DD CEN/TS 15718:2011

BSI Standards Publication

Railway applications — Wheelsets and bogies — Product requirements for cast wheels

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National foreword

This Draft for Development is the UK implementation of CEN/TS 15718:2011.

This publication is not to be regarded as a British Standard.

It is being issued in the Draft for Development series of publications and is of a provisional nature. It should be applied on this provisional basis, so that information and experience of its practical application can be obtained.

Comments arising from the use of this Draft for Development are requested so that UK experience can be reported to the international organization responsible for its conversion to an international standard. A review of this publication will be initiated not later than 3 years after its publication by the international organization so that a decision can be taken on its status. Notification of the start of the review period will be made in an announcement in the appropriate issue of *Update Standards.*

According to the replies received by the end of the review period, the responsible BSI Committee will decide whether to support the conversion into an international Standard, to extend the life of the Technical Specification or to withdraw it. Comments should be sent to the Secretary of the responsible BSI Technical Committee at British Standards House, 389 Chiswick High Road, London W4 4AL.

The UK participation in its preparation was entrusted to Technical Committee RAE/3/-/1, Railway Applications - Wheels and Wheelsets.

A list of organizations represented on this committee can be obtained on request to its secretary.

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Compliance with a British Standard cannot confer immunity from legal obligations.

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This Technical Specification (CEN/TS) was approved by CEN on 3 January 2011 for provisional application.

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Foreword

This document (CEN/TS 15718:2011) has been prepared by Technical Committee CEN/TC 256 “Railway applications”, the secretariat of which is held by DIN.

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Introduction

Prior to the publication of this Technical Specification, the only European Standard available to define quality requirements for monobloc wheels was EN 13262, which applies only to forged and rolled wheels. Forging and rolling was the only authorized process to be used by the UIC regulation that was applicable in the recent past for European countries.

Cast wheels are commonly used by AAR networks and have been introduced into Europe on some applications for freight wagons. As a reference document, this standard defines the product requirements of a monobloc cast wheel. In order for a cast wheel to maintain the same level of safety as for a forged and rolled wheel, for the product characteristics, the main content of this document is derived from EN 13262.

This standard addresses a complete definition of the product and delivery procedures for cast wheels by:

a) defining all the wheel characteristics;

NOTE 1 These are either verified during the qualification or for the delivery of the product (see Clause 3).

b) defining qualification procedures (see Annex D);

c) defining delivery conditions (see Annex E).

NOTE 2 A choice is given to the supplier, of either:

1) a traditional delivery procedure with a control by batch sampling as in existing documents (see E.4) or;

2) delivery procedure using quality assurance concepts (see E.4.6).

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1 Scope

This technical standard specifies the characteristics of cast railway wheels for use on European networks.

Two steel grades, C ER7 and C ER8, are defined in this Technical Specification. For tread-braked wheels; only C ER7 is used.

This Technical Specification is applicable to cast wheels which have a chilled rim. The standard is only applicable to cast wheels that have satisfied the technical approval procedure according to CEN/TS 13979-2.

This Technical Specification applies only to wheels used in freight wagon applications for speeds up to and including 120 km/h.

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 13262, *Railway applications — Wheelsets and bogies — Wheels — Product requirements*

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

EN ISO 148-1, *Metallic materials - Charpy pendulum impact test - Part 1: Test method (ISO 148-1:2009)*

EN ISO 6506-1, *Metallic materials — Brinell hardness test — Part 1: Test method (ISO 6506-1:2005)*

EN ISO 6892-1, *Metallic materials — Tensile testing. Part 1: Method of test at room temperature (ISO 6298-1:2009).*

ISO 1101, *Geometrical Product Specifications (GPS) – Geometrical tolerancing -- Tolerances of form, orientation, location and run-out.*

ISO 5948:1994, *Railway rolling stock material — Ultrasonic acceptance testing*

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

ISO/TR 9769[1)], *Steel and iron — Review of available methods of analysis*

ISO 14284, *Steel and iron — Sampling and preparation of samples for the determination of chemical composition*

ASTM E 399-90:1990, *Test method for plane-strain fracture toughness of metallic materials*

ASTM E1245, *Standard Practice for Determining the Inclusion or Second-Phase Constituent Content of Metals by Automatic Image Analysis*

SAE J827, *High-carbon cast-steel shot*

SAE J442, *Test strip, holder and gage for shot peening*

SAE J443, *Procedures for using standard shot peening test strip*

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1) See also CEN report CR 10261:1995.

SAE J444, *Cast shot and grit size specifications for peening and cleaning*

3 Product definition

When the characteristics of the wheel vary as a result of the casting process, the test pieces shall be taken from the worst-case location. The worst-case location has to be defined during the product qualification process by means of comparative tests in different parts of the wheel (feeder head area, outside feeder head area, intermediate). These defined locations are valid for a given manufacturing process and used for the ongoing production. In the case of a process change, these locations will have to be defined again.

3.1 Chemical composition

3.1.1 Values to be achieved

The maximum percentage contents of the various elements contained within cast wheels shall be as given in Table 1.

Table 1 — Maximum content of various elements within cast wheels

Steel grade	Maximum content %										
	C	Si[c]	Mn	P[a]	S[a, b]	Cr	Cu	Mo[c]	Ni	V	Cr + Mo + Ni
CER7	0,52	0,6	0,80	0,020	0,02	0,30	0,30	0,12	0,30	0,06	0,52
CER8	0,56	0,6	0,80	0,020	0,02	0,30	0,30	0,12	0,30	0,06	0,52

NOTE For special applications, variations within the maximum limit of these values may be agreed.

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

[b] A minimum sulfur content may be agreed at the time of enquiry and at the time of order in order to safeguard against hydrogen cracking.

[c] These values exceed those in EN 13262. It shall be ensured that use of these values does not adversely affect the metallurgical structure of the wheel.

3.1.2 Location of the sample

The sample used for determining the chemical composition shall be taken 15 mm below the tread at its nominal diameter.

3.1.3 Chemical analysis

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

3.2 Mechanical characteristics

3.2.1 Tensile test characteristics

3.2.1.1 Values to be achieved

Cast wheels shall have rim and web characteristics of at least the values given in Table 2.

Table 2 — Minimum tensile test values of the rim and web

Steel grade	Rim			Web	
	R_{eH} ≥[a] N/mm^2	R_m N/mm^2	A_5 ≥ %	R_m reduction ≥[b] N/mm^2	A_5 ≥ %
CER7	≥ 520	820/940	≥ 14	≥ 110	≥ 16
CER8	≥ 540	860/980	≥ 13	= 120	≥ 16

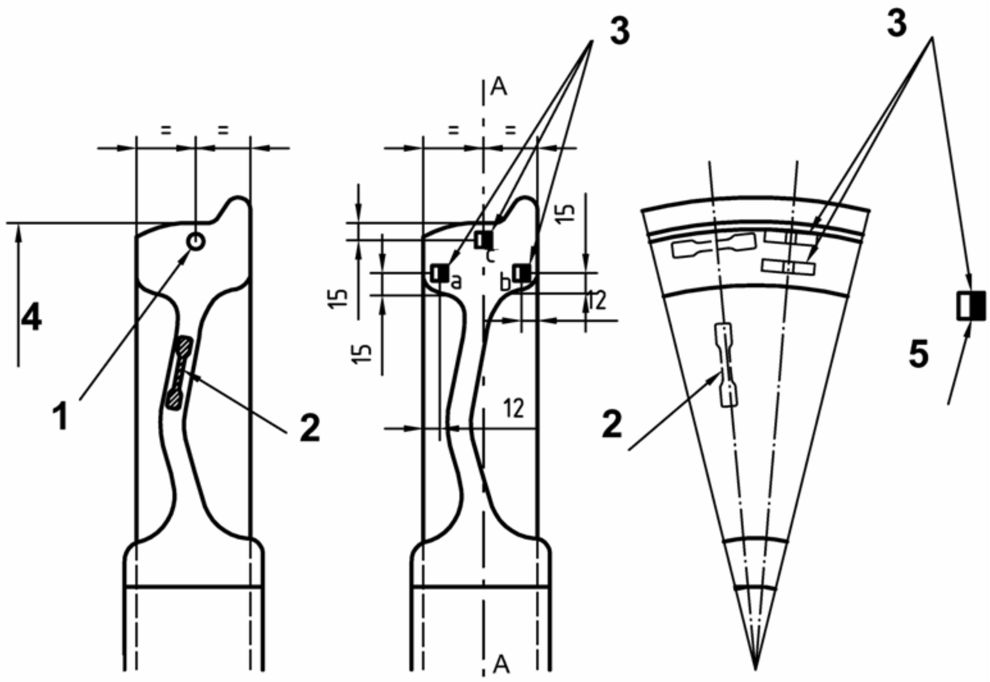
[a] If no distinctive yield strength is present, the proof stress $R_{p0,2}$ shall be determined.

[b] Reduction of tensile strength as compared to that of the rim on the same wheel.

3.2.1.2 Location of test pieces

Test pieces shall be taken from the rim and the web of the wheel, as indicated in Figure 1.

