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SWEDISH STANDARDS INSTITUTE

Järnvägar – Metod för bestämning av ekvivalent konicitet

Railway applications – Method for determining the equivalent conicity

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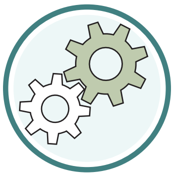

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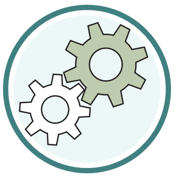

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Denna standard ersätter SS-EN 15302:2008, utgåva 1.

The European Standard EN 15302:2008+A1:2010 has the status of a Swedish Standard. This document contains the official version of EN 15302:2008+A1:2010.

This standard supersedes the Swedish Standard SS-EN 15302:2008, edition 1.

Upplysningar om sakinnehållet i standarden lämnas av SIS, Swedish Standards Institute, telefon 08-555 520 00. Standarder kan beställas hos SIS Förlag AB som även lämnar allmänna upplysningar om svensk och utländsk standard.

Information about the content of the standard is available from the Swedish Standards Institute (SIS), telephone +46 8 555 520 00. Standards may be ordered from SIS Förlag AB, who can also provide general information about Swedish and foreign standards.

Denna standard är framtagen av kommittén för Järnvägar, SIS/TK 254.

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EUROPEAN STANDARD

NORME EUROPÉENNE

EUROPÄISCHE NORM

EN 15302:2008+A1

November 2010

ICS 17.040.20; 45.060.01

Supersedes EN 15302:2008

English Version

Railway applications - Method for determining the equivalent conicity

Applications ferroviaires - Méthode de détermination de la conicité équivalente

Bahnanwendungen - Verfahren zur Bestimmung der äquivalenten Konizität

This European Standard was approved by CEN on 7 February 2008 and includes Amendment 1 approved by CEN on 28 September 2010.

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Ref. No. EN 15302:2008+A1:2010: E

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Foreword

This document (EN 15302:2008+A1:2010) 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 2011, and conflicting national standards shall be withdrawn at the latest by May 2011.

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 document includes Amendment 1, approved by CEN on 2010-09-28.

This document supersedes EN 15302:2008.

The start and finish of text introduced or altered by amendment is indicated in the text by tags A1 A1.

A1 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.

For relationship with EU Directive 2008/57/EC, see informative Annex ZA, which is an integral part of this document. A1

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, Croatia, 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.

Introduction

This European Standard is based on the UIC Code 519 OR submitted to CEN by the International Union of Railways (UIC) and which has been revised by CEN/TC 256/WG 10 "Vehicle/Track Interaction".

The contact geometry is fundamental to explain the dynamic running behaviour of a railway vehicle. Among the parameters by which the dynamic behaviour of a rail vehicle is characterised, the conicity plays an essential role since it allows the satisfactory appreciation of the wheel-rail contact on tangent track and on very large-radius curves (when operated with low cant deficiencies). A wheelset with conical profiles describes a waveform while running on a track. Klingel's theory states that the wavelength depends on the cone angle of the wheel profile and the distance between contact patches.

For practical wheel profiles with changing cone angles along the profile it is possible to evaluate the wavelength of the wheelsets movement by integration of the function of rolling radius difference depending on the lateral movement of the wheelset on the track. Equivalent conicity is evaluated by comparison of this wavelength with the one evaluated according to Klingel's theory.

It is necessary to have a clear procedure for the evaluation of equivalent conicity, which is used in European and national standards and documents (legal and technical).

The results need to be consistent. However it is possible to use different evaluation procedures to those given in this European Standard, provided that the procedure used leads to the determination of an equivalent conicity in accordance with the calculation results using reference profiles specified in Annex E.

To confirm whether an alternative evaluation procedure can achieve the results specified in this European Standard, three aspects of the process need to be evaluated in a benchmark process given in this European Standard and outlined below in Steps 1, 2 and 3:

In Step 1, tables of reference profiles in Annex D are applied to the interpolation and calculation algorithm which allows the location of the contact points in order to calculate the rolling radius difference as a function of the lateral position of the wheelset. Starting from this function the equivalent conicity is calculated as a function of the amplitude of the oscillation. A comparison of the achieved results with the reference results in Annex E and a defined field of allowed tolerances in Annex F determine the acceptance or rejection of the assessed evaluation procedure (see Figure 1).

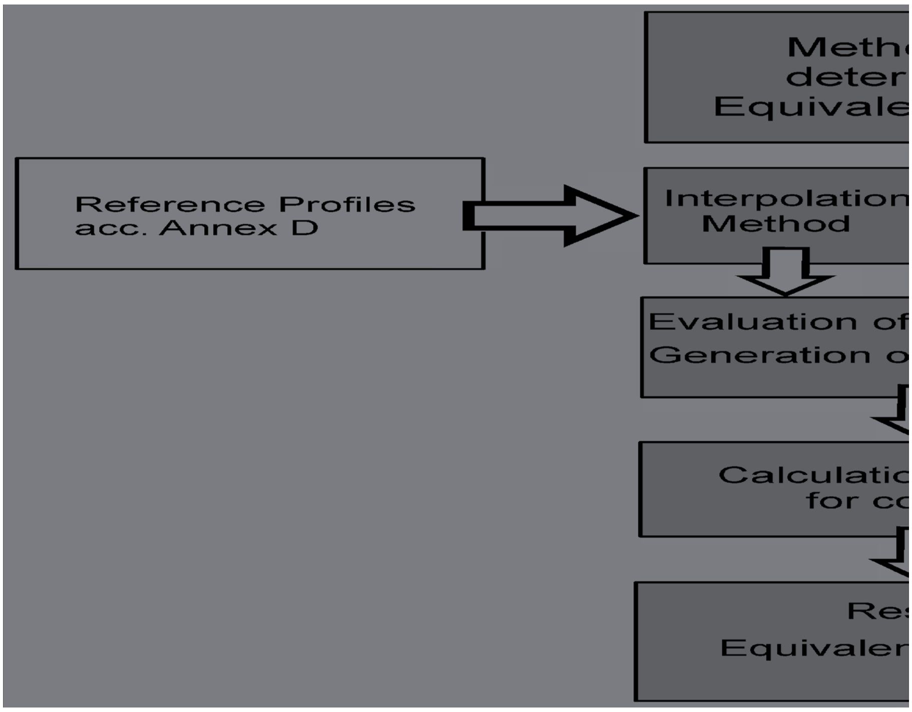

Figure 1 — Benchmark process, Step 1

In Step 2, random errors given in Annex G are added to the reference profiles in Annex D and are applied to the smoothing and interpolation algorithm. A comparison of the achieved results with the reference results including the field of tolerances in Annex F allows the assessment of the evaluation procedure (see Figure 2).

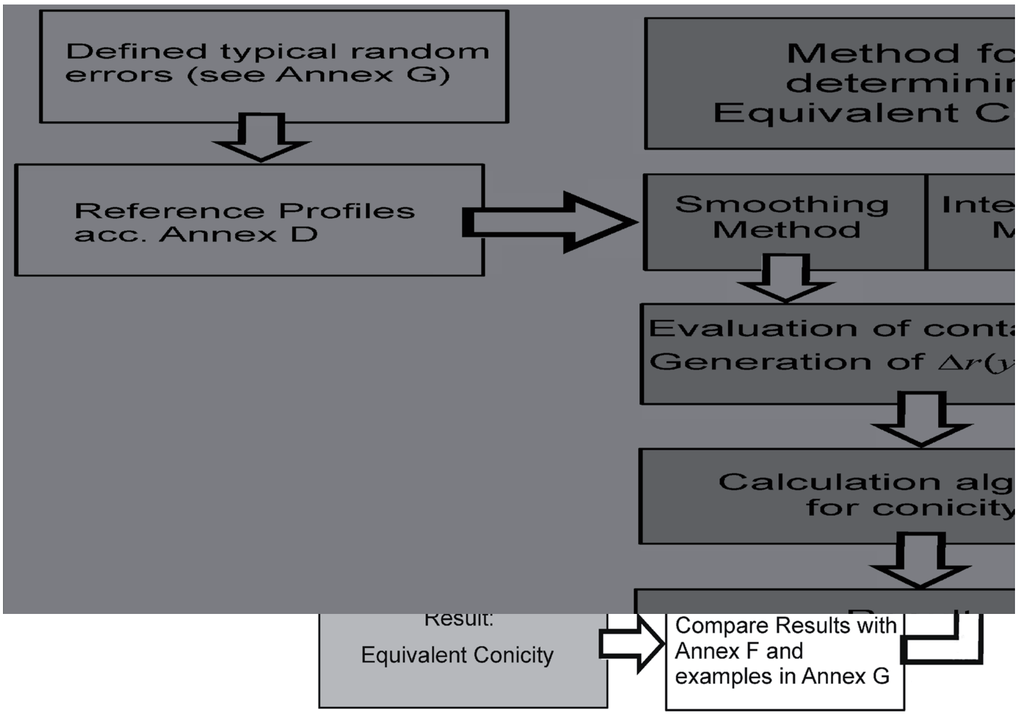

Figure 2 — Benchmark process, Step 2

In Step 3, the tolerances of the measuring system used are compared with the random errors applied in Step 2 in order to assess their influence on the results.

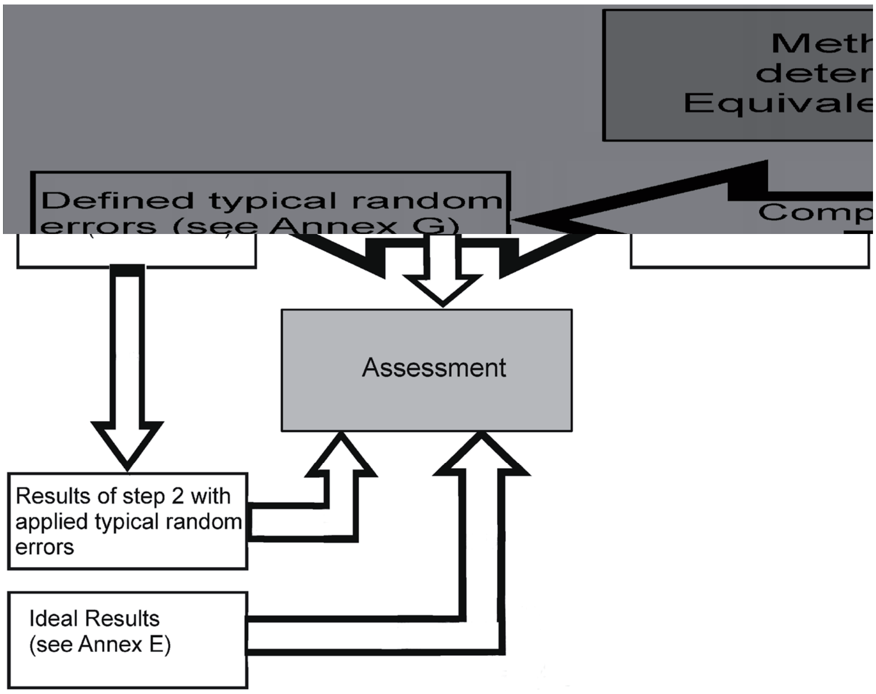

Figure 3 — Benchmark process, Step 3

1 Scope

This European Standard establishes an evaluation procedure for determining equivalent conicity. A benchmark calculation is specified to achieve comparable results on a consistent basis for the equivalent conicity, which may be calculated by different methods not given in this European Standard. This European Standard also proposes possible calculation methods. Informative examples of the use of the Klingel formula (see Annex B) and linear regression of the Δr-function (see Annex C) are included in this European Standard.

This European Standard includes reference profiles, profile combinations, tolerances and reference results with tolerance limits, which allow the user to assess the acceptability of a measuring and calculation system including random- and grid- errors of the measuring system. It sets down the principles of calculation that need to be followed but does not impose any particular numerical calculation method.

This European Standard does not define limits for the equivalent conicity and gives no tolerances for the rail profile and the wheel profile to achieve acceptable results for the conicity.

For purposes outside the scope of this European Standard (e.g. simulation of vehicle behaviour) it can be useful or necessary to use more sophisticated theories. These methods are not within the scope of this European Standard.

For the application of this European Standard some general recommendations are given in Annex I.

2 Normative references

The following referenced document is 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.

N/A

3 Symbols

For the purposes of this document, the following symbols apply.

x displacement of the wheelset in the longitudinal direction of the track

y displacement of the wheelset in the lateral direction of the track

Ψ angle of the movement in the x-y-plane

e nominal contact patches distance (approximately 1 500 mm for standard gauge)

λ wave length

r_0 radius of the wheels when the wheelset is centred on the track

r_1 rolling-radius of the right-hand wheel

r_2 rolling-radius of the left-hand wheel

r mean rolling-radius of both wheels

Δr difference of the rolling-radius between right-hand and left-hand wheels

R local radius of the wheel path

ds curve length of the path corresponding to the angle $d\Psi$

$\tan\gamma_e$ equivalent conicity

$\tan\gamma_a$ inclination of the wheel and rail profiles in the contact point

$\hat{y}$ amplitude of the wave

y_{em} y-displacement where Δr = 0

y_{emin}, y_{emax} minimum and maximum values of y-displacements

V speed of forward movement of the vehicle

γ angle of the tangent to the point of contact between wheel and rail

4 Principle of determining the equivalent conicity

4.1 Integration of the equation of the wheelset movement of a conical profile

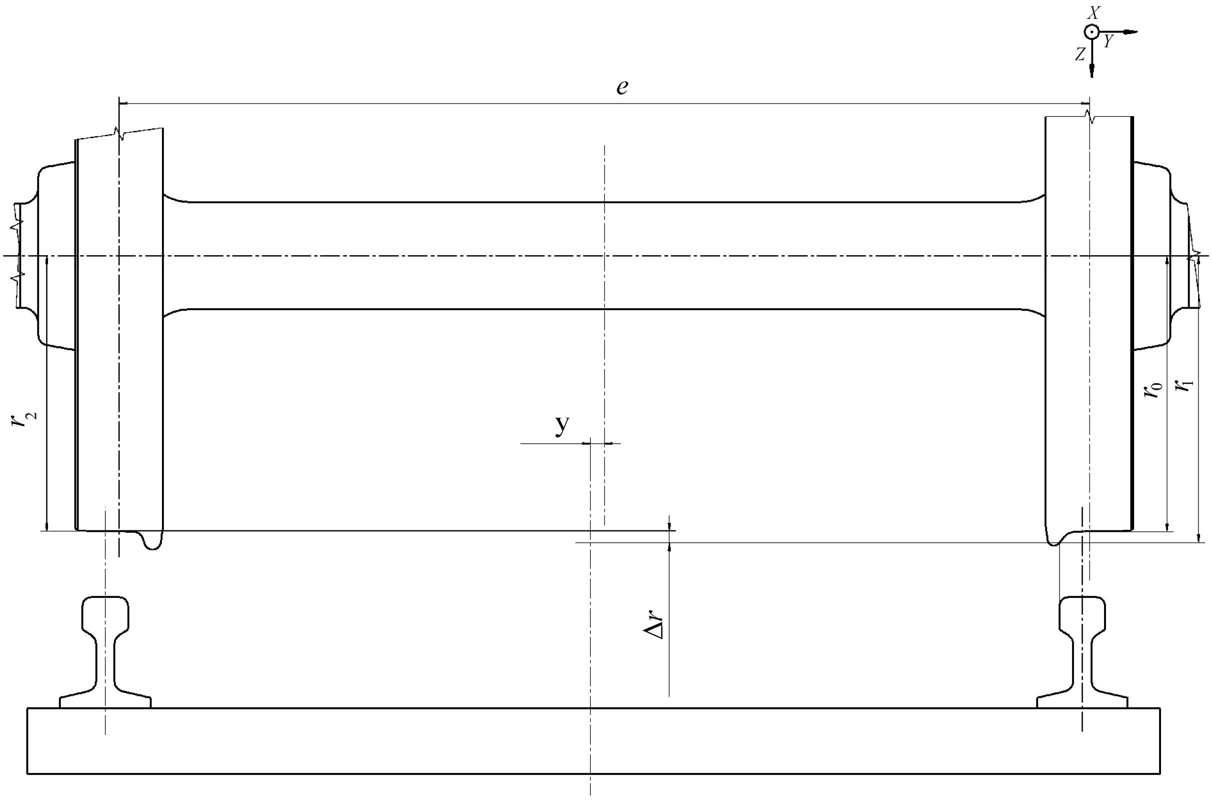

Figure 4 — Dimensions on the wheelset

The kinematic lateral movement of a free wheelset, with no inertia, running on a track, is defined by the following differential equation:

$$\ddot{y} + \frac{V^2}{er_0}\Delta r = 0 \tag{1}$$

Without limiting the conclusions concerning the calculation of the equivalent conicity, the speed of forward movement V of the vehicle can be assumed to be constant for the purposes of this European Standard, such that:

$$V = \frac{dx}{dt} \tag{2}$$

$$\text{hence } \frac{dy}{dt} = V\frac{dy}{dx} \text{ and } \frac{d^2y}{dt^2} = V^2\frac{d^2y}{dx^2} \tag{3}$$

The differential equation becomes:

$$\frac{d^2y}{dx^2} + \frac{\Delta r}{er_0} = 0 \tag{4}$$