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Introduction

This draft standard is based on national and international discussions. Your comments on this draft are invited and will assist in the preparation of the consequent standard.

For international standards, comments will be reviewed by the relevant UK national committee before sending the consensus UK vote and comments to the international committee, which will then decide appropriate action. If the international standard is approved, it is usual for the text to be published as a British Standard.

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UK Vote

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- **Annotated drafts are not acceptable and will be rejected.**
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Template for comments and secretariat observations

Date: xx/xx/20xx	Document: ISO/DIS xxxx
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1	2	(3)	4	5	(6)	7
MB	Clause No./ Subclause No./Annex (e.g. 3.1)	Paragraph/Figure/ Table/Note	Type of comment	Commend (justification for change) by the MB	Proposed change by the MB	Secretariat observations on each comment submitted
	3.1	Definition 1	ed	Definition is ambiguous and needs clarifying.	Amend to read '...so that the mains connector to which no connection...'	
	6.4	Paragraph 2	te	The use of the UV photometer as an alternative cannot be supported as serious problems have been encountered in its use in the UK.	Delete reference to UV photometer.	

English Version

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 Schwellensohlen

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

If this draft becomes a European Standard, CEN members are bound to comply with the CEN/CENELEC Internal Regulations which stipulate the conditions for giving this European Standard the status of a national standard without any alteration.

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European foreword

This document (prEN 16730:2025) 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 document will supersede EN 16730:2016.

In comparison with the previous edition, the following technical modifications have been made:

- to improve parts of the procedure that involve concrete blocks to make it easier to implement and increase its relevance;
- to review some requirements for USP surface planarity/flatness to make it more practical and improve the procedure for making concrete blocks;
- to review some requirements for USP to help to contribute to innovative products;
- to capitalize on the experience from the field gained by industry manufacturers and infrastructure managers since the previous publication.

Introduction

This document relates to the EN 13230 series when the sleepers or bearers are manufactured with Under Sleeper Pad (USP). The USP is an elastic layer fixed to the bottom surface of the sleepers or bearers. This document applies to the system constituted of the concrete sleepers or bearers and the Under Sleeper Pad.

For more information, the following document “IRS 70713-1”: “Railway Application - Track & Structure - “Under Sleeper Pads (USP) - Recommendations for Use” proposes different recommendations:

- for USP classification and their fields of applications;
- for cases of use of USP;
- for the design approval tests and routine tests.

1 Scope

This document is applicable to concrete sleepers or bearers with Under Sleeper Pads (USP) physically bonded to concrete used in ballast track and define the test procedures and their evaluation criteria. This document provides particular information in the following areas:

- test methods, test arrangements and evaluation criteria of Under Sleeper Pads;
- test methods, test arrangements and evaluation criteria of concrete sleepers and bearers with Under Sleeper Pads;
- data supplied by the purchaser and by the supplier;
- definition of general process of design approval tests;
- definition of routine tests.

This document defines the specific test procedures for design approval tests, routine tests and tests concerning the determination of relevant properties of Under Sleeper Pad with or without concrete sleepers and bearers:

- fatigue tests;
- tests of capability for stacking of concrete sleepers or bearers fitted with USP;
- pull-out test;
- temperature variation test.

This document also sets out procedures for testing fitness for purpose and provides information on quality monitoring as part of quality assurance procedures. This document 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 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 206,¹ *Concrete - 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 10027 (all parts), *Designation systems for steels*

EN 13230-1:2016, *Railway applications - Track - Concrete sleepers and bearers - Part 1: General requirements*

EN 13230-2:2016, *Railway applications - Track - Concrete sleepers and bearers - Part 2: Prestressed monoblock sleepers*

¹ Impacted by EN 206:2013+A1:2021

EN 13230-3:2016, *Railway applications - Track - Concrete sleepers and bearers - Part 3: Twin-block reinforced sleepers*

