INTERNATIONAL STANDARD

ISO 10140-5

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Acoustics — Laboratory measurement of sound insulation of building elements —

Part 5: Requirements for test facilities and equipment

Acoustique — Mesurage en laboratoire de l'isolation acoustique des éléments de construction —
Partie 5: Exigences relatives aux installations et appareillages d'essai

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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 10140-5 was prepared by Technical Committee ISO/TC 43, *Acoustics*, Subcommittee SC 2, *Building acoustics*.

This first edition of ISO 10140-5, together with ISO 10140-1, ISO 10140-2, ISO 10140-3 and ISO 10140-4, 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. ISO 10140-2 and ISO 10140-3 contain the general procedures for airborne and impact sound insulation measurements, respectively, and refer to ISO 10140-4 and this part of ISO 10140 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 ISO 10140-3. ISO 10140-4 contains basic measurement techniques and processes. This part of ISO 10140 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 5: Requirements for test facilities and equipment

1 Scope

This part of ISO 10140 specifies laboratory test facilities and equipment for sound insulation measurements of building elements, such as:

— components and materials;

— building elements;

— technical elements (small building elements);

— sound insulation improvement systems.

It is applicable to laboratory test facilities with suppressed radiation from flanking elements and structural isolation between source and receiving rooms.

This part of ISO 10140 specifies qualification procedures for use when commissioning a new test facility with equipment for sound insulation measurements. It is intended that these procedures be repeated periodically to ensure that there are no issues with the equipment and the test facility.

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

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 9052-1:1989, *Acoustics — Determination of dynamic stiffness — Part 1: Materials used under floating floors in dwellings*

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

ISO 10140-2, *Acoustics — Laboratory measurement of sound insulation of building elements — Part 2: Measurements of airborne sound insulation*

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

ISO 10140-4:2010, *Acoustics — Laboratory measurement of sound insulation of building elements — Part 4: Measurement procedures and requirements*

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

IEC 60942:2003, *Electroacoustics — Sound calibrators*

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

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

IEC 61672-2, *Electroacoustics — Sound level meters — Part 2: Pattern evaluation tests*

IEC 61672-3, *Electroacoustics — Sound level meters — Part 3: Periodic tests*

3 Laboratory test facilities for airborne sound insulation measurements

3.1 General

The laboratory test facility shall consist of two adjacent reverberant rooms with a test opening between them, in which the test element is inserted.

The area of the test opening can vary depending on the type of test element. This part of ISO 10140 defines full-sized test openings, a specific small-sized test opening and alternative reduced-size test openings.

For measurement of the improvement of sound reduction index by acoustical linings, these rooms shall be separated by a standard basic element on which the lining under test is installed (see Annex B).

3.2 Test rooms

3.2.1 Volume

The volumes of the test rooms shall be at least 50 m^3. Volumes and corresponding dimensions of the two test rooms should not be exactly the same. A difference of at least 10 % in room volumes and in the linear dimensions is recommended.

Choose the ratios of the room dimensions such that the eigen mode frequencies in the low-frequency bands are spaced as uniformly as possible.

When measuring the sound insulation of walls or floors, theoretical calculation as well as experiments have indicated that the test element should cover a total partition wall or ceiling of the test room, i.e. the test opening should extend from wall to wall and from floor to ceiling. In such a case, a volume of 50 m^3 to 60 m^3 is appropriate in view of the recommended size of the test opening.

3.2.2 Diffusion

Large variations of the sound pressure level in the room indicate the presence of dominating strong standing waves. In this case, diffusing elements shall be installed in the rooms. The positioning and number of diffusing elements should be arranged in such a way that the sound reduction index is not influenced when further diffusing elements are installed.

NOTE For some kinds of test element, as for elements with one surface significantly more absorbent than the other (see ISO 10140-2), the installation of diffusing elements is mandatory.

3.2.3 Reverberation time

The reverberation time in the rooms under normal test conditions (with negligible absorption by the test element) should not be excessively long or short. When the reverberation time at frequencies at and above 100 Hz exceeds 2 s or is less than 1 s, check whether the measured sound reduction index depends on the reverberation time. When such a dependence is found, even with diffusers in the rooms, the rooms shall be modified to adjust the reverberation time, T, such that:

$$1 \leqslant T \leqslant 2(V/50)^{2/3} \tag{1}$$

where

V is the value of the room volume, in cubic metres;

T is the reverberation time, in seconds.

