SLOVENSKI STANDARD
SIST EN 13261:2004

01-junij-2004

Železniške naprave - Kolesne dvojice in podstavni vozili - Osi - Zahtevane lastnosti proizvoda

Railway applications - Wheelsets and bogies - Axles - Product requirements

Bahnanwendungen - Radsätze und Drehgestelle - Radsatzwellen - Produktanforderungen

Applications ferroviaires - Essieux montés et bogies - Essieux-axes - Prescriptions pour le produit

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

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Railway applications - Wheelsets and bogies - Axles - Product requirements

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EUROPEAN COMMITTEE FOR STANDARDIZATION
COMITÉ EUROPÉEN DE NORMALISATION
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Management Centre: rue de Stassart, 36 B-1050 Brussels

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Foreword

This document EN 13261:2003 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of an identical text or by endorsement, at the latest by March 2004, and conflicting national standards shall be withdrawn at the latest by March 2004.

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

This document has been prepared under a mandate given the CEN by the European Commission and the European Free Trade Association, and supports essential requirements of EU Directive(s).

Annexes A, B, C, D, E, F and G are normative. Annexes H, I and J are informative.

This document contains a bibliography.

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

Introduction

Normative documents which have been used until now in Europe for axle delivery (UIC leaflets, national standards) had, for the main purpose, a complete definition of delivery procedures and axle characteristics that were to be measured.

Product qualification was sometimes mentioned but the procedures and the characteristics that had to be verified for the qualification were not given.

This standard addresses these issues by:

a) definition of all axle characteristics. These are verified either during qualification or delivery of the product (see clause 3);

b) definition of qualification procedures (see informative annex I);

c) definition of delivery conditions (see informative annex J). Here, a choice is given to the supplier of either:

— a traditional delivery procedure with a control by batch sampling as in existing documents (see J.4), or

— a delivery procedure using quality assurance concepts (see J.5).

1 Scope

This European Standard specifies the characteristics of axles for use on European networks.

It defines characteristics of forged or rolled solid and hollow axles, made from vacuum-degassed steel grade EA1N[1)] that is the most commonly used grade on European networks. For hollow axles, this standard applies only to those that are manufactured by machining of a hole in a forged or rolled solid axle

In addition, the particular characteristics for axles in grade EA1T[1)] and EA4T[1)] are given in annex A (normative).

Two categories of axle are defined, category 1 and category 2. Generally, category 1 is chosen when the operational speed is higher than 200 km/h.

This standard is applicable to axles that are designed in accordance with the requirements of EN 13103 and EN 13104

NOTE Different values for some characteristics may be agreed if a particular process of fabrication (e.g cold rolling, shot peening) has an influence on them.

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1) N for the normalized metallurgical condition
T for the quenched and tempered metallurgical condition

2 Normative references

This European Standard incorporates by dated or undated reference, provisions from other publications. These normative references are cited at the appropriate places in the text and the publications are listed hereafter. For dated references, subsequent amendments to or revisions of any of these publications apply to this European Standard only when incorporated in it by amendment or revision. For undated references the latest edition of the publication referred to applies (including amendments).

EN 10002-1, *Metallic materials – Tensile testing – Part 1: Method of test at ambient temperature*.

EN 10045-1, *Metallic materials – Charpy impact test – Part 1: Test method.*

EN 13103, *Railway applications – Wheelsets and bogies – Non-powered axles – Design method.*

EN 13104, *Railway applications – Wheelsets and bogies – Powered axles – Design method.*

EN 13260, *Railway applications – Wheelsets and bogies – Wheelsets – Product requirements.*

EN 20898-2, *Mechanical properties of fasteners – Part 2: Nuts with specified proof load values – Coarse thread (ISO 898-2:1992).*

EN 22768-1, *General tolerances – Part 1: Tolerances for linear and angular dimensions without individual tolerance indications (ISO 2768-1:1989).*

EN 22768-2, *General tolerances – Part 2: Geometrical tolerances for features without individual tolerance indications (ISO 2768-2:1989).*

ISO 643, *Steels – Micrographic determination of the apparent grain size.*

ISO 2409, *Paints and varnishes – Cross-cut test.*

ISO 2808, *Paints and varnishes – Determination of film thickness.*

ISO 4967, *Steel – Determination of content of non-metallic inclusions – Micrographic method using standard diagrams.*

