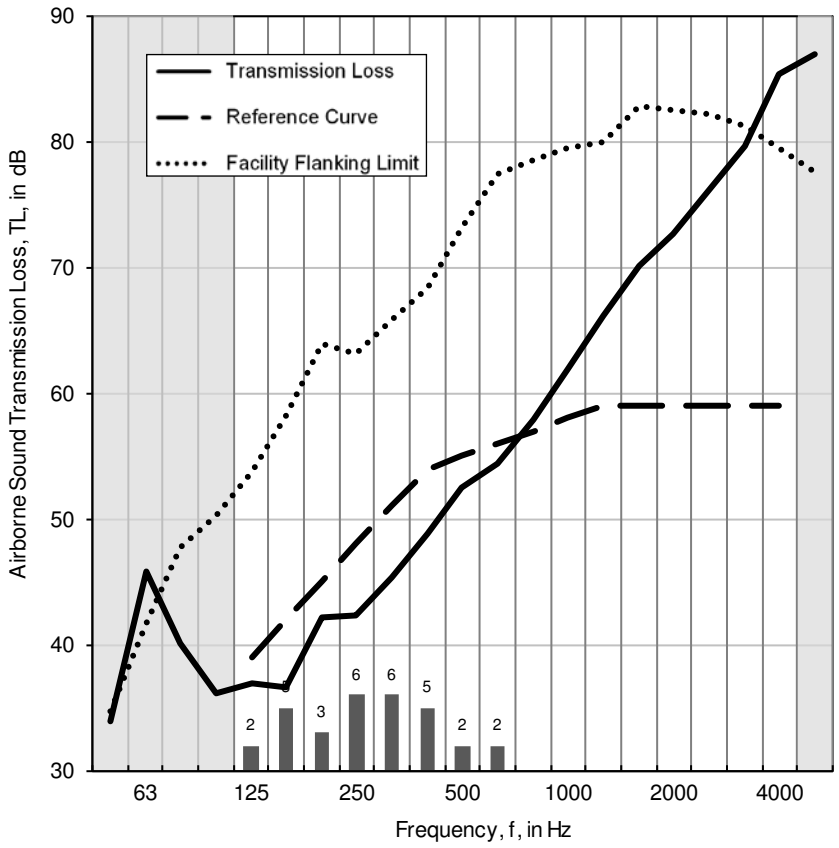
Airborne Sound Transmission Loss, *TL*, in Accordance with ASTM E 90

Client:	CPCI	Test ID:	TLF-18-002
Date of test:	11 January, 2018	Specimen ID:	A1-012467-3F

Area S of the test element:	17.85 m^2	**Mass per unit Area:**	357 kg/m^2

Room	Volume (m^3)	Air Temperature (ºC)	Relative Humidity (%)
Upper	175.1	24.4 to 24.5	31.8 to 31.9
Lower	176.9	22.1 to 22.1	33.6 to 33.6

Frequency *f* (Hz)	*TL* one-third octave (dB)
50	34*
63	46*
80	40
100	36
125	37
160	37
200	42
250	42
315	45
400	49
500	53
630	54
800	58
1000	62
1250	66
1600	70
2000	73
2500	76
3150	80*
4000	85*
5000	87*



Sum of Deficiencies	31 dB
Maximum Deficiency	6 dB at 250 Hz and 315 Hz
Sound Transmission Class (STC)	**55**

The solid line is the measured sound transmission loss for this specimen. The dashed line is the STC contour fitted to the measured values according to ASTM E413-16. The dotted line (may be above the displayed range) is 10 dB below the flanking limit established for this facility. For any frequency band where the measured transmission loss is above the dotted line, the reported value is potentially limited by flanking transmission via laboratory surfaces, and the true value may be higher than that measured. Bars at the bottom of the graph show deficiencies where the measured data are less than the reference contour as described in the fitting procedure for the STC, defined in ASTM E413-16. The shaded cells in the table and areas in the graph are outside the STC contour range.

