DRAFT INTERNATIONAL STANDARD

ISO/DIS 10140-3

ISO/TC **43**/SC **2**

Secretariat: **DIN**

Voting begins on:
2020-06-19

Voting terminates on:
2020-09-11

Acoustics — Laboratory measurement of sound insulation of building elements —

Part 3:
Measurement of impact sound insulation

Acoustique — Mesurage en laboratoire de l'isolation acoustique des éléments de construction —

Partie 3: Mesurage de l'isolation au bruit de choc

ICS: 91.120.20

This document is circulated as received from the committee secretariat.

ISO/CEN PARALLEL PROCESSING

Reference number
ISO/DIS 10140-3:2020(E)

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Published in Switzerland

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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.

The procedures used to develop this document and those intended for its further maintenance are described in the ISO/IEC Directives, Part 1. In particular, the different approval criteria needed for the different types of ISO documents should be noted. This document was drafted in accordance with the editorial rules of the ISO/IEC Directives, Part 2 (see www.iso.org/directives).

Attention is drawn to the possibility that some of the elements of this document may be the subject of patent rights. ISO shall not be held responsible for identifying any or all such patent rights. Details of any patent rights identified during the development of the document will be in the Introduction and/or on the ISO list of patent declarations received (see www.iso.org/patents).

Any trade name used in this document is information given for the convenience of users and does not constitute an endorsement.

For an explanation of the voluntary nature of standards, the meaning of ISO specific terms and expressions related to conformity assessment, as well as information about ISO's adherence to the World Trade Organization (WTO) principles in the Technical Barriers to Trade (TBT), see www.iso.org/iso/foreword.html.

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

This second edition cancels and replaces the first edition (ISO 10140-3:2010) and the Amendment ISO 10140-3:2010/Amd1:2015, which have been technically revised.

The main changes compared to the previous edition are as follows:

— normative references updated

— terms and definitions updated

— all references updated

— in 5.2 third paragraph added

— in 5.4 a) and b) revised

— title of Clause 8 changed to “Measurement uncertainty”

A list of all parts in the ISO 10140 series can be found on the ISO website.

Any feedback or questions on this document should be directed to the user’s national standards body. A complete listing of these bodies can be found at www.iso.org/members.html.

Introduction

ISO 10140 (all parts) concerns laboratory measurement of the sound insulation of building elements (see Table 1).

ISO 10140-1 specifies the application rules for specific elements and products, including specific requirements for preparation, mounting, operating and test conditions. ISO 10140-2 and this part of ISO 10140 contain the general procedures for airborne and impact sound insulation measurements, respectively, and refer to ISO 10140-4 and ISO 10140-5 where appropriate. For elements and products without a specific application rule described in ISO 10140-1, it is possible to apply ISO 10140-2 and this part of ISO 10140. ISO 10140-4 contains basic measurement techniques and processes. ISO 10140-5 contains requirements for test facilities and equipment. For the structure of ISO 10140 (all parts), see Table 1.

ISO 10140 (all parts) was created to improve the layout for laboratory measurements, ensure consistency and simplify future changes and additions regarding mounting conditions of test elements in laboratory and field measurements. It is intended for ISO 10140 (all parts) to present a well-written and arranged format for laboratory measurements.

It is intended to update ISO 10140-1 with application rules for other products.

Table 1 — Structure and contents of ISO 10140 (all parts)

Relevant part of ISO 10140	Main purpose, contents and use	Detailed content
ISO 10140-1	It indicates the appropriate test procedure for elements and products. For certain types of element/product, it can contain additional and more specific instructions about quantities and test element size and about preparation, mounting and operating conditions. Where no specific details are included, the general guidelines are according to ISO 10140-2 and ISO 10140-3.	Appropriate references to ISO 10140-2 and ISO 10140-3 and product-related, specific and additional instructions on: – specific quantities measured; – size of test element; – boundary and mounting conditions; – conditioning, testing and operating conditions; – additional specifics for test report.
ISO 10140-2	It gives a complete procedure for airborne sound insulation measurements according to ISO 10140-4 and ISO 10140-5. For products without specific application rules, it is sufficiently complete and general for the execution of measurements. However, for products with specific application rules, measurements are carried out according to ISO 10140-1, if available.	– Definitions of main quantities measured – General mounting and boundary conditions – General measurement procedure – Data processing – Test report (general points)

Table 1 *(continued)*

Relevant part of ISO 10140	Main purpose, contents and use	Detailed content
ISO 10140-3	It gives a complete procedure for impact sound insulation measurements according to ISO 10140-4 and ISO 10140-5. For products without specific application rules, it is sufficiently complete and general for the execution of measurements. However, for products with specific application rules, measurements are carried out according to ISO 10140-1, if available.	– Definitions of main quantities measured – General mounting and boundary conditions – General measurement procedure – Data processing – Test report (general points)
ISO 10140-4	It gives all the basic measurement techniques and processes for measurement according to ISO 10140-2 and ISO 10140-3 or facility qualifications according to ISO 10140-5. Much of the content is implemented in software.	– Definitions – Frequency range – Microphone positions – SPL measurements – Averaging, space and time – Correction for background noise – Reverberation time measurements – Loss factor measurements – Low-frequency measurements – Radiated sound power by velocity measurement
ISO 10140-5	It specifies all information needed to design, construct and qualify the laboratory facility, its additional accessories and measurement equipment (hardware).	Test facilities, design criteria: – volumes, dimensions; – flanking transmission; – laboratory loss factor; – maximum achievable sound reduction index; – reverberation time; – influence of lack of diffusivity in the laboratory. Test openings: – standard openings for walls and floors; – other openings (windows, doors, small technical elements); – filler walls in general. Requirements for equipment: – loudspeakers, number, positions; – tapping machine and other impact sources; – measurement equipment. Reference constructions: – basic elements for airborne and impact insulation improvement; – corresponding reference performance curves.

Acoustics — Laboratory measurement of sound insulation of building elements —

Part 3:
Measurement of impact sound insulation

1 Scope

This part of ISO 10140 specifies laboratory methods for measuring the impact sound insulation of floor assemblies.

The test results can be used to compare the sound insulation properties of building elements, classify elements according to their sound insulation capabilities, help design building products which require certain acoustic properties and estimate the in situ performance in complete buildings.

The measurements are performed in laboratory test facilities in which sound transmission via flanking paths is suppressed. The results of measurements made in accordance with this part of ISO 10140 are not applicable directly to the field situation without accounting for other factors affecting sound insulation, such as flanking transmission, boundary conditions, and loss factor.

A test method is specified that uses the standard tapping machine (see ISO 10140-5:2020, Annex E) to simulate impact sources like human footsteps when a person is wearing shoes. This part of ISO 10140 is applicable to all types of floors (whether heavyweight or lightweight) with all types of floor coverings. The test method applies only to laboratory measurements.

NOTE When the aim of impact sound insulation measurements is to have a strong correlation between a “real” impact source (e.g. a person walking or children jumping) and an artificial impact source (e.g. a tapping machine), it is intended that both sources apply the same input force spectrum to ensure the correct ranking of floors and floor coverings for the “real” and the artificial source, and it is intended that the impedance spectra of the sources be the same. If the “real” impact source is a walking person without shoes and the artificial source is a standard tapping machine such as that specified in Clause 4, the correlation is not strong.

An alternative method, using a heavy/soft impact source for assessing the impact sound insulation of a floor against impact sources with strong low-frequency components, such as human footsteps (bare feet) or children jumping, is given in Annex A. Alternative impact sources (i.e. a proposed modification of the standard tapping machine to make its dynamic source characteristics similar to those of a person walking barefoot and a heavy/soft impact source with dynamic source characteristics similar to those of children jumping) are defined in ISO 10140-5:2020, Annex F.

