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Acoustics — Laboratory measurement of the flanking transmission of airborne and impact sound between adjoining rooms —

Part 4: Application to junctions with at least one heavy element

Acoustique — Mesurage en laboratoire des transmissions latérales du bruit aérien et des bruits de choc entre pièces adjacentes —

Partie 4: Application aux jonctions ayant au moins un élément lourd

Reference number
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Case postale 56 • CH-1211 Geneva 20
Tel. + 41 22 749 01 11
Fax + 41 22 749 09 47
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Foreword

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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.

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ISO 10848-4 was prepared by the European Committee for Standardization (CEN) Technical Committee CEN/TC 126, *Acoustics properties of building elements and of buildings*, in collaboration with Technical Committee ISO/TC 43, *Acoustics*, Subcommittee SC 2, *Building acoustics*, in accordance with the Agreement on technical cooperation between ISO and CEN (Vienna Agreement).

ISO 10848 consists of the following parts, under the general title *Acoustics — Laboratory measurement of the flanking transmission of airborne and impact sound between adjoining rooms*:

— *Part 1: Frame document*

— *Part 2: Application to light elements when the junction has a small influence*

— *Part 3: Application to light elements when the junction has a substantial influence*

— *Part 4: Application to junctions with at least one heavy element*

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Introduction

ISO 10848 specifies measurement methods to be performed in a laboratory test facility in order to characterize the flanking transmission of one or several building components.

The measured quantities, normalized flanking level difference, normalized flanking impact sound pressure level or vibration reduction index, can be used to compare different products, or to express a requirement, or as input data for prediction methods, such as ISO 15712-1[1] and ISO 15712-2[2].

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Acoustics — Laboratory measurement of the flanking transmission of airborne and impact sound between adjoining rooms —

Part 4: Application to junctions with at least one heavy element

1 Scope

This part of ISO 10848 specifies laboratory measurements of normalized flanking level difference, normalized flanking impact sound pressure level or vibration reduction index of buildings where at least one of the elements that form the construction under test is not a light element.

This part of ISO 10848 applies to T- or X-junctions.

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 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 140-6:1998, *Acoustics — Measurement of sound insulation in buildings and of building elements — Part 6: Laboratory measurements of impact sound insulation of floors*

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 10848-1:2006, *Acoustics — Laboratory measurement of the flanking transmission of airborne and impact sound between adjoining rooms — Part 1: Frame document*

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3 Terms and definitions

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

3.1
normalized flanking level difference
$D_{n,f}$
difference in the space and time average sound pressure level produced in two rooms by one or more sound sources in one of them, when the transmission only occurs through a specified flanking path

NOTE $D_{n,f}$ is normalized to an equivalent sound absorption area (A_0) in the receiving room and is expressed in decibels:

$$D_{n,f} = L_1 - L_2 - 10 \lg \frac{A}{A_0} \text{ dB} \quad (1)$$

where

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

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

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

A_0 is the reference equivalent sound absorption area, in square metres; $A_0 = 10 \text{ m}^2$.

[ISO 10848-1:2006]

3.2
normalized flanking impact sound pressure level
$L_{n,f}$
space and time average sound pressure level in the receiving room produced by a standard tapping machine operating at different positions on a tested floor in the source room, when the transmission only occurs through a specified flanking path

NOTE $L_{n,f}$ is normalized to an equivalent sound absorption area (A_0) in the receiving room and is expressed in decibels:

$$L_{n,f} = L_2 + 10 \lg \frac{A}{A_0} \text{ dB} \quad (2)$$

where

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

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

A_0 is the reference equivalent sound absorption area, in square metres; $A_0 = 10 \text{ m}^2$.

[ISO 10848-1:2006]

3.3
vibration reduction index
K_{ij}
value given by the following equation and expressed in decibels:

$$K_{ij} = \overline{D_{v,ij}} + 10 \lg \frac{l_{ij}}{\sqrt{a_i a_j}} \text{ dB} \quad (3)$$

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where

$\overline{D_{v,ij}}$ is the direction-averaged velocity level difference between elements i and j, in decibels;

l_{ij} is the junction length between elements i and j in metres;

a_i, a_j are the equivalent absorption lengths of elements i and j, in metres.