No. of test report:	A1-012467.2	Signature:	See signature page
Name of test institute:	National Research Council	Date:	28 March 2018

Normalized Impact Sound Pressure Levels in Accordance with ASTM E 492

Client:	CPCI	Test ID:	IIF-18-002
Date of test:	11 January, 2018	Specimen ID:	A1-004972-03F

Area S of the test element:	17.85 m^2	**Mass per unit Area:**	357 kg/m^2

Room	Volume (m^3)	Air Temperature (°C)	Relative Humidity (%)
Upper	175.1	24.9 to 25.0	31.7 to 33.1
Lower	176.9	22.1 to 22.1	33.7 to 33.8

Frequency *f* (Hz)	*NISPL* one-third octave (dB)
50	48
63	47
80	48
100	48 c
125	42 c
160	33 *
200	36 c
250	39
315	37
400	35
500	34
630	30
800	21 c
1000	17 *
1250	14 *
1600	12 *
2000	12 *
2500	13 *
3150	14 *
4000	15 *
5000	17 *

Sum of Positive Differences	10 dB
Maximum Positive Difference	8 dB at 100 Hz
Impact Insulation Class (IIC)	**72**

The solid line is the measured normalized impact sound pressure level (NISPL) for this specimen. The dashed line is the IIC contour fitted to the measured values according to ASTM E989-06. The dotted line is the background sound level measured in the receiving room during this test (may be below the displayed range). For any frequency where measured NISPL is less than 10 dB above the dotted line, the reported values were adjusted as noted below. Bars at bottom of graph show positive differences; where the measured data are greater than the reference contour as defined in ASTM E989-06. Shaded cells in the table and areas in the graph are outside the IIC contour range.

No. of test report:	A1-012467.2	Signature:	See signature page
Name of test institute:	National Research Council	Date:	28 March 2018

1.5 Footnotes

1. The mass per unit area given in this report is for the individual precast/prestressed concrete hollowcore slabs. The mass per unit area of a floor built from the slabs will have a higher mass per unit area due to the mass of the grout used to fill the keyways. It is the higher mass per unit area that is used to calculate the ASTC rating of constructions which include precast/prestressed concrete hollowcore slabs such as the research report, *RR-331 Guide to calculating airborne sound transmission in buildings* [1].

2. Discussion

The transmission loss values for the floors are compared in Figure 5. Also shown in the figure is the transmission loss for a concrete hollowcore floor with a mass per unit area of 344 kg/m^2 which was measured as part of an earlier study [2].

