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Standard Test Method for Laboratory Measurement of the Effectiveness of Floor Coverings in Reducing Impact Sound Transmission Through Concrete Floors[1]

This standard is issued under the fixed designation E 2179; the number immediately following the designation indicates the year of original adoption or, in the case of revision, the year of last revision. A number in parentheses indicates the year of last reapproval. A superscript epsilon (ε) indicates an editorial change since the last revision or reapproval.

ε[1] NOTE—Sections 4.2 and 4.3 were editorially revised and section 12.1.3 was editorially added in September 2003.

INTRODUCTION

This test method is part of a set for evaluating the sound-insulating properties of building elements. It is designed to measure the reduction in transmission of impact sound due to a floor covering in a laboratory. Others in the set include the measurement of sound isolation in buildings (Test MethodE 336), the laboratory methods of measuring airborne sound transmisssion loss of building partitions such as walls, floor-ceiling assemblies, doors, and other space-dividing elements (Test Method E 90); the laboratory measurement of impact sound transmission through floors (Test Method E 492), the measurement of impact sound transmission in buildings (Test Method E 1007), the measurement of sound transmission through building facades and facade elements (Guide E 966), and the measurement of sound transmission through a common plenum between two rooms (Method E 1414).

1. Scope

1.1 This test method describes a method for the laboratory measurement of the effectiveness of floor coverings in reducing impact noise from a standard tapping machine through concrete floors. The test results are not necessarily directly related to the subjective evaluations of the floor coverings.

1.2 This test method applies to all floor coverings, whether single or multi-layered, as installed on a standard concrete floor. Multi-layered coverings may be factory-assembled or assembled at the test laboratory.

1.3 The test method applies only to laboratory measurements. It does not apply to the measurement of the effectiveness of a floor covering in a field situation.

1.4 *Laboratory Accreditation*—A procedure for accrediting a laboratory for performing this test method is given in Method E 492.

1.5 *This standard does not purport to address all of the safety concerns, if any, associated with its use. It is the responsibility of the user of this standard to establish appropriate safety and health practices and determine the applicability of regulatory limitations prior to use.*

2. Referenced Documents

2.1 *ASTM Standards:*

C 634 Terminology Relating to Environmental Acoustics[2]

E 90 Test Method for Laboratory Measurement of Airborne Sound Transmission Loss of Building Partitions and Elements[2]

E 336 Test Method for Measurement of Airborne Sound Insulation In Buildings[2]

E 492 Test Method for Laboratory Measurement of Impact Sound Transmission through Floor-Ceiling Assemblies Using the Tapping Machine[2]

E 966 Guide for Field Measurements of Airborne Sound Insulation of Building Facades and Facade Elements

E 989 Classification for Determination of Impact Insulation Class (IIC)[2]

E 1007 Test Method for Field Measurement of Tapping Machine Impact Sound Transmission Through Floor-Ceiling Assemblies and Associated Support Structures[2]

E 1414 Test Method for Airborne Sound Attenuation Between Rooms Sharing a Common Ceiling Plenum[2]

2.2 *ANSI Standards:*

S1.6 Standard Preferred Frequencies, Frequency Levels, and Band Numbers for Acoustical Measurements

S1.10 Pressure Calibration of Laboratory Standard Pressure Microphones

[1] This test method is under the jurisdiction of ASTM Committee E33 on Environmental Acoustics and is the direct responsibility of Subcommittee E33.03 on Sound Transmission.