EN 13230-4:2016+A1:2020, *Railway applications - Track - Concrete sleepers and bearers - Part 4: Prestressed bearers for switches and crossings*

EN 13230-5, *Railway applications - Track - Concrete sleepers and bearers - Part 5: Special elements*

EN 13230-6, *Railway applications - Track - Concrete sleepers and bearers - Part 6: Design*

EN 13450, *Aggregates for railway ballast*

EN 17343, *Railway applications - General terms and definitions*

EN ISO 527 (all parts), *Plastics — Determination of tensile properties (ISO 527, all parts)*

EN ISO 7500-1, *Metallic materials - Calibration and verification of static uniaxial testing machines - Part 1: Tension/compression testing machines - Calibration and verification of the force-measuring system (ISO 7500-1)*

EN ISO 9513:2012,² *Metallic materials - Calibration of extensometer systems used in uniaxial testing (ISO 9513:2012+AC:2013)*

EN 22768-1, *General tolerances - Part 1: Tolerances for linear and angular dimensions without individual tolerance indications (ISO 2768-1)*

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

ISO 291:2008, *Plastics — Standard atmospheres for conditioning and testing*

3 Terms and definitions

For the purposes of this document, the terms and definitions given in EN 17343 and the following apply.

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

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

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 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 and a typical sleeper or support spacing of 650 mm

² Impacted by EN ISO 9513:2012+AC:2013.

3.3

track category TC3

track using concrete sleepers or bearers with under sleeper pads designed for either:

- conventional main line railways with a typical axle load of 225 kN, a typical maximum speed of 200 km/h, a typical rail section of 60E1 and a typical sleeper or support spacing of 600 mm; or
- 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 200 kN, a typical maximum speed of 320 km/h, a typical rail section of 60E1, a typical sleeper or support spacing of 600 mm; or
- freight line railways with a typical axle load of 250 kN, a typical maximum speed of 120 km/h, a typical rail section of 60E1 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 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 and a typical sleeper or support spacing of 600 mm

3.5

ballasted track

track in which the sleepers or bearers are embedded in the ballast

3.6

sleeper

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

3.7

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 or other sleeper support

3.8

Under Sleeper Pad

USP

elastic layer fixed to the bottom surface of the sleepers or bearers including technologies of bonding between sleepers or bearers and under sleeper pad

3.9

stiffness

force per unit deflection measured under a uniaxial force

3.10

bedding modulus

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

3.11

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 two specified applied loads

3.12

static stiffness or bedding modulus

force or pressure per unit deflection measured under a uniaxial static load

3.13

dynamic stiffness or bedding modulus

force or pressure per unit deflection measured under a cyclic uniaxial load

Note 1 to entry: Low frequency dynamic stiffness or bedding modulus: stiffness or bedding modulus measured within the frequency range (2 to 30) Hz (without preloading between defined pressures, see Figure 1).

Note 2 to entry: Higher frequency dynamic stiffness or bedding modulus: stiffness or bedding modulus measured within the frequency range (20 to 450) Hz (under preloading conditions see Table H.1, see Figure 1).

3.14

vibration mitigation

reduction in emission of mechanical vibration and/or structure-borne noise into the surroundings

3.15

geometric ballast plate

GBP

rigid steel plate with a geometrically structured surface simulating ballast contact

Note 1 to entry: See *Annex A*.

3.16

design approval test

homologation procedure with description of the product properties and test results

3.17

routine test

quality control test in terms of regular manufacturing

3.18

purchaser

operator or user of the equipment, or the customer of the material on the user's behalf

3.19

supplier

body responsible for the use of the EN in response to the purchaser's requirement and also for requirements which apply to the producer or manufacturer

Note 1 to entry: Generally the supplier is the manufacturer of the concrete sleepers and has a sub-contractor for the USPs.

3.20

USP on concrete block

USP bonded on concrete block

Note 1 to entry: See *Annex B*.

4 Symbols

Table 1 lists the parameters and physical quantities used.

