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Road traffic noise reducing devices - Test method for determining the acoustic performance - Part 4: Intrinsic characteristics - In situ values of sound diffraction

Lärmschutzvorrichtungen an Straßen - Prüfverfahren zur Bestimmung der akustischen Eigenschaften - Teil 4: Produktspezifische Merkmale - In-situ-Werte der Schallbeugung

Dispositifs de réduction du bruit du trafic routier - Méthode d'essai pour la détermination de la performance acoustique - Partie 4 : caractéristiques intrinsèques - Valeurs in-situ de la diffraction acoustique

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English Version

Road traffic noise reducing devices - Test method for determining the acoustic performance - Part 4: Intrinsic characteristics - In situ values of sound diffraction

Dispositifs de réduction du bruit du trafic routier - Méthode d'essai pour la détermination de la performance acoustique - Partie 4 : caractéristiques intrinsèques - Valeurs in-situ de la diffraction acoustique

Lärmschutzvorrichtungen an Straßen - Prüfverfahren zur Bestimmung der akustischen Eigenschaften - Teil 4: Produktspezifische Merkmale - In-situ-Werte der Schallbeugung

This draft European Standard is submitted to CEN members for enquiry. It has been drawn up by the Technical Committee CEN/TC 226.

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 1793-4:2023) has been prepared by Technical Committee CEN/TC 226 “Road equipment”, the secretariat of which is held by AFNOR.

This document is currently submitted to the CEN Enquiry.

This document will supersede EN 1793-4:2015.

With respect to the superseded document, the following changes have been made:

— The title has been improved.

— The ‘References’ clause has been updated.

— The ‘Terms, definitions and symbols and abbreviations’ clause has been updated.

— The single-number rating $DL_{\Delta DI}$ is now reported with one decimal digit.

— Annex A “Low-frequency limit and window width” has been added.

— Annex C with a template of the test report has been added.

— Previous Annex A has been shifted to Annex D.

— The ‘Bibliography’ clause has been updated.

EN 1793-4 is part of a series and should be read in conjunction with the other parts. All parts are listed in the following:

— EN 1793-1:2023, *Road traffic noise reducing devices - Test method for determining the acoustic performance – Part 1: Intrinsic characteristics – Sound absorption under diffuse sound field conditions*;

— EN 1793-2:2023, *Road traffic noise reducing devices - Test method for determining the acoustic performance – Part 2: Intrinsic characteristics – Airborne sound insulation under diffuse sound field conditions*;

— EN 1793-3:2023, *Road traffic noise reducing devices - Test method for determining the acoustic performance – Part 3: Normalized traffic noise spectrum*;

— EN 1793-4:2023, *Road traffic noise reducing devices — Test method for determining the acoustic performance — Part 4: Intrinsic characteristics — Intrinsic sound diffraction*;

— EN 1793-5:2023, *Road traffic noise reducing devices - Test method for determining the acoustic performance – Part 5: Intrinsic characteristics - Sound absorption under direct sound field conditions*;

— EN 1793-6:20223 *Road traffic noise reducing devices - Test method for determining the acoustic performance – Part 6: Intrinsic characteristics - Airborne sound insulation under direct sound field conditions.*

Introduction

Part of the market of road traffic noise reducing devices is constituted of products to be added on the top of road traffic noise reducing devices and intended to contribute to sound attenuation acting primarily on the diffracted sound field. These products will be called added devices. This document has been developed to specify a test method for determining the acoustic performance of added devices.

The test method can be applied in situ, i.e., where the road traffic noise reducing devices and the added devices are installed. The method can be applied without damaging the road traffic noise reducing devices or the added devices.

The method can be used to qualify products before the installation along roads as well as to verify the compliance of installed added devices to design specifications. Repeated application of the method can be used to verify the long-term performance of added devices.

No other national or international standard exists about the subject of this document.

This method can be used to qualify noise reducing devices for other applications, e.g., to be installed nearby industrial sites. In this case, the single-number ratings can preferably be calculated using an appropriate spectrum.

1 Scope

This document describes a test method for determining the intrinsic characteristics of sound diffraction of added devices installed on the top of road traffic noise reducing devices. The test method prescribes measurements of the sound pressure level at several reference points near the top edge of a road traffic noise reducing device with and without the added device installed on its top. The effectiveness of the added device is calculated as the difference between the measured values with and without the added devices, correcting for any change in height (the method described gives the acoustic benefit over a simple barrier of the same height; however, in practice the added device can raise the height and this could provide additional screening depending on the source and receiver positions).