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[2] *Annual Book of ASTM Standards,* Vol 04.06

S1.11 Specification for Octave-band and Fractional-Octave-Band Analog and Digital Filters

2.3 *ISO Standards:*

ISO 717-2 Rating of Sound Insulation in Buildings and of Building Elements—Part 2: Impact Sound Insulation

ISO 140-6 Acoustics—Measurement of Sound Insulation in Buildings and of Building Elements—Part 6: Laboratory Measurements of Impact Sound Insulation of Floors

ISO 140-8 Acoustics Measurement of Sound Insulation in Buildings and of Building Elements—Part 8: Laboratory Measurements of the Reduction of Transmitted Impact Noise by Floor Coverings on a Heavyweight Floor

3. Terminology

3.1 Definitions of the acoustical terms used in this test method are given in Terminology C 634.

3.2 *Descriptions of Terms Specific to This Standard:*

3.2.1 *floor covering*—any resilient material, combination of resilient materials or combination of resilient material and rigid materials used to provide a finished walking surface on a floor. This includes all materials between the upper walking surface and the base concrete slab.

3.2.2 *reference concrete floor*—a hypothetical concrete floor used to calculate changes in impact insulation class (Δ*IIC*).

3.2.3 *standard concrete floor*—the actual concrete floor satisfying the provisions of this method used in the measurements.

4. Summary of Test Method

4.1 Two vertically adjacent rooms are used: the upper one being designated the source room and the lower one the receiving room. A standard concrete floor is installed in an opening between them. The rooms and the floor installation are designed so the only significant sound radiation into the receiving room is from the standard concrete floor.

4.2 A standard tapping machine is installed and activated on the standard concrete floor and the normalized impact sound pressure levels are measured in the room below. The floor covering to be evaluated is then installed on the standard concrete floor and the normalized impact sound pressure levels measured again.

4.3 The differences in normalized impact sound pressure level are subtracted from the levels defined for a reference concrete floor and an IIC rating is calculated for the resultant array. This is the IIC that the covering would produce in combination with the reference concrete floor. The second rating, ΔIIC, is obtained by subtracting 28 from the first (28 is the IIC for the reference concrete floor). This gives the improvement in IIC that the covering would produce on the reference concrete floor.

5. Significance and Use

5.1 The impact sound rating for a floor assembly is determined both by the basic floor assembly and the floor covering on the upper surface. The same floor covering in combination with different basic floor assemblies will not always give the same impact insulation class (IIC) ratings. This test method is designed to provide data that characterize the floor covering alone when installed over concrete slab floors.

5.2 The Δ*IIC* rating calculated in 13.4 is used to compare the effectiveness of different floor coverings on concrete floors.

5.3 The impact insulation class (IIC) calculated for the reference concrete floor with a covering provides an indication of the impact sound insulation that the covering will provide with typical, monolithic concrete floors.

5.4 When the normalized impact sound pressure levels below a bare concrete slab are known, the difference spectrum calculated in 13.1 may be used to estimate the impact sound pressure levels and hence the IIC that would result if the covering were installed on the slab.

5.5 **Warning:** Difference spectra measured using this method shall not be used to estimate impact sound pressure levels for floors comprising only one or two lightweight floor layers such as oriented strandboard or plywood. Such estimated impact sound pressure levels would be very inaccurate.

NOTE 1—The difference spectrum calculated in 13.1 gives unreliable estimates of the reduction in impact sound pressure levels due to the floor covering when it is placed on a joist floor incorporating a concrete topping (about 50 mm thick) poured directly on the plywood subfloor or steel deck. The estimated impact sound pressure levels are too low.[3]

5.6 This test method closely follows that described in ISO 140-8 except that the single number rating used is the impact insulation class (IIC) described in Classification E 989. The description of the standard concrete floor also differs.

NOTE 2—The requirement in Classification E 989 that no deviation above the reference contour may exceed 8 dB means that there is no simple relationship between ISO 140-8 test ratings and those generated by this method.

6. Test Rooms

6.1 The test rooms shall satisfy the requirements given in Method E 492.

7. Standard Concrete Floor

7.1 The standard concrete floor on which the test coverings are to be installed shall consist of a reinforced concrete slab or slab sections with a thickness of 150 ± 50 mm. The slab or slabs shall be homogeneous and of uniform thickness.

NOTE 3—A thickness of 150 mm is preferred for new facilities.

