SLOVENSKI STANDARD
SIST EN 16727-2-1:2018

01-oktober-2018

Železniške naprave - Zgornji ustroj - Protihrupne ovire in pripadajoče naprave, ki vplivajo na širjenje zvoka v zraku - Neakustične lastnosti - 2-1. del: Mehanske lastnosti pri dinamičnih obremenitvah zaradi mimo vozečih vlakov - Odpornost proti utrujanju

Railway applications - Track - Noise barriers and related devices acting on airborne sound propagation - Non-acoustic performance - Part 2-1: Mechanical performance under dynamic loadings due to passing trains - Resistance to fatigue

Bahnanwendungen - Oberbau - Lärmschutzwände und verwandte Vorrichtungen zur Beeinflussung der Luftschallausbreitung - Nicht akustische Eigenschaften - Teil 2-1: Mechanische Eigenschafts- und Stabilitätsanforderungen unter dynamischen Belastungen aufgrund vorbeifahrender Züge - Prüfverfahren

Ta slovenski standard je istoveten z: **EN 16727-2-1:2018**

ICS:

17.140.30	Emisija hrupa transportnih sredstev	Noise emitted by means of transport
93.100	Gradnja železnic	Construction of railways

SIST EN 16727-2-1:2018 **en**

EUROPEAN STANDARD

NORME EUROPÉENNE

EUROPÄISCHE NORM

EN 16727-2-1

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ICS 93.100

English Version

Railway applications - Track - Noise barriers and related devices acting on airborne sound propagation - Non-acoustic performance - Part 2-1: Mechanical performance under dynamic loadings due to passing trains - Resistance to fatigue

Applications ferroviaires - Voie - Écrans antibruit et dispositifs connexes influant sur la propagation aérienne du son - Performances non acoustiques - Partie 2-1 : Tenue mécanique sous charges dynamiques dues à la circulation ferroviaire - Résistance à la fatigue

Bahnanwendungen - Oberbau - Lärmschutzwände und verwandte Vorrichtungen zur Beeinflussung der Luftschallausbreitung - Nicht akustische Eigenschaften - Teil 2-1: Mechanische Eigenschaftsanforderungen unter dynamischen Belastungen aufgrund vorbeifahrender Züge - Prüfverfahren zum Ermüdungsverhalten

This European Standard was approved by CEN on 8 February 2018.

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This European Standard exists in three official versions (English, French, German). A version in any other language made by translation under the responsibility of a CEN member into its own language and notified to the CEN-CENELEC Management Centre has the same status as the official versions.

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EUROPEAN COMMITTEE FOR STANDARDIZATION
COMITÉ EUROPÉEN DE NORMALISATION
EUROPÄISCHES KOMITEE FÜR NORMUNG

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European foreword

This document (EN 16727-2-1:2018) 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 December 2018, and conflicting national standards shall be withdrawn at the latest by December 2018.

Attention is drawn to the possibility that some of the elements of this document may be the subject of patent rights. CEN shall not be held responsible for identifying any or all such patent rights.

This document is one of the series EN 16727, *Railway applications — Track — Noise barriers and related devices acting on airborne sound propagation — Non-acoustic performance*, as listed below:

— *Part 1: Mechanical performance under static loadings — Calculation and test method*;

— *Part 2-1: Mechanical performance under dynamic loadings due to passing trains — Resistance to fatigue* [this document];

— *Part 2-2: Mechanical performance under dynamic loadings caused by passing trains — Calculation method*;

— *Part 3: General safety and environmental requirements*.

It is intended to be read in conjunction with:

— EN 16727-1, *Railway applications — Track — Noise barriers and related devices acting on airborne sound propagation — Non-acoustic performance — Part 1: Mechanical performance under static loadings — Calculation and test method*;

— EN 16727-2-2, *Railway applications — Track — Noise barriers and related devices acting on airborne sound propagation — Non-acoustic performance — Part 2-2: Mechanical performance under dynamic loadings caused by passing trains — Calculation method*.

According to the CEN-CENELEC Internal Regulations, the national standards organizations of the following countries are bound to implement this European Standard: Austria, Belgium, Bulgaria, Croatia, Cyprus, Czech Republic, Denmark, Estonia, Finland, Former Yugoslav Republic of Macedonia, France, Germany, Greece, Hungary, Iceland, Ireland, Italy, Latvia, Lithuania, Luxembourg, Malta, Netherlands, Norway, Poland, Portugal, Romania, Serbia, Slovakia, Slovenia, Spain, Sweden, Switzerland, Turkey and the United Kingdom.

Introduction

Passing trains generate an air pressure wave, which impacts on noise barriers installed alongside the track. It is important that noise barriers withstand this impact without any part of them becoming detached or displaced in an unsafe manner; they should be designed for the specified requirements in ultimate, serviceability and fatigue limit states. Where no design rules or sufficient experience with components are available, the design should be based on calculation and/or tests carried out in a way that provides information on the properties of the component for design in ultimate and serviceability limit states and the resistance to fatigue. This document applies for noise barrier components or for noise barriers considered as a whole.

1 Scope

This document describes the basic requirements for the verification of ultimate and serviceability limit states and the resistance to fatigue either of the noise barrier or its components by means of analytical methods and/or tests.

Analytical methods can be used for the determination of the characteristic values and design values.

Where sufficient information is not available, the analytical procedure can be combined with results from tests.

This document provides the following types of test procedures:

— test on small samples for defining detail categories, which may not be covered by Eurocodes (verification procedure A);

— test on a global element for defining the limit state against fatigue (verification procedure B);

— full scale tests under a given representative loading (verification procedure C) to determine fatigue resistance of the noise barrier components for defined loading conditions; verification procedure C is given as alternative to verification procedures A and B.

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 1990:2002[1], *Eurocode — Basis of structural design*

EN 1992 (all parts), *Eurocode 2: Design of concrete structures*

EN 1993 (all parts), *Eurocode 3 — Design of steel structures*

EN 1999 (all parts), *Eurocode 9: Design of aluminium structures*

EN 16727-1, *Railway applications — Track — Noise barriers and related devices acting on airborne sound propagation — Non-acoustic performance — Part 1: Mechanical performance under static loadings — Calculation and test method*

3 Terms and definitions

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

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

- IEC Electropedia: available at http://www.electropedia.org/
- ISO Online browsing platform: available at http://www.iso.org/obp

[1] This document is currently impacted by the amendment EN 1990:2002/A1:2005 and corrigendum EN 1990:2002/A1:2005/AC:2010.

3.1
noise barrier
noise reducing device, which obstructs the direct transmission of airborne sound emanating from railways, and which will typically span between posts and also may overhang the railway

Note 1 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)

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

3.6
representative loading
loading which takes into account the load effects caused by the air pressure wave of the train, the site-dependent parameters, the dynamic amplification factor and the fatigue stress behaviour of the component, including the fatigue damage accumulation

Note 1 to entry: Examples of site-dependent parameters are: the design life, the number of trains per day, the maximum train speed, the spacing between the noise barrier and the rail track.

4 Symbols and abbreviations

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

Table 1 — Symbols and abbreviations

Symbol or abbreviation	Designation	Unit
a	term for the representation of the mean value (50 % exceedance probability) of the S-N curve on a logarithmic scale	-
a_k	auxiliary parameter	-
m	factor for the representation of the mean value (50 % exceedance probability) of the S-N curve on a logarithmic scale	-
$\Delta\sigma_i$	single value of the stress range	Pa
$\Delta\sigma_{c,m}$	stress range at 2 million load cycles, mean value	Pa
$\Delta\sigma_{c,k}$	characteristic value of the fatigue strength at 2 million load cycles	Pa
$\Delta\sigma_R$	stress range of the S-N-curve	Pa
N_i	single value of the number of load cycles	-
N_c	number of 2 million load cycles	-
$N_{c,k}$	spread around the mean value under the assumption of a Student-t distribution	-
N_R	number of load cycles of the S-N-curve	-
x_i	log $\Delta\sigma_i$	-
y_i	log N_i	-
$\bar{x}$	mean value of x_i	-
$\bar{y}$	mean value of y_i	-
n	number of specimens	-
S_{xx}	variance of the random variable x_i	-
S_{yy}	variance of the random variable y_i	-
S_{xy}	covariance of the random variables x_i and y_i	-
S_N	standard deviation	-
f	auxiliary parameter for the representation of the 95 % confidence interval derived from the S-N curve on a logarithmic scale	-
x_c	auxiliary parameter	-
$t(\alpha)$	parameter describing the Student-t Distribution with (n-2) degrees of freedom and a 95 % confidence interval	-

5 Analytical verification

Where the design can be performed by analytical models, the verification for the foundations, posts and panels shall be in accordance with relevant Eurocodes or European Assessment Documents (EAD)[2].

[2] European Assessment Documents (EAD), established by the European Organisation for Technical Assessment (EOTA), under the Construction Products Regulation (CPR) 305/2011. Freely available at https://www.eota.eu/.

Steel and aluminium elements shall be designed in accordance with the relevant part of Eurocode 3, i.e. the EN 1993 series, and Eurocode 9, i.e. the EN 1999 series. In particular, the following aspects shall be considered:

a) behaviour of all relevant details and the whole panel for alternating loading conditions and the corresponding frequency range;

b) failure of fasteners subject to multiple axial stress condition, e.g. shear from global bending and tension from local load effects;

c) interaction of bending, vertical shear and torsion;

d) behaviour of the panel and the bearings at the support area considering secondary load paths;

e) fatigue resistance of profiled, perforated and coated thin metal sheets;

f) consideration of different material-combinations, e.g. aluminium linked with stainless steel;

g) fatigue strength of cold-formed elements and cross-sections considering local load effects.

The analytical verification of concrete elements shall be performed in accordance with the EN 1992 series for bending, shear and torsion as well as for bearing conditions at the uprights and for the anchoring of the reinforcement. In particular, the following aspects shall be considered:

h) anchoring of the longitudinal reinforcement at the end support taking into account the anchoring length according to the EN 1992 series;

i) verification of the ultimate limit state and the fatigue limit state for the shear force and the end anchorage at the end of the panel for alternating actions;

j) verification of the ultimate limit state against fatigue of the porous layer of the panel (if any) against bonding failure in the interface and separation from the supporting concrete layer.

6 General requirements for testing

The following information shall be provided before testing:

a) scope for the use of the noise barrier or of its components;

b) relevant railway and construction parameters (designed speed, traffic density, train types, maximum wall height, minimum distance to track, spacing of uprights, foundation type, wind zone, etc.);

c) description of the noise barrier or components and of the global and local load transfer and bearing behaviour;

d) information about the torsional behaviour (torsional stiffness and stresses) of the component caused by end twisting;

e) drawings of the relevant noise barrier components including all details and information about tolerances;

f) photographic information of all construction details;

g) informative documents and certificates of used materials and fasteners, and the required material tests and the relevant standards to define the material properties;

h) description of test programme and test specimens; the structural supporting of the elements shall be in accordance with on-site conditions;

i) method for the evaluation of test results and for the determination of the characteristic and design values of resistance against fatigue in accordance with the EN 1999 series and Annex B of this document;

j) description of the load arrangement and load application: the load arrangement should be comparable with site conditions taking into account the effect of distributed loads due to the pressure wave and torsional deformations caused by the flexibility of the supporting posts; the influence of torsion may be neglected in testing if at critical points the increase of stresses due to torsion does not exceed 10 % of the corresponding stresses due to bending;

k) test measuring setup with information about measurement devices for deformations and strains;

l) specification of the representative loading in the case of use of verification procedure C;

m) specification of the state of the sample: new or aged, condition of ageing (e.g. natural or accelerated, chemical, mechanical, UV radiation, etc.).

7 Test arrangement and evaluation of results

7.1 General

In order to verify that the structural model used in verification procedures A and B is in accordance with the real behaviour of the element, two deformation-controlled static tests according to EN 16727-1 shall be carried out, taking into account the different mechanical behaviour of the two sides of the element (conventionally denoted as “facing the train” and “facing the receivers”). The sample under test shall be equipped with strain-gauges, in order to verify that the mechanical model used gives realistic data about the stresses at significant points. For the verification procedure A, at least one fatigue test with $N = 5 \times 10^6$ load-cycles using the design values of the action due to aerodynamic excitation, if necessary under consideration of inertia forces, shall be performed. This test shall allow an assessment of the deformation behaviour and of the possible degradation of the deformation and load-bearing behaviour of the element at the limit state against fatigue.

Fatigue tests for defining detail properties (verification procedure A) and fatigue tests according to verification procedure B shall be force-controlled. Alternatively, tests of whole panels (verification procedure B) may be deformation-controlled, but with checks and, if necessary, adjustment of the load amplitude at specified intervals (e.g. every 50 000 load-cycles). Where whole elements are tested, in addition to the measurement of deformations, strain gauge measurements are required in order to determine relevant stress ranges at all critical points.

Special preliminary tests are required where fatigue tests with whole elements are performed neglecting effects of torsion caused by the flexibility of the substructure. In this case, the fatigue resistance determined by verification procedure B shall be modified where the reduction due to torsion shall be verified by an appropriate mechanical model or by separate tests. In order to determine the torsional effects, tests for the determination of the torsional rigidity and the shear and warping stresses shall be carried out. For this purpose, an end twist shall be applied on the element equal to 1,25 times the maximum end twist resulting from the maximum opposing deformation of the uprights (boundary conditions given in the design specifications). The element is allowed to be assessed without taking torsion effects into account, if at the serviceability limit state the stress in the panel (and the fastener) due to torsion is less than 10 % of the stress due to pure bending. If there was no failure of the element during these tests, it is allowed to be used for further tests at the limit state against fatigue.