The test method is intended for the following applications:

- preliminary qualification, outdoors or indoors, of added devices to be installed on road traffic noise reducing devices;
- determination of sound diffraction index difference of added devices in actual use;
- comparison of design specifications with actual performance data after the completion of the construction work;
- verification of the long-term performance of added devices (with a repeated application of the method);
- interactive design process of new products, including the formulation of installation manuals.

The test method can be applied both in situ and on samples purposely built to be tested using the method described here.

Results are expressed as a function of frequency, in one-third octave bands between 100 Hz and 5 kHz. If it is not possible to get valid measurements results over the whole frequency range indicated, the results shall be given in the restricted frequency range and the reasons of the restriction(s) shall be clearly reported. A single-number rating is calculated from frequency data.

For indoors measurements see Annex A.

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 354:2003, *Acoustics - Measurement of sound absorption in a reverberation room (ISO 354:2003)*

EN 1793-1:2022, *Road traffic noise reducing devices — Test method for determining the acoustic performance — Part 1: Intrinsic characteristics — Sound absorption under diffuse sound field conditions*;

EN 1793-3:2022, *Road traffic noise reducing devices - Test method for determining the acoustic performance – Part 3: Normalized traffic noise spectrum*

EN 1793-5:2022, *Road traffic noise reducing devices — Test method for determining the acoustic performance — Part 5: Intrinsic characteristics — Sound absorption under direct sound field conditions;*

EN 1793-6:2022, *Road traffic noise reducing devices — Test method for determining the acoustic performance — Part 6: Intrinsic characteristics — Airborne sound insulation under direct sound field conditions*.

EN 61672-1:2013, *Electroacoustics – Sound level meters – Part 1: Specifications (IEC 61672-1:2013)*

ISO/IEC Guide 98-3:2008, *Uncertainty of measurement – Guide to the expression of uncertainty in measurement (GUM:1995)*

3 Terms and definitions

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

3.1
road traffic noise reducing device
RTNRD
device designed to reduce the propagation of traffic noise away from the road environment

Note 1 to entry: The RTNRD may comprise acoustic elements (3.2) only or both structural (3.3) and acoustic elements.

Note 2 to entry: Applications of RTNRD include noise barriers (3.5), claddings (3.6), covers (3.7) and added devices (3.8).

3.2
acoustic element
element whose primary function is to provide the acoustic performance of the device

3.3
structural element
element whose primary function is to support or hold in place acoustic elements

3.4
self-supporting acoustic element
acoustic element including its own structural element to support itself

3.5
noise barrier
road traffic noise reducing device which obstructs the direct transmission of airborne sound emanating from road traffic

3.6
cladding
road traffic noise reducing device which is attached to a wall or other structure and reduces the amount of sound reflected

3.7
cover
road traffic noise reducing device which either spans or overhangs the road

3.8
added device
additional component that influences the acoustic performance of the original road traffic noise reducing device

Note 1 to entry: The added device is acting primarily on the diffracted energy.

3.9
roadside exposure
use of the product as a noise reducing device installed alongside roads

3.10
sound diffraction index
quantity representing the amount of sound diffracted by the device under test

Note 1 to entry: This is the result of a sound diffraction test according to the present document

Note 2 to entry: The symbol for the sound diffraction index includes information on the setup used during the test: $DI_{x,refl}$ refers to measurements on a reflective reference wall. $DI_{x,abs}$ refers to measurements on an absorptive reference wall. $DI_{x,situ}$ refers to in situ measurements; where x is "0" when the added device is not on the top of the test construction and "ad" when the added device is on the top of the test construction (see Table 1).

Note 3 to entry: The test is specified by Formula (1)

3.11
sound diffraction index difference
difference between the results of sound diffraction tests on the same reference wall with and without an added device on the top

Note 1 to entry: This is described by the formulae (5a), (5b), (5c)

3.12
test construction
construction on which the added device is placed

Note to entry: For in situ measurements the test construction is an installed road traffic noise reducing device; for qualification tests it is a reference wall (see 5.2).

