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Acoustics — Field measurement of sound insulation in buildings and of building elements —

Part 2: Impact sound insulation

*Acoustique — Mesurage in situ de l'isolation acoustique des bâtiments et des éléments de construction —
Partie 2: Isolation des bruits d'impacts*

[Revision of first edition (ISO 140-14:2004) and second edition ISO 140-7:1998]

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This draft has been developed within the International Organization for Standardization (ISO), and processed under the **ISO lead** mode of collaboration as defined in the Vienna Agreement.

This draft is hereby submitted to the ISO member bodies and to the CEN member bodies for a parallel five month enquiry.

Should this draft be accepted, a final draft, established on the basis of comments received, will be submitted to a parallel two-month approval vote in ISO and formal vote in CEN.

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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.

International Standards are drafted in accordance with the rules given in the ISO/IEC Directives, Part 2.

The main task of technical committees is to prepare International Standards. 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.

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ISO 16283-2 was prepared by Technical Committee ISO/TC 43, *Acoustics*, Subcommittee SC 2, *Building acoustics*.

This edition cancels and replaces ISO 140-7:1998 and ISO 140-14:2004, which have been technically revised.

ISO 16283 consists of the following parts, under the general title *Acoustics — Field measurement of sound insulation in buildings and of building elements*:

- *Part 1: Airborne sound insulation*
- *Part 2: Impact sound insulation*
- *Part 3: Façade sound insulation*

Introduction

ISO 16283 (all parts) describes procedures for field measurements of sound insulation in buildings. Airborne, impact and façade sound insulation are described in ISO 16283-1, ISO 16283-2 and ISO 16283-3, respectively.

Field sound insulation measurements that were previously described in ISO 140-4, -5, and -7 were (a) primarily intended for measurements where the sound field could be considered to be diffuse, and (b) not explicit as to whether operators could be present in the rooms during the measurement. ISO 16283 differs from ISO 140-4, -5, and -7 in that (a) it applies to rooms in which the sound field may, or may not approximate to a diffuse field, (b) it clarifies how operators can measure the sound field using a hand-held microphone or sound level meter and (c) it includes additional guidance that was previously contained in ISO 140-14.

NOTE Survey test methods for field measurements of airborne and impact sound insulation are dealt with in ISO 10052.

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Acoustics — Field measurement of sound insulation in buildings and of building elements — Part 2: Impact sound insulation

1 Scope

This part of ISO 16283 specifies procedures to determine the impact sound insulation using sound pressure measurements with an impact source operating on a floor or stairs in a building. These procedures are intended for room volumes in the range from 10 m³ to 250 m³ in the frequency range from 50 Hz to 5 000 Hz. The test results can be used to quantify, assess and compare the impact sound insulation in unfurnished or furnished rooms where the sound field may, or may not approximate to a diffuse field.

Two impact sources are described: the tapping machine and the rubber ball. These impact sources do not exactly replicate all possible types of real impacts on floors or stairs in buildings.

The tapping machine can be used to assess a variety of light, hard impacts such as footsteps from walkers wearing hard-heeled footwear or dropped objects. A single number quantity can be calculated using the rating procedures in ISO 717-2. This single number quantity links the measured impact sound insulation using the tapping machine to subjective assessment of general impacts in dwellings that occur on floors or stairs in a building. The tapping machine is also well-suited to the prediction of impact sound insulation using ISO 15712-2. These two aspects facilitate the specification of impact sound insulation in National building requirements using only measurements with the tapping machine as an impact source.

The rubber ball can be used to assess heavy, soft impacts such as from walkers in bare feet or children jumping, as well as quantifying absolute values that can be related to human disturbance in terms of a Fast time-weighted maximum sound pressure level. At present, calculation procedures for a single number quantity do not currently exist in an ISO Standard.

2 Normative references

The following referenced documents are indispensable for the application of this document. For dated references, only the edition cited applies. For undated references, the latest edition of the referenced document (including any amendments) applies.

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

ISO 3382-2, *Acoustics — Measurement of room acoustic parameters — Part 2: Reverberation time in ordinary rooms*

ISO 10140-3, *Acoustics — Laboratory measurement of sound insulation of building elements — Part 3: Measurement of impact sound insulation*

ISO 10140-5, *Acoustics — Laboratory measurement of sound insulation of building elements — Part 5: Requirements for test facilities and equipment*

ISO 18233, *Acoustics — Application of new measurement methods in building and room acoustics*

IEC 60942, *Electroacoustics — Sound calibrators*

IEC 61183, *Electroacoustics — Random-incidence and diffuse-field calibration of sound level meters*

IEC 61260, *Electroacoustics — Octave-band and fractional-octave-band filters*

IEC 61672-1, *Electroacoustics — Sound level meters — Part 1: Specifications*

ISO/DIS 12999-1, *Determination and application of uncertainties in building acoustics — Part 1: Sound insulation*¹⁾

3 Terms and definitions

For the purposes of this document, the following terms and definitions apply

3.1

energy-average impact sound pressure level in a room

L_i
ten times the common logarithm of the ratio of the space and time average of the squared sound pressure to the square of the reference sound pressure where the impact source is the tapping machine and the space average is taken over the central zone of the room where nearfield radiation from the room boundaries has negligible influence

Note 1 to entry: L_i is expressed in decibels.

3.2

corner impact sound pressure level in a room

$L_{i,Corner}$
ten times the common logarithm of the ratio of the highest time average squared sound pressure from the set of corner measurements to the square of the reference sound pressure for the low-frequency range (50, 63, and 80 Hz one-third octave bands) where the impact source is the tapping machine

Note 1 to entry: $L_{i,Corner}$ is expressed in decibels.

3.3

low-frequency energy-average impact sound pressure level in a room

$L_{i,LF}$
ten times the common logarithm of the ratio of the space and time average of the squared sound pressure to the square of the reference sound pressure in the low-frequency range (50, 63, and 80 Hz one-third octave bands) where the impact source is the tapping machine and the space average is a weighted average that is calculated using the room corners where the sound pressure levels are highest and the central zone of the room where nearfield radiation from the room boundaries has negligible influence

Note 1 to entry: $L_{i,LF}$ is expressed in decibels.

Note 2 to entry: $L_{i,LF}$ is an estimate of the energy-average sound pressure level for the entire room volume.

3.4

energy-average maximum impact sound pressure level in a room

$L_{i,Fmax}$
ten times the common logarithm of the ratio of the space average of the squared maximum sound pressure with Fast time weighting to the square of the reference sound pressure where the impact source is the rubber ball and the space average is taken over the central zone of the room where nearfield radiation from the room boundaries has negligible influence

Note 1 to entry: $L_{i,Fmax}$ is expressed in decibels.

1) under development

3.5 reverberation time

T

time required for the sound pressure level in a room to decrease by 60 dB after the sound source has stopped

Note 1 to entry: T is expressed in seconds.

3.6 background noise level

measured sound pressure level in the receiving room from all sources except the impact source

3.7 fixed microphone

microphone that is fixed in space by using a device such as a tripod so that it is stationary

3.8 mechanized continuously-moving microphone

microphone that is mechanically moved with approximately constant angular speed in a circle, or is mechanically swept along a circular path where the angle of rotation about a fixed axis is between 270° and 360°

3.9 manually-scanned microphone

microphone attached to a hand-held sound level meter or an extension rod that is moved by a human operator along a prescribed path

3.10 manually-held microphone

microphone attached to a hand-held sound level meter or a rod that is hand-held at a fixed position by a human operator at a distance at least an arm's length from the trunk of the operator's body

3.11 partition

total surface of the floor or stair which is excited by the impact source

Note 1 to entry: For two rooms which are staggered vertically or horizontally, the total surface of the separating partition is not visible from both sides of the partition; hence it is necessary to define the partition as the total surface.

3.12 common partition

part of the floor or stair that is common to both the room in which the impact source is used and the receiving room

3.13 standardized impact sound pressure level

L'_{nT}

impact sound pressure level, L_i , reduced by a correction term which is given in decibels, being ten times the common logarithm of the ratio of the measured reverberation time, T , to the reference reverberation time, T_0 which is calculated using Equation (2) when the impact source is the tapping machine

$$L'_{nT} = L_i - 10 \lg \frac{T}{T_0} \quad (1)$$

where

T is the reverberation time in the receiving room;

T_0 is the reference reverberation time; for dwellings, $T_0 = 0,5$ s.

Note 1 to entry: L'_{nT} is expressed in decibels.

Note 2 to entry: The impact sound pressure level is referenced to a reverberation time of 0,5 s because in dwellings with furniture the reverberation time has been found to be reasonably independent of volume and frequency and to be approximately equal to 0,5 s.

Note 3 to entry: L'_{nT} provides a straightforward link to the subjective impression of impact sound insulation.

3.14 normalized impact sound pressure level

L'_n
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 , which is calculated using Equation (1) when the impact source is the tapping machine

$$L'_n = L_i + 10 \lg \frac{A}{A_0} \quad (2)$$

where

A is the absorption area in the receiving room;

A_0 is the reference absorption area; for dwellings, $A_0 = 10 \text{ m}^2$.

Note 1 to entry: L'_n is expressed in decibels.