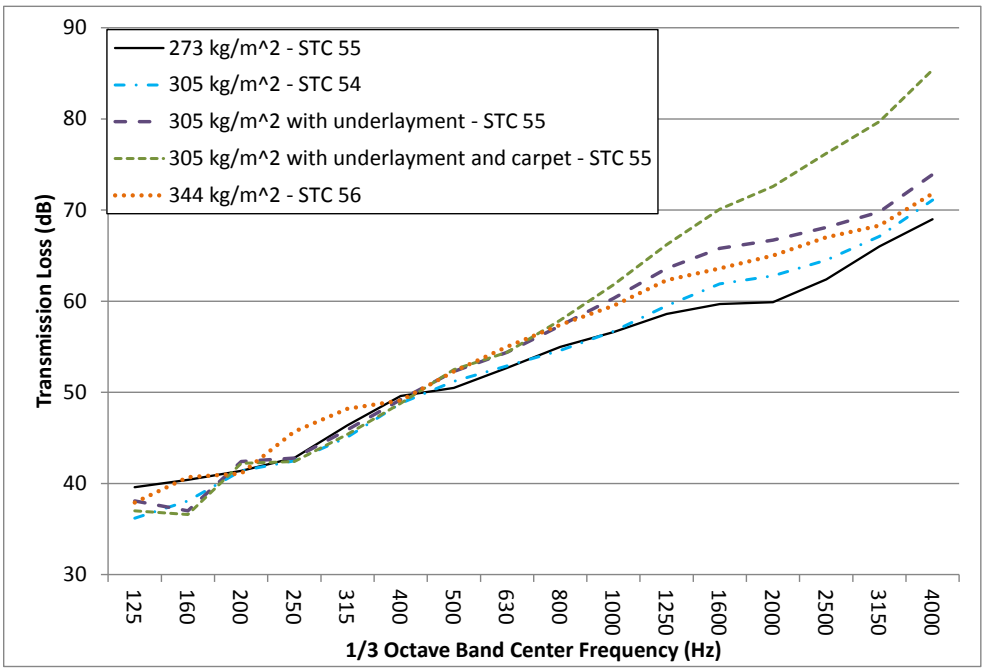


Figure 5: Comparison between the transmission loss curves for the different concrete hollowcore floors which were tested.

The 273 kg/m^2 concrete hollowcore floor had an STC rating of 55 whereas the heavier 305 kg/m^2 concrete hollowcore floor had a STC rating of 54 which was unexpected. As the curves in Figure 5 show, the 305 kg/m^2 concrete hollowcore floor had a dip in the 160 Hz 1/3 octave band, most likely corresponding to the critical frequency of the slabs whereas the 276 kg/m^2 concrete hollowcore does not. This dip resulted in a lower STC rating for the heavier floor.

At the frequencies above the 200 Hz 1/3 octave band, the heavier the concrete hollowcore floor, the better the transmission loss, but the STC rating does not capture this since the rating is driven by the dips in the transmission loss curves at the lower frequencies.

Also not captured by the STC rating is the improvement due to the addition of the linings. The addition of the 25.4 mm of underlayment or the underlayment and carpet did not improve the STC rating. However, Figure 5 shows that there was an improvement in the transmission loss above the 315 Hz 1/3 octave band, especially in the case of the underlay plus carpet where there was a significant increase in the transmission loss. It is expected that there would have been a bigger improvement if a lining was used between the underlayment and the concrete hollowcore floor rather than pouring the underlayment directly on the concrete hollowcore floor.

References

[1] Hoeller C, Quirt, D., Mahn J, NRC Research Report *RR-331: Guide to Calculating Airborne Sound Transmission in Buildings*: 3rd Edition. Ottawa, Canada: National Research Council Canada; 2017.

[2] Report A1-004972.1 - Measurements of Airborne Sound Transmission Loss (ASTM E90) and Impact Sound Transmission (ASTM E492) on One Bare Hollow Core Floor Assembly (203 mm).

Appendix A - Explanation of the transmission loss measurements

Explanation of the Data Presented in the Tables

The results in this report apply only to the specific sample submitted for measurement. No responsibility is assumed for performance of any other specimen. Airborne sound transmission loss measurements were conducted in accordance with the requirements of ASTM E90, "Standard Test Method for Laboratory Measurement of Airborne Sound Transmission Loss of Building Partitions and Elements."

ASTM E90 requires that at each measurement position in the receiving room, corrections shall be made unless the background level is more than 10 dB below the combination of signal and background. Values in the table which are followed by a "c" indicate that the measurements in the receiving room were 5 dB and 10 dB higher than the combined receiving room level and background level. The reported values have been corrected according to the procedure outlined in ASTM E90. Values marked "*" indicate that the measured background level was less than 5 dB below the combined receiving room level and background level, in which case, the corrected values provide an estimate of the lower limit of airborne sound transmission loss.

Facility and Equipment

The acoustics wall test facility comprises two reverberation rooms (referred to in this report as the upper and lower rooms) with a moveable test frame between the two rooms. In each room, a calibrated Bruel & Kjaer condenser microphone (type 4166 or 4165) with preamp is moved under computer control to nine positions, and measurements are made in both rooms using an 8-channel National Instrument NI-4472 system installed in a desktop PC-type computer. Each room has four bi-amped loudspeakers driven by separate amplifiers and noise sources. To increase the diffusivity of the sound field, there are fixed diffusing panels in each room.

