

Railway rolling stock materials

Part 4. Specification for forged and rolled tyres

Matériel roulant de chemin de fer
Matériel pour lames laminées ou forgées -
Specifications

Eisenbahnbetriebsmittel
Teil 1. Geschmiedete und gewalzte Reifen

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Foreword

This Part of BS 5892 was prepared under the direction of the Iron and Steel Standards Policy Committee and supersedes BS 5892 : Part 4 : 1986, which is withdrawn. BS 5892, which covers railway rolling stock material, is published in the following six parts.

Part 1 Specification for axles for traction and trailing stock

Part 2 Specification for forged and rolled wheel centres

Part 3 Specification for monobloc wheels for traction and trailing stock

Part 4 Specification for forged and rolled tyres

Part 5 Specification for steel bars for retaining rings for tyred wheels

Part 6 Specification for wheelsets for traction and trailing stock

The format of this Part of BS 5892 has been revised to incorporate the requirements for dimensional tolerancing for tyres which were previously included in BS 5892 : Part 6. This Part of BS 5892 is related to ISO 1005-1 and ISO 1005-2; however, it has not been possible to obtain equivalence. It is related to UIC 810-1 and UIC 810-2.

BS 5892 : Parts 1 to 3 and 6 have also been revised to ensure consistency with the requirements of this Part.

Product certification. Users of this British Standard are advised to consider the desirability of third party certification of product conformity with this British Standard based on testing and continuing surveillance, which may be coupled with assessment of a supplier's quality systems against the appropriate Part of BS 5750.

Enquiries as to the availability of third party certification schemes will be forwarded by BSI to the Association of Certification Bodies. If a third party certification scheme does not already exist, users should consider approaching an appropriate body from the list of Association members.

Compliance with a British Standard does not of itself confer immunity from legal obligations.

Specification

1 Scope

This Part of BS 5892 specifies requirements for the manufacture, inspection and testing of forged and rolled steel tyres for traction and trailing stock. This Part of BS 5892 includes requirements for the dimensions and tolerances that are to be adopted unless otherwise specified in the design drawing.

NOTE. The titles of the publications referred to in this Part of BS 5892 are listed on the inside back cover.

2 Information to be supplied by the purchaser

The following information to be supplied by the purchaser in the enquiry and order shall be fully documented:

- (a) the number of this British Standard, i.e. BS 5892 : Part 4;
- (b) a fully dimensioned drawing of the tyre;
- (c) the grade of steel required (see 3.1);
- (d) the type of heat treatment required (see 3.2);
- (e) the type of inspection and quality assurance system required (see clause 6);

- (f) whether ultrasonic testing is required (see 7.3.5);
- (g) whether a Brinell hardness test is required (see 7.3.4);
- (h) whether a statement giving the cast analysis and/or results of mechanical or other tests is required (see clause 11);
- (i) whether a product check analysis is required (see 9.1);
- (j) whether any special marking is required (see clause 5);
- (k) the method of protection against mechanical damage (see clause 12).

3 Classification and heat treatment

3.1 Grade of steel

The grade(s) of steel shall be selected from those listed in table 1 and table 3 (see item (d) of clause 2). Grades B1, B2, B3, B4, B5, B6 and B7 shall have the composition and properties given in tables 1, 2 and 3.

Grade of steel	Chemical composition										
	C max.	Si max.	Mn max.	P max.	S max.	Cr max.	Cu max.	Mo max.	Ni max.	V max.	(Cr + Mo + Ni) max.
	%	%	%	%	%	%	%	%	%	%	%
B1	0.48	0.50	1.20	0.040	0.040	0.30	0.30	0.08	0.30	0.05	0.60
B2	0.58	0.50	0.90	0.040	0.040	0.30	0.30	0.08	0.30	0.05	0.60
B3	0.60	0.50	1.10	0.040	0.040	0.30	0.30	0.08	0.30	0.05	0.60
B4	0.70	0.50	0.90	0.040	0.040	0.30	0.30	0.08	0.30	0.05	0.60
B5	0.60	0.50	0.80	0.040	0.040	0.30	0.30	0.08	0.30	0.05	0.60
B6	0.65	0.50	0.90	0.040	0.040	0.30	0.30	0.08	0.30	0.05	0.60
B7	0.80	0.50	1.00	0.040	0.040	0.30	0.30	0.20	0.30	0.05	0.70

