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Road traffic noise reducing devices - Test method for determining the acoustic performance - Part 5: Intrinsic characteristics - In situ values of sound reflection under direct sound field conditions

Lärmschutzvorrichtungen an Straßen - Prüfverfahren zur Bestimmung der akustischen Eigenschaften - Teil 5: Produktspezifische Merkmale - In-situ-Werte der Schallreflexion in gerichteten Schallfeldern

Dispositifs de réduction du bruit du trafic routier - Méthode d'essai pour la détermination de la performance acoustique - Partie 5: Caractéristiques intrinsèques - Valeurs in situ de réflexion acoustique dans des conditions de champ acoustique direct

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17.140.30	Emisija hrupa transportnih sredstev	Noise emitted by means of transport
93.080.30	Cestna oprema in pomožne naprave	Road equipment and installations

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Road traffic noise reducing devices — Test method for determining the acoustic performance — Part 5: Intrinsic characteristics — Sound absorption under direct sound field conditions

Lärmschutzeinrichtungen an Straßen — Prüfverfahren zur Bestimmung der akustischen Eigenschaften — Teil 5: Produktspezifische Merkmale — Schallabsorption in gerichteten Schallfeldern

Dispositifs de réduction du bruit du trafic routier — Méthode d’essai pour la détermination de la performance acoustique — Partie 5 : Caractéristiques intrinsèques — Absorption acoustique dans des conditions de champ acoustique direct

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European foreword

This document (prEN 1793-5:2023) has been prepared under the direction of Technical Committee CEN/TC 226 “Road equipment”, by Working Group 6 “Noise reducing devices”, the secretariat of which is held by AFNOR.

This document is currently submitted to the CEN Enquiry.

This document will supersede EN 1793-5:2016.

EN 1793-5:2023 includes the following significant technical changes with respect to EN 1793-5:2016:

— The definitions from 3.1 to 3.7 have been updated to be in accordance to the last version of EN 14388.

— The single number rating DL_{RI} is now reported with one decimal digit.

— Annex A on the low-frequency limit and the window width has been added.

— One value for the standard deviation of reproducibility and repeatability in each one-third octave frequency band has been retained, in place of three values (min, max and median) as before (see Table B.1).

— Annex C (template of the test report) is now normative.

— The example in C.5 on the declaration of the measurement uncertainty has been updated accordingly.

— Annex C of EN 1793-5:2016 has been deleted.

EN 1793-5:2023 is part of a series and should be read in conjunction with the the following:

EN 1793-1:2023, *Road traffic noise reducing devices - Test method for determining the acoustic performance – Part 1: 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 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 1793-6:2023, *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

This document describes a test method for determining the intrinsic characteristics of sound absorption of road traffic noise reducing devices designed for roads in non-reverberant conditions (a measure of intrinsic performance). The methodology assesses indirectly sound absorption by measuring sound reflection (the complementary characteristics). It can be applied indoors or outdoors. Indoors, it can be applied in a purposely built test facility (under direct sound field conditions). Outdoors, it can be applied in a purposely built test facilities, e.g. near a laboratory or a factory, as well as *in situ*, i.e. where the road traffic noise reducing devices are installed. The method can be applied without damaging the surface.

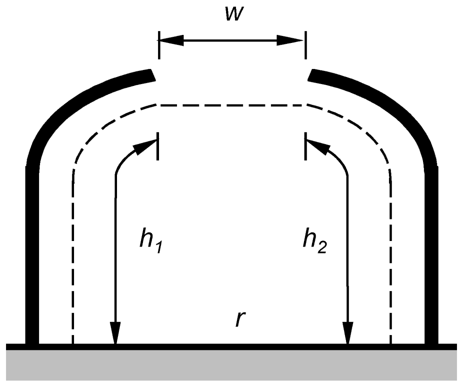
The method can be used to qualify products to be installed along roads as well as to verify the compliance of installed noise reducing devices to design specifications. Regular application of the method can be used to verify the long-term performance of noise reducing devices. The method requires the average of results of measurements taken in different points in front of the device under test and/or for specific angles of incidences. The method is able to investigate flat and non-flat products.

The measurement results of this method for sound absorption are not comparable with the results obtained under diffuse sound field conditions (EN 1793-1:2023), mainly because the present method uses a directional sound field, not a diffuse sound field. The test method described in the present document should not be used to determine the intrinsic characteristics of sound absorption of road traffic noise reducing devices to be installed in reverberant conditions, e.g. claddings inside tunnels or deep trenches.

