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Ģelezniģke naprave - Kolesne dvojice in podstavni voziļ ki - Monoblok kolesa - Postopek za tehniļ no odobritev - 1. del: Kovana in valjana kolesa

Railway applications - Wheelsets and bogies - Monobloc wheels - Technical approval procedure - Part 1: Forged and rolled wheels

Bahnanwendungen - Radsätze und Drehgestelle - Vollräder - Technische Zulassungsverfahren - Teil 1: Geschmiedete und gewalzte Räder

Applications ferroviaires - Essieux montés et bogies - Roues monobloc - Procédure d'homologation technique - Partie 1: Roues forgées et laminées

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45.040	Materiali in deli za železniško tehniko	Materials and components for railway engineering

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English Version

Railway applications - Wheelsets and bogies - Monobloc wheels - Technical approval procedure - Part 1: Forged and rolled wheels

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This European Standard was approved by CEN on 3 November 2003 and includes Amendment 1 approved by CEN on 24 February 2009.

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

Management Centre: Avenue Marnix 17, B-1000 Brussels

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Foreword

This document (EN 13979-1:2003+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of an identical text or by endorsement, at the latest by October 2009, and conflicting national standards shall be withdrawn at the latest by October 2009.

This document includes Amendment 1, approved by CEN on 2009-02-24.

This document supersedes EN 13979-1:2003.

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

Annexes A and B are normative.

[A1] Annexes C, D, E and F are informative. [A1]

This document contains a bibliography.

This European Standard is part of a series of two EN 13979 standards, Part 2 of which is:

[A1] Part 2: Cast wheels. [A1]

[A1] For relationship with EU Directives, 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, 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

To date, UIC regulations specified that for a wheel to be used in Europe:

— its design had to be standardized;

— it had to conform to the quality requirements of UIC leaflet 812-3.

In order to be able to adapt to new railway working conditions, on the one hand, and to facilitate the introduction of new technical solutions, on the other, it has been necessary to replace the concept of standardization with the definition of specifications that a wheel design shall meet to be accepted on a European network.

The standard covers these specifications and describes precisely how to assess the wheel design.

To be able to apply these specifications, it is essential to define the use of the wheel; this standard also states how to define this use.

At least four aspects are described with different purposes:

— a geometrical aspect: to allow interchangeability of different solutions for the same application;

— a thermomechanical aspect: to manage wheel deformations and to ensure that braking will not cause wheels to break;

— a mechanical aspect: to ensure that no fatigue cracks occur in the web;

— an acoustical aspect: to ensure that the solution chosen is as good as the reference wheel, for the use in question.

For each of these three latter aspects, the rules proposed tend to limit the procedure, the easier the objectives are to attain by the wheel under study.

This standard does not cover assessment of the hub nor of the static mechanical dimensioning of the wheel.

1 Scope

The aim of this European Standard is to define the requirements that a monobloc wheel of a freight of passenger railway vehicle non-powered axle shall meet in order to be able to be used on a European network.

For wheels of powered axles or wheels with noise dampers, the requirements may be amended or supplemented.

For light vehicles and tramways, other standards or documents accepted by the customer and supplier may be used.

This European Standard only applies to wheels of new design.

These requirements are intended to assess the validity of the design choice for the proposed use.

The assessment of these requirements is the technical approval procedure.

This European Standard is applicable to forged and rolled wheels for which the quality requirements are defined in [A1] EN 13262 [A1].

2 Normative references

[A1] 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. [A1]

EN 12668-3, *Non-destructive testing – Characterization and verification of ultrasonic examination equipment – Part 3: Combined equipment*

EN 13103, *Railway applications – Wheelsets and bogies – Non-powered axles – Design* [A1] *guide* [A1]

[A1] EN 13262 [A1], *Railway applications – Wheelsets and bogies – Wheels – Product requirements*

3 Parameters for the definition of the application covered

The application for which the wheel is to be approved shall be defined by the following parameters.

If the application parameters are changed for an approved wheel, the customer and supplier shall review the assessments.

3.1 Parameters for geometrical interchangeability

The application shall be defined by geometrical interchangeabliity parameters divided into three categories according to whether they are linked to functional, assembly or maintenance requirements.

3.1.1 Functional requirements

— the nominal tread diameter that influences the buffer height and the loading gauge;

— the maximum rim width linked to the points and crossing and the track brakes;

— the tread profile outside the conical part of the tread;

— the position of the rim internal surface relative to the corresponding surface of the hub;

— the conicity of the hub bore;

— the space required for disc brakes mounted on the wheel;

— the space needed on the bogie frame, braking equipment and suspension equipment.

3.1.2 Assembly requirements

— the bore diameter;

— the hub length to ensure overhanging of the hub on the wheelseat.

3.1.3 Maintenance requirements

— the wear limit diameter or the last reprofiling diameter;

— the wear groove shape;

— the geometry of the area for wheel clamping on reprofiling machines;

— the position and shape of the hole and groove for displacement under oil pressure;

— the general rim shape to allow ultrasonic measurement of residual stresses in wheels braked by shoes.

3.2 Parameters for thermomechanical assessment

The application shall be defined by:

— the maximum braking energy created by the friction of the brake shoes on the rail surface. This energy may be defined by a power P_a, a time t_a and a train speed V_a during drag braking. If it is defined by other parameters (for braking to a stop, for example), these parameters are defined by agreement between the customer and the supplier;

— the type of brake shoes applied to the wheel (nature, dimensions and number).

〈A1〉 NOTE For interoperable freight rolling stock, the thermomechanical behavior does not need to be verified when braking to a stop, but only drag braking, because of the lower energy in stop braking. 〈A1〉

3.3 Parameters for mechanical assessment

The application shall be defined by:

— the maximum vertical static force per wheelset;

— the type of service to be provided by the vehicles that will be fitted with the wheels to be approved:

  — description of the lines: geometric quality of the tracks, curve parameters, maximum speeds ... ;

  — running times on these lines;

— the calculated service life of the wheel, in kilometres.

3.4 Parameters for acoustic assessment

The application shall be defined by all the parameters influencing the noise emitted by the wheel and not directly involved in the design of the wheel to be approved, such as:

— the reference track on which the wheel is to run;

— the reference wheel to which the design will be compared;

— the reference rolling stock and one or more reference speeds;

— one or two surface roughness spectra representative of the range of operational values of the wheel under test.

4 Description of the wheel to be approved

The designer of the wheel to be approved shall supply documentation comprising:

— the description of the fabrication process (forging, rolling, heat treatment,…);

— the definition of the wheel geometry (drawing);

— the following fabrication parameters, if they differ from those defined in ▌A1⟩ EN 13262 ⟨A1▌:

  — geometrical tolerances;

  — surface finishes;

  — steel grade;

— the parameters for defining the application for which the approval is requested.

At the end of this technical approval procedure and before being put into service, a wheel shall be subjected to the product qualification procedure defined in ▌A1⟩ EN 13262 ⟨A1▌.

5 Assessment of the geometrical interchangeability

The wheel design shall conform to the requirements of 3.1.

6 Assessment of the thermomechanical behaviour

6.1 General procedure

This assessment may comprise three stages. The transition from one stage to the next depends on the results obtained.

The flowchart for this assessment is shown in normative annexe A.

For each of the three stages, the test shall be carried out on a new rim (nominal tread diameter) and a worn rim (wear limit tread diameter).

In each case, new rim and worn rim, the web geometry of the tested wheels shall be the least favourable for thermomechanical behaviour within the geometrical tolerance ranges. The wheel designer shall prove, by numerical simulation, that the tested wheels give the worst results. If that is not the case, the numerical simulation shall allow the results that would be obtained on wheels not in the most unfavourable geometrical conditions to be corrected.

〈A1〉 Required values of P_a for European interoperability are given in informative Annex F. 〈A1〉

In order to allow measurement of residual stress, the wheels to be tested shall not have either a wear limit groove or a bevel.

NOTE For the moment, the calculation codes and thermomechanical parameters are too imprecise and not well known enough to be used as assessment parameters in a standard. In future, if this situation develops, a thermomechanical calculation should be made as the first stage of the assessment.

6.2 First stage – Braking bench test

6.2.1 Test procedure

The test method and the measurements to be made are given in normative annex A.

The power to be applied during this test shall be equal to 1,2 P_a (P_a is defined in 3.2). The duration of each drag braking period and the train speed are those defined in 3.2 (t_a and V_a).

6.2.2 Decision criteria

Three criteria shall be met simultaneously for the wheel with the new rim and the wheel with the worn rim.

Wheel with new rim:

— maximum lateral displacement of the rim during braking :+ 3 / -1 mm;

— level of residual stress in the rim after cooling:

  — $\sigma_{rn} \leq + \Sigma_r$ N/mm^2 as the average of three measurements;

  — $\sigma_{in} \leq + (\Sigma_r + 50)$ N/mm^2 for each measurement;

— maximum lateral displacement of the rim after cooling:+ 1,5 / - 0,5mm.

Wheel with worn rim:

— maximum lateral displacement of the rim during braking :+ 3 / -1 mm;

— level of residual stress in the rim after cooling:

  — $\sigma_{rw} \leq +(\Sigma_r + 75)$ N/mm^2 as the average of three measurements;

  — $\sigma_{iw} \leq +(\Sigma_r + 100)$ N/mm^2 for each measurement;

— maximum lateral displacement of the rim after cooling:+ 1,5 / - 0,5mm.

The value of Σ_r shall be defined according to the criteria of the wheel rim steel grade. For grades ER6 and ER7 of 〈A1〉 EN 13262 〈A1〉, Σ_r = 200 N/mm^2.

The lateral displacement is positive if the distance between the two inner faces of the wheel of the wheelset increases.

For domestic traffic, if the track tolerances differ from general tolerances used in Europe, other values of lateral displacement may be agreed between the parties concerned

6.3 Second stage – Wheel fracture bench test

6.3.1 General

This second stage shall only be proceeded with if the residual stress levels measured during the first stage exceed the decision criteria.

6.3.2 Test procedure

The test procedure is given in normative annex A.

6.3.3 Decision criterion

The tested wheels shall not fracture.

6.4 Third stage – Field braking test

6.4.1 General

This third stage shall be proceeded with if one of the results of the first stage does not meet the decision criteria and the wheel is not rejected after the second stage.

6.4.2 Test procedure

The test method and the measurements to be taken are given in normative annex A.

The power to be taken into account for this test is 1,2 P_a (P_a is defined in 3.2). The duration of each drag braking and the running speed of the train are those defined in 3.2 (t_a et V_a).

6.4.3 Decision criteria

Three criteria shall be met simultaneously for the wheel with the new rim and the wheel with the worn rim.

Wheel with new rim:

— maximum lateral displacement of the rim during braking :+ 3 / -1 mm;

— level of residual stress in the rim after the tests and after cooling:

  — $\sigma_{rn} \leq + (\Sigma_r - 50)$ N/mm^2 as the average of the three measurements

  — $\sigma_{in} \leq + \Sigma_r$ N/mm^2 for each of the measurements

— maximum lateral displacement of the rim after cooling: + 1,5 /- 0,5 mm.

Wheel with worn rim:

— maximum lateral displacement of the rim during braking :+ 3 /-1 mm;

— level of residual stress in the rim after the tests and after cooling:

  — $\sigma_{rw} \leq + \Sigma_r$ N/mm^2 as the average of the three measurements;

  — $\sigma_{iw} \leq + (\Sigma_r + 50)$ N/mm^2 for each of the measurements;

— maximum lateral displacement of the rim after cooling: + 1,5 /- 0,5 mm

The value of Σ_r shall be defined according to the criteria of the wheel rim steel grade. For grades ER6 and ER7 of [A1] EN 13262 [A1], Σ_r = 200 N/mm^2.

The lateral displacement is positive if the distance between the two inner faces of the wheel of the wheelset increases.

For domestic traffic, if the track tolerances differ from the general tolerances used in Europe, other values of lateral displacement may be agreed between the parties concerned

7 Assessment of the mechanical behaviour

7.1 General procedure

This assessment may comprise two stages. The second stage is carried out depending on the results of the first stage. The purpose of this assessment is to ensure that there will be no risk of fatigue cracking either in the wheel web or in its connections with the hub or the rim during the service life of the wheel.

Both for the calculation and the test, the wheel geometry shall the least favourable with regard to the mechanical behaviour. If that is not the case for the test, the test parameters shall be corrected by the calculation.

The flowchart for this assessment is shown in normative annex B.

7.2 First stage - Calculation

7.2.1 Applied forces

Conventional forces shall be used. They are calculated on the basis of the value of load P. Load P is defined in EN 13103. It is half the vertical force per wheelset on the rail.

On the basis of the parameters necessary for the mechanical assessment defined in 3.3, additional forces shall be used if these parameters generate greater forces (for example,. tilting trains, curve parameters, frozen track, etc…).

