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Railway applications — Concrete sleepers and bearers for track —

Part 1: General requirements

Applications ferroviaires — Traverses et supports en béton pour la voie —

Partie 1: Exigences générales

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Foreword

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The procedures used to develop this document and those intended for its further maintenance are described in the ISO/IEC Directives, Part 1. In particular, the different approval criteria needed for the different types of ISO documents should be noted. This document was drafted in accordance with the editorial rules of the ISO/IEC Directives, Part 2 (see www.iso.org/directives).

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This document was prepared by Technical Committee ISO/TC 269, *Railway applications*, Subcommittee SC 1, *Infrastructure*.

This document is used in conjunction with ISO 22480-2.

A list of all parts in the ISO 22480 series can be found on the ISO website.

Any feedback or questions on this document should be directed to the user's national standards body. A complete listing of these bodies can be found at www.iso.org/members.html.

Introduction

This document covers the general requirements for concrete sleepers and bearers.

Concrete sleepers and bearers are safety critical components for railway applications. They are not covered by any other International Standards for structural concrete.

As safety critical components, an agreement is needed between the purchaser and the supplier to perform sleeper design and manufacture as well as to operate a factory quality system.

Railway applications — Concrete sleepers and bearers for track —

Part 1: General requirements

1 Scope

This document 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.

This document defines mechanical tests which provide assurance of the capability of sleepers or bearers to resist repetitive loading and provide sufficient durability. In addition, it places controls 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 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.

ISO 22480-2, *Railway applications — Concrete sleepers and bearers for track — Part 2: Prestressed monoblock sleepers*

ISO 6892-1, *Metallic materials — Tensile testing — Part 1: Method of test at room temperature*

ISO 6506-1, *Metallic materials — Brinell hardness test — Part 1: Test method*

3 Terms and definitions

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

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

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

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

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

3.2
supplier
body responsible for the use of this document in response to the *purchaser's* (3.1) requirement, and for requirements which apply to the *manufacturer* (3.3)

3.3
manufacturer
producer
body producing concrete *sleeper* (3.4) and *bearer* (3.5) products

3.4
sleeper
transverse component of the track which controls the rail gauge, inclination and which transmits loads from the rail to the ballast or other sleeper support

3.5
bearer
transverse component of switches and crossings which controls rail gauge, inclination and 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

3.6
bending moment
internal moment created by external loads applied to the concrete *sleeper* (3.4) or *bearer* (3.5) which produces tension and compression in the element

3.7
positive bending moment
bending moment (3.6) which produces tension or reduces compression at the bottom of a cross-section of a concrete *sleeper* (3.4) or *bearer* (3.5)

3.8
negative bending moment
bending moment (3.6) which produces tension or reduces compression at the top of a cross-section of a concrete *sleeper* (3.4) or *bearer* (3.5)

3.9
rail seat
area on which a running rail rests

3.10
rail seat area
rail seat (3.9) and the immediate area around the fastening system

3.11
twin-block reinforced sleeper
sleeper (3.4) in which two reinforced concrete blocks are connected by a steel connecting bar

3.12
test load
load applied during testing

3.13
bending crack
partial split in concrete due to an external *bending moment* (3.6)

3.14
residual crack
bending crack (3.13) measured during a test after an external *bending moment* (3.6) has been applied and has been removed

3.15
first crack
crack under loading irrespective of width which originates in the tensile face of the concrete *sleeper* (3.4) and *bearer* (3.5) extending to a minimum depth of 15 mm on one side or other of the concrete sleeper and bearer and which increases in width (at the depth of 15 mm) with further application of load

Note 1 to entry: The crack under loading is a *bending crack* (3.13) measured during a test with an external *bending moment* (3.6) applied.

3.16
minimum concrete cover
minimum cover given by the nominal cover reduced by the production tolerance

3.17
design approval test
test on a concrete *sleeper* (3.4) or *bearer* (3.5) or part of a concrete sleeper or bearer to demonstrate compliance with the acceptance criteria

3.18
routine test
test carried out on a concrete *sleeper* (3.4) or *bearer* (3.5), as a part of the manufacturing quality control process

4 Symbols and abbreviated terms

Symbol	Description	Unit
F_{c0}	initial reference load for positive bending test at centre section	kN
F_{c0n}	initial reference load for negative bending test at centre section	kN
F_{cr}	test load which produces first crack formation at the centre section during positive bending test at centre section; load preceding the load for which a crack width measured under load, at 15 mm depth, is equal or higher than 0,02 mm on one of the faces	kN
F_{crn}	test load which produces first crack formation at the centre section during negative bending test at centre section; load preceding the first negative test load for which a crack width measured under load, at 15 mm depth, is equal or higher than 0,02 mm on one of the faces	kN
F_{r0}	initial reference load for positive bending test at rail seat section	kN
$F_{r0,05}$	test load for which a crack width of 0,05 mm at the bottom of rail seat section persists after removal of the load during positive bending test at rail seat; load preceding the test load, for which a residual crack width measured at 15 mm depth, persisting after removal of the load and is equal or higher than 0,06 mm on one of the faces	kN
$F_{r0,5}$	test load for which a crack width of 0,5 mm at the bottom of the rail seat section persists after removal of the load; load preceding the first positive test load, for which a residual crack width measured at 15 mm depth persists after removal of the load and is equal or higher than 0,51 mm on one of the faces	kN
F_{r0n}	initial reference load for negative bending test at rail seat section	kN
F_{rB}	maximum test load which cannot be increased during positive bending test at rail seat section	kN
F_{rr}	test load which produces first crack formation at the rail seat section during positive bending test at rail seat; load preceding the load for which a crack width measured under load, at 15 mm depth, is equal or higher than 0,02 mm on one of the faces	kN
k_{1d}	coefficient used to calculate the acceptance criterion for test load $F_{r0,05}$ in the cyclic test	—
k_{1s}	coefficient used to calculate the acceptance criterion for test load $F_{r0,05}$ in the static test	—

k_{2d}	coefficient used to calculate the acceptance criterion for test loads $F_{r0,5}$ or F_{rB} in the cyclic test	—
k_{2s}	coefficient used to calculate the acceptance criterion for test load F_{rB} in the static test	—
k_3	coefficient used to calculate the acceptance criterion for test load F_{rB} in the fatigue test	—
k_t	coefficient used to calculate the acceptance criteria for test loads F_{rr}, F_{cr} and F_{crn} in static tests, taking into account the age of the sleeper or bearer at the time of testing (see Annex A)	—
M_0	reference test bending moment for design approval tests and routine tests	kNm
$M_{0,c,neg}$	reference test bending moment for the negative bending test at the centre section	kNm
$M_{0,c,pos}$	reference test bending moment for the positive bending test at the centre section	kNm
$M_{0,r,pos}$	reference test bending moment for the positive bending test at the rail seat section	kNm
M_{cr}	bending capacity for first crack formation of the prestressed concrete cross-section, calculated for the age of the sleeper at the time of testing	kNm
$M_{cr,c,neg}$	bending capacity for first crack formation for a negative bending moment at the sleeper centre	kNm
$M_{cr,c,pos}$	bending capacity for first crack formation for a positive bending moment at the sleeper centre	kNm
$M_{cr,r,pos}$	bending capacity for first crack formation for a positive bending moment at the rail seat	kNm
M_k	characteristic bending moment which is the bending moment due to dynamic rail seat load P_k	kNm
$M_{k,c,neg}$	characteristic negative bending moment at centre section which is the negative bending moment at centre section due to dynamic rail seat load P_k	kNm
$M_{k,c,pos}$	characteristic positive bending moment at centre section which is the positive bending moment at centre section due to dynamic rail seat load P_k	kNm
$M_{k,r,neg}$	characteristic negative bending moment at rail seat section which is the negative bending moment at rail seat due to dynamic rail seat load P_k	kNm
$M_{k,r,pos}$	characteristic positive bending moment at rail seat section, which is the positive bending moment at rail seat due to dynamic rail seat load P_k	kNm
P_k	dynamic rail seat load which is the characteristic load on a rail seat of the sleeper for normal service dynamic loading taking into account traffic demand and maintenance conditions	kN
$q_{max,fat}$	coefficient used to calculate the upper test load for the fatigue test	—

5 Determination of test loads

5.1 General

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

5.2 Loads for sleepers and bearers in track

5.2.1 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) lateral loads from guiding forces;

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

As rail traffic loads can vary in a large range, three different load levels shall be taken into account to define technical requirements for sleepers and bearers:

— normal service dynamic loads due to rail traffic under regular maintenance conditions for track and rolling stock;

— exceptional loads can occur repeatedly due to poor quality of rolling stock or track (e.g. impact loads due to large wheel flats, railhead corrugation, frozen ballast in combination with uplift at the sleeper centre);

— accidental loads (e.g. impact load due to derailment) occur once during service life, i.e. the sleepers or bearers are usually replaced after being exposed to accidental loads.

At normal service dynamic and exceptional loads levels on sleepers and bearers, the track shall retain its geometry including gauge, top level and alignment and its durability. Durability is no longer required after accidental load actuation.

5.2.2 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 elastic 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 to the rail. As a result, at normal service dynamic load level, the rail seat load applied to the concrete element is only a proportion of the wheel load.

For impact loads at the exceptional or accidental load level, the effect of load distribution by the rail can be reduced or even negligible.

5.2.3 Characteristic bending moments

The distributed loads generate bending moments in the sleepers and bearers. A characteristic value of bending moments, produced by characteristic dynamic rail seat loads, is used in this document to establish the technical requirements for sleepers and bearers.

The characteristic bending moments for sleepers and bearers shall be determined by the purchaser taking into account static wheel load and wheel load fluctuation, as well as the normal dynamic influence of wheel and track irregularities. This can be done by calculation or measurement in track.

The design of sleepers and bearers shall be based on the characteristic bending moments.

5.3 Test loads

5.3.1 General

Bending tests for concrete sleepers and bearers shall be undertaken for one of the following purposes:

a) method A: verification of bending capacities as predicted by the design calculation;

b) method B: verification of minimum performance requirements for loads in track.

The purchaser shall define the method to be used in order to ensure that the required performance is fulfilled at all load levels.

5.3.2 Method A: verification of bending capacities

Sleepers and bearers shall be tested in order to demonstrate compliance with the product design.

The bending capacities for the first crack formation, M_{cr}, shall be used as reference test bending moments, M_0, for the calculation of test loads and acceptance criteria in accordance with ISO 22480-2. Any relevant regional or national standard may be used to predict the bending capacity for the first crack formation, M_{cr}, of the sleeper or bearer (detailed information is given in Annex B).

The calculation of the bending capacity for the first crack formation shall take into account:

a) material properties;

b) dimensions;

c) prestressing force or reinforcement;

d) age of the sleeper at the moment of testing.

5.3.3 Method B: verification of minimum performance requirements

Sleepers and bearers shall be tested in order to demonstrate compliance with the minimum performance requirements defined by the purchaser. The test loads and acceptance criteria are based on characteristic bending moments, M_k, and additional requirements for exceptional and accidental loads based on measurement in track (detailed information is given in Annex C).

The age of the sleeper or bearer at the moment of testing is taken into account by a coefficient k_t used to determine the acceptance criterion for first crack formation.

Impact coefficients k_1, k_2 and k_3 are used to determine the acceptance criteria for the performance tests at the different load levels.

The characteristic bending moments, M_k, shall be used as reference test bending moments, M_0, for the calculation of test loads and acceptance criteria in accordance with ISO 22480-2.

6 Data to be supplied

6.1 General

The data required for production and testing of sleepers and bearers shall be supplied by the purchaser or the supplier depending on the design process and the test method required by the purchaser.

The purchaser shall define which method shall be used.

6.2 Data to be supplied by the purchaser

The purchaser shall specify at least the following data:

a) relevant regional or national standards to be taken into account;

b) required tests and choice of options for design approval;

c) age of the sleeper or bearer used for design approval and routine tests;

d) in case of method A; bending capacities $M_{cr,r,pos}$, $M_{cr,c,neg}$ and – if required – $M_{cr,c,pos}$;

e) in case of method B; characteristic bending moments $M_{k,r,pos}$, $M_{k,c,neg}$ and – if required – $M_{k,r,neg}$ and $M_{k,c,pos}$;

f) depending on tests required by the purchaser, the coefficients k_t, k_{1s}, k_{2s}, k_{1d}, k_{2d}, k_3 and $q_{max,fat}$;

g) drawings and specifications for:

   1) main dimensions (see Table 1) or detailed sleeper geometry, if specified by the purchaser;

2) if specified by the purchaser: prestressing system (including material strength, number and position of prestressing elements, pressing force, indentation of prestressing wires, if present and anchorage devices, if any);

3) if specified by the purchaser: material characteristics of concrete and additional reinforcement;

4) fastening system interface, rail profile and geometric layout;

5) particular tolerances (if deviating from 8.1.1, see Table 1);

6) if required, conductor rail insulator supports;

h) if required, absolute maximum and minimum weight of the concrete sleeper and bearer (kilograms per sleeper or kg/m);

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

j) if required, storage conditions of sleepers for testing.

6.3 Data to be provided by the supplier

6.3.1 Before the design approval tests

The supplier shall specify the following data:

a) detailed production drawing of the sleeper or bearer including the prestressing system or reinforcement;

b) characteristics of materials;

c) in case of method B: coefficient k_t for each section, to be approved by the purchaser;

d) description of manufacturing process;

e) description of the prestressing system including anchoring system (if any):

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

2) for anchor elements inside the sleeper: characteristics of chemical, dimensional and mechanical tolerances.

6.3.2 After the design approval tests

The supplier shall specify the design approval test report.

6.3.3 Prior to start-up of production

The supplier shall specify:

a) all data required in Clause 10;

b) the production file for manufacturing data as defined in 8.2.2.