Element	Range in which maximum of specified element falls	Variation on specified range
Carbon	Up to and including 0.50	+0.03 -0
	Over 0.50, up to and including 0.80	+0.04 -0
Silicon	Up to and including 0.50	+0.03 -0
Manganese	Up to and including 1.00	+0.04 -0
	Over 1.00, up to and including 1.20	+0.08 -0
Phosphorus	Up to and including 0.040	+0.006 -0
Sulfur	Up to and including 0.040	+0.006 -0

3.2 Heat treatment condition

The tyres shall be supplied in one of the following conditions (see item (d) of clause 2 and table 3):

- (a) normalized or normalized and tempered, which shall be designated by the letter N;
- (b) immersion quenched and tempered, which shall be designated by the letter E.

Examples. B2N is steel grade B2, delivered in the normalized or normalized and tempered condition.

5E is steel grade B5 delivered in the immersion quenched and tempered condition.

4 Manufacture

4.1 Steel making

The tyres shall be made from steel produced by the electric process or the basic oxygen process.

The steel shall be killed in the furnace or in the ladle and treated to ensure that the finished tyre has a grain size of 5 to 8 as determined by the method in appendix F of BS 4490 : 1989. Ingots shall be bottom poured.

4.2 Manufacture of tyres

The tyres shall be hot rolled from one of the following:

- (a) ingots; or
- (b) rolled or forged bars; or
- (c) continuously cast bars.

The ingot or bar sections shall be rough shaped and punched using a forging hammer or press and finally shaped by rolling.

Precautions shall be taken during hot working to ensure that material is not damaged by overheating or by grain growth due to high finish working temperatures.

NOTE. Generally, forging should not be done at temperatures above 1260 °C and should terminate between 850 °C and 1000 °C.

4.3 Hydrogen cracking (flakes)

Precautions shall be taken by the manufacturer throughout the process route to avoid the formation of hydrogen cracks (flakes).

4.4 Appearance

The tyres shall be free from forging or rolling defects. The surface shall not show any mark other than those specified (see clause 5).

NOTE. Brinell hardness testing indentations may be left on the surface of the tyre, however.

Table 3. Heat treatment condition and mechanical properties

Grade of steel	Heat treatment condition on delivery (see 3.2)	Mechanical properties			
		Tensile strength R_m	Elongation A min. ¹⁾	Minimum charpy U impact value at 20 °C KU ²⁾	Brinell hardness range
		N/mm ²	%	J	HB
B1	N	600 to 720	18	5	179 to 212
B2	N	700 to 820	14	10	207 to 241
B3	N	750 to 880	12	10	212 to 262
B4	N	800 to 940	10	10	235 to 277
B5	E	800 to 920	14	15	235 to 269
B6	E	920 to 1050	12	10	269 to 311
B7	E	1050 to 1200	10	5	311 to 352

¹⁾ A is the percentage elongation after fracture on gauge length $L_0 = 5.65\sqrt{S_0}$, where S_0 is the original cross-sectional area of the test piece.

²⁾ Mean value of three tests; one of the individual results may be lower than the minimum value given in this table provided it is not less than 70 % of the minimum

4.5 Identification of the tyres during manufacture

All ingots, rolled bars, concast bars and forged tyres shall be marked at each stage of manufacture so that before delivery each tyre can be identified as specified in clause 6. Where the identification marks are stamped, and differ from the final identification marks specified in clause 5, they shall not be visible on the finished tyre after machining.

4.6 Heat treatment

After hot working, tyres shall undergo the specified heat treatment (see item (d) of clause 2 and 3.2). Details of heat treatment temperatures and times shall be recorded. The required heat treatment operations shall ensure:

- (a) uniformity of structure and properties in comparable parts of the same tyre;
- (b) uniformity of structure and properties in all tyres from the same heat treatment batch;
- (c) that the rolled tyre shall be free from distortion and is capable of being machined as specified in 4.8.

4.7 Rectification of ovality and buckle

NOTE. It is permissible for any ovality and buckle of tyres, when formed and heat treated, and which does not exceed 6 mm to be corrected by cold forming without renewal of the heat treatment.

