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Acoustic Testing of a Bare Concrete Slab

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Client AMC Mecanocaucho
Pol. Industrial, Zone A - Pab 35.
Asteasu E-20159, Gipuzkoa. Spain

Specimen 150 mm (6") Precast Concrete Slab

Specimen ID A1-019524-06F

Specimen Description

Structural: The 150 mm (6”) precast concrete slab was installed in the test frame. The perimeter was sealed from below with duct putty. The perimeter was filled from above with glass fibre insulation and sealed with cloth tape.

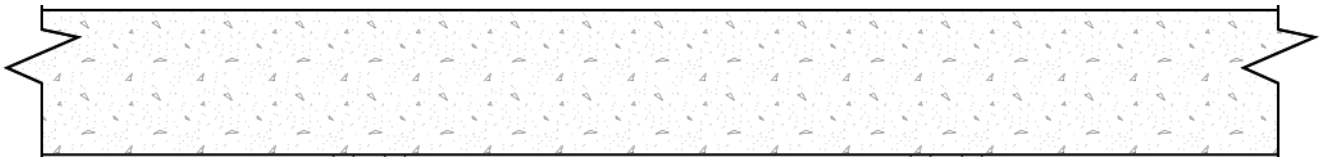


Figure 1: Cross-section of the specimen

Specimen Properties

Element	Actual thickness (mm)	Mass/length, area or volume
150 mm (6”) Precast Concrete Slab	155.6	370.6 kg/m2
Total	**155.6**	

Test Specimen Installation

- The exposed area of the floor specimen used for the calculations of the airborne sound transmission loss was 17.85 m² (4.71 m x 3.79 m)
- The total area of the floor assembly resting on the top of the lip was 19.32 m² (4.88 m x 3.96 m)
- The mass per area of the element above the lip was calculated using the total area (19.32 m²)

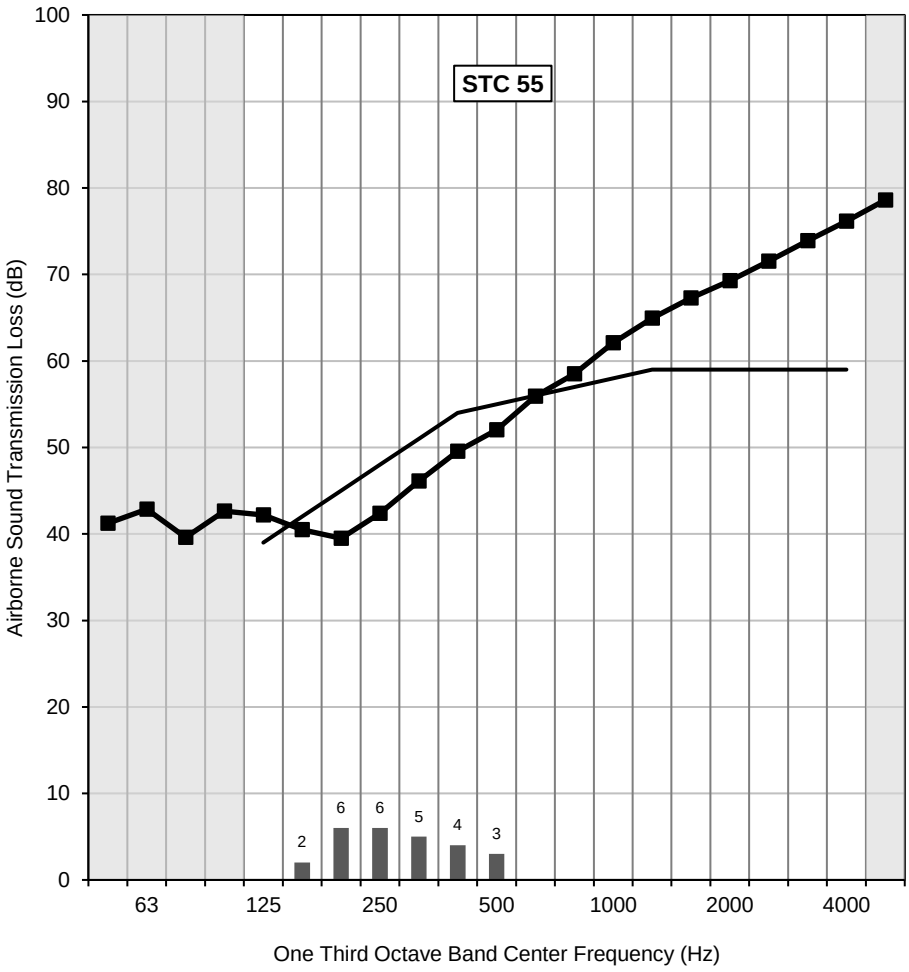
Airborne Sound Transmission Loss Measured in Accordance with ASTM E90 - 09(2016)