3.15 standardized maximum impact sound pressure level

$L'_{i,Fmax,V,T}$
maximum impact sound pressure level, $L_{i,Fmax}$, increased by a correction term for room volume and reduced by a correction term for reverberation time and Fast time weighting which is calculated using Equations (3), (4) and (5) when the impact source is the rubber ball

$$L'_{i,Fmax,V,T} = L_{i,Fmax} + 10 \lg \frac{V}{V_0} - 10 \lg \left[\frac{1 - C_0^{-1}}{1 - C^{-1}} \left(\frac{C^{(1-C)^{-1}} - C^{-(1-C)^{-1}}}{C_0^{(1-C_0)^{-1}} - C_0^{-(1-C_0)^{-1}}} \right) \right] \quad (3)$$

$$C_0 = \frac{T_0}{1.7275} \quad (4)$$

$$C = \frac{T}{1.7275} \quad (5)$$

where

T is the reverberation time in the receiving room;

T_0 is the reference reverberation time; for dwellings, $T_0 = 0,5$ s;

V is the receiving room volume, in cubic metres;

V_0 is the reference receiving room volume; for dwellings, $V_0 = 50 \text{ m}^3$.

Note 1 to entry: $L'_{i,Fmax,V,T}$ is expressed in decibels.

Note 2 to entry: Background information can be found in reference [13].

3.16 equivalent sound absorption area of a room

A
hypothetical area of a totally absorbing surface without diffraction effects which, if it were the only absorbing element in the room, would give the same reverberation time as the room under consideration and is calculated using Sabine's formula in Equation (6)

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

where

V is the receiving room volume, in cubic metres;

T is the reverberation time in the receiving room.

Note 1 to entry: A is expressed in square metres.

4 Instrumentation

4.1 General

The instruments for measuring sound pressure levels, including microphone(s) as well as cable(s), windscreen(s), recording devices and other accessories, if used, shall meet the requirements for a class 0 or 1 instrument according to IEC 61672-1 for random incidence application.

Filters shall meet the requirements for a class 0 or 1 instrument according to IEC 61260.

The reverberation time measurement equipment shall comply with the requirements defined in ISO 3382-2.

The impact sources shall meet the requirements given in Annex A.

4.2 Calibration

At the beginning and at the end of every measurement session and at least at the beginning and the end of each measurement day, the entire sound pressure level measuring system shall be checked at one or more frequencies by means of a sound calibrator meeting the requirements for a class 0 or 1 instrument according to IEC 60942. Each time the calibrator is used, the sound pressure level measured with the calibrator should be noted in the field documentation of the operator. Without any further adjustment, the difference between the readings of two consecutive checks shall be less or equal to 0,5 dB. If this value is exceeded, the results of measurements obtained after the previous satisfactory check shall be discarded.

4.3 Verification

Compliance of the sound pressure level measuring instrument, the filters and the sound calibrator with the relevant requirements shall be verified by the existence of a valid certificate of compliance. If applicable, random incidence response of the microphone shall be verified by a procedure from IEC 61183. All compliance testing shall be conducted by a laboratory being accredited or otherwise nationally authorized to perform the relevant tests and calibrations and ensuring metrological traceability to the appropriate measurement standards.

NOTE Unless national regulations dictate otherwise, it is recommended that the sound calibrator should be calibrated at intervals not exceeding 1 year, the compliance of the instrumentation system with the requirements of IEC 61672-1

should be verified at intervals not exceeding two years, and the compliance of the filter set with the requirements of IEC 61260 should be verified at intervals not exceeding two years.

5 Frequency range

5.1 Tapping machine as the impact source

All quantities 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

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

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

4 000, 5 000

NOTE Measurement of additional information in the low- and high-frequency ranges is optional.

5.2 Rubber ball as the impact source

All quantities shall be measured using one-third octave or octave band filters.

One-third octave band filters shall have at least the following centre frequencies, in hertz:

50, 63, 80, 100, 125, 160, 200, 250, 315, 400, 500, 630

6 General

Determination of the impact sound insulation according to this part of ISO 16283 requires that one room is chosen as the receiving room into which sound is radiated due to an impact source operating on a partition. The room or space in which the impact source is operated is referred to as the source room.

The measurements that are required include the sound pressure levels in the receiving room with the impact source operating, the background noise levels in the receiving room when the impact source is switched off and the reverberation times in the receiving room.

Two impact sources are described: the tapping machine and the rubber ball.

Two measurement procedures are described that shall be used for the sound pressure level, the reverberation time and the background noise; a default procedure and an additional low-frequency procedure.

For the sound pressure level and the background noise, the default procedure requires measurements to be taken in the central zone of a room at positions away from the room boundaries. With the tapping machine as the impact source, the default procedure for all frequencies is to obtain the energy-average sound pressure level using a fixed microphone or a manually-held microphone moved from one position to another, an array of fixed microphones, a mechanized continuously-moving microphone or a manually-scanned microphone. With the rubber ball as the impact source, the default procedure for all frequencies is to obtain the energy-average sound pressure level using a fixed microphone or a manually-held microphone moved from one position to another or an array of fixed microphones.

For the sound pressure level and the background noise with the tapping machine as the impact source, the low-frequency procedure shall be used for the 50 Hz, 63 Hz, and 80 Hz one-third octave bands in the receiving room when its volume is smaller than 25 m³ (calculated to the nearest cubic metre). This procedure