3.13
reference plane of the test construction
the vertical plane passing through the midpoint of the top edge of the construction (reference wall or installed road traffic noise reducing device) on which the added device has to be placed

Note 1 to entry: See figures 1, 2, 4, 5, 8.

3.14
reference height of the test construction without the added device
height of the highest point of the test construction in relation to the surrounding ground surface

Note 1 to entry: This highest point is not necessarily lying in the plane of longitudinal symmetry of the reference test construction, if this symmetry exists (Figure 1).

3.15
reference height of the test construction with the added device on the top
height of the highest point of the added device installed on the test construction in relation to the surrounding ground surface

Note 1 to entry: This highest point is not necessarily lying in the plane of longitudinal symmetry of the reference test construction, if this symmetry exists (Figure 4).

3.16
free-field measurement for sound diffraction index measurements
measurement carried out placing the loudspeaker and the microphone without any obstacle, including the test construction with or without added device, between them

Note 1 to entry: For example, see Figure 7.

Note 2 to entry: Microphone and loudspeaker placement is as specified in 5.3, 5.4 and 5.5.

3.17
Adrienne temporal window
composite temporal window

Note 1 to entry: As described in 5.8.5.

3.18
background noise
noise coming from sources other than the source emitting the test signal

3.19
signal-to-noise ratio
difference in decibels between the level of the test signal and the level of the background noise at the moment of detection of the useful event (within the Adrienne temporal window)

3.20
impulse response
time signal at the output of a system when a Dirac function is applied to the input

Note 1 to entry: The Dirac function, also called δ function, is the mathematical idealisation of a signal infinitely short in time that carries a unit amount of energy

Note 2 to entry: It is impossible in practice to create and radiate true Dirac delta functions. Short transient sounds can offer close enough approximations but are not very repeatable. An alternative measurement technique, generally more accurate, is to use a period of deterministic, flat-spectrum signal, like maximum-length sequence (MLS) or exponential sine sweep (ESS), and transform the measured response back to an impulse response.

4 Symbols and abbreviations

For the purposes of this document, the following symbols apply.

Table 1 — Symbols and abbreviations

Symbol or abbreviation	Designation	Unit
α	Sound absorption coefficient measured according to EN ISO 354	-
DI_j	Sound diffraction index in the *j*-th one-third octave frequency band	dB
$DI_{0,refl}$	Sound diffraction index for the reflective reference wall without the added device	dB
$DI_{ad,refl}$	Sound diffraction index for the reflective reference wall with the added device	dB
$DI_{0,abs}$	Sound diffraction index for the absorptive reference wall without the added device	dB

Symbol or abbreviation	Designation	Unit
$DI_{ad,abs}$	Sound diffraction index for the absorptive reference wall with the added device	dB
$DI_{0,situ}$	Sound diffraction index for the in-situ test construction without the added device	dB
$DI_{ad,situ}$	Sound diffraction index for the in-situ test construction with the added device	dB
δ_i	Any input quantity to allow for uncertainty estimates	-
Δf_j	Width of the *j*-th one-third octave frequency band	Hz
f	Frequency	Hz
$\boldsymbol{F}$	Symbol of the Fourier transform	-
f_{min}	Low frequency limit of sound diffraction index measurements	Hz
f_s	Sample rate	Hz
f_{co}	Cut-off frequency of the anti-aliasing filter	Hz
h_B	Noise barrier height	m
h_{ref}	Reference height of the test construction	m
$h_{ref,0}$	Reference height of the test construction without the added device	m
$h_{ref,ad}$	Reference height of the test construction with the added device	m
$h_{i,k}(t)$	Incident reference component of the free-field impulse response at the *k*-th measurement point	-
$h_{d,k}(t)$	Diffracted component of the impulse response at the *k*-th measurement point	-
j	Index of the *j*-th one-third octave frequency band (between 100 Hz and 5 kHz)	-
k	Index of the *k*-th measurement point ($k = 1 \dots n$)	-
k_p	Coverage factor	-
k_f	Constant used for the anti-aliasing filter	-
L_b	Minimum length of the reference wall	m
L_d	Minimum length of the added device under test	m
n	Number of measurement points	-
SI	Sound Insulation Index measured according to EN 16272-6	dB
t	Time	s or ms
t_C	Air temperature	°C
$T_{W,BH}$	Length of the Blackman-Harris trailing edge of the Adrienne temporal window	ms
u	Standard uncertainty	-