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Acoustics — Field measurement of sound insulation in buildings and of building elements —

Part 3: Façade sound insulation

Acoustique — Mesurage in situ *de l'isolement acoustique des bâtiments et des éléments de construction — Partie 3: Isolement aux bruits de façades*

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Foreword

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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).

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For an explanation on the meaning of ISO specific terms and expressions related to conformity assessment, as well as information about ISO's adherence to the WTO principles in the Technical Barriers to Trade (TBT) see the following URL: Foreword - Supplementary information

The committee responsible for this document is ISO/TC 43, *Acoustics*, Subcommittee SC 2, *Building acoustics*.

This first edition cancels and replaces ISO 140-5:1998 and ISO 140-14:2004, which have been technically revised.

ISO 16283 consists of the following parts, under the general title *Acoustics — Field measurement of sound insulation in buildings and of building elements*:

— *Part 1: Airborne sound insulation*

— *Part 2: Impact sound insulation*

— *Part 3: Façade sound insulation*

Introduction

ISO 16283 (all parts) describes procedures for field measurements of sound insulation in buildings. Airborne, impact, and façade sound insulation are described in ISO 16283-1, ISO 16283-2, and in this part of ISO 16283, respectively.

Field sound insulation measurements that were described previously in ISO 140-4, ISO 140-5, and ISO 140-7 were (a) primarily intended for measurements where the sound field could be considered to be diffuse and (b) not explicit as to whether operators could be present in the rooms during the measurement. ISO 16283 differs from ISO 140-4, ISO 140-5, and ISO 140-7 in that (a) it applies to rooms in which the sound field can or cannot approximate to a diffuse field, (b) it clarifies how operators can measure the sound field using a hand-held microphone or sound level metre, and (c) it includes additional guidance that was previously contained in ISO 140-14.

NOTE Survey test methods for field measurements of façade sound insulation are dealt with in ISO 10052.

Acoustics — Field measurement of sound insulation in buildings and of building elements —

Part 3:
Façade sound insulation

1 Scope

This part of ISO 16283 specifies procedures to determine the airborne sound insulation of façade elements (element methods) and whole façades (global methods) using sound pressure measurements. These procedures are intended for room volumes in the range from 10 m^3 to 250 m^3 in the frequency range from 50 Hz to 5 000 Hz.

The test results can be used to quantify, assess, and compare the airborne sound insulation in unfurnished or furnished rooms where the sound field can or cannot approximate to a diffuse field. The measured airborne sound insulation is frequency-dependent and can be converted into a single number quantity to characterize the acoustic performance using the rating procedures in ISO 717-1.

The element methods aim to estimate the sound reduction index of a façade element, for example, a window. The most accurate element method uses a loudspeaker as an artificial sound source. Other less accurate element methods use available traffic noise. The global methods, on the other hand, aim to estimate the outdoor/indoor sound level difference under actual traffic conditions. The most accurate global methods use the actual traffic as sound source. A loudspeaker can be used as an artificial sound source when there is insufficient level from traffic noise inside the room. An overview of the methods is given in Table 1.

The element loudspeaker method yields an apparent sound reduction index which, under certain circumstances, can be compared with the sound reduction index measured in laboratories in accordance with ISO 10140. This method is the preferred method when the aim of the measurement is to evaluate the performance of a specified façade element in relation to its performance in the laboratory.

The element road traffic method will serve the same purposes as the element loudspeaker method. It is particularly useful when, for different practical reasons, the element loudspeaker method cannot be used. These two methods will often yield slightly different results. The road traffic method tends to result in lower values of the sound reduction index than the loudspeaker method. In Annex D, this road traffic method is supplemented by the corresponding aircraft and railway traffic methods.

The global road traffic method yields the real reduction of a façade in a given place relative to a position 2 m in front of the façade. This method is the preferred method when the aim of the measurement is to evaluate the performance of a whole façade, including all flanking paths, in a specified position relative to nearby roads. The result cannot be compared with that of laboratory measurements.

The global loudspeaker method yields the sound reduction of a façade relative to a position that is 2 m in front of the façade. This method is particularly useful when, for practical reasons, the real source cannot be used; however, the result cannot be compared with that of laboratory measurements.

