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Laboratorijsko merjenje hrupa pri hoji po podu

Laboratory measurement of walking noise on floors

Messung von Gehschall auf Fußböden im Prüfstand

Mesurage en laboratoire du bruit des pas sur les planchers

Ta slovenski standard je istoveten z: EN 16205:2013+A1:2018

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EUROPEAN COMMITTEE FOR STANDARDIZATION
COMITÉ EUROPÉEN DE NORMALISATION
EUROPÄISCHES KOMITEE FÜR NORMUNG

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European foreword

This document (EN 16205:2013+A1:2018) has been prepared by Technical Committee CEN/TC 126 “Acoustic properties of building elements and of buildings”, the secretariat of which is held by AFNOR.

This European Standard shall be given the status of a national standard, either by publication of an identical text or by endorsement, at the latest by September 2018, and conflicting national standards shall be withdrawn at the latest by September 2018.

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This document includes Amendment 1 approved by CEN on 2018-02-12.

This document supersedes EN 16205:2013.

The start and finish of text introduced or altered by amendment is indicated in the text by tags [A1⟩ ⟨A1].

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Introduction

This document sets up a laboratory measurement method to determine noise radiated from a floor covering on a standard concrete floor when excited by a standard tapping machine. The noise is measured in the room where the floor covering and the excitation are located. There is no restriction concerning the type of floor covering unless that the required small pads of the flooring could not be assembled. Using the standard tapping machine according to EN ISO 10140 means that a more general excitation compared to walking alone is regarded – in the same way as it is accepted for impact sound improvement measurements of floor coverings. The results are expressed in terms of the normalised A-weighted average sound pressure level in the walking room. The results provide information about the noise radiated. A more sophisticated psychoacoustic evaluation did not seem to be appropriate in view of the fact that this measurement stands for a large range of sources with different acoustical behaviour (even if only different types of walking were regarded). A subjective classification of the quality of the floor coverings is not intended.

1 Scope

This European Standard specifies a laboratory measurement method to determine noise radiated from a floor covering on a standard concrete floor when excited by a standard tapping machine.

2 Normative references

The following documents, in whole or in part, are normatively referenced in this document and are indispensable for its application. For dated references, only the edition cited applies. For undated references, the latest edition of the referenced document (including any amendments) applies.

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

EN ISO 10140-2, *Acoustics — Laboratory measurement of sound insulation of building elements — Part 2: Measurement of airborne sound insulation (ISO 10140-2)*

EN ISO 10140-3, *Acoustics — Laboratory measurement of sound insulation of building elements — Part 3: Measurement of impact sound insulation (ISO 10140-3)*

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

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

3 Terms and definitions

For the purposes of this document, the terms and definitions given in EN ISO 10140 and the following apply.

3.1
sufficiently large specimen
specimen whose radiated sound power does not increase any longer with size, or which covers the total area of the floor

Note 1 to entry: In case of uncertainty the testing laboratory will decide, which size is sufficient.

3.2
pads
pieces of the flooring under test, which are as large as the hitting areas of the tapping machine hammers

Note 1 to entry: Quadratic pads should be the smallest possible including the whole hitting area.

3.3
walking sound pressure level (in third-octave band *i*)
$L_{n,\text{walk},i}$
normalised impact sound pressure level in the upper (walking) room with a standardised contribution of the concrete bare floor underneath the floor covering under test

Note 1 to entry: It is calculated according to Formula (1):

$$L_{n,\mathrm{walk},i} = \begin{cases} L_{i,\mathrm{ref,b}} + L_{i,\mathrm{Fl,c}} - L_{i,\mathrm{Fl,b}} & \text{if } L_{i,\mathrm{with}} < \left(L_{i,\mathrm{pads}} + 10 \cdot \log \left(\dfrac{T_{i,\mathrm{upper,with}}}{T_{i,\mathrm{upper,pads}}} \right) \right) \\ 10 \log_{10} \left(\dfrac{0{,}16 \cdot V_{\mathrm{upper}}}{A_0} \left(\dfrac{10^{\frac{L_{i,\mathrm{with}}}{10}}}{T_{i,\mathrm{upper,with}}} - \dfrac{10^{\frac{L_{i,\mathrm{pads}}}{10}}}{T_{i,\mathrm{upper,pads}}} \right) + 10^{\frac{L_{i,\mathrm{ref,b}} + L_{i,\mathrm{Fl,c}} - L_{i,\mathrm{Fl,b}}}{10}} \right) & \text{else} \end{cases} \quad (1)$$

where

$L_{i,\mathrm{with}}$ is the impact sound pressure level measured in the upper room, when a sufficiently large specimen is lying on the test floor;

