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Part 1: General requirements

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Partie 1: Exigences générales

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Foreword

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This document was prepared by Technical Committee ISO/TC 269, *Railway applications*, Subcommittee SC 01, *Infrastructure*.

A list of all parts in the ISO 18379 series can be found on the ISO website.

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Introduction

This document is intended to be used by customers, designers and specifiers of ballastless track systems as well as for reference and development by suppliers and construction contractors.

Railway infrastructure — Ballastless track —

Part 1:
General requirements

1 Scope

This document specifies the general requirements relating to the design of ballastless track systems, including configuration of ballastless track system, subsystems and components requirements, and other related interfaces.

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.

IEC 62128-1:2013, *Railway applications — Fixed installations — Electrical safety, earthing and the return circuit — Part 1: Protective provisions against electric shock*

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
design life
specified period for which a ballastless track system is planned to be used for its intended purpose

3.2
electromagnetic compatibility
EMC
ability of equipment or system to function satisfactorily in its electromagnetic environment without introducing intolerable electromagnetic disturbances to anything in that environment

3.3
floating slab
ballastless track system where a resilient element is introduced between the load-resisting element (typically a slab) and the *substructure* (3.4) which is one kind of mass-spring system

3.4
substructure
earthworks (embankment, cutting or at-grade) or bridges (or similar civil structures) or tunnel floor which provides support to the ballastless track system

3.5
static load
action that does not cause significant acceleration of the structure or structural members

3.6
quasi-static load
dynamic action represented by an equivalent static action in a static model

3.7
dynamic load
action that causes significant acceleration of the structure or structural members

3.8
exceptional load
infrequent load which exceeds the limit for the relevant operational conditions

3.9
filling layer
track component for fixing in position which provides connection and load transfer (full or partial) between subsystems of a ballastless track system

3.10
pavement
layered structure that is designed to provide a durable bearing capacity

3.11
track stiffness
resistance to deformation of the entire track structure in relation to the applied force

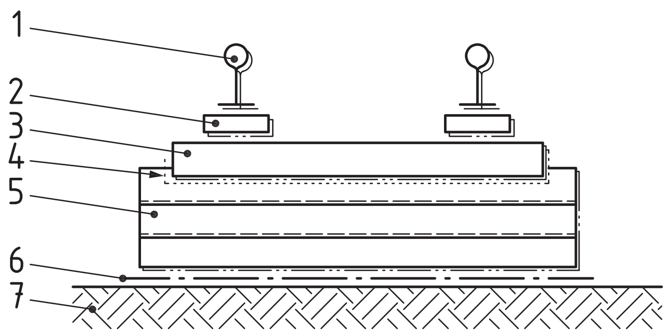
4 Configuration of ballastless track

4.1 General

The configuration of the ballastless track is an important determinant as to how the design can be approached.

4.2 Ballastless track system, subsystems and components

A ballastless track system can consist of (but is not limited to) the following levels of subsystems and exemplary components shown in Figure 1.



Key

1	rail/switch and crossing
2	fastening system/fastening system for embedded rail (e.g. clip, clamp, rail pad, adhesive/embedment material)
3	prefabricated element (e.g. sleeper, block, slab, frame)
4	intermediate layer (e.g. filling layer, boot, resilient element, fixation)
5	pavement (e.g. single-, multi-layered pavement, base layer(s))
6	intermediate layer (e.g. foil, sheeting, compensation layer)
7	substructure

Figure 1 — Ballastless track system — Subsystems and components

Figure 1 shows the structure of ballastless track system according to the subsystem and component levels. The sequence of subsystems in vertical direction as well as the presence or absence of subsystems and components within the ballastless track is up to the individual design. Intermediate layers may be used at different subsystem interfaces (levels).

Examples of system configurations are given in Annex A using the numbering system specified in Figure 1.

5 External actions

5.1 Types of actions

The actions on ballastless track systems are classified in the following types:

— permanent actions, which are mainly due to the self-weight of the components of the ballastless track system and other auxiliary elements (signals, ducts, barriers, etc) which can be eventually placed on or attached to the layers of the system; permanent actions can be determined with the density of the materials or the unit weight of the components;

— variable actions, which can be due to the railway traffic (5.2), indirect actions and conditions imposed by the substructure (5.3), and the environment (5.4).

5.2 Railway traffic loading

5.2.1 General

The main function of the track is to safely guide the vehicle and to distribute the loads through the ballastless track system to the substructure. The ballastless track system shall carry the loads from the railway traffic over the design life within the specified operational and safety limits.

Loads are generated by:

— static or quasi static actions;

— dynamic actions;

— exceptional actions.

Other loads associated with construction, maintenance and emergency access shall be considered as necessary.

The designer shall identify all relevant load models for application, considering the proposed operating speeds and maximum axle loads to be applied. Attention is drawn to the need to determine the worst-case combination of vertical, lateral and longitudinal loads.

NOTE Other vehicles that run during construction, maintenance or during an emergency or at level crossings on the track surface beside the rails are not in the scope of this document.

5.2.2 Vertical loads

5.2.2.1 Load models

Unless otherwise specified, the vertical loads shall be in accordance with relevant regional or national standards. Relevant regional or national standards are listed in Annex F.

Vertical traffic load models consist of one or more loads, in a pattern which can be related to axle spacing of rail vehicles. Different operating conditions can be defined by combinations of the loads with amplification factors applied according to relevant rules, e.g. for design speed. Load models representing real vehicles may be used.

5.2.2.2 Additional vertical loads

Vertical static loads act unequally on the inner and outer rails due to centrifugal effects in curves or non-uniform load distribution. If required, such effects shall be determined on the basis of the applied vehicle model, taking into account track alignment parameters such as cant and cant deficiency.

Additional vertical loads are specified in relevant regional or national standards, see Annex F.

5.2.2.3 Dynamic vertical loads

Dynamic effects produced by vertical loads are dependent on factors including the running speed, the condition of the vehicle and of the track quality. Unless otherwise specified, the dynamic loads shall be in accordance with relevant regional or national standards. For information on vertical loads of specific regions or nations, see Annex B.

The dynamic effects of traffic loads can be determined from dynamic analysis of the ballastless track system with the relevant substructure under operational train loads. Alternatively, dynamic effects can be obtained from a quasi-static analysis with the use of the load model multiplied by a consistent dynamic amplification.

5.2.2.4 Exceptional vertical loads

The impact and frequency of exceptional loads in the design should be assessed.

5.2.3 Lateral loads

Unless otherwise specified, the lateral loads shall be in accordance with relevant regional or national standards.

Lateral loads always act in combination with the corresponding vertical loads, see Annex B.

The following effects shall be considered:

— centrifugal forces (applicable to curves only);

— nosing load to represent vehicle dynamic effects due to irregularities of vehicle running or track irregularities;

— gauge spreading forces (concurrent outward force in the opposite direction to the centrifugal force) from the steering action.

5.2.4 Longitudinal loads

5.2.4.1 Braking and acceleration

Unless otherwise specified, longitudinal loads caused by braking and acceleration shall be considered in combination with the corresponding vertical loads, and be in accordance with relevant regional or national standards. For information on longitudinal loads of specific regions or nations, see Annex B.

5.2.4.2 Eddy current brake (ECB)

Where applicable, effects due to ECB shall be considered. Effects of ECB systems, if used for regular service braking are dependent on the activated brake force and the sequence of trains. Effects activated by emergency braking are significantly higher and should be handled as exceptional loading, according to

5.2.2.4 and 5.2.4.3 for magnetic rail brakes. The effects of ECB systems in terms of operational track loading are:

— a vertical attraction force between the brake and ferromagnetic components of the ballastless track system and track equipment;

  — the maximum vertical attraction force activated by magnets shall be determined and specified from the rolling stock. The attraction force can interfere with movable track components, e.g. in switches and crossings;

  — the vertical attraction forces between the braking system and the continuous welded rail (CWR) are usually not exceeding 40 kN/bogie and per rail due to operational and emergency braking;

— a longitudinal rail force equal to the activated braking force;

— heating of the rails:

  — this effect shall be calculated by increasing the maximum rail temperature. It shall also be considered for the definition of the neutral rail temperature for making of CWR;

  — the decisive rail temperature is equivalent to overall temperature of rail cross-section not surface temperature;

  — the use of ECB can raise temperature of the rails depending on the vertical attraction force activated and the train sequence driven operating ECB on the same track location. An example for additional rail constraint force calculated from rail temperature increase is given in Annex C. It shall also take into account the maximum contribution of ECB to operational deceleration and sequence of trains. An example for the calculation of rail temperature increase by ECB is given in Annex C;

  — alternatively, the maximum allowable rail temperature increase due to eddy current braking shall be specified. This requires a vehicle or track based rail temperature control system for acceptance of ECB as operational braking systems.

5.2.4.3 Exceptional longitudinal loads

Magnetic track brakes are used as emergency braking and also operational braking systems. Only thermal effects and longitudinal loads from emergency braking should be considered as exceptional track loadings for ballastless track systems. As long as the rail temperature increase by emergency braking does not exceed 6 K, the case is covered by the safety margin applied for track design procedures and no further calculation is required.

5.3 Indirect actions and conditions imposed by the substructure

5.3.1 General

This clause specifies the indirect actions and other load conditions or actions imposed by the substructure which affect the performance of the ballastless track system.

5.3.2 Indirect actions

The effect of the following indirect actions shall be considered:

— rheological effects (shrinkage, creep or relaxation) of concrete, cement-based materials and other materials of the ballastless track system and the interaction of those from the substructure;

— prestressing.

5.3.3 Earthworks

5.3.3.1 General

The characteristics and performance of an earthwork on the design of the ballastless track system shall be in accordance with relevant regional or national standards. Relevant regional or national standards are listed in Annex F.

For a ballastless track system, it is necessary to limit permanent deformations (settlement or heave) as well as elastic deformations due to variable loading. The design limits for these parameters shall be determined for the design of the ballastless track system and to define the specification for design and construction of the earthworks.

During construction, appropriate tests should be undertaken to ensure achievement of the designed deformation response to load in the track formation.

5.3.3.2 Stiffness

The stiffness of the substructure shall be defined, in order to design the ballastless track system.

5.3.3.3 Bearing capacity

The limiting stress to be applied by the ballastless track system to the formation should be specified.

5.3.3.4 Residual permanent deformation

A ballastless track system does not normally tolerate significant permanent deformation of the substructure which would adversely affect the design speed or ride quality for railway traffic. Permanent deformation limits, e.g. due to settlement or heave, shall be specified. The effects of these indirect actions on the performance of the ballastless track system shall be evaluated.

5.3.4 Bridges

5.3.4.1 General

The characteristics and performance of a bridge on the design of the ballastless track system shall be in accordance with relevant regional or national standards. Relevant regional or national standards are listed in Annex F.

The maximum allowed deflections and rotations of the bridge deck shall be used as input conditions for the ballastless track system design, with specific consideration of local effects at bridge deck ends.

The ballastless track design shall take into account the stresses produced due to the response of the bridge to the applied loads and actions (i.e. concave deformed shape in the span and convex over the bridge supports).

The ballastless track design on bridges shall consider the impact of use of rail expansion devices (REDs) or turnouts where required by the situation.

5.3.4.2 Long term bridge deformation

The relationship between the bridge deck deformation and the span or length it affects shall be considered. Provisions for long term deformation after installation of the ballastless track shall be included in the track system design.

Long term deformation can be caused by e.g. permanent load, seasonal temperature differences, creep and shrinkage or relaxation of prestressed concrete elements.

The relationship between the bridge span (affected length) and the vertical bridge deck deformation shall be calculated in accordance with the relevant regional or national standards, see Annex F.