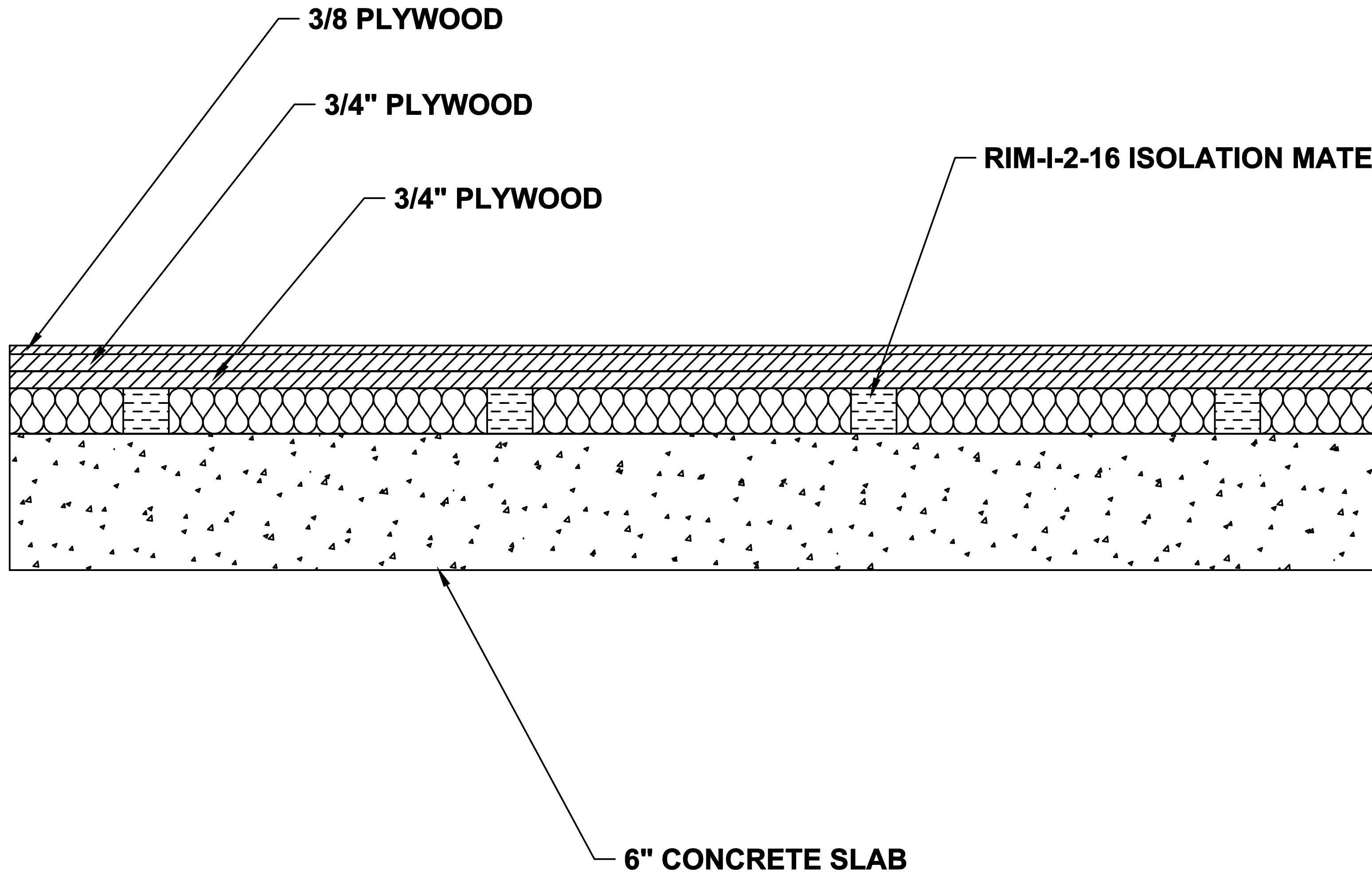
# STC 66
# IIC 63




| KINETICS Noise Control | TITLE<br>TEST A15-a | LAST DATE REVISED<br>11-08-04 | REVISED BY<br>JAE | DRAWING NO.<br>A15-a |
|---|---|---|---|---|

National Research Council Canada
Conseil national de recherches Canada

NRC·CNRC

# Client Report

B-3140.1

## Airborne and Impact Sound Transmission Measurements Performed on Specimen B3140-1

for

Kinetics Noise Control
6300 Irelan Place
P.O. Box 655
Dublin, OH
43017-0655

02 November 1999

Institute for Research in Construction IRC

# Airborne and Impact Sound Transmission Measurements Performed on Specimen B3140-1

Author

J.A. Birta

Quality Assurance

A.C.C. Warnock

Approved

M.R. Atif
Director, Indoor Environment

Report No: B-3140.1
Report Date: November 2 1999
Contract No: B-3140
Reference: Agreement dated June 11 1999
Program: Indoor Environment