Table 1 — Overview of the different measurement methods

No.	Method	Reference in this part of ISO 16283	Result	Field of application
	Element			
1	Element loudspeaker	9.5	$R'_{45°}$	Preferred method to estimate the apparent sound reduction index of façade elements
2	Element road traffic	10.3	$R'_{tr,s}$	Alternative to method No.1 when road traffic as a sound source provides a sufficient level
3	Element railway traffic	Annex E	$R'_{rt,s}$	Alternative to method No.1 when railway traffic as a sound source provides a sufficient level
4	Element aircraft traffic	Annex E	$R'_{at,s}$	Alternative to method No.1 when aircraft traffic as a sound source provides a sufficient level
	Global			
5	Global loudspeaker	9.6	$D_{ls,2m,nT}$ $D_{ls,2m,n}$	Alternative to methods Nos. 6, 7, and 8
6	Global road traffic	10.4	$D_{tr,2m,nT}$ $D_{tr,2m,n}$	Preferred method to estimate the global sound insulation of a façade exposed to road traffic as a sound source
7	Global railway traffic	Annex E	$D_{rt,2m,nT}$ $D_{rt,2m,n}$	Preferred method to estimate the global sound insulation of a façade exposed to railway traffic as a sound source
8	Global aircraft traffic	Annex E	$D_{at,2m,nT}$ $D_{at,2m,n}$	Preferred method to estimate the global sound insulation of a façade exposed to aircraft traffic as a sound source

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.

ISO 717-1, *Acoustics — Rating of sound insulation in buildings and of building elements — Part 1: Airborne sound insulation*

ISO 3382-2, *Acoustics — Measurement of room acoustic parameters — Part 2: Reverberation time in ordinary rooms*

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

ISO 15712-3, *Building acoustics — Estimation of acoustic performance of buildings from the performance of elements — Part 3: Airborne sound insulation against outdoor sound*

ISO 18233, *Acoustics — Application of new measurement methods in building and room acoustics*

IEC 60942, *Electroacoustics — Sound calibrators*

IEC 61183, *Electroacoustics — Random-incidence and diffuse-field calibration of sound level meters*

IEC 61260, *Electroacoustics — Octave-band and fractional-octave-band filters*

IEC 61672-1, *Electroacoustics — Sound level meters — Part 1: Specifications*

3 Terms and definitions

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

3.1
average outdoor sound pressure level on the test surface
$\boldsymbol{L_{1,s}}$
ten times the common logarithm of the ratio of the surface and time average of the squared sound pressure to the square of the reference sound pressure, the surface average being taken over the entire test surface including reflecting effects from the test specimen and façade

Note 1 to entry: $L_{1,s}$ is expressed in decibels.

3.2
average outdoor sound pressure level at a distance 2m in front of the façade
$\boldsymbol{L_{1,2m}}$
ten times the common logarithm of the ratio of the time average of the squared sound pressure to the square of the reference sound pressure, at a position 2 m in front of the façade

Note 1 to entry: $L_{1,2m}$ is expressed in decibels.

3.3
energy-average sound pressure level in a room
$\boldsymbol{L_2}$
ten times the common logarithm of the ratio of the space and time average of the squared sound pressure to the square of the reference sound pressure, the space average is taken over the central zone of the room where the nearfield radiation from the room boundaries has negligible influence

Note 1 to entry: L_2 is expressed in decibels.

3.4
corner sound pressure level in a room
$\boldsymbol{L_{2,Corner}}$
ten times the common logarithm of the ratio of the highest time average squared sound pressure from the set of corner measurements to the square of the reference sound pressure, for the low-frequency range (50 Hz, 63 Hz, and 80 Hz one-third octave bands)

Note 1 to entry: $L_{2,Corner}$ is expressed in decibels.

3.5
low-frequency energy-average sound pressure level in a room
$\boldsymbol{L_{2,LF}}$
ten times the common logarithm of the ratio of the space and time average of the squared sound pressure to the square of the reference sound pressure in the low-frequency range (50 Hz, 63 Hz, and 80 Hz one-third octave bands) where the space average is a weighted average that is calculated using the room corners where the sound pressure levels are highest and the central zone of the room where the nearfield radiation from the room boundaries has negligible influence

Note 1 to entry: $L_{2,LF}$ is expressed in decibels.

