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Acoustics — Laboratory and field measurement of flanking transmission for airborne, impact and building service equipment sound between adjoining rooms —

Part 4: Application to junctions with at least one Type A element

Acoustique — Mesurage en laboratoire et sur le terrain des transmissions latérales du bruit aérien, des bruits de choc et du bruit d'équipement technique de bâtiment entre des pièces —

Partie 4: Application aux jonctions ayant au moins un élément de Type A

Reference number
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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 on 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 the following URL: 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 10848-4:2010), which has been technically revised. The main change is the extension to field measurements.

A list of all the parts in the ISO 10848 series can be found on the ISO website.

Acoustics — Laboratory and field measurement of flanking transmission for airborne, impact and building service equipment sound between adjoining rooms —

Part 4:
Application to junctions with at least one Type A element

1 Scope

ISO 10848 (all parts) specifies measurement methods to characterize the flanking transmission of one or several building components.

This document specifies laboratory and field measurements of buildings where at least one of the elements that form the construction under test is a Type A element (defined in ISO 10848-1).

Laboratory measurements are used to quantify the performance of the junction with suppressed flanking transmission from the laboratory structure. Field measurements are used to characterize the *in situ* performance and it is not usually possible to suppress unwanted flanking transmission sufficiently; hence, the results are primarily representative of the performance of that junction when installed in that particular building structure.

The measured quantities can be used to compare different products, or to express a requirement, or as input data for prediction methods, such as ISO 12354-1 and ISO 12354-2.

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 10848-1:2017, *Acoustics — Laboratory and field measurement of flanking transmission for airborne, impact and building service equipment sound between adjoining rooms — Part 1: Frame document*

ISO 12999-1, *Acoustics — Determination and application of measurement uncertainties in building acoustics — Part 1: Sound insulation*

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 http://www.iso.org/obp

3.1
vibration reduction index
K_{ij}
direction-averaged velocity level difference between two elements across a junction that is normalised to the junction length and the equivalent sound absorption length of both elements as follows

$$K_{ij} = \overline{D_{v,ij}} + 10\lg\left(\frac{l_{ij}}{\sqrt{a_i a_j}}\right)$$

where

$\overline{D_{v,ij}}$	is the direction-averaged velocity level difference between elements *i* and *j*, in dB;
l_{ij}	is the junction length between elements *i* and *j*, in m;
a_i, a_j	are the equivalent absorption lengths of elements *i* and *j*, in m.

Note 1 to entry: This quantity is expressed in decibels.

Note 2 to entry: K_{ij} can be obtained from measurements of the velocity level difference in both directions across the junction and the structural reverberation time of the two elements *i* and *j*.

4 Principle

The relevant quantity to be measured is selected in accordance with ISO 10848-1:2017, 4.5. The performance of the building components is expressed as the vibration reduction index, K_{ij}, which, in principle, is an invariant quantity.

5 Instrumentation

The equipment shall fulfil the requirements of ISO 10848-1:2017, Clause 5.

6 Test arrangement

6.1 Requirements for the laboratory

The general requirements on the test facility shall be fulfilled according to ISO 10848-1:2017, 6.1.

For measurement of the vibration reduction index, K_{ij}, with structure-borne excitation, it is not necessary to have a building envelope forming a source and receiving room around the junction.

NOTE The presence or absence of such a building envelope can have a significant effect on coupled concrete/masonry elements[5].

6.2 Requirements for a building structure in the field situation

The requirements on the test facility and test elements for laboratory measurements in ISO 10848-1:2017, 6.1 can be used as a guide for field measurements. However, it will not usually be possible to satisfy them in the field; hence, the connected building structure shall be described in the test report.

NOTE In the field situation, the velocity level difference will typically be lower than in the laboratory due to flanking transmission involving other connected elements, and when measuring structural reverberation times, the energy returning from other connected elements tends to increase the error in the absorption length[5].

6.3 Installation of the test junction

6.3.1 Type A elements

The behaviour of Type A elements can be influenced significantly by the boundary conditions. At low frequencies, the mode count in a one-third octave band and the modal overlap factor are important parameters for the measurement accuracy.

The mode count in a one-third octave band, N, is determined by modal analysis or estimated from Formula (1):

$$N = B\, n \tag{1}$$

where

B is the bandwidth of a one-third octave band which shall be assumed to be 0,23 f, where f is the band centre frequency;

n is the modal density, in modes per hertz, estimated from Formula (2):

$$n = \frac{\sqrt{3}S}{hc_\mathrm{L}} = \frac{\pi S f_\mathrm{c}}{c_0^2} \tag{2}$$

where

S is the surface area of the element, in m^2;

h is the plate thickness, in m;

c_L is the longitudinal wavespeed, in m/s;

f_c is the critical frequency, in Hz;

c_0 is the speed of sound in air, in m/s.

The critical frequency shall be calculated according to ISO 10848-1:2017, 4.3.3.

The modal overlap factor, M, is calculated from Formula (3):

$$M = \frac{2{,}2\,n}{T_\mathrm{s}} \tag{3}$$

where T_s is the measured structural reverberation time, in s.