$L_{i,\mathrm{pads}}$ is the impact sound pressure level measured in the upper room, when only pads of the flooring material are lying on the test floor below the tapping machine hammers;

$L_{i,\mathrm{Fl,b}}$ is the impact sound pressure level measured in the lower room, when the tapping machine acts on the bare floor in the upper room;

$L_{i,\mathrm{Fl,c}}$ is the impact sound pressure level measured in the lower room, when the tapping machine acts on the sufficiently large specimen in the upper room;

$L_{i,\mathrm{ref,b}}$ is the reference values for the bare floor as given in Annex B;

V_{upper} is the volume of the upper room, in cubic metres;

$T_{i,\mathrm{upper,with}}$ is the reverberation time in the upper room with sufficiently large floor covering installed, in seconds;

$T_{i,\mathrm{upper,pads}}$ is the reverberation time in the upper room with pads installed, in seconds;

A_0 10 m².

This definition presumes, that the reverberation time in the lower room does not change between the measurements of $L_{i,\mathrm{Fl,c}}$ and $L_{i,\mathrm{Fl,b}}$.

Note 2 to entry: This can be achieved by leaving the lower room unchanged.

3.4
A-weighted walking sound pressure level

$L_{n,\mathrm{walk,A}}$

A-weighted sound pressure level, calculated from $L_{n,\mathrm{walk},i}$ according to Formula (2) with C_i according to EN 61672-1:

$$L_{n,\mathrm{walk,A}} = 10 \cdot \lg \sum_{i=1}^{21} 10^{\left(L_{n,\mathrm{walk},i} + C_i\right)/10} \quad (2)$$

A1⟩

3.5
Radiated walking sound
RWS
subjective perceived loudness radiated from a floor when a person with hard heel is walking on it

3.6
loudness
perceived strength of steady-state sound calculated according to Zwicker

Note 1 to entry: Its unit is sone. Loudness is a linear measure; hence a redoubling of the sone value results in a redoubling of the perceived loudness. Loudness is based on the concept of critical bands.

3.7
critical band
loudness-model for human hearing system processes perceived sound in sub-bands called critical bands.

Note 1 to entry: Critical bandwidth differs within the frequency range.

Note 2 to entry: The critical band produces the critical band scale. Its unit is Bark. ⟨A1

4 Principle

A floor test facility according to EN ISO 10140 for impact and airborne sound measurements is used. It consists of two medium sized and medium damped rooms above each other, separated by a standard homogeneous concrete floor. As a walking noise source, a standard tapping machine according to EN ISO 10140 is applied. Several average sound pressure level measurements in third-octave bands are made in the upper and lower rooms with the bare floor either uncovered or covered with pads or sufficiently large "full-size" specimens of the tested flooring. In the upper room the reverberation times with large specimens and with merely pads present shall be determined.

The walking sound pressure level is then calculated according to Formula (1) from the sound power directly radiated from the floor covering into the upper room plus the sound power from the bare floor under the floor covering, which radiates back into the upper room. Finally the A-weighted walking sound pressure level is calculated from the measured average sound pressure levels.

In Formula (1) the radiation from the bare floor through the floor covering is corrected for deviations of the actual laboratory floor from the reference spectrum in Annex B. Furthermore, the tapping machine self noise theoretically cancels out and therefore is not needed explicitly. However, because of the uncertainty of the measured quantities, the resulting walking sound pressure level in the second line in Formula (1) may become very uncertain and even complex, in particular when a loud tapping machine is used and the flooring doesn't radiate much itself. Complex values are avoided by setting the inner bracket to zero as a minimum (first line in Formula (1)). To detect unreliable results, the uncertainty of $L_{n,\mathrm{walk}}$ shall be calculated for each third octave band and stated in the test report.

All details like test facility requirements, tapping machine characteristics, positioning of tapping machine and microphones, averaging etc. are kept as close as possible to the requirements of laboratory measurements of impact noise as given in EN ISO 10140.

5 Test arrangement

5.1 Test facilities

A room arrangement for impact and airborne sound pressure level measurements according to EN ISO 10140 shall be used.

5.2 Equipment

See EN ISO 10140.

