INTERNATIONAL STANDARD

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Acoustics — Laboratory measurement of sound insulation of building elements —

Part 2: Measurement of airborne sound insulation

Acoustique — Mesurage en laboratoire de l'isolation acoustique des éléments de construction —
Partie 2: Mesurage de l'isolation au bruit aérien

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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.

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.

ISO 10140-2 was prepared by Technical Committee ISO/TC 43, *Acoustics*, Subcommittee SC 2, *Building acoustics*.

This first edition of ISO 10140-2, together with ISO 10140-1, ISO 10140-3, ISO 10140-4 and ISO 10140-5, cancels and replaces ISO 140-1:1997, ISO 140-3:1995, ISO 140-6:1998, ISO 140-8:1997, ISO 140-10:1991, ISO 140-11:2005 and ISO 140-16:2006, which have been technically revised.

It also incorporates the Amendments ISO 140-1:1997/Amd.1:2004 and ISO 140-3:1995/Amd.1:2004.

ISO 10140 consists of the following parts, under the general title Acoustics — Laboratory measurement of sound insulation of building elements:

— *Part 1: Application rules for specific products*

— *Part 2: Measurement of airborne sound insulation*

— *Part 3: Measurement of impact sound insulation*

— *Part 4: Measurement procedures and requirements*

— *Part 5: Requirements for test facilities and equipment*

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. This part of ISO 10140 and ISO 10140-3 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 this part of ISO 10140 and ISO 10140-3. 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. It is also intended to incorporate ISO 140-18 into ISO 10140 (all parts).

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)
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 2:
Measurement of airborne sound insulation

1 Scope

This part of ISO 10140 specifies a laboratory method for measuring the airborne sound insulation of building products, such as walls, floors, doors, windows, shutters, façade elements, façades, glazing, small technical elements, for instance transfer air devices, airing panels (ventilation panels), outdoor air intakes, electrical raceways, transit sealing systems and combinations, for example walls or floors with linings, suspended ceilings or floating floors.

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 total loss factor.

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

ISO 717-1, *Acoustics — Rating of sound insulation in buildings and of building elements — Part 1: Airborne sound insulation*

ISO 10140-1, *Acoustics — Laboratory measurement of sound insulation of building elements — Part 1: Application rules for specific products*

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

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

3 Terms and definitions

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

3.1
sound reduction index
R
ten times the common logarithm of the ratio of the sound power, W_1, that is incident on the test element to the sound power, W_2, radiated by the test element to the other side

$$R = 10 \lg \frac{W_1}{W_2} \tag{1}$$

NOTE 1 R is expressed in decibels.

For laboratory measurements using sound pressure, the sound reduction index is calculated using:

$$R = L_1 - L_2 + 10 \lg \frac{S}{A} \tag{2}$$

where

L_1 is the energy average sound pressure level in the source room, in decibels;

L_2 is the energy average sound pressure level in the receiving room, in decibels;

S is the area of the free test opening in which the test element is installed, in square metres;

A is the equivalent sound absorption area in the receiving room, in square metres.

NOTE 2 The derivation of Equation (2) from Equation (1) assumes that the sound fields are diffuse and that the only sound radiated into the receiving room is from the test element.

NOTE 3 The expression “sound transmission loss” (TL) is also in use in English-speaking countries. It is equivalent to “sound reduction index”.

NOTE 4 Related quantities can be introduced in other documents or test codes, often by adding subscripts, i.e. R_I for the sound reduction index as measured by intensity methods, R_s as the sound reduction index per unit length of slits or ΔR as the improvement in sound reduction index by linings or suspended ceilings.

3.2
apparent sound reduction index
R'
ten times the common logarithm of the ratio of the sound power, W_1, that is incident on a test element to the total sound power radiated into the receiving room if, in addition to the sound power, W_2, radiated by the test element, the sound power, W_3, radiated by flanking elements or by other components is significant

$$R' = 10 \lg \left(\frac{W_1}{W_2 + W_3} \right) \tag{3}$$

NOTE 1 R' is expressed in decibels.

NOTE 2 In general, the sound power transmitted into the receiving room consists of the sum of several components. Also, in this case, under the assumption that there are diffuse sound fields in the two rooms, the apparent sound reduction index is evaluated from Equation (4).

$$R' = L_1 - L_2 + 10 \lg \frac{S}{A} \tag{4}$$

Thus, in the apparent sound reduction index, the sound power transmitted into the receiving room is related to the sound power that is incident on the test element, as in Equation (2), irrespective of the actual conditions of transmission.

3.3
element-normalized level difference
$D_{n,e}$
level difference corresponding to a reference value of absorption area in the receiving room with sound transmission through the small technical element only; this level difference is evaluated from Equation (5)

$$D_{n,e} = L_1 - L_2 + 10 \lg\left(\frac{A_0}{A}\right) \quad (5)$$

where

L_1 is the energy average sound pressure level in the source room, in decibels;

L_2 is the energy average sound pressure level in the receiving room, in decibels;

A_0 is the reference absorption area, in square metres (for the laboratory, $A_0 = 10$ m^2);

A is the equivalent absorption area in the receiving room, in square metres.

NOTE 1 $D_{n,e}$ is expressed in decibels.

NOTE 2 To achieve a better signal-to-noise ratio, simultaneous measurements can be performed on more than one element. When performing simultaneous measurements, replace Equation (5) by Equation (6).

$$D_{n,e} = L_1 - L_2 + 10 \lg\left(\frac{nA_0}{A}\right) \quad (6)$$

where

$D_{n,e}$ is the element-normalized level difference of an individual element;

n is the number of installed elements.