ISO 5948, *Railway rolling stock material – Ultrasonic acceptance testing.*

ISO 6933:1986, *Railway rolling stock material – Magnetic particle acceptance testing.*

ISO 9227, *Corrosion tests in artificial atmospheres – Salt spray tests.*

ISO/TR 9769[2)], *Steel and iron – Review of available methods of analysis.*

ISO 14284:1996, *Steel and iron – Sampling and preparation of samples for the determination of chemical composition.*

3 Product definition

3.1 Chemical composition

3.1.1 Values to be achieved

The maximum percentage contents of the various elements are given in Table 1.

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2) See also CR10261

Table 1

C	Si	Mn	P[a]	S[ab]	Cr	Cu	Mo	Ni	V
0,40	0,50	1,20	0,020	0,020	0,30	0,30	0,08	0,30	0,06

[a] A maximum content of 0,025 % may be agreed at the time of enquiry and the order.

[b] A minimum sulfur content may be agreed at the time of enquiry and the order according to the steelmaking process, in order to safeguard against oxygen cracking.

3.1.2 Location of sample

The test sample shall be taken at mid-radius of solid axles or at mid-distance between external and internal surfaces of hollow axles.

3.1.3 Chemical analysis

The chemical composition analysis shall be performed according to the methods and definitions described in ISO/TR 9769.

3.2 Mechanical characteristics

3.2.1 Characteristics from tensile test

3.2.1.1 Values to be achieved

The values to be achieved at mid-radius of solid axles or at mid-distance between external and internal surfaces of hollow axles are given in Table 2.

The values to be achieved near the external surface shall be greater than or equal to 0,95 times the values measured at mid-radius of solid axles or at the mid-distance between external and internal surfaces of hollow axles.

The values to be achieved in the centre of solid axles or near the internal surface of hollow axles shall be greater than or equal to 0,8 times the values measured at mid-radius or at mid-distance between external and internal surfaces.

Table 2

R_{eH} (N/mm^2)[a]	R_m (N/mm^2)	A_s %
≥ 320	550-650	≥ 22

[a] If no distinctive yield strength is present, the proof stress $R_{0,2}$ shall be determined

3.2.1.2 Location of test pieces

The test pieces shall be taken from three levels in the largest axle section:

— as near as possible to the external surface for all the axles;

— at mid-radius and in the centre of solid axles;

— at mid-distance between external and internal surfaces, and near the internal surface of hollow axles;

as shown in Figure 1 a) and b).

Dimensions in millimetres.

