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Railway applications — Track — Noise barriers and related devices acting on airborne sound propagation — Test method for determining the acoustic performance

Part 3-2: Normalized railway noise spectrum and single number ratings for direct field applications

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Bahnanwendungen - Oberbau - Lärmschutzwände und verwandte Vorrichtungen zur Beeinflussung der Luftschallausbreitung - Prüfverfahren zur Bestimmung der akustischen Eigenschaften - Teil 3-2: Standardisiertes Schienenverkehrslärmspektrum und Einzahl-Angaben für gerichtete Schallfelder

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Contents

Foreword

This document (EN 16272-3-2:2014) has been prepared by Technical Committee CEN/TC 256 “Railway applications”, the secretariat of which is held by DIN.

This European Standard shall be given the status of a national standard, either by publication of an identical text or by endorsement, at the latest by January 2015 and conflicting national standards shall be withdrawn at the latest by January 2015.

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This European Standard is one of the series EN 16272, *Railway applications — Track — Noise barriers and related devices acting on airborne sound propagation — Test method for determining the acoustic performance*, as listed below:

— *Part 1: Intrinsic characteristics — Sound absorption in the laboratory under diffuse sound field conditions*;

— *Part 2: Intrinsic characteristics — Airborne sound insulation in the laboratory under diffuse sound field conditions*;

— *Part 3-1: Normalized railway noise spectrum and single number ratings for diffuse field applications*;

— *Part 3-2: Normalized railway noise spectrum and single number ratings for direct field applications* (the present document);

— *Part 5: Intrinsic characteristics — In situ values of sound reflection under direct sound field conditions* (Technical Specification);

— *Part 6: Intrinsic characteristics — In situ values of airborne sound insulation under direct sound field conditions*.

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Introduction

This document is to be read in conjunction with prEN 16272-4, CEN/TS 16272-5 and EN 16272-6 and will be applied only to situations as described in those documents (direct sound field).

As the two main intrinsic acoustic characteristics of noise barriers and related devices acting on airborne sound propagation in a direct sound field, the sound reflection index and the sound insulation index, are frequency dependent, there is a need to define a reference railway noise spectrum for test purposes.

Also the sound diffraction index difference, the main intrinsic acoustic characteristic of added devices, i.e. products which may be added on the top of noise barriers and intended to contribute to sound attenuation acting primarily on the diffracted sound field, is frequency dependent and there is an analogous need to define a reference railway noise spectrum for test purposes.

This European Standard defines the basic properties of railway noise measured at the rail track side in terms of a characteristic normalized railway noise spectrum which is needed to evaluate single-number ratings of noise barriers and related devices acting on airborne sound propagation, except those used in reverberant conditions, e.g. inside tunnels or deep trenches.

1 Scope

This European Standard specifies a normalized railway noise spectrum for the evaluation and assessment of the acoustic performance of devices designed to reduce airborne railway noise near railways.

All noise reducing devices different from noise barriers and related devices acting on airborne sound propagation, e.g. devices for attenuation of ground borne vibration and on board devices, are out of the scope of this European Standard.

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.

prEN 16272-4:2014, *Railway applications — Track — Noise barriers and related devices acting on airborne sound propagation — Test method for determining the acoustic performance — Part 4: Intrinsic characteristics — In situ values of sound diffraction under direct sound field conditions*

CEN/TS 16272-5:2014, *Railway applications — Track — Noise barriers and related devices acting on airborne sound propagation — Test method for determining the acoustic performance — Part 5: Intrinsic characteristics — In situ values of sound reflection under direct sound field conditions*

EN 16272-6:2014, *Railway applications — Track — Noise barriers and related devices acting on airborne sound propagation — Test method for determining the acoustic performance — Part 6: Intrinsic characteristics — In situ values of airborne sound insulation under direct sound field conditions*

3 Terms and definitions

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

3.1
noise barrier
noise reducing device, which obstructs the direct transmission of airborne sound emanating from railways

Note 1 to entry: It may either span or overhang the railway.