[ISO 10848-1:2006]

NOTE 1 The equivalent absorption length depends on the structural reverberation time as defined in ISO 10848-1:2006, 3.8. For light, well-damped types of elements where the actual situation has no real influence on the sound reduction index and damping of an element, a_j is 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.

NOTE 2 The vibration reduction index is related to the vibrational power transmission over a junction between structural elements, normalized in order to make it an invariant quantity.

4 Principle

The relevant quantity to be measured is selected in accordance with ISO 10848-1:2006, 4.4. The performance of the building components is expressed either as an overall quantity for the combination of elements and junction like $D_{\mathrm{n,f}}$ and $L_{\mathrm{n,f}}$ or as the vibration reduction index, K_{ij}, of a junction. $D_{\mathrm{n,f}}$ and $L_{\mathrm{n,f}}$ depend on the actual dimensions of the elements, while K_{ij} is in principle an invariant quantity.

For general application of the test results, $D_{\mathrm{n,f}}$ and $L_{\mathrm{n,f}}$ are the relevant quantities to measure for characterizing the transmission between two light, well-damped types of elements, e.g. timber- or metal-framed stud walls or wooden floors on beams. To characterize the transmission between two heavy elements with reverberant vibration fields, K_{ij} is the relevant quantity to measure. It is not possible to give general guidelines about which quantity to select for transmission between light and heavy elements.

5 Measuring equipment

The equipment shall fulfill the requirements of ISO 10848-1:2006, Clause 5.

6 Test arrangement

6.1 Requirements for the laboratory

The general requirements for test specimens and test rooms given in ISO 10848-1:2006, Clause 6 shall be fulfilled.

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

6.2 Installation of the test junction

6.2.1 Light elements

For light 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 heavy concrete, a light test element may be mounted according to common practice, or according to the manufacturer's instructions.

If the test junction is just placed on the floor, without any supporting structure, the edges of all light elements may generally be left free.

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6.2.2 Heavy elements

For heavy elements, the mode count in a one-third-octave-band and the modal overlap factor are important parameters for the obtainable measurement accuracy at low frequencies. The mode count in a one-third-octave-band, N, is determined by modal analysis or estimated from:

$$N = B\,n \tag{4}$$

where

B is the bandwidth of a one-third-octave-band, approximated by 0,23 f in which f is the centre frequency of the band;

n is the modal density, estimated from:

$$n = \frac{\pi S f_c}{c_0^2} \tag{5}$$

in which

S is the surface area, in square metres, of the element j;

f_c is the critical frequency, in hertz;

c_0 is the speed, in metres per second, of sound in air.

Determination of the critical frequency is specified in ISO 10848-1:2006, 8.1.1.

The modal overlap factor, M, is calculated from:

$$M = \frac{2{,}2\,n}{T_s} \tag{6}$$

where

n is the the modal density;

T_s is the measured structural reverberation time.

For every heavy 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.

NOTE K_{ij} is generally overestimated when measured for a transmission path that includes an element with a modal overlap factor less than unity.

IMPORTANT — For measurement accuracy, the modal overlap factor needs to be as high as possible and preferably at least unity. The mode count in a one-third-octave-band should also be as high as possible. Five or more modes per one-third-octave-band is always regarded as satisfactory. It follows from Equations (4) to (6) that the mode count in a one-third-octave-band as well as the modal overlap factor increase with increasing surface area of the element, and that the modal overlap factor is also increased when the energy loss of the element is increased. Higher energy loss may 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 (an example is shown in Figure 1). For some types of elements, higher energy loss can be obtained with damping material between the vibrating elements and non-vibrating surroundings to obtain large shear deformation of the damping material.