Dimensions in millimetres



Key

1 tensile test piece
2 tensile test piece
3 impact test piece
4 nominal diameter
5 notch

Figure 1 — Location of test pieces

3.2.1.3 Test method

This shall be performed in accordance with EN ISO 6892-1. The test piece diameter shall be at least 10 mm in the parallel length and the gauge length shall be 5 times the diameter.

NOTE If the wheel design prevents a sample of the stated size from being taken, a smaller sized sample may be taken after agreement between the customer and supplier.

3.2.2 Hardness characteristics in the rim

3.2.2.1 Values to be achieved

Minimum values of Brinell hardness applicable to the whole wear zone of the rim shall be as given in Table 3. These values shall be achieved up to a maximum depth of 35 mm under the tread, even if the wear depth is higher than 35 mm. These measurements shall be taken from the points defined by B, C and D in Figure 2.

Hardness values in the rim-web transition (point A in Figure 2) shall be at least 10 points lower than the wear limit values.

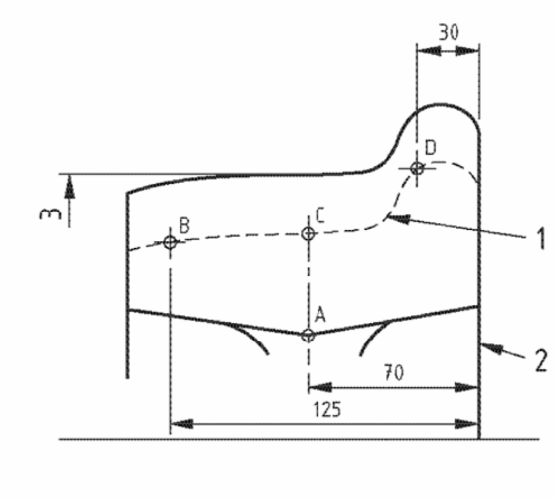
Table 3 — Minimum hardness values

Steel grade	Minimum value for Brinell hardness
CER7	235
CER8	245

3.2.2.2 Location of readings

Four readings shall be carried out on a radial section of the rim as shown in Figure 2. Where the microstructure of the wheel varies as a result of the casting process, the test locations shall occur in the worst-case areas of the wheel.

Dimensions in millimetres



Key

1 limit of wear or last turning diameter (according to customer's requirements)

2 inside surface of finished wheel

3 nominal diameter

Figure 2 — Readings taken on a radial section of the rim

3.2.2.3 Test method

This shall be performed in accordance with EN ISO 6506-1. The ball diameter is 5 mm.

3.2.3 Impact test characteristics

3.2.3.1 Values to be achieved

Cast wheels shall have the average and minimum impact values as given in Table 4.

NOTE The values represent the average and minimum values for the three test specimens defined in 3.2.3.2.

At +20 °C, U-notch specimens shall be used. At -20 °C, V-notch specimens shall be used.

Table 4 — Average and minimum impact test characteristics

Steel grade	KU (J) at +20 °C		KV (J) at -20 °C	
	Average values	Minimum values	Average values	Minimum values
CER7	≥ 17	≥ 12	≥ 10	≥ 7
CER8	≥ 17	≥ 12	≥ 10	≥ 5

3.2.3.2 Location of the test pieces

Test pieces shall be taken from the rim of the wheel, as indicated in Figure 1.

The bottom notch axis shall be parallel to the A-A axis of Figure 1.

3.2.3.3 Test method

This shall be performed in accordance with EN 10045-1.

3.2.4 Fatigue characteristics

3.2.4.1 Values to be achieved

Regardless of the steel grade, the web shall withstand the stress variation, $\Delta\sigma$, given in Table 5 during 10^7 cycles without any crack initiation, with a probability of 99,7 %.

Table 5 — Minimum fatigue characteristics

State of delivery of the web	$\Delta\sigma$ N/mm^2
Fully machined	450
Partially machined or as cast and shot peened	315

NOTE 1 The aim of these characteristics is to ensure that product characteristics are higher than those used for the definition of permissible stresses for the fatigue design of the web.

NOTE 2 As there are many approximations in a fatigue calculation, it is not realistic to distinguish between the two steel grades.

3.2.4.2 Specimens for fatigue test

Specimens shall consist of wheels as delivered. Their surface appearances shall be those defined in 3.7.

3.2.4.3 Test method

The test method shall allow bending stresses to be created in a web section.

The tests to demonstrate the fatigue properties shall be performed in such a manner that statistical evaluation to assess the results can be applied.

Tests shall be monitored by measuring the radial stresses which exist in the crack initiation area.

NOTE An example of the method is given in Annex B.

3.2.5 Fracture toughness characteristics of the rim

3.2.5.1 General

This characteristic shall only be verified on tread-braked wheels (service brake or parking brake).

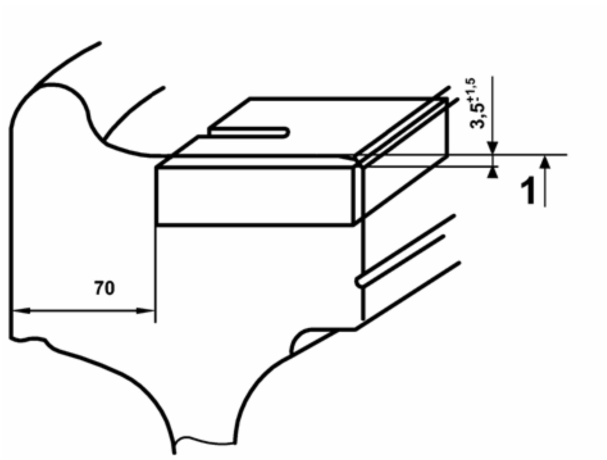
3.2.5.2 Values to be achieved

For steel grade CER7, the average value obtained from six test pieces shall be greater than or equal to 80 N/mm^2 $\sqrt{m}$ and any single value shall not be below a minimum of 70 N/mm^2 $\sqrt{m}$.

3.2.5.3 Location of test pieces

Six test pieces shall be taken from the rim as indicated in Figure 3. Where the microstructure of the wheel varies as a result of the casting process, the test locations shall be in the worst-case areas of the wheel.

Dimensions in millimetres



Key

1 nominal diameter

Figure 3 — Test pieces taken from the rim

3.2.5.4 Test method

The test shall be performed according to ASTM E 399-90.

The test conditions shall be as follows:

a) the compact specimen shall have a CT thickness of 30 mm (CT 30 specimen), with chevron notch having an aperture angle of 90° (see Figure 4 of ASTM E 399.90);

b) temperature during the test between +15 °C and +25 °C;

c) measurement of the crack displacement of the specimen as indicated in Figure 3 of ASTM E 399.90;

d) rate of increase of stress intensity, ΔK/s (stress intensity per second), shall be within the range 0,55 $N/mm^2\sqrt{m}/s$ to 1 $N/mm^2\sqrt{m}/s$ (see 8.3 of ASTM E 399-90);

e) the value of the toughness to be considered shall be the value K_Q which is calculated from the value of the load F_Q from the load-displacement record.

3.3 Heat treatment homogeneity

3.3.1 Location of measurement

The hardness measurements shall be taken at three points on the outside surface of the rim. Where the casting process uses risers (see Note), the test locations shall occur both in-line and between the riser positions.

The impressions shall be made on a same diameter in the area located as defined in Figure E.1.

NOTE Risers are defined in this document as the reservoir of molten metal from which the casting feeds as it shrinks during solidification.

3.3.2 Values to be achieved

The hardness value variation shall be within a 30 HB range for a wheel.

3.3.3 Test method

The test shall be performed in accordance with EN ISO 6506-1. The ball diameter is 10 mm.

3.4 Metallurgical structure

The absence of bainitic structure shall be checked by a micrographic examination.

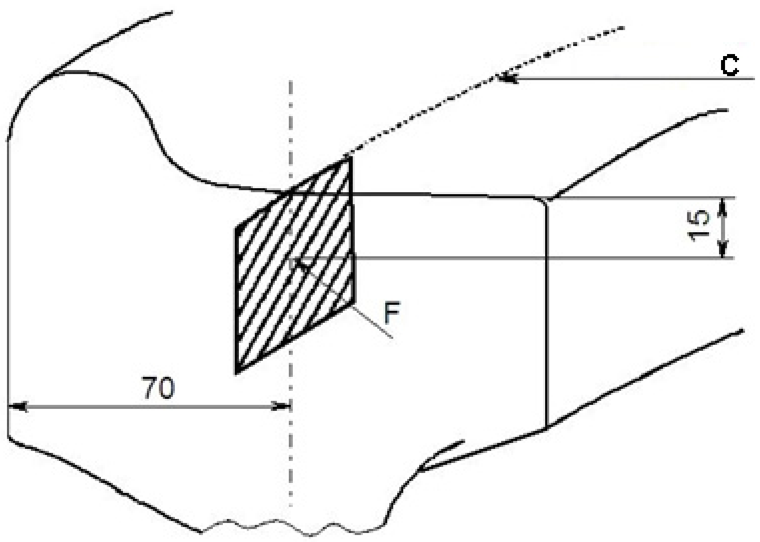
3.5 Material cleanliness

3.5.1 Micrographic cleanliness

3.5.1.1 Sample size and location

A minimum of six samples shall be taken from each wheel tested approximately equidistant around the circumference of the wheel. Each sample shall be 22 mm wide in the circumferential direction (the running direction) and 13 mm thick in the radial direction (that of the rim thickness). Its centre F shall be located 15 mm below the wheel tread and 70 mm from the back rim face as shown in Figure 4.