Note 2 to entry: Noise barriers are generally made of acoustic and structural elements (3.3 and 3.4).

3.2
cladding
noise reducing device, which is attached to a wall or other structure and reduces the amount of sound reflected

Note 1 to entry: Claddings are generally made of acoustic and structural elements (3.3 and 3.4).

3.3
acoustic element
element whose primary function is to provide the acoustic performance of the device

3.4
structural element
element whose primary function is to support or hold in place acoustic elements

Note 1 to entry: In some noise barriers the acoustic function and the structural function cannot be clearly separated and attributed to different components.

3.5
added device
added component that influences the acoustic performance of the original noise-reducing device (acting primarily on the diffracted energy)

3.6
normalized railway noise spectrum
spectrum that is used for the calculation of the acoustic performance of noise barriers and related devices acting on airborne sound propagation near railways, in terms of single-number ratings of sound reflection index, sound insulation index and sound diffraction index difference, as applicable

Note 1 to entry: The spectrum is expressed in terms of relative A-weighted sound pressure levels in decibels, for one-third octave bands, L_i, in the frequency range from 100 Hz to 5 kHz.

3.7
one-third octave bands level
L_i
relative A-weighted sound pressure levels in decibels, of a normalized railway noise spectrum for one-third octave bands with centre frequency range f_i

4 Normalized railway noise spectrum

The normalized railway noise spectrum shown in Table 1 shall be used to assess the acoustic performance of noise barriers and related devices acting on airborne sound propagation near railways.

Table 1 — Normalized railway noise spectrum

f_i Hz	L_i railways dB
100	- 27
125	- 25
160	- 23
200	- 21
250	- 19
315	- 17
400	- 15
500	- 13
630	- 12
800	- 11
1 000	- 10
1 250	- 9
1 600	- 9
2 000	- 9
2 500	- 9
3 150	- 10
4 000	- 13
5 000	- 17

5 Single-number rating of sound reflection index DL_{RI}

A single-number rating shall be derived to indicate the performance of the product related to sound reflection index. The individual sound reflection index values shall be weighted according to the normalized railway noise spectrum defined in Table 1.

The single-number rating of sound reflection index DL_{RI}, in decibels, is given by:

$$DL_{RI} = -10 \times \lg \left[\frac{\sum_{i=m}^{18} RI_i \cdot 10^{0,1L_i}}{\sum_{i=m}^{18} 10^{0,1L_i}} \right] \quad (1)$$

where

RI_i is the sound reflection index measured in front of the acoustic elements, in the *i*-th one-third octave band;

m is the number of the lowest reliable one-third octave frequency band;

L_i is the relative A-weighted sound pressure levels (dB) of the normalized railway noise spectrum, as defined in Table 1, in the *i*-th one-third octave band.

For product qualification tests in laboratory conditions, the single number rating DL_{RI} shall be calculated for samples of minimum dimensions of 4 m x 4 m.

The RI_i values to be inserted in Formula (1) are the spatial averaged values of the sound reflection index according to Table 2 of CEN/TS 16272-5:2014.

In some cases the ratio of the summation terms in the expression of DL_{RI} can exceed 1 which precludes the correct calculation of DL_{RI}. For this reason the maximum value of this ratio shall be limited to 0,99.

NOTE Annex A provides guidance to the use of the single-number rating of sound reflection index.

6 Single-number ratings of sound insulation index DL_{SI}

6.1 General

Whenever possible, three single-number ratings shall be derived from measurements to indicate the performance of the product related to sound insulation index: one for acoustic elements, one for posts (if applicable) and a global rating. The individual sound insulation index values coming from element scanning and post scanning shall be weighted according to the normalized railway noise spectrum defined in Table 1.