Test Procedure - Transmission Loss

Airborne sound transmission measurements were conducted in accordance with the requirements of ASTM E90, "Standard Method for Laboratory Measurement of Airborne Sound Transmission Loss of Building Partitions". Airborne sound transmission loss tests were performed in the forward (receiving room is the large room) and reverse (receiving room is the small room) directions. Results presented in this report are the average of the tests in these two directions. In each case, sound transmission loss values were calculated from the average sound pressure levels of both the source and receiving rooms and the average reverberation times of the receiving room. One-third octave band sound pressure levels were measured for 32 seconds at nine microphone positions in each room and then averaged to get the average sound pressure level in each room. Five sound decays were averaged to get the reverberation time at each microphone position in the receiving room; these reverberation times were averaged to get the average reverberation times for each room. Information on the flanking limit of the facility and reference specimen test results are available on request.

Significance of Test Results - Transmission Loss

ASTM E90 requires measurements in 1/3-octave bands in the frequency range 100 Hz to 5000 Hz. Within those ranges, reproducibility has been assessed by inter-laboratory round robin studies. The standards recommend making measurements and reporting results over a larger frequency range, and this report presents such results, which may be useful for expert evaluation of the specimen performance. The precision of results outside the 100 to 5000 Hz range has not been established, but is expected to depend on laboratory-specific factors.

Sound Transmission Class (STC)

The STC rating was determined in accordance with ASTM E413-16, “Classification for Rating Sound Insulation”. The Sound Transmission Class (STC) is a single-figure rating scheme intended to rate the acoustical performance of a partition element separating offices or dwellings. The higher the value of the rating, the better the performance. The rating is intended to correlate with subjective impressions of the sound insulation provided against the sounds of speech, radio, television, music, and similar sources of noise characteristic of offices and dwellings. The STC is of limited use in applications involving noise spectra that differ markedly from those referred to above (for example, heavy machinery, power transformers, aircraft noise, motor vehicle noise). Generally, in such applications it is preferable to consider the source levels and insulation requirements for each frequency band.

Appendix B - Explanation of the impact sound transmission measurements

Test Procedure - Impact Sound Transmission

Impact sound transmission measurements were conducted in accordance with ASTM E492, “Standard Test Method for Laboratory Measurement of Impact Sound Transmission Through Floor-Ceiling Assemblies Using the Tapping Machine”. This test uses a standard tapping machine placed at four prescribed positions on the floor. 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 room; these nine reverberation times were averaged to get the spatial average reverberation times for the room. The spatial-average sound pressure levels and reverberation times of the receiving room were used to calculate Normalized Impact Sound Pressure Levels.

Significance of Test Results - Impact Sound Transmission

ASTM E492 requires measurements in 1/3-octave bands in the frequency range 100 Hz to 3150 Hz. Within this range, reproducibility has been assessed by inter-laboratory round robin studies. The standard recommends making measurements and reporting results over a larger frequency range, and this report presents such results, which may be useful for expert evaluation of the specimen performance. The precision of results outside the standard ranges has not been established, and is expected to depend on laboratory-specific factors such as room size and specimen dimensions.

Impact Insulation Class (IIC)

The Impact Insulation Class (IIC) was determined in accordance with ASTM E989, “Standard Classification for Determination of Impact Insulation Class (IIC)”. The IIC is a single-figure rating scheme intended to rate the effectiveness of floor-ceiling assemblies at preventing the transmission of impact sound from the standard tapping machine. A higher IIC value indicates a better floor performance.

In Situ Performance

Ratings obtained by this standard method tend to represent an upper limit to what might be measured in a field test, due to structure-borne transmission (“flanking”) and construction deficiencies in actual buildings.