Dimensions in millimetres



Key

C nominal wheel tread

F centre of sample

Figure 4 — Location of sample for the micrographic examination

3.5.1.2 Sample preparation

Each 22 mm x 19 mm x 13 mm sample shall be meticulously prepared and evaluated to ASTM E1245. The flicker method shall be used to establish the correct setting of the grey-level threshold limits.

The total area evaluated for each sample shall be not less than 161 mm^2. All inclusions greater than 2,5 µm shall be counted.

3.5.1.3 Level to be achieved

The average and worst field area percentage of inclusions and voids shall be recorded.

The maximum permissible values for the six samples are:

— 0,1 % for the average inclusions plus voids;

— 0,75 % for the worst field, inclusions plus voids.

NOTE The criteria of these characteristics have to be confirmed by in-service experience of wheels to demonstrate that there is no fatigue crack propagation beneath the tread.

3.5.2 Internal integrity

3.5.2.1 General

Internal integrity shall be determined from ultrasonic examination. The examination shall be carried out before shot peening.

Standard defects are flat bottom holes with different diameters.

3.5.2.2 Level to be achieved

3.5.2.2.1 Rim

The rim shall have no internal defects that give echo magnitudes higher than or equal to those obtained for a standard defect situated at the same depth. The diameter of this standard defect shall be 2 mm.

There shall be no attenuation of the back echo higher than 4 dB during axial examination.

3.5.2.2.2 Web

The web shall not have:

a) more than 10 echoes with magnitudes greater than or equal to those obtained for standard defects of diameter 3 mm;

b) echoes with magnitudes greater than or equal to those obtained for standard defects of diameter 5 mm.

The distance between two acceptable defects shall be at least 50 mm.

3.5.2.2.3 Hub

The hub shall not have:

a) more than 3 echoes of magnitude greater than or equal to those obtained for standard defects of 3 mm diameter;

b) echoes of magnitude greater than or equal to those obtained for standard defects of 5 mm diameter.

The distance between two acceptable defects shall be at least 50 mm.

For one circumferential examination, no attenuation of the back echo equal to or greater than 6 dB shall be permitted.

3.5.2.3 Test piece

Examination shall be made of the complete wheel, after heat treatment, either before shot peening or before any anti-corrosion protection is applied.

3.5.2.4 Method of examination

3.5.2.4.1 General

Samples shall undergo ultrasonic examination in accordance with ISO 5948 in accordance with the following special conditions of 3.5.2.4.2, 3.5.2.4.3 and 3.5.2.4.4.

3.5.2.4.2 Rim

The rim examination shall be made in accordance with ISO 5948:1994, Table 1 methods D_1 and D_2.

Defect estimation shall be made by comparison to artificial defects in the standard rim in accordance with ISO 5948:1994, Figures 1 and 2.

In addition, ultrasonic examination shall be performed to cover the rim to web transition.

3.5.2.4.3 Web

The web examination shall be made on both faces. The direction of the examination is perpendicular to the surface.

Defect estimation shall be made by comparison to artificial defects in a standard web.

The web shall be defined as the part of the wheel between the two diameters at “*m*” and “*n*” (see Figure 6).

The thickness, “*e*”, of the web shall be defined with the following equation:

$$e = \left(\frac{m+n}{2} \right)$$

where

e is the thickness of the web;

m is the thickness at the connection with the rim at diameter "*m*";

n is the thickness at the connection with the hub at diameter "*n*".

The location of the artificial defects shall be given as a function of *e*. They shall be at least 100 mm apart in a circumferential orientation.

- $e \leq 10$ mm
  - One 3 mm diameter flat bottom hole located 5 mm below the inner surface of the web
  - One 5 mm diameter flat bottom hole located 5 mm below the inner surface of the web
- 10 mm $< e \leq$ 20 mm
  - Two 3 mm diameter flat bottom holes located 5 mm and (e - 5) mm below the inner surface of the web
  - Two 5 mm diameter flat bottom holes located 5 mm and (e - 5) mm below the inner surface of the web
- $e > 20$ mm
  - Three 3 mm diameter flat bottom holes located 5 mm, $\left(\frac{e}{2}\right)$ mm and (e – 5) mm below the inner surface of the web
  - Three 5 mm diameter flat bottom holes located 5 mm, $\left(\frac{e}{2}\right)$ mm and (e – 5) mm below the inner surface of the web

3.5.2.4.4 Hub

The hub examination shall be made on both faces. The direction of the examination shall be perpendicular to the surface.

Defect estimation shall be made by comparison to artificial defects in the standard hub shown in Figure 5.

Calibration references are:

— 3 standard defects of diameter 3 mm located at different depths;

— 3 standard defects of diameter 5 mm located at different depths.

Spacing as shown below.

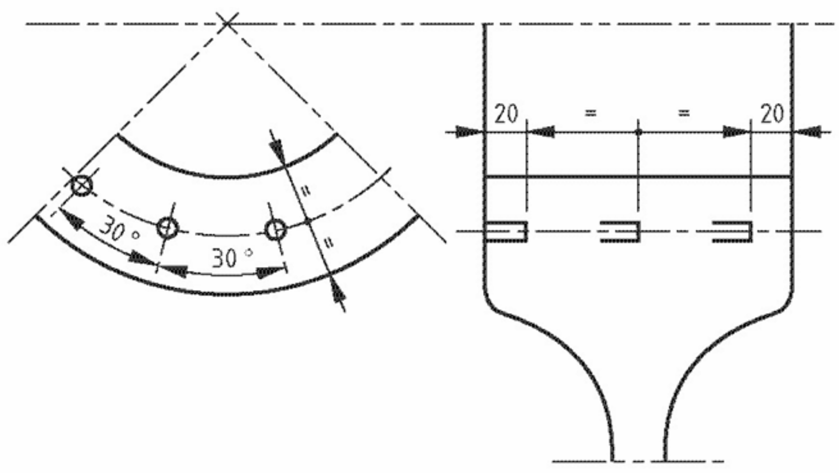


Figure 5 — Standard hub for ultrasonic examination

3.6 Residual stresses

3.6.1 General

Wheel heat treatment shall induce a compressive circumferential residual stress field inside the rim.

3.6.2 Values to be achieved

The level of compressive circumferential stresses shall be measured near the surface of the tread and shall be in the range 80 N/mm^2 to 150 N/mm^2. These stresses shall be equal to zero between 35 mm and 50 mm.

NOTE The stress distribution is shown in Figure 6 below the tread.

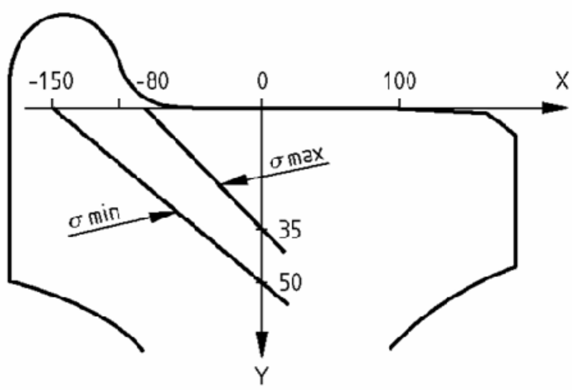


Figure 6 — Range in variation of circumferential stress values

3.6.3 Test piece

The test piece shall be the complete wheel after heat treatment.

3.6.4 Measurement methods

Measurement methods shall estimate the variation of circumferential stresses located deep under the tread. This method shall be agreed between the supplier and the customer.

Annex C gives an example method that can be used for this measurement; the stress distribution values given in Figure 6 shall be applied to this method.

3.7 Surface characteristics

3.7.1 Surface appearance

3.7.1.1 Characteristics to be achieved

The wheel surface shall not show any marks other than those at the positions stipulated in this Technical Specification.

NOTE According to their use, wheels may be fully or part machined.

The "as cast" faces of the web extending approximately one half of the way into the hub and rim fillet radii on the front and on the back of the wheel shall be shot peened.

Average surface roughness (R_a) area values of "finished" or "ready for assembly" wheels shall be as given in Table 6.

Table 6 — Average surface roughness

Area of the wheel	State of delivery[a]	Roughness, R_a µm
Bore	Finished	≤ 12,5
	Ready for assembly[b]	0,8 to 3,2
Web and hub	Finished[c]	≤ 12,5
Rim tread	Finished[c]	≤ 6,3
Rim faces	Finished[c]	≤ 6,3

[a] See F.2.

[b] If the wheel has to be fitted on a hollow axle, other values may be required for the purpose of the in-service ultrasonic inspection.

[c] If defined in the order, this area of the wheel may remain unmachined, provided the tolerances indicated in this table are achieved.

3.7.1.2 Measurement method

The roughness of the wheel surfaces (R_a) at the delivery stage indicated in Table 6 shall be inspected by comparison with the roughness specimen described or measured with a profile meter on the plane surface.

3.7.2 Surface integrity

3.7.2.1 General

Surface integrity shall be determined by a magnetic particle test of the web, carried out in accordance with 3.7.2.4 and visual inspection (for porosity and other visible defects) both in the web and elsewhere.

3.7.2.2 Level to be achieved

The maximum indicated length of permissible surface breaking defects on a finished wheel shall be 2 mm.

3.7.2.3 Test piece

Examination shall be made on the complete wheel after heat treatment and after shot cleaning, but before shot peening and before the application of any temporary corrosion protection.

3.7.2.4 Methods of inspection

General requirements for the magnetic particle test shall be defined in accordance with ISO 6933 with the following exceptions:

a) the level of surface magnetic induction shall be greater than 4 mT;

b) the level of ultra-violet light energy shall be greater than 15 W/m².

The magnetisation method shall be performed in accordance with ISO 6933:1986, Figure 2c. The apparatus used shall scan the entire wheel surface and be able to detect the defects whatever their orientation.

3.8 Geometric tolerances

The geometry and dimensions of wheels shall be defined by a drawing included with the order.

The geometric tolerances shall conform to those given in Table 7.

The symbols used in Table 7 are defined in Figure 7.

Table 7 — Geometric tolerances

Designation		Symbols [a]		Values (mm)	
		Dimensions	Geometric [b]	Unmachined	Finished
Rim	External diameter	*a*			0 / +4
	Internal diameter (outer)	b_1			0 / -4
	Internal diameter (inner)	b_2		0 / -6	0 / -4
	Width	*d*			± 1
	Tread profile [e]		v		≤ 0,5
	Circularity of the tread		s		≤ 0,2
	Total run out in axial direction		t		≤ 0,3
	Total run out in radial direction of the jaw hold		j		≤ 0,2
	External diameter of the groove (i.e. wear line)	*w*			0 / +2
Hub	External diameter (outer)	f_1		0 / +10	0 / +5
	External diameter (inner)	f_2		0 / +10	0 / +5
	Internal diameter of the bore: “Finished” [c]	g_1			0 / -2
	“Finished ready for assembly” [c]	g_2		In accordance with the drawing or a standard to ensure the interference fit	
	Cylindricity of internal diameter of the bore: “Finished” [c]	x_1			≤ 0,2
	“Finished ready for assembly” [c]	x_2			≤ 0,02 [d]
	Length	*h*			0 / +2
	Hub to wheel overhang	*r*			0 / +2
	Total run out of the diameter of the bore: “Finished” [c]		Q1		≤ 0,2
	“Finished ready for assembly” [c]		Q2		≤ 0,1
Web	Position for the web at the connection with the rim and the hub		K	≤8	≤ 8
	Thickness at the connection with the rim	*m*		+8 / 0	+ 5 / 0
	Thickness at the connection with the hub	*n*		+10 / 0	+ 5 / 0

[a] See Figure 7

[b] See EN ISO 1101

[c] See E.2 for terms related to bore of the hub

[d] Any slight taper within the permitted tolerance shall be such as the “larger” diameter is at the axle entry end of the bore on assembly of the wheel on the axle

[e] From the top of the flange as far as the external chamfer

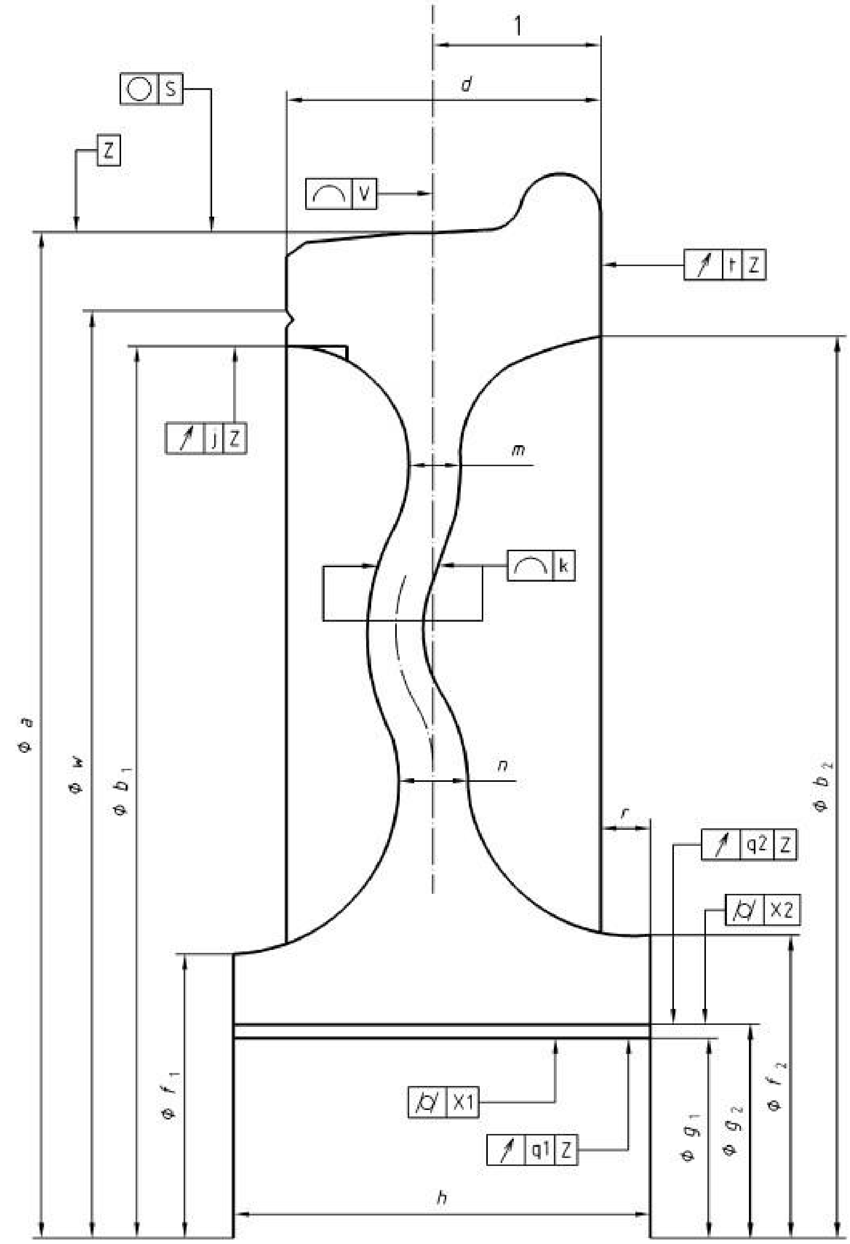


Figure 7 — Symbols

3.9 Static imbalance

The maximum static imbalance of a finished wheel in the delivery condition shall be ≤ 125 g·m (symbol E3). The means and methods of measurement shall be agreed between the customer and the supplier.

3.10 Shot peening - Requirements

3.10.1 General

This subclause covers the shot peening of cast wheels intended to improve the web fatigue strength.

The shot shall be the Society of Automotive Engineers shot designated SAE No. 550 or a larger hardened steel as specified in the Society of Automotive Engineers technical standards SAE J827 and SAE J444.

All the wheels shall be subjected to shot peening after completion of the corrective operations to the surfaces in the web area as specified in 3.7.1.1.

A portable peening device may be used to re-peen small reconditioned areas no larger than about 50 mm x 75 mm on wheel web surfaces excluding the critical fillet areas (front hub and back rim).

3.10.2 Values to be achieved

3.10.2.1 Fixed installations

The peening machines shall be equipped with a separator for continuously removing broken shot. Sufficient new shot shall be added to ensure that a minimum of 85 % of SAE No. 550 or larger shot is maintained in the machines at all times.

The peening intensity shall be sufficient to produce an average arc height of not less than 0,008 (0,0075+) Almen C-2 within the zones defined in 3.7.1.1.

3.10.2.2 Portable equipment

Portable peening equipment shall be capable of peening an Almen C strip to develop the required average arc height of 0,008 Almen-C2 within a reasonable time.

Peening time of wheel webs shall be at least as long as the time required to develop the 0,008 Almen C2.arc height. The equipment shall be tested on an Almen C strip after each 8 hour shift that the portable peener is used. A record of the Almen C test results shall be maintained.

3.10.3 Measurement method

Measurements of arc height shall be made in accordance with SAE J442 or SAE J443.

The minimum peening time shall be sufficient to ensure full coverage is attained on the Almen C strip as defined in SAE J443.

3.11 Protection against corrosion

Protection shall be provided

- on all fully machined surfaces with the exception of the surface of the rims;
- on the unmachined web and unmachined hub of other wheels.

3.12 Wheel maintenance capacity

For specific wheel uses, it is possible to verify the level of residual stresses by a non-destructive method in the maintenance system.

3.13 Manufacture's markings

Each wheel shall bear, as a minimum, the following marks:

a) manufacturer's mark;

b) cast number;

c) steel grade;

d) month and two last figures of the year of production;

e) position of residual imbalance and its symbol (see 3.9);

f) serial number after heat treatment.