6.2 Acoustic elements

The single-number rating for acoustic elements $DL_{SI,E}$, in decibels, is given by:

$$DL_{SI,E} = -10 \times \lg\left[\frac{\sum_{i=m}^{18} 10^{0,1L_i} 10^{-0,1SI_{E,i}}}{\sum_{i=m}^{18} 10^{0,1L_i}}\right] \quad (2)$$

where:

$SI_{E,i}$ is the sound insulation index measured in front of the acoustic elements, in the *i*-th one-third octave band;

m is the number of the lowest reliable one-third octave frequency band;

L_i is the relative A-weighted sound pressure levels (dB) of the normalized railway noise spectrum, as defined in Table 1, in the *i*-th one-third octave band.

The single-number rating for acoustic elements $DL_{SI,E}$ shall be calculated for samples of minimum dimensions conforming to 5.3 and 5.5.8 in EN 16272-6:2014

NOTE Annex B provides guidance to the use of the single-number rating of sound insulation index.

6.3 Posts

The single-number rating for posts $DL_{SI,P}$, in decibels, is given by:

$$DL_{SI,P} = -10 \times \lg\left[\frac{\sum_{i=m}^{18} 10^{0,1L_i} 10^{-0,1SI_{P,i}}}{\sum_{i=m}^{18} 10^{0,1L_i}}\right] \quad (3)$$

where:

$SI_{P,i}$ is the sound insulation index measured in front of a post, in the *i*-th one-third octave band;

m is the number of the lowest reliable one-third octave frequency band;

L_i is the relative A-weighted sound pressure levels (dB) of the normalized railway noise spectrum, as defined in Table 1, in the *i*-th one-third octave band.

The single-number rating for posts $DL_{SI,P}$ shall be calculated for samples of minimum dimensions conforming to 5.3 and 5.5.8 in EN 16272-6:2014

NOTE Annex B provides guidance to the use of the single-number rating of sound insulation index.

6.4 Global

The global single-number rating for the sample under test $DL_{SI,G}$, in decibels, is given by:

$$DL_{SI,G} = -10 \times \lg\left[\frac{10^{-0,1DL_{SI,E}} + 10^{-0,1DL_{SI,P}}}{2}\right] \quad (4)$$

where

$DL_{SI,E}$ is the single-number rating for acoustic elements, in decibels,

$DL_{SI,P}$ is the single-number rating for posts, in decibels.

If the single-number rating for posts cannot be derived, then the global single-number rating for the sample under test is equal to the single-number rating for acoustic elements.

NOTE Annex B provides guidance to the use of the single-number rating of sound insulation index.

7 Single-number ratings of sound diffraction index difference $DL_{\Delta DI}$

7.1 General

Whenever possible, one or more single-number ratings shall be derived from measurements to indicate the performance of an added device related to sound diffraction index difference: one for the product on the reflecting reference wall, one for the product on the absorbing reference wall, one for the product on the *in situ* test construction (if applicable). The individual diffraction index values shall be weighted according to the normalized railway noise spectrum defined in Table 1.

The formulae are given in 7.2, 7.3 and 7.4.

In all cases:

L_i is the relative A-weighted sound pressure levels (dB) of the normalized traffic noise spectrum, as defined in Table 1, in the *i*-th one-third octave band.

The single-number ratings of the diffraction index difference shall be calculated for samples of minimum dimensions conforming to 4.2 in prEN 16272-4:2014.

7.2 Single-number rating of sound diffraction index difference $DL_{\Delta DI,refl}$

The single-number rating of sound diffraction index difference of an added device on the reflecting reference wall, $DL_{\Delta DI,refl}$, in decibels, is given by:

$$DL_{\Delta DI,refl} = -10 \cdot \lg\left[\frac{\sum_{i=1}^{18} 10^{0,1L_i} 10^{-0,1\Delta DI_{refl,i}}}{\sum_{i=1}^{18} 10^{0,1L_i}}\right] \quad (5)$$

where

$\Delta DI_{refl,i}$ is the sound diffraction index difference measured with the added device under test on the reflective reference wall, in the *i*-th one-third octave band.

