Designation: E 1007 – 97

Standard Test Method for Field Measurement of Tapping Machine Impact Sound Transmission Through Floor-Ceiling Assemblies and Associated Support Structures[1]

This standard is issued under the fixed designation E 1007; 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.

INTRODUCTION

This test method is part of a set of standards for evaluating the sound insulating properties of building elements. It is designed to measure the impact sound insulation of a floor-ceiling assembly and associated supporting structures in field situations using a standard tapping machine. Other in the set cover laboratory measurement of impact sound transmission through floor-ceiling assemblies (Test Method E 492); and the laboratory (Test Method E 90) and field (Test Method E 336) methods of measuring airborne sound transmission loss of building partitions such as walls, floor-ceiling assemblies, doors, and other space-dividing elements; the measurement of sound transmission through building facades and facade elements (Guide E 966); the measurement of sound transmission through a common plenum between two rooms (Test Method E 1414), a quick method for the determination of airborne sound isolation in multiunit buildings (Practice E 597), and the measurement of sound transmission through door panels and systems (Test Method E 1408).

1. Scope

1.1 This test method covers the measurement of the transmission of impact sound generated by a standard tapping machine through floor-ceiling assemblies and associated supporting structures in field situations.

1.2 Measurements may be conducted on all types of floor-ceiling assemblies, including those with floating-floor or suspended ceiling elements, or both, and floor-ceiling assemblies surfaced with any type of floor-surfacing or floor-covering materials.

1.3 This test method further prescribes:

1.3.1 A uniform procedure for reporting test data, that is, the normalized one-third octave band sound pressure levels generated in the receiving room by the operation of the standard tapping machine on the floor-ceiling assembly.

1.3.2 The use of a single-figure classification rating, "Field Impact Insulation Class, FIIC" that can be used by architects, builders, and specification and code authorities for acoustical evaluation purposes in completed buildings. The FIIC is obtained by matching a standard reference contour to the plotted normalized one-third octave band sound pressure levels at each test frequency obtained in accordance with this test method. For details regarding the derivation and significance of the FIIC, see Classification E 989.

1.4 *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[2]

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

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

E 597 Practice for Determining a Single-Number Rating of Airborne Sound Isolation for Use in Multiunit Building Specifications[2]

E 966 Guide for Field Measurement of Airborne Sound Insulation of Building Facades and Facade Elements[2]

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

[1] This test method is under the jurisdiction of ASTM Committee E-33 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.

E 1408 Test Method for Laboratory Measurement of the Sound Transmission Loss of Door Panels and Door Systems[2]

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

2.2 *ANSI Standards:*

S1.4 Specification for Sound-Level Meters[3]

S1.10 Pressure Calibration of Laboratory Standard Pressure Microphones[3]

S1.11 Specification for Octave Band and Fractional-Octave-Band Analog and Digital Filters[3]

2.3 *ISO Standard:*

ISO 140—Acoustics—Measurement of Sound Insulation in Buildings and of Building Elements; Part VI—Laboratory Measurement of Impact Sound Insulation of Floors, and Part VII—Field Measurements of Impact Sound Insulation of Floors[3]

2.4 *IEC Standard:*

IEC 804 Specification for Integrating Sound Level Meters

3. Terminology

3.1 *Definitions*—For definitions of terms pertaining to acoustics used in this test method, see Terminology C 634.

3.2 *Definitions of Terms Specific to This Standard:*

3.2.1 *source room*—the room containing the tapping machine.

3.2.2 *receiving room*—a room below or adjacent to the floor specimen under test in which the impact sound pressure levels are measured.

NOTE 1—The receiving room is usually the room below the floor specimen but it may also be on the same level, diagonally below, or, in some cases, it could be above the source room.

3.2.3 *impact sound pressure level*—the average sound pressure level in a specified frequency band produced in the receiving room by the operation of the standard tapping machine on the floor assembly, averaged over each of the specified machine positions.

3.2.4 *normalized impact sound pressure level*—the impact sound pressure level normalized to a reference absorption of 10 m^2(108 sabins).

3.2.5 *field impact insulation class (FIIC)*—a single-number rating derived from measured values of normalized one-third octave band impact sound pressure levels in accordance with Classification E 989.

NOTE 2—FIIC provides an estimate of the sound insulating performance of a floor-ceiling assembly and associated support structures under tapping machine excitation.

4. Summary of Test Method

4.1 A standard tapping machine is placed in operation on a floor specimen. The transmitted impact sound is characterized by the one-third octave band spectrum of the average sound pressure level produced by the tapping machine in the receiving room located beneath or adjacent to the floor specimen under test.

4.2 Since the spectrum and level depend on the absorption of the receiving room, the impact sound pressure levels are normalized to a reference absorption for purposes of comparing results obtained in receiving rooms that differ in absorption.

5. Significance and Use

5.1 The spectrum of the noise produced in the receiving room by the standard tapping machine is determined by (1) the size and the mechanical properties of the floor-ceiling assembly, such as its weight, surface properties, mounting or edge restraints, stiffness, and internal damping; (2) the acoustical response of the receiving room; and (3) the degree of flanking transmission through associated structures.

5.2 The standardized tapping machine specified in 7.1.1 produces a continuous series of uniform impacts at a uniform rate on a test floor assembly and generates in the receiving room broadband sound pressure levels high enough to make accurate and reproducible measurements possible. The tapping machine, however, is not designed to simulate any one type of impact, such as male or female footsteps nor to simulate the weight of a human walker. Thus the subjectively annoying creak or boom generated by human footfalls on a limber floor assembly may not be adequately evaluated by this test method.

5.3 Test Method E 492 calls for the elimination of flanking sound transmission and for highly diffuse sound fields in the receiving room. The problems associated with making acoustical measurements in buildings are much more difficult than those met in the laboratory. In ordinary buildings, a great variety of test room shapes and sizes are encountered. The amount of energy exchange at the nominal boundaries of the test specimen, the manner of construction and factors such as structure-borne flanking paths, for example, transmission in the side walls, varies widely. Highly diffuse fields are seldom found in the field and the special efforts that would be required to simulate laboratory conditions and eliminate flanking sound are impractical.

5.4 This test method accepts these limitations and gives measurement procedures for determining the average impact sound pressure level in nearly all cases that may be encountered in the field. The test procedure evaluates the floor-ceiling assembly and adjacent structures as installed (including structure-borne flanking paths). Results are not meant to be identical to laboratory tests of the floor-ceiling assembly alone. Because of the uncontrollable factors mentioned in 5.1-5.3, caution must be used when using test results to predict the performance of other floors with similar construction. It is preferable to confine the use of test results to the comparison of closely similar floors and supporting structures.

6. Test Specimens

6.1 *Types*—All types of floor-ceiling assemblies surfaced with any type of material may be tested by this test method, including assemblies with floating floors or suspended ceilings.

6.1.1 In all cases the test specimen should be installed in accordance with customary field practice including normal constraint and sealing conditions at the perimeter and at the joints within the specimen.

[3] Available from American National Standards Institute, 11 W. 42nd St., 13th Floor, New York, NY 10036.

TABLE 1 Recommended Minimum Aging Periods Before Test

Material	Recommended Minimum Aging Period
Masonry	28 days
Plaster:	
Thicker than 3 mm (⅛ in.)	28 days
Thinner than 3 mm (⅛ in.)	3 days
Wallboard Partitions:	
With water-base laminating adhesives	14 days
With non-water-base laminating adhesives	3 days
With typical joint and finishing compounds	12 h
Other	As appropriate for caulking and adhesive compounds involved

6.2 *Aging of Specimens*—Test specimens that incorporate materials for which there is a curing process (for example, adhesives, plasters, concrete, mortar, and damping compound) shall age for a sufficient interval before testing. Aging periods for certain common materials are recommended in Test Method E 90 and summarized in Table 1 of this test method.

6.3 *Installation of Floor-Surfacing Materials*:

6.3.1 Since floor-surfacing materials of significant weight, such as carpets and pads, may exert a damping or restraining effect on the flexural motion of lightweight floor structures, it is recommended that the entire area of the floor structure under test be covered with the floor surfacing materials. Any exception to this shall be noted in the test report.

6.3.2 The installation or application of floor-surfacing materials should be in accordance with manufacturer's instruction, especially in regard to cleaning and priming of the subfloor.