The markings shall be applied to the hub-web fillet or at a position defined by the customer.

These marks shall be stamped or cast in, except for imbalance marks which may be made by other means. Stamps with sharp edges shall not be used.

Annex A
(normative)

Hydrogen control at the point of steel melt for monobloc wheels

A.1 Sampling

The sample shall be taken prior to pouring into the mould. Any one of the following four methods shall be acceptable:

a) copper mould;

b) silica dip tubes;

c) quartz bubbling tube (translucent quartz is prohibited because of its hygroscopic ability);

d) immersion probe method (carrier gas method with thermal conductivity detector).

A.2 Analysis methods

Two methods only shall be acceptable:

a) “vacuum extraction” at a temperature range of 650 °C to 1 050 °C;

b) injecting a carrier gas at (650 ± 20) °C into the liquid steel; the resulting diffused gas containing hydrogen shall be recovered for re-circulation and analysis.

A.3 Operating precautions

Operating precautions shall be taken in accordance with ISO 14284.

It shall be demonstrated that the hydrogen content value does actually characterize the maximum value of this parameter during the cast (casting).

NOTE Operators should be specifically trained in the above methods.

Annex B
(informative)

Example of a test method for the determination of fatigue characteristics

B.1 Test piece

The specimen is the wheel itself. Where the cast wheel has risers in the web, the force shall be applied in the same radial position as the riser, on the assumption that this represents the weakest part of the web.

B.2 Test rig

The principle of the test rig is shown in Figure B.1.

The wheel is fitted on a simulated axle which is fixed to a face plate. Forces are applied to the rim by a hydraulic actuator and the wheel remains fixed.

B.3 Test monitoring

The actuator is controlled by monitoring forces which are calibrated against the radial stresses. Radial stresses are measured in the area where the crack initiates.

The maximum and minimum forces applied are symmetrical about a mean load of 0 N.

B.4 Analysis of results

The Bastenaire method may be used.

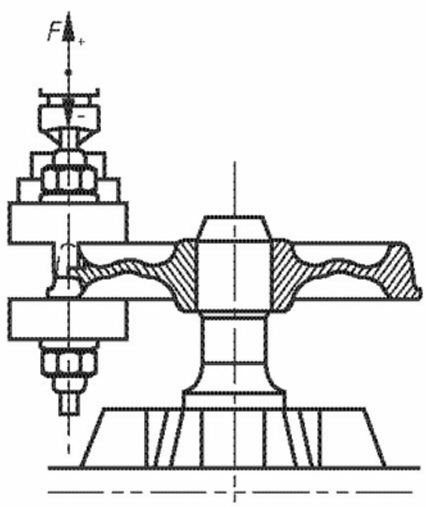


Figure B.1 — Block diagram

Annex C
(informative)

Strain gauge method for determining the variation of circumferential residual stresses located deep under the tread
(destructive method)

C.1 Principle

The method consists of cutting operations leading to the progressive relief of residual stresses present in the rim.

The change in the state of residual stresses, which happens in each cutting operation, is evaluated at the surface by measuring local deformation using strain gauges.

The change in state inside the rim is obtained by a linear interpolation of the state evaluated at the surface.

The evaluation is usually performed for one radial cross section only, because from experience, it is known that the heat treatment induces effectively a uniform circular state of residual stress. However, for cast wheels with riser positions in the web, this test shall be performed at two radial positions; one radially in line with a riser position and the other radially in line with a between-riser position. In which case, two separate wheels shall be used for both sets of measurements.

C.2 Procedure

C.2.1 Fitting of a rim cross section with strain gauges prior to wheel cutting[2)]

Apply the strain gauges as follows:

a) in the circumferential and axial directions, at point 1 of the tread located in the plane of symmetry of the web-rim connection;

b) in the circumferential and radial directions, at point 2E of the external side and 2I of the internal side of the rim and at points 3E of the external side and 3I of the internal side of the web-fillet.

C.2.2 Execution of cutting[3)]

The chosen cutting method is required to have no effect on the residual stresses at the test position (e.g. a fine-tooth saw).

Perform three cutting operations in the following order:

a) extract a rim section of a length that is at least twice the rim width (Operation 1 of Figure C.2a);

b) cut along a plane parallel to the axle, located at the start of the web-rim connection (Operation 2 of Figure C.2b);

2) See Figure C.1.

3) See Figure C.2.

c) cut along a plane parallel to the axle crossing the rim (Operation 3 of Figure C.2c). Only perform this cutting process if the thickness of the rim is greater than 30 mm.

C.2.3 Operations to be executed during cutting

Perform the following operations during cutting:

a) measure the strains after cutting operation 1;

b) record the exact profile of the radial cross section on one of the ends of the rim sections;

c) bond strain gauge 4 (see Figure C.2b);

d) measure the strains of gauges 1 and 4 after cutting operation 2 (see Figure C.2b);

e) measure the thickness of h_1 and h_2 (see Figure C.2b);

f) bond strain gauge 5 (see Figure C.2c);

g) measure the strains of gauges 1 and 5 after cutting operation 3 (see Figure C.2c);

h) measure the thickness h_1 and h_2 (see Figure C.2c).

C.3 Expression of results

C.3.1 Calculation of the variation of the circumferential residual stress located deep under the tread

Calculate the variation of the circumferential stresses, σ^i_j, resulting from each cutting operation "i" at measurement point "j" using the following formula:

$$\sigma_j^i = -\frac{E}{1-\upsilon^2}\left[e_{cir_j}{}^i + \upsilon e_{\perp j}^{\;i}\right]$$

where

E is the Young's modulus with a constant of 210 000 expressed in megapascal (MPa);

v is the Poisson's ratio with a constant of 0,28;

$e_{cir_j}{}^i$ is the circumferential strain;

$e_{\perp j}^{\;i}$ is the axial (or radial) strain;

σ is the stress in Méga-Pascal (MPa).

C.3.2 Calculation of the variation of the circumferential stress created by cutting operation 1

Calculate stresses $\sigma^1{}_1$, $\sigma^1{}_{2E}$, $\sigma^1{}_{2I}$, $\sigma^1{}_{3E}$, and $\sigma^1{}_{3I}$. The stress values at points 2 and 3 (Fig. C 3a) shall be given by the following formulae:

$$\sigma_2^1 = \frac{a}{a+b}\sigma_{2I}^1 + \frac{b}{a+b}\sigma_{2E}^1$$

$$\sigma_3^1 = \frac{c}{c+d}\sigma_{3I}^1 + \frac{d}{c+d}\sigma_{3E}^1$$

a, *b*, *c* and *d* are defined in Figure C.2d.

The radial variation of the stress is represented by the straight line passing through the ordinates corresponding to points 1 and 3 in the stress diagram, in relation to the distance between point and tread.

The representation of the calculated stress (see Figure C.3a) at point 2 shall be located on this straight line, ± 20 N/mm².

C.3.3 Calculation of the variation of the circumferential stress created by cutting operation 2

Calculate stresses $\sigma^2{}_1$ and, $\sigma^2{}_4$ then the stress at point A (see Figure C.2b) using the following formula:

$$\sigma_A^2 = \frac{-(2h_1 + h_2)S_1\sigma_1^2 + h_2 S_2 \sigma_4^2}{S_1(h_1 + h_2)}$$

h_1, h_2, S_1 and S_2 are defined in Figure C.2b).

The radial variation of the stress is represented by the straight line passing through the ordinates corresponding to points 1 and A in the stress diagram, in relation to the distance between point and tread (see Figure C.3b).

C.3.4 Calculation of the variation of the circumferential stress created by cutting operation 3

Calculate stresses $\sigma^3{}_1$ and, $\sigma^3{}_5$ then the stress at point B (see Figure C.2c) using the following formula:

$$\sigma_B^3 = -\frac{(2h_1 + h_2)}{h_1 + h_2}\sigma_1^3 + \frac{(h_2)^2}{h_1(h_1 + h_2)}\sigma_5^3$$

h_1 and h_2 are defined in Figure C.2c).

The radial variation of the stress is represented by the straight line passing through the ordinates corresponding to points 1 and B in the stress diagram, in relation to the distance between point and tread (see Figure C.3c)).

C.3.5 Final diagram representing the variation of the circumferential stress located deep under the tread

Determine stress values: $\sigma^1{}_B$ and $\sigma^2{}_B$, see Figure C.3a and Figure C.3b.

The value of the circumferential residual stress σ_1 at point 1 is equal to the algebraic sum of the measured values of the stresses after each cutting process:

$$\sigma_1 = \sigma_1^1 + \sigma_1^2 + \sigma_1^3$$

Similarly, the σ_B value at point B is equal to:

$$\sigma_B = \sigma_B^1 + \sigma_B^2 + \sigma_B^3$$

The final diagram of the variation of the deep-located circumferential stress is represented by the straight line passing through the ordinates σ_1 and σ_B corresponding to points 1 and B in the stress diagram, in relation to the distance between point and tread (see Figure C.3d).