5.3 Mounting of the specimens

The floor coverings or the corresponding pads shall be mounted according the instructions of EN ISO 10140 and Annex C.

6 Test procedure

All specifications of EN ISO 10140, concerning:

— generation of the sound field;

— measurement of impact sound pressure levels;

— measurement of reverberation time;

— correction for background noise; and

— additional measures to be regarded at low frequencies (EN ISO 10140-4:2010, Annex A)

shall be followed. The measurement shall run in third-octave bands from 50 Hz to 5 000 Hz.

Proceed as follows:

1	Apply the tapping machine on the bare floor in the upper room.	Measure $L_{i,\mathrm{Fl,b}}$ in the lower room.	Ensure negligible air-borne sound transmission through the lab floor. Reverberation time in the lower room shall remain unchanged until the end of all measurements.
2	Let the tapping machine hammer on pads of the investigated flooring. (Support the feet with pieces of the flooring, too, to keep the falling height of the hammers.)	Measure reverberation time $T_{\mathrm{i,upper,pads}}$ and $L_{\mathrm{i,pads}}$ in the upper room.	
3	Install a sufficiently large piece of the floor covering on the floor.	Measure reverberation time $T_{\mathrm{i,upper,with}}$ and $L_{\mathrm{i,with}}$ in the upper room.	
4		Determine $L_{\mathrm{i,Fl,c}}$ in the lower room.	Ensure negligible air-borne sound transmission through the lab floor. Check that reverberation time in the lower room (or state of the room) is unchanged.

7 Evaluation of results

From the measured sound pressure levels, the following final results shall be evaluated:

a) walking sound pressure level $L_{n,\text{walk},i}$ (in third-octave bands) according to Formula (1);

b) the uncertainty of the walking sound pressure level, $u_{\text{walk},i}$, according to Formula (3);

c) the A-weighted walking sound pressure level $L_{n,\text{walk,A}}$ according to Formula (2);

d) the uncertainty of the A-weighted walking sound pressure level, $u_{\text{walk,A}}$, according to Formula (4).

8 Precision

It is assumed, that in Formula (1) essentially only the four measured levels and the reverberation times are uncertain. The uncertainty of the walking noise level of a third-octave band i, $u_{\text{walk},i}$, then results from Formula (3).

$$u_{\text{walk},i} = 10^{-L_{n,\text{walk},i}/10} \cdot \sqrt{2 \cdot 10^{\left(L_{i,\text{Fl,c}}+L_{i,\text{ref,b}}-L_{i,\text{Fl,b}}\right)/5} \cdot u_{\text{L}}^2 + \left(\frac{0{,}16\, V_{\text{upper}}}{A_0}\right)^2 \left[\left(\frac{10^{L_{i,\text{pads}}/10}}{T_{i,\text{upper,pads}}}\right)^2 + \left(\frac{10^{L_{i,\text{with}}/10}}{T_{i,\text{upper,with}}}\right)^2\right] \cdot \left(u_{\text{L}}^2 + u_{\text{LT}}^2\right)} \quad (3)$$

where

u_{L} is the uncertainty of the measured levels, in decibels;

u_{LT} is the uncertainty of the reverberation time levels, in decibels.

If particular values are not known, the following ones according to [4] and [5] should be used for all third-octave bands:

— u_{L} = 0,4 dB;

— u_{LT} = 0,5 dB.

Shielding effects by the tapping machines ([6] and [7]) are ignored here.

The uncertainty of the A-weighted walking sound pressure level results from Formula (4).

$$u_{\text{walk,A}} = \frac{1}{\sum_{j=1}^{21} 10^{\left(L_{n,\text{walk},j}+C_j\right)/10}} \cdot \sqrt{\sum_{i=1}^{21} \left[10^{\left(L_{n,\text{walk},i}+C_i\right)/10} \cdot u_{\text{walk},i}\right]^2} \quad (4)$$

where

C_i, C_j are the A-weighting coefficients in the third-octave bands i resp. j.

9 Expression of results

$L_{i,\text{ref,b}}$, $L_{i,\text{Fl,b}}$, $L_{i,\text{Fl,c}}$, $L_{i,\text{with}}$, $L_{i,\text{pads}}$, $L_{n,\text{walk},i}$ and $u_{\text{walk},i}$ shall be given in a table as third octave band levels in dB to one decimal place.

$L_{n,\text{walk},i}$ shall be given together with uncertainty bars of ± $u_{\text{walk},i}$ in a graph, scaled as follows: