

SLOVENSKI STANDARD

SIST EN 13803-2:2007+A1:2010

01-marec-2010

Railway applications - Track - Track alignment design parameters - Track gauges 1 435 mm and wider - Part 2: Switches and crossings and comparable alignment design situations with abrupt changes of curvature

Railway applications - Track - Track alignment design parameters - Track gauges 1 435 mm and wider - Part 2: Switches and crossings and comparable alignment design situations with abrupt changes of curvature

Bahnanwendungen - Oberbau - Linienführung in Gleisen - Spurweiten 1 435 mm und größer - Teil 2: Weichen und Kreuzungen sowie vergleichbare Trassierungselemente mit unvermitteltem Krümmungswechsel

Applications ferroviaires - Voie - Paramètres de conception du tracé de la voie - Écartement 1 435 mm et plus large - Partie 2: Appareils de voie et situations comparables de conception du tracé avec changements brusques de courbure

Ta slovenski standard je istoveten z: **EN 13803-2:2006+A1:2009**

ICS:

45.080	Vlæ } æ^ Å Å^ ^: } æ\ æ^ ä	Rails and railway components
93.100	Gradnja železnic	Construction of railways

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EUROPEAN STANDARD
NORME EUROPÉENNE
EUROPÄISCHE NORM

EN 13803-2:2006+A1

November 2009

ICS 93.100

Supersedes EN 13803-2:2006

English Version

**Railway applications - Track - Track alignment design
parameters - Track gauges 1 435 mm and wider - Part 2:
Switches and crossings and comparable alignment design
situations with abrupt changes of curvature**

Applications ferroviaires - Voie - Paramètres de conception
du tracé de la voie - Écartement 1 435 mm et plus large -
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Spurweiten 1 435 mm und größer - Teil 2: Weichen und
Kreuzungen sowie vergleichbare Trassierungselemente mit
unvermitteltem Krümmungswechsel

This European Standard was approved by CEN on 4 November 2006 and includes Corrigendum 1 issued by CEN on 11 July 2007 and Amendment 1 approved by CEN on 19 October 2009.

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Foreword

This document (EN 13803-2:2006+A1:2009) has been prepared by Technical Committee CEN/TC 256 "Railway applications", the secretariat of which is held by DIN.

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of an identical text or by endorsement, at the latest by May 2010 and conflicting national standards shall be withdrawn at the latest by May 2010.

Attention is drawn to the possibility that some of the elements of this document may be the subject of patent rights. CEN [and/or CENELEC] shall not be held responsible for identifying any or all such patent rights.

This European Standard includes Corrigendum 1 issued by CEN on 11 July 2007 and Amendment 1 approved by CEN on 19 October 2009.

This document supersedes EN 13803-2:2006.

The start and finish of text introduced or altered by amendment is indicated in the text by tags $\boxed{A_1}$ $\boxed{A_1}$.

The modifications of the related CEN Corrigendum have been implemented at the appropriate places in the text and are indicated by the tags \boxed{AC} \boxed{AC} .

$\boxed{A_1}$ This document has been prepared under a mandate given to CEN/CENELEC/ETSI by the European Commission and the European Free Trade Association, and supports essential requirements of EU Directive 2008/57/EC. $\boxed{A_1}$

$\boxed{A_1}$ For relationship with EU Directive 2008/57/EC, see informative Annex ZA, which is an integral part of this document. $\boxed{A_1}$

EN 13803 "Railway applications — Track — Track alignment design parameters — Track gauges \boxed{AC} 1 435 \boxed{AC} mm and wider" consists of the following parts:

- Part 1: Plain line;
- Part 2: Switches and crossings and comparable alignment design situations with abrupt changes of curvature.

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

1 Scope

This European Standard specifies the rules and values for the track alignment design parameters used to determine the maximum operating speeds over tracks with abrupt changes in curvature and, consequently, abrupt changes of cant deficiency. Such conditions occur in the following situations:

- in the diverging tracks in switch and crossing layouts;
- when it is not practical to design an alignment with transition curves;
- if the length of a transition curve is less than the minimum required for plain line track.

Engineering requirements specific to the mechanical behaviour of switch and crossing components and subsystems are to be found in the relevant standards.

This European Standard presupposes that the homologation of the operating vehicles will be valid and specified for conditions corresponding to the limiting values specified in this European Standard.

This European Standard is applicable to abrupt changes in curvature in switch and crossing layouts and plain lines with track gauges of $\boxed{\Delta C}$ 1 435 $\boxed{\Delta C}$ mm and wider. Annex C is applicable to track gauges wider than $\boxed{\Delta C}$ 1 435 $\boxed{\Delta C}$ mm.

This European Standard specifies the requirements for preventing buffer locking.

The limiting values specified in this European Standard, when applied at the switch toe, are for switches with tangential geometry (as defined in EN 13232-1).

This European Standard need not be applicable to certain urban and suburban lines.

This European Standard is not applicable to track alignment requirements for tilting body vehicles. However, Annex H draws the designer's attention to the consequences and the restrictions imposed when tilting vehicles are operated over switch and crossing layouts and alignments without transition curves.

2 Normative references

The following referenced documents are indispensable for the application of this document. For dated references, only the edition cited applies. For undated references, the latest edition of the referenced document (including any amendments) applies.

EN 13232-1:2003, *Railway applications — Track — Switches and crossings — Part 1: Definitions*

EN 13232-9, *Railway applications — Track — Switches and crossings — Part 9: Layouts*

ENV 13803-1:2002, *Railway applications — Track alignment design parameters — Track gauges 1435 mm and wider — Part 1: Plain line*

3 Terms and definitions

For the purposes of this document, the terms and definitions given in EN 13232-1:2003 and ENV 13803-1:2002 and the following apply.

3.1

abrupt change of cant deficiency $\boxed{\Delta C}$

$\Delta I \boxed{\Delta C}$

abrupt change of the cant deficiency and/or cant excess due to an abrupt change in curvature

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3.2

rate of change of cant deficiency at an abrupt change in curvature as function of time $\Delta I / \Delta t$ $\langle AC \rangle$

$\Delta I / \Delta t$ $\langle AC \rangle$

value used in the theoretical model of the principle of the virtual transition calculation (see Annex E). The value of Δt is the time required to travel over the length of the virtual transition at the specified speed

3.3

distance between bogie centres L_b $\langle AC \rangle$

L_b $\langle AC \rangle$

distance between the bogie centres of the characteristic vehicle used to calculate $\Delta I / \Delta t$ $\langle AC \rangle$ (see Annex E). The characteristic vehicle is usually the passenger vehicle with the shortest distance between bogie centres operating over a route

3.4

total length of the intermediate element(s) between two abrupt changes of curvature L_s $\langle AC \rangle$

L_s $\langle AC \rangle$

total length of the straight and/or curved element(s) between two abrupt changes of curvature (see Clause 8)

3.5

parameter of clothoid A $\langle AC \rangle$

A $\langle AC \rangle$

parameter describing the linear change of curvature as function of the length (see 9.2.2.2)

3.6

high speed lines

$\langle A_1 \rangle$ (see Directive 2008/57/EC) $\langle A_1 \rangle$

3.7

conventional lines

$\langle A_1 \rangle$ (see Directive 2008/57/EC) $\langle A_1 \rangle$

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4 Symbols and abbreviations

The symbols and abbreviations specified in ENV 13803-1 are also applicable to this European Standard. Additional symbols and abbreviations are as follows :

Table 1 — Symbols and abbreviations

No.	Symbol	Designation	Unit
101	A	parameter of clothoid	m
102	C	factor for calculation of equilibrium cant	mm·m·h ² /km ²
103	I_i	cant deficiency of the alignment element i ; $i = 1, 2$	mm
104	I_{\max}	maximum value of cant deficiency within the length of the diverging track	mm
105	ΔI $\langle AC \rangle$	abrupt change of the cant deficiency and/or cant excess due to an abrupt change in curvature	mm
106	$\Delta I / \Delta t$ $\langle AC \rangle$	rate of change of cant deficiency at an abrupt change in curvature as function of time	mm/s
107	ΔI_c $\langle AC \rangle$	abrupt change of cant deficiency on the crossing side of a turnout with curves of variable curvature in diverging track	mm
108	ΔI_i $\langle AC \rangle$	abrupt change of the cant deficiency and/or cant excess due to an abrupt change in curvature at tangent point i	mm
109	ΔI_s $\langle AC \rangle$	abrupt change of cant deficiency on the switch side of a turnout with curves of variable curvature in diverging track	mm

No.	Symbol	Designation	Unit
110	L_b	distance between bogie centres of the characteristic vehicle	m
111	L_s	total length of intermediate element(s) between two abrupt changes of curvature	m
112	n	inverse turnout angle	-
113	q_A	factor for calculation of rate of change of cant deficiency	$\text{mm} \cdot \text{m}^2 \cdot \text{h}^3 / (\text{s} \cdot \text{km}^3)$
114	q_S	factor for calculation of minimum length of intermediate element(s) between two abrupt changes of curvature	m·h/km
115	q_V	factor for conversion of the units for vehicle speed	$\text{km} \cdot \text{s} / (\text{h} \cdot \text{m})$
116	R_0	radius of the diverging track of the switch and crossing unit in the version for straight track	m
117	R_i	radius of the alignment element i within one track; $i = 1, 2$	m
118	R_{id}	equivalent radius for reverse curves (see 8.4)	m
119	R_j	radius of track j within one switch and crossing unit; $j = \text{I, II}$	m
120	R_s	effective radius at a toe of a non-tangential switch	m
121	t_i	tangent length i	m
122	v	versine	m

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5 General requirements

The track alignment designer is free to specify the most appropriate values for the various parameters at the specified operating speeds, when considering safety, geographical, engineering, historical, and economic constraints. These values and parameters shall be specified in the contract documents.

The designer shall endeavour not to exceed the AC recommended values AC specified in this European Standard and avoid unnecessary use of the maximum (or minimum) limiting values. Annex G describes the constraints and risks associated with the use of maximum (or minimum) limiting values.

Whenever necessary, the track alignment designer shall take into account national standards when these are more restrictive.

The most important requirements for the installation of switch and crossing layouts are specified in Annex B. These requirements have an influence on the design of the alignment elements for both tracks in switch and crossing layouts and, consequently, they influence the maximum operating speeds and life cycle costs. The designer should, as far as it is practicable, comply with these requirements.

Existing installations, which do not conform to this European Standard, should be modified as soon as possible if safety requirements (for example abrupt change of cant deficiency, length of element(s) between abrupt changes of curvature and the safety related parameters listed in ENV 13803-1) are compromised. Other non-conforming installations should, if possible, be modified during the next track renewal.

The railway authority or the manufacturer shall specify the limits (e.g. requirement for the switch entry angle) for non-tangential switches (see also EN 13232-9). Annex F describes a method for calculating the maximum permissible speed at the toe of a non-tangential switch.

6 Principles for the assessment of abrupt changes of cant deficiency at abrupt changes in curvature

6.1 General

The main principle described in 6.2 is based on in-service experiences in terms of safety and passenger comfort.

Some European railway authorities use the principle of the virtual transition described in Annex E (informative).

There are in current use various types of turnouts that have curves of variable curvature combined with circular curves or straights in the diverging track. The different geometrical layouts used in these types of turnout are described in 9.2.2. The curves of variable curvature used in these turnouts are normally of the Clothoid form.

Annex D describes a theoretical calculation method that can be used to compare the effects of a succession of different alignment elements with vehicles of different characteristics.

6.2 Principle based on limiting values of abrupt change of cant deficiency (ΔI_{AC})

This principle is based on limiting the abrupt change in cant deficiency between an abutting curve and straight, or between the abutting arcs of a compound or reverse curve. The relationship between cant deficiency, speed, radius, and cant is expressed by the equation:

$$I_i = C \cdot \frac{V^2}{R_i} - D_i \quad [\text{mm}]$$

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where

$$C = 11,8 \text{ mm} \cdot \text{m} \cdot \text{h}^2 / \text{km}^2 \text{ and } I = 1,2$$

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For curves with cant excess, the equation $I = -E$ shall be used.

Between two abutting curves (i.e. two arcs without an intermediate element) the abrupt change in cant deficiency is $\Delta I_{AC} = |I_2 \pm I_1|$. For a reverse curve it is $\Delta I_{AC} = |I_2 + I_1|$ and for a compound curve it is $\Delta I_{AC} = |I_2 - I_1|$. The limiting values are specified in 7.1.

The limiting lengths of intermediate element(s) between two abrupt changes of curvature are specified in 8.2. The value of abrupt change in cant deficiency to be taken into account when there is no intermediate element between curves, or the intermediate element is of substandard length, is specified in 8.3.2.

7 Circular curves without transition curves

7.1 Limiting values based on the principle of abrupt change of cant deficiency (ΔI_{lim})

7.1.1 General

This principle of abrupt change of cant deficiency is described in 6.2.

The maximum permissible speed over an abrupt change in curvature between a curve without cant and a straight shall be based on the limiting values for abrupt change of cant deficiency (ΔI_{lim}) specified in 7.1.2 and 7.1.3.

$$\Delta I = C \cdot \frac{V^2}{R} \leq \Delta I_{lim} \quad [\text{mm}]$$

where

$$C = 11,8 \text{ mm} \cdot \text{m} \cdot \text{h}^2 / \text{km}^2$$

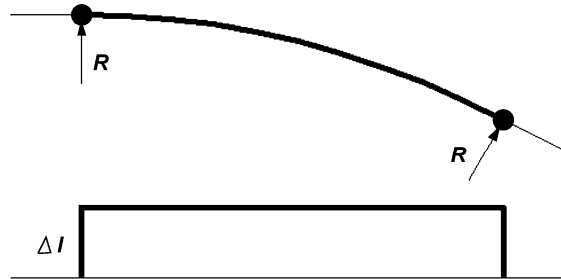


Figure 1 — Combination of circular curve and straight without cant

NOTE When designs are based on the principle of limiting values for abrupt change of cant deficiency (ΔI_{lim}), in accordance with 6.2, it is not necessary to conform to the limiting values for the rate of change of abrupt change of cant deficiency ($\Delta I / \Delta t$), specified for the principle of the virtual transition as described in the informative Annex E.

7.1.2 Switch and crossing layouts

The limiting values for an abrupt change of cant deficiency in the tracks of a switch and crossing layout shall be as specified in Table 2.

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Table 1a — Limiting values of abrupt change of cant deficiency (ΔI_{lim}) – High-speed lines

Speed V [km/h]	$V \leq 70$	$70 < V \leq 170$	$170 < V \leq 230$
Recommended values ΔI_{lim} [mm]	100	80	60
Maximum limiting values ΔI_{lim} [mm]	120	105	85

Table 2b — Limiting values of abrupt change of cant deficiency (ΔI_{lim}) – Conventional lines

Speed V [km/h]	$V \leq 100$	$100 < V \leq 170$	$170 < V \leq 220$	$220 < V \leq 230$
Recommended values ΔI_{lim} [mm]	100	$133 - 0,33 V$		60
Maximum limiting values ΔI_{lim} [mm]	120	$141 - 0,21 V$	$161 - 0,33 V$	

NOTE A tolerance of 10 mm on the maximum limiting values is permitted for existing turnouts laid on lines to be upgraded for high-speed.

- plain tracks with a small deviation in direction or distance between track centre lines.

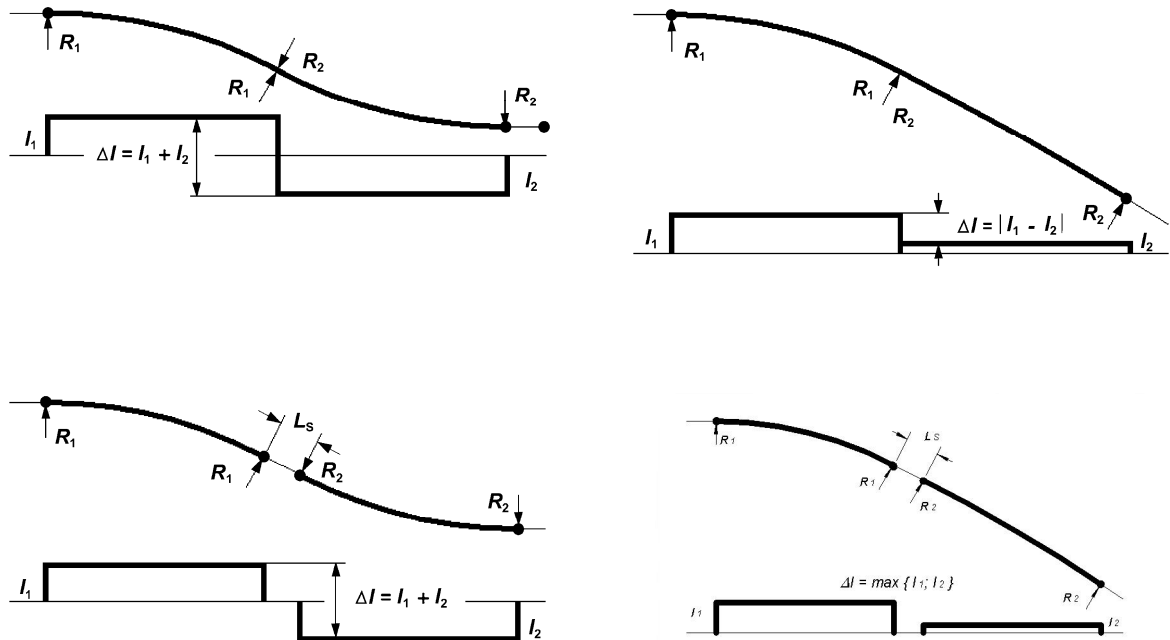


Figure 2 — Combinations of alignment elements
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Clause 8 specifies:

- the limiting length of the intermediate element(s) between two abrupt changes of curvature (L_{slim});
- the abrupt change of cant deficiency ($\Delta/\langle AC \rangle$) applicable for the each combination of alignment elements;
- the requirements for preventing buffer locking.

8.2 Limiting length of intermediate element(s) between two abrupt changes of curvature (L_{slim})

A tangent point with an abrupt change of curvature generates disturbed vehicle dynamics. Therefore, there should be a minimum length to the next tangent point with an abrupt change of curvature.

The limiting length of intermediate element(s) between two abrupt changes of curvature is defined as:

$$L_{\text{slim}} = q_{\text{slim}} \cdot \langle AC \rangle \cdot V \cdot \langle AC \rangle \quad [\text{m}]$$

where

q_{slim} is a factor $\langle AC \rangle$ [m·h/km] $\langle AC \rangle$ defined in Table 4

$\langle AC \rangle \cdot V \cdot \langle AC \rangle$ is the maximum train speed $\langle AC \rangle$ [km/h] $\langle AC \rangle$