Three load cases shall be considered (see Figure 1):

— Case 1: straight track (centred wheelset)

  F_z = 1,25 P

  F_{y1} = 0

— Case 2: curve (flange pressed against the rail)

  F_z = 1,25 P

F_{y2} = 0,6 P for non-guiding wheelsets

F_{y2} = 0,7 P for guiding wheelsets

— Case 3: negotiation of points and crossings (inside surface of flange applied to the rail)

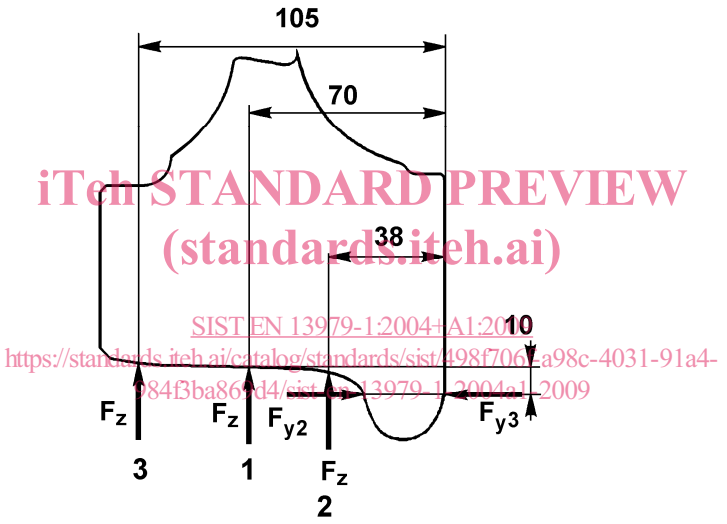
F_z = 1,25 P

F_{y3} = 0,6 F_{y2} = 0,36 P for non-guiding wheelsets

F_{y3} = 0,6 F_{y2} = 0,42 P for guiding wheelsets

Figure 1 shows, for the general case, the application points of the different forces.

Dimensions in millimetres



Key

1 Straight track
2 Curve
3 Negotiation of points and crossings

Figure 1 — Application points of the different forces

7.2.2 Calculation procedure

A finite element calculation code shall be used to determine the stresses. The validity of the code shall be proven and the choice of parameters having a critical influence on the results shall be justified. Informative annexe C gives one method of demonstrating this.

The stresses shall be analysed as follows:

— determination of the principal stresses at all points in the mesh (nodes) for each of the three load cases;

— assessment, for each node, of the maximum principal stress for the three load cases (σ_{max}) and of the direction of this principal stress;

— assessment, for each node, of the minimum stress equal to the lowest normal stress in the direction of σ_{max}, for the three load cases (σ_{min});

— calculation for each node of:

$$\Delta\sigma = \sigma_{max} - \sigma_{min}$$

7.2.3 Decision criteria

The range of dynamic stress $\Delta\sigma$ shall be less than the permissible stresses at all points of the web.

The permissible ranges of dynamic stresses, A, are as follows:

— for wheels with a machined web: A = 360 N/mm^2 ;

— for wheels with a non-machined web: A = 290 N/mm^2.

7.3 Second stage – Bench test

7.3.1 General

This second stage shall be carried out if the results of the first stage go beyond the decision criteria.

7.3.2 Definition of bench loading and of the test procedure

They shall be agreed between the designer of the wheel and the body leading the technical approval.

The loading and the test procedure shall reproduce in the web the stresses representative (direction, level and number of cycles) of those the wheel is subjected to throughout its entire life.

Informative annex D gives one method of doing this.

7.3.3 Decision criteria

Four wheels shall be tested.

No fatigue cracks shall be observed after the test. A fault is considered to be a crack if its length is greater than or equal to 1 mm.

8 Assessment of the acoustical behaviour

8.1 General procedure

The assessment of the acoustical behaviour of a wheel is widely dependent on several parameters that are not directly related to the design of the particular wheel to be approved. This is why the result of a new wheel design shall be compared with that of a rail system/reference wheel for a given state of maintenance of the rail surface.

A schematic diagram representing the acoustical approval procedure for the wheel is given in informative annex E. The acoustical technical approval of the wheel may be obtained by a calculation if the type of wheel to be approved allows reliable results to be obtained and/or from field measurements if requested: