SLOVENSKI STANDARD
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Železniške naprave - Zgornji ustroj proge - Betonski pragi in kretniški betonski pragi

Railway applications - Track - Concrete sleepers and bearers with under sleeper pads

Bahnanwendungen - Infrastruktur - Gleis- und Weichenschwellen aus Beton mit Schwellenbesohlungen

Applications ferroviaires - Voie - Traverses et supports en béton avec semelles sous traverse

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ICS:

45.080	Tračnice in železniški deli	Rails and railway components
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Railway applications - Track - Concrete sleepers and bearers with under sleeper pads

Applications ferroviaires - Voie - Traverses et supports en béton avec semelles sous traverse

Bahnanwendungen - Oberbau - Gleis- und Weichenschwellen aus Beton mit Schwellenbesohlungen

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EUROPEAN COMMITTEE FOR STANDARDIZATION
COMITÉ EUROPÉEN DE NORMALISATION
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Foreword

This document (prEN 16730:2014) 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.

Introduction

This European Standard completes the series EN 13230 *Railway applications – Track – Concrete sleepers and bearers,* when the sleepers or bearers are manufactured with Under Sleeper Pad (USP). The USP is an USP fixed to the bottom surface of the sleepers or bearers. This standard applies to the system constituted of the concrete sleepers or bearers and the Under Sleeper Pad.

The following terms are used within to define the parties involved in using the EN as the technical basis for a transaction:

— Purchaser: the operator or user of the equipment, or the customer of the material on the user's behalf.

— Supplier: the body responsible for the use of the EN in response to the purchaser's requirement. The supplier is also responsible for requirements which apply to the producer or manufacturer. (Generally the Supplier is the manufacturer of the concrete sleepers and has a Sub-contractor for the USPs.)

1 Scope

This European Standard is applicable to concrete sleepers or bearers with Under Sleeper Pads (USP) physically bonded to concrete used in ballast track and defines the test procedures and their acceptance criteria.

This standard provides particular information in the following areas:

— tests methods, tests arrangements and acceptance criteria of Under Sleeper Pads,

— tests methods, tests arrangements and acceptance criteria of concrete sleepers and bearers with Under Sleeper Pads,

— data supplied by the purchaser and by the supplier,

— definition of general process of qualification,

— definition of routine tests.

This standard defines the specific test procedures for Under Sleeper Pad with or without concrete sleepers and bearers:

— Fatigue tests,

— Tests of capability for stacked stocking of concrete sleepers or bearers fitted with USP,

— Pull-out test,

— Severe environmental condition test

In addition to specifying the basic testing of relevant properties of USP, this standard also sets out procedures for testing fitness for purpose and provides information on quality monitoring as part of quality assurance procedures. This standard does not, however, contain requirements pertaining to the properties of Under Sleeper Pads. It is the responsibility of the purchaser to define these requirements.

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 206-1, *Concrete – Part 1: Specification, performance, production and conformity*

EN 1542, *Products and systems for the protection and repair of concrete structures – Test methods – Measurement of bond strength by pull-off*

EN 13230 (series), *Railway applications – Track – Concrete sleepers and bearers*

EN 13450:2002 + AC:2004, *Aggregates for railway ballast*

EN 13674-1, *Railway applications – Track – Rail – Part 1: Vignole railway rails 46kg/m and above*

EN 13674-4, *Railway applications – Track – Rail – Part 4: Vignole railway rails from 27 kg/m to, but excluding 46 kg/m*

EN ISO 527 (series), *Plastics – Determination of tensile properties*

EN ISO 7500-1:2004 + AC:2009, *Metallic materials – Verification of static uniaxial testing machines – Part 1: Tension/compression testing machines – Verification and calibration of the force-measuring system (ISO 7500-1:2004 + Cor 1:2008)*

EN ISO 9513:2012, *Metallic materials – Calibration of extensometer systems used in uniaxial testing (ISO 9513:2012)*

ISO 37, *Rubber, vulcanized or thermoplastic – Determination of tensile stress-strain properties*

ISO 2768, *Permissible machining variations in dimensions without tolerance indication*

ISO 5893, *Rubber and plastics test equipment – Tensile, flexural and compression types (constant rate of traverse) – Specification*

3 Terms and definitions

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

3.1
track category TC1
track using concrete sleepers or bearers with under sleeper pads designed for urban light rail and some industrial track with a typical axle load between 100 kN and 130 kN, a typical maximum speed of 100 km/h, a typical rail section of 49E1 (as defined in EN 13674-4) and a typical sleeper or support spacing of 650 mm (maximum 750 mm)