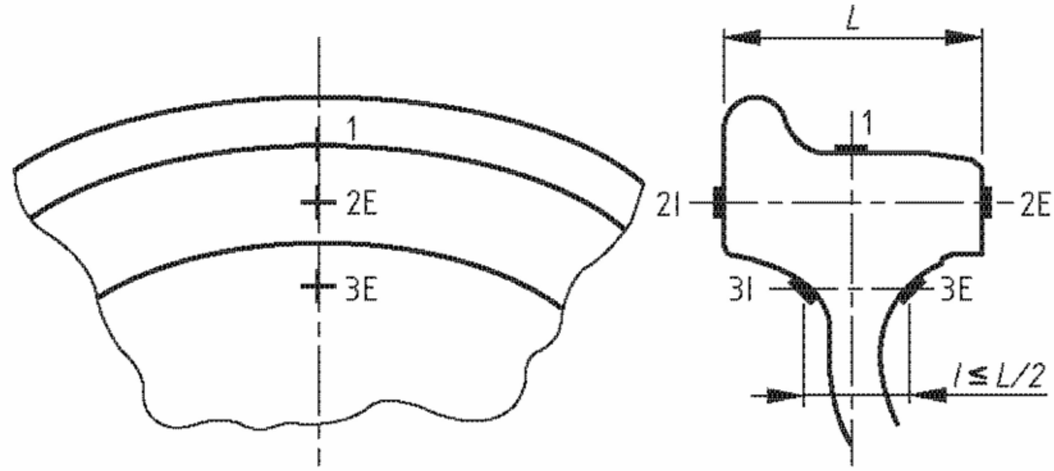
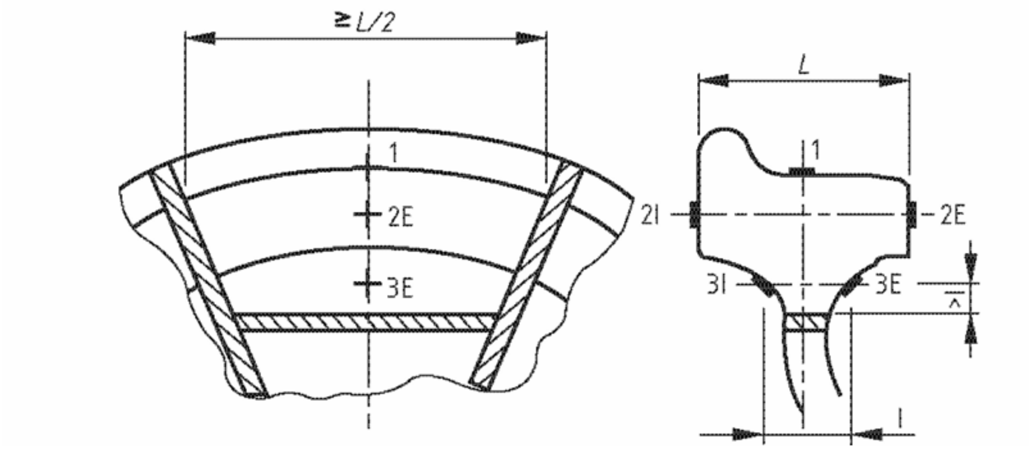
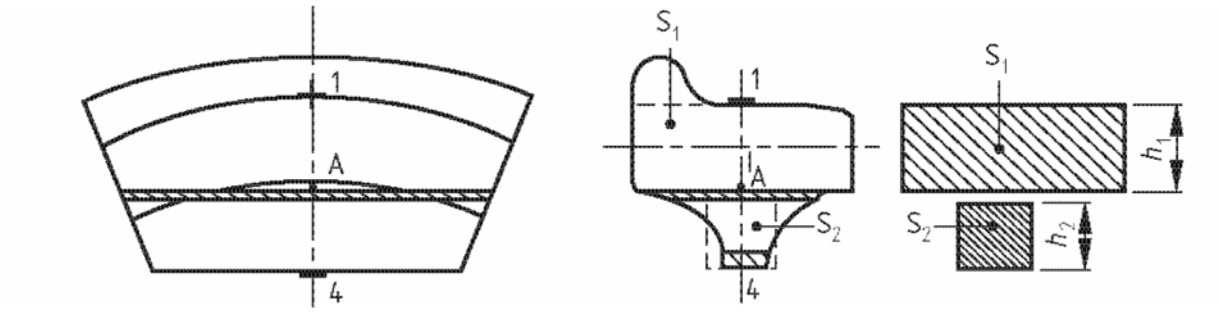


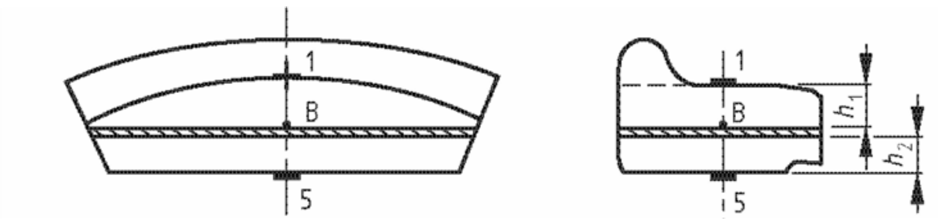
Figure C.1 — Fitting of strain gauges



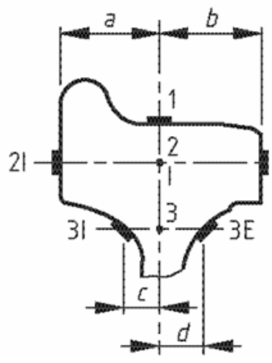
a) Operation 1



b) Operation 2

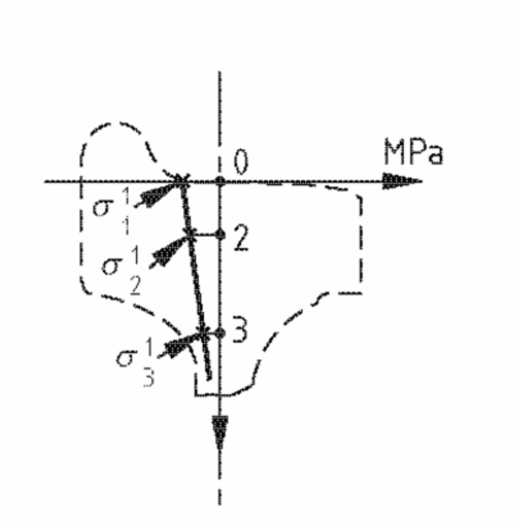


c) Operation 3

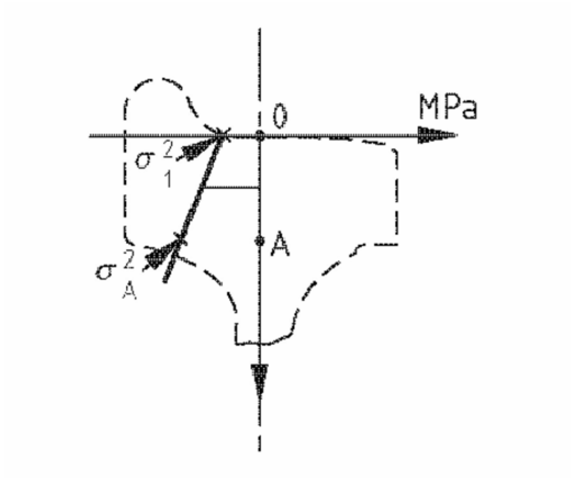


d) Operation 4

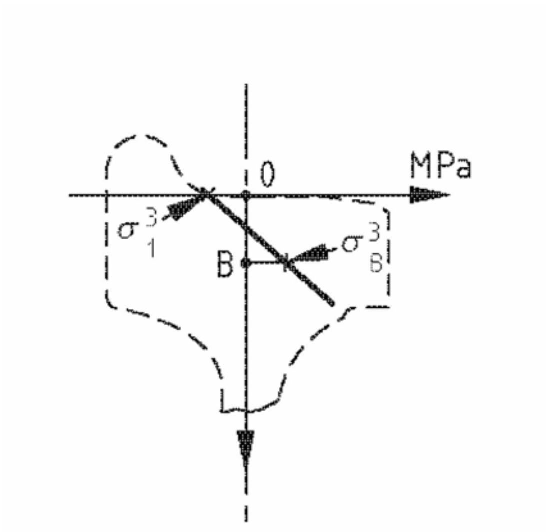
Figure C.2 — Cutting operations



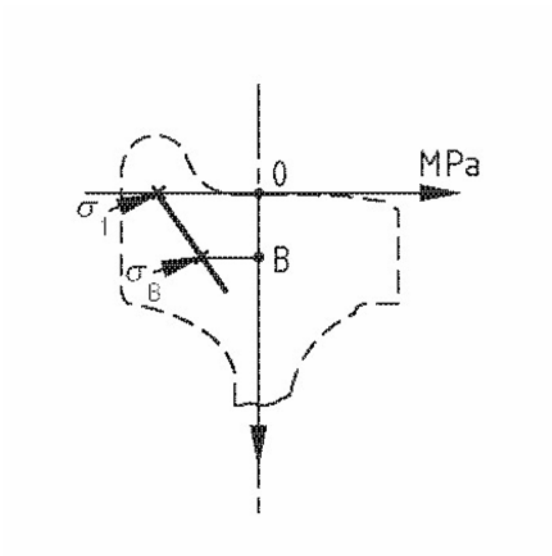
a) Variation of the stress created by operation 1



b) Variation of the stress created by operation 2



c) Variation of the stress created by operation 3



d) Variation of the stress final diagram

Figure C.3 — Method for determining the variation of the circumferential stress located deep under the tread

Annex D
(informative)

Product qualification

D.1 General

Before acceptance for use by a European railway network, a wheel shall be qualified.