7.3 Single-number rating of sound diffraction index difference $DL_{\Delta DI,abs}$

The single-number rating of sound diffraction index difference of an added device on the absorbing reference wall, $DL_{\Delta DI,abs}$, in decibels, is given by:

$$DL_{\Delta DI,abs} = -10 \cdot \lg\left[\frac{\sum_{i=1}^{18} 10^{0,1L_i} 10^{-0,1\Delta DI_{abs,i}}}{\sum_{i=1}^{18} 10^{0,1L_i}}\right] \quad (6)$$

where

$\Delta DI_{abs,i}$ is the sound diffraction index difference measured with the added device under test on the absorptive reference wall, in the *i*-th one-third octave band.

7.4 Single-number rating of sound diffraction index difference $DL_{\Delta DI,situ}$

The single-number rating of sound diffraction index difference of an added device on the *in situ* test construction, $DL_{\Delta DI,situ}$, in decibels, is given by:

$$DL_{\Delta DI,situ} = -10 \cdot \lg\left[\frac{\sum_{i=1}^{18} 10^{0,1L_i} 10^{-0,1\Delta DI_{situ,i}}}{\sum_{i=1}^{18} 10^{0,1L_i}}\right] \quad (7)$$

where

$\Delta DI_{situ,i}$ is the sound diffraction index difference measured with the added device under test on the *in situ* test construction, in the *i*-th one-third octave band.

NOTE Annex C provides guidance to the use of the single-number ratings of sound diffraction index difference.

8 Expression of results

If the single-number rating of sound reflection index DL_{RI} is to be reported, then this shall be done in the test report of the sound reflection index measurement according to CEN/TS 16272-5.

The single-number rating of sound reflection index DL_{RI} shall be reported after having been rounded to the nearest integer.

If the single-number rating of sound insulation index DL_{SI} is to be reported, then this shall be done in the test report of the sound insulation index measurement according to EN 16272-6.

The single-number ratings of sound insulation index $DL_{SI,E}$, $DL_{SI,P}$ (if applicable) and $DL_{SI,G}$ shall be reported after having been rounded to the nearest integer.

If the single-number ratings of sound diffraction index difference $DL_{\Delta DI,refl}$, $DL_{\Delta DI,abs}$ and $DL_{\Delta DI,situ}$ are to be reported, then this shall be done in the test report of the sound diffraction index difference measurement according to prEN 16272-4.

The single-number ratings of sound diffraction index difference $DL_{\Delta DI,refl}$, $DL_{\Delta DI,abs}$ and $DL_{\Delta DI,situ}$ (if applicable) shall be calculated keeping one decimal digit and reported after having been rounded to the nearest integer.

Annex A
(informative)

Guidance note on use of the single-number rating of sound reflection index DL_{RI}

The use of the single-number rating DL_{RI} is for the purpose of comparing the overall performance of noise barriers and related devices, irrespective of local conditions, rail traffic composition and track type.

However, presentation of results in one third octave bands may be more informative than single-number rating when selecting products.

Annex B
(informative)

Guidance note on use of the single-number rating of airborne sound insulation index DL_{SI}

The use of the single-number ratings $DL_{SI,E}$, $DL_{SI,P}$ or $DL_{SI,G}$ is for the purpose of comparing the overall performance of noise reducing devices, irrespective of local conditions, rail traffic composition and track type.

However, presentation of results in one third octave bands may be more informative than single-number ratings when selecting products.

Annex C
(informative)

Guidance note on use of the single-number rating of sound diffraction index difference $DL_{\Delta DI}$

The use of the single-number ratings $DL_{\Delta DI,refl}$, $DL_{\Delta DI,abs}$ or $DL_{\Delta DI,situ}$ is for the purpose of comparing the overall performance of added devices, irrespective of local conditions, rail traffic composition and track type.

However, presentation of results in one third octave bands may be more informative than single-number ratings when selecting products.

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