

# ISO

INTERNATIONAL ORGANIZATION FOR STANDARDIZATION

## ISO RECOMMENDATION R 1005/VI

RAILWAY ROLLING STOCK MATERIAL

SOLID WHEELS FOR TRAILER STOCK

1st EDITION

May 1969

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Printed in Switzerland

Also issued in French and Russian. Copies to be obtained through the national standards organizations.

## BRIEF HISTORY

The ISO Recommendation R 1005/VI, *Railway rolling stock material - Solid wheels for trailer stock*, was drawn up by Technical Committee ISO/TC 17, *Steel*, the Secretariat of which is held by the British Standards Institution (BSI).

Work on this question led to the adoption of a Draft ISO Recommendation based on a corresponding UIC\* code.

In January 1968, this Draft ISO Recommendation (No. 1380) was circulated to all the ISO Member Bodies for enquiry. It was approved, subject to a few modifications of an editorial nature, by the following Member Bodies :

Austria	Hungary	South Africa, Rep. of
Belgium	India	Spain
Canada	Israel	Sweden
Colombia	Italy	Switzerland
Czechoslovakia	Netherlands	Turkey
Denmark	New Zealand	U.A.R.
Finland	Norway	United Kingdom
France	Poland	Yugoslavia
Germany	Romania	

One Member Body opposed the approval of the Draft :

Japan

The Draft ISO Recommendation was then submitted by correspondence to the ISO Council, which decided, in May 1969, to accept it as an ISO RECOMMENDATION.

\* Union Internationale des Chemins de fer (International Union of Railways).

RAILWAY ROLLING STOCK MATERIAL  
SOLID WHEELS FOR TRAILER STOCK

## 1. SCOPE

This ISO Recommendation applies to the manufacture of solid rolled unalloyed steel wheels for trailer stock, as-rolled, rough-machined, half-finished or fully finished.\*

## 2. CLASSIFICATION

This ISO Recommendation covers two classes of solid rolled unalloyed steel wheels :

- class BV 1
- class BV 2

## 3. CHEMICAL COMPOSITION

Solid wheels for trailer stock should be manufactured from non-alloy steel\*\* of the following chemical purity :

phosphorus	≤ 0.05 %
sulphur	≤ 0.05 %
phosphorus + sulphur	≤ 0.09 %

\* The terms in question are defined as follows :

- (a) *As-rolled.* A wheel obtained by hot-working and which, having to be subsequently machined, has not yet undergone any machining whatsoever.
- (b) *Rough-machined.* A wheel having received no final machining, but having been rough-machined on all or certain portions, which have to be machined.
- (c) *Half-finished.* A wheel having received final machining on certain portions which have to be machined.
- (d) *Fully finished.* A wheel in which all portions having to be machined have undergone their final machining.

\*\* For this steel, the content of elements other than carbon should not exceed the following limits :

manganese . . . . . 1.20 %	molybdenum . . . . . 0.05 %
silicon . . . . . 0.50 %	vanadium . . . . . 0.05 %
nickel . . . . . 0.30 %	copper . . . . . 0.30 %
chromium . . . . . 0.30 %	

#### 4. MECHANICAL PROPERTIES

##### 4.1 Tensile strength $R_m$

The tensile strength of the solid wheels should be as follows :

class BV 1 : between 60 and 72 kgf/mm<sup>2</sup> ;

class BV 2 : between 70 and 84 kgf/mm<sup>2</sup> .

Narrower ranges coming within the limits shown above may be used if indicated on the order.

##### 4.2 Coefficient of quality $C$

The coefficient of quality (defined in Table 1, below) should be as follows :

wheels which have not been normalized :  $C \geq 95$  with  $A \geq 8\%$  on a test piece having a gauge length  $L_0 = 5.65 \sqrt{S_0}$ , for class BV 2 ;

normalized wheels :  $C \geq 109$ .

TABLE 1 - Coefficient of quality  $C$

$L_0$	$C$
$8.16 \sqrt{S_0}$	$R_m + 2.5 A$
$5.65 \sqrt{S_0}^*$	$R_m + 2.2 A$
$4 \sqrt{S_0}$	$R_m + 2 A$

\* This formula should preferably be adopted.  
The other formulae are retained provisionally.

where

$L_0$  is the gauge length used to measure the elongation after fracture, expressed in millimetres;

$S_0$  is the cross-sectional area of the gauge length of the test piece, expressed in square millimetres;

$R_m$  is the tensile strength, expressed in kilogrammes-force per square millimetre;

$A$  is the percentage elongation after fracture.

##### 4.3 Resistance to impact

The wheel should be able to withstand consecutive blows which cause a permanent deflection of at least 10% of the radial length of the web, without incurring flaws, cracking or breaking.

##### 4.4 Notched bar impact strength KCU

(Applicable only where the wheels are in the normalized condition)

The notched bar impact strength should be as follows :

class BV 1 : KCU at + 20 °C  $\geq 3$  kgf.m/cm<sup>2</sup> ;

class BV 2 : KCU at + 20 °C  $\geq 2$  kgf.m/cm<sup>2</sup> .

##### 4.5 Brinell hardness

The difference between the extreme Brinell hardness values of wheels from the same cast should not be more than 30 HB units.

## 5. PHYSICAL CHARACTERISTICS

### 5.1 Macrostructure and macrographic appearance

After ordinary polishing, the surface examined should show no sign of any piping or discontinuity.

The sulphur print obtained should not reveal worse faults than those shown in the prints contained in the album forming an Annex to this ISO Recommendation.

### 5.2 Soundness and appearance

The wheels should be sound throughout and without cracks, blow-holes, inclusions, flaws, burrs, lack of metal, laps, or any other defect detrimental to their use.

The texture should be of a fine, close structure, with no discontinuities or traces of foreign matter.

The portions remaining black should be perfectly trimmed without trace of diejoint or other defect liable to impair the appearance or use of the wheels.

The finish of the machined surfaces should comply with the indications given on the drawing or comparison specimens.

### 5.3 Static balance

(To be verified only on half-finished or fully finished wheels for which only the rough-machined bore remains to be brought to the final dimension.)

The out-of-balance of the solid wheels should be capable of correction by a balance weight attached to the wheel at a distance of 500 mm from the centre and having a maximum mass of 250 g\*.

The radial position and value of the residual out-of-balance should be stamped according to the requirements stated in the specification or drawing.

\* For certain vehicles, the order can stipulate a lower limit for the maximum out-of-balance.

## 6. DIMENSIONAL CHARACTERISTICS

Solid wheels should be manufactured in accordance with the information given on the standards or drawings relating to the shape, dimensions and dimensional tolerances.

Unless otherwise indicated, the machining allowances and tolerances should be those given in the following tables :

TABLE 2 – Machining allowances and dimensional tolerances  
General cases

Allowances and tolerances in millimetres

	Unmachined parts			Rough-machined parts		Fully finished parts
	Machining allowances in the event of subsequent machining on the consignee's premises	Tolerances		Machining allowances (when ready for delivery)	Tolerances	Tolerances
		In the event of subsequent machining on the consignee's premises	When maintained in the black condition			
<b>Rim</b>	External diameter . . . . .	8	+12 0	—	*	*
	Width . . . . .	8	+8 0	—	*	*
	Internal diameter . . . . .	6	0 -10	0 -8	—	—
	Out-of-round . . . . .	—	3	—	—	1
	Buckle . . . . .	—	3	—	—	1
<b>Hub</b>	External diameter . . . . .	10	+20 0	+15 0	—	—
	Maximum eccentricity . . . . .	—	5	5	—	—
	Internal diameter . . . . .	20	0 -20	—	5	0 -2
	Length . . . . .	15	+10 0	—	3	+2 0
<b>Web</b>	Position of the web . . . . .	—	4	5	—	—
	Thickness at the connection with the rim . . . . .	8	+6 0	+8 0	—	—
	Thickness at the connection with the hub . . . . .	10	+8 0	+10 0	—	—

as shown  
on the  
drawing

\* See ISO Recommendation R 1005/II , *Railway rolling stock material – Rough tyres for trailer stock – Dimensions and tolerances.*

TABLE 3 – Machining allowances and dimensional tolerances  
Special case of solid wheels on vehicles running at high speeds

Allowances and tolerances in millimetres

		Unmachined parts			Rough-machined parts		Fully finished parts
		Machining allowances in the event of subsequent machining on the consignee's premises	Tolerances		Machining allowances (when ready for delivery)	Tolerances	Tolerances
			In the event of subsequent machining on the consignee's premises	When maintained in the black condition			
Rim	External diameter . . . . .	8	+8 0	—	4	+2 0	as shown on the drawing
	Width . . . . .	8	+8 0	—	4	±1	
	Internal diameter . . . . .	6	0 -6	0 -8	—	—	
	Out-of-round . . . . .	—	3	—	—	1	
	Buckle . . . . .	—	3	—	—	1	
Hub	External diameter . . . . .	10	+10 0	+15 0	—	—	
	Maximum eccentricity . . . . .	—	5	5	—	—	
	Internal diameter . . . . .	20	0 -20	—	5	0 -2	
	Width . . . . .	15	+10 0	—	3	+2 0	
Web	Position of the web . . . . .	—	4	5	—	—	
	Thickness at the connection with the rim . . . . .	6	+4 0	+8 0	—	—	+2 0
	Thickness at the connection with the hub . . . . .	8	+6 0	+10 0	—	—	+2 0

## 7. IDENTIFYING MARKS

Each wheel should be stamped with the marks defined in the standards or drawings, and in particular with:

- the number of the cast;
- the manufacturer's marks;
- if applicable, the consecutive number of the wheel;
- the number of the month and the last two figures of the year of manufacture;
- the class of steel (BV 1 or BV 2).

*Example* : 2320 – XY – 21352 – 2.69 – BV 1.

These identifying marks should be hot-stamped, immediately after forging or rolling, at 3 or 4 mm depth, using stamps with blunt edges, in the position indicated on the drawing or the order.

Cold-stamping on a machined surface of the hub can also be carried out in the other cases, provided the purchaser agrees.

Next to the identifying marks, a circular recess 20 mm in diameter should be made to a depth of 2 mm, for the purpose of accommodating the accepting inspector's stamp.

## 8. STEELMAKING PROCESS

The solid wheels should be made from steel produced by the open hearth or electric processes. The purchaser may, however, allow other processes which he considers equivalent.

## 9. MANUFACTURE OF THE SOLID WHEELS

The solid wheels should be manufactured from cropped ingots.

Individual ingots, of special shape and uncut, may only be used with the formal agreement of the purchaser on the order.

The cropping of ingots and blooms should be sufficient to eliminate all defective parts at the top and bottom of the ingot.

Surface flaws observed on the ingot sections should be removed or, if this is not possible, the defective sections should be discarded.

The ingot sections should be forged, punched and rough-shaped by means of a power hammer or a press; they should be finished by rolling.

During re-heating before hot working, and during hot working itself, the temperature of the ingot sections or of rough wheels should never exceed 1250 °C.

Rolling should be completed at a temperature between 850 and 1000 °C.

After forming, rolling, gauging (if applicable) and stamping, the wheels should

- in general, be left to cool to ambient temperature sheltered from draughts, preferably in a covered cooling pit or under a cover, especially in the case of class BV 2 steel;
- if specified on the order, or if required by the manufacturer, be normalized\* after having been allowed to cool without special precautions being taken.

The normalizing of a cast can also be carried out by mutual agreement between the manufacturer and the purchaser, for the purpose of improving unsatisfactory mechanical properties; in this case, the properties obtained after this operation should conform to those required for wheels which have been ordered as normalized.

In general, all the operations should be carried out with the greatest possible care and in such a way as to ensure the uniformity of the structure of the different points of the same wheel and that of the wheels of the same cast.

\* Normalizing should be understood to mean leaving the wheels to cool after rolling until they have reached ambient temperature, then heating them uniformly to a temperature above that of the transformation point, and maintaining them at that temperature for a sufficiently long period, before leaving them to cool in still air sheltered from draughts.

## 10. REMOVAL OF SURFACE DEFECTS

Surface defects may be eliminated by removal of metal, either with a tool or a grinding wheel, provided the dimensional and balance tolerances are maintained; a blowpipe should not be used for removing these defects.

Any treatment which is carried out with the object of hiding a defect should be strictly forbidden and should result in the rejection of the complete order.

## 11. SUBMISSION FOR ACCEPTANCE

### 11.1 During manufacture

11.1.1 The accepting inspector should verify the specifications of section 9 relating to cropping

- on ingot sections by visual examination of the cross-section of the cut;
- on individual ingots by visual examination of the top end of the ingots after cropping.

The purchaser may agree to have these verifications carried out by the supplier, not in the presence of his inspector.

11.1.2 The accepting inspector should be able to verify the temperature of the rough wheels, that of the wheels after rolling and that of the furnaces used for the heat treatment.

For this purpose he should be provided with

- correctly calibrated optical pyrometers in order to verify the temperature of the rough wheels and that of the wheels after rolling;
- the charts of correctly calibrated recording pyrometers in order to verify the temperature of the furnaces used for the heat treatment.

The purchaser may dispense with the temperature verification specified above in whole or in part if he thinks this advisable.

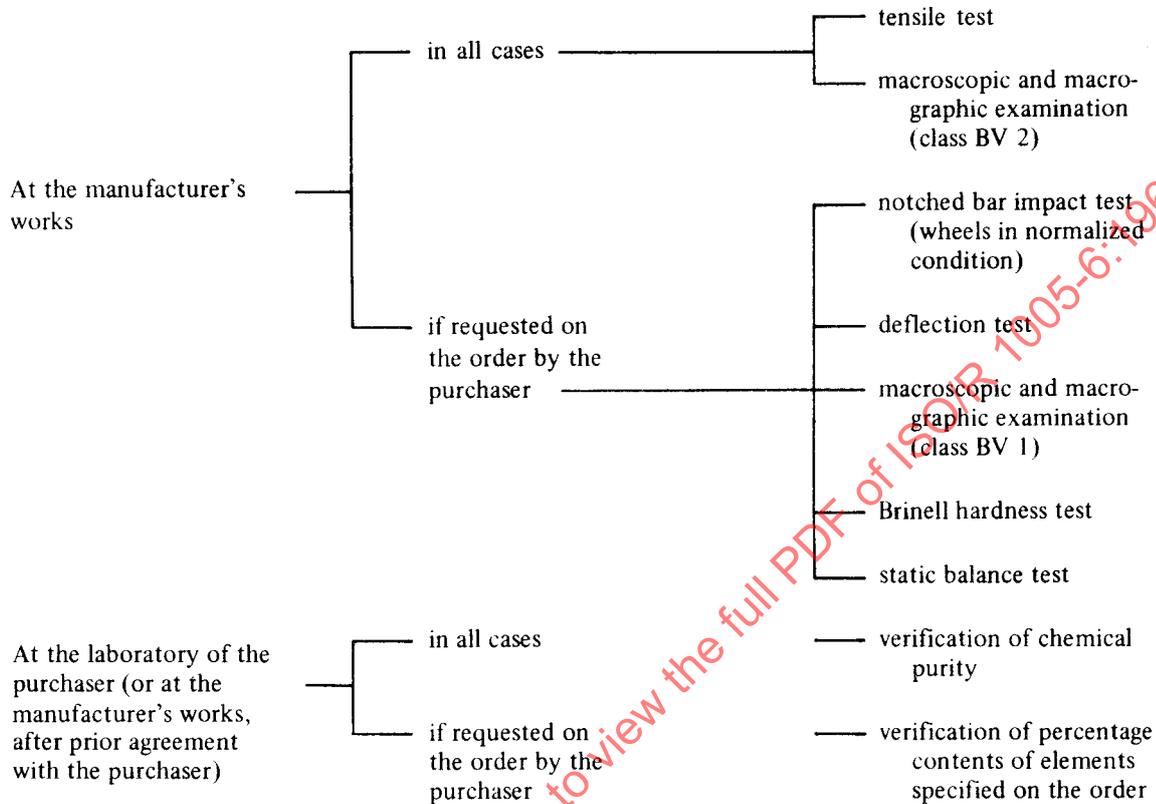
### 11.2 Finished wheels ready for delivery

The wheels should be submitted for acceptance grouped according to their cast; each cast may contain wheels of different types.

Wheels originating from the same cast, having undergone the same heat treatment and forming the subject of the same presentation, form a batch.

## 12. TYPES AND NUMBERS OF TESTS

The wheels should be subjected to the following inspections and tests :



The deflection, tensile and notched bar impact tests and the macrographic examination should be carried out on the number of wheels indicated in Table 4.

TABLE 4 - Number of wheels to be tested

Number of wheels in the batch	Number of wheels to be tested
$\leq 75$	1
$> 75$	2

The chemical analysis should be performed on one wheel per cast taken from those indicated in Table 4.

The Brinell hardness test should be performed on each wheel.

The same should apply to the verification of static balancing, unless otherwise specified in the order.

### 13. INTERPRETATION OF TESTS – ADDITIONAL TESTS

Any characteristic which does not comply with the specified requirements can result in the rejection of the corresponding batch.

If the purchaser agrees to additional tests, the number of wheels to be submitted to these tests should be defined by special agreement between the supplier and the purchaser.

### 14. SELECTION AND PREPARATION OF SAMPLES AND TEST PIECES

#### 14.1 Selection of sample

From each batch submitted, the accepting inspector should designate the wheel or wheels for the tests and stamp them.

He should mark, on those wheels intended for destructive testing, a sample section bounded by two radial planes from which the test pieces are to be taken.

The sample section should be cut after the deflection test when the latter is required.

#### 14.2 Number and position of test pieces

14.2.1 *Tensile test.* Two test pieces should be taken from the sample section at the positions indicated in Figure 1.

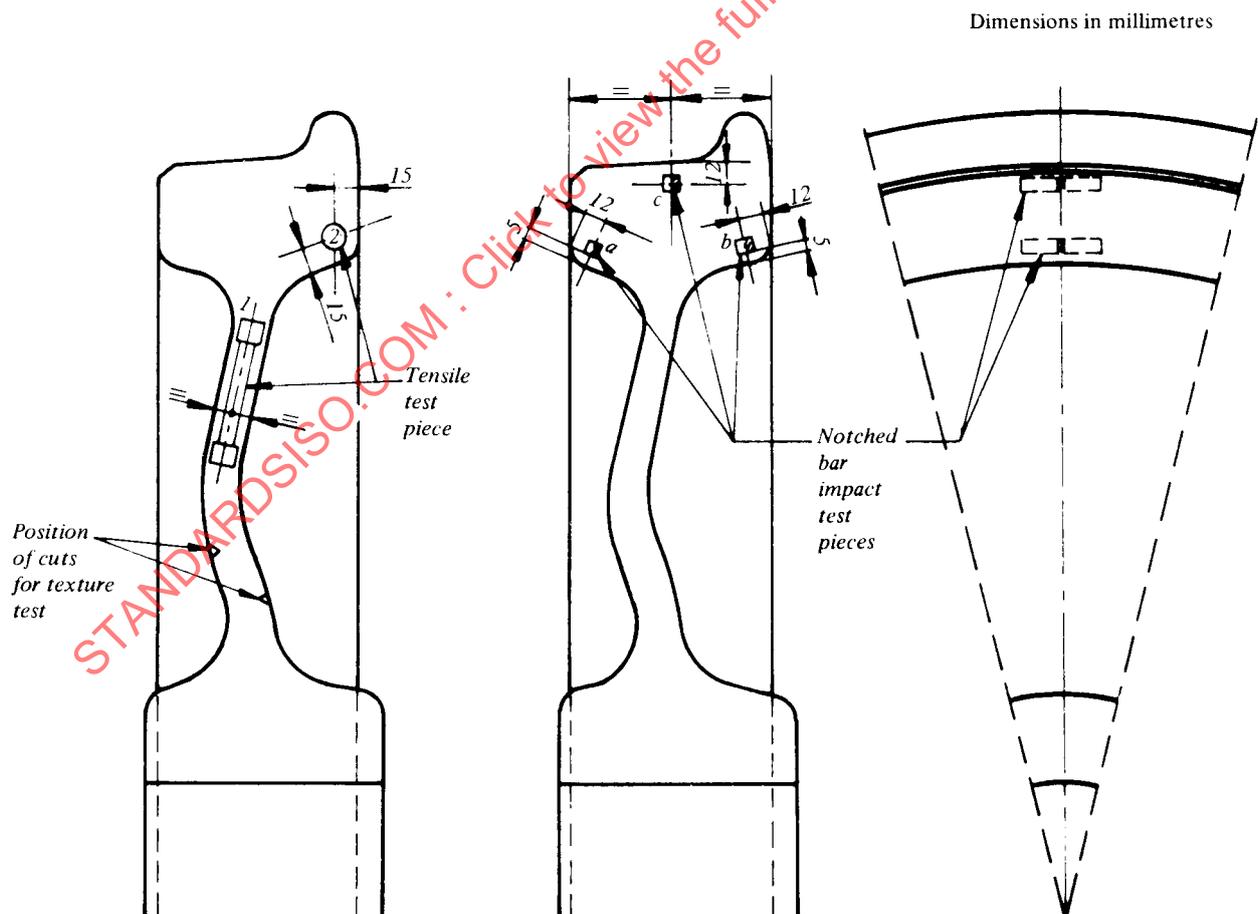


FIG. 1

FIG. 2

- 14.2.2 *Macroscopic and macrographic examinations.* One of the slices cut from the sample section constitutes the test piece.
- 14.2.3 *Notched bar impact test.* Three test pieces should be taken from the sample section at the positions indicated in Figure 2.
- 14.2.4 *Brinell hardness test.* A ball impression should be made on the flat surface opposite to the flange.
- 14.2.5 *Chemical analysis.* Unless stated to the contrary on the order, a sample representing the average composition of a radial section and weighing at least 50 g should be taken.

### 14.3 Stamping, cutting up and preparation of test pieces

The samples should be cut, stamped and marked in accordance with the indications of the accepting inspector.

The marking of the impact test pieces should be such as to show without doubt which side of the bar was originally parallel to a plane tangent to the bore of the wheel.

The cutting up of the sample and the machining of the test pieces should take place when completely cold and precautions should be taken so that these operations do not produce any surface work hardening or appreciable heating of the metal.

After machining, if marks left by the tool make it likely that the results of the test may be affected, these should be eliminated either by passing through a grinding machine (with abundant spraying) or by polishing with a fine rasp and emery paper, provided that the method of rectification adopted maintains the dimensions and the form of the test piece within the tolerances specified for the corresponding test.

The face of the sample section intended for the macroscopic and macrographic examinations should be polished.

The test pieces should retain the stamp marks of the accepting inspector.

## 15. TESTING

### 15.1 Deflection test

15.1.1 *Test piece.* The test piece should be a complete wheel.

15.1.2 *Test method.* The wheel should be laid flat, so that the rim rests on a ring, and only the rim is supported; if the web is not perpendicular to the axis of the boss, the blows to be applied should tend to accentuate the obliquity.

Blows of 3000 kgf·m should be applied in the direction of the axis of the boss until the plane of the machined surface of the boss shows a permanent deflection. The radial length of the web should be measured between the commencement of the fillets connecting the web with the boss and with the rim.

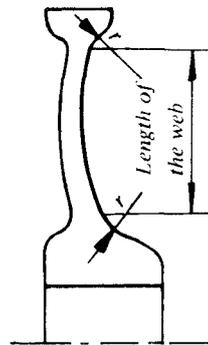


FIG. 3

The boss should then be removed from the rim by fracture of the web beneath a power hammer or press, this fracture being previously started by circular cuts made with a tool at the points indicated in Figure 1.

15.1.3 *Results to be obtained* : see clause 4.3.