SLOVENSKI STANDARD
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Železniške naprave - Progovni sistemi z utrjenimi tirnicami - 4. del: Posebni progovni sistemi z utrjenimi tirnicami za dušenje vibracij

Railway applications - Ballastless track systems - Part 4: Special ballastless track systems for attenuation of vibration

Bahnanwendungen - Feste Fahrbahn-Systeme - Teil 4: Spezielle Feste Fahrbahn-Systeme zur Vibrationsdämpfung

Applications ferroviaires - Systèmes de voie sans ballast - Partie 4: Système spécial de voie sans ballast pour l'atténuation des vibrations

Ta slovenski standard je istoveten z: **prEN 16432-4**

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17.160	Vibracije, meritve udarcev in vibracij	Vibrations, shock and vibration measurements
45.080	Tračnice in železniški deli	Rails and railway components
93.100	Gradnja železnic	Construction of railways

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Railway applications - Ballastless track systems - Part 4: Special ballastless track systems for attenuation of vibration

Applications ferroviaires - Systèmes de voie sans ballast - Partie 4 : Système spéciale de voie sans ballast pour l'atténuation des vibrations

Bahnanwendungen - Feste Fahrbahn-Systeme - Teil 4: Spezielle Feste Fahrbahnsysteme zur Schwingungsdämpfung

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

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European foreword

This document (prEN 16432-4:2024) 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 CEN enquiry.

Introduction

Ballastless track systems may be affected by acoustic requirements for the protection of the environment against noise and vibration.

This document covers the integration of additional acoustic requirements in the ballastless track system design.

This part of the EN 16432 series is used in conjunction with the following parts:

— Part 1: General requirements;

— Part 2: System design, subsystems and components;

— Part 3: Acceptance.

1 Scope

This part of EN 16432 series specifies how to integrate the particular aspects of ballastless track systems for attenuation of vibration into the system and subsystem design and component configuration according to EN 16432-2:2017.

The general system and subsystem design requirements are assigned from EN 16432-1:2017.

Additional noise and vibration requirements can be project specific and are not provided by this document. Acoustic requirements are considered as input for the track design from the acoustic design. The acoustic design and the track design affect each other and may require an iterative overall design process.

The range of applicability covers all kind of rail systems including Urban Rail systems.

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 1991 (all parts), *Eurocode 1 — Actions on structures*

EN 1992-1 (all parts), *Eurocode 2 — Design of concrete structures — Part 1-2: Structural fire design*

EN 16432-1:2017, *Railway applications — Ballastless track systems — Part 1: General requirements*

EN 16432-2:2017, *Railway applications — Ballastless track systems — Part 2: System design, subsystems and components*

EN 16432-3:2021, *Railway applications — Ballastless track systems — Part 3: Acceptance*

EN 17495:2022, *Railway Applications — Acoustics — Determination of the dynamic stiffness of elastic track components related to noise and vibration: Rail pads and rail fastening assemblies*

EN 17682, *Railway applications — Infrastructure — Resilient element for floating slab system*

3 Terms and definitions

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

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

— ISO Online browsing platform: available at https://www.iso.org/obp/

— IEC Electropedia: available at https://www.electropedia.org/

3.1
mass spring system
ballastless track system using a designed mass in combination with its designed support stiffness provided by resilient elements to tune it to a specific natural frequency

3.2
longitudinal resilient element
resilient element placed vertically for MSS in order to constrain the longitudinal movement of the mass

Note 1 to entry: It is installed perpendicular to the track axis.

3.3
lateral resilient element
resilient element placed vertically for MSS in order to constrain the lateral movement of the mass

Note 1 to entry: It is installed parallel to the track axis.

3.4
full surface resilient element
mat arranged between mass and its substructure to provide the required support stiffness

3.5
strip resilient element
linear support between mass and its substructure to provide the required support stiffness

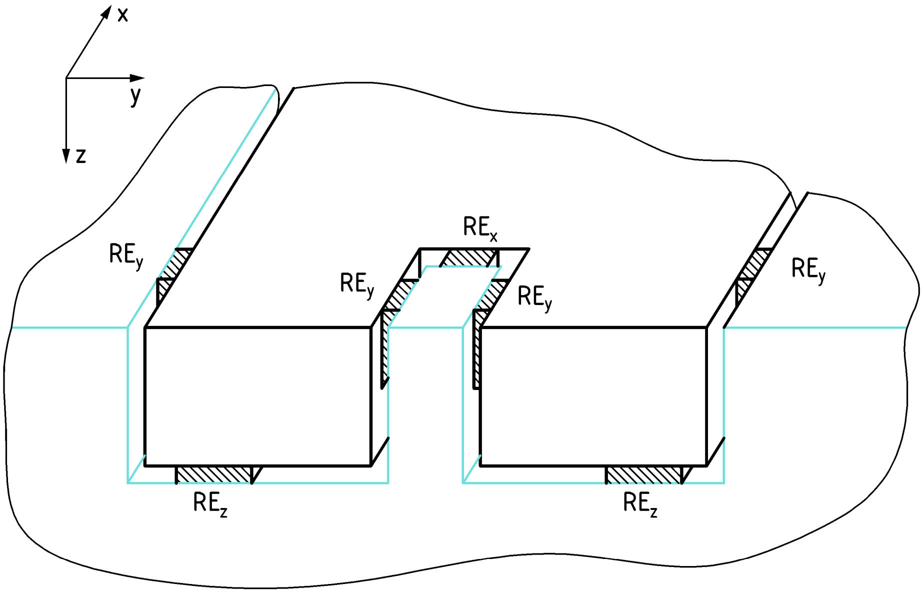
3.6
discrete resilient element
point support between mass and its substructure to provide the required support stiffness

3.7
dynamic stiffness
force or stress per unit deflection measured under an uniaxial force which acts periodically at a given frequency of (5 – 20) Hz between specific force or stress levels

Note 1 to entry: This value is determined mainly for calculation of dynamic deformation of tracks.

3.8
acoustic stiffness
dynamic stiffness of a resilient track support component that is measured under a static preload and at small amplitudes of displacement or velocity applied in the frequency range relevant to noise or vibration perception

3.9
insertion loss
relative reduction [dB] of vibration as a function of frequency resulting from the insertion of a subsystem/component in the vibration transmission path



Key

X longitudinal direction

Y lateral direction

Z vertical direction

RE_x longitudinal resilient element

RE_y lateral resilient element

RE_z vertical resilient element

Figure 1 — Orientation of resilient elements (example: arranged as point supports)

4 Symbols and abbreviations

For the purposes of this document, the abbreviations in Table 1 apply.

Table 1 — Abbreviations

Abbreviation	Abbreviated term
MSS	Mass Spring System
CRCP	Continuously Reinforced Concrete Pavement
MWCC	Main Works Civil Contractor
GB N&V	Ground Borne Noise and Vibration
S&C	Switches and Crossings
FEM	Finite Element Method

5 Design approach

The physical behaviour of ballastless track systems influences vibrations transmitted to the sub-structure and noise emitted from the track. In situations where such vibrations or noise are unacceptable due to local or regional requirements, the ballastless track system might be designed to control vibration transmission and, therefore, incorporate elements, layers or components which in turn might affect the structural and functional performance of the ballastless track system.

The general system and subsystem design requirements for ballastless tracks are set out in EN 16432-1. The static and dynamic performance of the entire ballastless track system, including the interaction of different subsystems and subsystem configurations (e.g. use of resilient fastening system or resilient mats supporting a ballastless track), shall be considered in the design requirements.

Though the additional noise and vibration requirements are project-specific and not provided by this document, the eventual influence of the components for vibration or noise mitigation shall be accounted for in the design verifications (for example, they can govern the track stiffness or affect the degree of interlayer interaction). In this regard, ballastless track systems configurations for noise and vibration mitigation commonly consist of prefabricated elements and/or a pavement structurally independent from the substructure, incorporating resilient elements which lead to subsystem configurations eventually distinct from those considered in EN 16432-2:2017, 5.2. The consequence is that design-relevant parameters (stresses, displacements, stiffness, etc.) resulting from the pavement design approach of EN 16432-2 can be significantly affected due to the higher bending flexibility of the system. In case that such design parameters do not fulfill the limits of EN 16432-2, a pavement-based design might not be sufficient and structural design methods can be thus required. Furthermore, specific dynamic analysis might be required in addition to the design methods specified in EN 16432-2 when e.g. simplified dynamic amplification factors are not sufficient.

For track systems where acoustic, noise and vibration requirements apply, the relevant criteria for performance shall have been established. These criteria shall detail how this performance can be demonstrated in design and following construction, for acceptance. The criteria may include one or more of the following for ground borne noise and vibration requirements:

— the insertion loss for the track system with respect to a reference track form;

— the natural frequency of the track system;

— maximum or weighted level of accelerations at the track or at specific locations next to the track.

For airborne noise requirements influenced by the track system the criteria may include:

— track Decay Rate (see EN 15461);

— track Roughness (see EN 15610), for the relevant wavelength range.

6 System design

6.1 Establishing the interface between acoustic design and track design

Special ballastless track systems for attenuation of vibration (not noise) are custom-fitted solutions requiring a specific design. The two decisive elements for characterizing the mitigation behaviour of the system, are the system's natural frequency and the insertion loss. The determination of the resilient element depends on both the natural frequency and the insertion loss.

The design of mitigation systems includes works for the acoustic designer and the track designer, which are usually split in between different contractors. The interface between the different designers requires an information exchange, including detailed descriptions of the exchanged information, see Annex A.

The natural frequency and the insertion loss are usually determined by the acoustic designer in the ground-borne noise and vibration prediction assessment. However, both the natural frequency and the insertion loss are often determined based on simple assessments in early project stages.

When progressing the design of the mitigation system, more detailed modelling of the mitigation system is required, including the assessment for different loading conditions, the nonlinear behaviour of resilient elements, and the stiffness characteristics and finally assessments of the system under service condition.

The main aim of the acoustic designer is to provide a mitigation concept fulfilling the applicable limit values at the sensitive receptor, including:

— determination of locations requiring resilient trackforms as a mitigation system;

— determination of the stiffness of the fastening system;

— determination of mitigation system's natural frequency and required mass of the system;

— determination of the required insertion loss;

— preliminary schematic cross-section.

The main aim of the track designer is to provide a design of the resilient trackform able to fulfil the required vibration mitigation behaviour including:

— achievement of the required natural frequency (of the loaded / unloaded system);

— achievement of the required insertion loss (of the loaded / unloaded system);

— fulfilling the requirements set in EN 16432-1 and EN 16432-2.

The determination and assurance of the system's natural frequency and insertion loss is usually an iterative process for which both the acoustic designer and the track designer are responsible. It is therefore essential to specify the following assumptions on which the assessment has been based in the information exchange between the acoustic and track designers:

— applied load assumptions, which may be:

  - self-weight only;
  - self-weight including parts of the vehicle's load (undamped wheel-set masses of the train/s);
  - entire vehicles' axle load configuration (e.g. operating vehicle, design vehicle) and operating conditions (e.g. speed).

— assumptions for determination of natural frequency or insertion loss, which may:

  - include the vehicle's load;
  - include only parts of the vehicle's load (e.g. undamped wheel-set mass);
  - exclude the vehicle's load (or parts of it).