

Railway rolling stock materials –

Part 3: Specification for monobloc wheels for traction and trailing stock

ICS 45.040

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Committees responsible for this British Standard

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- British Railways Board
- British Steel Industry
- London Underground Ltd.
- Ministry of Defence
- Railway Industry Association of Great Britain

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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prepared under the direction of the Iron and Steel Standards Policy Committee and supersedes BS 5892-3:1982, which is withdrawn.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 has been revised to incorporate the requirements for dimensional tolerances and surface finish for monobloc wheels which were previously included in BS 5892-6. This Part of BS 5892 is related to ISO 1005-6; however, it has not been possible to obtain equivalence. It is also related to UIC 812-3.

BS 5892-1, BS 5892-2, BS 5892-4 and BS 5892-6 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 of 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.

The start and finish of text introduced or altered by Amendment No. 2:2009 is indicated in the text by tags **A2** **A2**. Minor editorial changes are not tagged.

This publication does not purport to include all the necessary provisions of a contract. Users are responsible for its correct application.

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

Summary of pages

This document comprises a front cover, an inside front cover, pages i and ii, pages 1 to 24, an inside back cover and a back cover.

This Standard has been updated (see copyright date) and may have had amendments incorporated. This will be indicated in the amendment table on the inside front cover.

1 Scope

This Part of BS 5892 specifies requirements for the manufacture, inspection and testing of rolled or forged monobloc wheels in the unmachined, finish machined or ready for assembly condition for traction and trailing stock. This Part of BS 5892 includes requirements for the dimensions, tolerances and surface finish 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.

A1 BS 5892-3 is not applicable to wheels to be fitted to axles designed to BS EN 13103 and BS EN 13104, the manufacture, inspection and testing of which are specified in BS EN 13261. **A1**

2 Definitions

For the purposes of this Part of BS 5892 the following definitions apply.

2.1

unmachined

condition of a monobloc wheel in the forged and heat treated condition having undergone no machining operation other than proof machining by the manufacturer

2.2

finish machined

condition of a monobloc wheel where all the machining operations have been carried out apart from those required for assembly onto the axle

2.3

ready for assembly

condition of a monobloc wheel that has received all machining operations required for assembly

2.4

normal speed

operational speed up to and including 200 km/h

2.5

high speed

operational speed greater than 200 km/h

3 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 5892-3;

- b) a fully dimensioned drawing of the monobloc wheel;
- c) whether high or normal speeds apply (see 2.4 and 2.5);
- d) the grade of steel (see 4.1);
- e) the type of heat treatment required (see 4.2);
- f) the degree of finish (see 4.3);
- g) the maximum permissible amount of imbalance if not in accordance with Table 7 (see 5.8);
- h) the conditions for machining and the elimination of imbalance if not in accordance with Table 7 (see 5.8);
- i) the type of inspection and quality assurance system required (see clause 7);
- j) whether ultrasonic testing is required (see 9.7 and 10.7);
- k) whether checks on uniformity of rim hardness are required (see 8.3.6.1);
- l) whether assessment of residual stress is required (see 9.6);
- m) whether a statement giving the cast analysis and/or results of mechanical or other tests is required (see clause 12);
- n) whether a product check analysis is required (see 8.3.2 and 10.1);
- o) whether any special marking is required (see clause 6);
- p) the method of protection against corrosion and mechanical damage (see clause 13);
- q) whether static balancing tests are required (see 5.8).

4 Classification and heat treatment

4.1 Grades of steel

The grade(s) of steel shall be selected from those listed in Table 1 and Table 3 (see item d) of clause 3). Grades R1, R2, R3, R6, R7, R8 and R9 shall have the composition and properties given in Table 1, Table 2 and Table 3.

Table 1 – Chemical composition

Grade of steel	Cast 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.
	%	%	%	%	%	%	%	%	%	%	%
R1	—	0.50	1.20	0.040	0.040	0.30	0.30	0.08	0.30	0.05	0.60
R2	—	0.50	1.20	0.040	0.040	0.30	0.30	0.08	0.30	0.05	0.60
R3	0.70	0.50	0.90	0.040	0.040	0.30	0.30	0.08	0.30	0.05	0.60
R6	0.48	0.40	0.75	0.040	0.040	0.30	0.30	0.08	0.30	0.05	0.60
R7	0.52	0.40	0.80	0.040	0.040	0.30	0.30	0.08	0.30	0.05	0.60
R8	0.56	0.40	0.80	0.040	0.040	0.30	0.30	0.08	0.30	0.05	0.60
A_2 RS8	0.56	1.10	1.10	0.040	0.040	0.30	0.30	0.08	0.30	0.05	0.60 A_2
R9	0.60	0.40	0.80	0.040	0.040	0.30	0.30	0.08	0.30	0.05	0.60

