SLOVENSKI STANDARD

oSIST prEN 16727-2-1:2016

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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: **prEN 16727-2-1**

ICS:

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

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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

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This draft European Standard is submitted to CEN members for enquiry. It has been drawn up by the Technical Committee CEN/TC 256.

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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 foreword

This document (prEN 16727-2-1:2015) has been prepared by Technical Committee CEN/TC 256 “Railway applications”, the secretariat of which is held by DIN.

This document is currently submitted to the CEN Enquiry.

This European Standard is part 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 methods*

— *Part 2-1: Mechanical performance under dynamic loadings due to passing trains – Resistance to fatigue*

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

— *Part 3: General safety and environmental requirements*

It should be read in conjunction with:

— prEN 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 methods*

— prEN 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*

Introduction

Passing trains generate an air pressure wave, which impacts on noise barriers installed alongside the track. It is necessary that noise barriers withstand this impact without any part of them becoming detached or displaced in an unsafe manner and 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 European Standard applies for noise barrier components or for noise barriers considered as a whole.

1 Scope

This European Standard 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 may be combined with results from tests.

The following types of test procedures may be used:

— test on small samples for defining detail categories, which may not be covered by Eurocodes (verification procedure A provided within the present European Standard);

— test on a global element for defining the limit state against fatigue (verification procedure B provided within the present European Standard).

In order to verify the assumptions of the design model, a static load test of the components shall be performed according to prEN 16727-1.

Alternatively, fatigue resistance of the noise barrier components can be determined for defined loading conditions by mean of full scale tests under a given representative loading (verification procedure C provided within the present 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.

EN 1990:2002 + A1:2005, *Eurocode – Basis of structural design*

EN 1999 series, *Eurocode 9: Design of aluminium structures*

prEN 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 methods*

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; it 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)

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	$\log \Delta\sigma_i$	

Symbol or abbreviation	Designation	Unit
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 should be in accordance with relevant Eurocodes or ETA.

Steel and aluminium elements should be designed in accordance with the relevant part of Eurocode 3 and Eurocode 9. In particular, the following aspects should 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 should be performed in accordance with 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 should 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, 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 EN 1999 series and Annex B of this European Standard;

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 prEN 16727-1 shall be carried out, taking into account the different mechanical behaviour of the two sides of the element (facing the train and the receiver). The sample under test needs to 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, has to 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 should 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 method B shall be modified where the reduction due to torsion has to 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 have to 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.

Depending on the load application constructions and the load frequencies, possible inertia influences from the load application construction on global element tests should be taken into account.

Effects of tolerance on post dimensions should be considered at the test planning stage.

7.2 Verification procedure A

The test specimen for the determination of the detail category and the fatigue strength curve has to be planned in such a way that the stresses which occur within the element are simulated on a realistic basis.

This applies especially to the local stresses in the bearing region of the element or fasteners, when those are subject to unintended secondary effects (e.g. at metallic sheets with the combination of shear stresses from the global load bearing behaviour and unintended tension force resulting from local pressure and suction forces at the edge parts).

For the determination of the fatigue-strength curve according to the EN 1999 series it is necessary to perform at least two test series with three tests at different load levels for each detail.

The load level shall be chosen so that it is possible to get information about the constant fatigue limit amplitude.

7.3 Verification procedure B

When defining the resistance against fatigue of the whole element, at least two test series with two groups of three tests have to be performed.

The first test series is for the assessment of the sample due to cyclic bending at mid-span. The second test series has to be performed for the assessment of the fatigue resistance due to vertical shear at supports and/or due to failure of the bearing at the support.

For each series, two groups with three tests and different load levels for each group should be performed. The load level for each group of tests has to be chosen so that it is possible to get