INTERNATIONAL STANDARD

ISO 140-8

Second edition
1997-10-15

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 standard floor

Acoustique — Mesurage de l'isolement acoustique des immeubles et des éléments de construction —

Partie 8: Mesurages en laboratoire de la réduction de la transmission du bruit de choc par les revêtements de sol sur un plancher lourd normalisé

Reference numbe
ISO 140-8:1997(E)

Contents

International Organization for Standardization
Case postale 56 • CH-1211 Genève 20 • Switzerland
Internet central@iso.ch
X.400 c=ch; a=400net; p=iso; o=isocs; s=central

Printed in Switzerland

Foreword

ISO (the International Organization for Standardization) is a worldwide federation of national standards bodies (ISO member bodies). The work of preparing International Standards is normally carried out through ISO technical committees. Each member body interested in a subject for which a technical committee has been established has the right to be represented on that committee. International organizations, governmental and non-governmental, in liaison with ISO, also take part in the work. ISO collaborates closely with the International Electrotechnical Commission (IEC) on all matters of electrotechnical standardization.

Draft International Standards adopted by the technical committees are circulated to the member bodies for voting. Publication as an International Standard requires approval by at least 75 % of the member bodies casting a vote.

International Standard ISO 140-8 was prepared by Technical Committee ISO/TC 43, , Subcommittee SC 2, *Building acoustics*.

This second edition cancels and replaces the first edition (ISO 140-8:1978), which has been technically revised.

ISO 140 consists of the following parts, under the general title *Acoustics — Measurement of sound insulation in buildings and of building elements*:

— *Part 1: Requirements of laboratory test facilities with suppressed flanking transmission*

— *Part 2: Determination, verification and application of precision data*

— *Part 3: Laboratory measurements of airborne sound insulation of building elements*

— *Part 4: Field measurements of airborne sound insulation between rooms*

— *Part 5: Field measurements of airborne sound insulation of facade elements and facades*

— *Part 6: Laboratory measurements of impact sound insulation of floors*

— *Part 7: Field measurements of impact sound insulation of floors*

— *Part 8: Laboratory measurements of the reduction of transmitted impact noise by floor coverings on a heavyweight standard floor*

— *Part 9: Laboratory measurement of room-to-room airborne sound insulation of a suspended ceiling with a plenum above it*

— *Part 10: Laboratory measurement of airborne sound insulation of small building elements*

— *Part 12: Laboratory measurement of room-to-room airborne and impact sound insulation of an access floor*

Annex A forms an integral part of this part of ISO 140. Annexes B and C are for information only.

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 standard floor

1 Scope

This part of ISO 140 specifies a method for measuring the acoustic properties of floor coverings from the view-point of reducing impact noise transmission. The purpose of this part of ISO 140 is to establish a method for determining the noise reducing value of a floor covering under standard test conditions. The test is limited to the specification of procedures for the physical measurement of sound originating from an artificial source (standard tapping machine) under laboratory conditions and is not directly related to the subjective significance of the results.

This part of ISO 140 is applicable to all floor coverings, whether single or multi-layered, as installed on a standard floor. In the case of multi-layered coverings, they may be factory-assembled or assembled at the test site. The test method applies only to laboratory measurements. It does not contain any provision that permits an assessment of the effectiveness of a floor covering *in situ*.

2 Normative reference(s)

The following standards contain provisions which, through reference in this text, constitute provisions of this part of ISO 140. At the time of publication, the editions indicated were valid. All standards are subject to revision, and parties to agreements based on this part of ISO 140 are encouraged to investigate the possibility of applying the most recent editions of the standards indicated below. Members of IEC and ISO maintain registers of currently valid International Standards.

ISO 140-1:1997, *Acoustics — Measurement of sound insulation in buildings and of building elements — Part 1: Requirements for laboratory test facilities with suppressed flanking transmission.*

ISO 140-2:1991, *Acoustics — Measurement of sound insulation in buildings and of building elements — Part 2: Determination, verification and application of precision data.*

ISO 140-6:— [1], *Acoustics — Measurement of sound insulation in buildings and of building elements — Part 6: Laboratory measurements of impact sound insulation of floors.*

ISO 140-7:— [2] *Acoustics — Measurement of sound insulation in buildings and of building elements — Part 7: Field measurements of impact sound insulation of floors.*