13 pages
Copy No. 4 of 4 copies

## INTRODUCTION

Airborne and impact sound transmission measurements were performed on a floor assembly which comprised 9.5 mm thick plywood, building paper sandwiched between two layers of 19 mm plywood, Kinetics Noise Control RIM-I-2-16 Rollout Isolation Material and a 146 mm thick concrete slab. For report purposes, this specimen is identified as Specimen B3140-1. 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 27.4°C and 62.1%, respectively. The measured temperature and relative humidity in the lower chamber during testing 26.0°C and 50.5%, 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.

In addition to the requirements of this contract, calculations were made according to ISO 717, Rating of sound insulation in buildings and building elements. - Part 2 : Impact sound insulation. These calculations are summarized in the Additional Calculations Section.

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 27-Aug-99. The airborne sound transmission loss tests were performed on 07-Sept-99. The floor assembly comprised the following elements, listed from top to bottom.

Table 1: Element breakdown of Specimen B3140-1.

| Element | Surface weight ($kg/m^2$) | Mass (kg) |
|---|---|---|
| 9.5 mm plywood | 4.5 | 88.0 |
| 19 mm plywood | 8.5 | 170.3 |
| 1 mm #30 Builders Felt | 0.8 | 15.2 |
| 19 mm plywood | 8.3 | 162.6 |
| 50 mm Kinetics Noise Control RIM-I-2-16 Rollout Isolation Material (including KIP-22I2 isolator pads) | 1.2 | 18.8 |
| 146 mm thick concrete slab | 356.3 | 7029.5 |
| **TOTAL** | | **7484.4** |

Total thickness: 244.5 mm

The 146 mm concrete reference slab, provided by NRC, was installed in the floor test frame. A roll of yellow glass fibre insulation with 51 mm square greenish pads imbedded into it was laid on top of the concrete. This insulation was identified by the client as Kinetics Noise Control RIM-I-2-16 Rollout Isolation Material (including KIP-22I2 isolator pads). The side of the pads which were stamped “top” were face up.

A layer of 19 mm thick spruce plywood was installed on top of the insulation. #30 Builders Felt was laid on top of the plywood. A second layer of 19 mm spruce plywood was installed on top of the Builders Felt. This top layer of 19 mm plywood was installed perpendicular to the bottom layer of 19 mm plywood and had the plywood joints staggered a minimum of 305 mm from the bottom layer of 19 mm plywood. 32 mm long Type G (coarse thread) drywall screws were used to attach the two layers of 19 mm plywood and Builders Felt together. The screws were spaced 203 mm on center.

A layer of 9.5 mm fir plywood was installed perpendicular to the top layer of 19 mm plywood with adhesive supplied by the client. The adhesive was identified by the client as "Franklin 711 Flooring Adhesive". A 5 mm wide x 6 mm deep C-C-V notch trowel, supplied by the client, was used to spread the glue.

## RESULTS

Results of the airborne sound transmission loss measurements of Specimen B3140-1 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