Measurement of the reverberation time is given in ISO 10140-4.

3.2.4 Background noise

The background noise level in the receiving room shall be sufficiently low to permit measurements of the sound transmitted from the source room, considering the power output in the source room and the sound insulation of the test elements for which the laboratory is intended (see ISO 10140-4:2010, 4.3).

3.2.5 Suppression of flanking transmission

In laboratory test facilities designed for measuring the sound reduction index, the sound transmitted by any indirect path should be negligible compared with the sound transmitted through the test element. One approach to achieve this in such facilities is to provide sufficient structural isolation between source and receiving rooms. Another approach is to cover all surfaces of both rooms with linings that reduce the flanking transmission in such a way that the requirements on room volumes and reverberation times are still met.

Annex A gives methods for estimating the maximum achievable sound reduction index, R'_{max}, which is determined by indirect paths.

3.3 Test opening

A horizontal and a vertical full-sized test opening, as well as a specific vertical small-sized test opening are defined. Other reduced-size test openings may be applied under certain restrictions.

3.3.1 Full-sized test opening

The area of the full-sized test opening shall be approximately 10 m^2 for walls, and between 10 m^2 and 20 m^2 for floors, with the length of the shorter edge being not less than 2,3 m for both walls and floors.

3.3.1.1 General frame specification

The measured sound reduction index of a test element can be affected by the connections to the laboratory structure surrounding the element. The mass ratio of the tested structure to the surrounding structure should be taken into consideration. For tests on lightweight structures ($m < 150$ kg/m^2), there are no special requirements to be taken into account. For heavier structures under test, it should be ensured that the loss factor, η, of the test element is not less than that given by Equation (2):

$$\eta_{min} = 0{,}01 + \frac{0{,}3}{\sqrt{f}} \tag{2}$$

where f is the test frequency value, in hertz.

To check this requirement, use as the test element a brick or block wall having a mass of (400 ± 40) kg/m^2 plastered on one side. Measurement of the loss factor is given in ISO 10140-4.

3.3.1.2 Specific requirements on the frame for lightweight twin-leaf partitions

With lightweight twin-leaf partitions, the sound reduction index is affected by vibration transmission between the wall leaves via the frame of the test opening (see Figure 1). This is influenced by the mounting conditions in the laboratory test opening and by the material properties and dimensions of the frame(s). Vibration transmission between the coupled structures of the partition itself (e.g. common or coupled studs) is dependent on the specific construction of the partition and is a property of the test element itself. This vibration transmission is not treated in this part of ISO 10140.

In order to improve the reproducibility of the sound reduction index between laboratories for walls, guidance is given for the mass per unit area of the frame of the test opening. If there is an acoustic break in the laboratory test opening, the frame on one side of that break should be considered. The mass per unit area of the frame shall be much larger than the mass per unit area of the heaviest leaf of the double partition. The ratio of the mass per unit area of the heaviest leaf of the double partition to that of the frame of the test opening shall be at least 1:6. The minimum thickness of the frame should be 100 mm and the minimum depth should be 200 mm. The frame shall have a density of at least 2 000 kg/m^3. The cross-sectional surface mass shall be more than 450 kg/m^2. In addition, the frame(s) shall consist of a homogeneous, massive construction, such as dense concrete or masonry. Wood or metal frames connecting the two leaves shall not be used.

The surface mass per unit area is calculated from the density, ρ, and the thickness, t, of the elements, as shown in Figure 2, using Equations (3) and (4):

$$m'_{\mathrm{L}} = \rho_{\mathrm{L}}\, t_{\mathrm{L}} \tag{3}$$

where

m'_{L} is the mass per unit area of the test facility wall, in kilograms per square metre;

ρ_{L} is the density of the test facility wall, in kilograms per cubic metre;

t_{L} is the thickness of the test facility wall, in metres.

