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SLOVENSKI STANDARD
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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 16205:2020

ICS:

17.140.01	Akustična merjenja in blaženje hrupa na splošno	Acoustic measurements and noise abatement in general
91.060.30	Stropi. Tla. Stopnice	Ceilings. Floors. Stairs
91.120.20	Akustika v stavbah. Zvočna izolacija	Acoustics in building. Sound insulation

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EUROPEAN STANDARD

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EN 16205

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English Version

Laboratory measurement of walking noise on floors

Mesurage en laboratoire du bruit des pas sur les planchers

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This European Standard was approved by CEN on 21 September 2020.

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

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EN 16205:2020 (E)

Contents

Page

iTeh STANDARD PREVIEW
(standards.iteh.ai)

2

European foreword

This document (EN 16205:2020) 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of an identical text or by endorsement, at the latest by May 2021, and conflicting national standards shall be withdrawn at the latest by May 2021.

Attention is drawn to the possibility that some of the elements of this document may be the subject of patent rights. CEN shall not be held responsible for identifying any or all such patent rights.

This document supersedes EN 16205:2013+A1:2018.

In comparison with the previous edition, the following technical modifications have been made:

— amendment of the Annex E to include the room correction.

According to the CEN-CENELEC Internal Regulations, the national standards organisations of the following countries are bound to implement this European Standard: Austria, Belgium, Bulgaria, Croatia, Cyprus, Czech Republic, Denmark, Estonia, Finland, France, Germany, Greece, Hungary, Iceland, Ireland, Italy, Latvia, Lithuania, Luxembourg, Malta, Netherlands, Norway, Poland, Portugal, Republic of North Macedonia, Romania, Serbia, Slovakia, Slovenia, Spain, Sweden, Switzerland, Turkey and the United Kingdom.

EN 16205:2020 (E)

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 the required small pads of the flooring could not be assembled. Using the standard tapping machine according to EN ISO 10140 (all parts) 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 normalized 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 document 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 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.

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 (all parts) and the following apply.

ISO and IEC maintain terminological databases for use in standardization at the following addresses:

— ISO Online browsing platform: available at https://www.iso.org/obp

— IEC Electropedia: available at http://www.electropedia.org/

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)
$L_{n,walk,i}$
normalized impact sound pressure level in the upper (walking) room with a standardized contribution of the concrete bare floor underneath the floor covering under test

EN 16205:2020 (E)

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

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

where

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

$L_{i,\text{pads}}$ 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;

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

$L_{i,\text{Fl},c}$ 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;

$L_{i,\text{ref},b}$ 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;

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

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

A_0 10 m².

Note 2 to entry: This definition presumes, that the reverberation time in the lower room does not change between the measurements of $L_{i,\text{Fl},c}$ and $L_{i,\text{Fl},b}$.

Note 3 to entry: This can be achieved by leaving the lower room unchanged.

3.4
A-weighted walking sound pressure level
$L_{n,\text{walk},A}$
A-weighted sound pressure level, calculated from $L_{n,\text{walk},i}$ according to Formula (2) with C_i according to EN 61672-1:

$$L_{n,\text{walk},A} = 10 \cdot \log_{10} \sum\nolimits_{i=1}^{21} 10^{(L_{n,\text{walk},i} + C_i)/10}$$ (2)

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.

4   Principle

A floor test facility, according to EN ISO 10140-1 through EN ISO 10140-5, 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 10140-1 through EN ISO 10140-5 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.

iTeh STANDARD PREVIEW

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 does not 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 $L_{n,\text{walk}}$ 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 (all parts) shall be used.

5.2 Equipment

See EN ISO 10140 (all parts).

5.3 Mounting of the specimens

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

6 Test procedure

All specifications of EN ISO 10140 (all parts), 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 $L_{i,\text{Fl,b}}$ 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 $T_{i,\text{upper,pads}}$ and $L_{i,\text{pads}}$ in the upper room.	
3	Install a sufficiently large piece of the floor covering on the floor.	Measure reverberation time $T_{i,\text{upper,with}}$ and $L_{i,\text{with}}$ in the upper room.	
4		Determine $L_{i,\text{Fl,c}}$ 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).

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

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 [6] and [7] should be used for all third-octave bands:

— u_L = 0,4 dB;

— u_{LT} = 0,5 dB.

Shielding effects by the tapping machines ([8] and [9]) 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.