Table 1 — Symbols

Symbols	Characterization	Units
A	area	mm^2
a	acceleration in measurement of higher frequency bedding modulus	m/s^2
C	bedding modulus	N/mm^3
d	displacement	mm
Δ	variation	-
F	force	N
f	frequency in measurement	Hz
k	stiffness	N/mm
L_H	vibration level related to reference value of $5 \times 10^{-8} \text{ m/s}$	dB
m	mass	kg
N	number of cycles	-
η	loss factor	-
p	pressure	N/mm^2
κ	stiffening 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 higher frequency bedding modulus)	s^{-1}

Table 2 lists the indices used with the parameters and physical quantities.

Table 2 — Indices of the symbols

Indices	Characterization
0	for frequency, definition of natural frequency
5 Hz, 10 Hz, 20 Hz, 30 Hz	value of frequency in measurement
af	after
av	average
be	before
dyn	low frequency dynamic
H	higher frequency
max	maximum
min	minimum

Indices	Characterization
number	sequential number in order to differentiate types of measurements
pre	preload
stat	static
tend	tendency
test	test load

5 Design approval tests and routine tests

5.1 General

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

The data sheets and the general processes of USP and sleeper with USP are described in Annex F and Annex G.

If a tested USP is used with different concrete sleepers or bearers (different types or different manufacturing process), the purchaser shall state, as a selection of in Tables 3 to 5 given tests, which tests shall be performed.

5.2 Summary of design approval tests and routine tests

The design approval tests and the routine tests consist of the following three stages:

- tests of USP alone and of USP on concrete block (see Table 3);
- tests of concrete sleepers and bearers without USP (see Table 4);
- tests of USP on concrete sleepers and bearers (see Table 5).

The frequency of routine tests is defined according to the quality plan of the suppliers (see Clause 8).

Table 3 — Tests of USP alone and of USP on concrete block

Tests	Subclause	Design approval tests	Routine tests
Tensile strength of USP material	5.3.1	Optional	Optional
Static and low frequency dynamic bedding modulus of USP on concrete block with GBP	5.3.2	Mandatory for static, 5 and 10 Hz, optional for 20 and 30 Hz	1 of 2 is Mandatory
Static and low frequency dynamic bedding modulus of USP alone with GBP	5.3.3	Optional	
Higher frequency dynamic bedding modulus of USP on concrete block	5.3.4	Optional (but recommended if USP is used for vibrations attenuation)	Not Applicable
Fatigue test of USP on concrete block in ballast	5.3.5	Mandatory	Not Applicable

Tests	Subclause	Design approval tests	Routine tests
Fatigue test of USP on concrete block with GBP	5.3.6	Optional (but recommended if USP is used for vibrations attenuation)	Not Applicable
Capability of stacking of sleepers with USP on concrete block	5.3.7	Optional	Not Applicable
Effect of temperature variation on USP on concrete block	5.3.8	Optional	Not Applicable
Resistance to water (Hydrolysis)	5.3.9	Optional	Not Applicable
Resistance to chemical agents related to the manufacture of sleepers or bearers	5.3.9	Optional	Not Applicable
Resistance to fire	5.3.9	Optional	Not Applicable
Resistance to hydrocarbon	5.3.9	Optional	Not Applicable
Resistance to ozone	5.3.9	Optional	Not Applicable

Table 4 — Tests of concrete sleepers and bearers without USP

Tests	Subclause	Design approval tests	Routine tests
Requirements of concrete sleepers and bearers	5.4	Mandatory	Mandatory

Table 5 — Tests of USP on concrete sleepers and bearers

Tests	Subclause	Design approval tests	Routine tests
Dimensions and masses of sleepers and bearers with USP	5.5.1	Mandatory	Mandatory
Bond strength by pull-out of USP on sleeper and bearer	5.5.2	Mandatory	Mandatory
Fatigue test of USP on sleeper	5.5.3	Optional	Not Applicable
Environment and end of life	5.5.4	Optional	Not Applicable

5.3 Tests of USP alone and of USP on concrete block

5.3.1 Tensile strength of USP material

The tensile strength measured during the design approval 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).

a) Test arrangement:

The test is performed on USP in accordance with the 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.

NOTE For USP materials not considered by these two standards, adaptation on the sample size can be allowed, in accordance with the purchaser.

b) Design approval tests:

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 within the range of purchaser's acceptance values.

5.3.2 Static and low frequency dynamic bedding modulus of USP on concrete block with GBP

The static and the low frequency dynamic bedding modulus of the USP on concrete block with GBP allow the bedding modulus of the USP to be quantified without the influence of manufacturing process of the sleepers.

a) Test arrangement:

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

The low frequency dynamic bedding modulus is measured at (5 ± 1) Hz and (10 ± 1) Hz (and optional frequency tests at (20 ± 2) Hz and (30 ± 3) Hz).

b) Design approval tests:

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

The purchaser shall define the evaluation criteria(s) within the list:

- 1) purchaser minimum value $\leq C_{\text{stat}} \leq$ purchaser maximum value (average or/and individual value);
- 2) purchaser minimum value $\leq (C_{\text{dyn},5 \text{ Hz}} \text{ or } C_{\text{dyn},10 \text{ Hz}}) \leq$ purchaser maximum value (average or/and individual value).

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

5.3.3 Static and low frequency dynamic bedding modulus of USP alone with GBP

The static and the low frequency dynamic bedding modulus of the USP alone with GBP allows the vertical bedding modulus of the USP to be quantified without the influence of a bonding system in concrete. This method requires a USP without a bonding system or with a bonding system which has no influence on the bedding modulus.

The static and low frequency dynamic bedding modulus measured during the design approval tests shall determine the reference value of these bedding moduli to follow the quality of the production of USP during the routine tests

NOTE 1 The values of bedding modulus with and without concrete block can be different.

a) Test arrangement:

The static and low frequency dynamic bedding modulus of USP alone with GBP shall be measured in accordance with Annex C.

The low frequency dynamic bedding modulus is measured at (5 ± 1) Hz and (10 ± 1) Hz (and optional frequency tests at (20 ± 2) Hz and (30 ± 3) Hz).

b) Design approval tests:

The test method shall be applied on 3 USP alone.

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

NOTE 2 The bedding modulus with and without concrete block are not necessarily the same values.

