

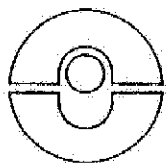
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4th edition, 01.01.89

Technical specification
for the supply of
rolled or forged steel wheel centres
for tractive and trailing stock
Quality requirements



**NUMERISATION DANS
L'ETAT DU DOCUMENT**

International Union of Railways

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Leaflet to be classified in Volumes:

- V - Transport stock
- VIII - Technical specifications

Amendments

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This leaflet carries *obligatory* status except for chemical compositions which are *recommendatory*.

Note

This leaflet forms part of a set which also includes the following leaflets in particular:

- Leaflet 510-1 : Wagon running gear - Normalisation
- Leaflet 515 : Coaches - Running gear
- Leaflet 530-2 : Wagons - Running safety
- Leaflet 541-3 : Brakes - Disc brakes and disc brake linings
- Leaflet 571-1 : Standard wagons - Ordinary two-axle wagons - Characteristics
- Leaflet 571-2 : Standard wagons - Ordinary bogie wagons - Characteristics
- Leaflet 571-3 : Standard wagons - Wagons adapted for certain types of traffic - Characteristics
- Leaflet 571-4 : Standard wagons - Wagons for combined transport - Characteristics
- Leaflet 579-1 : Wagons - Periodical overhaul - Method for establishing its frequency and nature
- Leaflet 853-1 : Technical specification for the supply of tyres for ordinary use on tractive stock.

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1 - Purpose and scope

This technical specification applies to the manufacture of rolled or forged steel wheel centres for tractive and trailing stock.

Its contents are broadly in line with ISO Standard 1005/4 "Rolled or forged wheel centres for tyred wheels for tractive and trailing stock - Quality requirements".

2 - References

This technical specification contains references to the following documents:

- | | | |
|-------------------|---|--|
| ISO/6892 | - | Metallic materials - Tensile test |
| ISO/83 | - | Steel - Charpy resilience testing (U-notch) |
| ISO/R 377 | - | Selection and preparation of samples and test pieces for shear steel |
| UIC Leaflet 510-2 | - | Trailing stock. Wheels and wheelsets. Conditions concerning the use of wheels of various diameters |
| UIC Leaflet 842-3 | - | Surface preparation of metallic and non-metallic materials used in the construction of railway vehicles and containers |
| UIC Leaflet 842-5 | - | Protection against corrosion and painting of coaches and tractive units. |

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3 - Particulars to be supplied by the Purchasing Railway

The following particulars shall be supplied by the Purchasing Railway when inviting tenders and when placing the purchase order:

- a) the number of this technical specification,
- b) the steel grade (see 4.1 and table 1) and, where relevant, additional details concerning its chemical composition,
- c) the metallurgical condition at time of delivery (see 4.2),
- d) any stipulations for checking the chemical composition based on cast analysis (see 5.1),
- e) the degree of finish of the different parts (see 4.3) and the surface condition of machined parts (see 5.3),
- f) the limiting value of residual out-of-balance (see 5.2.4),
- g) the dimensions of the wheel centre (see 5.3),
- h) possible stipulation of a special marking (see 5.4),
- i) possible stipulation of vacuum degassing (see 6.1),
- k) machining and balancing conditions (see 6.2.5),
- l) the type of checks to be performed (see 7.1),
- m) the type of sample and test-piece preparation when it differs from the provisions of paragraphs 7.7.2 and 7.7.3,
- n) the surfaces (if any) to be protected against oxidation (see 8.1),
- o) possible stipulation of macroscopic and macroflux tests (see points 5.2.2.1, 5.2.2.2 and Table 2).

4 - Classification

Wheel centres shall be identified by the steel grade used and by the metallurgical condition at delivery.

4.1 - Steel grade

This technical specification stipulates the following steel grades (C1, C2, C3 and C4) according to the mechanical properties outlined in Table 1.

4.2 - Metallurgical condition on delivery

Wheel centres shall be delivered:

- a) in non-treated condition (no symbol)
- b) in normalised condition (Symbol N)
The "N" condition means that the wheel centre is heated from an initial temperature not exceeding 540° C to one that exceeds by about 25°C the temperature for transforming the steel grade concerned and is kept at this temperature for a sufficient lapse of time and then left to cool in still air.
- c) in hardened and annealed condition (symbol E)
The "E" condition means that the wheel centre is heated, from an initial temperature not exceeding 540°C, to one that exceeds by about 25°C the temperature for transforming the steel grade concerned, is kept at this temperature for a sufficient lapse of time, then left to cool immersed in a suitable liquid. Immersion is followed by annealing at a minimum temperature of 500°C. The wheel centre is then left to cool in still air.

The immersion process (wheel centres E) shall be performed in such a way as to avoid cold cracks.

4.3 - Degree of finish

The degree of finish of the different parts of a wheel centre at delivery may be as follows:

- a) rough cast, when the wheel centre, in the as-rolled or as-cast state, has not undergone any machining except for the machining that the manufacturer must perform to ensure the wheel centre complies with the provisions of the present specification;
- b) rough-machined, when machining is required;
- c) finished, when machining is definitive (inapplicable for borings and bearings);
- d) ready for mounting, this being the condition for a boring that has been definitively machined before mounting.

Unless otherwise specified in the order or its appended documents, the following degrees of finishing shall be applicable:

- hub and webs: rough
- hub surfaces: finished,
- rim and borings: rough-machined.

5 - Characteristics

5.1 - Chemical composition

Unless otherwise stipulated in the order or its appended documents, the maximum contents of the different elements are as given in Table 1. These values shall apply for product analysis.

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Subject to agreement when placing the order, the Purchasing railway can accept checking of the chemical composition by cast analysis in preference to the product-analysis method. Cast analysis shall be performed on the basis of the values in Table 1, less the permissible variations specified in table 3.

5.2 - Physical and mechanical characteristics

5.2.1 - Appearance

Parts kept rough must be perfectly trimmed and blend in smoothly with machined parts.

The surfaces of wheel centres shall not present any marking outside the areas assigned for this purpose in the order or its appended documents.

5.2.2 - Structure

In the case of structural examination, the structure shall after micrographic testing comply with the stipulations in the order or its appended documents.

5.2.2.1 - Macroscopic examination

After polishing, the surface examined shall not reveal any breaks in continuity whatsoever.

5.2.2.2 - Macroflux examination (Baumann method)

After etching the picture obtained shall not reveal any defects that are more pronounced than those given in the album appended to UIC Leaflet 812-3.

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5.2.3 - Soundness

Wheel centres shall be sound in all their parts and shall not have any defect liable to impair their use.

5.2.4 - Residual out-of-balance

Unless otherwise specified in the order or its appended documents, the out-of-balance moment of the wheel centre shall not exceed the maximum limiting values given in the table below:

Wheel centre for vehicles running at	Maximum residual out of-balance in g/m
$V \leq 120$ km/h	125 1)
$120 < V \leq 200$ km/h	75 2)
1) to be stipulated when placing order. 2) Maximum speeds for tyred wheels: see UIC Leaflet 510-2	

5.2.5 - Mechanical characteristics

The mechanical characteristics of wheel centres shall comply with the provisions of Table 1.

5.3 - Dimensional characteristics and condition of surfaces

The dimensions of wheel centres shall be specified in the order or its appended documents.

Dimensional tolerances, form errors, permissible machining allowances as well as surface roughness values shall comply with the provisions of UIC Leaflet 812-5.

5.4 - Manufacturing brand marks

The marking shall comply with the instructions (positions and dimensions) of the technical specifications, or those given in the order or its appended documents.

Unless otherwise stipulated, each wheel centre shall be stamped with following markings:

- a) manufacturer's mark,
- b) number of cast,
- c) steel grade and symbol of metallurgical condition,
- d) date of manufacture (month and last two figures of year of manufacture)
- e) inspector's stamp
- f) location of out-of-balance with indication of its value.

In the absence of specific instructions regarding siting the marks a) to d), these marks shall be stamped on the outer surface of the hub. The use of stamping dies with sharp edges is prohibited.

Likewise, in the absence of specific instructions on the location of the out-of-balance, the latter shall be identified by a radial line some 15mm wide to pinpoint the position of the out-of-balance. In the latter case, the value of the out-of-balance shall be indicated as follows beneath the line extremity:

- E2 when the mandatory out-of-balance is \leq 75 gm;
- E3 when the mandatory out-of-balance is \leq 125 gm.

6 - Manufacture

The manufacture of wheel centres may only be commissioned to firms approved by the Purchasing Railway for this type of supply.

6.1 - Steel production and casting

The wheel centres shall be made from steel produced by electric processes, by pure-oxygen top-blowing process or by any other process certified equivalent by the Purchasing Railway.

The steel shall be killed, bottom-cast and, when specified in the order or its appended documents, vacuum-degassed.

Continuous casting shall also be allowed, subject to the prior agreement of the Purchasing Railway.

6.2 - Manufacture of wheel centres

6.2.1 - Rough-forging, forging or rolling

Wheel centres shall be manufactured from:

- cropped ingots each capable of delivering two or more wheel centres;
- or cropped rough-rolled ingots.

Non-cropped ingots sufficient for only one wheel centre can only be used with the agreement of the Purchasing Railway.

Ingots used shall be sufficiently cropped to ensure total elimination of the defective areas at the top and bottom of the ingots.

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Any surface flaw observed shall be removed either before or during the wheel centre manufacturing process. When this is not possible, sections found to contain flaws shall be declared unfit for manufacturing purposes and definitively scrapped.

Ingot or bloom sections shall be cast, punched and rough-shaped by power-hammer or press. They shall then be finished by rolling or stamping, supplemented by calibration where applicable.

Wheel centres in the as-rolled or as-stamped condition shall comply with the provisions in paragraph 5.3.

Precautions shall be taken before and during the hot-working phase to avoid metal overheating or grain coarsening through protracted exposure to high temperature.

The temperature of the material shall never exceed 1260°C, and the forging or rolling phase shall be completed at a temperature ranging from 850°C to 1000°C.

When the steel has not been degassed, precautions shall be taken to avoid flaking, for example by allowing the wheel centres to cool down slowly to room temperature after forging, rolling, calibrating (where applicable) and punching of identification markings.

Wheel centres shall in all cases be left to cool down in still air after forging, rolling, calibrating (where applicable), and hot-punching of identification markings.

6.2.2 - Removal of defective parts

Surface defects, when the soundness characteristics stipulated in paragraphs 5.2.1 and 5.2.3 cannot be guaranteed, shall be removed before or during manufacture of the wheel centres.

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6.2.3 - Identification of wheel centres during manufacture

All ingots, blooms, sections and wheel centres shall be marked at each manufacturing stage so that each wheel centre before delivery should be identifiable as stipulated in § 5.4. The depth of punched identification markers, when these differ from the manufacturing marks defined in § 5.4, must be minimal enough to prevent these markers subsisting on the finished wheel centre.

6.2.4 - Heat treatment

Wheel centres shall be subjected to heat treatment stipulated in the order or its appended documents (see 4.2).

6.2.5 - Machining and balancing

Machining conditions shall be selected in a way that ensures the wheel centres comply with the surface-condition and tolerance criteria stipulated in the order or its appended documents.

Unless otherwise specified in the order or its appended documents, the out-of-balance shall be eliminated by off-centred turning or smooth grinding of the fillet radius between web and rim, on the inner surface (see Figure 1). The thickness of metal removed shall not exceed 4mm, and the reworked surface shall also be joined to adjacent surfaces with care.

Addition of extra mass shall not be authorised under any circumstances.

Piercing of static-equilibration holes shall be prohibited for the wheel centres of powered stock. It shall be allowed for the wheel centres of hauled stock only after prior agreement notified by the Purchasing Railway.

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6.2.6 - Possible corrective finishing**6.2.6.1 - Authorised corrective finishing**

Subject to the agreement of the Purchasing Railway, surface defects can be eliminated by metal removal, by machining or smooth grinding, providing these methods do not cause any cracks to occur due to heat, and on condition they ensure compliance with the dimensional tolerances.

6.2.6.2 - Unauthorised corrective finishing

All weldings, all traces of blow pipe, heating, incipient arcing, all resurfacing by metallization, by electroplating or chemical deposit, etc., as well as all corrective finishing aimed at hiding a defect, shall be strictly prohibited and shall result in rejection of the whole batch.

7 - Inspection**7.1 - Type of inspection**

Inspections shall include manufacturing checks and the inspection of characteristics.

The order or its appended documents shall specify whether inspections shall be performed:

- a) by delegation granted to the manufacturer's specialist department
- b) or with the representative of the Purchasing Railway in attendance.

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Unless otherwise stipulated in the order or its appended documents, the stipulations in column 5 of table 2 shall apply.

The delegation for inspection granted by the Purchasing Railway to the manufacturer's specialist department shall not remove the Purchasing Railway's right to check the efficiency of manufacturing checks and to ensure (if required) that the checking and testing methods used are efficient.

To this end, the representative of the Purchasing Railway shall be authorised to attend all the tests carried out under the responsibility of the manufacturer and to verify the results obtained.

7.2 - Manufacturing checks

The manufacturer shall inform the Purchasing Railway of the procedure followed for carrying out the orders and shall seek its agreement for any modifications that might be deemed necessary for various reasons.

It shall be possible for the representative of the Purchasing Railway to check that the different manufacturing operations effectively comply with the provisions of this specification and its appended documents.

To this end, this representative shall be provided, in particular, with properly calibrated radiation pyrometers and recording pyrometer graphs.

7.3 - Verification of the characteristics of wheel centres**7.3.1 - Nature of checks and tests**

As part of the works acceptance process, each batch of wheel centres shall be put through the mandatory or optional checks and tests stipulated in Table 2.

7.3.2 - Test unit and batching

The test units identifying with the different cases are defined in Column 7 of Table 2.

For quality control, the wheel centres shall be presented in batches. Each batch shall contain wheel centres taken from the same casting and heat-treated under the same conditions. It may comprise wheel centres of different shapes providing these wheel centres have the same nominal diameter and rim section, in the case of wheel centres for powered stock.

7.3.3 - Condition of wheel centres for presentation

Wheel centres for presentation shall be in the condition stipulated in Table 2, Column 6.

7.4 - Notification of presentation to the representative of the Purchasing Railway

The date of presentation shall be notified to the representative of the Purchasing Railway in writing (see 7.5.2). The notification document shall state the number - by type- of wheel centres presented in each batch, as well as the references of the order to which they relate.

Presentation of wheel centres may be arranged in two phases:

- a) once before machining to check the chemical, mechanical and physical characteristics, except in respect of appearance and residual out-of-balance;
- b) a second time in delivery condition for the other checks.

7.5 - Certification

7.5.1 - The manufacturer, irrespective of whether his specialist department or the representative of the Purchasing Railway is responsible for the inspection process, shall provide a certificate stating that the manufacturing regulations in the present technical specification have been effectively observed. The final test certificate shall also contain the results of the following tests:

- chemical analysis (see 7.7.3.1)
- tensile test (see 7.7.3.2)
- resilience test (see 7.7.3.3)
- appearance and dimensional checks.

7.5.2 - The manufacturer shall provide the relevant certificates for the tests and checks falling under his responsibility:

- a) at the time of delivery if responsibility for all the tests rests with the supplier;
- b) at the time of initial presentation for checking (see point 7.4) if he is only responsible for part of the tests.

7.6 - Number of checks and tests

The number of wheel centres to be submitted for checks per test unit and the number of tests per wheel centre are specified in Table 2, columns 8 to 10.

7.7 - Sampling and preparation of samples and test pieces

7.7.1 - Sampling

The inspector, after identifying the batch, shall random select the wheel centre(s) for testing and shall punch them indelibly.

He shall trace on each of these wheel centres the boundaries of a sample sector (Figure 2) from where the samples shall be taken.

7.7.2 - Preparation of samples and test pieces

When the conditions of preparation of samples and test pieces are not specified in the working documents, this preparation shall be carried out in accordance with the provisions of Recommendation ISO/R 377

Samples and test pieces shall retain the identification markings and the inspector's stamp. Any transfer may only be effected in the presence of the inspector.

7.7.3 - Number and location of test pieces

Test pieces shall be taken from sample zones previously identified by the inspector and stamped by him.

7.7.3.1 - Chemical analysis

Unless otherwise stipulated in the order or its appended documents, the following shall be removed from the wheel centre:

- a sample of at least 50 grams of chippings representing the mean chemical composition of a radial wheel-centre section;
- or, in the case of spectrographic analysis, a test piece taken at location 1 of Figure 2 from the sample subjected to tensile tests.

7.7.3.2 - Tensile test

A test piece shall be taken at location 1 from the sample mentioned in Figure 2.

The test pieces shall conform to the provisions of ISO standard 6892. They shall be at least 10 mm in diameter and the length between markers shall be equal to $L_0 = 5.65 \sqrt{S_0}$.

7.7.3.3 - Resilience test (with U notch)

Three test pieces a, b, c, shall be taken in the sample zone at the locations mentioned in Figure 2.

Marking of the resilience test-pieces shall allow easy identification of the longitudinal surfaces of these test pieces parallel to Section AA (Figure 2).

The test pieces shall conform to the provisions of ISO Standard 83. The axes of the cylinders forming the notch bases shall be parallel to diameter AA (see Figure 2).

7.7.3.4 - Structural examination

The test piece shall be removed in accordance with instructions given in the order or its appended documents.

7.7.3.5 - Macroscopic and macroflux examination (Baumann method)

The test piece shall consist of a radial slice cut down the entire cross section of a wheel. One of the surfaces shall be ground or polished sufficiently for machining traces to disappear and for a clear macroflux picture to be obtained.

7.7.3.6 - Balancing

The test piece shall consist of the finished wheel centre (see § 4.3c).

7.8 - Organisation of checks and tests

7.8.1 - Chemical analyses

These analyses shall be performed in accordance with the methods defined in the corresponding ISO Standards or, in case of dispute, using any other method accepted by the purchasing Railway.

7.8.2 - Tensile test

The tensile test shall be performed in accordance with the provisions of ISO Standard 6892.

7.8.3 - Resilience test (with U notch)

The resilience test shall be performed in accordance with the provisions of ISO Standard 83.

7.8.4 - Balancing test

The residual out-of-balance of each wheel centre shall be measured using a suitable device certified by the Purchasing Railway.

7.8.5 - Appearance check

Appearance check shall be based on visual inspection before delivery.

7.8.6 - Verification of dimensions and surface roughness

This verification shall be carried out using all appropriate means provided by the manufacturer and previously certified by the Purchasing Railway, and more particularly regularly recalibrated gauges.

7.9 - Conclusion of checks

Any reported appearance or dimensional defect shall cause the corresponding wheel centre to be rejected.

Any other result that does not match the stipulated characteristics shall cause the corresponding batch to be rejected.

Prior to their despatch, accepted wheel centres shall be stamped by the representative of the Purchasing Railway.

7.10 - Cross-checks

In cases where the results do not comply with specifications and where the Purchasing Railway accepts organisation of cross-checks, the procedures for such tests and for any additional tests shall be defined by special agreement between the Purchasing Railway and the manufacturer.

8 - Delivery

8.1 - Protection against corrosion

After acceptance, and before storage or shipment, the wheel centres shall receive a protective coating acceptable to the Purchasing Railway.

Preparation of the surfaces shall comply with the provisions of Leaflet 842-3, and protection against corrosion shall preferably be ensured by applying the provisions of UIC Leaflet 842-5, Appendix 2, point 2.2.

Protection shall be provided:

- on all the parts of fully-machined wheel centres; however, wheel centres destined for new powered stock under construction shall only receive a thin oil or grease coating over all their parts;
- on the other wheel centres and, when stipulated in the order of its appended documents, on the rough-machined or machined parts of the hub.

8.2 - Protection against impact

Proper protection against impact for fully machined parts, in particular wheel centre borings, shall be afforded before despatch.

9 - Guarantee

Guarantee terms shall be agreed between manufacturer and purchasing railway when the order is being placed. Unless otherwise stipulated in the order or its appended documents, wheel centres shall be guaranteed by the manufacturer for a five-year period against any defect ascribable to manufacture and which was not detected during factory inspection.

This period shall be calculated from the end of the month stamped on the wheel centre.

In the case of wheel centres mounted on new stock, the delivery date of the vehicles to which they are fitted shall be considered as starting date of the guarantee period.

Wheel centres which, during the guarantee period, reveal defects making them unfit for use or liable to shorten their service life, shall be rejected.

However, before they are definitively rejected, defective wheel centres can be subjected to check tests by the Purchasing Railway and the manufacturer when this is requested by the latter.

When the check test confirms that the defects are effectively ascribable either to manufacture or to non-compliance with the protection methods stipulated in §§ 8.1 and 8.2, the wheel centres concerned shall be definitively rejected.

When the results of the check-tests fail to produce an agreement between the Purchasing Railway and the manufacturer, experts approved by both parties shall be enlisted to resolve the dispute. The corresponding costs shall be borne by the party declared responsible.

When two wheel centres from the same casting have ruptured in service (in other words when they have become unusable owing to a break in continuity), or when over 5% of wheel centres from the same casting have been found to contain defects leading to their rejection, the Purchasing Railway shall be entitled to reject the whole batch of wheel centres from the casting concerned.

Rejected wheel centres shall be made available to the manufacturer with a view to their replacement or reimbursement of their as-new value at the time of withdrawal.

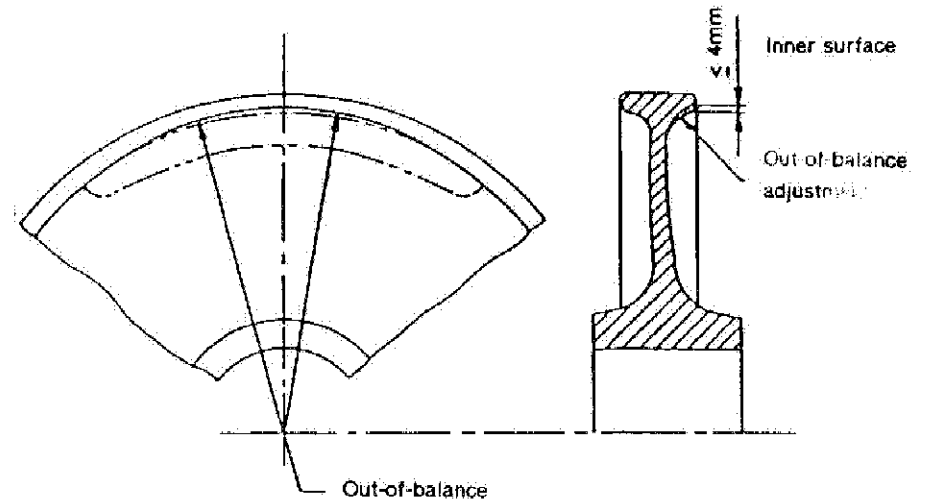


Figure 1 - Out-of-balance adjustment

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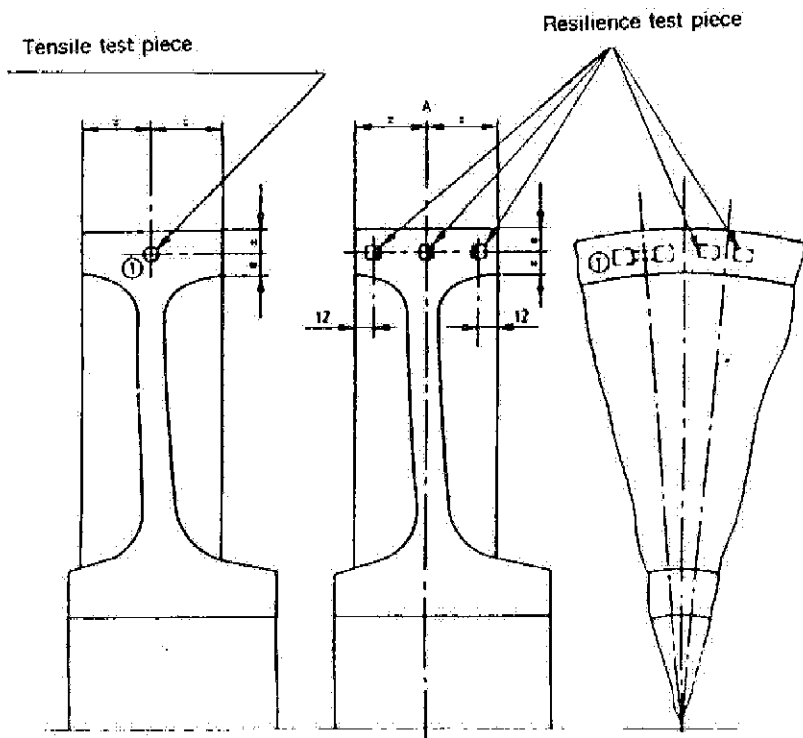


Figure 2 - Location of tensile and resilience test pieces (dimensions in mm)

Table 1 : Steel grade, chemical composition, heat treatment in delivery condition and mechanical characteristics.

Preliminary remark:

The chemical composition and heat treatment characteristics in delivery condition shall apply unless otherwise stipulated in the order or its appended documents (see § 5.1).

