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Bahnanwendungen - Radsätze und Drehestelle - Vollräder - Technische Zulassungsverfahren - Teil 2: Gussräder

Applications ferroviaires - Essieux montés et bogies - Roues monobloc - Procédure d'homologation technique - Partie 2 : Roues en acier moulé

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Foreword

This document (CEN/TS 13979-2:2011) has been prepared by Technical Committee CEN/TC 256 “Railway applications”, the secretariat of which is held by DIN.

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This document has been prepared as part of a mandate given to CEN by the European Commission and the European Free Trade Association and provides support for the main requirements of EU Directive 2008/57/CE.

This European Standard is part of a series *Railway applications — Wheelsets and bogies — Monobloc wheels — Technical approval procedure* which consists of the following parts:

— *Part 1: Forged and rolled wheels*;

— *Part 2: Cast wheels*.

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Introduction

Part 1 of this series applies to monobloc wheels manufactured by forging and rolling. This process was the only authorized process accepted in the UIC regulations that were applicable in the recent past in most of the European countries.

Cast wheels are commonly used by AAR networks and have been introduced into Europe on some applications for freight wagons. This standard defines the specified requirements linked to the casting process for the technical approval of a monobloc wheel. It follows the same methodology as Part 1.

As this standard applies only to freight wagons and supports European interoperability, this standard defines in the informative Annex F the specific parameters for the thermomechanical assessment of a freight wagon wheel designed for European interoperability.

The standard describes how to assess the wheel design. To be able to apply the 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 geometric 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 acoustic 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; thus, the easier the objectives are to attain by the wheel under study.

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

The main content of this standard is derived from Part 1. The only technical differences are linked to the needs of the cast process for the product.

1 Scope

This Technical Specification defines the requirements for a cast monobloc wheel of a freight railway vehicle non-powered axle for use on a European network.

It only applies to wheels of new design or new European application.

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 Technical Specification does not address the quality requirements for cast wheels. These quality requirements are defined in Technical Specification CEN/TS 15718.

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 reference document (including any amendments) applies.

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

CEN/TS 15718, *Railway applications — Wheelsets and bogies — Product requirements for cast wheels*

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 geometric interchangeability

The application shall be defined by geometric interchangeability 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 (where required);

— 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 tread 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. Required values of P_a for European interoperability are given in informative Annex F;

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

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

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 (casting, shot peening, heat treatment, machining condition);

— the definition of the wheel geometry (drawing);

— the following fabrication parameters:

  — geometric 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 product qualification as defined in Technical Specification CEN/TS 15718.

5 Assessment of the geometric 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 flowchart for this assessment is shown in normative Annexe A. It shall be noted that stages 1 and 2 can occur in any order as they are both mandatory for cast wheels. The following text maintains the same order as EN 13979-1; however, it shall be noted that the sequence shown in Annex A may be preferable in practice.

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 geometric tolerance ranges. The wheel designer shall prove by numeric simulation that the tested wheels give the worst results. If that is not the case, the numeric simulation shall allow correction of the results to correspond with those that would be obtained on wheels in the most unfavourable geometric conditions.

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:

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

  — $\sigma_{i\,n} \leq + (\Sigma_r + 50)$ 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:

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

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

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

For steel grade CER7, a value of $\Sigma r = 200$ N/mm^2 is adopted. For CER8, the value of Σr shall be determined.

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 is mandatory for cast wheels due to the currently limited European experience on those products.

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 and 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:

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

  — $\sigma_{i\,n} \leq + \Sigma_r$ 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:

  — $\sigma_{r\,w} = + \Sigma_r$ N/mm^2 as the average of the three measurements;

  — $\sigma_{i\,w} = + (\Sigma_r + 50)$ N/mm^2 for each of the measurements;

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

— For steel grade CER7, a value of Σr = 200 N/mm^2 is adopted. For CER8, the value of Σr shall be determined.

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 shall comprise two stages. 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 be 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, 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

— 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.