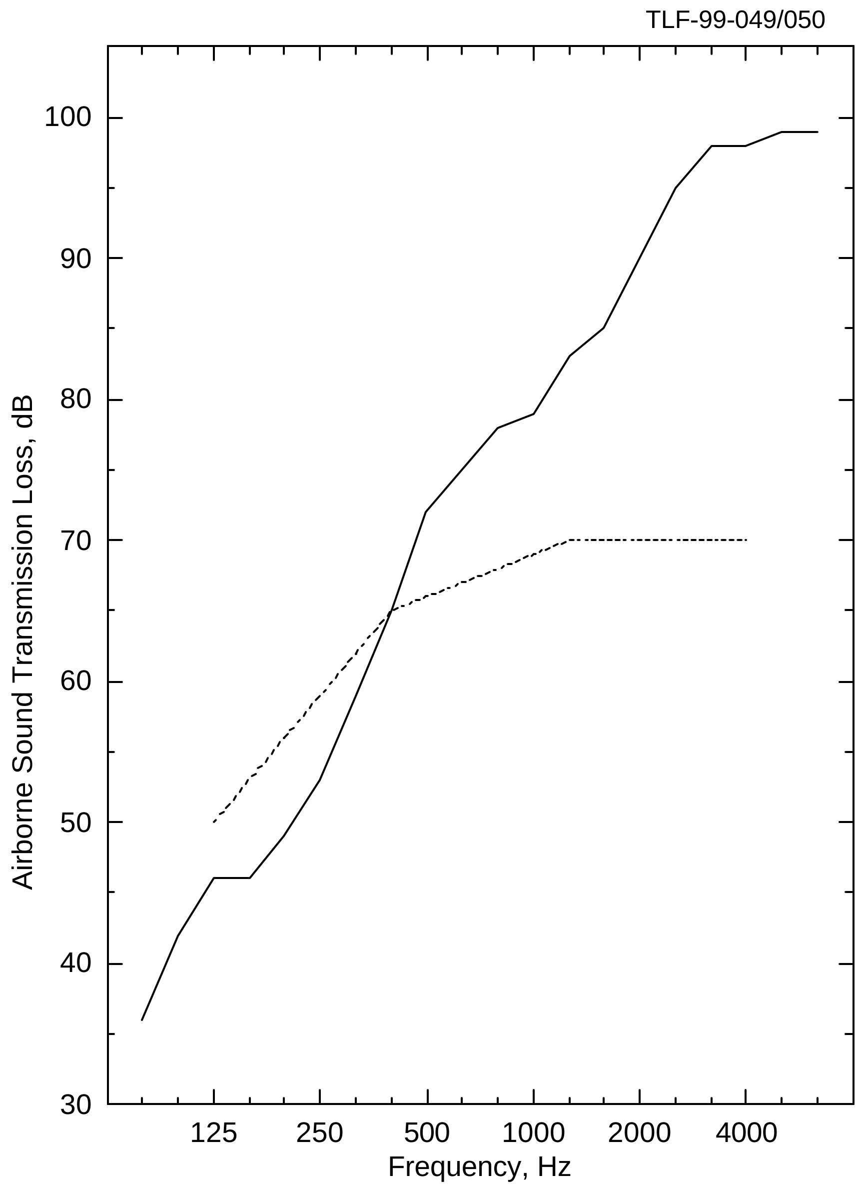
Table 2: Airborne sound transmission loss measurements of Specimen B3140-1, TLF-99-049/050.

| Frequency (Hz) | Airborne Sound Transmission Loss (dB) | 95% Confidence Limit[1] | Deviation Below the STC Contour |
|---|---|---|---|
| 80 | 36 | ±2.3 | |
| 100 | 42 | ±1.9 | |
| 125 | 46 | ±1.2 | 4 |
| 160 | 46 | ±1.1 | 7 |
| 200 | 49 | ±0.9 | 7 |
| 250 | 53 | ±0.7 | 6 |
| 315 | 59 | ±0.5 | 3 |
| 400 | 65 | ±0.5 | |
| 500 | 72 | ±0.4 | |
| 630 | 75 | ±0.4 | |
| 800 | 78 | ±0.3 | |
| 1000 | 79 | ±0.3 | |
| 1250 | 83 | ±0.3 | |
| 1600 | 85 | ±0.2 | |
| 2000 | 90 c | ±0.3 | |
| 2500 | 95 c | ±0.3 | |
| 3150 | 98 * | ±0.3 | |
| 4000 | 98 * | ±0.3 | |
| 5000 | 99 * | ±0.3 | |
| 6300 | 99 * | ±0.5 | |
| Sound Transmission Class (STC)[2] = 66 | | | |
| Weighted Sound Reduction ($R_W$)[3] = 66 | | | |

[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 | 36 | |
| 100 | 42 | |
| 125 | 46 | |
| 160 | 46 | |
| 200 | 49 | |
| 250 | 53 | |
| 315 | 59 | |
| 400 | 65 | |
| 500 | 72 | |
| 630 | 75 | |
| 800 | 78 | |
| 1000 | 79 | |
| 1250 | 83 | |
| 1600 | 85 | |
| 2000 | 90 | c |
| 2500 | 95 | c |
| 3150 | 98 | * |
| 4000 | 98 | * |
| 5000 | 99 | * |
| 6300 | 99 | * |

