BS EN 13230-1:2016

BSI Standards Publication

Railway applications — Track — Concrete sleepers and bearers

Part 1: General requirements

bsi.

National foreword

This British Standard is the UK implementation of EN 13230-1:2016. It supersedes BS EN 13230-1:2009 which is withdrawn.

The UK participation in its preparation was entrusted to Technical Committee RAE/2, Railway Applications - Track.

A list of organizations represented on this committee can be obtained on request to its secretary.

This publication does not purport to include all the necessary provisions of a contract. Users are responsible for its correct application.

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European foreword

This document (EN 13230-1:2016) has been prepared by Technical Committee CEN/TC 256 "Railway applications", the secretariat of which is held by DIN.

This document supersedes EN 13230-1:2009.

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of an identical text or by endorsement, at the latest by November 2016, and conflicting national standards shall be withdrawn at the latest by November 2016.

This document has been prepared under a mandate given to CEN 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.

This European Standard is one of the EN 13230 series "*Railway applications – Track – Concrete sleepers and bearers*", which consist of the following parts:

— Part 1: General requirements;

— Part 2: Prestressed monoblock sleepers;

— Part 3: Twin-block reinforced sleepers;

— Part 4: Prestressed bearers for switches and crossings;

— Part 5: Special elements;

— Part 6: Design.

This European Standard is used as the technical basis for transaction between corresponding parties (purchaser – supplier).

Annexes A to F are informative; they can be used as normative requirements by completion of a contract, if agreed by the contracting parties.

The Annex E of EN 13230-1:2009 is deleted and is shifted into EN 13230-6.

There is a change in the wording of the documents of EN 13230 (series) "design bending moment" is replaced by "characteristic bending moment" and "test bending moment".

According to the CEN/CENELEC Internal Regulations, the national standards organisations of the following countries are bound to implement this European Standard: Austria, Belgium, Bulgaria, Croatia, Cyprus, Czech Republic, Denmark, Estonia, Finland, Former Yugoslav Republic of Macedonia, France, Germany, Greece, Hungary, Iceland, Ireland, Italy, Latvia, Lithuania, Luxembourg, Malta, Netherlands, Norway, Poland, Portugal, Romania, Slovakia, Slovenia, Spain, Sweden, Switzerland, Turkey and the United Kingdom.

Introduction

This part of the EN 13230 series covers the general requirements for concrete sleepers and bearers and is used in conjunction with the following parts:

— Part 2: Prestressed monoblock sleepers;

— Part 3: Twin-block reinforced sleepers;

— Part 4: Prestressed bearers for switches and crossings;

— Part 5: Special elements;

— Part 6: Design.

Concrete sleepers and bearers are safety critical components for railway applications. They are not covered by any other standards.

As safety critical components, an agreement is needed between purchaser and supplier to operate a factory Quality System.

This position about safety critical relevance has always been highlighted by decisions from CEN/TC 256/SC 1 "*Railway applications / Infrastructure*" and Annex ZA provides detailed information.

1 Scope

This part of the EN 13230 series defines technical criteria and control procedures which need to be satisfied by the constituent materials and the finished concrete sleepers and bearers, i.e.: precast concrete sleepers, twin-block reinforced sleepers, bearers for switches and crossings, and special elements for railway tracks.

The main requirement of concrete sleepers and bearers is the transmission of vertical, lateral and longitudinal loads from the rails to the ballast or other support. In use, they are also exposed to frost damage and to moisture, which can result in detrimental chemical reactions within the sleeper.

In this standard mechanical tests are defined which provide assurance of the capability of sleepers or bearers to resist repetitive loading and provide sufficient durability. In addition, controls are placed on manufacturing processes and tests to ensure that the concrete will not suffer degradation in service through chemical reaction and frost damage.

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 206, *Concrete - Specification, performance, production and conformity*

EN 934-2, *Admixtures for concrete, mortar and grout – Part 2: Concrete admixtures – Definitions, requirements, conformity, marking and labelling*

EN 1008, *Mixing water for concrete - Specification for sampling, testing and assessing the suitability of water, including water recovered from processes in the concrete industry, as mixing water for concrete*

EN 10080, *Steel for the reinforcement of concrete - Weldable reinforcing steel - General*

FprEN 10138 (all parts), *Prestressing steels*

EN 12620, *Aggregates for concrete*

EN 13146-5, *Railway applications - Track - Test methods for fastening systems - Part 5: Determination of electrical resistance*

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

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

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

prEN 13230-6:2015, *Railway applications – Track – Concrete sleepers and bearers – Part 6: Design*

EN 13481-2, *Railway applications - Track - Performance requirements for fastening systems - Part 2: Fastening systems for concrete sleepers*

EN 13481-5, *Railway applications - Track - Performance requirements for fastening systems - Part 5: Fastening systems for slab track with rail on the surface or rail embedded in a channel*

EN 13481-7, *Railway applications - Track - Performance requirements for fastening systems - Part 7: Special fastening systems for switches and crossings and check rails*

3 Terms and definitions

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

3.1
purchaser
body responsible for purchasing the product on the user's behalf

3.2
supplier
body responsible for the use of the European Standard in response to the purchaser's requirement, and for requirements which apply to the producer or manufacturer

3.3
sleeper
transverse component of the track which controls the gauge and transmits loads from the rail to the ballast or other sleeper support

3.4
bearer for switches and crossings
transverse component of switches and crossings which controls the relative geometry of two or more stretches of running rails and different pieces of special track work, and transmits loads from the rails to the ballast or other bearer support

3.5
bending moment
moment applied on the concrete sleeper or bearer which produces tension and compression in the element

3.6
positive bending moment
moment which produces tension or reduces compression at the bottom of the concrete sleeper or bearer

3.7
negative bending moment
moment which produces tension or reduces compression at the top of the concrete sleeper or bearer

3.8
rail seat
area on which a running rail rests

3.9
rail seat area
rail seat and the immediate area around the fastening system

3.10
rail seat bending moment
moment under the centre line of the rail

3.11
centre bending moment
moment at the centre part of a monoblock sleeper

3.12
prestressed monoblock sleeper
monoblock sleeper using pre-tensioned or post-tensioned tendons for prestressing the concrete

3.13
twin-block reinforced sleeper
sleeper in which two reinforced concrete blocks are connected by a steel connecting bar

3.14
prestressed concrete bearer
monoblock bearer using pre-tensioned or post-tensioned tendons for prestressing the concrete

3.15
test load
load applied during testing

3.16
crack
partial split in concrete due to an external bending moment

3.17
crack under loading
crack measured during a test with an external bending moment applied

3.18
residual crack
crack measured during a test after an external bending moment has been applied and has been removed

3.19
minimum concrete cover
minimum cover given by the nominal cover reduced by the tolerance

Note 1 to entry: Construction tolerances do not apply to the anchorage system of prestressed sleepers, in which case only the ordinary construction tolerances indicated by the manufacturer are applied.

3.20
dynamic rail seat load
$\boldsymbol{P}_{\mathbf{k}}$
characteristic load on a rail seat of the sleeper for normal service dynamic loading

3.21
characteristic bending moment
$\boldsymbol{M}_{\mathbf{k}}$
bending moment from dynamic rail seat load P_k

3.22
characteristic positive bending moment for rail seat section
$\boldsymbol{M_{k,r,pos}}$
positive bending moment at rail seat from dynamic rail seat load P_k

3.23
characteristic negative bending moment for rail seat section
$\boldsymbol{M_{k,r,neg}}$
negative bending moment at rail seat from dynamic rail seat load P_k

3.24
characteristic negative bending moment for centre section
$\boldsymbol{M_{k,c,neg}}$
negative bending moment at centre section from dynamic rail seat load P_k

3.25
characteristic positive bending moment for centre section
$\boldsymbol{M_{k,c,pos}}$
positive bending moment at centre section from dynamic rail seat load P_k

4 Common characteristics

4.1 General

The track is an assembly of transverse sleepers or bearers secured to the rails by means of a fastening system and supported by ballast or other support. It is characterized by the gauge of the track, the rail profile, the inclination of the rails and the spacing of the concrete sleepers and bearers.

4.2 Loading

4.2.1 Loads

The track is subjected to repeated loads in three different directions, generally applied simultaneously:

a) vertical loads from axle load and service conditions;

b) transverse loads from guiding forces;

c) longitudinal loads from acceleration and braking, thermal stresses in continuous welded rail, etc.

Under all loading conditions, the track has to retain its geometry including gauge, top level and alignment.

The characteristic load is calculated by applying a dynamic coefficient to the static wheel load.

The dynamic coefficient takes into account the normal dynamic effects of wheel and track irregularities.

Loads and the corresponding bending moments are the responsibility of the purchaser.

4.2.2 Load distribution

The assembled rail, fastening system and concrete sleepers and bearers on ballast or other support shall be considered as a beam on a continuous resilient support.

The moment of inertia of the rail profile, the spacing of the concrete sleepers and bearers and the elasticity of the whole assembly on its support, have an influence on the longitudinal distribution of the vertical loads applied on the rail. As a result, the rail seat load applied on the concrete element is only a proportion of the wheel load.

4.3 Characteristic bending moments

The characteristic bending moments are defined in kNm by the concrete sleeper and bearer design criteria and are used to calculate test loads.

Characteristic bending moments are seldom reached in the life time of the sleeper.

See prEN 13230-6:2015, 4.2.

4.4 Data to be supplied

4.4.1 General

The purchaser can require all the data from the supplier before the design approval tests.

4.4.2 Data to be supplied by the purchaser

The purchaser shall specify the following data:

a) all characteristic bending moments ($M_{k,r,pos}$; $M_{k,c,pos}$; $M_{k,c,neg}$) and when required ($M_{k,r,neg}$);

b) impact coefficients (k_{1d}) and (k_{2d}), and when required (k_{1s}) and (k_{2s}) as defined in prEN 13230-6:2015;

c) test coefficient (k_t) as defined in prEN 13230-6:2015;

d) required tests and choice of options (see for example Annexes A, B, C);

e) drawings and specifications necessary to define:

   1) critical dimensions (distance between sleeper gauge points L1 – length – width – depth at rail seat – etc.);

   2) fastening system interface and geometric lay-out (6.1);

   3) particular tolerances (6.1, Table 1);

   4) conductor rail insulator supports;

   5) scope of the test arrangements and procedures indicating whether the options are used;

f) absolute maximum and minimum weight of the concrete sleeper and bearer (kg/sleeper or kg/m);

g) any additional technical specification, e.g. electrical insulation;

h) rail profile definition;

i) minimum strength class of concrete (optional).

4.4.3 Data to be provided by the supplier

4.4.3.1 Before the design approval tests

a) Detailed drawings of the concrete sleeper and bearer;

b) characteristics of materials;

c) description of manufacturing process;

d) description of the prestress anchoring system (if any) for prestressed sleepers and bearers:

   1) for bonded anchoring systems, the adherence specification of the tendons, for example indentation;

   2) how prestress is applied to sleeper;

   3) characteristics of chemical, dimensional and mechanical tolerances for anchor devices.

4.4.3.2 After the design approval tests

— Design approval test report.

4.4.3.3 Prior to start-up of production

a) All data required in Clause 8 “Quality control”;

b) production file for manufacturing data as defined in the following:

   1) EN 13230-2:2016, Clause 5;

   2) EN 13230-3:2016, 7.1;

   3) EN 13230-4:2016, 6.1.

5 Materials

5.1 General requirements

All materials shall comply with European standards or if no European Standards exist, with appropriate national standards. Materials other than those specified below shall only be used with the agreement of the purchaser.

Great care shall be exercised in the selection of materials to ensure the long term durability of the concrete. Consideration shall be given to the requirements for freeze–thaw resistance, porosity and abrasion resistance.

Where aggregates contain varieties of silica susceptible to attack by alkalis (Na_2O and K_2O originating from cement or other sources) and as the concrete is exposed to humid conditions, precautions in the choice of constituents shall be taken. Typical precautions are stated below. Other precautions may include provisions which are valid in the place of use of the concrete taking into account previous long-term experience using the particular combination of cement and aggregate and agreed by the purchaser.

The supplier shall provide a document including all precautions about Alkali Silica Reaction for agreement by the purchaser.

Typical precautions are the following:

a) use of low-alkali cement with total alkali content, stated as Na_2O equivalent, less than or equal to 0,60 %;

b) where national recommendations exist, use of additions allowed by EN 206 as partial cement replacement;

c) use of only non-reactive aggregates, regularly confirmed by ex-quarry petrographic analysis (see 5.3);

d) the total mass of reactive alkalis in the concrete not exceeding 3,0 kg/m^3 or being in accordance with national recommendations where available.

5.2 Cement

Use of Portland cement type CEM I with minimum strength-grade class 42.5 complying with EN 197-1 is recommended.

Cement other than type CEM I shall only be used if the durability of the sleepers can be demonstrated and approval is obtained from the purchaser.

The maximum SO_3 content and the curing procedure shall comply with 6.2.

The total alkali content expressed as Na_2O equivalent shall comply with national recommendations unless European standards exist.

The manufacturer shall obtain certificates from the cement supplier detailing the chemical and physical properties of the cement at a sufficient frequency to comply with the quality plan.

5.3 Aggregates

Aggregates shall comply with EN 12620 unless a specific criterion is not within its scope, in which case national standards shall be used.

The manufacturer shall supply the following information to the purchaser concerning aggregates to be used:

a) grading curve;

b) petrographic analysis including:

   1) susceptibility to alkali-silica-reaction and alkali-carbonate-reaction;

   2) presence of particles leading to poor abrasion resistance;

   3) presence of absorbent particles leading to frost damage;

c) chemical analysis including:

   1) maximum chloride content;

   2) maximum sulfate content;

   3) maximum organic material content.

The petrographic analysis shall be carried out at least every two years and each time the source (quarry face or strata) changes.

Aggregates not occurring naturally shall only be used with the agreement of the purchaser.

The maximum size of aggregates shall be determined taking into account the minimum cover and minimum spacing of reinforcement.

The properties of the fine aggregates shall not allow unacceptable abrasion of the concrete element on the parts in contact with the ballast or on the rail seat (7.6).

Use of recycled aggregates is permitted, subject to the agreement of the purchaser, when the supplier can provide evidence of origin and suitable quality of materials.

5.4 Mixing water

In general, potable water is suitable for concrete.

If non-potable water is used, it shall be tested according to EN 1008 unless a specific criterion is not within its scope, in which case national standards shall be used.

5.5 Admixtures

Admixtures shall comply with EN 934-2 unless a specific criterion is not within its scope, in which case national standards shall be used.

Calcium chloride setting acceleration admixtures shall not be used.

The supplier shall offer a solution for durability. The purchaser has the authority to accept it or not.

5.6 Concrete

5.6.1 Material requirements

The concrete shall generally comply with EN 206 plus the following requirements:

a) minimum compressive strength shall be class C45/55 MPa unless otherwise required by the purchaser;

b) water/cement ratio shall be less than 0,45 in mass;

c) minimum cement content shall be 300 kg/m^3;

d) compaction of the concrete shall be sufficient to minimize water penetration (7.6, c));

e) heat treatment may be used (6.2.3).

5.6.2 Information to be provided by the supplier

The supplier shall submit to the purchaser the following information about the concrete:

a) description of the constituent materials including origin, composition, shape and size;

b) mix design;

c) full description of the production process for the concrete including cold weather working, and the storage and measurement of materials;

d) technical report on the following requirements:

1) alkali content according to national standards;

2) design test on the concrete, according to 7.4;

3) the following tests if required:

   i) abrasion resistance, see Annex A;

   ii) freeze–thaw resistance, see Annex B;

   iii) water absorption, see Annex C.

5.6.3 Changes for the material and processes

No change shall be made to the materials and processes used without the agreement of the purchaser.

5.7 Steel

5.7.1 Prestressing tendons

Prestressing tendons shall consist of wires, strands or bars according to the FprEN 10138 series.

5.7.2 Reinforcing steel

Reinforcing steel shall comply with EN 10080 and provisions valid in the place of use. It may be smooth, indented or deformed and shall be of weldable quality where required for reinforcement assembly. Welds shall only be used to aid assembly and shall not affect the fatigue performance of the sleeper.

5.7.3 Steel connecting bar

See EN 13230-3:2016, Clause 5.

5.8 Embedded components

The fastening inserts are defined by the fastening system used by the purchaser and shall comply with the technical specifications and drawings of the system.

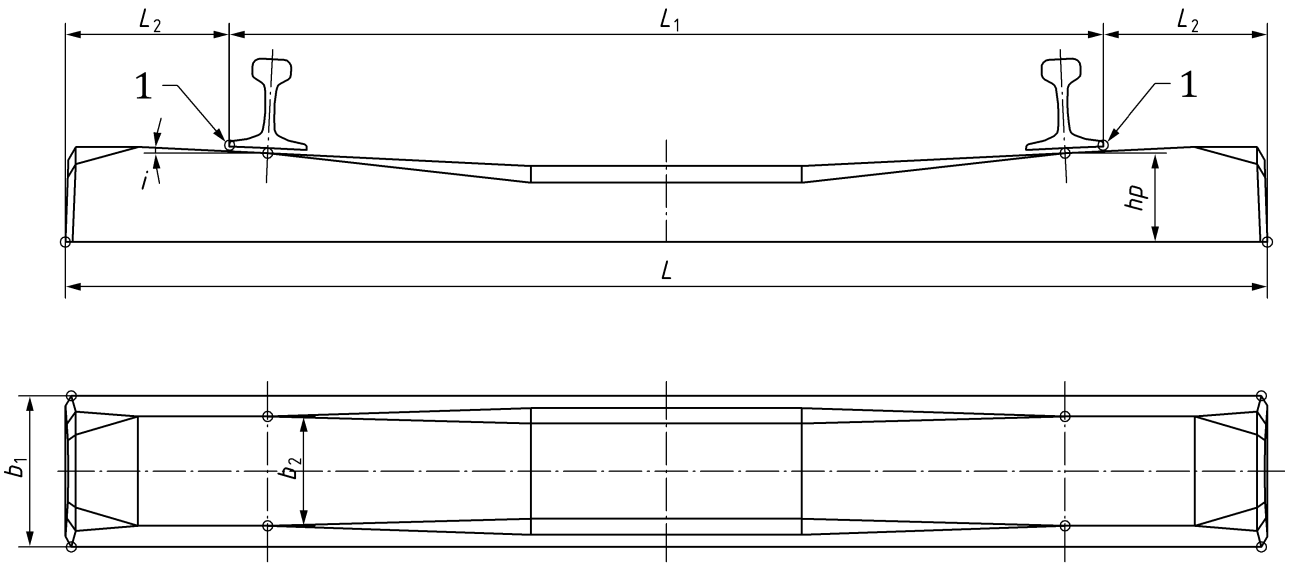
The surface of these components in contact with concrete shall be free of mud, oil, loose rust and scale or other contamination.

6 General requirements

6.1 Design

6.1.1 Geometrical design

Typical concrete envelopes for concrete sleepers and bearers are shown in Figures 1, 2 and 3.

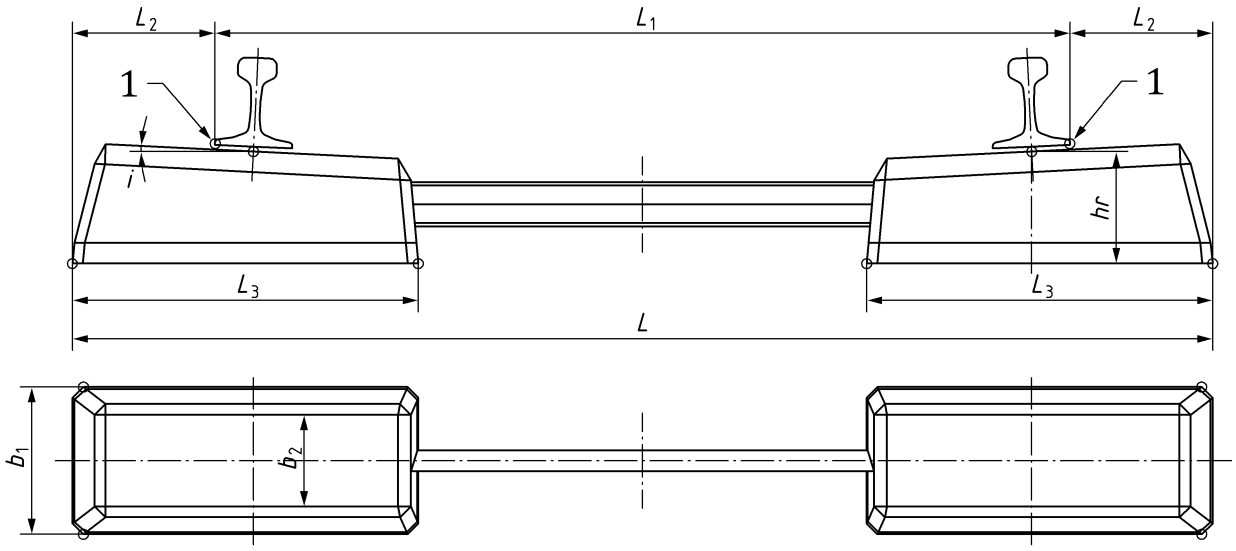


Key

1 gauge points

NOTE L1: Distance between sleeper gauge points taking into account the fastening system, the rail and the track gauge.

Figure 1 — Typical prestressed monoblock sleeper



Key

1 gauge points

NOTE L1: Distance between sleeper gauge points taking into account the fastening system, the rail and the track gauge.

Figure 2 — Typical twin-block reinforced sleeper

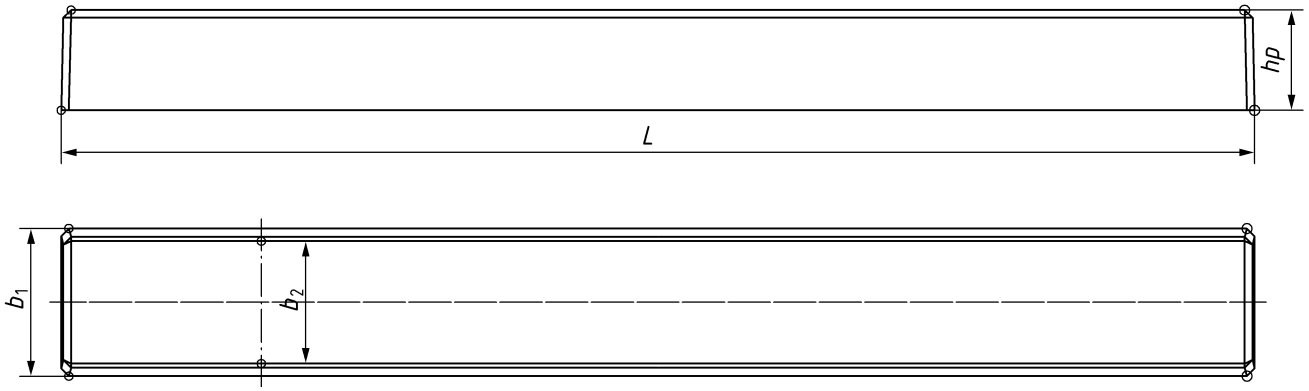


Figure 3 — Typical prestressed concrete bearer

The values of the main dimensions shall be determined by the purchaser.

The maximum tolerances specified in Table 1 apply to ballasted track and can be varied by the purchaser in the case of special requirements such as dedicated concrete elements for ballastless track or use of a sleeper laying machine, etc.

Table 1 — Maximum tolerances

Symbols	Description	Tolerances
L	Overall length of the concrete element	±10 mm
b_1, b_2	Top and bottom width of the concrete element	±5 mm
hr	Depth at any position along the total length of the reinforced concrete element measured in accordance with the quality plan	$\binom{+10}{-3}$ mm
hp	Depth at any position along the total length of the prestressed concrete element measured in accordance with the quality plan	$\binom{+5}{-3}$ mm
L_1	Distance between the rail fastening gauge points	$\binom{+2}{-1}$ mm
L_2	Position of the rail fastening gauge point with regard to the end of the concrete element	±8 mm
L_3	Total length of reinforced concrete block	±8 mm
i	Inclination of the rail seat (see Annex D)	±0,25°
f	Planeness of each rail seat area: with regard to 2 points 150 mm apart (monoblock and twin-block sleepers only)	1 mm
T	Relative twist between rail seats for monoblock sleepers (see Annex D)	0,5°
T	Relative twist between rail seats for twin-block sleepers (see Annex D)	0,8°
T	Relative twist between rail seats from same track for concrete bearers (see Annex D)	0,5°
m	Mass of the sleeper (variation with regard to nominal weight) [a]	±5 %

[a] The purchaser shall indicate if all or part of the fastening system is included in the mass of the concrete element.

The design, dimensions and tolerances of the fastening system shall be defined by the purchaser.

The purchaser shall specify the minimum clearances between rail fastening component and reinforcement according to the fastening system to be used, and between reinforcement and connecting bar for twin-block sleepers.

For abbreviations, see Table 1.

6.1.2 Concrete cover

Unless there is an alternative agreement by the purchaser, the minimum concrete cover for prestressing tendons shall be 30 mm from the bottom surface and 20 mm from the other surfaces except at the ends of sleepers and bearers.

The minimum concrete cover for reinforcing steels shall be 25 mm from the bottom surface and 15 mm for the rail seat area and 20 mm from the other surfaces, except for the end of spacing bars.

6.1.3 Prestressing system design

The supplier shall define all data in relation with the nominal prestressing force, nominal position of each tendon, anchorage system.

The vertical position of the centroid of the prestressing shall be within ± 3 mm of the nominal vertical position relative to the rail seat.

The vertical position of each individual prestressing tendon shall be within ± 6 mm of the nominal position relative to the rail seat.

The horizontal position of each individual prestressing tendon shall be within ± 6 mm of the nominal position relative to the sleeper axis.

The total prestressing force shall be applied within ± 5 % of the specified nominal force.

6.1.4 Reinforcing steel design

The supplier shall define all data in relation with the design of the reinforcing steel and nominal position in the concrete element.

The reinforcing steel shall be within ± 5 mm of the nominal position in all directions.

6.2 Manufacturing process

6.2.1 General requirements

Details of production plant and equipment are the responsibility of the supplier. The supplier shall supply to the purchaser a description of the manufacturing process.

The processes for curing, mould removal and handling conditions of the concrete sleepers and bearers are part of the manufacturing process. They shall be submitted to the purchaser for approval.

Any change in the manufacturing process shall be submitted to the purchaser for approval. The purchaser is entitled to verification that such changes will have no adverse effect on the concrete sleepers and bearers.

The concrete temperature shall be monitored.

When the temperature is measured in the concrete, it shall be measured as near as possible at the mid depth and mid width of the sleeper.

When the manufacturer can provide evidence of the relationship between concrete and air temperature at all stages throughout the curing cycle, it is permissible for the air temperature within the immediate curing environment to be measured instead of the concrete temperature.

6.2.2 Natural curing

Curing and protection should start as soon as possible after the compaction of the concrete.

Curing is prevention against premature drying, particularly by solar radiation and wind. The curing method shall be approved by the purchaser.

The principal measures for curing concrete are:

a) keeping the formwork in place;

b) covering with plastic films;

c) placing of wet coverings;

d) sprinkling with water;

e) application of curing compounds which form protective membranes.

The methods can be used separately or in combination.

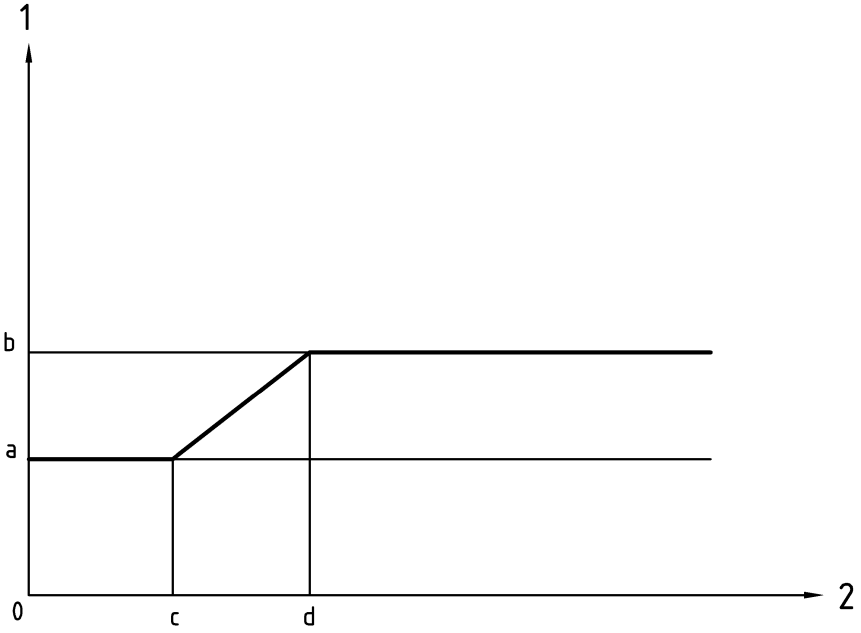
To avoid surface cracking caused by heat generated in the concrete under normal conditions, the temperature difference between the centre and the surface of the concrete shall be less than 20 °C.

The maximum permitted temperature shall not exceed those shown in Figure 4 and shall be reduced if the sulfur trioxide content of the cement expressed as a percentage of the cement by weight exceeds 2 % (see Figure 5).

6.2.3 Accelerated curing

The introduction of heat to the concrete, in addition to the heat of hydration, shall be allowed to increase the rate of gain of strength of the concrete. The maximum permitted temperature shall not exceed those shown in Figure 4 and shall be reduced if the sulfur trioxide content of the cement expressed as a percentage of the cement by weight exceeds 2 % (see Figure 5).

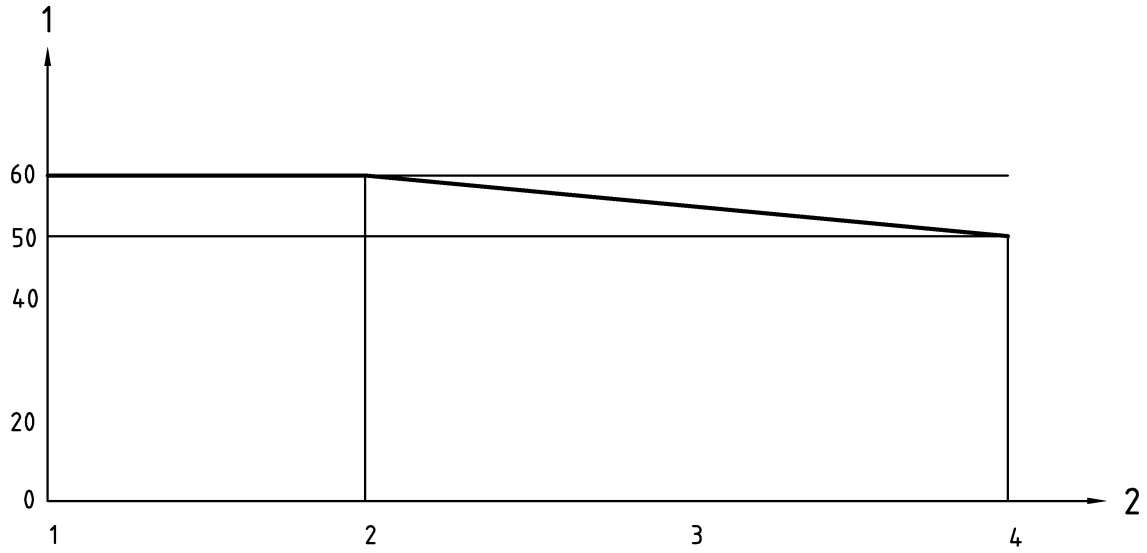
Any change in the curing process, such as maximum temperature of concrete and supported by results from additional design tests shall be submitted to the purchaser for agreement.



Key

1	concrete temperature (°C)
2	time
a	start temperature ≤ 30 °C
b	max. temperature: see Figure 5
0 - c	waiting time = 2 h or preset time of concrete whichever is greater
c - d	increase period: max. 15 °C/hour and 10 °C/half-hour, in any hour

Figure 4 — Maximum temperature curve



Key

1 concrete temperature (°C)

2 sulfur trioxide (content of the cement % by mass)

Figure 5 — Maximum curing temperature as a function of sulfur trioxide content in the cement

6.3 Surface finish

The top surface and sides of the concrete element shall have a uniform appearance. A random scattering of air holes is permitted on any surface.

For sleepers intended for ballasted tracks, the bottom surface shall be rough and uniform.

For sleepers on non-ballasted tracks, particular requirements for the bottom surface may be requested.

Particular attention shall be paid to the rail seat area, which shall be free of any individual large void.

The minimum requirement for finish to all surfaces shall be agreed between the purchaser and the supplier and shall be represented by samples and/or by photographs.

Remedial work on a concrete element after demoulding, which does not affect the mechanical performance of the product may only be carried out if detailed procedures have been included within the description of the manufacturing process.

An example for requirements on surface finish can be found in Annex E.

6.4 Marking

Each concrete sleeper and bearer shall have the following permanent marking:

a) year of manufacture;

b) mould identification;

c) identification mark of the production plant.

The purchaser may require additional information (permanent or not) to be identified on the concrete sleepers and bearers.

7 Product testing

7.1 General

This section defines the testing regime and rules for acceptance of concrete sleepers and bearers.

Two kinds of tests are used:

a) design approval test: a test on a concrete sleeper or bearer or part of a concrete sleeper or bearer to demonstrate compliance with the design. It is carried out on a more than 4-week-old concrete sleeper or bearer;

b) routine test: a product test as a part of the manufacturing quality control process.

Bending tests are defined for each type of concrete sleeper and bearer in EN 13230-2:2016, EN 13230-3:2016 and EN 13230-4:2016 may differently for type approval and routine tests.

The routine test procedures are carried out on concrete sleepers and bearers selected at random from the manufacturing production line. No additional preparation to normal production is allowed. Routine tests are usually assessed on a defined statistical basis.

In some railway networks, dual gauge and convertible gauge sleepers are used. In these cases, the test procedures in this section may still be used but judgement shall be made by the purchaser on the combination of tests for two gauges.

7.2 Mechanical parameters

The following parameters are used in the tests defined in 7.3.

First crack: a crack irrespective of width which originates in the tensile face of the concrete sleeper and bearer extending to a minimum depth of 15 mm on one side or other of the concrete sleeper and bearer and which increases in depth with further application of load.

Measurements are carried out at approximately 15 mm from the tensile face of the concrete element on both sides.

Position of 15 mm is determined from the rail seat surface as detailed in Figure 6.

Dimension X is calculated with $X = (hp - 15)$ mm or $X = (hr - 15)$ mm.

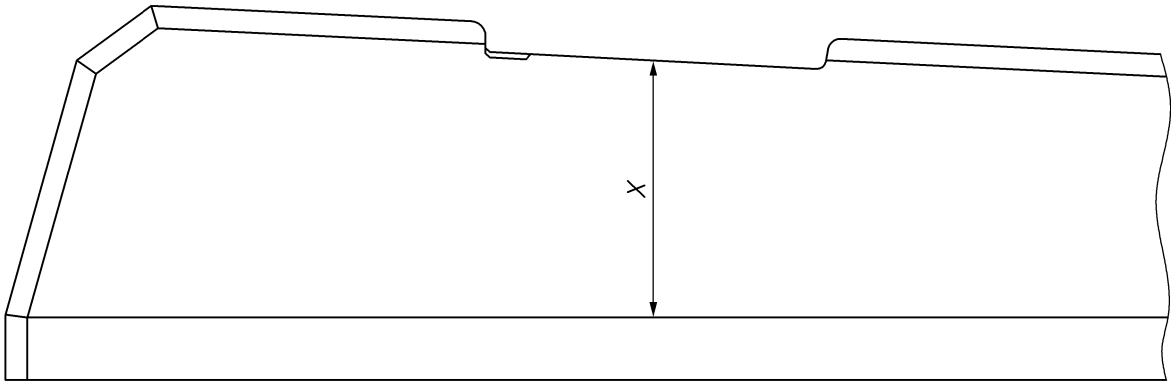


Figure 6 — Area for measurement of crack

Application of test loads is defined in EN 13230-2:2016, EN 13230-3:2016 and EN 13230-4:2016.

When there are requirements on crack width, it shall be measured using a graduated microscope of minimum magnifying power of 20 times to an accuracy of 0,01 mm.

7.3 Tests on product

The tests carried out are:

a) static bending test: a static load condition to confirm the behaviour of a concrete sleeper or bearer. Required for design approval and routine tests;

b) dynamic bending test: a dynamic load condition which applies a pulsating and increasing load to the concrete sleeper or bearer in order to simulate the situation in the track of effects of cyclic loads and impact loads. Only required for design approval tests;

c) fatigue bending test: a dynamic condition to simulate the loads applied to the concrete sleeper or bearer by traffic. An optional design approval test carried out at the request of the purchaser.

7.4 Tests on concrete

The tests to be carried out are:

a) design approval tests on the concrete mix and routine tests on the concrete used;

b) tests on the properties of concrete carried out in accordance with EN 206.

7.5 Tests in combination with the fastening system

The tests to be carried out are:

a) design approval tests, if required, which shall be defined by the purchaser according to EN 13481-2, or EN 13481-5 or EN 13481-7;

b) electrical insulation design approval tests, if required, shall be carried out according to EN 13146-5;

c) routine test, if required, shall be defined by the purchaser.

7.6 Additional tests

The following additional tests relating to the durability of the concrete may be required by the purchaser:

a) abrasion resistance of fine aggregate (see Annex A);

b) freeze–thaw resistance (see Annex B);

c) water absorption of concrete at atmospheric pressure (see Annex C).

8 Quality control

8.1 General

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 concrete sleepers and bearers and services that the supplier provides are to the agreed requirements.

The quality manual shall include a quality plan for the production of concrete sleepers and bearers, which defines and details the following:

a) the organization, structure and responsibilities;

b) all the materials, processes and procedures for manufacturing, storing and transporting of the concrete sleepers and bearers as described in EN 13230-2:2016, EN 13230-3:2016 and EN 13230-4:2016;

c) all testing requirements including definition of testing equipment, method of testing, frequency of tests, etc.;

d) all other quality control procedures to ensure and verify that the concrete sleepers and bearers and services provided are to the agreed requirements.

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

NOTE Guidance on quality systems is given in EN ISO 9000.

8.2 Quality control during design approval tests

The supplier shall provide to the purchaser all quality documents in relation with the concrete elements to be submitted to design approval tests.

This includes:

a) detailed drawings of the concrete element and components included;

b) detailed information of the anchoring system for prestressed elements;

c) detailed information about concrete composition as mentioned in 5.6;

d) procedure showing how all testing requirements are fulfilled:

   1) This includes geometrical tests with description of the gauge and measurement method for each dimension;

   2) This includes load tests on concrete and sleeper with the description of the measurement means and method.

e) general description of the manufacturing process;

f) test report showing compliance of the sleepers submitted to 7.3 “Tests on products” with the dimensions and maximum tolerances defined in Table 1.

Design approval tests results may be used for the determination of test loads to be used for routine tests.

8.3 Quality control during manufacturing

Prior to start of manufacturing the supplier shall provide to the purchaser a quality plan including all quality documents in relation with the acceptance of materials and manufacturing of the concrete elements.

For routine tests, alternative test arrangements can be used if the manufacturer can provide evidence of results complying with approved test arrangements.

The quality plan shall detail:

a) frequency of testing for each dimensional requirement;

b) frequency for load tests on concrete and on sleeper;

c) mechanism used to increase the inspection frequency when defects are identified;

d) actions to be taken in the case of defects being found to ensure recheck for compliance.

In case of early dimensional inspection of the concrete element, the quality plan shall take into account further shortening of the element.

At the request of the purchaser, the supplier can be asked to carry out from time to time certain non-routine tests included in this standard, and confirm compliance with the standard for the routine tests.

Information for inspection frequency is given in Annex F.

Annex A
(informative)

Test method to determine the Taber Wear index for a fine aggregate

A.1 General

This test procedure specifies a method to assess the abrasion resistance of a fine aggregate.

Principle

Following the preparation of mortar tile samples cured in water at (20 ± 2) °C for 28 days, the samples are abraded in a Taber Abrasion Testing machine for 500 cycles and the loss in weight calculated. Following a calculation of density the Taber Wear index for the sample can be calculated.

A.2 Apparatus

a) Teledyne Taber Abrasion Testing machine (model 503, 5103, 5105 or similar) with a pair of Taber H22 calibrated, vitrified, coarse grain, medium bond wheels and a 500 g loading;

b) ventilated oven capable of maintaining a temperature of (105 ± 5) °C;

c) temperature controlled water tank capable of maintaining a temperature of (20 ± 2) °C;

d) sample mould capable of producing mortar tiles (100 ± 3) mm × (100 ± 3) mm × (15 ± 3) mm in size;

e) weighing instrument with an accuracy of at least 0,01 % of the mass to be weighed;

f) suitable water lubricated grinding apparatus.

A.3 Preparation of Mortar Tiles

A.3.1 Sampling

A 5 kg sample considered to be representative of the fine aggregate to be tested shall be collected.

Sampling is not the responsibility of the test laboratory except where specially requested.

A.3.2 Mortar Tile preparation

A sample of sand shall be dried to give a constant weight at (105 ± 5) °C. The dried sand shall be batched with Ordinary Portland cement and water to the following criteria:

a) sand/cement ratio of 3:1 by weight;

b) water/cement ratio of 0,55.

The mortar produced shall be hand compacted into moulds to produce 6 tiles (4 for test plus 2 as spares as a contingency measure) of (100 ± 3) mm × (100 ± 3) mm × (15 ± 3) mm in size.

A.3.3 Mortar Tile curing

Initially the cast tiles shall be covered by polyethylene and left to set overnight in a temperature controlled room at (20 ± 2) °C.

The tiles shall be de-moulded and cured in water at (20 ± 2) °C for 28 days.

A.3.4 Grinding of Mortar Tiles

One surface of each tile shall be ground to remove approximately 1-2 mm from the outer surface to clearly expose the sand grains and produce a flat, even surface.

The tiles shall then be air-dried to a constant weight (W_0) at (20 ± 2) °C.

A.4 Test procedure

The tiles shall be mounted in a Taber abrasion testing machine and tested for 500 cycles using a pair of Taber H22 calibrated wheels and a 500 g loading.

The new weight of the tiles (W_1) shall be recorded and the weight loss (W_3) in milligrams ($W_3 = W_0 - W_1$) determined.

The density (d) of the tiles shall then be determined.

A.5 Calculation of Taber Wear Index

The Taber Wear Index for each tile shall be calculated as follows:

$$\mathrm{TWI} = \frac{W_3\left(\mathrm{mg}\right)}{d\left(\mathrm{mg/m^3}\right)} \times \frac{1000\ \mathrm{cycles}}{n} \qquad \text{(A.1)}$$

where

TWI is Taber Wear Index;

n is the number of test cycles.

The Taber Wear Index shall be average of 4 results and shall not exceed a value specified by the purchaser.

Annex B
(informative)

Test method for freeze–thaw resistance

Any test method can be used if agreed by the parties concerned.

Annex C
(informative)

Test method for measuring the water absorption of concrete at atmospheric pressure

C.1 Introduction

Resistance to disruptive expansion of concrete can be improved by producing low porosity concrete. An indication of the porosity can be obtained by measuring the water absorption at atmospheric pressure.

C.2 Samples

The sequence of tests is performed on samples taken from routine production by coring two samples from each concrete element with approximate dimensions of 40 mm diameter and 120 mm length.

C.3 Sequence of test

The samples are dried at a temperature of (105 ± 2) °C until a constant mass M_1 is obtained.

The constant mass is considered to have been reached when the deviation between two successive weighing measurements is less or equal to 1/1000 (usually 48 hours are necessary to achieve this limit).

After drying, the samples are laid horizontally in a container partially filled with potable water at a temperature between 15 °C and 20 °C up to their axis.

After 24 h the water level is raised to 5 mm above the top of the samples over a minimum of 15 min.

After 48 h the samples are weighted in the water (hydrostatic weight) to obtain the mass M_2.

The samples are wiped to eliminate any surface water, and weighed to get the mass M_3 (saturated weight).

C.4 Results

The porosity is the ratio between the total volume of voids to the apparent volume.

Assuming the water specific density between 15 °C and 20 °C is 1:

a) the total volume of voids is: $M_3 - M_1$;

b) the absolute volume is: $M_1 - M_2$.

The apparent volume is: volume of voids + absolute volume = $M_3 - M_2$.

$$Vp = \frac{M_3 - M_1}{M_3 - M_2} \times 100\% \qquad \text{(C.1)}$$

where:

Vp is the porosity.

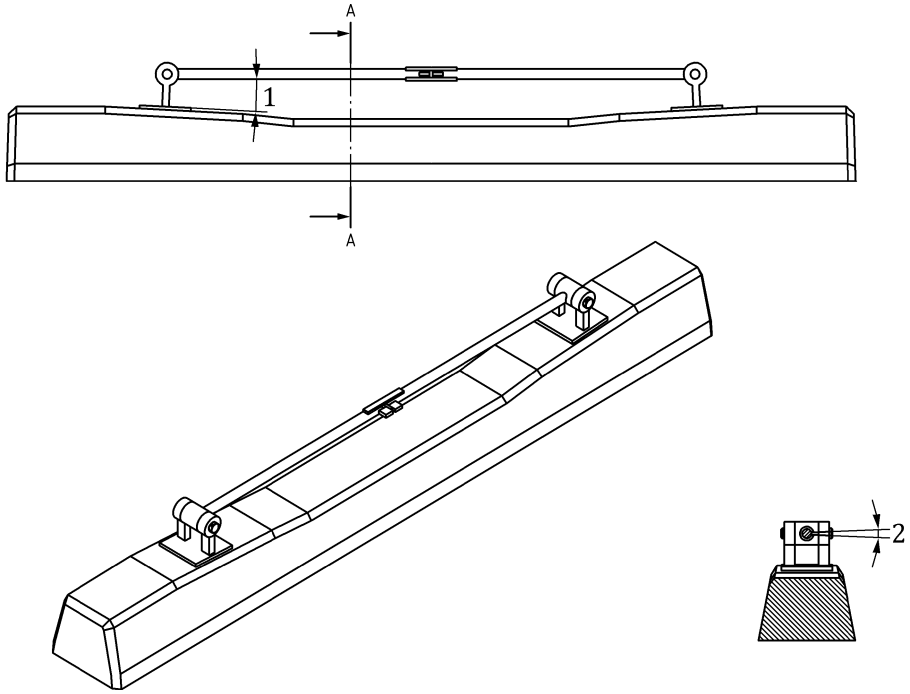
C.5 Requirements

Each sample porosity value shall be less than (or equal to) 12 %.

Annex D
(informative)

Definition and recommendation for measurement of rail seat inclination and twist between rail seats

Rail seat inclination and twist between rail seats shall be evaluated as angle or angle variation between the two rail seats planes.



Key

1 measurement of rail seat inclination

2 measurement of twist between rail seats

Figure D.1 — Example of gauge for measurement of rail seat inclination and twist between rail seats

For measurement, the reference of each rail seat plane shall be defined by a plate with a minimum length of 150 mm in each direction.

The gauge should be calibrated with a reference sleeper.

The reference plate of the concrete rail seat surface should take into account planeness tolerances.

Annex E
(informative)

Surface finish

E.1 General

Surface finish of the concrete sleeper may be a major issue between purchaser and manufacturer as the evaluation of surface finish is difficult to perform.

Evaluation may be eased with the use of sample sleepers or photographs as mentioned in 6.3.

This annex provides guidelines for better understanding of the matter and offers a standard for surface finish.

E.2 General information for surface finish

Requirements for surface finish of the concrete element shall take into account what may affect the durability and the behaviour of the element and what affects the general appearance of the element.

The general appearance of the concrete sleeper surface finish relates to the manufacturing process: instant demoulding process gives rough concrete surface and late demoulding smooth surface.

The quality level for the rail seat area surface finish is independent of the manufacturing process: instant demoulding or late demoulding.

Cement and aggregates give colour variation according to the source of materials. Surface of the sleeper may be stained due to salt appearance. Such variations have no influence on the behaviour of the sleeper.

Regarding the general appearance, defects which do not affect the durability of the sleeper do not need to be repaired except when required and approved by the purchaser.

The specific requirements can be different according to the area involved.

For example, special surface finish may be specified:

a) for the rail seat area in connection with the rail pad or base plate geometry and stiffness;

b) for the sleeper bottom surface where roughness may be needed;

c) for the sides of the sleeper.

E.3 Surface finish of the rail seat

The surface finish is normally checked by a visual inspection as a quality control procedure during manufacture and if necessary the following objective criteria should be used.

The surface of the rail seats should have a smooth ex-mould finish and be free of significant holes or blemishes except as follows, noting that air holes of less than 5 mm in length should be ignored.

No individual air hole exceeding 5 mm in depth or 20 mm in length is acceptable.

No more than 20 air holes or blemishes greater than 5 mm in length of any size up to and including the above sizes are permitted in each rail seat.

No more than three holes can be greater than 10 mm in length.

Holes exceeding certain dimensions can be filled with an approved repair material if requested by the purchaser.

The above numbers may be increased in proportion to the width for rail seats wider than 160 mm for both sleepers and bearers.

E.4 Surface finish of all other surfaces

All other surfaces exhibit an ex-mould finish except for remedial work areas as described in E.5.

E.5 Detailed procedure for remedial work

Remedial work on a concrete element after demoulding, including spalling of bottom edges and ends, which does not affect the performance of the product should only be carried out if detailed procedures have been included within the description of the manufacturing process, as part of the quality plan and approved by the purchaser.

Annex F
(informative)

Quality control during manufacturing – Routine tests and frequency of testing

F.1General

This annex provides guidelines for the organization of routine tests and proposals for frequency of testing.

This annex applies to mass production of sleepers.

In case of smaller quantity, frequency of testing can be modified.

F.2Data of the sleeper to be checked

Tables F.1, F.2 and F.3 define the most important data of the concrete sleeper to be checked for routine tests.

Table F.1 — Raw materials

Item	Description	Reference of standard
Cement	Certificates from the cement supplier	EN 197–1
Aggregates	Petrographic analysis	EN 12620
Steel	Certificates from steel supplier	EN 10080 (all parts)/FprEN 10138
Fastening system components	Certificates from component suppliers	

Table F.2 — Manufacturing process

Item	Description	Reference of standard
Concrete	Compressive strength at 7 and 28 days Water/cement ratio Compressive strength at prestressing transfer	EN 206
Steel	Position of steel with regard to nominal position	
Curing	Accelerated curing cycle and maximum temperature	Recording of curve in comparison with design curing curve
Prestressing force	Prestressing force applied (direct or indirect according to manufacturing process)	

Table F.3 — Finished product

Item	Description	Reference of standard
Sleeper	Routine static load test at rail seat	EN 13230–2:2016 EN 13230–3:2016 EN 13230–4:2016
Surface finish and general appearance	Visual inspection of the sleeper	Part of quality plan of manufacturer to be approved by purchaser
Fastening system	Routine tests in relation with the fastening system	Part of quality plan of manufacturer to be approved by purchaser
b_1, b_2	Top and bottom width of the concrete element	Part of quality plan of manufacturer to be approved by purchaser
hr	Depth at any position along the total length of the reinforced concrete element measured in accordance with the quality plan	Part of quality plan of manufacturer to be approved by purchaser
hp	Depth at any position along the total length of the prestressed concrete element measured in accordance with the quality plan	Part of quality plan of manufacturer to be approved by purchaser
L_1	Distance between the rail fastening gauge points	Part of quality plan of manufacturer to be approved by purchaser
L	Overall length of sleeper or bearer	Part of quality plan of manufacturer to be approved by purchaser
i	Inclination of the rail seat (see Annex D)	Part of quality plan of manufacturer to be approved by purchaser
f	Planeness of each rail seat area: with regard to 2 points 150 mm apart (monoblock and twin-block sleepers only)	Part of quality plan of manufacturer to be approved by purchaser
T	Relative twist between rail seats (monoblock, twin-block and concrete bearers only) (see Annex D)	Part of quality plan of manufacturer to be approved by purchaser
Mass		Part of quality plan of manufacturer to be approved by purchaser
Vertical deviation of bearer		Part of quality plan of manufacturer to be approved by purchaser

F.3Examples for frequency of testing

Frequency of testing on raw materials and on manufacturing process and the products during manufacturing is the choice of the manufacturer with the agreement of the purchaser.

For the inspection of finished products, several methods can be used such as sampling, etc.

There is a general agreement in Europe for mass production. Geometrical inspection for main items of 1,5 % of finished products gives clear understanding of the product quality. Range can be adjusted from 1 % to 2 %.

Frequency of routine load tests at rail seat is linked to the manufacturing process.

Annex ZA
(informative)

Relationship between this European Standard and the Essential Requirements of EU Directive 2008/57/EC

This European Standard has been prepared under a mandate given to CEN/CENELEC/ETSI by the European Commission and the European Free Trade Association to provide a means of conforming to Essential Requirements of the Directive 2008/57/EC[1)].

Once this standard is cited in the Official Journal of the European Union under that Directive and has been implemented as a national standard in at least one Member State, compliance with the clauses of this standard given in Table ZA.1 for infrastructure confers, within the limits of the scope of this standard, a presumption of conformity with the corresponding Essential Requirements of that Directive and associated EFTA regulations.

[1)] This Directive 2008/57/EC adopted on 17th June 2008 is a recast of the previous Directives 96/48/EC 'Interoperability of the trans-European high-speed rail system' and 2001/16/EC 'Interoperability of the trans-European conventional rail system' and revisions thereof by 2004/50/EC 'Corrigendum to Directive 2004/50/EC of the European Parliament and of the Council of 29 April 2004 amending Council Directive 96/48/EC on the interoperability of the trans-European high-speed rail system and Directive 2001/16/EC of the European Parliament and of the Council on the interoperability of the trans-European conventional rail system'.

Table ZA.1 — Correspondence between this European Standard, the Commission Regulation N° 1299/2014 of 18 November 2014 on the technical specifications for interoperability relating to the 'infrastructure' subsystem of the rail system in the European Union (published in the Official Journal L 356, 12.12.2014, p.1) and Directive 2008/57/EC

Clause(s)/ sub-clause(s) of this European Standard	Chapter/§/annexes of the TSI	Corresponding text, articles/§/annexes of the Directive 2008/57/EC	Comments
The whole standard is applicable	4. Description of the infrastructure subsystem 4.2. Functional and technical specifications of subsystem 4.2.4. Track parameters 4.2.4.1. Nominal track gauge 4.2.4.7. Rail inclination 4.2.6 Track resistance to applied loads 5.Interoperability constituents 5.3.Constituents performances and specifications 5.3.3.Track sleepers 6..Assessment of conformity of interoperability constituents and EC verification of the subsystems 6.1.Interoperability Constituents 6.1.4.EC declaration of conformity for interoperability constituents 6.1.4.4.EC declaration of conformity for track sleepers 6.1.5.Particular assessment procedures for interoperability constituents 6.1.5.2.Assessment of sleepers 6.2.Infrastructure subsystem 6.2.5.Technical solutions giving presumption of conformity at design stage 6.2.5.1. Assessment of track resistance for plain line 6.2.5.2.(1).Assessment for switches and crossing. Appendix C - Technical characteristics of track design and switches and crossings design Appendix D - Conditions of use of track design and switches and crossings design	Annex III, Essential requirements 1 General requirements 1.1 Safety Clauses 1.1.1, 1.1.2, 1.1.3 1.5 Technical compatibility	According 5.2.(3) of the TSI rails, fastenings and sleepers used for switches and crossings are not considered to be interoperability constituents According 5.3.3 of the TSI track sleepers are interoperability constituents. According to Part 1 of the standard, the purchaser has to define the L_1 dimension in order to ensure the required track gauge. Assessment of the sleeper is based on L_1 dimension. According to part 1 of the standard, the purchaser has to define the fastening system interface and geometric lay-out for each bearer in order to ensure the required track gauge.

Warning – Other requirements and other EU Directives may be applicable to the product(s) falling within the scope of this standard.

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[1] EN ISO 9001, *Quality management systems - Requirements (ISO 9001)*

[2] UIC Report 713 R, *Design of monoblock concrete sleepers*, 1st edition, November 2004

[3] EN 197-1, *Cement - Part 1: Composition, specifications and conformity criteria for common cements*

[4] EN ISO 9000, *Quality management systems - Fundamentals and vocabulary (ISO 9000)*

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