SLOVENSKI STANDARD
oSIST prEN 15657:2016

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Akustične lastnosti gradbenih elementov in stavb - Laboratorijsko merjenje strukturalnega zvoka v gradbenih elementih servisne opreme za vse načine namestitve

Acoustic properties of building elements and of buildings - Laboratory measurement of structure-borne sound from building service equipment for all installation conditions

Akustische Eigenschaften von Bauteilen und von Gebäuden - Messung des Körperschalls von haustechnischen Anlagen im Prüfstand für alle Installationsbedingungen

Propriétés acoustiques des éléments de construction et des bâtiments - Mesurage en laboratoire des bruits structuraux des équipements de bâtiment pour toute condition d'installation

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English Version

Acoustic properties of building elements and of buildings - Laboratory measurement of structure-borne sound from building service equipment for all installation conditions

Propriétés acoustiques des éléments de construction et des bâtiments - Mesurage en laboratoire des bruits structuraux des équipements de bâtiment pour toute condition d'installation

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This draft European Standard is submitted to CEN members for enquiry. It has been drawn up by the Technical Committee CEN/TC 126.

If this draft becomes a European Standard, CEN members are bound to comply with the CEN/CENELEC Internal Regulations which stipulate the conditions for giving this European Standard the status of a national standard without any alteration.

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Recipients of this draft are invited to submit, with their comments, notification of any relevant patent rights of which they are aware and to provide supporting documentation.

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

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European foreword

This document (prEN 15657:2016) 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 document is currently submitted to the CEN Enquiry.

This document will supersede EN 15657-1:2009.

Introduction

The aim of the standard is to estimate the structural power injected to the building element to which the equipment is connected (called installed power) for all installation conditions: where the equipment mobilities are higher or lower than, or match with the receiver mobilities (see definition of mobility in Clause 3) and therefore including heavyweight and lightweight receiving building elements. This power is used as input data in predicting the structure-borne sound levels produced in the buildings by the equipment and specified in EN 12354-5:2009. The existing edition of EN 12354-5:2009 is restricted to heavyweight buildings and is about to be revised, in order to take into account lightweight buildings. The installed power depends on the source and the receiver mobilities, as well as on the source activity i.e. the free velocity or blocked force. These quantities (source and receiver mobilities as well as source activity) are to be evaluated and this standard specifies the methods allowing their determination.

The expression giving the installed power has been simplified and approximated in order to use 1/3 octave single equivalent quantities, easily measurable in laboratory as input data (see section 4).

This standard corresponds to the merging of former standard EN 15657-1:2009, which was restricted to receivers of mobility much lower than the source mobility, with draft prEN 15657-2, valid for all installation conditions. The merging of the two parts has been decided at TC level.

In the revised standard, the measurement of airborne sound has been removed. If a measurement of the airborne sound power of the equipment is required, then refer to EN ISO 3740:2000, 47 and use the same source mounting conditions and operating conditions as in measuring using prEN 15657.

1 Scope

As for the document predicting the structure borne sound levels produced in the buildings by service equipment (EN 12354-5:2009), this European standard covers sanitary installations, mechanical ventilation, heating and cooling, service equipment, lifts, rubbish chutes, boilers, blowers, pumps and other auxiliary service equipment, and motor driven car park doors; it can also be applied to other equipment attached to or installed in buildings. However, this standard is so far restricted to stationary sources.

This revised standard:

— specifies laboratory measuring methods for determining the source input data required to calculate the source installed power, i.e. the equipment free velocity, the equipment blocked force and the equipment mobility;

— defines the expression of the source installed power for any source-receiver mobility conditions, including lightweight and heavyweight receiving building elements. This power is used as input data in EN 12354-5:2009, which predicts the structure borne sound pressure level generated by the source installed *in situ* in a building;

— defines a method to calculate the structure borne sound power generated by the equipment fictively mounted on two reference test rigs (respectively heavyweight and lightweight) ; the two results will inform the manufacturers on the difference in the equipment performance between these two common but very different situations;

— does not now specify any method for the measurement of the source airborne sound power. If measurements of the equipment airborne sound power are required, then refer to EN ISO 3740, 47 and use the same source mounting conditions and operating conditions as in measuring using prEN 15657.

Throughout this standard the frequency range is limited to the 21 1/3 octave bands with mid-frequencies from 50 Hz to 5000 Hz.

