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Järnvägar – Bulleremission – Karakterisering av dynamiska egenskaper hos spårsträckor för mätning av buller från förbipasserande tåg

Railway applications – Noise emission – Characterisation of the dynamic properties of track sections for pass by noise measurements

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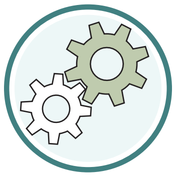

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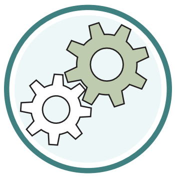

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Europastandarden EN 15461:2008+A1:2010 gäller som svensk standard. Detta dokument innehåller den officiella engelska versionen av EN 15461:2008+A1:2010.

Denna standard ersätter SS-EN 15461:2008, utgåva 1.

The European Standard EN 15461:2008+A1:2010 has the status of a Swedish Standard. This document contains the official version of EN 15461:2008+A1:2010.

This standard supersedes the Swedish Standard SS-EN 15461:2008, edition 1.

Upplysningar om sakinnehållet i standarden lämnas av SIS, Swedish Standards Institute, telefon 08-555 520 00. Standarder kan beställas hos SIS Förlag AB som även lämnar allmänna upplysningar om svensk och utländsk standard.

Information about the content of the standard is available from the Swedish Standards Institute (SIS), telephone +46 8 555 520 00. Standards may be ordered from SIS Förlag AB, who can also provide general information about Swedish and foreign standards.

Denna standard är framtagen av kommittén för Järnvägar, SIS/TK 254.

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EUROPEAN STANDARD

NORME EUROPÉENNE

EUROPÄISCHE NORM

EN 15461:2008+A1

November 2010

ICS 17.140.30; 93.100

Supersedes EN 15461:2008

English Version

Railway applications - Noise emission - Characterisation of the dynamic properties of track sections for pass by noise measurements

Applications ferroviaires - Emission sonore - Caractérisation des propriétés dynamiques de sections de voie pour le mesurage du bruit au passage

Bahnanwendungen - Schallemission - Charakterisierung der dynamischen Eigenschaften von Gleisabschnitten für Vorbeifahrtgeräuschmessungen

This European Standard was approved by CEN on 28 December 2007 and includes Amendment 1 approved by CEN on 28 September 2010.

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

Management Centre: Avenue Marnix 17, B-1000 Brussels

Ref. No. EN 15461:2008+A1:2010: E

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Foreword

This document (EN 15461:2008+A1:2010) 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 May 2011, and conflicting national standards shall be withdrawn at the latest by May 2011.

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

This document includes Amendment 1, approved by CEN on 2010-09-28.

This document supersedes EN 15461:2008.

The start and finish of text introduced or altered by amendment is indicated in the text by tags [A1) (A1].

[A1) This document has been prepared under a mandate given to CEN/CENELEC/ETSI by the European Commission and the European Free Trade Association, and supports essential requirements of EU Directive 2008/57/EC.

For relationship with EU Directive 2008/57/EC, see informative Annex ZA, which is an integral part of this document. (A1]

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Introduction

The interaction between the wheels of a railway vehicle and the track during operation is translated by vibrations which, in movement, generate rolling noise. The vibration response of the track structure determines the level of its sound contribution to this noise.

The method assumes that the vibration waves in the rail can be regarded as the superposition of two bending waves, one vertical and the other transverse, of the rail represented as a simple beam. Although the track rail does not behave in this way over all the frequencies covered by the measurement, this simplification permits the "decay rates" to be measured for an estimation of the dynamic behaviour of the track which is one of the basic parameters influencing the generation of rolling noise.

1 Scope

This European Standard specifies a method for characterizing the dynamic behaviour of the structure of a track relative to its contribution to the sound radiation associated with the rolling noise.

This European Standard describes a method for:

a) acquiring data on mechanical frequency response functions on a track;

b) processing measurement data in order to calculate an estimate of the vibration decay rates along the rails in an audible frequency range associated with the rolling noise;

c) presenting this estimate for comparison with the lower limits of the decay rates.

It is applicable for evaluating the performance of sections of reference tracks for measuring railway vehicle noise within the framework of official approval tests.

The method is not applicable for characterizing the vibration behaviour of tracks on loadbearing structures such as bridges or embankments.

2 Normative references

The following referenced documents are indispensable for the application 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 61260, *Electroacoustics — Octave-band and fractional-octave-band filters (IEC 61260:1995)*

EN ISO 266, *Acoustics — Normal frequencies (ISO 266:1997)*

EN ISO/IEC 17025, *General requirements for the competence of testing and calibration laboratories (ISO/IEC 17025:2005)*

ISO 2041, *Vibration and shock — Vocabulary*

ISO 7626-1, *Vibration and shock — Experimental determination of mechanical mobility — Part 1: Basic definitions and transducers*

ISO 7626-5, *Vibration and shock — Experimental determination of mechanical mobility – Part 5: Measurements using impact excitation with an exciter which is not attached to the structure*

3 Terms and definitions

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

3.1
frequency-response function (FRF)
frequency-dependent ratio of the motor-response phasor to the phasor of the excitation force (see ISO 7626-1)

NOTE 1 In this document, the term also refers to the mean spectral amplitude of the FRF in the form of a one-third octave spectrum.

NOTE 2 In this standard, the term frequency-response function (FRF) is used to refer generically either to accelerance (accelerometric response/excitation force) or to mobility (speed response/excitation force). The term is not used to refer to receptance (dynamic compliance).

NOTE 3 The FRF is generally calculated as the interspectrum ratio between the response and the force with the autospectrum. This estimate of the FRF is called estimate H1.

NOTE 4 A set of FRF between a single excitation point and multiple response points or even between a single response point and multiple excitation points may be used. In this standard, the case of a fixed accelerometer and a mobile instrumented excitation hammer is the easiest to implement.

3.2
accelerance
complex ratio of the acceleration at one point in a mechanical system to the force at the same point or at a different point during a single harmonic motion (see also ISO 7626-1 and ISO 2041)

NOTE Accelerance is an FRF currently expressed as a narrow-band complex spectrum. It is also used in this standard to express a one-third octave spectrum.

3.3
mobility
complex ratio of the speed at one point in a mechanical system to the force at the same point or at a different point during a single harmonic motion (see also ISO 7626-1 and ISO 2041)

NOTE Mobility is an FRF currently expressed as a narrow-band complex spectrum. It is also used in this standard to express a one-third octave spectrum.

3.4
direct FRF, FRF at the point of application
FRF for which the response is measured at the same position (as close as possible physically with an impact hammer and an accelerometer) and the same direction (see also ISO 7626-1)

NOTE In this standard, the term refers both to force and response FRF in the vertical and transverse directions.

3.5
transfer FRF
FRF for which the response amplitude is measured at a different position to the force application point

NOTE In order to define the FRF, the direction and position of the application force and the response should be mentioned.

3.6
decay rate on the track
vibration amplitude decay rate of the vertical or transverse bending waves of the rail as a function of the distance along the rail

NOTE It is represented by a one-third octave band spectrum of the values of the decay rate, expressed in decibels per metre (dB/m) representing the attenuation as a function of the distance.

3.7
test section
<railway applications> section of track specifically associated with a particular set of measurement data

3.8
accelerometer position
fixed position of the accelerometer(s) for which a complete set of FRF measurements is taken

3.9
structural wave
vibration wave that is propagated along the rail resulting in a deformation of the whole rail section

NOTE For example, vertical and transverse bending waves of the rail behaving like a beam or waves that involve deformation modes in the cross-section of the rail propagating along the rail. The vibration waves with wavelengths that are smaller than the rail cross-section dimensions, such as the Rayleigh ultrasonic waves or the shear or compression waves in the material are not covered in the definition associated with the subject of this standard.

3.10
one third-octave band spectrum
spectrum of the added squared values or the root mean squares of the FRF in each of the normal frequencies one-third octave band (see EN ISO 266).

NOTE In this document, also refers to the speed and acceleration vibration spectrum, to the excitation effort spectrum, to the mobility and accelerance FRF spectrum and to the resulting decay rate

3.11
reference track section
portion of track used to characterize the rail system noise emission performances that meet the requirements of the interoperability technical specifications from the railway interoperability directives

NOTE These requirements cover the track vibration response via the track decay rate and the acoustic roughness level of the rail. They are intended to ensure the reproducibility of the measurements

3.12
instrumented hammer
instrument with an integrated force transducer for applying an excitation force to the structure

4 Symbols and abbreviations

x position along the track. The reference position x_0 = 0 is situated at the measuring point of the direct FRF,

dx differential operator over x,

n number of measuring positions,

Δx_n n^{th} interval,

x_{max} position of the maximum distance considered along the track,

$A(x_n)$ FRF at position x_n along the track,

β response amplitude decay constant,

DR decay rate,

FRF frequency-response function,

FFT fast Fourier transform

5 Principles

The decay rates are determined on the basis of an FRF at the application point and a certain number of frequency-response function measurements relative to the position on the rail of the excitation force application point (transfer function). An instrumented hammer shall be used to excite the rail. For the purpose of this standard, an accelerometer shall be fixed to the rail and the measurements shall be taken for various distances from the force application point in relation to it.

The full set of FRF shall be measured in the vertical and transverse directions. The decay rates of the vertical and transverse bending waves as a function of the distance shall be calculated on the basis of this set of FRF measurements.

The stages of the test method are specified in the following subclauses.

6 Data acquisition

6.1 Selection of the test section

The test section shall meet the following conditions:

a) the constitution of the track shall be constant over the whole test section for all the parameters that could affect the decay rates. These parameters include the rail cross-sections, the stiffness of the pad beneath the rail, the cant of the rails and the space between the sleepers;

b) the test section shall be fitted with long welded rails. Specifically, it shall not have any rail expansion joints.

6.2 Position of the accelerometers

Within the test section, each position to which the accelerometer is fixed to the rail shall satisfy the following conditions:

a) it shall be located inside the test section, at least 20 m from the centre of the test section;

b) it shall be located at the median point of a space between the sleepers;

c) the accelerometer shall not be located close to rail supports in an unusual condition; in particular:

1) there shall be no pumping sleeper less than 3 metres from the accelerometer position;

2) there shall be no missing or damaged fastening clip (or fastening of any other type, if necessary) on the supports directly adjacent to the measuring accelerometer position;

3) the accelerometer shall not be located less than 5 m from a rail weld;