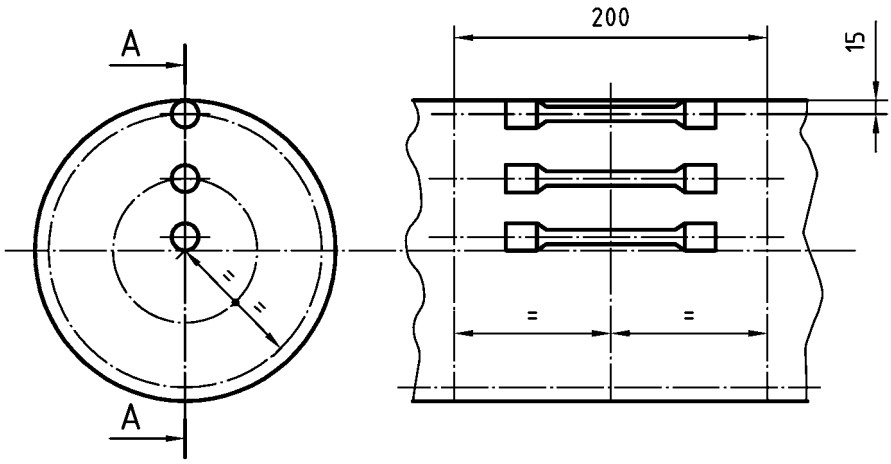

Figure 1 a) — Solid axle

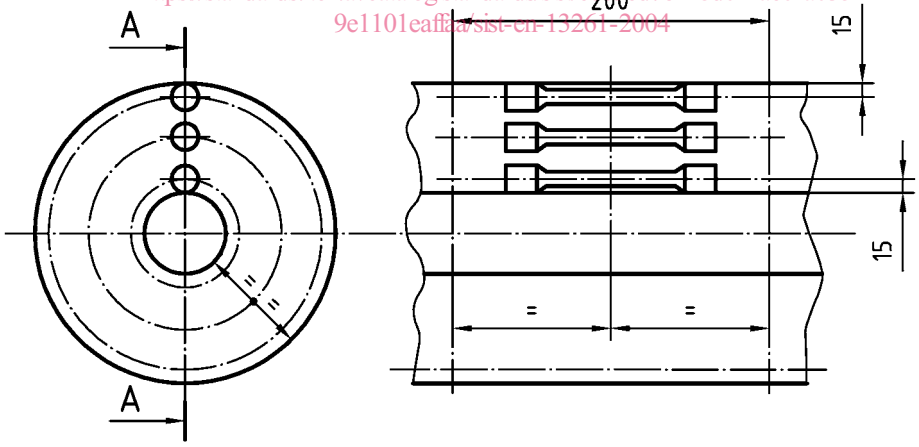

Figure 1 b) — Hollow axle

3.2.1.3 Test method

The test shall be carried out in accordance with EN 10002-1. The test piece diameter shall be at least 10 mm in the machined-down portion. The gauge length shall be five times the diameter.

3.2.2 Impact test characteristics

3.2.2.1 Values to be achieved

Impact test characteristics shall be determined at 20°C in the longitudinal and the transverse directions. Values to be achieved at mid-radius of solid axles, or at mid-distance between external and internal surfaces of hollow axles, are given in Table 3.

Near the surface, they shall be greater than or equal to 0,95 times the values measured at mid-radius, or at mid-distance between external and internal surfaces of hollow axles.

In the centre of solid axles, or near the internal surface of hollow axles, they shall be greater than 0,8 times the values measured at mid-radius or at mid-distance between external and internal surfaces.

For each level (surface, mid-radius, centre), the average value of the 3 test pieces (see 3.2.2.2) is defined in Table 3.

No individual value shall be less than 70 % of the values in Table 3.

Table 3

***KU* longitudinal (J)**	***KU* transverse (J)**
≥ 30	≥ 25

3.2.2.2 Location of test pieces

The test pieces shall be taken from three levels in the largest axle section:

— as near as possible to the external surface for all the axles;

— at mid-radius and in the centre of solid axles;

— at mid-distance between external and internal surfaces, and near the internal surface of hollow axles,

as shown in Figure 2 a) and b).

3.2.2.3 Test method

The test shall be carried out in accordance with EN 10045-1.

Dimensions in millimetres

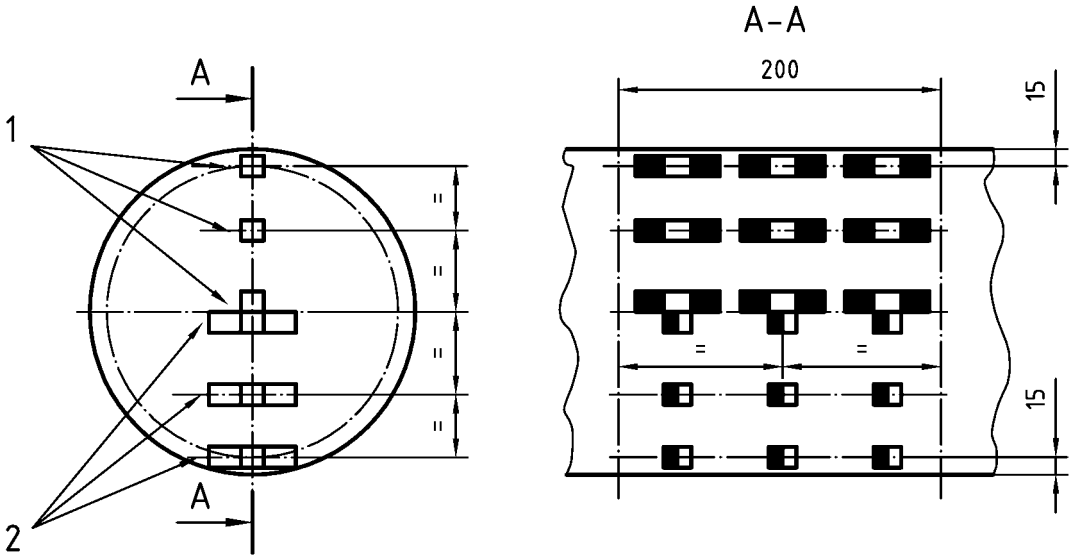

Figure 2 a) — Solid axle

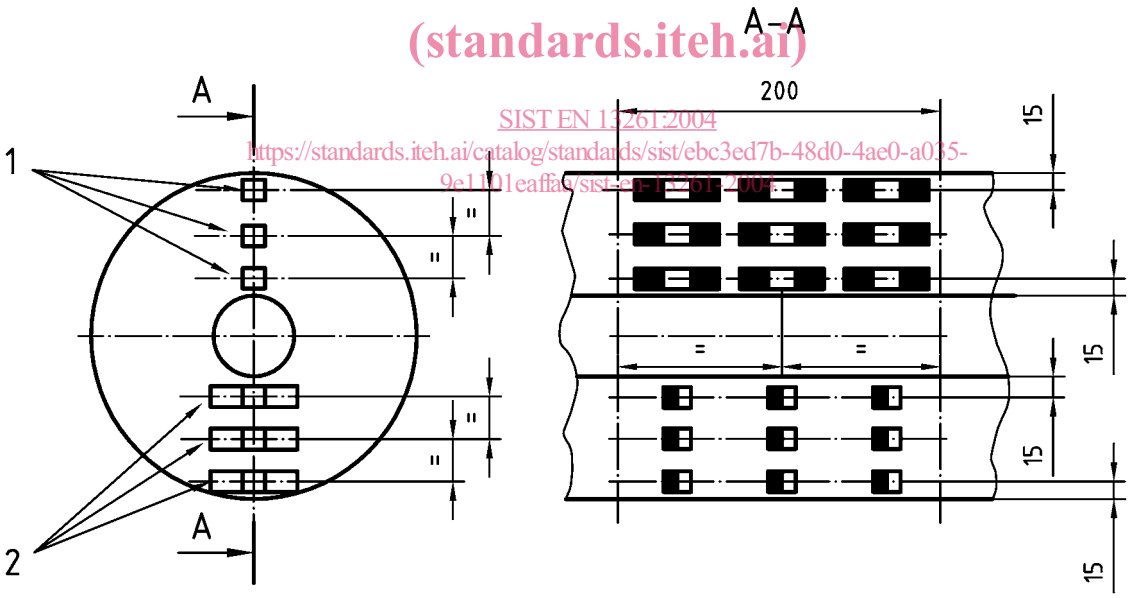

Figure 2 b — Hollow axle

Key

1 Longitudinal test piece
2 Transverse test piece

3.2.3 Fatigue characteristics

3.2.3.1 General

Verification of the fatigue characteristics is essential in order to have a correctly dimensioned axle. The satisfactory performance of an axle in service depends upon these characteristics. The values defined in this subclause are used for the calculation of the maximum permissible stresses that are referred to in the design rules in EN 13103 and EN 13104.

It is necessary to estimate the fatigue limits in the following two areas, in order to predict the behaviour of the axle under in-service stresses:

— for the material, tests are made on reduced test pieces, for which the shapes do not depend upon the product geometry,

— for the product, tests are made on full size test pieces, for which the dimensions and manufacture are similar to the final product and its associated permissible fabrication defects.

3.2.3.1.1 Fatigue limits on reduced test pieces

The fatigue limits defined with reduced test pieces are used to verify that the notch effect of the material used for the fabrication of the axle is in accordance with the security coefficient "*S*", defined in design standards EN 13103 and EN 13104. They are determined from:

— smooth surface test pieces (fatigue limit R_{fL}) and

— notched test pieces (fatigue limit R_{fE})

3.2.3.1.2 Fatigue limits on full size test pieces

The limits determined on full size test pieces are used to verify that the axle fatigue characteristics are in accordance with those that are used to calculate the maximum permissible stresses referred to in design standards EN 13103 and EN 13104.

These fatigue limits apply to different axle areas. Only the fatigue limits applying to the axle body are taken into account in this standard. The limits applying to the wheelset depend mostly on the assembly and are referred to in EN 13260.