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 10140-3, *Acoustics — Laboratory measurement of sound insulation of building elements — Part 2: Measurement of impact sound insulation*

EN ISO 10848-1, *Acoustics - Laboratory measurement of the flanking transmission of airborne and impact sound between adjoining rooms - Part 1: Frame document (ISO 10848-1)*

ISO 1683, *Acoustics — Preferred reference values for acoustical and vibratory levels*

ISO 5348, *Mechanical vibration and shock — Mechanical mounting of accelerometers*

ISO 7626-1:2011, *Mechanical vibration and shock — Experimental determination of mechanical mobility — Part 1: Basic terms and definitions, and transducer specifications*

ISO 7626-2, *Mechanical vibration and shock — Experimental determination of mechanical mobility — Part 2: Measurements using single-point translation excitation with an attached vibration exciter*

ISO 7626-5, *Vibration and shock — Experimental determination of mechanical mobility — Part 5: Measurements using impact excitation with an exciter which is not attached to the structure*

ISO 9611:1996, *Acoustics — Characterization of sources of structure-borne sound with respect to sound radiation from connected structures — Measurement of velocity at the contact points of machinery when resiliently mounted*

ISO 16063-21, *Methods for the calibration of vibration and shock transducers — Part 21: Vibration calibration by comparison to a reference transducer*

3 Terms and definitions

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

NOTE A list of the symbols and units used in this standard is given in Annex A.

3.1
source
service equipment or component of service equipment (to be connected to building structures) under test

3.2
receiver
building element to which the tested service equipment is to be attached, that can be a floor or a wall or a combination of floor and walls

Note 1 to entry: For the laboratory test, the receivers are reception plates, details of which are described in section 6.

3.3
source free velocity
expression of source activity at each of the contacts (the connections with the receiver building elements when installed), with the source either freely suspended (disconnected from the receiver) or connected to a much higher mobility receiver called high mobility reception plate (see section 6), when operating under conditions described in the test report

3.4
single equivalent source free velocity
$v_{f,rms,eq}^2$
expression of the source activity, which is obtained either as the sum of the squared rms free velocities over the N contacts,

$$v_{f,rms,eq}^2 = \sum_{i}^{N} v_{f,rms,i}^2 \qquad (1)$$

or approximately from the high mobility reception plate power defined in section 6.3

3.5
source blocked force
expression of the source activity as the force at each of the contacts (the connections with the receiver building elements when installed), with the source connected to a much lower mobility receiver, called heavy reception plate, also when operating under the same conditions described in the report

3.6
single equivalent blocked force
$F^2_{b,rms,eq}$
expression of the source activity as the single equivalent blocked force, which is defined as the sum of the squared rms blocked forces over the N contacts,

$$F^2_{b,rms,eq} = \sum_i^N F^2_{b,rms,i} \tag{2}$$

and obtained approximately from the low mobility reception plate power defined in section 6.2

3.7
point mobility
ratio Y_i of the complex (magnitude and phase) vibrational velocity that a point force produces at its point of application i, to the force applied, both force and velocity being normal to the receiver

3.8
single equivalent mobility
$\boldsymbol{Y_{eq}}$
quantity obtained approximately as the mean value of the point mobility at each contact i, averaged over the N contacts, which for the magnitude, is according to:

$$\left|Y_{eq}\right| \approx \frac{1}{N}\sum_i^N \left|Y_i\right| \tag{3}$$

and for the real part, is according to:

$$\mathrm{Re}(Y_{eq}) \approx \frac{1}{N}\sum_i^N \mathrm{Re}(Y_i) \tag{4}$$

3.9
mobility in 1/3 octave bands
value obtained from measurement in narrow frequency bands (see section 5)

Note 1 to entry: 1/3 octave values of both mobility magnitude and real part are obtained as the mean value of the narrow band data averaged over the frequencies within the band considered (M frequency components k):

$$\left|Y\right|_{1/3oct} = \frac{1}{M}\sum_k^M \left|Y_k\right| \tag{5}$$

$$\mathrm{Re}(Y)_{1/3oct} = \frac{1}{M}\sum_k^M \mathrm{Re}(Y_k) \tag{6}$$

The magnitudes and real parts of mobilities can also be measured directly in 1/3 octaves using existing measuring devices. In this standard, all the results are expressed in 1/3 octave bands.

3.10
characteristic mobility of a plate
point mobility of an infinite plate having the same thickness and made of the same material as the plate considered

3.11
installed power
structural power (calculated) injected to each building element to which the equipment is connected (input datum for the prediction method).

Note 1 to entry: Equipment connected to two or three building elements (whirlpool bath connected to floor and walls for example) will be characterized by two or three installed power components respectively.