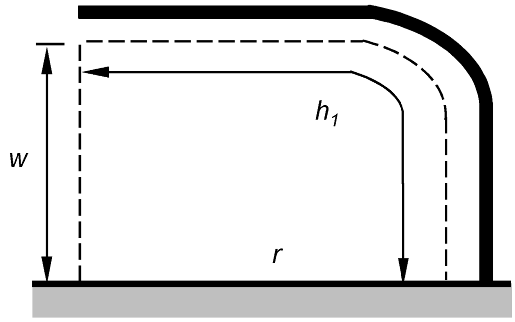
For the purpose of this document reverberant conditions are defined based on the envelope, e, across the road formed by the device under test, trench sides or buildings (the envelope does not include the road surface) as shown by the dashed lines in Figure 1. Conditions are defined as being reverberant when the percentage of open space in the envelope is less than or equal to 25 %, i.e. reverberant conditions occur when $w/e \leq 0,25$, where $e = (w+h_1+h_2)$.

This method introduces a specific quantity as a function of frequency, called reflection index, to define the sound reflection in front of a road traffic noise reducing device and then calculate a single-number rating for sound absorption from it, while the measurements under diffuse sound field conditions (according to EN 1793-1:2023) gives a sound absorption coefficient as a function of frequency and then calculate a single-number rating for sound absorption from it. Values of the sound absorption coefficient measured under diffuse sound field conditions can be converted to conventional values of a reflection coefficient taking the complement to one. In this case, research studies suggest that some correlation exists between diffuse sound field data, measured according to EN 1793-1:2023 and direct sound field data, measured according to the method described in this document [6] [9] [17] [18] [19].

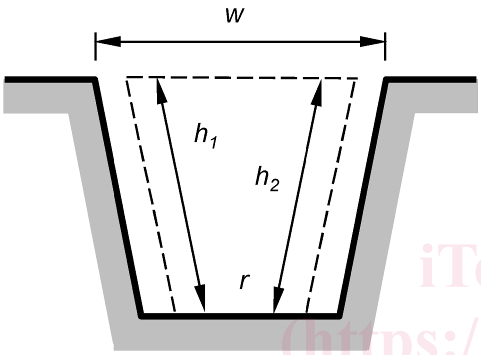
NOTE This method can be used to qualify noise reducing devices for other applications, e.g. to be installed nearby industrial sites. In this case, the single-number ratings can preferably be calculated using an appropriate spectrum.



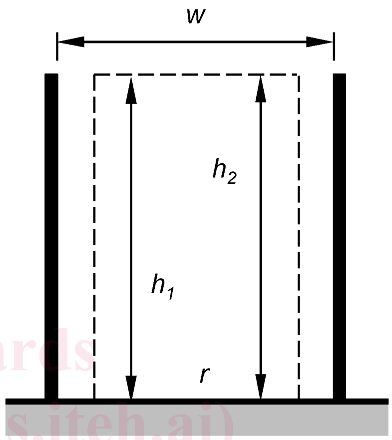
(a) Partial cover on both sides of the road; envelope, $e = w+h_1+h_2$.



(b) Partial cover on one side of the road; $e = w+h_1$. $h_2 = 0$.



(c) Deep trench envelope, $e = w+h_1+h_2$.



(d) Tall barriers or buildings; envelope, $e = w+h_1+h_2$. In all cases r: road surface; w: width of open space

Figure 1 — (not to scale) Sketch of the reverberant condition check in four cases

1 Scope

This document describes a test method for measuring a quantity representative of the intrinsic characteristics of sound reflection from road noise reducing devices, the sound reflection index, and then calculate a single-number rating for sound absorption from it.

The test method is intended for the following applications:

— determination of the intrinsic characteristics of sound absorption of noise reducing devices to be installed along roads, to be measured either on typical installations alongside roads or on a relevant sample section;

— determination of the intrinsic characteristics of sound absorption of road traffic noise reducing devices in actual use under direct sound field conditions;

— comparison of design specifications with actual performance data after the completion of the construction work;

— verification of the long-term performance of road traffic noise reducing devices (with a repeated application of the method).

The test method is not intended for the following applications:

— determination of the intrinsic characteristics of sound absorption of road traffic noise reducing devices to be installed in reverberant conditions, e.g. inside tunnels or deep trenches.

Results for the sound reflection index are expressed as a function of frequency, in one-third octave bands, where possible, between 100 Hz and 5 kHz. If it is not possible to get valid measurements results over the whole frequency range indicated, the results should be given in a restricted frequency range and the reasons of the restriction(s) should be clearly reported.