5.3.4 Higher frequency dynamic bedding modulus of USP on concrete block

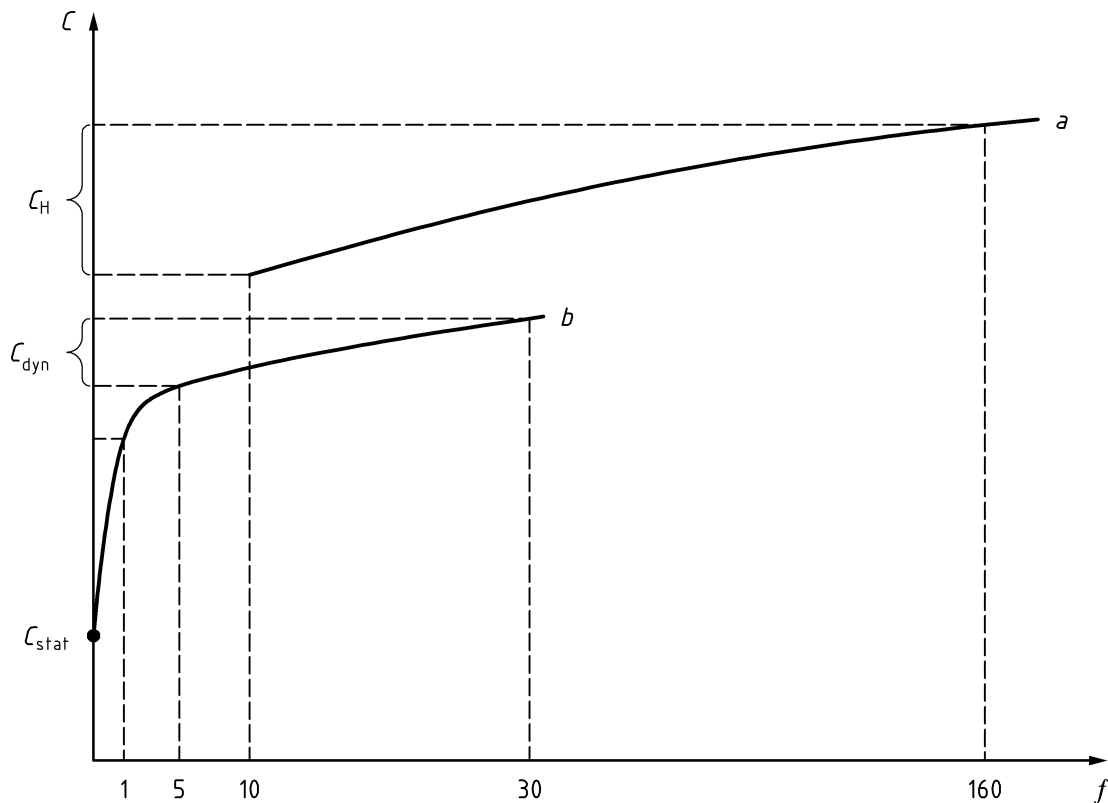
This test evaluates the capacity of USP to insulate vibrations.

a) Test arrangement:

The higher frequency dynamic bedding modulus of USP on concrete block with GBP shall be measured in accordance with Annex H. The testing procedure and equipment are different to the determination of low frequency dynamic bedding modulus.

NOTE 1 In contrast to the test of the low frequency dynamic bedding modulus C_{dyn} , the test procedure to measure the higher 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, $C_H (20 \text{ Hz}) \neq C_{dyn} (20 \text{ Hz})$ (see Figure 1).

NOTE 2 The magnitude of the loss factor η of a USP influences the dynamic magnification in the region of the natural frequency of the elastically supported track as an oscillatory system. It determines the edge steepness of the amplitude response and thus the insertion loss of the overall system (see H.3).



Key

- a curve for higher frequency dynamic bedding modulus
- b curve for static and low frequency dynamic bedding modulus
- C bedding modulus, in N/mm³
- f frequency, in Hz

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

b) Design approval tests:

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

The purchaser shall define the evaluation criteria.

5.3.5 Fatigue test of USP on concrete block in ballast

This test evaluates the durability of USP in contact with ballast. This fatigue test permits the evaluation of the interaction of the ballast with USP.

a) Test arrangement:

The fatigue test of the USP on concrete block shall be carried out in accordance with Annex D.

b) Design approval tests:

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

Visual inspection shall be according to the purchaser's criteria.

5.3.6 Fatigue test of USP on concrete block with GBP

This test evaluates the durability, stability of bedding modulus and vibration characteristics (in case of use for vibration applications) of USP in contact with GBP. This test permits the evaluation of the long term variation of bedding modulus of USP.

a) Test arrangement:

The fatigue test of USP on concrete block shall be measured in accordance with Annex I.

b) Design approval tests:

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

The purchaser shall define the evaluation criteria in the list:

- 1) $\Delta C_{\text{stat}} \leq \text{purchaser value}$;
- 2) $\Delta C_{\text{dyn}, 5 \text{ Hz}} \leq \text{purchaser value}$.

5.3.7 Capability of stacking of sleepers with USP, testing by USP on a concrete block

This test permits the impact on the USP when stacked in storage to be quantified.

a) Test arrangement:

The capability for stacking of USP shall be measured in accordance with Annex J.

The purchaser defines the minimum test pressure $p_{\text{test,min}}$.