STC 66

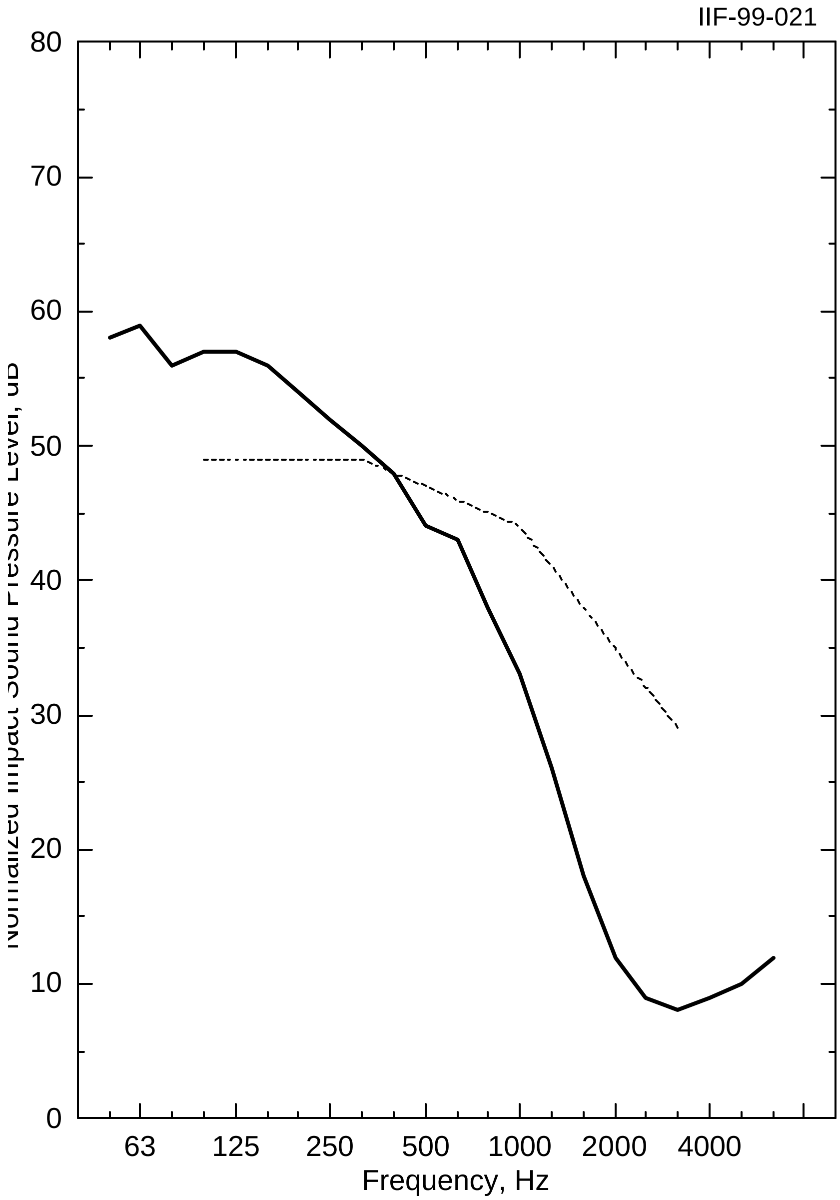
Figure 1: Airborne sound transmission loss measurements of a Specimen B3140-1. The solid line is the experimental data and the dotted line is the STC 66 contour.

Table 3: Impact sound transmission measurements of Specimen B3140-1, IIF-99-021.

| Frequency (Hz) | Normalized Impact Sound Pressure Level (dB) | 95% Confidence Limit[1] | Deviation Above the IIC Contour |
|---|---|---|---|
| 50 | 58 | ±2.0 | |
| 63 | 59 | ±2.0 | |
| 80 | 56 | ±0.9 | |
| 100 | 57 | ±1.0 | 8 |
| 125 | 57 | ±0.6 | 8 |
| 160 | 56 | ±0.5 | 7 |
| 200 | 54 | ±0.4 | 5 |
| 250 | 52 | ±0.3 | 3 |
| 315 | 50 | ±0.3 | 1 |
| 400 | 48 | ±0.2 | |
| 500 | 44 | ±0.1 | |
| 630 | 43 | ±0.2 | |
| 800 | 38 | ±0.1 | |
| 1000 | 33 | ±0.1 | |
| 1250 | 26 | ±0.2 | |
| 1600 | 18 | ±0.1 | |
| 2000 | 12 * | ±0.1 | |
| 2500 | 9 * | ±0.1 | |
| 3150 | 8 * | ±0.1 | |
| 4000 | 9 * | ±0.0 | |
| 5000 | 10 * | ±0.0 | |
| 6300 | 12 * | ±0.0 | |
| Impact Insulation Class (IIC)[4] = 63 | | | |
| Weighted Normalized Impact Sound Pressure Level ($L_{n,w}$)[5] = 48 | | | |

[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 | 58 | |
| 63 | 59 | |
| 80 | 56 | |
| 100 | 57 | |
| 125 | 57 | |
| 160 | 56 | |
| 200 | 54 | |
| 250 | 52 | |
| 315 | 50 | |
| 400 | 48 | |
| 500 | 44 | |
| 630 | 43 | |
| 800 | 38 | |
| 1000 | 33 | |
| 1250 | 26 | |
| 1600 | 18 | |
| 2000 | 12 | * |
| 2500 | 9 | * |
| 3150 | 8 | * |
| 4000 | 9 | * |
| 5000 | 10 | * |
| 6300 | 12 | * |

IIC 63

Figure 2: Impact sound transmission measurements of Specimen B3140-1. The solid line is the experimental data and the dotted line is the IIC 63 contour.