4 Source power determination

4.1 Installed power determination

For all installation conditions, the installed power level in dB ref. 10^{-12} Watt is approximated from the single equivalent free velocity level in dB ref. 10^{-9} m/s of the source and the single equivalent mobilities of the source and the receiver, all quantities being evaluated in 1/3 octave bands, according to:

$$L_{Winst} \approx 10\lg\left[\frac{\mathrm{Re}(Y_{\mathrm{Re}q})}{\left|Y_{Seq}\right|^2+\left|Y_{\mathrm{Re}q}\right|^2}\right]+L_{veq}-60 \qquad (7)$$

Explanations about how this approximated expression of the installed power has been obtained can be found in references [1] to [4]. It should be noted that the single equivalent mobilities in Formula (7) are approximated from point mobilities, as defined in Clause 3.8.

The approximation given in Formula (7) can be reduced for the case when the receiver mobility is much lower than the source mobility (by a factor of 10 at least). The only required source quantity is then the equivalent blocked force, leading to the following expression in terms of power levels in dB ref 10^{-12} Watt and force levels in dB ref 10^{-6} N:

$$L_{Winst} \approx 10\lg(\mathrm{Re}(Y_{\mathrm{Re}q}))+L_{Fbeq} \qquad (8)$$

For any other mobility conditions, Formula (7) shall be used.

The following Clauses 5 and 6 specify methods for the measurements of the input quantities used in Formulae (7) and (8). Only direct measurements of the receiver mobilities are proposed. There are three ways of obtaining the input quantities for the source:

— direct measurements of the source free velocity and mobility, leading in principle to more precise results;

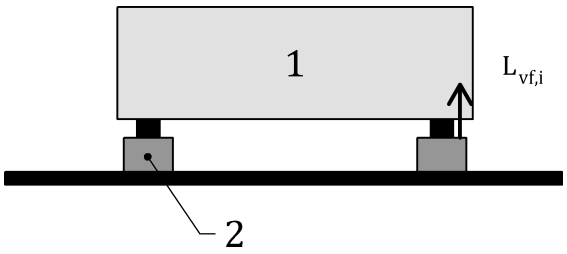
— indirect measurements of the source free velocity and blocked force using the reception plate method, which is a more robust laboratory approach to estimate the source single equivalent quantities (free velocity and blocked force, from which the mobility magnitude is deduced), but not as accurate in principle as direct measurements;

— a combination of direct and indirect measurements, e.g. direct measurement of source free velocity and indirect measurement of blocked force using the reception plate method.

5 Direct measurement of source quantities

5.1 Source free velocity measurement

The translational velocity is measured at each contact point, according to ISO 9611. The component of velocity corresponds to the excitation normal to the receiving structure when the source is installed. The results are expressed in terms of 1/3 octave (rms) velocity levels in dB ref. 10^{-9} m/s according to ISO 1683 (symbol: $L_{vf,i}$ for contact point i). The source is mounted on isolators as indicated in Figure 1.



Key

1 source

2 isolator

Figure 1 — Source mounted on isolators

NOTE As an alternative way, the source can be freely suspended.

Expression of the results

For each frequency band, the velocity levels $L_{vf,i}$ are energetically summed over the contact points, leading to the source single equivalent free velocity level $L_{vf,eq}$:

$$L_{vf,eq} = 10\lg\left(\sum_{i}^{N} 10^{L_{vf,i}/10}\right) \quad (9)$$

Formula (9) corresponds to Formula (1) when expressed in dB.

5.2 Direct measurement of mobility (source and receiver)

The recommendations for direct measurement apply to both sources and receivers. However, sources should be isolated according to ISO 9611 (as shown in Figure 1) or freely suspended, and receivers should be statically unloaded, when measuring mobility. Point mobility measurements at the contact points are required for estimating the source equivalent magnitude of mobility according to Formula (3), the receiver equivalent magnitude of mobility according to Formula (3), and the receiver equivalent real part of mobility according to Formula (4).

The measurements are performed according to ISO 7626-1:2011 and limited to single point translational excitation (normal to the receiving plate) according to ISO 7626-2; impact excitation is allowed, according to ISO 7626-5. The ISO 7626- series considers mobility measurements in narrow frequency bands. 1/3 octave band values are then obtained using Formula (5) for sources, and Formulae (5) and (6) for receivers.

NOTE Since the source mobility is required only as a magnitude, for the installed power (Formula (7)), this can be obtained directly in 1/3 octaves.