ISO 354:1985, *Acoustics — Measurement of sound absorption in a reverberation room.*

ISO 717-2:1996, *Acoustics — Rating of sound insulation in buildings and of building elements —Part 2: Impact sound insulation.*

---

1) To be published. (Revision of ISO 140-6:1978)

2) To be published. (Revision of ISO 140-7:1978)

IEC 651:1979, *Sound level meters.*

IEC 804:1985, *Integrating-averaging sound level meters.*

IEC 942:1988, *Sound calibrators.*

IEC 1260:1995, *Electroacoustics — Octave-band and fractional-octave-band filters.*

3 Definitions

For the purposes of this part of ISO 140, the following definitions apply.

3.1 average sound pressure level in a room, L: Ten times the common logarithm of the ratio of the space and time average of the sound pressure squared to the square of the reference sound pressure, the space average being taken over the entire room with the exception of those parts where the direct radiation of a sound source or the near field of the boundaries (wall, etc.) is of significant influence; it is expressed in decibels.

If a continuously moving microphone is used, L is determined by

$$L = 10 \lg \frac{\frac{1}{T_m} \int_0^{T_m} p^2(t)\, dt}{p_0^2} \quad \text{dB} \qquad ..(1)$$

where

p is the sound pressure, in pascals;

p_0 is the reference sound pressure and is equal to 20 µPa;

T_m is the integration time, in seconds.

If fixed microphone positions are used, L is determined by

$$L = 10 \lg \frac{p_1^2 + p_2^2 + \ldots + p_n^2}{n\, p_0^2} \quad \text{dB} \qquad ...(2)$$

where p_1, p_2,..., p_n are the r.m.s. sound pressures at n different positions in the room.

In practice, usually the sound pressure levels L_j are measured. In this case L is determined by

$$L = 10 \lg \left(\frac{1}{n} \sum_{j=1}^{n} 10^{L_j/10} \right) \quad \text{dB} \qquad ...(3)$$

where L_j is the sound pressure level L_1 to L_n at n different positions in the room.

3.2 impact sound pressure level, L_i: The average sound pressure level in a one-third-octave band in the receiving room when the floor under test is excited by the standardized impact sound source; it is expressed in decibels.

3.3 normalized impact sound pressure level, L_n**:** The impact sound pressure level L_i increased by a correction term which is given in decibels, being ten times the common logarithm of the ratio between the measured equivalent absorption area A of the receiving room and the reference equivalent absorption area A_0; it is expressed in decibels.

$$L_n = L_i + 10 \lg \frac{A}{A_0} \quad \text{dB} \qquad ..(4)$$

with $A_0 = 10$ m^2.

3.4 reduction of impact sound pressure level ; improvement of impact sound insulation, ΔL**:** For a given one-third-octave band, the reduction in normalized impact sound pressure level resulting from installation of the test floor covering; it is expressed in decibels.

$$\Delta L = L_{n0} - L_n \qquad ...(5)$$

where

L_{n0} is the normalized impact sound pressure level of the heavyweight standard floor without floor covering;

L_n is the normalized impact sound pressure level of the heavyweight standard floor with the floor covering.

NOTE — If the receiving room absorption is unchanged during the test, it is assumed that the reduction in impact sound pressure level is equivalent to the reduction in normalized impact sound pressure level.

4 Equipment

The equipment shall comply with the requirements of clause 6.

The tapping machine shall meet the requirements given in annex A.

The accuracy of the sound level measurement equipment shall comply with the requirements of accuracy classes 0 or 1 defined in IEC 651 and IEC 804. The complete measuring system including the microphone shall be adjusted before each measurement using a sound calibrator which complies with the requirements of accuracy class 1 defined in IEC 942. For sound level meters calibrated for measurements in sound fields of progressive plane waves corrections for the diffuse sound field shall be applied.

The filters shall comply with the requirements given in IEC 1260.

The reverberation time measurement equipment shall comply with the requirements given in ISO 354.

NOTE — For pattern evaluation (type testing) and regular verification tests, recommended procedures for sound level meters are given in OIML R58 [1] and OIML R88 [2].

5 Test arrangement

5.1 General arrangement

Two vertically adjacent rooms are used, the upper one being designated the "source room" and the lower one the "receiving room". They are separated by a standard floor on which the floor covering under test is installed. The airborne sound insulation between source room and receiving room shall be such that the level of airborne sound transmission from source room to receiving room will be at least 10 dB below the level of transmitted impact sound in each frequency band, see ISO 140-1.

5.2 Details of test arrangement

5.2.1 Source room

There are no specific requirements for the size and shape of the source room.

5.2.2 Receiving room

The receiving room shall comply with the requirements of ISO 140-1.

5.2.3 Test floor

The floor on which the test coverings are to be installed shall consist of a reinforced concrete slab of thickness (120^{+40}_{-20}) mm — preferably 140 mm for the construction of new laboratories. It should be homogeneous and of uniform thickness. The surface area, viewed from the receiving room, shall be at least 10 m^2. On the source side, the permissible test area for installation of floor coverings of category I (see 5.3.3) will be the region at least 0,5 m from the edges of the floor slab.

5.2.4 Condition of floor surface

It shall be ensured that the surface of the test floor is flat, to ± 1 mm in a horizontal distance of 200 mm, and sufficiently hard to endure the impacts of the tapping machine. If a screed is applied to the surface of the test floor, it shall be ensured that it adheres perfectly at all points, and that it does not chip, crack or become pulverized.

5.3 Preparation and installation of test specimen

5.3.1 Classification

Depending upon the type of floor covering, the test specimens shall be either slightly larger than the tapping machine with supports or equal to the floor area (see 6.6).

5.3.1.1 Category I (small specimens)

This category includes flexible coverings (plastics, rubber, cork, matting, or combinations thereof), which may be installed loosely or by adhesion to the floor surface. Describe the method of installation clearly in the report.

5.3.1.2 Category II (large specimens)

This category includes rigid homogeneous surface materials or complex floor coverings of which at least one constituent is rigid. The assembled floor covering may be tested under load. A normal furnishing should be simulated with a uniformly distributed load of 20 kg/m^2 to 25 kg/m^2. The distributed load should be arranged with at least one weight per square meter of the flooring area.

5.3.1.3 Category III (stretched materials)

This category includes flexible coverings which cover the floor from wall to wall. Large specimens should be tested, but loading is not required.

5.3.1.4 Materials of uncertain classification

In the case of uncertainty as to the appropriate category for a material, the testing laboratory will decide whether small or large specimens will be tested.

5.3.2 Installation

Follow strictly the manufacturer's installation instructions, pay attention especially to the edges of the specimen.

5.3.2.1 Adhesive mounting

Install coverings to be mounted with adhesive with great care, normally with adhesive covering the entire surface. If the adhesive is applied in isolated patches, describe the exact procedure. 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.

5.3.2.2 Curing period prior to test

Do not test coverings such as concrete floating slabs cast in place before the customary curing period has passed — for example, three weeks are recommended for ordinary concrete.

5.3.3 Size and number of specimen

5.3.31 Category I

Install three samples (see 5.2.3), preferably of different production runs but from the same source. Each sample shall be large enough to support the whole tapping machine.

5.3.3.2 Category II and III

The specimen shall cover the whole surface from wall to wall, or in any case at least 10 m^2 with a smaller dimension of at least 2,3 m.

5.4 Influence of temperature and humidity

Usually, and always in the case of surface whose acoustic properties are likely to depend on either temperature or humidity, measure and report the temperature at the centre of the upper floor surface and the humidity of the air in the source room. The floor temperature thus observed should preferably be in the range 18 °C to 25 °C.

6 Test procedure and evaluation

6.1 Generation of sound field

The impact sound shall be generated by the tapping machine (see clause 4).

With the exception of testing category I specimen, the tapping machine shall be placed in at least four different positions randomly distributed on the floor under test. The distance of the tapping machine from the edges of the floor shall be at least 0,5 m.

The impact sound pressure levels may reveal a time dependency after the tapping is started. In such a case the measurements do not begin until the noise level has become steady. If stable conditions are not reached after 5 min, then carry out the measurements during a well-defined measurement period. The measurement period shall be reported.

When soft floor coverings are under test it is necessary that the standard tapping machine fulfills special requirements given in annex A. Advice regarding the mounting of the standard tapping machine on soft floor coverings is given also in annex A.

6.2 Measurement of impact sound pressure level

Obtain the impact sound pressure level by using a single microphone moved from position to position or by an array of fixed microphones or by a continuously moving or oscillating microphone. The sound pressure levels at the different microphone positions shall be averaged [see equations (1) to (3)] for all positions of the tapping machine.

6.2.1 Microphone positions

As a minimum, four microphone positions shall be used; these shall be distributed within the maximum permitted space throughout the room, spaced uniformly. At least one pair of microphones may be related to two tapping machine positions and another pair to the other two positions (see 6.6).

The following separating distances are minimum values and shall be exceeded where possible:

0,7 m between microphone positions;

0,7 m between any microphone position and room boundaries or diffusers;

1,0 m between any microphone position and the upper floor being excited by the tapping machine.

When using a moving microphone, the sweep radius shall be at least 1 m. The plane of the traverse shall be inclined in order to cover a large proportion of the permitted room space and shall not lie in any plane within 10° of a room surface. The duration of a traverse period shall be not less than 15 s.

6.2.2 Averaging time

At each individual microphone position, the averaging time shall be at least 6 s at each frequency band with centre frequencies below 400 Hz. For bands of higher centre frequencies, it is permissible to decrease the time to not less than 4 s. Using a moving microphone the averaging time shall cover a whole number of traverses and shall be at least 30 s.

6.3 Frequency range of measurements

The sound pressure level shall be measured using one-third-octave band filters having at least the following centre frequencies, in hertz:

100 125 160 200 250 315
400 500 630 800 1 000 1 250
1 600 2 000 2 500 3 150 4 000 5 000

If additional information in the low-frequency range is required, use one-third-octave band filters with the following centre frequencies, in hertz:

50 63 80

Guidance is given in ISO 140-6:—, annex C for such additional measurements in the low-frequency bands.

6.4 Measurement of reverberation time and evaluation of the equivalent sound absorption area

The correction term of equation (4) containing the equivalent sound absorption area is evaluated from the reverberation time measured according to ISO 354 and determined using Sabine's formula

$$A = \frac{0{,}16V}{T} \qquad ..(6)$$

where

A is the equivalent absorption area, in square metres;

V is the receiving room volume, in cubic metres;

T is the reverberation time, in seconds.

In accordance with ISO 354, the evaluation of the reverberation time from the decay curve shall begin about 0,1 s after the sound source has been switched off, or from a sound pressure level a few decibels lower than that at the beginning of the decay. The range used shall not be less than 20 dB, and shall not be so large that the observed

decay cannot be approximated by a straight line. The bottom of this range shall be at least 10 dB above the background noise level.

The minimum number of measurements required for each frequency band is six decays. At least one loudspeaker position and three microphone positions with two readings in each case shall be used.

Moving microphones which meet the requirements of 6.2.1 may be used but the traverse time shall be not less than 30 s.

6.5 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. To check the latter condition, replace the microphone by a dummy microphone. 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.

For using the signal levels without corrections the background level shall be at least 6 dB (and preferably more than 15 dB) below the level of signal and background noise combined. If the difference in levels is smaller than 15 dB but greater than 6 dB, calculate corrections to the signal level according to the equation

$$L = 10 \lg \left(10^{L_{sb}/10} - 10^{L_b/10}\right) \quad \text{dB} \qquad ..(7)$$

where

L is the adjusted signal level;

L_{sb} is the level of signal and background noise combined;

L_b is the background noise level.

If the difference in levels is less than or equal to 6 dB in any of the frequency bands, use the correction 1,3 dB corresponding to a difference of 6 dB. In that case, the relevant values shall be given indicated in the measurement report so that it clearly appears that the reported values are the limit of measurement (for example, indicate ΔL values as $\Delta L >$ ... dB).

6.6 Position of the tapping machine

6.6.1 Adjustment of the tapping machine

For the adjustment of the falling height of the hammers of the tapping machine guidance is given in annex A. When situated on a specimen covering the whole floor, the hammers shall touch the specimen at least 100 mm from the edges.

6.6.2 Materials of category I

Place the tapping machine successively on each specimen of floor covering, being wholly on the specimen in each case, and on the bare floor slab on either side of the specimen and as close to it as possible with the supports on the bare floor, the axis of the hammers being always parallel to the long dimension of the specimen (see figure 1).

For each specimen of floor covering, the impact noise level corresponding to the bare floor is the arithmetic mean of the level determined for the two machine positions on either side of the specimen.

6.6.3 Materials of category II and III

Place the tapping machine successively on the bare floor and on the floor when entirely covered by the floor covering.