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Acoustics — Measurement of sound insulation in buildings and of building elements —

Part 1:
Requirements for laboratory test facilities with suppressed flanking transmission

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

Partie 1: Spécifications relatives aux laboratoires sans transmissions latérales

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Contents

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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.

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 140-1 was prepared by Technical Committee ISO/TC 43, *Acoustics*, Subcommittee SC 2, *Building acoustics*.

This third edition cancels and replaces the second edition (ISO 140-1:1990), 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*

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

Acoustics — Measurement of sound insulation in buildings and of building elements —

Part 1:
Requirements for laboratory test facilities with suppressed flanking transmission

1 Scope

This part of ISO 140 lays down specifications concerning laboratory test facilities for sound insulation measurements of building elements. It applies to laboratory test facilities with suppressed radiation from flanking elements; and/ or structural isolation between source and receiving rooms.

2 Normative references

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 140-3:1995, *Acoustics — Measurement of sound insulation in buildings and of building elements — Part 3: Laboratory measurements of airborne sound insulation of building elements.*

ISO 140-8:1997, *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.*

3 Laboratory test facilities for airborne sound insulation measurements under diffuse field conditions

The laboratory test facility consists of two adjacent reverberant rooms with a test opening between them in which the test specimen is inserted.

3.1 Rooms

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

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

NOTE — Theoretical calculation as well as experiments have indicated that it is probably advisable, when measuring walls or floors, that the specimen should cover a total partition wall or ceiling of the test room, i.e. the test opening should extend from wall to wall and/or from ceiling to floor. 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.

Large variations of the sound pressure level in the room indicate the presence of dominating strong standing waves. In this case it is necessary to install diffusing elements in the rooms. Evaluate by experiments the positions and the necessary number of elements with the goal that the sound reduction index is not influenced when further diffusing elements are installed.

The reverberation time in the rooms under normal test conditions (with negligible absorption by the test object) should not be excessively long or short. Where the reverberation time at low frequencies 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 room shall be modified to adjust the reverberation time, T, in seconds, at low test frequencies such that

$$1 \text{ s} \le T \le 2 (V/50)^{2/3} \text{ s}$$

where V is the value of the room volume, in cubic metres.

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 specimens for which the laboratory is intended.

In laboratory test facilities for measuring the sound reduction index, the sound transmitted by any indirect path should be negligible compared with the sound transmitted through the test specimen. One way to achieve this in such facilities is to provide sufficient structural isolation between source and receiving room. Another method might be to cover all surfaces of both rooms with linings that reduce the flanking transmission sufficiently.

Methods for the estimation of the maximum achievable sound reduction index R'_{max}, which is determined by indirect paths are given in annex A.

The measured sound reduction index of a specimen is affected by the internal loss factor of the structures surrounding the specimen. The mass ratio of the tested structure to the surrounding ones are to be taken into account. For tests on lightweight structures (m < 150 kg/m^2) there are no special related requirements to be taken into account. For heavier structures under test it should be ensured that the power dissipation of the surrounding structures is such that the loss factor η of the test specimen is not less than

$$\eta_{min} = 0{,}01 + 0{,}3/\sqrt{f}$$

where f is the value of test frequency, in hertz.

To check this requirement, use a brick or block wall having a mass of (400 ± 40) kg/m^2 plastered on one side as the test object. For measurement of the loss factor see ISO 140-3:1995, annex E.

3.2 Test opening

3.2.1 Walls and floors

The area of the test opening should 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 not less than 2,3 m for both walls and floors.

A test opening with a smaller area may be used, if the wavelength of free flexural waves at the lowest frequency considered is smaller than half the minimum dimensions of the specimen. The smaller the specimen, however, the more sensitive the results will be to edge constraint conditions and to local variations in sound fields. The sound insulation of the specimen itself is also dependent on the size. If appropriate, it is recommended to use the test opening for glazings described in annex C.

3.2.2 Doors and similar components

For tests of doors and similar components, a test opening with an area of less than 10 m^2 may be appropriate. The test opening for doors shall be so arranged that the lower edge is situated near to the level of the floor of the test rooms such that conditions in the building are reproduced.