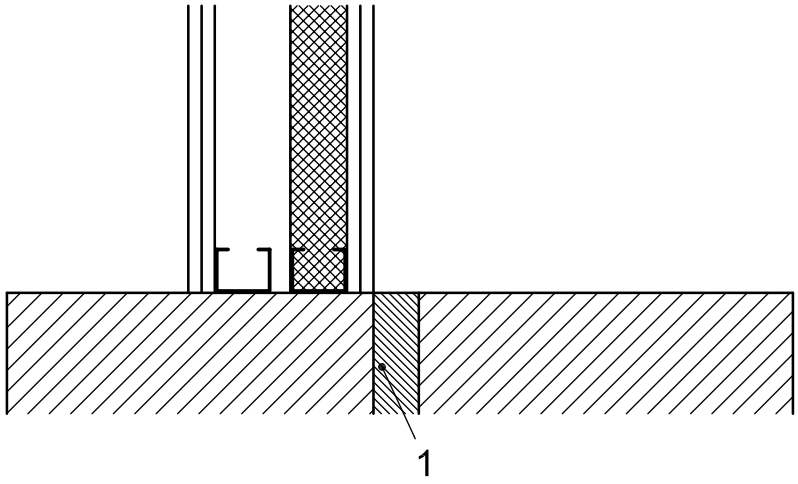
$$m'_{\mathrm{e}} = \rho_{\mathrm{e}}\, t_{\mathrm{e}} \tag{4}$$

where

m'_{e} is the mass per unit area of the element, in kilograms per square metre;

ρ_{e} is the density of the element, in kilograms per cubic metre;

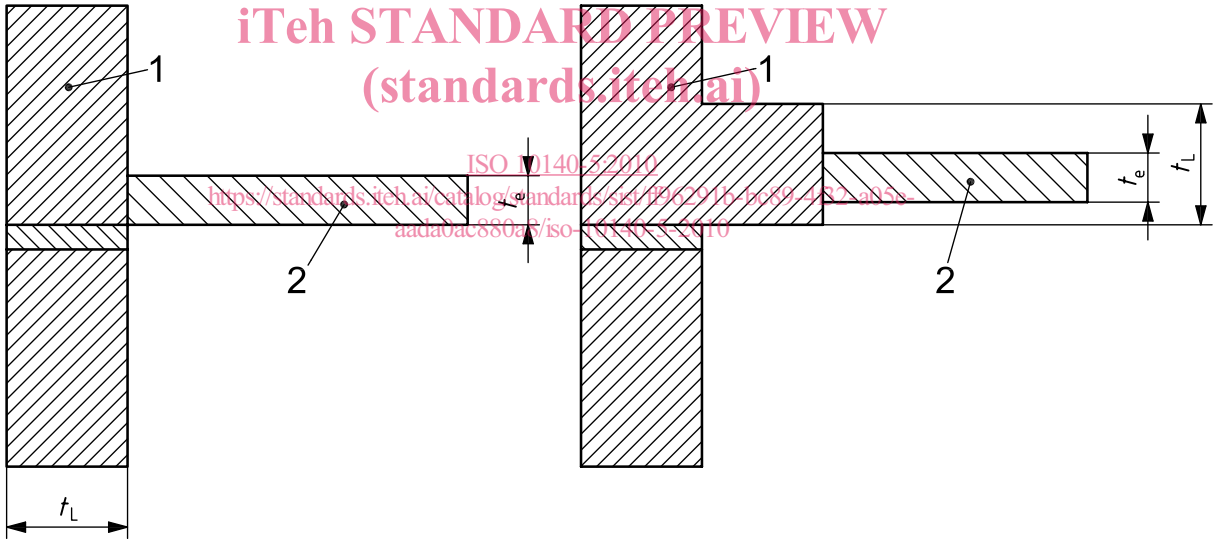
t_{e} is the thickness of the element, in metres.



Key

1 frame of the test opening

Figure 1 — Vibration transmission across the border frame of the test opening



Key

1 test facility wall

2 element under test

t_L thickness of the test facility wall

t_e thickness of the test element

Figure 2 — Determination of the mass per unit area of the elements

3.3.2 Reduced-size test opening

The test opening may have a reduced area:

a) if the test element area is smaller than the full-sized test opening;

b) if special acoustical conditions are met on the test element;

c) if the test element is a small technical element.

Reduced-size test openings are specified in ISO 10140-1 and ISO 10140-2.

3.3.3 Specific small-sized test opening

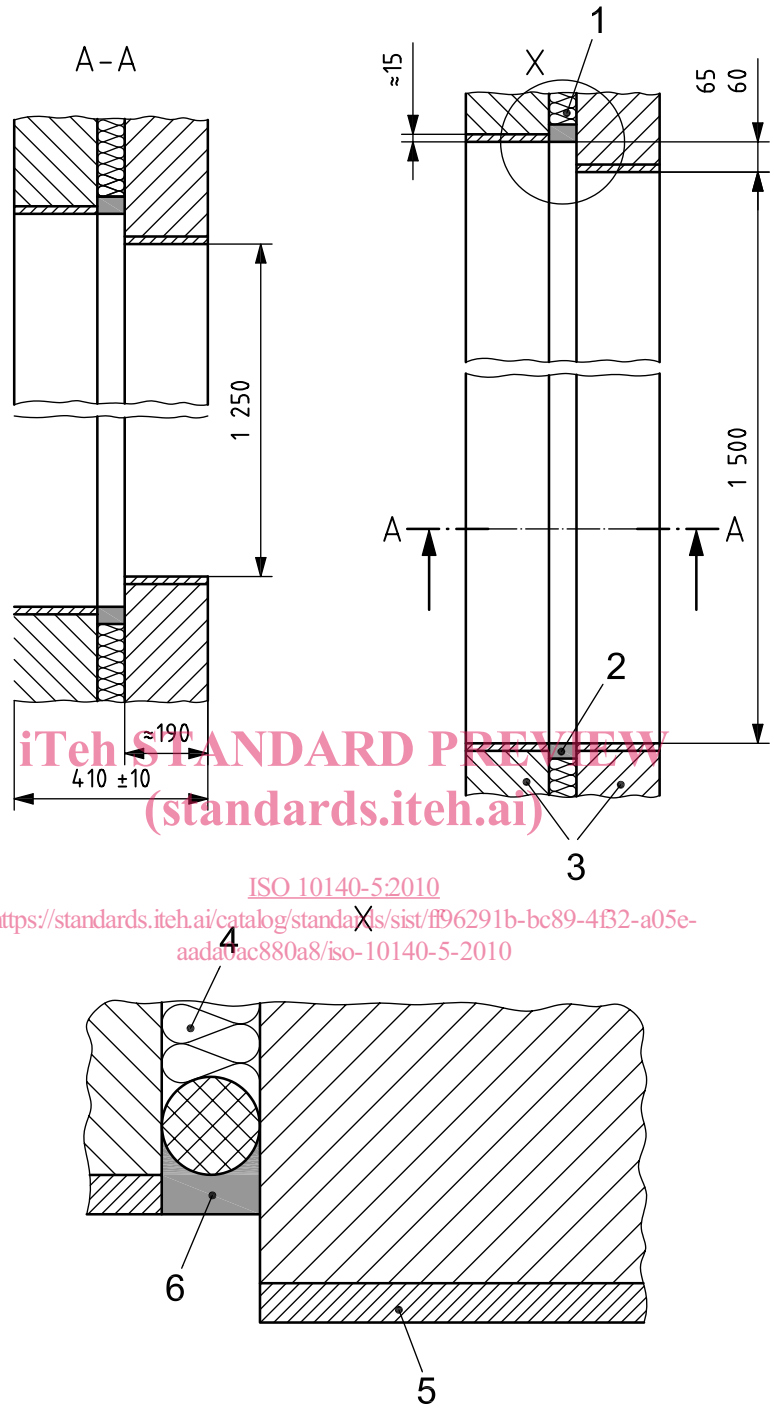
Specific small-sized test openings are 1 250 mm in width and 1 500 mm in height, with an allowable tolerance on each dimension of ± 50 mm, preferably maintaining the same aspect ratio. The test opening has a maximum depth of 500 mm, with staggered niches with a reflective finish. The larger niche is 60 mm to 65 mm wider at the sides and the top only.

The wall with the test opening is constructed from two walls of about equal thickness made of concrete, plastered bricks or similar material with a density of at least 1 800 kg/m^3. The gap between the two walls is filled with mineral wool and shall be covered with an airtight reflecting material. This wall may be a filler wall in the full-sized test opening.

A vertical and a horizontal section are shown in Figure 3 with a detail of the gap as an example of the test opening within the specifications given. The dimensions of the niches in the horizontal section shall be the same as in the vertical section.

The minimum distance between the small-sized test opening and any wall, floor or ceiling of either room shall be 500 mm. The opening should not be symmetrical in the separating wall.

Dimensions in millimetres



Key

1	mineral wool	4	mineral wool
2	resilient material (acoustically reflective)	5	reflective finishing
3	double partition wall	6	resilient material (acoustically reflective)

Care should be taken to ensure that the resilient material does not add flanking transmission by coupling the two walls.

Figure 3 — Example of the construction of the specific small-sized test opening