Note 2 to entry: $L_{2,LF}$ is an estimate of the energy-average sound pressure level for the entire room volume.

3.6
reverberation time
$\boldsymbol{T}$
time required for the sound pressure level in a room to decrease by 60 dB after the sound source has stopped

Note 1 to entry: T is expressed in seconds.

3.7
background noise level
measured sound pressure level in the receiving room from all sources except the sound source used for the measurement

3.8
fixed microphone
microphone that is fixed in space by using a device such as a tripod so that it is stationary

3.9
mechanized continuously-moving microphone
microphone that is mechanically moved with approximately constant angular speed in a circle, or is mechanically swept along a circular path where the angle of rotation about a fixed axis is between 270° and 360°

3.10
manually-scanned microphone
microphone attached to a hand-held sound level metre or an extension rod that is moved by a human operator along a prescribed path

3.11
manually-held microphone
microphone attached to a hand-held sound level metre or a rod that is hand-held at a fixed position by a human operator at a distance at least an arm's length from the trunk of the operator's body

3.12
apparent sound reduction index
$\boldsymbol{R'_{45^\circ}}$
measure of the airborne sound insulation of a building element when the sound source is a loudspeaker at an angle of incidence is 45° and the outside microphone position is on the test surface, which is given by ten times the common logarithm of the ratio of the sound power, $W_{1,45^\circ}$, which is incident on a test element when the angle of sound incidence is 45° to the total sound power radiated into the receiving room if, in addition to the sound power, W_2, radiated by the test element, the sound power, W_3, radiated by flanking elements or by other components, is significant

$$R'_{45^\circ} = 10 \lg \frac{W_{1,45^\circ}}{W_2 + W_3}$$

for which the apparent sound reduction index is evaluated using the following formula:

$$R'_{45^\circ} = L_{1,\mathrm{s}} - L_2 + 10 \lg \frac{S}{A} - 1{,}5\,\mathrm{dB}$$

where

S is the area of the test specimen, in square metres, determined as given in Annex A;

A is the equivalent absorption area of the receiving room, in square metres.

Note 1 to entry: R'_{45° is expressed in decibels.

Note 2 to entry: In general, the sound power transmitted into the receiving room consists of the sum of several components from different elements (window, ventilator, door, wall, etc.).

Note 3 to entry: The second formula is based on the assumption that the sound is incident from one angle only, 45°, and the sound field in the receiving room approximates to a diffuse field.

3.13
apparent sound reduction index
***R'*tr,s**
measure of the airborne sound insulation of a building element when the sound source is road traffic and the outside microphone position is on the test surface for which the apparent sound reduction index is evaluated using the following formula:

$$R'_{tr,s} = L_{1,s} - L_2 + 10\lg\frac{S}{A} - 3\text{dB}$$

where

S is the area of the test specimen, in square metres, determined as given in Annex A;

A is the equivalent absorption area of the receiving room, in square metres.

Note 1 to entry: $R'_{tr,s}$ is expressed in decibels.

Note 2 to entry: The formula is based on the assumption that the sound is incident from all angles, and the sound field in the receiving room approximates to a diffuse field.

3.14
level difference
***D*2m**
level difference between $L_{1,2m}$ and L_2 evaluated using the following formula:

$$D_{2m} = L_{1,2m} - L_2$$

Note 1 to entry: D_{2m} is expressed in decibels.

Note 2 to entry: The notation is $D_{tr,2m}$ when traffic noise is used as the sound source, and $D_{ls,2m}$ when a loudspeaker is used.

3.15
standardized level difference
D*2m,n*T
level difference (3.14) that is standardized to a reference value of the *reverberation time* (3.6) in the receiving room and calculated using the following formula:

$$D_{2m,nT} = D_{2m} + 10\lg\frac{T}{T_0}$$

where

T is the reverberation time in the receiving room;

T_0 is the reference reverberation time; for dwellings, T_0 = 0,5 s.