Example of calculation of $p_{\text{test,min}}$: $p_{\text{test,min}} = (\text{safety coefficient}) \times 0,8 \text{ N/mm}^2$ (15 sleepers of 3 000 N each on two wood battens with a contact section with USP of 280 mm x 100 mm $\geq 0,8 \text{ N/mm}^2$).

NOTE Safety coefficient is usually 1,2

The USP manufacturer chooses the test pressure p_{test} . This test pressure shall be greater or equal to $p_{\text{test,min}}$. Results are valid for all the values less or equal to the test load.

b) Design approval tests:

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

Visual inspection shall be according to the purchaser criteria.

The purchaser shall define the evaluation criteria in the list:

- 1) $\Delta C_{\text{stat}} \leq \text{purchaser value}$;
- 2) $\Delta C_{\text{dyn}, 5 \text{ Hz}} \leq \text{purchaser value}$;
- 3) variation of thickness of the USP $\leq \text{purchaser value}$.

5.3.8 Effect of temperature variation on USP on concrete block

This test evaluates the effect of temperature variation on the USP (and its bonding to the sleeper) to quantify its resistance to seasonal changes in ambient conditions. In addition, it evaluates the suitability of the USP for use with accelerated concrete curing processes.

The variations of static and the low frequency dynamic bedding modulus of USP on concrete block with GBP are measured in accordance with Annex C in order to quantify the variation of bedding modulus characteristics after the effect of temperature variation of USP on concrete block.

a) Test arrangement:

The effect of temperature variation on USP on concrete block is required, it shall be measured in accordance with Annex N.

b) Design approval tests:

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

Visual inspection shall be according to the purchaser criteria.

The purchaser shall define the evaluation criteria in the list:

- 1) $(\Delta C_{\text{stat}} \text{ or } \Delta C_{\text{dyn}}, 5 \text{ Hz}) \leq \text{purchaser value};$
- 2) average value of at least 3 pull-out tests $\geq$ purchaser average value;
- 3) minimum value of at least 3 pull-out tests $\geq$ purchaser minimum value.

5.3.9 Resistance to other environmental parameters

The chemical agents used for the production of the USP should not modify the properties of the sleepers or bearers. The purchaser shall define test methods.

Water, Hydrocarbons and Ozone (in track) shall not modify significantly the material characteristics of USP. The test is performed with the supplier's instructions which are approved by the purchaser.

In case of fire the USP should not propagate the fire or create toxic fumes. The purchaser shall define test methods. The requirements can be different for tunnel, station or open track.

The purchaser shall define the evaluation criteria and the number of samples for:

- 1) resistance to chemical agents related to the manufacture of sleepers or bearers;
- 2) resistance to water (hydrolysis);
- 3) resistance to hydrocarbon;
- 4) resistance to ozone;
- 5) resistance to fire.

5.4 Tests of concrete sleepers and bearers without USP

The sleeper or bearer shall fulfil the requirements given in the EN 13230 series. The purchaser shall define performances of concrete sleepers or bearers used.

5.5 Tests of USP on concrete sleepers and bearers

5.5.1 Dimensions and masses of sleepers and bearers with USP

Dimension of the USP shall fit to the dimensions of the concrete sleeper/bearer bottom surface.

USP may cover the whole or part of the bottom surface of the sleeper or bearer.

USP geometry and position at sleeper bottom surface shall take into account events during lifetime: storage before use, track laying works, maintenance works in track.

The dimensions of USP shall take into account potential damage of the sleeper/bearer with USP in case of misuse during tamping.

The embedment of the USP shall have no effects to the load capacity of the sleeper or bearer. This means that embedment leads to no depth reduction of the concrete part of the sleeper.

Embedment of the USP in the concrete sleeper/bearer does not modify the requirements for the concrete cover on steel as defined in EN 13230-1.