Table 2 – Permitted variations of product analysis from the specified range for significant elements

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 0.70	+ 0.04 – 0
A_2 Silicon	Up to and including 0.50	+ 0.03 – 0
	Over 0.50, up to and including 0.70	+ 0.04 – 0
	Over 0.70, up to and including 1.10	+ 0.06 – 0 A_2
Manganese	Up to and including 1.0	+ 0.04 – 0
	Over 1.0, up to and including 1.20	+ 0.08 – 0
Sulfur	A_2 Up A_2 to and including 0.040	+ 0.006 – 0
Phosphorus	A_2 Up A_2 to and including 0.040	+ 0.006 – 0

4.2 Heat treatment condition

The wheels shall be supplied in one of the following conditions (see item e) of clause 3):

- a) untreated, in the case of steels R1, R2 and R3, which shall be designated by the letter U;
- b) normalized or normalized and tempered, in the case of steels R1, R2 and R3, which shall be designated by the letter N;

c) rim chilled, in the case of steels R6, R7, R8, A_2 , RS8 A_2 and R9, which shall be designated by the letter T;

d) immersion quenched and tempered in the case of steels R6, R7, R8 and R9, which shall be designated by the letter E.

Examples. R3N is steel grade R3 delivered in the normalized or normalized and tempered condition. R7E is steel grade R7 delivered in the immersion quenched and tempered condition.

Table 3 – Heat treatment condition and mechanical properties

Grade of steel	Heat treatment condition on delivery (see 4.2)	Mechanical properties			
		Tensile strength R_m	Elongation A , min. ^a	Minimum charpy U impact value at 20 °C KU ^b	Brinell hardness range
		N/mm ²	%	J	HB
R1	U	600 to 720	12	—	179 to 217
	N	600 to 720	18	15	179 to 217
R2	U	700 to 840	9	—	207 to 248
	N	700 to 840	14	10	207 to 248
R3	U	800 to 940	7	—	235 to 277
	N	800 to 940	14	10	235 to 277
R6	T (Rim)	770 to 890	15	15	229 to 262
	E (Rim)	730 to 890	15	15	217 to 262
	T (Web)	740 $\langle A_2 \rangle$ max. $\langle A_2 \rangle$	16	—	—
R7	T (Rim)	820 to 940	14	15	241 to 277
	E (Rim)	780 to 940	14	15	229 to 277
	T (Web)	760 $\langle A_2 \rangle$ max. $\langle A_2 \rangle$	16	—	—
R8	T (Rim)	860 to 980	13	15	255 to 285
	E (Rim)	820 to 980	13	15	241 to 285
	T (Web)	820 $\langle A_2 \rangle$ max. $\langle A_2 \rangle$	16	—	—
$\langle A_2 \rangle$ RS8 ^c	T (Rim)	900 to 1 020 max.	13	15	262 to 302
	T (Web)	900 max.	16	—	— $\langle A_2 \rangle$
R9	T (Rim)	900 to 1 050	12	10	262 to 311
	E (Rim)	860 to 1 050	12	10	255 to 311
	T (Web)	880 $\langle A_2 \rangle$ max. $\langle A_2 \rangle$	14	—	—

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

^b 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.

^c $\langle A_2 \rangle$ RS8T offers improved rolling contact fatigue (RCF) resistance. It may be used as an alternative to disc-braked wheelsets designed to R8T requirements. It should not be used for tread-braked wheels. If it is to be considered for applications involving higher permissible design stresses than R8T then it should be demonstrated that it is appropriate for such applications. $\langle A_2 \rangle$

4.3 Degree of finish

The wheels shall be supplied in one of the following degrees of finish (see clause 2 and item f) of clause 3):

- a) unmachined;
- b) finish machined;
- c) ready for assembly.

5 Manufacture

5.1 Steelmaking

The wheels 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 wheels have a grain size of 5 to 8 as determined by the method in Appendix F of BS 4490:1989. Ingots shall be bottom poured.

5.2 Manufacture of the wheels

Wheels shall be manufactured by hot forging and rolling 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 forging or 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 1 260 °C and should terminate between 850 °C and 1 000 °C.

After forging or rolling and stamping of the identification marks, the wheels shall be left to cool in still air.

5.3 Hydrogen cracking (flakes)

If the steel has not been vacuum degassed precautions shall be taken to avoid the formation of hydrogen cracks (flakes).

5.4 Non-conforming material

Non-conforming material which would prevent compliance with 10.8 shall be removed before or during the manufacture of the wheels. The wheels shall be sound throughout without defects detrimental to their end use.

5.5 Identification of the wheels during manufacture

All ingots, bars, forgings and wheels shall be marked at each stage of manufacture so that each wheel can be identified as specified in clause 6. Where the identification marks are stamped, and differ from the final identification marks specified in clause 6, they shall not be visible on the finished wheel after machining.

5.6 Heat treatment

After hot working wheels shall undergo the specified heat treatment (see item e) of clause 3 and 4.2). Details of heat treatment temperatures and times shall be recorded.

In the case of rim chilled (T) and immersion quenched and tempered (E) wheels the tempering temperature shall be not less than 500 °C.

The required heat treatment operations shall ensure:

- a) uniformity of structure and properties of comparable parts of the same wheel;

- b) uniformity of structure and properties in all wheels of the same heat treatment batch;

- c) that the forging is sufficiently undistorted to enable the wheel to be produced as specified in 10.9.

5.7 Dimensions

Unless otherwise specified on the wheel drawing or order, the machining allowances and dimensional tolerances shall be those given in Table 4, Table 5 and Table 6 (see also Figure 1 and Figure 2).

NOTE 1 In the ready for assembly condition, whilst every effort should be made to ensure size conformity, it is permissible, unless otherwise specified, for the internal hub bore dimension to be tailored to a specific axle. However, the maximum size deviation from the drawing should be no more than 0.5 mm such that in all instances the assembly requirements specified in BS 5892-6 are achieved.

The bore of the wheel shall be perpendicular to the plane of the wheel and concentric with the tread within the run-out requirements of the finished assembly as specified in BS 5892-6.

The bore shall not have a lead-in taper.

Provision shall be made for wheel removal by means of the oil injection method. The oil injection groove and the injection hole parameters shall be in accordance with Figure 3. The edges of the oil injection grooves and the oil injection holes shall be blended out to remove sharp corners.

The tread and flange contour shall be as specified on the appropriate drawing.

NOTE 2 This may be machined before or after assembly of the wheel onto the axle.

When specified, a limited wear groove shall be provided as shown in Figure 4.

Table 4 – Machining allowances and dimensional tolerances for solid wheels (non-disc brake)

Part	Designation	Symbol for machining allowance (see Figure 1)	Symbol for dimension (see Figure 1)	Unmachined ^a				Finish machined ^a				Ready for assembly ^a	
				Machining allowance		Tolerance		Machining allowance		Tolerance		Tolerance	
				Normal speed	High speed	Normal speed	High speed	Normal speed	High speed	Normal speed	High speed	Normal speed	High speed
Rim	External diameter	A	a	6	6	mm	mm	mm	mm	mm	mm	mm	mm
		—	a_1	—	—	mm	mm	—	—	mm	mm	—	—
	Total run-out ^b in radial direction (wheel tread)	—	b	—	—	mm	mm	—	—	mm	mm	—	—
	Internal diameter (outer)	C	c	3 ^c	3	mm	mm	mm	mm	mm	mm	mm	mm
		—	c_1	—	—	mm	mm	—	—	mm	mm	—	—
	Total run-out ^b in radial direction (outer)	—	d	—	—	mm	mm	—	—	mm	mm	—	—
	Internal diameter (inner)	E	e	3 ^c	3	mm	mm	mm	mm	mm	mm	mm	mm
		—	e_1	—	—	mm	mm	—	—	mm	mm	—	—
	Total run-out ^b in radial direction (inner)	—	f	—	—	mm	mm	—	—	mm	mm	—	—
	Width	G	g	5	5	mm	mm	mm	mm	mm	mm	mm	mm
		—	g_1	—	—	mm	mm	—	—	mm	mm	—	—
	Diameter at wear groove	Y	y	—	—	mm	mm	—	—	mm	mm	—	—