Client:	AMC Mecanocaucho	Test ID:	TLF-22-024
Date of Test:	02 May 2022	Specimen ID:	A1-019524-06F

Room	Volume (m^3)	Air Temperature (^oC)	Relative Humidity (%)
Upper	174.3	22.1	35.4 to 35.5
Lower	179.6	19.2	46.5 to 47.4

Frequency (Hz)	*TL* (dB)
50	41
63	43
80	40
100	43
125	42
160	40
200	39
250	42
315	46
400	50
500	52
630	56
800	59
1000	62
1250	65
1600	67
2000	69
2500	72
3150	74
4000	76
5000	79

Sum of Deficiencies	26
Maximum Deficiency	6 dB at 200 Hz and 250 Hz
Sound Transmission Class (STC)	**55**



The measurement of the airborne sound transmission loss was conducted in full accordance with the requirements of ASTM E90 - 09(2016), "Standard Test Method for Laboratory Measurement of Airborne Sound Transmission Loss of Building Partitions and Elements". The values are an average of transmission directions. The test results in this report are only applicable for the specific test specimen described in this report. Changes to the components or to the assembly may change the results. No responsibility is assumed for the performance of any specimen other than that described in this report.

Notes on the Figure: The reference contour (solid line) is fitted to the transmission loss data (symbols + line) in accordance with ASTM E413-22. The 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 E413-22. The shaded areas in the figure and table are outside of the frequency range of the measurement standard and are presented for reference only.

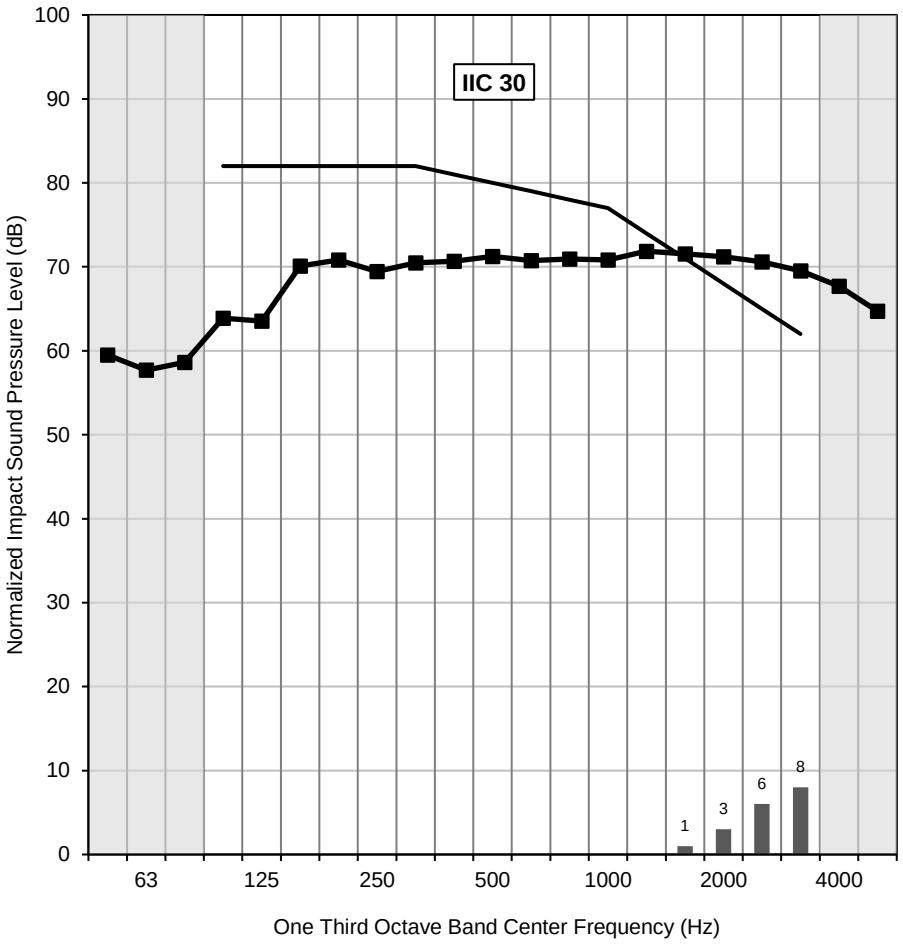
Notes on the Table: The values marked "c" indicate that the measured background level was between 5 dB and 10 dB below the combined receiving room level and background level and the reported values were corrected according to the procedure outlined in ASTM E90 -09(2016). Values marked "*" indicate that the measured background level was less than 5 dB below the combined receiving room level and background level and therefore, the values only provide an estimate of the lower limit of the sound transmission loss.