For every Type A element that is a part of the junction under test, check whether the modal overlap factor is at least unity at 250 Hz and higher frequencies.

The modal overlap factor should be at least unity or representative of the *in situ* value. The mode count in a one-third octave band should be as high as possible, and five or more modes per one-third octave band is often considered sufficient.

NOTE K_{ij} is generally overestimated when measured for a transmission path that includes an element with a modal overlap factor less than unity[6]. It follows from Formulae (2) and (3) that the mode count in a one-third octave band, as well as the modal overlap factor, can be increased by increasing the surface area of the element, and that the modal overlap factor can also be increased when the energy loss of the element is increased. Higher energy losses can be provided by connecting the edges of the elements to structurally independent constructions to increase the energy loss to these constructions without having a short circuit through the supporting structure. For some types of elements, higher energy losses can also be obtained by using viscoelastic damping material between the vibrating elements and non-vibrating surroundings to obtain large shear deformation of the damping material.

6.3.2 Type B elements

For Type B elements, it is not compulsory to use realistic construction techniques at the boundaries of the test element with the test facility. When the test facility is made of concrete, a Type B test element may be mounted according to common practice or according to the manufacturer's instructions.

If the test junction is built off the floor without any supporting structure, the other edges can be left unconnected.

6.3.3 Transmission through structures of the test facility or building structure in the field situation

The verification specified in ISO 10848-1:2017, Clause 8 shall be carried out. The number of transmission paths to be checked depends on the test facility and test elements.

7 Test procedures

The frequency range for measurements is given in ISO 10848-1:2017, 7.4.

K_{ij} shall be measured with structure-borne excitation as described in ISO 10848-1:2017, 7.2.

An assessment of strong coupling between Type A elements shall be carried out as described in ISO 10848-1:2017, 4.3.3.

For Type B elements where the actual situation has no real influence on the sound reduction index and damping of an element, a_j shall be taken as numerically equal to the surface area S_j of the element, $a_j = S_j/l_0$, where the reference length l_0 = 1 m.

8 Precision

The measurement procedure shall give satisfactory repeatability. This is determined in accordance with the method described in ISO 12999-1 and shall be verified from time-to-time, particularly when a change is made in the procedure or instrumentation.

Different organizations should periodically perform comparison measurements on the same test specimen to check repeatability and reproducibility of their test procedures.

9 Expression of results

For the statement of the vibration reduction index, K_{ij}, the results shall be given at all frequencies of measurement to one decimal place 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, using the following dimensions:

— 5 mm for one-third octave;

— 20 mm for 10 dB.

The use of a form in accordance with ISO 10140-2:2010, Annex B or ISO 10140-3:2010, Annex B is recommended. All information of importance regarding the test specimen, the test procedure, and the test results shall be stated.

If results are needed in octave-bands, these values shall be calculated from the three one-third octave band values in each octave-band using Formula (4):

$$K_{ij,\mathrm{oct}} = -10\lg\left(\frac{1}{3}\sum_{n=1}^{3}10^{-K_{ij,1/3\mathrm{oct}.n}/10}\right) \tag{4}$$

If, for any Type A element that is a part of the junction under test, the modal overlap factor is less than unity at 250 Hz or higher frequencies, values for the modal overlap factor and mode count in a one-third octave band are determined in accordance with 6.3.1 and reported for all frequencies where the modal overlap factor is less than unity. The accuracy of the test results is reduced at these frequencies. If, for any of the Type A elements under investigation, the modal overlap factor at 250 Hz or higher frequencies is less than 0,25, results for K_{ij} are given in brackets at any frequency where the modal overlap factor is less than 0,25.

For the evaluation of a single-number rating for K_{ij}, see ISO 10848-1:2017, Clause 10. This single-number rating should not be based on measured values at frequencies where the modal overlap factor for any of the Type A elements under investigation is less than 0,25.

10 Test report

The test report shall contain at least the following information:

a) a reference to this document, i.e. ISO 10848-4:2017;

b) the name of the organization that performed the measurements;

c) an identification of the test site as laboratory (including name and address of the testing laboratory) or field;

d) the date of test;

e) the name of client;

f) the manufacturer's name and product identification;

g) a description of test junction with sectional drawing and mounting conditions, including size, thickness, mass per area, materials, curing time and conditions of components;

h) a statement indicating who mounted the laboratory test object (test institute or manufacturer);

i) a description of which transmission paths *i*, *j* have been investigated;

j) a brief description of test procedures and equipment, including any deviations from the procedures and any unusual features observed;

k) the type of excitation (stationary or transient structure-borne);

l) the vibration reduction index as a function of frequency and in terms of the single-number quantity for each of the low-frequency, mid-frequency, and high-frequency ranges defined in ISO 10848-1:2017, Clause 10;

m) the structural reverberation times;

n) information about whether the equivalent absorption length has been determined from the measured structural reverberation time or from the surface area;

o) an indication of results which are to be taken as limits of measurement. They shall be given in the form $K_{ij} \geq$ ... dB and applied if the velocity level on the receiving element in any band is not measurable on account of background noise (vibrational or electrical) and also if the measured value has been affected by transmission through other junctions with the constructions of the test facility;