If the ovality and/or buckle exceeds 6 mm, hot rectification shall be carried out and all such tyres shall be subjected to a stress relief at a temperature not greater than 50 °C below the tempering temperature (if applicable) and in any case not greater than 600 °C.

4.8 Dimensions

Unless otherwise specified on the drawing and order, the dimensional rolling tolerances relative to finished size shall be those given in table 4 (see also figure 1).

Table 4. Dimensional rolling tolerances relative to nominal finished sizes

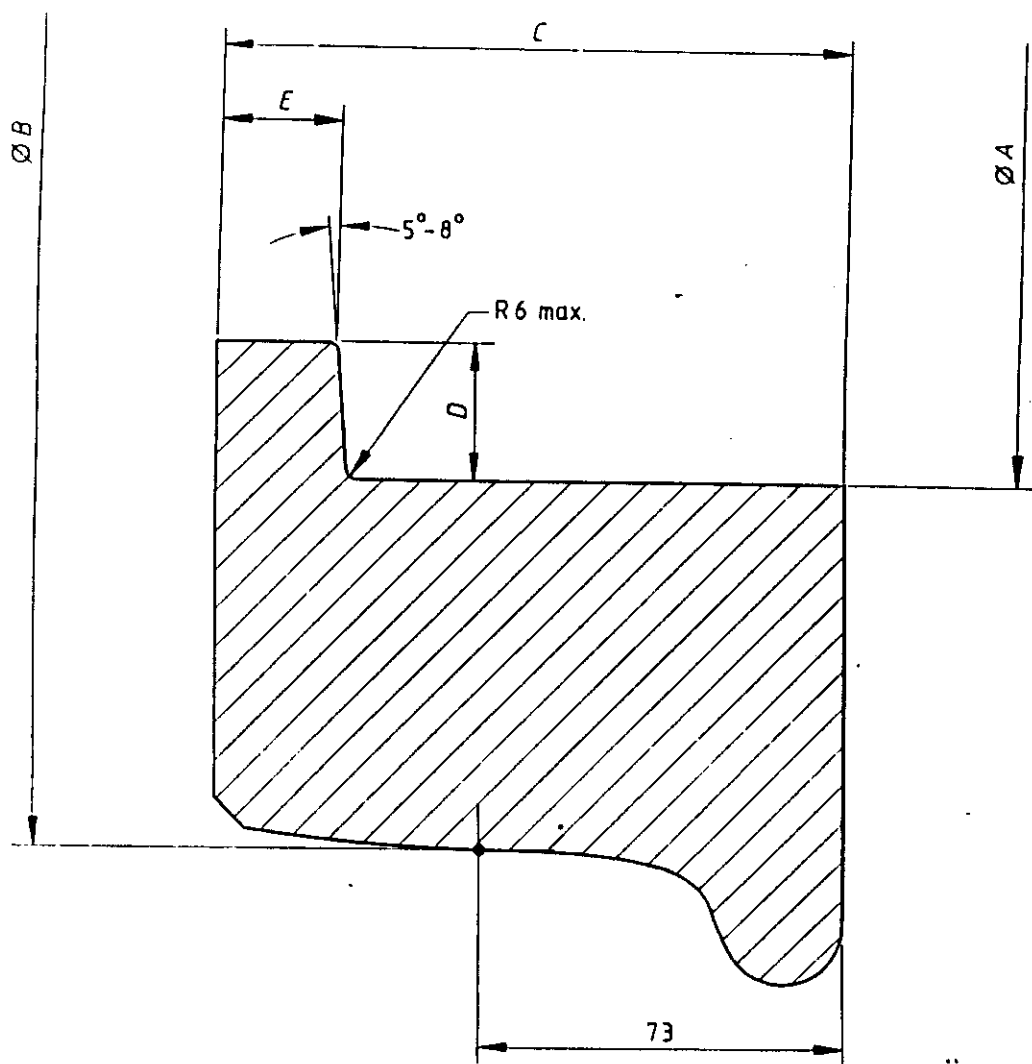
Dimensions (see figure 1 for symbols)	Rolling tolerance	
	mm	
Bore diameter <i>A</i>	-9 -15	
Tread diameter <i>B</i>	+6 +12	
Tyre width (see note 1) <i>C</i>	+6 +9	
Snip height <i>D</i>	+0 +3	
Snip width <i>E</i>	+6 +9	
Quality Buckle Eccentricity	See note 2	
NOTE 1. Subject to a minimum allowance of 3.0 mm on each side.		
NOTE 2. To be within the limits on bore, tread diameter and width.		

The bore of the tyre shall be perpendicular to the plane of the tyre and concentric with the rim within the run-out requirements of the finished assembly as defined in BS 5892 : Part 6.

4.9 Removal of surface defects

Rectified surfaces shall have no heat cracking, shall be within specified tolerances and surface finishes and shall be smoothly blended into the surrounding area.

Rectification by welding, chemical deposition of metal, metal spraying or by use of local heating shall not be carried out.



Linear dimension is in millimetres.

Figure 1. Key to the symbols used in table 4

5 Manufacturer's brand marks

Unless the purchaser indicates that special marking is required (see item (j) of clause 2), each tyre shall be identified by the manufacturer with stamp marks in the position shown in figure 2. The markings shall include the following:

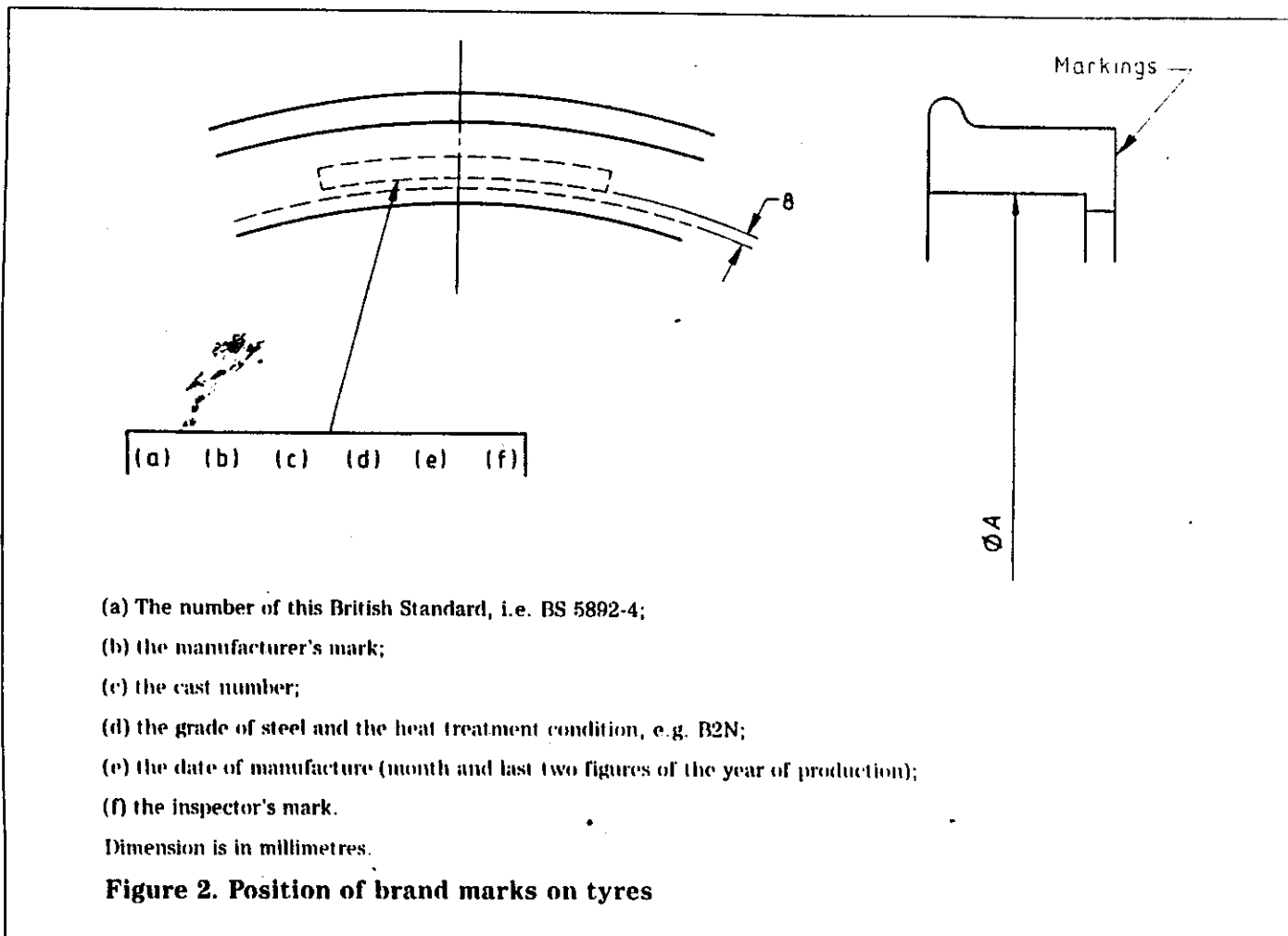
- (a) the number of this British Standard, i.e. BS 5892-1¹⁾
 - (b) the manufacturer's mark;
 - (c) the cast number;
 - (d) the grade of steel and the heat treatment (e.g. B2N);
 - (e) the date of manufacture (month and last two figures of the year of production);
 - (f) the inspector's mark.
- Items (a) to (c) should be hot-stamped and item (f) should be cold stamped.

6 Inspection

The inspection of tyres shall be undertaken in one of the following ways (see item (e) of clause 2):

- (a) by the purchaser or his nominated representative, who shall inspect the tyres ordered and witness any of the tests; or
- (b) by delegation of the responsibility for the inspection by the purchaser to the manufacturer; or
- (c) within the application of a quality assurance system (see BS 5750 and the foreword).

¹⁾Marking BS 5892-1 on or in relation to a product represents a manufacturer's declaration of conformity, i.e. a claim by or on behalf of the manufacturer that the product meets the requirements of the standard. The accuracy of the claim is therefore solely the responsibility of the person making the claim. Such a declaration is not to be confused with third party certification of conformity, which may also be desirable.



7 Type and number of tests

7.1 Type of test

The type and number of tests to be carried out shall be in accordance with table 5.

7.2 Test unit, subdivision into batches and number of test pieces

The test unit for the various types of test shall be in accordance with table 5. For the purpose of testing, the tyres shall be grouped in batches. Each batch shall comprise tyres produced from the same cast having undergone a similar heat treatment, if applicable.

NOTE. It is permissible to include, within a batch, tyres of different size and shape.

The number of tyres per batch to be subjected to the tests, the number of tests per tyre and the condition of the tyre when submitted for testing shall be in accordance with table 5.

NOTE. For orders of eight or less tyres which cannot be grouped with other batches the supplier, with the agreement of the purchaser, may carry out the tests on a separate forged test sample.

If a separate test sample is used, it shall:

- be from the same cast of material;
- be of an equivalent ruling section to the tyre;
- have undergone a similar degree of hot work;
- be heat treated with the tyres.

The axis of the test piece shall be parallel to the direction of the principal grain flow of the test sample.

7.3 Sampling and preparation of samples and test pieces

7.3.1 General

The tyre(s) intended for testing, selected at random from the batch, shall be identified by indelible stamping.

The identity of samples and test pieces shall be maintained throughout testing.

7.3.2 Tensile test

One test piece shall be selected from the sample tyre at the position shown in figure 3.

The test piece shall be prepared in accordance with BS EN 10002-1.

7.3.3 Impact test (Charpy U)

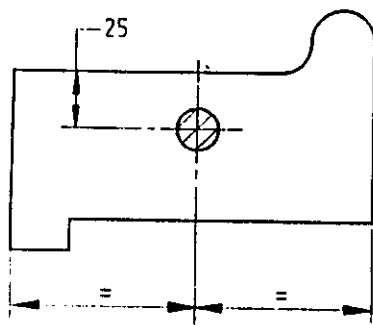
Three closely adjacent test pieces shall be taken from the positions in the sample tyre indicated in figures 3 and 4. The marking of the impact test piece shall enable identification of the two flat surfaces of the test pieces which are parallel to section A-A (see figure 4). The test pieces shall be prepared in accordance with BS EN 10015-1. The axis of the cylindrical bottom of the notch shall be at right angles to the tread of the tyre (see section A-A in figure 4).

Table 5. Type and number of tests

Requirements	Heat treatment condition on delivery	Status of test	Test unit	Number of tyres per batch to be subject to the checks and tests for batches of:		Number of tests per tyre
				Up to 100	Over 100	
Cast chemical analysis	All	m	s	—	—	1
Product check analysis	All	o	c	1	1	1
Tensile test	All	m	ch	1	2	1
Impact test (KU)	All	m	ch	1	2	3
Brinell hardness (uniformity)	All	o	ch	10 %	10 %	1
Ultrasonic flaw detection	All	o	t	100 %	100 %	1
Appearance	All	m	t	100 %	100 %	1
Dimensional check	All	m	t	100 %	100 %	1

Key

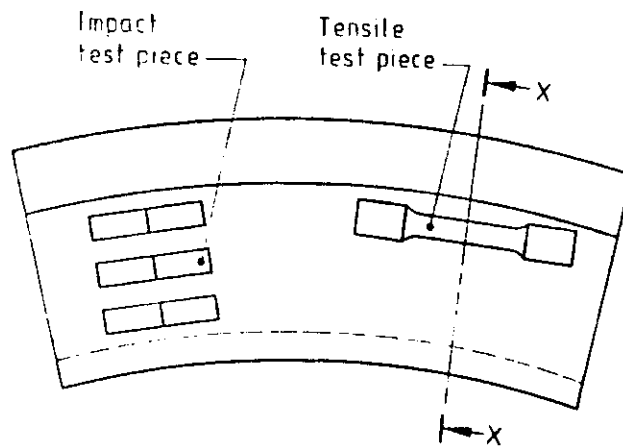
- s — signifies steel from the cast;
- c — signifies tyres from the same cast;
- ch — signifies tyres from the same cast and the same heat treatment batch;
- t — signifies that the tyre is the test unit;
- m — signifies mandatory tests;
- o — signifies optional tests, i.e. tests which need only be carried out if specified in the order or its appended documents.



Section X-X

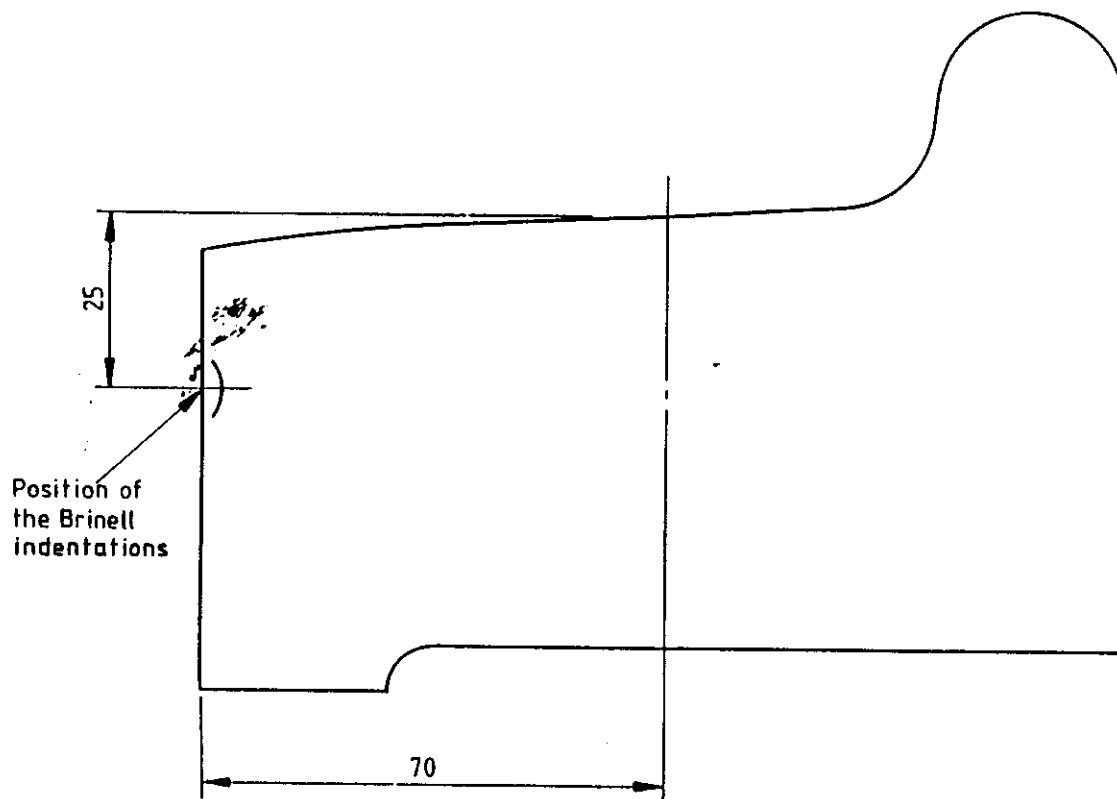
Dimension is in millimetres.

(a) Position of tensile test pieces



(b) Position of tensile and impact test pieces

Figure 3. Position of tensile and impact test pieces



All dimensions are in millimetres.

Figure 5. Position of the Brinell hardness indentations

7.3.4 Uniformity of hardness

When specified (see item (g) of clause 2) the Brinell hardness test shall be carried out on the plane face on the side opposite the flange. The indentation shall be situated on a circumference with a radius approximately 25 mm less than that of the running circle (see figure 5). The test position shall be prepared by lightly grinding in order to remove any carburization.

7.3.5 Ultrasonic test

When specified (see item (f) of clause 2) the test shall be carried out after heat treatment. The tyre shall be scanned from the plane face of the rim situated on the side opposite the flange.

7.3.6 Dimensional checks

The manufacturer shall carry out dimensional checks to ensure that the wheel centres are in accordance with table 4.

8 Test methods

8.1 Chemical analysis

NOTE. It is permissible to use any recognized method for the determination of cast analysis.

In cases of dispute the analysis shall be carried out in accordance with BS 6200.

8.2 Tensile test

The tensile test shall be carried out in accordance with BS EN 10002-1.

8.3 Impact test (Charpy U)

The impact test shall be carried out in accordance with BS EN 10045-1 using a 5 mm deep U-notch sample, and the mean value of the three tests shall be determined.

8.4 Hardness

The Brinell hardness test shall be carried out in accordance with BS 240.

8.5 Ultrasonic flaw detection test

The ultrasonic test shall be carried out in accordance with ISO 5948. For ultrasonic tests using the comparison method (see ISO 5948), the sensitivity shall be adjusted so that the height of the first backwall echo is 50 % full screen height.

8.6 Checking of dimensions

The dimensional checks shall be carried out using appropriate measuring instruments forming part of a measurement and calibration system in accordance with BS 5781.

9 Test results

9.1 Chemical analysis

The cast composition shall be in accordance with the values given for the appropriate grade of steel in table 1. If a product check analysis is required (see item (i) of clause 2), the variations permitted in product analysis given in table 2 shall apply.

9.2 Mechanical properties

The tensile and impact properties determined on test pieces prepared in accordance with 7.3.2 and 7.3.3 and tested in accordance with 8.2 and 8.3 shall be in accordance with the values given in table 3 for the appropriate grade. The value of one of the impact tests may be less than the minimum value given in table 3 but it shall not be less than 70 % of this minimum value. Where Brinell tests are carried out, the results shall be in accordance with the values given in table 3.

9.3 Ultrasonic test

Tyres shall indicate no more than 10 defect signals for which the ratio of amplitude of the defect signal or supplementary echo to that of the backwall echo of an adjacent sound zone does not exceed 0.25 and there shall be at least 15 mm between any two of these adjacent defect signals.

9.4 Dimensions

The dimensions shall be as specified on the drawing and the tolerances shall be in accordance with table 4.

9.5 Re-tests

If the tensile test piece fails to comply with 9.2, twice the original number of test pieces shall be selected for retesting, at least one of which shall be taken from the tyre from which the original test sample was taken, unless that item has been withdrawn by the manufacturer. The mechanical properties obtained from the test pieces prepared from further test samples shall comply with 9.2. Should any of the retests fail, the material represented shall be deemed not to comply with this Part of BS 5892.

If the average of three impact values is lower than the specified value, or if any one value is lower than 70 % of this specified value, three additional test pieces shall be taken from the same sample and tested. The average value of the six tests shall be not less than the specified value. Not more than two of the individual values shall be lower than the specified value and not more than one shall be lower than 70 % of this value.

If any hardness test results fall below the minimum value specified, when 10 % of tyres are being tested in accordance with table 5, hardness tests shall be taken on 100 % of the batch.

In the event of failure to meet the mechanical test requirements, the manufacturer shall have the right to re-heat the batch and to re-submit it for testing.

10 Conclusion of inspection

After final inspection the tyres shall be stamped by the purchaser's inspector or the delegated authority to signify conformance.

11 Certification

If required (see item (h) of clause 2), the manufacturer shall supply a certificate of conformance to BS 5892 : Part 4 and to the purchaser's requirements in accordance with clause 2.

Records of all tests shall be traceable to the cast and heat treatment batch (see 7.2) and shall be available for examination.

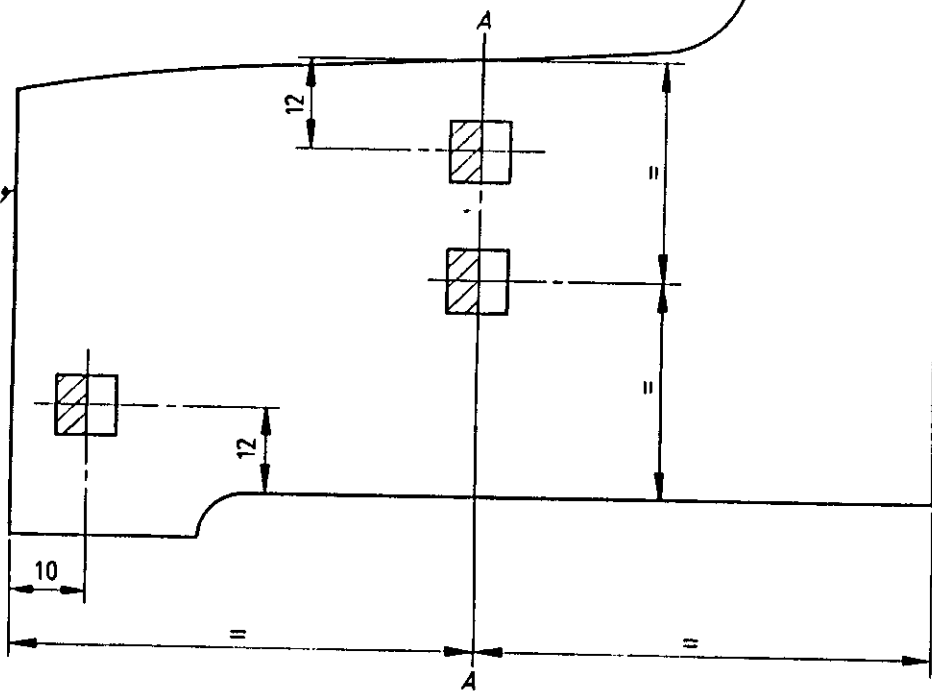
12 Protection in transport

The method for protection against mechanical damage shall be as specified by the purchaser (see item (k) of clause 2).

Publication(s) referred to

BS 240	Method for Brinell hardness test and for verification of Brinell hardness testing machines
BS 4490	Methods for micrographic determination of the grain size of steel
BS 5750	Quality systems Part 1 Specification for design/development, production, installation and servicing Part 2 Specification for production and installation Part 3 Specification for final inspection and test
BS 5892	Railway rolling stock materials Part 6 Specification for wheelsets for traction and trailing stock
BS 6200	Sampling and analysis of iron, steel and other ferrous metals
BS EN 10002-1	Tensile testing of metallic materials Part 1 Method of test at ambient temperature
BS EN 10045-1	Charpy impact test on metallic materials Part 1 Test method (V- and U-notches)
ISO 1005-1 ¹⁾	Railway rolling stock material — Part 1 : Rough-rolled tyres for tractive and trailing stock — Quality requirements
ISO 1005-2 ¹⁾	Railway rolling stock material — Part 2 : Tyres, wheel centres and tyred wheels for tractive and trailing stock — Dimensional, balancing and assembly requirements
ISO 5948	Railway rolling stock material — ultrasonic acceptance testing
UIC 810-1 ¹⁾	Technical specification for the supply of rough rolled non-alloy steel tyres for tractive and trailing stock
UIC 810-2 ¹⁾	Technical specification for the supply of rough tyres for tractive and trailing stock — Tolerances

¹⁾ Referred to in the foreword only.



All dimensions are in millimetres.

Figure 4. Position of the impact test pieces