3.2
track category TC2
track using concrete sleepers or bearers with under sleeper pads designed for urban light rail and some industrial track with a typical axle load of 160 kN, a typical maximum speed of 140 km/h, a typical rail section of 54E1 (as defined in EN 13674-1) and a typical sleeper or support spacing of 650 mm

3.3
track category TC3
track using concrete sleepers or bearers with under sleeper pads designed for conventional main line railways with a typical axle load of 225 kN, a typical maximum speed of 250 km/h, a typical rail section of 60E1 (as defined in EN 13674-1) and a typical sleeper or support spacing of 600 mm

3.4
track category TC4
track using concrete sleepers or bearers with under sleeper pads designed for lines with large radius curves, often used for high speed trains and having a typical axle load of 180 kN, a typical rail section of 60E1 (as defined in EN 13674-1), a typical sleeper or support spacing of 600 mm and any typical maximum speed.

3.5
track category TC5
track using concrete sleepers or bearers with under sleeper pads designed for mixed traffic line carrying heavy freight trains with a typical axle load of 300 kN, a typical maximum speed of 200 km/h, a typical rail section of 60E1 (as defined in EN 13674-1) and a typical sleeper or support spacing of 600 mm

3.6
ballasted track
track in which the sleepers or bearers are supported by ballast

3.7
sleeper
transverse components of the track which control the gauge and transmit loads from the rail to the ballast

3.8
bearer
transverse components of switches and crossings which control the relative geometry of two or more stretches of running rails and different pieces of special track work, and transmit loads from the rails to the ballast

3.9
Under Sleeper Pad (USP)
USP fixed to the bottom surface of the sleepers or bearers including technologies of bonding between sleepers or bearers and under sleeper pad

3.10
stiffness
force per unit deflection measured under a uniaxial force

3.11
bedding modulus
pressure (force per surface) per unit deflection and measured under a uniaxial load

3.12
vertical stiffness or bedding modulus
stiffness or bedding modulus in vertical direction measured normal to the base of the sleeper where the support is a slab, between specified minimum and maximum applied loads

3.13
static stiffness or bedding modulus
force or pressure per unit deflection measured under a uniaxial static load

3.14
dynamic stiffness or bedding modulus
force or pressure per unit deflection measured under a cyclic uniaxial load:

— low frequency dynamic stiffness or bedding modulus : Stiffness or bedding modulus measured within the frequency range (3 – 30) Hz (without preloading between defined pressures, see Figure 1)

— high frequency dynamic stiffness or bedding modulus : Stiffness or bedding modulus measured within the frequency range (20 – 450) Hz (under preloading conditions see Table H.1, Figure 1)

3.15
noise attenuation
reduction in emission of mechanical vibration and/or structural borne noise into the surroundings

3.16
geometric ballast plate (GBP)
rigid steel plate with a geometrically structured surface simulating ballast contact

Note 1 to entry: See in Annex A.

3.17
qualification
description of the product properties

4 Symbols

Table 1 — Symbols

Symbols	Characterization	Units
A	area	mm^2
a	acceleration in measurement of high frequency stiffness	m/s^2
C	bedding modulus	N/mm^3
d	Displacement	mm
Δ	Variation	-
F	Force	kN
f	frequency in measurement	Hz
k	stiffness	N/mm
L	point stiffness level for high frequency stiffness	dB re 1 N/m
m	mass	kg
N	number of cycles	-
p	pressure	N/mm^2
κ	rigidification coefficient between low frequency dynamic bedding modulus and static bedding modulus	-
σ	stress (pressure or tensile)	N/mm^2
ω	angular frequency = $2\pi \cdot f$ (for high frequency stiffness)	s^{-1}

Table 2 — Indices of the symbols

Indices	Characterization
0	for frequency, definition of natural frequency
4 Hz, 10 Hz, 20 Hz, 30 Hz	value of frequency in measurement
af	after
av	average
be	before
dyn	low frequency dynamic
H	high frequency
max	maximum
min	minimum
number	sequential number in order to differentiate types of measurements
pre	preload
stat	static

Indices	Characterization
tend	tendency
test	test load

5 Requirements for qualification and routine tests

5.1 General

This clause defines the objectives of tests or of demanded information about the system (sleeper with USP), USP and concrete sleepers and bearers.

The general process and data sheets (USP and sleepers with USP) are described in Annex F and G.

If a tested USP is used with different concrete sleepers or bearers (different types or different manufacturing process), the purchaser shall define which tests shall be done.

5.2 Summary of qualification tests and routine tests

The qualification tests and the routine tests consist of the following three stages:

— Tests for USP alone and for concrete block with USP (see Table 3);

— Tests for concrete sleepers and bearers without USP (see Table 4);

— Tests for concrete sleepers and bearers with USP (see Table 5).

Table 3 —Tests for USP alone and for concrete block with USP

Tests	Qualification tests	Routine tests
Dimensions and masses of USP in 5.3.1 and 5.6	Mandatory	Mandatory
Tensile strength of USP in 5.3.2 and 5.6	Optional	Optional
Static and low frequency dynamic vertical bedding modulus of USP with concrete block determined with GBP in 5.3.3 and 5.6	Mandatory	1 of 2 is Mandatory
Static and low frequency dynamic vertical bedding modulus of USP alone with GBP in 5.3.4 and 5.6	Optional	
High frequency dynamic vertical stiffness of USP with concrete block in 5.3.5	Optional (but recommended if USP is used for vibrations attenuation)	
Fatigue test with USP applied on concrete block in 5.3.6	Mandatory	
Fatigue test with USP applied on concrete block, with GBP in 5.3.7	Optional (but recommended if USP is used for vibrations attenuation)	
Capability for stacked stocking of sleepers with USP on concrete block in 5.3.8	Optional	
Resistance to water (Hydrolysis) in 5.3.9	Optional	
Resistance to chemical agents related to the manufacture of sleepers or bearers in 5.3.9	Optional	
Resistance to fire in 5.3.9	Optional	

Tests	Qualification tests	Routine tests
Resistance to hydrocarbon in 5.3.9	Optional	
Resistance to ozone in 5.3.9	Optional	

Table 4 —Tests for concrete sleepers and bearers without USP

Tests	Qualification tests	Routine tests
Requirements of Concrete sleepers and bearers in 5.4 and 5.6	Mandatory	Mandatory

Table 5 —Tests for concrete sleepers and bearers with USP

Tests	Qualification tests	Routine tests
Dimensions and masses of sleepers and bearers with USP in 5.5.1 and 5.6	Mandatory	Mandatory
Bond strength by pull-out of sleeper and bearer with USP in 5.5.2 and 5.6	Mandatory	Mandatory
Variation of static and low frequency dynamic vertical bedding modulus of sleeper and bearer with USP determined with GBP in 5.5.3	Optional	
Fatigue test with USP applied on sleeper in 5.5.4	Optional	
Effect of severe environmental conditions of sleeper and bearer with USP in 5.5.5	Optional	
Environment and end of life in 5.5.6	Optional	

5.3 Requirements for USP without concrete sleepers and bearers

5.3.1 Dimensions and masses of USP

The dimensions and masses of USP shall permit to respect the requirements of 5.4.

Test arrangement:

Dimensions and masses are measured with instruments adapted to controlled dimension (instruments validated by the purchaser).

Qualification:

The purchaser shall approve the drawing and technical documentations given by supplier.

All the samples for qualification shall be checked according to the drawing and technical documentations.

5.3.2 Tensile strength of USP

The tensile strengths of USP are determined without the influence of manufacture of the sleepers.

The tensile strengths measured during the qualification tests shall determine the reference value of these tensile strengths to confirm the quality of the USP during the routine tests. The test should permit the measurement of the tensile strengths both parallel and perpendicular to the production direction of USP (if there is a difference in production direction).

Test arrangement:

The test is performed on USP in accordance with EN ISO 527 series or ISO 37 and with the supplier's indications which are approved by the purchaser. The test shall be done on the USP without bonding and protection layer. The supplier shall specify the thickness of the samples.

Qualification:

The test method shall be applied on 6 tested samples (3 samples are stamped out parallel to the production direction of USP and 3 samples perpendicular to the production direction of USP).

The supplier shall provide a reference value of tensile strength and the range of purchaser's acceptance values.

5.3.3 Static and low frequency dynamic vertical stiffness (bedding modulus) of USP with concrete block determined with GBP

The static and the low frequency dynamic vertical stiffness (bedding modulus) of USP with GBP permit to quantify a vertical stiffness (bedding modulus) of the USP without the influence of manufacture of the sleepers.

Test arrangement:

The static and low frequency dynamic vertical stiffness of concrete block with USP with GBP shall be measured in accordance with the Annex C.

The low frequency dynamic stiffness and low frequency dynamic bedding modulus is measured at 4 Hz ±1 Hz and 10 Hz ±1 Hz (and optional frequency tests at 20 Hz and 30 Hz).

Qualification:

The test method shall be applied on 3 concrete blocks with USP.

The purchaser shall define the acceptance criteria(s) in the list:

— purchaser minimum value ≤ C_{stat} ≤ purchaser maximum value;

— purchaser minimum value ≤ $C_{dyn\ 4\ Hz}$ or $C_{dyn\ 10\ Hz}$ ≤ purchaser maximum value.

The supplier shall provide a reference value of bedding modulus for routine test, in the range of purchaser acceptance values.

5.3.4 Static and low frequency dynamic vertical stiffness (bedding modulus) of USP alone with GBP

The static and the low frequency dynamic vertical stiffness (bedding modulus) of USP alone with GB permit to quantify a vertical stiffness (bedding modulus) of the USP without the influence of a bonding to the sleepers. This method demands an USP without bonding system or with bonding system which have no influence on the vertical stiffness (bedding modulus).

The static and low frequency dynamic vertical stiffness (bedding modulus) measured during the qualification shall determine the reference value of these stiffnesses to follow the quality of the production of USP during the routine tests.

Test arrangement:

The static and low frequency dynamic vertical stiffness of USP alone with GBP shall be measured in accordance with the Annex C.

For the low frequency dynamic stiffness and low frequency dynamic bedding modulus is measured at 4 Hz ±1 Hz and 10 Hz ±1 Hz (and optional frequency tests at 20 Hz and 30 Hz).

Qualification:

The test method shall be applied on 3 USP alone.

The supplier shall provide a reference value of bedding modulus for routine test, in the range of the results.

NOTE The bedding modulus with and without concrete block are not necessary the same values.

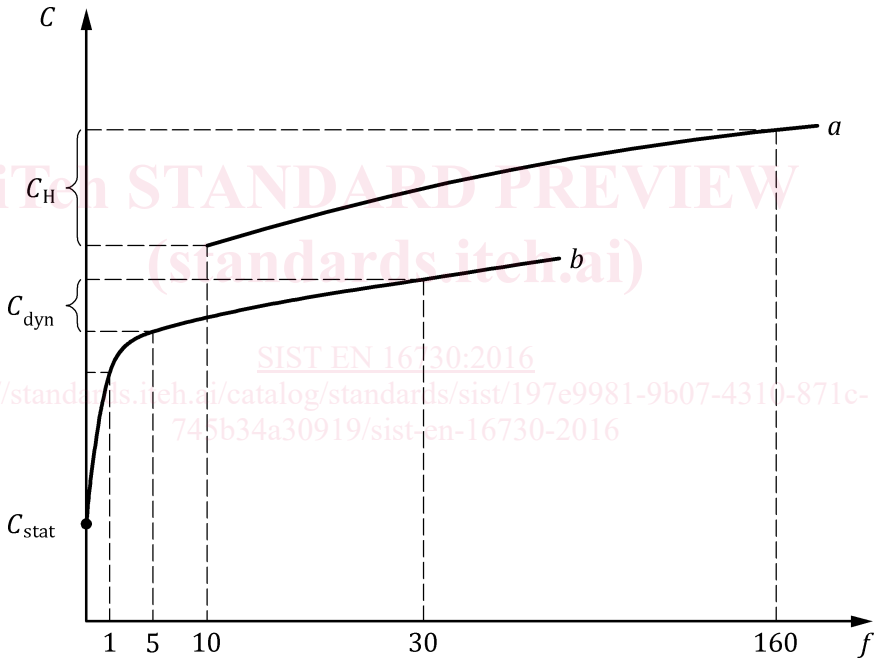
5.3.5 High frequency vertical stiffness (bedding modulus) of USP

This requirement should verify the capacities of USP to isolate vibrations.

Test arrangement:

The high frequency dynamic vertical stiffness of concrete block with USP with GBP shall be measured in accordance with the Annex H. The testing routine and equipment is different to the determination of low frequency dynamic stiffness.

NOTE In contrast to the test of the low frequency dynamic bedding modulus $C_{dyn,}$ the test procedure to measure the high frequency dynamic bedding modulus C_H is carried out with static preloading and with smaller vibration amplitude. For this reason the values of the two moduli are not the same when measured at the same frequency, e.g. at 20 Hz, C_H (20 Hz) ≠ C_{dyn} (20 Hz). (see Figure 1)



Key

a curve for high frequency dynamic bedding modulus
b curve for static and low frequency dynamic bedding modulus
C bedding modulus
f frequency

Figure 1 — Example of a frequency dependant bedding modulus curve (with and without preloading force)

Qualification:

The test method shall be applied on one concrete block with USP.

The purchaser shall define the acceptable criteria.