A method to test floor coverings is described in ISO 10140-1:2020, Annex H, for single- or multi-layer floor coverings installed on specific reference floors. In the case of multi-layer coverings, they can be factory-assembled or assembled at the test site.

2 Normative references

The following documents are referred to in the text in such a way that some or all of their content constitutes requirements 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/DIS 10140-1:2020, *Acoustics — Laboratory measurement of sound insulation of building elements — Part 1: Application rules for specific products*

ISO/DIS 10140-4:2020, *Acoustics — Laboratory measurement of sound insulation of building elements — Part 4: Measurement procedures and requirements*

ISO/DIS 10140-5:2020, *Acoustics — Laboratory measurement of sound insulation of building elements — Part 5: Requirements for test facilities and equipment*

IEC 60942, *Electroacoustics — Sound calibrators*

IEC 61260-1, *Electroacoustics — Octave-band and fractional-octave-band filters — Part 1: Specifications*

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

3 Terms and definitions

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

ISO and IEC maintain terminological databases for use in standardization at the following addresses:

— IEC Electropedia: available at http://www.electropedia.org/

— ISO Online browsing platform: available at https://www.iso.org/obp

3.1
impact sound pressure level
L_i
energy 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 source

Note 1 to entry: L_i is expressed in decibels.

Note 2 to entry: The energy average sound pressure level in a room is defined in ISO 10140-4.

3.2
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

$$L_n = L_i + 10 \lg \frac{A}{A_0} \text{ dB} \quad (1)$$

where

A_0 = 10 m^2.

Note 1 to entry: L_n is expressed in decibels.

Note 2 to entry: The measured equivalent absorption area, A, of the receiving room is defined in ISO 10140-4.

4 Facilities and equipment

Laboratory test facilities shall comply with the requirements of ISO/DIS 10140-5:2020, Annex A.

The tapping machine shall meet the requirements given in ISO/DIS 10140-5:2020, Annex E.

Requirements for equipment used to measure the sound level, and for calibration of that equipment, are given in ISO 10140-5.

NOTE Alternative methods using a modified tapping machine or a standard heavy/soft impact source can provide information suitable for assessing the impact sound insulation of a floor or a floor covering against common impact sources, for instance a person walking without shoes or a child jumping. Procedures for measurements using a heavy/soft impact source are given in Annex A, with requirements for alternate impact sources given in ISO/DIS 10140-5:2020, Annex F.

5 Test procedure and evaluation

5.1 General procedure

Two vertically adjacent rooms are used, the upper one being designated the "source room" and the lower one the "receiving room". A floor, which is the test element, separates these two rooms (see Clause 6). The impact source is placed on top of the test element at different positions and the sound pressure levels are measured in the receiving room, normally in the frequency range of 100 Hz to 5 000 Hz (optional down to 50 Hz). The equivalent sound absorption area in the receiving room is calculated from reverberation time measurements. From the sound pressure levels in the receiving room, the quantities described in Clause 3 shall be evaluated by taking into account the equivalent absorption area. The procedures used to determine the energy average sound pressure level corrected for background noise and the reverberation time are specified in ISO/DIS 10140-4:2020, 4.2 and 4.3.

Precautions should be taken to verify that airborne sound transmission from the source to the receiving room (including any leakage at the perimeter of the test element) is at least 10 dB below the level of transmitted impact sound in each frequency band, see 5.4.

A method for testing floor coverings is described in ISO/DIS 10140-1:2020, Annex H, for single- or multi-layer floor coverings installed on specific reference floors. In the case of multi-layer coverings, they may be factory-assembled or assembled at the test site.

5.2 Generation of sound field

The impact sound shall be generated by the standard tapping machine, as specified in Clause 4. Each set of measurements should be made with as many impact source positions as necessary to yield a reliable mean value.