7.2 The surface of the test floor shall be smooth and sufficiently hard to endure the impacts of the tapping machine. Any screed applied to the surface of the test floor shall adhere solidly at all points so the screed does not chip, crack or become pulverized.

7.3 Inspect the surface of the slab frequently to assess surface damage. Repairs shall be made when the surface is no longer smooth.

NOTE 4—Altering the position of the tapping machine slightly for each test will reduce wear on the standard slab and prolong the life of the surface.

[3] "Impact Sound Measurements on Floors Covered with Small Patches of Resilient Materials or Floating Assemblies," A.C.C. Warnock. Internal Report IRC IR-802. National Research Council Canada. January 2000.

8. Test Specimens

8.1 *Classification of Test Specimens*:

8.1.1 *Category I (Small Specimens)*—This category includes flexible coverings (plastics, rubber, cork, matting, carpet or combinations thereof), which are installed loosely or by adhesion to the floor surface.

8.1.1.1 Use three samples, preferably from different production runs but from the same source. Each sample shall measure at least 1 × 0.5 m.

8.1.2 *Category II*—This category includes rigid, homogeneous surface materials or complex floor coverings of which at least one constituent is rigid. When the area of the standard concrete floor is less than 10 m^2, the specimen shall cover the whole surface of the standard concrete floor. When the area of the standard concrete floor is greater than 10 m^2, the specimen area need not exceed 10 m^2 provided that the smallest dimension of the specimen is not less than 3 m.

8.1.3 *Materials of Uncertain Classification*—In the case of uncertainty as to the appropriate category for a material, the testing laboratory shall decide whether small or large specimens will be tested. In any case the specimen shall be described in detail in the test report.

8.2 *Preparation and Installation of Test Specimens*:

8.2.1 *Adhesive Mounting*—Install coverings to be mounted with adhesive with great care, normally with adhesive covering the entire surface of the test specimen. If the adhesive is applied in isolated patches, describe the exact procedure in the report. Follow strictly the manufacturer's instructions for use of the adhesive, especially with regard to the amount and the bonding-time. Report the type of adhesive and the bonding-time.

8.2.2 To avoid damage to the standard concrete slab and ease removal of specimens, it is acceptable to first apply a removable thin layer such as double-faced tape or thin paper using soluble paste. Adhesives for coverings may then be applied to the removable layer. Users shall establish by experiment that such protective coverings have negligible effect on the measurements. The data collected during such experiments shall be kept on file and made available on request.

8.3 *Room Temperature and Humidity*—Measure and report the temperature and the humidity of the air in each room. The temperature shall be in the range 18 to 25°C in the upper room.

8.4 *Aging of Specimens*—Test specimens that incorporate materials for which there is a curing process (for example adhesives, plasters, concrete, mortar, damping compound) shall age for a sufficient interval before testing. Manufacturers may supply information about curing times for their products. Aging periods for certain common materials are given in Methods E 492 and E 90.

9. Microphone Requirements

9.1 Microphones shall meet the requirements in Method E 492.

10. Tapping Machine Requirements

10.1 The standard tapping machine used shall meet the requirements in Method E 492.

11. Frequency Range and Bandwidth for Analsis

11.1 *Bandwidth*—For each test band, the overall frequency response of the electrical system, including the filter or filters in the source or microphone systems, shall satisfy the specifications given in ANSI Specification S1.11 for a one-third octave band filter set, Order 3 or higher, Type 1.

11.2 *Standard Test Frequencies*—Measurements shall be made in all one-third-octave bands with mid-band frequencies specified in ANSI S1.6 from 50 to 5000 Hz.

12. Procedure

12.1 *Measurement of Normalized Impact Sound Pressure Level*—The average impact sound pressure level in the receiving room shall be measured as detailed in Method E 492, once with the tapping machine striking the bare standard concrete floor and once on the floor covering installed on the standard concrete floor. The paper described in 8.2.2 shall not be present when measurements are made on the bare floor. The average impact sound pressure levels are denoted L_0 and L_c respectively.