3.2.3 Windows and glazings

A test opening with an area of less than 10 m^2 may also be appropriate for tests on glazing samples or window assemblies. These shall be inserted into a filler wall built into the test aperture between the two rooms.

The filler wall shall comply with the following requirements:

a) its sound insulation at any test frequency shall be such that the sound energy transmitted through the wall is at least 6 dB, but preferably more than 15 dB lower than that transmitted by the test specimen (a method for testing the sound insulation of the filler wall including any flanking transmission is given in annex B);

b) the total thickness of the filler wall shall not exceed 500 mm;

c) the niche depths on each side of the test specimen shall be different, preferably approximately in the ratio of 2:1 and the boundaries of the niche shall be lined with materials having a sound absorption coefficient of less than 0,1 at all test frequencies.

The dimensions of the test opening for glazings shall be 1250 mm × 1500 mm with an allowable tolerance on each dimension of ± 50 mm, preferably maintaining the same aspect ratio. The same size is preferred for windows, but variations from this size may be necessary in recognition of national building practice.

In the case of a window assembly or a glazed door, dimensions may be chosen to be representative of the assembly used in practical circumstances.

For glazings the test opening shall be staggered on both sides and on the top with a step between 60 mm and 65 mm. The glazing shall be mounted in the smaller opening as shown in figure 1, for windows the test opening may be staggered or not, but a staggered opening is preferred for certification purposes.

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

An example of a suitable construction for the filler wall with the test opening is given in annex C.

NOTE — The details for the test conditions for the measurement of the sound insulation of glazings are prescribed in order to ensure the best possible comparison between results obtained by different laboratories.

Dimensions in millimetres

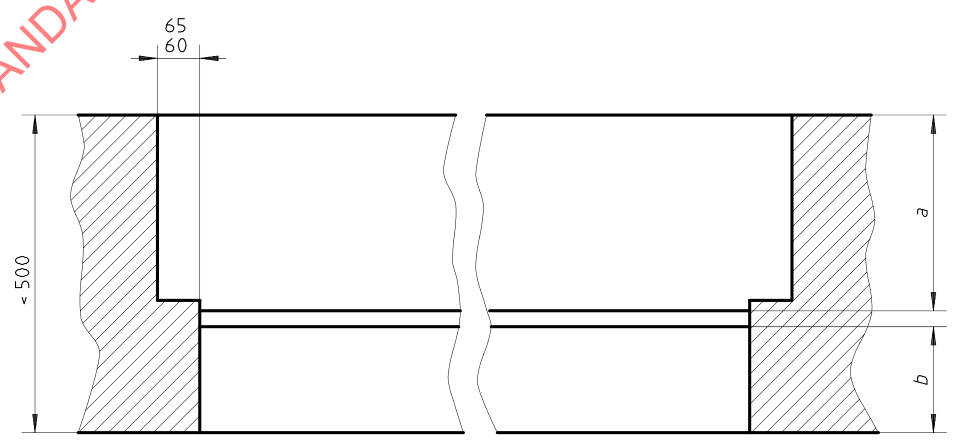

Figure 1 — Geometry of the test opening with glazing, horizontal section

4 Laboratory test facilities for impact sound insulation measurements of floors and floor coverings

4.1 Receiving room

The volume of the receiving room shall be not less than 50 m^3. The ratios of the receiving room dimensions shall be so chosen that the modal frequencies in the low-frequency bands are spaced as uniformly as possible. If necessary, diffusing elements shall be installed in the receiving room to obtain a diffuse sound field.

NOTE — Theoretical calculation as well as some experiments have indicated that it may be advisable that the specimen should cover the total ceiling of the receiving room, i.e. the test opening should extend from wall to wall. 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.

The reverberation time in the receiving room under normal test conditions (with negligible absorption by the test object) should not be excessively long or short. Where the reverberation time at low frequencies exceeds 2 s or is less than 1 s, check whether the measured impact sound insulation depends on the reverberation time. When such a dependence is found, even with diffusers in the room, the room shall be modified to adjust the reverberation time, T, in seconds, at low test frequencies such that

$$1 \text{ s} \leq T \leq 2\,(V/50)^{2/3} \text{ s}$$

where V is the value of the room volume, in cubic metres.