3.4
small technical element
building element, excluding windows and doors, with an area of less than 1 m^2, which occurs in a certain number of discrete sizes and transmits sound between two adjacent rooms or between one room and the outdoors independently of any adjoining building elements

4 Facilities and equipment

Laboratory test facilities shall comply with the requirements given in ISO 10140-5.

The equipment used to generate the sound field shall meet the requirements given in ISO 10140-5.

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

5 Test procedure and evaluation

5.1 General procedure

Two horizontally or vertically adjacent rooms are used, one being designated the source room and the other the receiving room. The test element is mounted in an opening in the partition between those rooms (see Clause 6). In the source room, a diffuse sound field is generated by a moving loudspeaker or loudspeakers at two or more fixed positions. The average sound pressure levels are measured in the source and receiving

rooms, normally in the frequency range of 100 Hz to 5 000 Hz (optionally down to 50 Hz). The equivalent sound absorption area in the receiving room is calculated from reverberation time measurements. From the sound pressure level difference between the rooms, the quantities described in Clause 3 can be evaluated by taking into account the equivalent absorption area and, where appropriate, the size or number of test elements. The procedures used to determine the average sound pressure levels corrected for background noise and the reverberation time are specified in ISO 10140-4.

People shall not be present in the source or receiving rooms during measurements to avoid affecting the sound field.

In the case of sound insulation improvement systems, such as acoustical linings, this procedure is repeated for the basic element and that the element with the lining under test.

5.2 Sound field in the source room

Qualification of the loudspeaker system, the number and positions of loudspeakers and the method of operation shall be performed in accordance with ISO 10140-5.

When using a single sound source at two or more positions, these may be in the same room or the measurements may be repeated in the opposite direction by changing source and receiving rooms with one or more source positions in each room. The latter is not possible if the test element has one surface which is significantly more absorbent than the other (see 6.1).

The microphone positions in the source room shall be outside the direct sound field of the source and the radiation characteristics of the sources shall be taken into account when determining microphone positions, as specified in ISO 10140-4.

5.3 Data processing

Calculate the sound reduction index or the element-normalized level difference (as defined in Clause 3) from the measured (and, if necessary, corrected) energy average sound pressure levels in the rooms and the measured reverberation time, as described in ISO 10140-4.

If sound reduction indices or element-normalized level differences are needed in octave bands, these values shall be calculated from the three one-third octave band values in each octave band using Equation (7) or Equation (8):

$$R_{\text{oct}} = -10\lg\left(\sum_{n=1}^{3}\frac{10^{-R_{1/3\text{oct},n}/10}}{3}\right) \tag{7}$$

$$D_{\text{n,e,oct}} = -10\lg\left(\sum_{n=1}^{3}\frac{10^{-D_{\text{n,e,1/3oct},n}/10}}{3}\right) \tag{8}$$

Perform all calculations with the appropriate accuracy and present the final results with no higher precision than to 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 717-1.

5.4 Expression of results

For the statement of the airborne sound insulation of the test element, the measurement results, R or $D_{\text{n,e}}$, shall be given in decibels at all measurement frequencies in one-third octave bands to one decimal place, both in tabular form and in the form of a curve.

Graphs in the test report shall show the value in decibels plotted against frequency on a logarithmic scale; the following dimensions shall be used:

a) 5 mm for a one-third octave band;

b) 20 mm for 10 dB.

The use of a test report form in accordance with Annex B is preferred. Being a short version of the test report, it shall state all information of importance regarding the test element, the test procedure and the test results.

6 Test arrangement

6.1 General

General requirements for the preparation, curing, installation and mounting of the test element is described in this clause. For specific types of elements and products, detailed specifications may be given in related documents; for instance, test codes are covered in ISO 10140-1.

The test element can be of the following different types [a) to e)].

a) The test element can have dimensions that can be fitted in the available full-size test opening (e.g. brick wall, wooden floor). In this case, it shall be in accordance with 6.2 (test element in large test opening).

b) The test element can be of the same kind as in a), but smaller, provided it fulfils the requirement of 6.3.

c) The dimensions of the test element can be fixed and smaller than the test opening (e.g. doors, windows, window panes and panels). In this case, it shall fulfil the requirements of 6.4.

d) The test element can be small in size and its dimensions ill-defined (e.g. transfer air devices and outdoor air intakes). In this case, shall be in accordance with 6.5.

e) The test element of interest can be connected to a base wall/floor element, for example wall lining, floating floor, window frame and sealing. In this case, it shall fulfil the requirements for specific test codes for procedures and evaluation of the data in ISO 10140-1.

Sound transmission can depend on the temperature, relative humidity and static pressure in the test rooms at the time of test and during curing or conditioning of the test element. The conditions shall be reported.

The sound reduction index of heavyweight walls and floors depends on structural coupling to the laboratory structure. In order to describe the effect of the mounting, it is recommended that the total loss factor be measured and the result stated in the test report (see ISO 10140-4:2010, 4.7).

If the test element is installed in an aperture between the source room and the receiving room, the ratio of the aperture depths on either side of the test element shall be approximately 2:1, within 20 % if possible, unless this is inconsistent with the practical use of the test element.

If the test element has one surface which is significantly more absorbent than the other, the surface with the higher absorption shall face the source room and diffusing elements shall be installed in the source room.

If the test element is intended to be openable, install it for the test in such a way that it can be opened and closed in the normal manner, and open and close it before testing (see ISO 10140-1).

6.2 Full-size test opening

The size of the test element is determined by the full-size test opening of the laboratory test facility as defined in ISO 10140-5.