Impact Sound Transmission Measured in Accordance with ASTM E492-09(2016)e1

Client:	AMC Mecanocaucho	Test ID:	IIF-22-016
Date of Test:	02 May 2022	Specimen ID:	A1-019524-06F

Room	Volume (m^3)	Air Temperature (^oC)	Relative Humidity (%)
Upper	174.3	22.2	35.6
Lower	179.6	19.1	45.2 to 45.7

Frequency (Hz)	NISPL (dB)
50	60
63	58
80	59
100	64
125	64
160	70
200	71
250	69
315	70
400	71
500	71
630	71
800	71
1000	71
1250	72
1600	72
2000	71
2500	71
3150	70
4000	68
5000	65
Sum of Difference (dB)	18
Maximum Difference (dB)	8 dB at 3150 Hz
Impact Insulation Class (IIC)	**30**
High Impact Insulation Class (HIIC)	**30**



The measurement of the impact sound transmission was conducted in full accordance with the requirements of ASTM E492-09(2016)e1, "Standard Test Method for Laboratory Measurement of Impact Sound Transmission Through Floor-Ceiling Assemblies Using the Tapping Machine." The test results in this report are only applicable for the specific test specimen described in this report. Changes to the components or to the assembly may change the results. No responsibility is assumed for the performance of any specimen other than that described in this report.

Notes on the Figure: The reference contour (solid line) is fitted to the measurement data (symbols + line) in accordance with ASTM E989-21. The bars at the bottom of the graph show positive differences where the measured data is higher than the reference contour as described in the fitting procedure for the IIC, defined in ASTM E989-21. The positive differences are shown as bars at the bottom of the figure. The shaded areas in the figure and table are outside of the frequency range of the measurement standard and are presented for reference only.

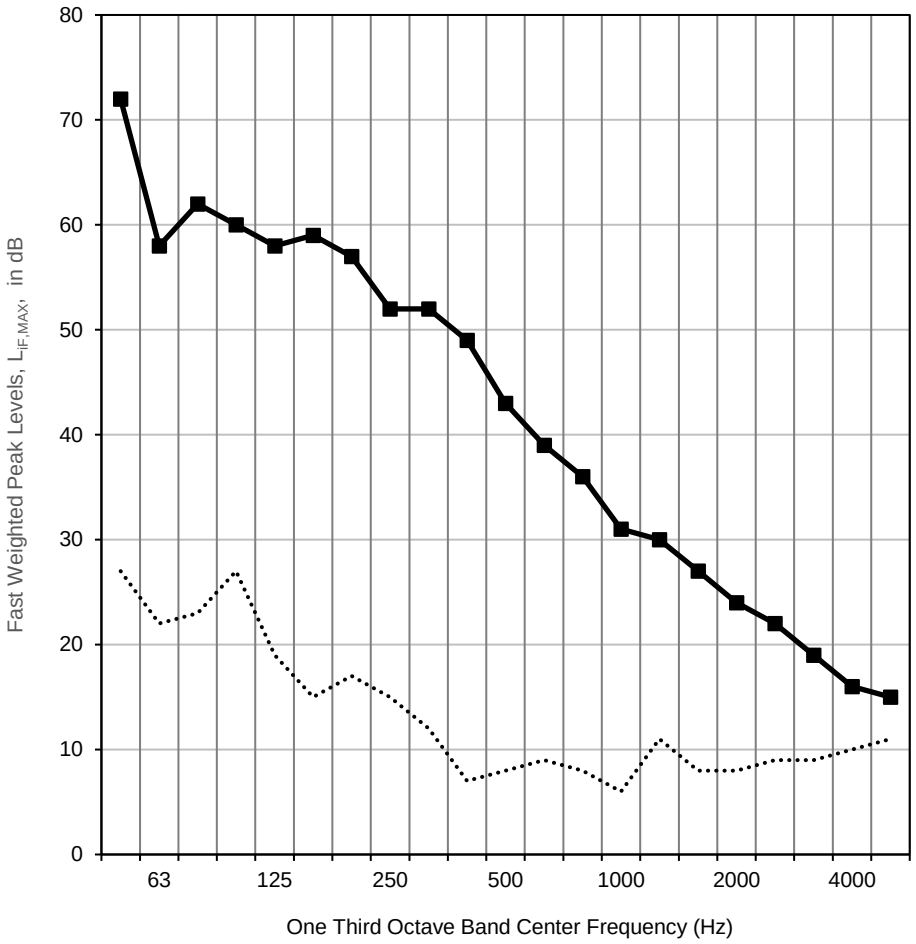
Notes on the Table: The values marked "c" indicate that the measured background level was between 5 dB and 10 dB below the combined receiving room level and background level and the reported values were corrected according to the procedure outlined in ASTM E492-09(2016)e1. Values marked "*" indicate that the measured background level was less than 5 dB below the combined receiving room level and background level and therefore, the values only provide an estimate of the upper limit of the impact sound transmission. The high-frequency impact sound insulation (HIIC) was calculated in accordance with ASTM E322-20a.

Fast Weighted Peak Levels – Heavy/Soft Impact Source (Ball)

Client:	AMC Mecanocaucho	Test ID:	HVF-22-013
Date of Test:	02 May 2022	Specimen ID:	A1-019524-06F

Room	Volume (m^3)	Air Temperature (^oC)	Relative Humidity (%)
Upper	174.3	22.2	35.7 to 36.4
Lower	179.6	19.1	45.0 to 45.3

Frequency (Hz)	$L_{iF,MAX}$ (dB)
50	72
63	58
80	62
100	60
125	58
160	59
200	57
250	52
315	52
400	49
500	43
630	39
800	36
1000	31
1250	30 c
1600	27 c
2000	24 c
2500	22 c
3150	19 c
4000	16 *
5000	15 *



For a description of the test specimen and mounting conditions see text pages before. The results in this report apply only to the specific sample submitted for measurement. No responsibility is assumed for performance of any other specimen. See appendix "Heavy Impact Sound Transmission – Floor Facility" for more details on the test procedure.

Notes on the Figure: The solid line is the measured fast weighted peak levels ($L_{iF,MAX}$) for this specimen using a heavy/soft impact source as described in Annex F of ISO 10140-5:2010. The dotted line is the background sound level measured in the receiving room during this test (may be below displayed range). For any frequency where measured $L_{iF,MAX}$ is less than 15 dB above the dotted line, the reported values were adjusted as noted below.

Notes on the Table: Values marked "c" indicate that the measured background level was between 6 dB and 15 dB below the combined receiving room level and background level. The marked values of $L_{iF,MAX}$ have been corrected according to the procedure outlined in ISO 10140-4 section 4.3. Values marked "*" indicate that the measured background level was less than 6 dB below the combined receiving room level and background level, in which case, the corrected values provide an estimate of the upper limit of $L_{iF,MAX}$.

APPENDIX: ASTM E90 - 09(2016) - Airborne Sound Transmission Loss
Floor Sound Transmission Facility

Facility and Equipment: The NRC Construction Floor Sound Transmission Facility comprises two reverberation rooms (referred to in this report as the upper and lower rooms) with a moveable test frame between the rooms. Both rooms have an approximate volume of 175 m^3. In each room, there are eight Brüel & Kjær Type 4942 pre-polarized diffuse-field ½" microphones. Data is measured with a NI PXI-4499 DAQ system with LabVIEW measurement software. Each room has four bi-amped loudspeakers driven by separate amplifiers and noise sources. There are fixed diffusing panels in each room as per the requirements of ASTM E90 - 09(2016).

Test Procedure: The airborne sound transmission measurements were conducted in accordance with the requirements of ASTM E90 - 09(2016), "Standard Test Method for Laboratory Measurement of Airborne Sound Transmission Loss of Building Partitions and Elements." The airborne sound transmission loss tests were performed in the forward (upper room to the lower room) and reverse (lower room to the upper room) directions. The results presented in this report are the average of the tests in these two directions. In each case, the 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. The sound pressure levels were measured for thirty-two seconds at eight microphone positions in each room and then averaged to determine the average sound pressure level in each room. Ten sound decays were averaged for each microphone located in the respective receiving rooms; these eight reverberation times were averaged to get the average reverberation times for each room`.

Significance of the Test Results: ASTM E90-09 requires measurements in one-third octave bands in the frequency range 100 Hz to 5000 Hz. 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 100 Hz to 5000 Hz range has not been established, but is expected to depend on laboratory-specific factors.

Sound Transmission Class (STC): The Sound Transmission Class (STC) was determined in accordance with ASTM E413-22, "Classification for Rating Sound Insulation". It is a single-number 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 or motor vehicle noise). Generally, in such applications it is preferable to consider the source levels and insulation requirements for each frequency band.