## ADDITIONAL CALCULATIONS

In addition to the requirements of this contract, calculations were made according to ISO 717 Rating of sound insulation in buildings and building elements. - Part 2: Impact sound insulation.

The calculations for evaluating the weighted impact sound improvement index of floor coverings are shown in the tables below.

The ISO 717 impact sound rating is called the weighted normalized impact sound pressure level and is denoted $L_{n,w}$. The rating curve is identical to that used in calculating the ASTM IIC rating. The sole difference in the fitting procedure is that the ISO standard allows unfavorable deviations to exceed 8 dB; the ASTM E989 standard does not. When this 8 dB limitation is not invoked, the two ratings are related by the equation

$$IIC = 110 - L_{n,w}$$

The ISO reference slab has an IIC rating of 28 and $L_{n,w}$ = 78 dB.

Table 4 shows the reduction in normalized impact sound pressure level relative to the 146 mm concrete slab for the specimen tested. Following the procedures in ISO 717, these differences were added to the impact sound levels for the idealized reference floor in that standard. The levels for the reference floor and the estimated levels for the specimen are shown in Table 5. $L_{n,w,r}$ in that table is the estimated value of normalized impact sound pressure level for the tested toppings on the reference ISO slab. ?$L_w$ is the improvement in weighted normalized impact sound pressure level. This number is not equal to the improvement in IIC because the 8 dB rule was applied when calculating the IIC for the bare 146 mm thick IRC concrete slab.

Table 4: Reduction in normalized impact sound pressure level relative to the 146 mm concrete slab.

| Frequency (Hz) | Specimen B3140-1 |
|---|---|
| 50 | 2.0 |
| 63 | -2.2 |
| 80 | 6.3 |
| 100 | 6.9 |
| 125 | 9.7 |
| 160 | 14.2 |
| 200 | 17.9 |
| 250 | 21.7 |
| 315 | 23.8 |
| 400 | 27.3 |
| 500 | 32.0 |
| 630 | 33.1 |
| 800 | 37.2 |
| 1000 | 41.7 |
| 1250 | 49.2 |
| 1600 | 57.0 |
| 2000 | 62.5 |
| 2500 | 64.9 |
| 3150 | 66.0 |

Table 5: Estimated levels using the ISO Reference Floor.

| Frequency (Hz) | ISO Reference Floor | Specimen B3140-1 |
|---|---|---|
| 100 | 67.0 | 60.1 |
| 125 | 67.5 | 57.8 |
| 160 | 68.0 | 53.8 |
| 200 | 68.5 | 50.6 |
| 250 | 69.0 | 47.3 |
| 315 | 69.5 | 45.7 |
| 400 | 70.0 | 42.7 |
| 500 | 70.5 | 38.5 |
| 630 | 71.0 | 37.9 |
| 800 | 71.5 | 34.3 |
| 1000 | 72.0 | 30.3 |
| 1250 | 72.0 | 22.8 |
| 1600 | 72.0 | 15.0 |
| 2000 | 72.0 | 9.5 |
| 2500 | 72.0 | 7.1 |
| 3150 | 72.0 | 6.0 |
| $L_{n,w,r}$ | 78 | 46 |
| $\Delta L_w$ | - | 32 |
| $IIC_{est}$ | 28 | 60 |

## 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 rank 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 rank the effectiveness of floor-ceiling assemblies at preventing the transmission of impact sound from the standard tapping machine. The *higher* the value of the IIC rating, the better the floor performance. The *lower* the value of the $L_{n,w}$ rating, the better the floor performance.

### ***Reduction in Weighted Impact Sound Pressure Level***

The reduction in weighted normalized impact sound pressure level, $\Delta L_w$, is a single figure rating intended to rank the effectiveness of floor coverings at preventing the transmission of impact sound from the standard tapping machine. The higher the value of the rating, the greater the reduction in impact sound pressure level due to the covering. The number is approximately the change in IIC or $L_{n,w}$ that would occur if the topping were placed on top of any concrete slab.