NOTE When the aim of impact sound insulation measurements is to have a strong correlation between a "real" impact source (e.g. a person walking or children jumping) and an artificial impact source (e.g. a tapping machine), both sources apply the same input force spectrum, to ensure the correct ranking of floors and floor coverings for the "real" and the artificial source, and the impedance spectra of the sources are the same. If the "real" impact source is a walking person without shoes and the artificial source is a standard tapping machine such as that specified in Clause 4, the correlation is not strong.

An alternative method, using a heavy/soft impact source for assessing the impact sound insulation of a floor against impact sources with strong low-frequency components, such as human footsteps (bare feet) or children jumping, is given in Annex A. Alternative impact sources (i.e. a proposed modification of the standard tapping machine to make its dynamic source characteristics similar to those of a person walking barefoot and a heavy/soft impact source with dynamic source characteristics similar to those of children jumping) are defined in ISO 10140-5:2020, Annex F.

Also other types of impact sources can be applied, as for example rainfall on roofs and roof elements. Such sources are defined in ISO 10140-5:2020, Annex H, while the specific application is treated in ISO 10140-1:2020, Annex K.

When a floor element includes a soft covering, the standard tapping machine shall fulfil special requirements (specified in ISO/DIS 10140-5:2020, Annex E). If the test surface is covered with an extremely soft covering or the surface is very uneven, such that the hammers are not able to fall down

the requisite 40 mm to the surface on which the supports rest, pads may be used under the supports to ensure the correct falling height of 40 mm.

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

For testing a floor, the tapping machine shall be placed in at least four different positions. The minimum distance between tapping machine positions shall be at least 0,7 m. The distance of the tapping machine from the edges of the floor shall be at least 0,5 m.

For heavyweight homogeneous floors, such as solid concrete, the positions and orientation of the tapping machine shall be randomly distributed over the whole area of the floor under test.

For inhomogeneous floor constructions (such as hollow core concrete slabs or lightweight floors with ribs, beams, joists, etc.) or floors with rough and/or irregular floor coverings, additional positions should be used to yield a reliable mean value. The positions shall be randomly distributed on the floor under test. The line of hammers shall be orientated at 45° to the direction of the beams, ribs or joists (see ISO/DIS 10140-1:2020, H.4.6.2).

Additional requirements for positioning the tapping machine when testing floor coverings are given in ISO/DIS 10140-1:2020, Annex H. Each set of measurements (bare floor and covered floor) shall be made with as many machine positions as necessary to yield a reliable mean value, but the specific locations and the number of positions depend both on the category of floor covering and on the type of reference floor on which the covering is installed.

The sound field in the receiving room shall not be affected by the presence of people in the source or receiving room during the tests.

5.3 Data processing

Calculate the normalized impact sound pressure levels (as defined in Clause 3) from the measured (and, if necessary, corrected-for-background noise) energy average sound pressure levels in the receiving room and the measured reverberation times, as described in ISO/DIS 10140-4:2020, 4.2, 4.3, 4.5 and 4.6.

If normalized impact sound pressure levels are needed in octave bands, these values shall be calculated from the three one-third octave band values in each octave band using Equation (2):

$$L_{\mathrm{n,oct}} = 10\ \lg\left(\sum_{j=1}^{3} 10^{L_{\mathrm{n,1/3oct},j}/10}\right) \qquad (2)$$

Perform all calculations with the appropriate accuracy and present the final results with a precision no higher than the nearest 0,1 dB.

The evaluation of the single-number rating from the results in one-third octave bands shall be done in accordance with ISO 717-2.

5.4 Correction of airborne sound transmission

In case that the airborne sound transmission from the source to the receiving room cannot be neglected (this applies to situations where airborne and impact sound pressure level in the receiving room differ by less than 10 dB, for instance for long reverberation times in the source room or floors with good impact but poor airborne sound insulation) the measured impact sound shall be corrected. Make the correction in the following way:

a) Place the loudspeaker at the edge of the source room at a distance of 1,0 m from the closest wall, and height of 1,0 m from the floor (both distances are relative to the centre of the loudspeaker). Only one (1) loudspeaker position is required. With the loudspeaker source on, the resulting sound