SLOVENSKI STANDARD

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Železniške naprave - Zgornji ustroj proge - Kretnice in križišča za Vignolove tirnice - 2. del: Geometrijske zahteve pri načrtovanju

Railway applications - Track - Switches and crossings for Vignole rails - Part 2: Requirements for geometric design

Bahnanwendungen - Oberbau - Weichen und Kreuzungen für Vignolschienen - Teil 2: Anforderungen an den geometrischen Entwurf

Applications ferroviaires - Voie - Appareils de voie - Partie 2: Exigences de la conception géométrique

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ICS:

45.080	Tračnice in železniški deli	Rails and railway components
93.100	Gradnja železnic	Construction of railways

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English Version

Railway applications - Track - Switches and crossings for Vignole rails - Part 2: Requirements for geometric design

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EUROPEAN COMMITTEE FOR STANDARDIZATION
COMITÉ EUROPÉEN DE NORMALISATION
EUROPÄISCHES KOMITEE FÜR NORMUNG

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Contents

Foreword

This document (prEN 13232-2:2014) has been prepared by Technical Committee CEN/TC 256 “Railway applications”, the secretariat of which is held by DIN.

This document is currently submitted to the CEN Enquiry.

This document will supersede EN 13232-2:2003+A1:2011.

This series of standards “*Railway applications – Track – Switches and crossings for Vignole rails*” covers the design and quality of switches and crossings in flat bottomed rail. The list of Parts is as follows:

— *Part 1: Definitions*

— *Part 2: Requirements for geometric design*

— *Part 3: Requirements for wheel/rail interaction*

— *Part 4: Actuation, locking and detection*

— *Part 5: Switches*

— *Part 6: Fixed common and obtuse crossings*

— *Part 7: Crossings with moveable parts*

— *Part 8: Expansion devices*

— *Part 9 : Layouts*

Part 1 contains terminology used throughout all parts of this series. Parts 2 to 4 contain basic design guides and are applicable to all switch and crossing assemblies. Parts 5 to 8 deal with particular types of equipment including their tolerances. These use Parts 1 to 4 as a basis. Part 9 defines the functional and geometric dimensions and tolerances for layout assembly.

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

Customer the Operator or User of the equipment, or the Purchaser of the equipment on the User's behalf.

Supplier the Body responsible for the use of the EN in response to the Customer's requirements.

1 Scope

This part of this European Standard covers the following subjects:

- describe the design process of switches and crossings, and the use of the other parts of this standard;
- geometric design principles for wheel guidance;
- definition of basic limits of supply;
- applied forces and their adequate support;
- tolerance levels.

These are illustrated herein by application to a turnout. The main switch and crossing components are represented in turnouts and the principles used in turnouts apply equally to more complex layouts.

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..

prEN 13232-1:2013, *Railway applications – Track – Switches and crossings for Vignole rails – Part 1: Definitions*

prEN 13232-3:2014, *Railway applications – Track – Switches and crossings for Vignole rails – Part 3: Requirements for wheel/rail interaction*

prEN 13232-5:2014, *Railway applications – Track – Switches and crossings for Vignole rails – Part 5: Switches*

prEN 13232-9:2014, *Railway applications – Track – Switches and crossings for Vignole rails – Part 9: Layouts*

UIC 505-4:2007, *Effects of the application of the kinematic gauges defined in the 505 series of leaflets on the positioning of structures in relation to the tracks and of the tracks in relation to each other*

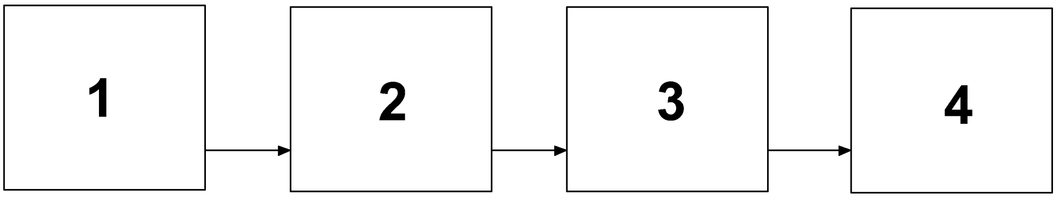
3 General design process

3.1 General process

The design process of switches and crossings is complex due to the many requirements that apply and the different situations that may occur. Figure 1 gives a schematic representation of the general design process. It separates the whole process into 4 main steps:

- step 1 contains the general design of the S&C. It consists of the geometrical design, the design of the wheel-rail interaction and the design requirements for compliance with the actuation, locking and detection system. It permits the definition of the main aspects of the S&C, respecting the main design requirements. Geometric design is defined in this part; other aspects are dealt with in parts 3 and 4;
- step 2 is the main constructional design process, which specifies the main construction of the S&C. It is based on the technology used by the supplier and is not dealt with in detail by any standard. It is mainly based on the suppliers' experience and expertise;
- step 3 consists of the detailed design of the individual components. It is dealt with in different standards. The design of the main components shall respect the requirements laid down in parts 5 to 8. Other components, such as fastenings, bearers, etc, are dealt with in respective EN's;

— step 4 is the product acceptance, which is described in Part 9.