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

EN 14389:2022, *Road traffic noise reducing devices - Procedures for assessing long-term performance*

EN 61672-1:2013, *Electroacoustics - Sound level meters - Part 1: Specifications*

ISO/IEC Guide 98-3:2008, *Uncertainty of measurement — Part 3: 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.

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

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

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

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: An RTNRD can comprise acoustic elements (3.2) only or both structural (3.3) and acoustic elements.

Note 2 to entry: Applications of RTNRDs 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 the parts of the RTNRD.

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 reflection index
quantity representing the amount of sound not absorbed by the device under test

Note 1 to entry: Formula (1) specifies how to calculate the sound reflection index.

Note 2 to entry: The sound reflection index values in one-third octave bands are the result of a test according to the present document.

3.11
measurement grid for sound reflection index measurements
measurement grid constituted of nine equally spaced microphones in a 3x3 squared configuration

Note 1 to entry: The orthogonal spacing between two subsequent microphones, either vertically or horizontally, is s = 0,40 m.

Note 1 to entry: See Figure 3, 5 and 6.

Note 2 to entry: Microphones are numbered like in Figure 3.

3.12
reference height
height h_S equal to half the height, h_B, of the road traffic noise reducing device under test: $h_S = h_B/2$

Note 1 to entry: When the height of the device under test is greater than 4 m and, for practical reasons, it is not advisable to have a height of the source $h_S = h_B/2$, it is possible to have h_S = 2 m, accepting the corresponding low frequency limitation (see 5.6.2 and 5.6.4).

Note 2 to entry: See Figures 2 and 3.

3.13
source and microphone reference surface for sound reflection index measurements
ideal, smooth surface facing the sound source side of the road traffic noise reducing device under test and just touching the most protruding and significant parts of it within the tested area

Note 1 to entry: The reference surface is as smooth as possible, and follows the inclination or curve of the device under test within the tested area. For vertical and flat road traffic noise reducing devices, the reference surface is a vertical plane. For inclined and flat road traffic noise reducing devices, the reference surface is a plane with the same inclination. For curve and flat noise reducing devices, the reference surface is a curve surface with the same curvature.

Note 2 to entry: See Figures 2, 4, 7, 8, and 9.

3.14
source reference position
position facing the side to be exposed to noise when the road traffic noise reducing device is in place, located at the reference height h_S and placed so that the horizontal distance of the source front panel to the reference surface is d_S = 1,50 m

Note 1 to entry: See Figures 2 and 3.

3.15
measurement grid reference position
position of the measurement grid during the test

Note 1 to entry: the conditions and distances for a correct measurement reference position are specified in 5.6.2.1.

Note 2 to entry: for flat noise reducing devices, see Figures 2, and 3. For non-flat noise reducing devices, see Figure 7. For inclined or curved noise reducing devices, see Figures 8 and 9.

3.16
reference loudspeaker-measurement grid distance
distance between the front panel of the loudspeaker and the central microphone (microphone n. 5) of the measurement grid

Note 1 to entry: The reference loudspeaker-measurement grid distance is equal to d_{SM} = 1,25 m (see Figures 2 and 4).

3.17
free-field measurement for sound reflection index measurements
measurement taken with the loudspeaker and the measurement grid in an acoustic free field in order to avoid reflections from any nearby object, including the ground, keeping the same geometry as when measuring in front of the noise reducing device under test

Note 1 to entry: See Figure 4.

3.18
maximum sampled area
surface area, projected on a front view of the road traffic noise reducing device under test for reflection index measurements, which must remain free of reflecting objects causing parasitic reflections

3.19
Adrienne temporal window
analysis window in the time domain to be used for the data processing

Note 1 to entry: Data processing according to the present document.

Note 1 to entry: The Adrienne temporal window is described in 5.5.6.

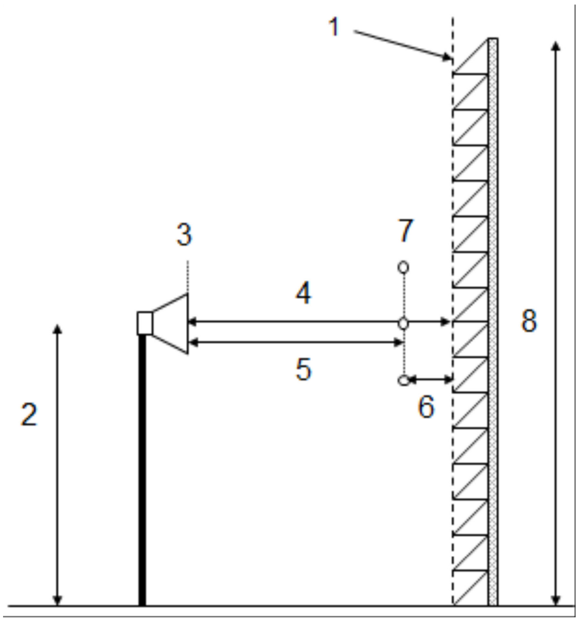
3.20
background noise
noise coming from sources other than the sound source emitting the test signal

3.21
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)

3.22
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.

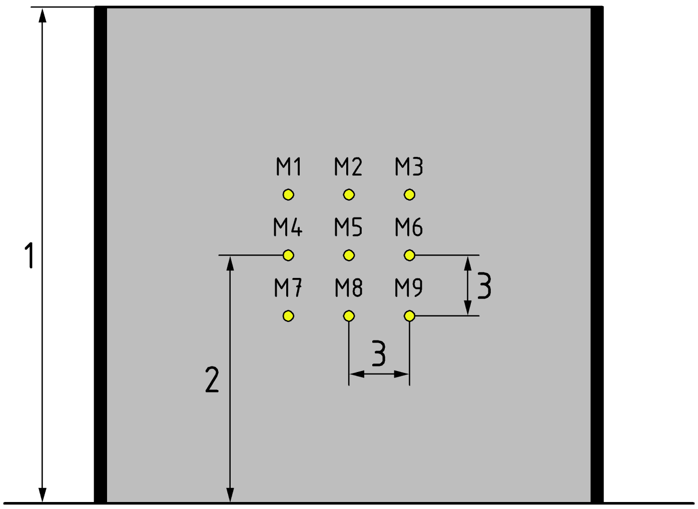
Note 2 to entry: It is impossible in practice to create and radiate true Dirac delta functions. Short transient sounds can offer close enough approximations but are not very repeatable. An alternative measurement technique, generally more accurate, is to use a period of deterministic, flat-spectrum signal,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



Key

1 Source and microphone reference surface	2 Reference height h_S [m]
3 Loudspeaker front panel	4 Distance between the loudspeaker front panel and the reference surface, d_S [m]
5 Distance between the loudspeaker front panel and the measurement grid, d_{SM} [m]	6 Distance between the measurement grid and the reference surface, d_M [m]
7 Measurement grid	8 Road traffic noise reducing device height, h_B [m]

Figure 2 — (not to scale) Sketch of the sound source and the measurement grid in front of the road traffic noise reducing device



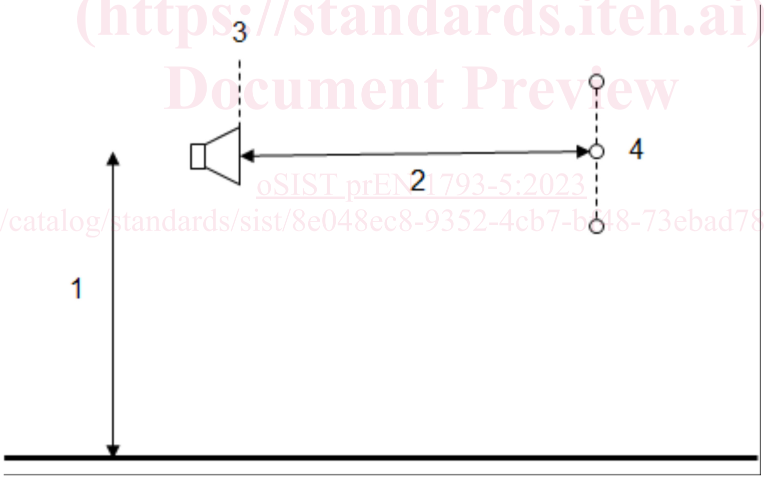
Key

1 road traffic noise reducing device height h_B [m]

2 Reference height h_S [m]

3 Orthogonal spacing between two subsequent microphones s [m]

Figure 3 — (not to scale) Measurement grid for sound reflection index measurements in front of the device under test (sound source side); the yellow circles indicate the microphone positions, labelled from M1 to M9



Key

1 Reference height h_S [m]

2 Distance between the loudspeaker front panel and the measurement grid d_{SM} [m]

3 Loudspeaker front panel

4 Measurement grid

Figure 4 — (not to scale) Sketch of the set-up for the reference “free-field” sound measurement for the determination of the sound reflection index