It is necessary to define two fatigue limits:

— on the body surface, limit F_1,

— on the bore surface in the case of a hollow axle, limit F_2.

3.2.3.2 Values to be achieved

The values to be achieved are given in Table 4.

Table 4

Limit	F_1	F_2	R_{fL}	R_{fE}	$q = R_{fL}/R_{fE}$
Value	≥ 200 N/mm^2	≥ 80 N/mm^2	≥ 250 N/mm^2	≥ 170 N/mm^2	≤ 1,47

3.2.3.3 Fatigue test pieces

For F_1 and F_2 determination, the test piece areas where the cracks initiate shall have a similar geometry and surface roughness to those of the axle areas that have to be analysed. For F_2 determination, the test piece surface shall have a 1 mm deep notch as shown in Figure 3a. All of these test pieces shall come from the same fabrication process as that for the axle.

For R_{fL} and R_{fE} determination, the test piece diameter is nominally 10 mm in the area where the crack initiates. The roughness (R_a) of the test piece for R_{fL} determination is less than or equal to 0,4 µm. The notch for R_{fE} determination is shown in Figure 3b. These test pieces are located as near as possible to the surface of the axle body.

Dimensions in millimetres

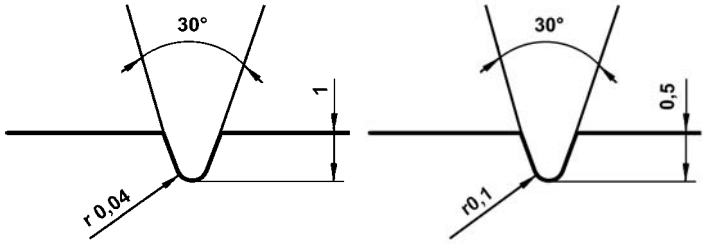

Figure 3 a — Solid axle **Figure 3b — Hollow axle**

Examples of full size and reduced test piece drawings are given in annex H (informative).

3.2.3.4 Test method

The tests shall be performed with machines that induce rotating bending stresses in the area where it is required to initiate a fatigue crack.

For each limit, F_1 and F_2, it shall be verified that for three test pieces there is no crack after 10^7 cycles of load that generates a surface stress level equal to F_1 and F_2. The values of the stresses are calculated by classical beam theory where it may be applied. If not, the stresses shall be measured by strain gauges in the areas where the fatigue cracks initiate.

R_{fL} and R_{fE} shall be determined for 10^7 cycles for a non-fracture probability of 50 %, which requires the use of at least 15 test pieces for each limit and a statistical method for the interpretation of the results.

3.3 Microstructure characteristics

3.3.1 Values to be achieved

The microstructure shall be one of ferrite and perlite. The grain size shall not be greater than that defined by the reference diagram V of ISO 643.

3.3.2 Location of the test piece

The test pieces shall be taken from the largest axle section in a 200 mm^2 plane, perpendicular to arrow F, at mid-radius of solid axles, or at mid-distance between external and internal surface of hollow axles, as shown in Figure 4.

3.3.3 Test method

Tests shall be performed in accordance with ISO 643.

3.4 Material cleanliness

3.4.1 Micrographic cleanliness

3.4.1.1 Cleanliness level to be achieved

The level of cleanliness shall be measured by micrographic examination as defined in 3.4.1.2 and 3.4.1.3. The maximum values of thick series inclusions to be obtained are given in Table 5. Thin series inclusions are not taken into account.

Table 5

Type of inclusions	Category 1		Category 2	
	Thick series (maximum)	Thin series (maximum)	Thick series (maximum)	Thin series (maximum)
A (Sulfur)	1,5	1,5	1,5	2
B (Aluminate)	1	1,5	1,5	2
C (Silicate)	1	1,5	1,5	2
D (Globular oxide)	1	1,5	1,5	2
B + C + D	2	3	3	4

3.4.1.2 Location of the micrographic sample

The examination field is given in Figure 4.

The examination shall be made in a 200 mm² plane, perpendicular to arrow F, at mid-radius of the solid axles, or at mid-distance between external and internal surface of hollow axles. The test pieces shall be taken from the largest axle section.