Steel grade	Designation as per other standards	Chemical composition, (maximum content in %)										Heat treatment in delivery condition	Mechanical characteristics			
		C	Si	Mn	P	S	Cr	Cu	Mo	Mi	Y		Re ³⁾ N/mm ²	Rm ² N/mm ²	A min % min ⁴⁾	KU min (1)
C1	C22	0,22	0,50	1,20	0,040	0,040	0,30	0,30	0,05	0,30	0,05	N	No-tional	410-490	27	35
C2	C35 ⁵⁾	0,37	0,50	1,20	0,040	0,040	0,30	0,30	0,05	0,30	0,05	N		500-650	20	25
C3	C45 ⁵⁾	0,52	0,50	0,90	0,040	0,040	0,30	0,30	0,08	0,30	0,05	N	val-ues	650-760	16	15
C4	46 Mn S14	0,50	0,90	1,20	0,040	0,040	0,30	0,30	0,05	0,30	0,05	E		750-850	20	20

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1) Analysis of casting (see 5.1).

2) R_e = Elastic limit, R_m = Tensile strength

A = Percentage elongation at rupture: $(L_0 = 5.65 \sqrt{S_0})$

KU = resilience test with ISO test piece with U-notch at 20°C

3) When the conventional elastic limit of steel for a total elongation of 0.5 % ($R_{t 0.5}$) does not exceed 600 N/mm², R_t 0.5 can be used in place of R_{eH} or 3p 0.2.

4) When only one of the values obtained with the resilience test pieces a, b, c defined in § 7.7.3.3. is comprised between 70% and 100% of the minimum prescribed limit, check tests can be carried out on two new test pieces taken as close as possible to the area of the test piece which yielded an unsatisfactory result. The result obtained on each of these new test pieces shall at least equal the minimum prescribed value. However, the aggregate of the results and of the resilience obtained on the defective test-piece must at least equal three times the minimum prescribed value.

5) The criteria imposed for the composition of steel grades C35E4 and C45E4 as per ISO R 683 1 are compatible with the limiting values given for steel grades E2 and C3.

Table 2: Nature and number of tests with wheel centres

1	2	3	4	5	6	7	8	9	10
Delivery condition 1)	Nature of checks and tests	Remarks	2) 3) 4)		Test unit	Number of wheel centres to be submitted for checking per batch		Number of tests per wheel centre	
			2)	3)		Total number of wheel centres per batch ≤ 250	Total number of wheel centres per batch > 250		
1	all	Chemical analysis 6)	m	a		c	1	1	1
2	all	Tensile test	m	b	h	c, h	1	2	1
3	all	Resilience test (KU)	m	b	h	c, h	1	2	3
4	E	Micrographic test	o	a	h	c, h	1	2	1
5	all	Macroscopic and macroflux test	o	a	h	c, h	1	2	1
6	all	Balancing	o 7)	a	f	W	100 %	100 %	1
7	all	Appearance and dimensions	m	a	f	W	100 %	100 %	1

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- 1) E = hardened and tempered
- 2) m = mandatory,
 - a = optional, in other words: the test is only to be carried out when stipulated in the order or its appended documents
- 3) Unless otherwise agreed (see 7.1), checks and tests shall be performed by:
 - a = the manufacturer's specialist department, or
 - b = in the purchaser's presence
- 4) h = the tests shall not be performed before the prescribed heat treatment
 - f = the acceptance tests shall be performed in final delivery condition
- 5) c = wheel centres from the same casting
 - c, h = wheel centres from the same casting or from the same heat-treatment batch (see 7.3.2)
 - w = the wheel centre is the test unit
- 6) see 5.1
- 7) m = for wheel centres mounted on vehicles with a maximum speed in excess of 120 km/h

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Table 3: Permitted variations (reductions) in cast analysis from composition limits specified in Table 1 for product analysis

Element	Specified limits on product (%)	Permitted variation in relation to the product composition (%)
C	≤ 0.55	- 0.02
Si	≤ 0.50 > 0.50 ≤ 0.90	- 0.03 + 0.04
Mn	≤ 1.00 > 1.00 ≤ 1.20	- 0.04 - 0.05
P	≤ 0.040	- 0.005
S	≤ 0.040	- 0.005
Cr	≤ 0.30	- 0.05
Mo	≤ 0.08	- 0.03
Ni	≤ 0.30	- 0.05
V	≤ 0.05	- 0.02
Cu	≤ 0.3	- 0.02

Application

With effect from 1 January 1989.

All UIC railways.

Record references

Most recent heading under which the question has been examined:

- Item 5.1 - Approval of revised Leaflet 812-1.
"Technical specification for the supply of rolled or forged steel wheel centres for tractive and trailing stock - Quality requirements".

(Traction and Rolling Stock Committee : Paris; June 1988)