Note 1 to entry: $D_{2m,nT}$ is expressed in decibels.

Note 2 to entry: The level difference is referenced to a reverberation time of 0,5 s because in dwellings with furniture the reverberation time has been found to be reasonably independent of volume and frequency and to be approximately equal to 0,5 s.

Note 3 to entry: The notation is $D_{tr,2m,nT}$ when traffic noise is used as the sound source, and $D_{ls,2m,nT}$ when a loudspeaker is used.

3.16
normalized level difference
***D*$_{2m,n}$**
level difference (3.14) that is normalized to a reference value of the absorption area in the receiving room and calculated using the following formula:

$$D_{2m,n} = D_{2m} - 10 \lg \frac{A}{A_0}$$

where

A_0 is the reference absorption area; for dwellings, A_0 = 10 m^2

Note 1 to entry: $D_{2m,n}$ is expressed in decibels.

Note 2 to entry: The notation is $D_{tr,2m,n}$ when traffic noise is used as the sound source, and $D_{ls,2m,n}$ when a loudspeaker is used.

3.17
equivalent absorption area
A
sound absorption area which is calculated using Sabine's formula

$$A = \frac{0,16\,V}{T}$$

where

V is the receiving room volume, in cubic metres;

T is the reverberation time in the receiving room.

Note 1 to entry: A is expressed in square metres.

3.18
single event level
***L*$_E$**
single event level of a discrete noise event calculated using the following formula:

$$L_E = 10 \lg \frac{1}{t_0} \int_{t_1}^{t_2} \frac{p^2(t)}{p_0^2} \mathrm{d}t$$

where

$p(t)$ is the instantaneous sound pressure, in Pascals;

t_2-t_1 is a stated time interval long enough to encompass all significant sound energy of a stated event;

p_0 is the reference sound pressure, with p_0 = 20 µPa;

t_0 is the reference duration, with t_0 = 1s.

Note 1 to entry: L_E is expressed in decibels.

3.19
single event level difference
***D*E,2m**
level difference between the outdoor *single event level* (3.18), $L_{E1,2m}$, and the space and time average single event level, L_{E2}, in the receiving room and calculated using the following formula:

$$D_{E,2m} = L_{E1,2m} - L_{E2}$$

Note 1 to entry: $D_{E,2m}$ is expressed in decibels.

Note 2 to entry: The notation is $D_{at,E,2m}$ when aircraft traffic is used as the sound source and $D_{rt,E,2m}$ when railway traffic is used as the sound source.

3.20
standardized single event level difference
D*E,2m,n*T
single event level difference (3.19) that is standardized to a reference value of the *reverberation time* (3.6) in the receiving room and calculated using the following formula:

$$D_{E,2m,nT} = D_{E,2m} + 10\lg\frac{T}{T_0}$$

Note 1 to entry: $D_{E,2m,nT}$ is expressed in decibels.

Note 2 to entry: The notation is $D_{at,E,2m,nT}$ when aircraft traffic is used as the sound source, and $D_{rt,E,2m,nT}$ when railway traffic is used as the sound source.

3.21
normalized single event level difference
***D*E,2m,n**

single event level difference (3.19) that is normalized to a reference value of the absorption area in the receiving room and calculated using the following formula:

$$D_{E,2m,n} = D_{E,2m} - 10\lg\frac{A}{A_0}$$

Note 1 to entry: $D_{E,2m,n}$ is expressed in decibels.

Note 2 to entry: The notation is $D_{at,E,2m,n}$ when aircraft traffic is used as the sound source, and $D_{rt,E,2m,n}$ when railway traffic is used as the sound source.

3.22
apparent sound reduction index
***R'*at,s**
measure of the airborne sound insulation of a building element when the sound source is aircraft traffic and the outside microphone position is on the test surface, it is calculated using the following formula:

$$R'_{at,s} = L_{E1,s} - L_{E2} + 10\lg\frac{S}{A} - 3\text{dB}$$

where

$L_{E1,s}$ is the spatial average value of the single event level on the surface of the test specimen which includes the effect of reflections from the test specimen and façade;

L_{E2} is the average value of the single event level in the receiving room;

S is the area of the test specimen, in square metres;