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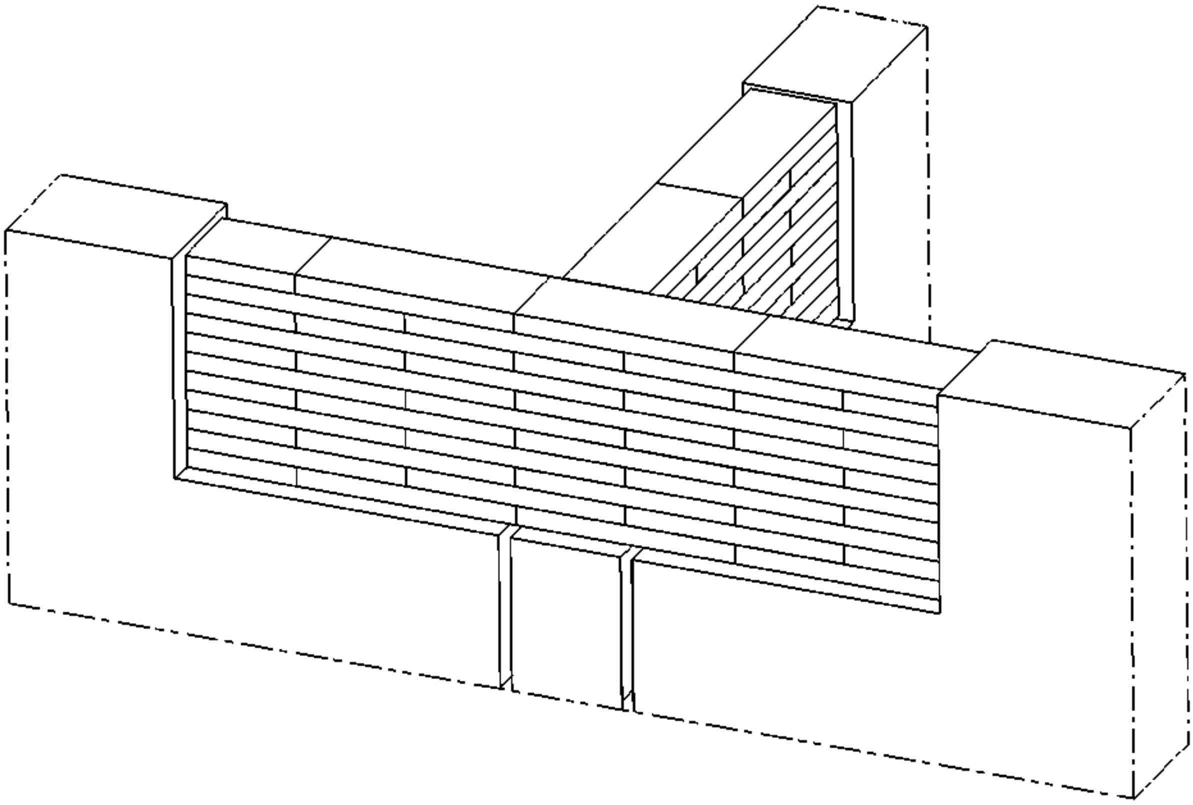

Figure 1 — Example of junction and surrounding constructions

6.2.3 Transmission through structures of the test facility

The verification specified in ISO 10848-1:2006, 8.1.1 shall be carried out. The number of transmission paths to be checked depends on the test facility and test specimen.

6.3 Shielding technique

Shielding is specified in ISO 10848-1:2006, Clause 9. Consider shielding if airborne excitation is used, or measure the sound pressure level on the receiving side of the junction as a part of the test.

7 Test procedures

Measure $D_{n,f}$ and $L_{n,f}$ as specified in ISO 10848-1:2006, 7.1 with airborne excitation or with a standardized tapping machine.

For measurements of $L_{n,f}$, the larger room shall be the receiving room.

Measure K_{ij} as specified in ISO 10848-1:2006, 7.2 (structure-borne excitation) or ISO 10848-1:2006, 7.4 (airborne excitation). The relevance of the test results is evaluated in accordance with ISO 10848-1:2006, 4.3.4.

The frequency range is given in ISO 10848-1:2006, 7.5.

Verify the maximum coupling between heavy elements in accordance with ISO 10848-1:2006, 4.3.3.

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8 Precision

The measurement procedure shall give satisfactory repeatability. This is determined in accordance with the method shown in ISO 140-2 and should be verified from time to time, particularly when a change is made in the procedure or instrumentation.