Key

1 Step 1: General design
2 Step 2: Main constructional design
3 Step 3: Detailed component design
4 Step 4: Acceptance

Figure 1 — General design process

3.2 Design step details

a) Every design step requires sufficient **input data** to enable the design to be completed.

b) Input data is dealt with by the supplier through the **design rules**. The rules are defined in EN 13232, Parts 2 to 8.

c) The results of the different design steps are **outputs**.

All these aspects are schematically represented for each design step in Annex A, with a reference to the different parts and clauses where these aspects are dealt with in detail.

3.3 Practical use of the design process

The previous scheme deals with the complete design process of the S&C. The use of the standard is not limited to this case only.

The customer may choose to request the supplier to perform the whole design process and therefore gives all necessary input data to permit the supplier to perform the design.

The customer may also opt to request the supplier to perform only parts of the design process. In this case the customer shall deliver all inputs of the design steps he has requested the supplier to perform. This means that he has to deliver all outputs of the previous design steps.

EXAMPLE 1 The customer may request to perform the detailed design of an S&C layout based on the geometry of an existing design for use on a main railway line. In this case the supplier shall receive from the customer the outputs from geometrical requirements (the geometry plan) as well as the requirements for wheel-rail interaction, specified by the functional and safety dimensions.

Based on this information and the inputs for both conformity for actuation, locking and detection (ALD) and general requirements, he performs the general and detailed component design.

EXAMPLE 2 The customer may request the supplier to fabricate an S&C layout in accordance with an existing design. He therefore shall deliver all detailed plans to the supplier. The supplier only has to do step 4 of the general design process.

4 General Design (step 1)

4.1 Introduction

Geometry is represented in the running plane by the running edges. For the purpose of determination of permissible speeds and for definition of the turnout, curvature is defined by the radius of the track centreline.

The guiding principles of curves are given in this standard as they apply to switches and crossings. Switches and crossings are normally designed without differential cant; particular requirements shall be specified.

In order to maintain safe and continuous support and guidance of wheels, certain rules of tangency are imposed. Speed and radius are then related to lateral acceleration. Cant deficiency is derived from this. Switches and crossings are characterised by changes in lateral acceleration, so rules for both steady and sudden changes between radii are included in this section.

Calculations and rules relate to vehicles with 2 axles or vehicles with 2-axle bogies. Vehicles with other than 2 axles may require special consideration and as such their configuration shall be provided by the Customer.

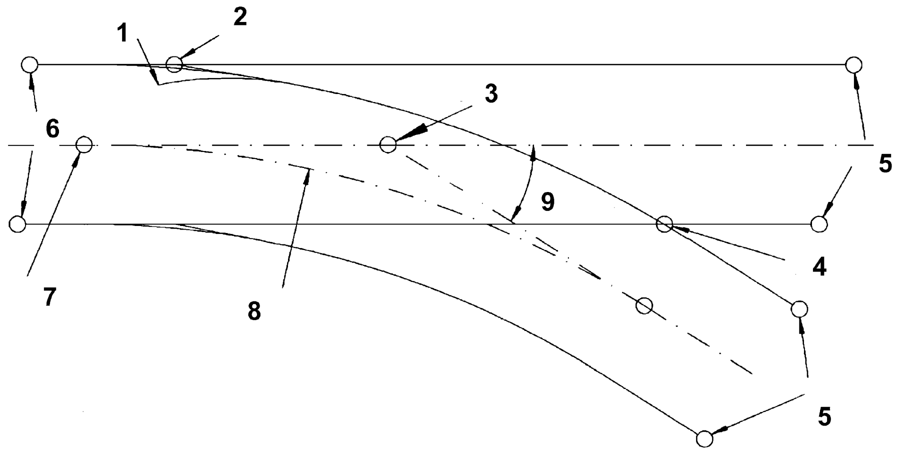
These rules are defined for steady-state design, i.e. without acceleration. Requirements of a dynamic nature shall be stated by the Customer.

4.2 General requirements

4.2.1 References, terms and definitions

For the purposes of this part of the European Standard, the terms and definitions given in prEN 13232-1:2013 and the following apply.

Key reference points relating to turnout geometry and the limits of supply of a turnout are illustrated in Figure 2.



Key

1 Actual switch toe
2 Mathematical point of switch
3 Turnout intersection
4 Theoretical intersection
5 Limits of supply (heel joints)
6 Limits of supply (front joints)
7 Origin of switch curve
8 Centreline radius
9 Turnout angle

Figure 2 — Key reference points

4.2.2 General tangency rules

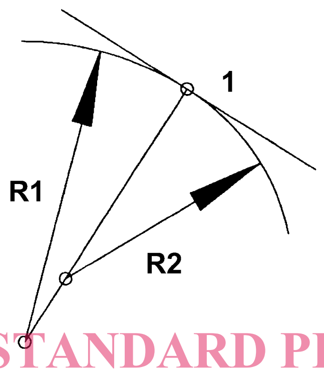
At any change in radius the two radii shall be mutually tangential at the running edges. To achieve this, the centres of adjacent curves shall lie on the same radial line (see Figure 3).

Exceptions to the mutual tangency rule may occur. These are:

— along the low-side curve of a turnout where variation in track gauge occurs;

— at the switch toe, for example, to shorten the switch rail.

Details are given in prEN 13232-3:2014 and prEN 13232-5:2014.



Key

1 Tangent

Figure 3 — Mutual tangency

4.2.3 Inputs

For a concise definition of the geometry of an assembly of switches and crossings, a minimum amount of basic quantitative information is required. The following items are both necessary and sufficient for such a definition of a turnout. Refer also to clause A.1.

The following shall be defined by the Customer and numerical values provided to the Supplier. Note that some values may be different from those for plain line:

— track gauge;

— speed;

— maximum lateral acceleration or cant deficiency;

— maximum rate of change of lateral acceleration or cant deficiency;

— turnout intersection point and angle (see Figure 4);

— limits of supply (front joints, heel joints);

— lowside track gauge variation (if any).

For a crossover or junction, in addition, the following shall be defined by the Customer and provided to the Supplier:

— distance between main line track centrelines.

For switches and crossings on a curved main line, the following must be defined and provided by the Customer:

— main line curvature;

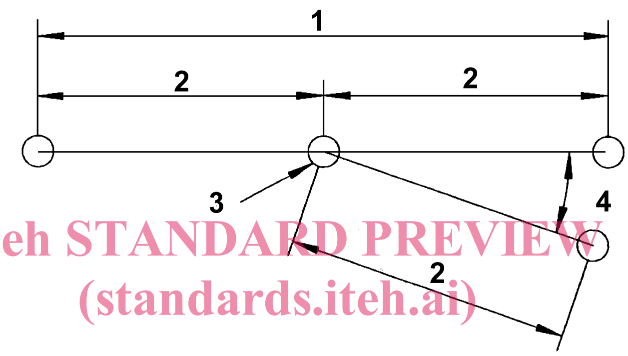
— main line and branch line cant through turnout.

The key points whose location shall be agreed between Customer and Supplier are as follows:

— origin of switch curve;

— real switch toe (RP);

— theoretical intersection (of crossing).



Key

1 Overall length
2 Tangent length
3 Turnout intersection
4 Turnout angle

Figure 4 — Setting out diagram

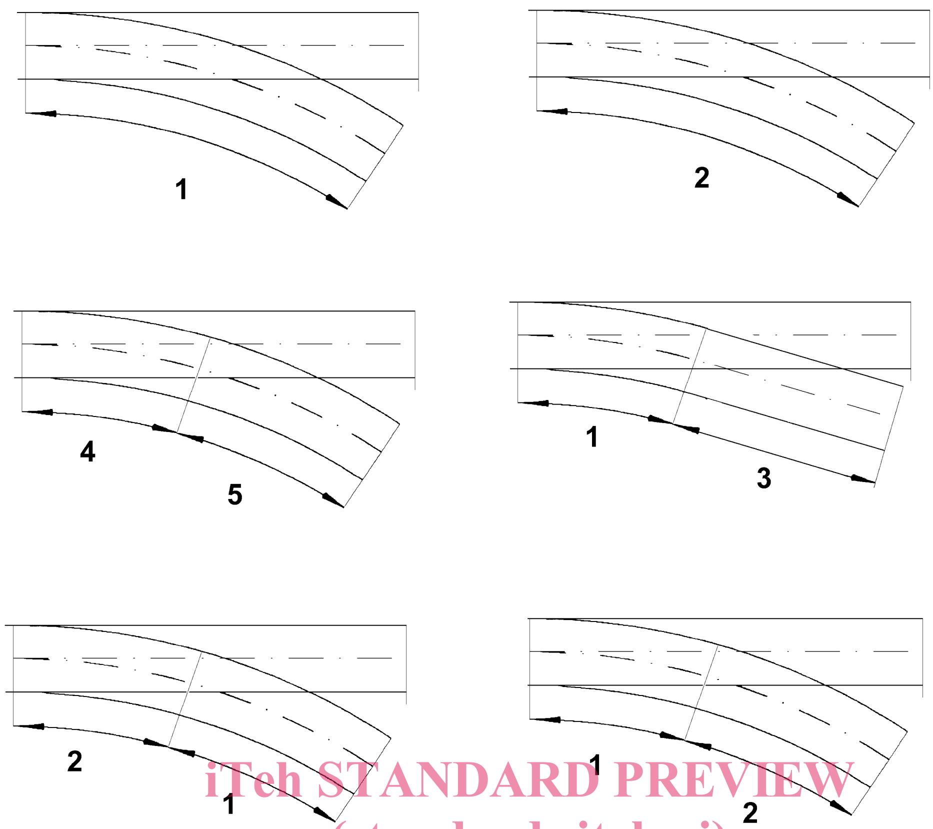
Radii of main and branch lines and the positions at which they change shall be agreed, for example as illustrated in Figure 4, for various types of geometry, together with:

— centreline radii;

— origin of switch curve to positions of changes of radii;

— tangent offset (if any);

where such changes of radii shall be bounded either by included angle, or by longitudinal distance or by lateral offset, or in the case of a transition section, by such data as is necessary to uniquely define its shape.



Key

1 Radius
2 Transition
3 Straight
4 Radius 1
5 Radius 2

Figure 5 — Examples of geometry types

4.3 Design Rules

4.3.1 Speed relationships

Fundamental rules of circular motion determine the relationship between radius and speed around a curve. For railway specific applications the following formula applies:

$$v_{\max} = \sqrt{(a_{\max} R_c)} \quad (1)$$

where:

R_c is the local centreline radius of the curve in metre;

$a_{\max}$ is the maximum lateral acceleration in m/s^2;

$v_{\max}$ is the maximum local velocity in m/s.

Alternatively with $V_{\max}$ in km/h:

$$V_{max} = 3{,}6 \sqrt{(a_{max} R_c)} \quad (2)$$

Often it is convenient to express maximum speed in terms of more physical measures, using the variables cant deficiency and wheel contact gauge. Firstly, wheel contact gauge is expressed conventionally as:

$$s_w = s_t + s_r \quad (3)$$

where:

s_w is the wheel contact gauge, or distance between the two upper wheel/rail contacts, in millimetre;

s_t is the track gauge in millimetre;

s_r is the rail head width in millimetre.

If s_r is not specified then, for standard gauge (1435 mm), s_w takes the value 1500 mm. The speed relationship is then given by:

$$V_{max} = 3{,}6 \sqrt{(h_d\ g\ R_c / s_w)} \quad (4)$$

where:

h_d is the maximum permitted cant deficiency in millimetre;

g is the acceleration due to gravity, normally taken as 9,81 m/s^2.

4.3.2 Effects of changes in curvature

4.3.2.1 Introduction

Most real situations yield a step change in curvature, since a smooth curvature change only occurs in transition curves. The effects of step changes are mitigated by the vehicle's suspension system, but an approximate rule is necessary to enable the switch and crossing supplier to match the vehicle's requirements. In the following the rules for steady transitions are covered first, then the rules for step changes in curvature.

See Figure 5 for examples of alternative arrangements of transitions within turnouts.

4.3.2.2 Change of lateral acceleration

The steady change of curvature is quantified by the rate of change of lateral acceleration. Alternatively it may be termed a rate of change of cant deficiency. This is related to a rate of change of lateral acceleration which is calculated with the following formula:

$$\frac{dh_d}{dt} = \frac{s_w}{g} \cdot \frac{da}{dt} \quad (5)$$

where:

$\frac{dh_d}{dt}$ is the rate of change of cant deficiency in mm/s;

$\frac{da}{dt}$ is the rate of change of lateral acceleration in m/s^3.