The background noise level in the receiving room shall be sufficiently low to permit measurements of the transmitted impact sound, considering the properties of the tapping machine and the sound insulation of the specimen for which the test facility is intended.

The airborne sound insulation between the receiving room and the source room shall be sufficiently high that the sound field measured in the receiving room is only that generated by the impact excitation of the floor under test.

4.2 Test opening

It is recommended that the size of the test opening for floors should be between 10 m^2 and 20 m^2, with the shorter edge length not less than 2,3 m.

When measuring reduction in impact sound pressure level by floor coverings in accordance with ISO 140-8, the size of the test opening shall be at least 10 m^2.

Annex A
(normative)

Estimation of the maximum achievable sound reduction index

A.1 General

A sketch showing the different transmission paths between the rooms in a test facility is given in figure A.1. The direct path is Dd; whereas Fd, Ff, Df are flanking paths.

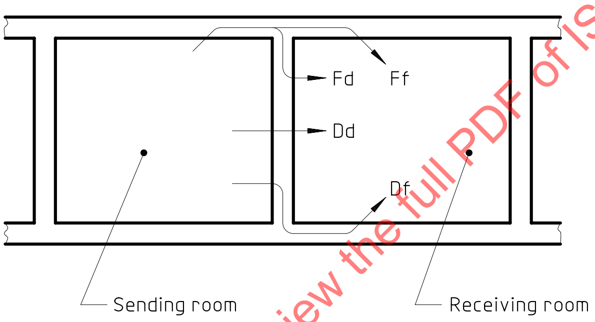

Figure A.1 — Transmission paths in a test facility

The maximum sound reduction index of a building element that can be measured in a laboratory without being significantly affected by flanking transmission will depend on the type of element being tested. Therefore, it would be desirable to assess the contribution of flanking transmission whenever a high performance element is tested. As this is impractical, R'_{max} shall be measured for a range of constructions which are representative of those normally tested. The appropriate R'_{max} shall be stated in the test report as required by ISO 140-3.

Six representative constructions are specified below, and the ones most similar to the elements normally tested by the laboratory shall be used for the R'_{max} tests. Laboratories with a test opening for testing walls have either a solid or cavity permanent separating wall. When it is a cavity type, the two leaves of the representative construction may be built on the same side of the cavity or with one leaf on each side of the cavity. However, the values of R'_{max} obtained shall only apply to the configurations tested. The procedure to check the validity of test results with regard to R'_{max} is given in ISO 140-3:1995, 5.2.1.

A.2 Representative constructions

For wall and floor constructions of type A (see below), the flanking path is mainly Ff and is only slightly influenced by the type of test construction. For wall and floor constructions of types B and C, flanking includes paths Ff, Fd, and Df which are all influenced by the mass of the nominal separating construction. For wall and floor constructions of types B and C, the additional lining shall be applied to the heavyweight test construction in such a way that only transmission via path Dd is reduced.

A.2.1 Walls

Type A: Lightweight panels

A two leaf partition; each leaf should comprise layers of plasterboard or other board material of similar mass per area (at least 30 kg/m^2). The cavity between the leaves shall be at least 200 mm wide and shall contain mineral wool at least 100 mm thick. The leaves shall be supported on timber or metal studs and shall not be mechanically connected to each other. The perimeter of the lightweight panels shall not be rigidly bonded to the permanent structure.

Type B: Lightweight masonry wall

A brick or block wall, plastered on one side, having a mass per unit area of (100 ± 10) kg/m^2. On one side there shall be constructed an independent lining comprising two layers of 12,5 mm plasterboard supported on a timber or metal stud frame which is not connected to the wall. The lining shall be on that side of the wall facing that room on which the wall is supported. The perimeter of the lightweight lining shall not be rigidly bonded to the permanent structure. The cavity between the wall and the lining shall be at least 50 mm wide and shall contain mineral wool.

Type C: Heavyweight masonry wall

A brick or block wall, plastered on one side, having a mass per unit area of (400 ± 40) kg/m^2. On one side there shall be constructed an independent lining comprising two layers of 12,5 mm plasterboard supported on a timber or metal stud frame which is not connected to the wall. The cavity between the wall and the lining shall be at least 50 mm wide and shall contain mineral wool. The lining shall be on that side of the wall facing that room on which the wall is supported. The perimeter of the lightweight lining shall not be rigidly bonded to the permanent structure.

A.2.2 Floors

Type A: Lightweight floor

The lightweight floor can be constructed with the ceiling supported from joists below those which support the floor. The construction details shall be equivalent to the lightweight wall described above.

Type B: Lightweight masonry floor

A masonry base having a mass per unit area of (100 ± 10) kg/m^2, sealed on one side with plaster. A lining comprising two layers of 12,5 mm plasterboard should be suspended below the masonry from independent joists, with mineral wool in the cavity. The perimeter of the lightweight suspended lining shall not be rigidly bonded to the permanent structure. Alternatively, the lining may "float" on the masonry, supported by 75 mm thick mineral wool.

Type C: Heavyweight concrete floor

A homogeneous, reinforced concrete slab of thickness (120^{+40}_{-20}) mm — preferably 140 mm for the construction of new laboratories — meeting the requirements of the reference floor in ISO 140-8. A lining comprising two layers of 12,5 mm plasterboard should be suspended below the concrete floor from independent joists, with mineral wool in the cavity. The lightweight suspended lining shall not be rigidly bonded to the permanent structure. Alternatively, the lining may "float" on the concrete floor, supported by 75 mm thick mineral wool.

Table A.1 gives typical values of R'_{max} for a laboratory capable of measuring walls and floors of type C having values of R_w up to 55 dB. The values in table A.1 are for example only and should not be regarded as target values.

Table A.1 — Typical values of R'_{max} in a laboratory for testing walls and floors of type C

Frequency	Hz	100	125	160	200	250	315	400	500	630
R'_{max} **for paths Ff, Fd and Df**	dB	45	50	53	56	58,5	61	63,5	66	68,5
Frequency	Hz	800	1 000	1 250	1 600	2 000	2 500	3 150	4 000	5 000
R'_{max} **for paths Ff, Fd and Df**	dB	71	73,5	76	78,5	81	83,5	86	88,5	91

Annex B
(normative)

Measurement of the sound reduction index of the filler wall (and any flanking construction) for test openings for windows and glazings

B.1 General

The apparent sound reduction index of the filler wall including all flanking elements, calculated using the area of the test opening, should be at least 6 dB higher than the sound reduction index of the test specimen at any frequency. This can be determined by measuring the apparent sound reduction index with substantially reduced transmission through the test specimen. This value used for the test purpose only is denoted as R'_T.

B.2 Recommended method

A recommended way of reducing transmission through the test specimen in order to measure R'_T is to mount an additional flexible layer of mass per unit area of 25 kg/m^2 (e.g. gypsum board covered with 2 mm thick iron sheet) of which the perimeter will be completely tight, flush with the face of the filler wall in that part of the test opening where the test specimen is mounted and fill the space between this layer and the test specimen with absorbing material.

B.3 Alternative method

An alternative method to determine R'_T, described below, may be used if the method given above is not applicable, for example when there is resonance between the test object and the additional layer.

Use the additional layer but remove the test specimen and install 1 mm thick sheet lead glued to wood chipboard at the place of the test opening where the test specimen was mounted and fill the intervening space with absorbing material. The joint between the two layers of the filler wall (if relevant) shall not be covered by this construction.

B.4 Expression of results

Results of sound reduction index measurements of glazings or windows which have to be calculated in accordance with ISO 140-3 by use of the area S which is equal to the free test opening and which are to be tested regarding the influence of the filler wall are denoted here as R'_S. These values of R'_S shall be compared with the values of the apparent sound reduction index R'_T measured with the constructions described above or an equivalent method. If the difference is greater than or equal to 6 dB but smaller than 15 dB, the result of the measurement R'_S shall be corrected for the influence of the flanking transmission by calculating R_S as follows:

$$R_S = -10 \lg \left(10^{-R'_S/10} - 10^{-R'_T/10} \right) \text{ dB}$$

where

R_S is the corrected sound reduction index of the test specimen, in decibels;

R'_S is the sound reduction index measured with the test specimen in the test opening, in decibels;

R'_T is the sound reduction index measured with the special construction in the test opening, in decibels.