12.1.1 *Category I Specimens*—The normalized impact sound pressure levels for the bare standard concrete floor shall be obtained by operating the tapping machine in the middle of each area to be occupied by the three small specimens. The three sets of levels obtained shall be averaged and the normalized result used as L_0 in the calculations.

12.1.1.1 The three samples shall be placed side by side on the standard concrete floor. The supporting feet of the tapping machine shall rest on the sample being tested. The tapping machine shall be operated on top of each sample in turn in the position it occupied on the bare floor and the results averaged as specified below. The levels for the three samples shall be averaged and the result used as L_c in the calculations.

12.1.2 *Category II Specimens*—For the bare standard concrete floor and the floor with covering, the standard tapping machine shall be operated in the four positions defined in Method E 492 and the normalized impact sound pressure levels measured for each position. If the temperature and relative humidity in the receiving room do not differ by more than 1°C and 2% respectively during measurements with and without the specimen, then measurements of the decay rates in the receiving room are not mandatory. The difference in impact sound pressure levels may be assumed to be equal to the difference in normalized impact sound pressure levels.

NOTE 5—This situation often arises when the standard concrete floor and the room below are undisturbed between tmeasurements with and without specimens.

12.1.3 If the temperature and relative humidity in the receiving room do not differ by more than 1°C and 2% respectively during measurements with and without the specimen, then measurements of the decay rates in the receiving room are not mandatory. The difference in impact sound pressure levels may be assumed to be equal to the difference in normalized impact sound pressure levels.

NOTE 6— This situation often arises when the standard concrete floor and the room below are undisturbed between measurements with and without specimens.

12.2 *Averaging Time, Stationary Microphones*—For each sampling position, the averaging time shall be sufficient to yield an estimate of the time-averaged level to within ±0.5 dB. This requires longer averaging times at low frequencies than at high. For 95 % confidence limits of ±*e* dB in a one-third octave band with mid-band frequency *f*, the integration time, *T*, shall be estimated from

$$T = \frac{310}{fe^2} \quad (1)$$

Thus at 125 Hz, the minimum averaging time for confidence limits of ±0.5 dB is 9.9 s. At 100 Hz, an averaging time of 12.4 s is needed. For more information on averaging times, see footnote.[4]

12.2.1 If a moving or rotating diffuser is used, determine the average sound pressure level at each microphone position during an integral number of diffuser cycles. Alternatively, average over a time so long that contributions from fractions of a diffuser cycle are negligible.

12.2.2 *Averaging Time, Moving Microphones*—The averaging time for a moving microphone shall be long enough that differences between repeat measurements are less than 0.5 dB. The average levels shall be determined over at least one complete traverse of the moving microphone.

NOTE 7—A typical time for a complete traverse is 60 s but operators should determine acceptable times by experiment.

12.3 *Correction for Background Noise*—Measurements of background noise levels shall be made to ensure that the observations in the receiving room are not affected by extraneous sound such as noise from outside the test room or electrical noise in the receiving system. Take care that the airborne noise produced by the tapping machine and transmitted to the receiving room does not influence the impact sound pressure level in the receiving room.

12.3.1 Where necessary, make corrections for background noise as described in Method E 492. Mark in the report those levels that could not be corrected because of the influence of background noise.

NOTE 8—Sound pressure levels that are limited by background noise lead to underestimation of the performance of the floor covering.

13. Calculations

13.1 In each one-third octave band, *f*, calculate the difference:

$$L_d(f) = L_0(f) - L_c(f) \quad (2)$$

where:

L_0 = average normalized impact sound pressure level measured on the bare standard concrete floor, and

L_c = average normalized impact sound pressure level measured with the covering installed (see 12.1).

13.1.1 Take note of those values of L_d that are limited because of the influence of background noise when measuring L_c.

13.2 Subtract the array L_d from the reference array, L_{ref}, in Table 1. Designate the resulting array as $L_{ref,c}$.

NOTE 9—The frequency range shown in Table 1 used for calculating IIC represents only a portion of the frequency range required in 11.2. However, experience has shown that data obtained outside the IIC range have proven useful for comparing specimens.