It is recommended that different organizations 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 normalized flanking level difference, $D_{n,f}$, the normalized flanking impact sound pressure level, $L_{n,f}$, or 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 140-3:1995, Annex G, or ISO 140-6:1998, Annex E is recommended. Being a short version of the test report, 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 one of Equations (7) to (9):

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

$$L_{n,f,oct} = 10 \lg \left(\sum_{n=1}^{3} 10^{L_{n,f,1/3oct.n}/10} \right) \text{dB} \tag{8}$$

$$K_{ij,oct} = -10 \lg \left(\frac{1}{3} \sum_{n=1}^{3} 10^{-K_{ij,1/3oct.n}/10} \right) \text{dB} \tag{9}$$

If $D_{n,f}$ is measured and the test procedure is repeated either in the same or in the opposite measurement direction, the arithmetic mean of all measurement results at each frequency band shall be calculated.

For the evaluation of single number ratings from the curves $D_{n,f}(f)$ or $L_{n,f}(f)$, see ISO 717-1 and ISO 717-2, respectively. The quantities obtained are the weighted normalized flanking level difference, $D_{n,f,w}$ (C; C_{tr}), and the weighted normalized flanking impact sound pressure level, $L_{n,f,w}$ (C_I).

If, for any heavy 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 6.2.2 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 heavy elements under investigation, the modal overlap factor at 250 Hz or higher frequencies is less than 0,25, results for $D_{n,f}$, $L_{n,f}$ or K_{ij} are given in brackets at any frequency where the modal overlap factor is less than 0,25.

For the evaluation of single number rating from the curve $K_{ij}(f)$, see ISO 10848-1:2006, Annex A.

Single number rating must not be based on measured values at frequencies where the modal overlap factor for any of the heavy elements under investigation is less than 0,25.

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10 Test report

The test report shall contain at least the following information:

a) a reference to this part of ISO 10848 (ISO 10848-4:2010);

b) name of the organization that performed the measurements;

c) identification of test site;

d) date of test;

e) name of client;

f) manufacturer's name and product identification;

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

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

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

j) volumes of both reverberant rooms if any;

k) air temperature and humidity in the measuring rooms or environments of the junction;

l) brief description of details of test procedure and equipment.

If $D_{n,f}$ and/or $L_{n,f}$ have been measured:

m) normalized flanking level difference or normalized flanking impact sound pressure level of the test junction as a function of frequency;

n) indication of results which are to be taken as limits of measurement. They shall be given as $D_{n,f} \geqslant x$ dB or $L_{n,f} \leqslant x$ dB. This shall be applied if the sound pressure level in any band is not measurable on account of background noise (acoustic or electrical) and also if the measured value has been affected by sound transmission through the constructions of the test facility;

If K_{ij} has been measured:

o) vibration reduction index and direction-averaged velocity level difference as a function of frequency;

p) type of excitation (stationary structure-borne, transient structure-borne or airborne);

q) structural reverberation time if measured;

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

s) possible limitations of the relevance of K_{ij} if the vibration fields of the elements are not reverberant or the coupling between the elements is too strong;

t) indication of results which are to be taken as limits of measurement — given in the form $K_{ij} \geqslant x$ dB and applied if the velocity level 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;

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If the modal overlap factor is less than unity at 250 Hz or higher frequencies for any heavy element that is a part of the junction under test:

u) information about the modal overlap factor and mode count in a one-third-octave-band in accordance with Clause 8;

v) remark on the test results for the considered frequencies stating that the accuracy of the results is reduced because of insufficient number of modes or lack of damping of the test construction;

w) remark on test results in brackets in accordance with Clause 8, stating that the accuracy of these results is very low because the modal overlap factor is less than 0,25 for at least one of the heavy elements under investigation.

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Bibliography

[1] ISO 15712-1, *Building acoustics — Estimation of acoustic performance of buildings from the performance of elements — Part 1: Airborne sound insulation between rooms*

[2] ISO 15712-2, *Building acoustics — Estimation of acoustic performance of buildings from the performance of elements — Part 2: Impact sound insulation between rooms*

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