This Annex specifies the requirements and procedures to be applied for product qualification.

Qualification of a wheel is directly linked to the supplier and a wheel can only be qualified if the supplier meets the requirements specified in D.2.

The requirements and procedures of this Annex shall be applied only to wheels for which the design has been approved by the recognized technical approval procedure in CEN/TS 13979-2 or equivalent.

The requirements shall be applied in the following cases:

a) any wheel from a new supplier;

b) any non-qualified wheel from a supplier, when its geometry is appreciably different to qualified wheels from this supplier (e.g. shape and thickness of the web, diameter, etc.);

c) any change in the manufacturing process of a producer for a qualified wheel.

D.2 Requirements

D.2.1 Requirements for the producer

D.2.1.1 General

When manufacture of a wheel involves more than one supplier, the following requirements shall be satisfied by all concerned.

D.2.1.2 Quality organization

A quality assurance system conforming to EN ISO 9001 represents an appropriate means of assuring conformity of a range of products to this Technical Specification. Other appropriate and equivalent quality systems may be applied.

D.2.1.3 Staff qualification

Staff trained in non-destructive testing shall be qualified in accordance with EN 473.

D.2.1.4 Equipment

The equipment used by the supplier for production, control and monitoring shall allow the requirements of this Technical Specification to be satisfied.

An automatic process shall be used for ultrasonic examination of the rim for internal defects during manufacture.

D.2.2 Requirements for the product

The product shall be in accordance with the product requirements defined in Clause 3.

Each wheel shall be traceable throughout the manufacturing process.

D.3 Qualification procedure

D.3.1 General

The qualification procedure for the product shall comprise four successive stages:

a) provision of technical documents by the supplier;

b) evaluation of the manufacturing equipment and production processes;

c) laboratory tests;

d) service experience of wheels.

After the third stage, a temporary qualification certification shall be given in order to allow in-service experience of the wheels to be gained.

D.3.2 Documentation required

At the time of a qualification request, the supplier shall provide a document that comprises:

a) a description of the products which are the subject of the request;

b) a description of the company stating:

   - company size (number of people employed, defining the proportion between fabrication, control and quality assurance);

   - production per year of all products;

   - a list of all the means of manufacture and control;

c) data about the company organization with the appropriate organization charts;

d) a description of manufacturing processes with descriptions of the different stages of manufacturing;

e) data about raw materials with the list of suppliers;

f) results of tests on products which are the subject of the request;

g) qualification certificates, if the product has been previously qualified.

NOTE If documents have already been provided by a supplier for the qualification of another wheel, the documents to be provided by this supplier, for the qualification of a new wheel, have only to be those with new information about the company or this specific wheel.

D.3.3 Evaluation of manufacturing equipment and of the production processes

Evaluation shall comprise:

a) an inspection of the manufacturing plant and examination of the production process;

b) an inspection of the raw material manufacturing plant and examination of its production process;

c) auditing of the manufacturing organization against the requirements of D.2.1;

d) auditing of the information provided in the documents referred to in D.3.2.

At the end of this stage, a report shall be produced that identifies all the production processes, including those of the raw material, which are essential for product quality.

The report shall give an assurance that manufacturing equipment and the production processes satisfy the requirements of D.2.1 for the qualification procedure to continue.

D.3.4 Laboratory tests

All characteristics defined in Clause 3 shall be proven for two wheels produced by the supplier's standard processes, except for fatigue and circumferential residual stress where other requirements are stated.

The fatigue characteristics shall be verified irrespective of the level of stress calculated in accordance with CEN/TS 13979-2.

The fatigue characteristics shall also be verified:

a) if the roughness of the web of the production wheel is higher than that adopted in a previous qualification for that wheel;

b) if the manufacturing processes are significantly different from those used for wheels which are qualified in comparable service.

In order to be sure that the fatigue characteristics defined in 3.2.4.1 are achieved, two wheels shall be tested using the method described in 3.2.4.3, but without statistical evaluation. Radial stress levels shall be equal to those given in Table D.1 and there shall be no fatigue crack initiation after 10^7 cycles.

Table D.1 — Radial stress levels

Symmetrical loading	**Partially machined or as cast and shot peened web** N/mm^2	**Fully machined web** N/mm^2
Value of radial stress for verification	± 168	± 240

For a better understanding of the characteristics of the product to be qualified, there may be a need for further tests (e.g. micrographics and macrographics, etc.) to be conducted at this stage in addition to those mentioned in Clause 3. The results of such tests have no influence on the final decision to be made on qualification.

A report shall be drawn up at the end of this stage, describing the test pieces, the test carried out and the test results. It shall specify whether or not the wheels tested conform to the requirements.

If the outcome is satisfactory, a provisional qualification certificate may be issued.

D.3.5 Testing of wheels

D.3.5.1 Extended production inspection

After provisional qualification, the first batches of an industrial production of the product to be qualified shall be subjected to extended inspection in accordance with the “Qualification” column of Table E.1. Each batch shall comprise wheels of the same melting charge and shall have been heat-treated under the same conditions. The first batch shall comprise at least 24 wheels.

D.3.5.2 Operational testing method

The first wheels supplied on the basis of a provisional qualification shall be specially monitored in service. For this purpose, a programme shall be agreed upon between the supplier and the customer. It shall comprise:

- definition of the number of wheels to be monitored;
- description of the intermediate and final inspections;
- time period for the testing.

D.3.5.3 Results of operational testing

The product shall be deemed as qualified at the earliest 2 years after the first wheel has entered service provided that the acceptance tests defined in the "Qualification" column of Table E.1 have not resulted in any repeated problems. The number of wheels supplied according to the "Qualification" column of Table E.1 is limited to 1 000 wheels or 10 batches. A new report shall be produced. It shall contain as a minimum:

- the number of wheels and batches;
- the results of the operational testing;
- the number of wheels rejected during the tests and the reasons for the rejection.

NOTE The criteria associated with micrographic cleanliness have to be confirmed by in-service experience to demonstrate that there is no fatigue crack propagation beneath the tread.

D.4 Qualification certificate

D.4.1 Condition of the validity

The certificate of qualification shall define the limits of validity, at least for:

a) steel grades;

b) wheel diameters;

c) web thicknesses and shapes.

D.4.2 Modification and extension

At the supplier’s request, the scope of the certification validity may be modified or extended if:

a) other products are to be considered;

b) the main parameters have been modified (e.g. manufacturing processes, quality organization, etc.).

D.4.3 Transference

In the case of a change of ownership, an existing qualification may, when the request is made, be transferred to another company if the relevant content and the conditions prior to qualification have not been modified.

D.4.4 Lapsed certificate

If there has been no production for two years of qualified products that have been previously certified, the wheels of the first batch of the new production shall be delivered in accordance with the "Qualification" column of Table E.1

D.4.5 Cancellation

If the customer records significant defects on the product, the relevant parts of the qualification procedure shall be repeated.

NOTE If the supplier has not respected important conditions of the qualification, it may be cancelled.

D.5 Qualification documents

For every qualified product, a qualification document is produced. It shall contain:

a) the application request of the supplier;

b) the documents supplied by the supplier (see D.3.2);

c) the evaluation reports (see D.3.3);

d) the laboratory test report (see D.3.4);

e) the utilization report (see D.3.5);

f) the qualification certificate (see D.4).

Annex E
(informative)

Product delivery

E.1 General

In its order, the customer shall define:

a) geometry and dimensions of the wheel (drawing);

b) maximum phosphorus content and other minimum and maximum contents if necessary (see Table 1);

c) braking mode of the wheel (e.g. tread brake, disc brake type, etc.) (see 3.2.5);

d) the type of corrosion protection (see 3.11);

e) the location of wheel markings (see 3.13);

f) whether the marking of the nominal diameter of the tread is required;

g) the delivery condition (see E.2).

In its offer, the supplier shall make a proposal for the manufacturing quality control of its products:

h) either by batch control, as described in E.4;

i) or a quality plan approved by the customer, as indicated in E.4.6.

The customer and supplier shall agree on the following points:

j) specimen diameter (see 3.2.1.3);

k) measurement methods (see 3.6.4, 3.9, E.4.3);

l) surface integrity inspection (see Table E.1);

m) imbalance (see E.4).

E.2 Delivery condition

The wheels shall be delivered in one of the following conditions:

— **unmachined** (as-cast and shot-peened condition) where the wheel has not been machined except for what the manufacturer has to do to make the wheel compatible with the requirements of this Technical Specification;

— **rough-machined**, (requested by the customer) where the wheel has been machined and requires subsequent machining;

— **semi-finished**, where the wheel, except for the bore, is finish machined in some parts, but other parts require final machining;

— **finished**, where the wheel has undergone final machining (all parts apart from the bore);

— **finished, ready for assembly**, where all parts of the wheels including the bore are in the final machined state for assembly.