13.3 Following Method E 989, calculate the impact insulation class, IIC_c, for the array $L_{ref,c}$.

13.4 Calculate the improvement in impact insulation class due to the floor covering as:

$$\Delta IIC = IIC_c - 28 \quad (3)$$

where:

28 = IIC rating for the reference concrete floor.

13.5 When sound pressure levels that are limited by background noise contribute to the determination of IIC_c, it shall be noted in the report that the values of ΔIIC and IIC_c are low estimates.

NOTE 10—The data collected may be used to calculate the single number ratings defined in ISO 717 and specified by ISO 140-8. Differences between the two test methods are minor except that Category II specimens in ISO 140-8 are loaded uniformly to simulate the weight of furniture. The load is in the range 20 to 25 kg/m^2. Thus for Category II specimens, the difference spectrum will differ to some unknown extent.

14. Report

14.1 Include the following information in the test report:

14.1.1 A statement, if true in every respect, that the tests were conducted according to this test method.

14.1.2 A description of the test specimen. The description must be sufficiently detailed to identify the specimen, at least for those elements that may affect its attenuation of impact sound, unless the test sponsor wishes to withhold information of a proprietary nature.

14.1.2.1 The specimen size, including thickness, and the average mass per unit area shall always be reported. Wherever possible, the testing laboratory should observe and report the materials, dimensions, masses per unit area or densities, and other relevant physical properties of the major components.

14.1.2.2 A description of the methods used to combine the components, the fastening elements used (type of screws, nails

TABLE 1 Average Normalized Impact Sound Pressure Level, L_{ref}, Assumed for the Reference Floor

Frequency, Hz	L_{ref}, dB
100	67.0
125	67.5
160	68.0
200	68.5
250	69.0
315	69.5
400	70.0
500	70.5
630	71.0
800	71.5
1000	72.0
1250	72.0
1600	72.0
2000	72.0
2500	72.0
3150	72.0

[4] "Noise and Vibration Control," Ed. by L.L Beranek, McGraw-Hill, 1971, p. 115.

or glue etc.) and the spacing between them should also be given. A designation and description furnished by the sponsor of the test may be included in the report provided that they are attributed to the sponsor.

14.1.2.3 If some details of the specimen construction are withheld at the sponsor's request, the report shall state this.

14.1.2.4 The curing period, if any, and the condition of the specimen as tested (shrinkage, cracks, etc.) shall be reported.

14.1.2.5 In the case of concrete floating slab floors, report the curing time for the concrete.

14.1.2.6 Any visible damage suffered by the test specimen during the test (for example, compaction) must be reported.

14.1.3 A description of the method of installation of the specimen on the standard concrete slab.

14.1.4 The dates of construction and testing.

14.1.5 The temperature and humidity in the rooms during the measurements.

14.1.6 The volume of the receiving room.

14.1.7 The dimensions of the standard concrete floor.

14.1.8 The averaging time used during measurement of sound pressure levels.

14.1.9 The normalized impact sound pressure levels rounded to the nearest 0.1 dB for the bare standard concrete slab, the standard concrete slab with the floor covering installed, and the calculated levels for the reference concrete floor. Mark, in some convenient manner, those levels that are limited by the presence of background noise (12.3.1).

14.1.10 The reduction in normalized impact sound pressure levels rounded to the nearest 0.1 dB for the frequency bands required in 11.2 and any other bands measured. Mark, in some convenient manner, those differences that are limited by the presence of background noise (12.3.1).

14.1.11 The increase in impact insulation class, ΔIIC, calculated according to 13.4.

15. Precision and Bias

15.1 *Precision*—Not enough data have been collected to generate a precision statement for this method.

15.2 *Bias*—There is no bias in this method since the true value is defined by the test method.

16. Keywords

16.1 impact insulation class; impact sound insulation; impact sound pressure level; tapping machine