The dimensions and the masses of sleepers and bearers with USP shall be defined by the purchaser in order to control the mass of sleepers and the thickness of sleepers and shall not disrupt the maintenance operation (tamping for example) and the installation of sleepers in track.

a) Test arrangement:

Dimensions and masses are measured with suitable instruments (instruments accepted by the purchaser).

b) Design approval tests:

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

All the samples for design approval tests shall be checked according to the drawing and technical documentations.

5.5.2 Bond strength by pull-out of USP on sleeper and bearer

The bond strength by pull-out of USP on sleepers and bearers permits the bonding efficiency of the USP on concrete sleepers to be quantified.

The pull-out bond strength measured during the design approval tests shall determine the reference value to be used to verify the quality of the production of USP during the routine tests.

a) Test arrangement:

The bond strength by pull-out of USP on sleeper and bearer with USP shall be measured in accordance with Annex E.

b) Design approval tests:

The test method shall be applied on 3 concrete sleepers or bearers with USP with 4 pull-out tests per sleeper.

The average of 12 measurements of pull-out σ_{av} shall be calculated.

Average value $\geq$ purchaser average value.

Minimum value $\geq$ purchaser minimum value.

5.5.3 Fatigue test of USP on sleeper

This requirement is to verify the durability of sleepers with USP in contact with ballast. This ballast attrition resistance test shall quantify the impact of the ballast on USP on sleeper in function of the variation of characteristics of USP on sleeper.

The variations of static and the low frequency dynamic bedding modulus of USP on sleepers with GBP are measured in accordance with Annex K in order to quantify the variation of bedding modulus characteristics after the fatigue test of USP on sleeper.

NOTE 1 The bedding modulus measured with this methodology cannot be compared to the bedding modulus on a block.

a) Test arrangement:

The ballast attrition resistance of sleeper and bearer with USP shall be measured in accordance with Annex L or Annex M.

NOTE 2 At the moment, there is not enough feedback to be able to compare the test results. There is no ranking or equivalence between the two tests. The test in Annex M (Alternative test procedure for fatigue test behaviour with of USP applied on sleeper) has been designed to be equivalent to the test in Annex L (Vibrogir): loads, number of cycle, etc.

b) Design approval tests:

The test method shall be applied on one sleeper with USP.

Visual inspection shall be according to the purchaser criteria.

$\Delta m \leq$ purchaser value in %.

The purchaser should ask to test the concrete sleeper or bearer (of the same batch) without USP in the same conditions in order to have a reference about visual inspection and variation of mass.

5.5.4 Environment and end of life

If there are national regulations concerning environment and end-of-life, the sleeper with USP should follow these regulations.

The USP should not be an element of the track which pollutes the environment.

The USP should not adversely affect the recyclability of the concrete sleeper or bearer.

6 Data to be supplied

6.1 General

The purchaser can require data according to subclause 6.3.2 from the supplier before the design approval tests.

The supplier shall supply all data of the USP and of the concrete sleeper with USP.

The general process of the design approval tests is described in informative Annex G.

6.2 Data supplied by the purchaser

The purchaser shall specify the following data:

- a) all data for the concrete sleeper and bearer as defined in EN 13230-1:2016, subclause 4.4.2;
- b) track category;
- c) drawings and specifications necessary to define:
 - 1) critical dimensions of the USP including tolerance (length, width, etc.) (see subclause 5.5.1);
 - 2) geometry and position of USP on the sleeper including tolerance (see subclause 5.5.1);
- d) requirement for static and low frequency dynamic bedding modulus of USP on concrete block with GBP (see subclause 5.3.3);
- e) requirement for fatigue test with USP on concrete block (see subclause 5.3.6);
- f) requirement for bond strength of pull-out of the USP on sleeper (see subclause 5.5.2);
- g) for each optional test selected, the purchaser shall specify the relevant evaluation criteria for:
 - 1) requirement for tensile strength of USP (see subclause 5.3.1);