In Situ Performance: The STC rating obtained by this standard method represent an upper limit to what might be measured in a field test since they do not include the effect of sound transmission via flanking paths or the effect of possible construction deficiencies.

APPENDIX: E492-09(2016)e1 - Impact Sound Transmission Through Floor-Ceiling Assemblies Using the Tapping Machine

Facility and Equipment: The NRC Construction Floor Sound Transmission Facility comprises two reverberation rooms (referred to in this report as the upper and lower rooms) with a moveable test frame between the rooms. Both rooms have an approximate volume of 175 m^3. In each room, there are eight Brüel & Kjær Type 4942 pre-polarized diffuse-field ½" microphones. Data is measured with a NI PXI-4499 DAQ system with LabVIEW measurement software. Each room has four bi-amped loudspeakers driven by separate amplifiers and noise sources. There are fixed diffusing panels in each room as per the requirements of ASTM E90 - 09(2016).

Test Procedure: The impact sound transmission measurements were conducted in accordance with E492-09(2016)e1, "Standard Test Method for Laboratory Measurement of Impact Sound Transmission through Floor-Ceiling Assemblies Using the Tapping Machine." This method uses a standard tapping machine placed at four prescribed positions on the floor. The sound pressure levels were measured for thirty-two seconds at eight microphone positions in the receiving room and then averaged to determine the average sound pressure level in the room. Ten sound decays were averaged for each microphone located in the respective receiving rooms; these eight reverberation times were averaged to get the average reverberation times for each room. The spatial average sound pressure levels and reverberation times of the receiving room were used to calculate the Normalized Impact Sound Pressure Levels.

Significance of the Test Results: E492-09(2016)e1 requires measurements in one-third octave bands in the frequency range 100 Hz to 3150 Hz. 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 E989-21, "Standard Classification for Determination of Single-Number Metrics for Impact Noise". It is a single-number 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.

High-frequency Impact Insulation Class (HIIC): The High-frequency Impact Insulation class (HIIC) was determined in accordance with ASTM E3222-20a, "Standard Classification for Determination of High-frequency Impact Sound Ratings." It is a single number rating intended to represent the behavior of the floor assembly at the high frequencies (400 Hz to 3150 Hz) where the impact sound insulation is typically determined by the characteristics of the floor topping. A higher HIIC value indicates a better performance.

In Situ Performance: The STC and IIC ratings obtained by this standard method represent an upper limit to what might be measured in a field test since they do not include the effect of sound transmission via flanking paths or the effect of possible construction deficiencies.

APPENDIX: Heavy Impact Sound Transmission – Floor Facility

Facility and Equipment: The NRC Construction Floor Sound Transmission Facility comprises two reverberation rooms (referred to in this report as the upper and lower rooms) with a moveable test frame between the rooms. Both rooms have an approximate volume of 175 m^3. In each room, there are eight Brüel & Kjær Type 4942 pre-polarized diffuse-field ½" microphones. Data is measured with a NI PXI-4499 DAQ system with LabVIEW measurement software. Each room has four bi-amped loudspeakers driven by separate amplifiers and noise sources. There are fixed diffusing panels in each room as per the requirements of ASTM E90 - 09(2016).

Test Procedure: Impact tests were conducted following the recommendations in ISO 10140-3:2010 Annex A. A heavy/soft impact source described in Annex F of ISO 10140-5:2010 was dropped from a height of 100 cm over 5 different positions, on quarter lengths of both floor diagonals and in the centre of the room. Receive levels in the room below were measured simultaneously at 8 different microphone positions as fast-weighted (125 ms) peak levels in one-third octave bands ($\mathbf{L_{iF,MAX}}$). The $\mathbf{L_{iF,MAX}}$ values measured at the different microphone positions were energy averaged for each excitation position. Then, the calculated fast weighted peak levels of all excitation positions were also energy averaged. One-third octave band background sound pressure levels were measured for 32 seconds at each microphone position in the receiving room and then averaged to get the average background sound pressure level in the room.

Significance of Test Results: The precision of results has not been established, and is expected to depend on laboratory-specific factors such as room size, sound absorption and specimen dimensions. The results are specific to the room in which they were measured, and an increase in volume and/or sound absorption reduces the measured fast weighted levels.

In Situ Performance: Levels obtained by this method tend to represent an upper limit to what might be measured in a field test with the same volume and absorption, due to structure-borne transmission (“flanking”) and construction deficiencies in actual buildings.