E.3 Controls on each wheel

Whether quality assurance during manufacture is controlled by batch sampling (see E.4), or with a quality plan (see E.4.6), the special characteristics which are defined in Clause 3 require controls to be made on each delivered wheel.

The following specific controls shall be made on each delivered wheel:

a) internal integrity of the rims (see 3.5.2);

b) surface integrity (see 3.7.2 or E.4.5);

c) imbalance (see 3.9);

d) tread diameter, bore diameter, rim profile (see 3.8).

E.4 Batch control

E.4.1 Controls

The nature and number of controls shall be as defined in the "Delivery" column of Table E.1. Batches shall be made up of wheels from the same melt and heat treated in the same conditions.

Table E.1 — Type and number of controls to be carried out

Characteristics to be verified	Number of wheels per batch to control			Clause reference
	Qualification (see D.3.5)	Delivery (see E.2)		
Maximum size of the batch	≤ 100	≤ 250	> 250	-
Chemical composition	1	1	1	3.1
Hydrogen content	[a]	[a]	[a]	[b]
Tensile characteristics:				
in the rim	1	1	2	3.2.1
in the web	1	1	2	3.2.1
Hardness on rim parts	1	1	2	3.2.2
Hardness on rim (homogeneity)	100 %	100 %	100 %	E.4.2
Impact tests	1	1	2	3.2.3
Toughness [c]	1	1	1	3.2.5
Heat treatment homogeneity	10 %	-	-	3.3
Inclusion cleanliness	1	1	2	3.4.1

Table E.1 *(continued)*

Characteristics to be verified	Number of wheels per batch to control			Clause reference
	Qualification (see D.3.5)	Delivery (see E.2)		
Internal integrity				
Rim	100 %	100 %	100 %	3.5.2
Hub	100 %	-	-	3.5.2
Web	20 % [d]	-	-	3.5.2
Residual stresses trends	1	1	2	[h]
State of surface	100 %	100 %	100 %	3.7.1
Surface integrity	100 %	100 % [e]	100 % [e]	3.7.2
Geometry and dimensions	100 % [f]	100 % [f]	100 % [f]	3.8
Static imbalance	100 %	100 %	100 %	3.9
Shot peening				3.10 and E.4.4
Complementary tests	[g]	-	-	E.3.4

[a] One analysis per cast. Care shall be taken to ensure that the reported maximum hydrogen level is representative for the whole cast

[b] The hydrogen content is determined according to methods described in Annex A. It has to be < 2,5 ppm

[c] Only tread-braked wheels

[d] The non-conformance of one wheel will require verification of the whole batch

[e] Magnetic particle inspection is mandated for the web (see 3.7.2.4), and by agreement between the customer and supplier magnetic particle inspection can be replaced by visual inspection for other parts of the wheel

[f] Tread diameter, bore diameter, rim profile

[g] To be defined according to test laboratory results

[h] 3.6 for qualification and E.4.3 for delivery

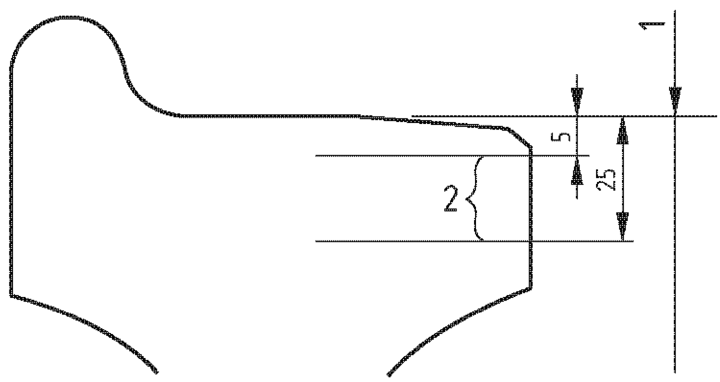
E.4.2 Uniformity of batches by measurement of rim hardness

The measurement of Brinell hardness (ball of diameter 10 mm) shall be checked on the rim of each wheel, after heat treatment.

The test shall be carried out in accordance with EN ISO 6506-1, EN ISO 6506-2 and EN ISO 6506-3 on the flat surface opposite to the flange. The impression shall be located as defined in Figure E.1.

The range of hardness values of the rims of wheels from the same batch shall not exceed 30 HB.

NOTE Brinell hardness impressions may be left on the surface. The test can be made before machining.



Key

1 nominal diameter of tread

2 area of measurement of Brinell hardness

Figure E.1 — Location of hardness measurements

E.4.3 Orientation of residual stresses on rim chilled wheels

The existence of compressive stresses shall be verified by the measurement of the reduction in the distance between two marks, 100 mm apart, marked in the middle of the rim thickness, on the opposite side to the flange. A radial cut shall be made from the top of the flange to the bore, at a position half way between the two marks.

After the internal stresses are relieved, the distance between the two marks shall reduce by a value ≥ 1 mm.

NOTE Other methods may be used by agreement between the customer and supplier.

E.4.4 Shot peening

E.4.4.1 Wheel surface condition

The peened appearance of the rim and hub shall not be cause for rejection. The peening operation shall not prejudice the ability to carry out ultrasonic inspection of the rim in the delivery condition.

E.4.4.2 Frequency of test

Arc height determination shall be made on Almen C strips attached to a test wheel as often as is required to ensure proper adherence to the specification. The suitable frequency shall be established, otherwise, the arc height shall be measured at least once a day, as defined in document AAR M 107 M 208.

E.4.4.3 Retest

If a test fails to meet the arc height requirements of 0,008 Almen C-2, two retests shall be made. These retests shall be averaged with the first test. The average shall not be less than 0,008 and no more than one value of the three shall be less than 0,008.

E.4.4.4 Re-peening

When test values fail to meet the requirements of E.4.4.3, corrective action shall be initiated and satisfactory test values secured before proceeding with production peening. If the average Almen value of the unsatisfactory test is 0,006 to 0,007, the last half of the wheels peened prior to the unsatisfactory test but subsequent to a satisfactory test shall be re-peened with at least half of the original exposure time. If the average Almen value is less than 0,006, all the wheels peened since the last satisfactory test shall be re-peened with full exposure.

E.4.5 Visual inspection

This shall be undertaken in good lighting conditions.

Criteria shall be established with reference images agreed between the customer and supplier.

E.4.6 Quality plan

E.4.6.1 General

In the case of quality control by a quality plan (defined in accordance with EN ISO 9000) of the products to be delivered, it shall be established by the supplier and shall be agreed with the customer.

This quality plan shall refer to the supplier’s quality policy; it shall contain specific elements for the product.

E.4.6.2 Purpose

The plan shall be submitted together with the offer, with the objective of describing the processes and quality control of the supplier in order to achieve the required quality of the product to be delivered. The reasons for their selection shall be provided.

This quality plan shall define the controls which are made during the manufacturing process and those for product delivery.

NOTE These controls may be collated in the control plan of the manufacturing process.

E.4.6.3 Application of the quality plan

Any modification to the quality plan shall only be made with the agreement of the customer.

If the quality plan is cancelled, controls and tests defined by the “control by sampling of batches” are applied in their entirety instead of initial dispensations.

NOTE If a non-conformity is discovered by the customer on the products to be delivered, the clauses relating to application of the quality plan may be discussed and, if the result is unsatisfactory, the quality plan may be cancelled.

E.5 Allowable rectification

The elimination of surface defects by fine-grained grinding with gradual transition shall be allowed within dimensional, geometrical and finished surface tolerances, except on tread surface and bore.

All rectifications shall be in accordance with the conditions given in 3.7.2.

Elimination of any residual imbalance shall be achieved by eccentric machining of the fillet between the web and the rim, on the flange side. The thickness of the removed metal shall not exceed 4 mm and the resultant surface shall be carefully blended into adjacent material. If damping equipment is fitted in this area, the area for the removal of residual imbalance shall be arranged by special agreement between the supplier and customer.

Bibliography

[1] EN ISO 9001, *Quality management systems — Requirements — (ISO 9001:2000)*

[2] NF A 03-405, *Metallic materials — Fatigue tests — Statistical data processing*

[3] EN ISO 6506-3, *Metallic materials — Brinell hardness test — Part 3: Calibration of reference blocks* (ISO 6506-3:2005)

[4] EN 473, *Non-destructive testing — Qualification and certification of NDT personnel — General principles*

[5] EN ISO 9000, *Quality management systems — Fundamentals and vocabulary* (ISO 9000:2005)

[6] EN ISO 6506-2, *Metallic materials — Brinell hardness test — Part 2: Verification and calibration of testing machines* (ISO 6506-2:2005)

[7] CEN/TS 13979-2, *Railway applications — Wheelsets and bogies — Monobloc wheels — Technical approval procedure — Part 2: Cast wheels*

[8] ISO 4967:1998, *Steel — Determination of content of nonmetallic inclusions — Micrographic method using standard diagrams*

[9] CR 10261:1995, *ECISS information circular 11 — Iron and steel — Review of available methods of chemical analysis*

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