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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

Lärmschutzeinrichtungen an Straßen - Prüfverfahren zur Bestimmung der akustischen Eigenschaften - Teil 4: Produktspezifische Merkmale - Insitu-Werte der Schallbeugung

Dispositifs de réduction du bruit du trafic routier - Méthode d'essai pour la détermination des performances acoustiques - Partie 4 : Caractéristiques intrinseques - Valeurs in situ de la diffraction acoustique

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English version

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This Technical Specification (CEN/TS) was approved by CEN on 6 June 2003 for provisional application.

The period of validity of this CEN/TS is limited initially to three years. After two years the members of CEN will be requested to submit their comments, particularly on the question whether the CEN/TS can be converted into a European Standard.

CEN members are required to announce the existence of this CEN/TS in the same way as for an EN and to make the CEN/TS available. It is permissible to keep conflicting national standards in force (in parallel to the CEN/TS) until the final decision about the possible conversion of the CEN/TS into an EN is reached.

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EUROPEAN COMMITTEE FOR STANDARDIZATION
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Contents

Foreword

This document (CEN/TS 1793-4:2003) has been prepared by Technical Committee CEN/TC 226 "Road equipment", the secretariat of which is held by AFNOR.

It should be read in conjunction with :

EN 1793-1, *Road traffic noise reducing devices - Test method for determining the acoustic performance – Part 1 : Intrinsic characteristics of sound absorption*

EN 1793-2, *Road traffic noise reducing devices - Test method for determining the acoustic performance – Part 2 : Intrinsic characteristics of airborne sound insulation*

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

CEN/TS 1793-5, *Road traffic noise reducing devices - Test method for determining the acoustic performance – Part 5: Intrinsic characteristics – In situ values of sound reflection and airborne sound insulation.*

According to the CEN/CENELEC Internal Regulations, the national standards organizations of the following countries are bound to announce this Technical Specification: Austria, Belgium, Czech Republic, Denmark, Finland, France, Germany, Greece, Hungary Iceland, Ireland, Italy, Luxembourg, Malta, Netherlands, Norway, Portugal, Slovakia, Spain, Sweden, Switzerland and the United Kingdom.

Introduction

Part of the market of road traffic noise reducing devices is constituted of products to be added on the top of 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 standard 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 traffic noise reducing devices and the added devices are installed. The method can be applied without damaging the 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.

NOTE – This method could be used to qualify added devices for other applications, e.g. to be installed along railways or nearby industrial sites. In this case special care has to be taken into account in considering the location of the noise sources and the single-number ratings should be calculated using an appropriate spectrum.

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

1 Scope

This document describes a test method for determining the intrinsic characteristics of sound diffraction of added devices installed on the top of traffic noise reducing devices. The test method prescribes measurements of the sound pressure level at several reference points near the top edge of a 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 test method is intended for the following applications:

- preliminary qualification, outdoors or indoors, of added devices to be installed on 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).

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 indoor measurements see Annex B.

2 Normative references

This European Standard incorporates by dated or undated reference, provisions from other publications. These normative references are cited at the appropriate place in the text and the publications are listed hereafter. For dated references, subsequent amendments to or revisions of any of these publications apply to this European Standard only when incorporated in it by amendment or revision. For undated references, the latest edition of the publication applies.

EN 1793-3: 1997, *Road traffic noise reducing devices - Test method for determining the acoustic performance - Part 3: Normalized traffic noise spectrum.*

EN 60651: 1979, *Sound level meters.*

3 Definitions and symbols

3.1 Definitions

For the purpose of this standard the following definitions apply:

3.1.1
structural elements
those elements whose primary function is to support or hold in place acoustic elements

3.1.2
acoustical elements
those elements whose primary function is to provide the acoustic performance of the device

3.1.3
noise barrier
noise reducing device which obstructs the direct transmission of airborne sound emanating from road traffic

3.1.4
added device
acoustic element added on the top of a noise reducing device and intended to contribute to sound attenuation acting primarily on the diffracted sound field

3.1.5
roadside exposure
The use of the product as a noise reducing device installed alongside roads

3.1.6
diffraction index
The result of a sound diffraction test described by formula (1). DI_{refl} refers to measurements on a reflective reference wall. DI_{abs} refers to measurements on an absorptive reference wall. DI_{situ} refers to in situ measurements

3.1.7
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, described by formula (4)

3.1.8
test construction
construction on which the added device is placed. For in situ measurements it is an installed noise reducing device; for qualification tests it is a reference wall (see 4.2)

3.1.9
reference plane of the test construction
the vertical plane passing through the midpoint of the top edge of the construction (reference wall or installed noise reducing device) on which the added device has to be placed (see figures 1, 2, 4, 5, 8)

3.1.10
reference height of the test construction without the added device, $h_{ref,0}$
height of the highest point of the test construction in relation to the surrounding ground surface. This highest point is not necessarily lying in the plane of longitudinal symmetry of the reference test construction, if this symmetry exists (figure 1)

3.1.11
reference height of the test construction with the added device on the top, $h_{ref,add}$
height of the highest point of the added device installed on the test construction in relation to the surrounding ground surface. This highest point is not necessarily lying in the plane of longitudinal symmetry of the reference test construction, if this symmetry exists (figure 4)

3.1.12
free-field measurement for diffraction index measurements
Measurement carried out placing the loudspeaker and the microphone as specified in 4.5 and 4.8 without any obstacle, including the test construction with or without added device, between them (see for example figure 7)

3.1.13
adrienne temporal window
the composite temporal window described in 4.5.5

3.1.14
background noise
noise coming from sources other than the source emitting the test signal

3.1.15
signal-to-noise ratio, S/N
The 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)

3.1.16
impulse response
the time signal at the output of a system when a Dirac function is applied to the input. 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

3.2 Symbols

$DI_{0,refl}$ is the diffraction index for the reflective reference wall without the added device (dB),

$DI_{ad,refl}$ is the diffraction index for the reflective reference wall with the added device (dB),

$DI_{0,abs}$ is the diffraction index for the absorptive reference wall without the added device (dB),

$DI_{ad,abs}$ is the diffraction index for the absorptive reference wall with the added device (dB),

$DI_{0,situ}$ is the diffraction index for the in situ test construction without the added device (dB),

$DI_{ad,situ}$ is the diffraction index for the in situ test construction with the added device (dB).

4 Diffraction index difference measurements

4.1 General principle

The sound source emits a transient sound wave that travels toward the noise reducing device under test and is partly reflected, partly transmitted and partly diffracted by it. The microphone placed on the other side of the noise reducing device receives both the transmitted sound pressure wave travelling from the sound source through the noise reducing device and the sound pressure wave diffracted by the top edge of the noise reducing device under test (for the test to be meaningful the diffraction from the vertical edges of the test construction shall be sufficiently delayed in order to be outside the Adrienne temporal window). If the measurement is repeated without the added device and the test construction between the loudspeaker and the microphone, the direct free-field wave can be acquired. The power spectra of the direct and the top-edge diffracted components, corrected to take into account the path length difference of the two components, give the basis for calculating the diffraction index.

The final diffraction index shall be a weighted average of the diffraction indices measured at different points (see Figures 1 to 6).

When the test method is applied in situ, the measurement procedure and diffraction index calculation shall be carried out two times, with and without the added device placed on the test construction.

When the test method is applied on samples purposely built to be tested according to the present standard, the added device shall be subsequently placed on the top of two reference walls (see 4.2) and the measurement procedure and diffraction index calculation shall be carried out for both walls, with and without the added device on the top.

The measurement must take place in an essentially free field in the direct surroundings of the device, i.e. a field free from reflections coming from surfaces other than the surface of the device under test. For this reason, the acquisition of an impulse response having peaks as sharp as possible is recommended: in this way, the reflections coming from other surfaces than the tested device can be identified from their delay time and rejected.

4.2 Dimensions and specifications

4.2.1 Added devices

The added device shall have a minimum length L_d of 10 m. The reference wall shall have a minimum length L_b of 10 m and a minimum height of 4 m. The reference wall shall be vertical, flat and fixed firmly and without any air gaps on a supporting construction (foundation, floor etc.). The top surface of the supporting construction shall be level with the surrounding ground surface.

The maximum size of the added device measured perpendicularly from the reference plane either in the direction of the source or in the direction of the microphones shall not exceed a value of 0,75 m (see figure 8).

4.2.2 Reference walls

Two versions of the reference wall shall be used in the tests:

A A reflective reference wall, constructed of homogeneous concrete panels with a mass per unit area of at least 100 kg/m^2 and a smooth surface finish. The wall shall be free of air leaks and shall have a thickness not greater than 0,20 m.

B An absorptive reference wall, constructed of concrete panels as mentioned under A, lined on the source side with an absorptive layer of 50 mm fibrous material having a flow resistivity value between 2000 and 4000 Pa·s/m^2.

4.2.3 In situ tests

When applying the test method in situ on existing noise reducing devices, with the intention of obtaining results valid over the entire frequency range specified in 4.6, the test construction shall satisfy the requirements in 4.2.2.

If these requirements cannot be fulfilled by the existing noise reducing device, the obtained results shall only be valid over a restricted frequency range (see 4.8.7) and for the type of noise reducing device being tested.

4.3 Positions of the sound source

Two angles of incidence, 90° and 45°, shall be used (see figures 2 and 5).

For execution of the diffraction test at a right angle to the test construction the sound source shall be placed as follows (see figures 1, 2, 4 and 5):

- in the vertical plane containing the perpendicular bisector plane to the reference plane;
- horizontally: at 2 m distance from the reference plane of the test construction;
- vertically: in relation to the reference height h_{ref} of the test construction,

  for the obligatory source position S1: centre of the source 0,50 m lower than h_{ref};

  for the additional source position S2: centre of the source 0,15 m lower than h_{ref} ;

  for the additional source position S3: centre of the source 0,65 m lower than h_{ref} ;
- oriented towards the microphone position M2 (see 4.4 and figures 1 and 3).

For execution of the diffraction test at an angle of 45° with the reference plane of the test construction the sound source shall be placed as follows (see Figures 2 and 5):

- in a vertical plane that makes an angle of 45° with the reference plane of the test construction, passing through its mid-point;

- horizontally: at 2 m distance from the reference plane of the test construction;
- vertically in relation to the reference height h_{ref} of the test construction,

  for the obligatory source position S4: centre of the source 0,50 m lower than h_{ref};

  for the additional source position S5: centre of the source 0,15 m lower than h_{ref} ;

  for the additional source position S6: centre of the source 0,65 m lower than h_{ref} ;
- oriented towards the microphone position M8 (see 4.4 and figures 2 and 3).

4.4 Position of the microphones

For execution of the diffraction test at a right angle to the test construction the microphones shall be placed as follows (see Figures 1 to 6):

- in the vertical plane containing the perpendicular bisector plane to the reference plane;
- horizontally: at 2 m distance from the reference plane of the test construction;
- vertically in relation to the reference height h_{ref} of the test construction,

  for the obligatory microphone positions M1, M2, M3 and M4:

  – microphone M1: 0,75 m higher;

  – microphone M2: 0,50 m higher;

– microphone M3: equal to the reference height;

– microphone M4: 0,50 m lower;

for the additional microphone positions 5 and 6:

– microphone M5: 0,25 m higher;

– microphone M6: 0,25 m lower.

- making an angle in the horizontal plane so as to be oriented toward the sound source.

For execution of the diffraction test at an angle of 45° with the reference plane of the test construction the microphones shall be placed as follows (see Figures 1, 2, 3, 5 and 6):

- in a vertical plane that makes an angle of 45° with the reference plane of the test construction, passing through its mid-point;
- horizontally: at 2 m distance from the longitudinal axis of the test construction;
- vertically in relation to the reference height h_{ref} of the test construction,

for the obligatory microphone positions M7, M8, M9 and M10:

– microphone M7: 0,75 m higher;

– microphone M8: 0,50 m higher;

– microphone M9: equal to the reference height;

– microphone M10: 0,50 m lower.

for the additional microphone positions 10, 11 and 12:

– microphone M11: 0,25 m higher;

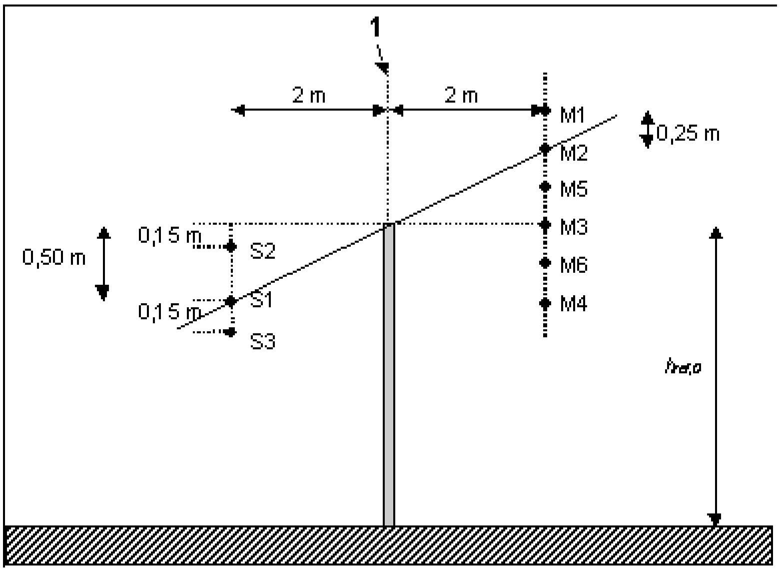
– microphone M12: 0,25 m lower.

- making an angle in the horizontal plane so as to be oriented toward the sound source.

4.5 Free-field measurements

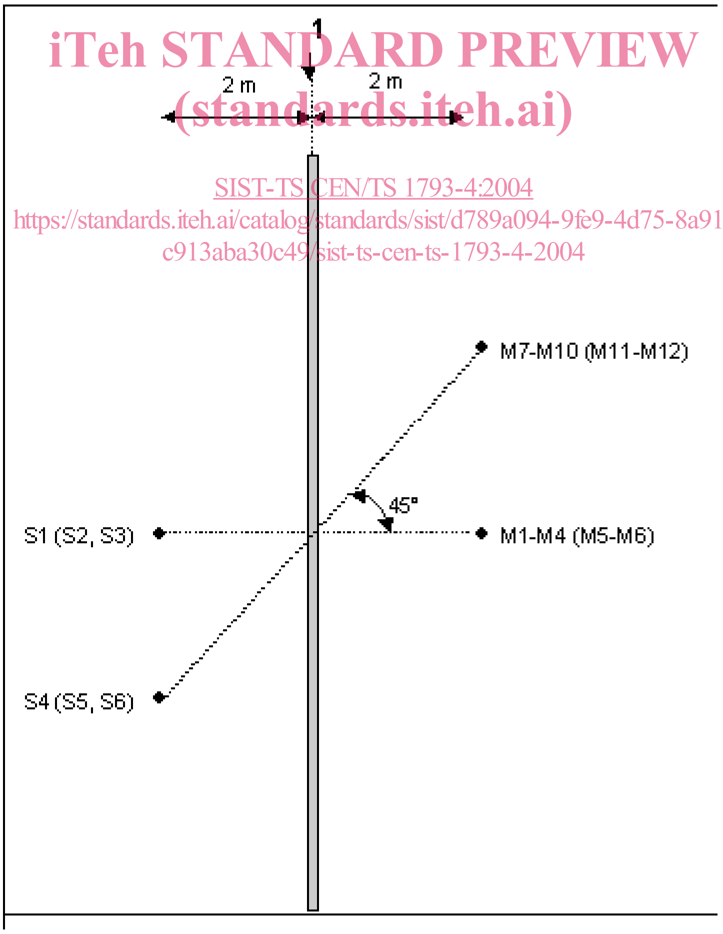
For each set of measurements done placing the sound source according to 4.3 (90° and 45°), at least one free-field measurement shall be carried out, placing the microphone at relative distances from the sound source as in the position S1-M2 for normal incidence measurements and in position S4-M8 for measurements at an angle of 45° (see for example Figure 7). A whole set of measurements shall be carried out within two hours. Otherwise a new free-field measurement has to be carried out.

No obstacle shall be present within a distance of 3 m from the microphone.



1 Reference plane

Figure 1 - Source and microphone positions in a vertical cross section of the test construction without added device.



1 Reference plane

Figure 2 - Source and microphone positions in a top view of the test construction without added device.