6.3.3 Floor-surfacing materials that are intended to be applied with adhesive should not be tested merely laying on the subfloor unless otherwise noted in the report.

6.3.4 Although most floors are ready for immediate use after being installed, it is recommended that measurements on floors with adhesive-applied surfacing materials be deferred for at least 24 h after installation to allow the adhesive to cure.

6.4 *Receiving Room Volume*—Ideally, the receiving room should be large enough so that an approximately diffuse sound field exists in all measurement bands. In the field, sound fields are deemed acceptable down to 100 Hz if the room volume is greater than 60 m^3(2100 ft^3), to 125 Hz if the room volume is greater than 40 m^3(1400 ft^3), and to 160 Hz if the room volume is greater than 25 m^3(880 ft^3).

NOTE 3—The requirement at 125 Hz is obtained by assuming that a minimum of 10 room modes will provide a sufficiently good approximation to a diffuse sound field; those at 100 and 160 Hz are obtained by requiring the same average modal spacing as at 125 Hz.

7. Tapping Machine

7.1 *Tapping Machine Specifications*:

7.1.1 This test method is based on the use of a standardized tapping machine that conforms to the specifications in ISO 140/VI.[4] It shall have five hammers equally spaced in a line with about 400 mm between the two end hammers. The machine shall deliver 10 impacts/s at equal intervals, such that the time between successive impacts is 100 ± 5 ms. The effective mass of each hammer shall be 0.5 ± 0.012 kg. The drop of a hammer on a flat hard floor shall be equivalent to a free drop without friction of 40 ± 1 mm. The part of the hammer that strikes the floor shall be a cylinder of steel, 30 mm in diameter with a spherical steel end having a radius of 500 ± 10 mm. Check both the hammer drop and the radius of curvature of the hammer heads with a gage or template for conformance with the given specifications. Replace hammer heads failing to meet the specifications.

7.1.2 The bottoms of the machine supports shall be at least 100 mm from the nearest hammer and capped with soft sponge rubber pads about 5 mm thick so that the requirements in 7.2.1 are satisfied.

NOTE 4—Investigations **(1)**[5] involving light-frame floating floors have shown that both the resiliency of the tapping machine supports as well as their spacing from the hammers significantly affect the impact sound pressure levels in frequency bands below 400 Hz.

7.1.3 Following adjustment of the hammer drop in accordance with the specifications, the tapping machine is ready for use on any floor, including those surfaced with soft or resilient materials.

7.2 *Operational Noise and Vibration*:

7.2.1 The tapping machine shall be constructed so that the vibratory excitation of the floor structure under test is due primarily to hammers impacting on the floor surface. The one-third octave band noise levels produced in the receiving room by excitation of the floor due to the extraneous mechanical operations of the tapping machine shall be at least 10 dB below those produced by the impacting of the hammers. This requirement can be verified by placing a strip of soft, very resilient material under the impacting hammers. If there is at least a 10-dB reduction in the sound pressure level in the receiving room for each frequency band, extraneous vibrational transmission can be considered negligible.

7.2.2 The presence of airborne sound flanking could cause atypical noise levels to exist in the receiving room. Therefore, the sound pressure levels in the receiving room due to airborne transmission of the noise from the operation of the tapping machine should be at least 10 dB less than those due to hammer impacts transmitted structurally (see also 7.2.1).

NOTE 5—A loudspeaker or other convenient airborne noise source can be used to evaluate the extent of airborne sound transmission between the rooms (see Test Method E 336).

7.3 *Tapping Machine Positions*—The spectrum of the noise in the receiving room may be influenced by the location of the tapping machine on the floor specimen. For purposes of this test method, the tapping machine positions described in 7.3.1-7.3.4 shall be used (see Fig. 1).

7.3.1 *Position 1*—The middle hammer of the tapping machine shall be coincident with the midpoint of the floor area, that is, approximately at the intersection of floor diagonals. In

[4] Suitable tapping machines are available from Scantek Inc., 916 Gist Ave., Silver Spring, MD 20850 and Bruel and Kjaer Instruments, Inc., 185 Forest St., Marlborough, MA 01752.

[5] The boldface numbers in parentheses refer to the list of references at the end of this standard.