- 2) requirement for static and low frequency dynamic bedding modulus of USP alone (see subclause 5.3.3);
- 3) requirement for higher frequency dynamic bedding modulus of USP (see subclause 5.3.4);
- 4) requirements for fatigue test with USP on concrete block, with GBP (see subclause 5.3.6);
- 5) requirement for capability for stacked stocking of sleepers with USP on concrete block (see subclause 5.3.7);
- 6) requirements for resistance of USP to water (see subclause 5.3.9);
- 7) requirements for resistance of USP to fire (see subclause 5.3.9);
- 8) requirements for resistance of USP to hydrocarbon (see subclause 5.3.9);
- 9) requirements for resistance of USP to ozone (see subclause 5.3.9);
- 10) requirements for resistance of USP to chemical agents (see subclause 5.3.9);
- 11) requirements for fatigue test with USP applied on sleeper (see subclause 5.5.3);
- 12) requirements for temperature variation of sleeper/bearer with USP (see subclause 5.3.8);
- 13) requirements for environment and end of life conditions for sleeper/bearer with USP (see subclause 5.5.4).

6.3 Data supplied by the supplier of sleeper with USP

6.3.1 General

The supplier shall provide the following documentation to the purchaser in confidence.

6.3.2 Before the design approval tests

The sleeper supplier shall provide to the purchaser the following documentation prior to design approval tests:

- a) all data for the manufacturing of the concrete sleeper and bearer as defined in EN 13230-1:2016, subclause 4.4.3;
- b) technical data sheet (Annex F) of the USP including relevant standards which apply to the materials;
- c) detailed drawings of the USP;
- d) detailed drawings of the sleeper with USP;
- e) description of the manufacturing process for bonding of the USP on the sleeper.

6.3.3 After the design approval tests

The supplier shall provide to the purchaser the following documentation after the completion of the design approval tests:

- a) design approval tests report for the USP and for USP on concrete block (including data to be used for routine tests);
- b) design approval tests report for the sleepers and bearers without USP;

- c) design approval tests report for the sleepers and bearers with USP.

6.3.4 Prior to first start-up of production

The supplier shall provide to the purchaser the following documentation prior to start of production:

- a) all data required for the manufacturing of concrete sleepers and bearers as defined in EN 13230-1:2016, Clause 8;
- b) quality manual from the USP manufacturer;

NOTE Information on quality management systems is provided in EN ISO 9001

- c) in addition, quality manual includes “Inspection and test plan” which details all tests and evaluation criteria derived from design approval tests on USP;
- d) production file for manufacturing data as defined in the following:
 - 1) EN 13230-2:2016, Clause 5;
 - 2) EN 13230-3:2016, Clause 7.1;
 - 3) EN 13230-4:2016, Clause 6.1.

With the addition of manufacturing data for fixing USP on the concrete sleeper:

- e) detailed procedure for handling and stacking concrete sleepers with USP.

7 Rules for use of sleepers and bearers with USP

The essential rules to be complied with for the storage, handling and laying in track of sleepers and bearers shall be stated in a document drawn up by the supplier and validated by the purchaser.

These rules can be the subject of an addition to the sleeper or bearer manufacturing process file.

8 Quality control

The supplier shall operate a quality system which is defined and maintained in a quality manual. This manual shall address all actions, functions and resources, procedures and practices concerned with achieving, and providing documentary evidence that, the quality of the delivered USP, concrete sleepers and bearers with USP and services that the supplier provides conforming to the agreed requirements. The quality manual of the USP and sleeper supplier shall include a quality plan respectively for the USP and for the concrete sleepers and bearers with USP which shall define and detail the following:

- the organization, structure and responsibilities;
- all the materials, processes and procedures for manufacturing, storing and transportation of the concrete sleepers and bearers with USP;
- all testing requirements;
- all other quality control procedures to ensure and verify that the USP, the concrete sleepers and bearers with USP and service provided are to the agreed requirements.

The purchaser shall have access to the quality manual at the premises of the supplier.

NOTE Information on quality management systems is provided in EN ISO 9001.