

Railway rolling stock materials —

Part 1: Specification for axles for traction and trailing stock

ICS 45.040

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Committees responsible for this British Standard

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Contents

	Page
Committees responsible	Inside front cover
Foreword	ii
1 Scope	1
2 Definitions	1
3 Information to be supplied by the purchaser	1
4 Classification and heat treatment	1
5 Manufacture	2
6 Manufacturer's brand marks	11
7 Inspection	11
8 Type and number of tests	11
9 Test methods	15
10 Test results	15
11 Conclusion of inspection	15
12 Certification	16
13 Protection in transport	16
Appendix A Method for ultrasonic testing of part finished axles	17
Appendix B Method for surface magnetic particle inspection	18
Figure 1 — Key to the symbols used in Table 5	8
Figure 2 — Key to the symbols used for dimensional characteristics and surface roughness in Table 6 and Table 7	9
Figure 3 — Key to the symbols used for geometrical tolerances in Table 6 and Table 7	10
Figure 4 — Position of tensile test samples and test pieces	13
Figure 5 — Position of impact test samples and test pieces	14
Figure 6 — Standard calibration block	18
Table 1 — Chemical composition	2
Table 2 — Permitted variations of product analysis from the specified range for significant elements	2
Table 3 — Heat treatment condition and mechanical properties	3
Table 4 — Heat treatment after straightening	3
Table 5 — Machining allowances and dimensional tolerances for unmachined forged and rolled axles	4
Table 6 — Dimensional requirements for part machined and ready for assembly axles	5
Table 7 — Average surface roughness for part machined and ready for assembly axles	7
Table 8 — Type and number of tests	12
Publications referred to	Inside back cover

Foreword

This Part of BS 5892 was prepared under the direction of the Iron and Steel Standards Policy Committee. BS 5892-1:1992+A3:2009 supersedes BS 5892-1:1992+A2:2007 which is withdrawn. BS 5892, which covers railway rolling stock materials, 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 tolerancing and surface finish for axles which were previously included in BS 5892-6. This Part of BS 5892 is related to ISO 1005-3; however, it has not been possible to obtain equivalence. It is also related to UIC 811-1 and 811-2.

BS 5892-2 to BS 5892-4 and BS 5892-6 have also been revised to ensure consistency with the requirements of this Part.

Requirements for hollow axles are included for the first time as are requirements for the non-destructive testing of axles.

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.

The start and finish of text introduced or altered by Amendment No. 1 (and Nos. 2 and 3) is indicated in the text by tags **A1** **A1** (and **A2** **A2** and **A3** **A3**). 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 20, 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 forged and/or rolled axles (solid or hollow) in the unmachined, part 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] This Part of BS 5892 is not applicable 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

solid axle

an axle of homogeneous steel, produced by forging and/or rolling, that has not been bored

2.2

hollow axle

an axle of homogeneous steel, produced by forging and/or rolling, that has been through bored along its centre line

2.3

unmachined

condition of an axle that has been forged and/or rolled having undergone no machining operation other than finishing to length and providing machining centres but is in the heat treatment condition specified

2.4

part machined

condition of an axle that is machined to the design dimensions except for the wheel or wheel centre seats, and if applicable, the brake disc seats, journals and abutments and gear wheel seats

2.5

ready for assembly

condition of an axle that has received all machining operations required for assembly

2.6

normal speed

operational speed up to and including 200 km/h

2.7

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 5892-1;
- b) a fully dimensioned drawing of the finished axle;
- c) whether high or normal speeds apply (see 2.6 and 2.7);
- 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) type of inspection and quality assurance system required (see clause 7);
- h) whether an impact test is required (see 8.3.4);
- i) whether ultrasonic testing is required (see 9.3.1 and Appendix A);
- j) whether magnetic particle inspection tests are required (see 9.3.2 and Appendix B);
- k) whether a statement giving the cast analysis and/or results of mechanical or other test is required (see clause 12);
- l) whether a product check analysis is required (see 8.3.2);
- m) whether any special marking is required (see clause 6);
- n) the method of protection against corrosion and mechanical damage (see clause 13).

4 Classification and heat treatment

4.1 Grades of steels

The grade(s) of steel shall be selected from those listed in Table 1 and Table 3. Grades A1, A2, A3 and A4 shall have the composition and properties given in Table 1, Table 2 and Table 3 [see item d) of clause 3].

4.2 Heat treatment condition

The axles shall be supplied in one of the following conditions [see item e) of clause 3]:

- a) normalized or normalized and tempered in the case of steels A1 and A2, which shall be designated by the letter N;
- b) immersion quenched and tempered, in the case of steels A1, A2, A3 and A4, which shall be designated by the letter T.

NOTE Stress relieving of axles at an intermediate machining stage is permissible. The permissible stress relieving processes are given in Table 4.

Examples. A2N is steel grade A2 delivered in the normalized or normalized and tempered condition. A1T is steel grade A1 delivered in the immersion quenched and tempered condition.

4.3 Degree of finish

Axles shall be supplied in one of the following degrees of finish [see clause 2 and item f) of clause 3]:

- a) unmachined;
- b) part machined;

c) ready for assembly.

5 Manufacture

5.1 Steelmaking

The axles 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 axles 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.

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.
	%	%	%	%	%	%	%	%	%	%
A1	0.40	0.50	1.20	0.04	0.04	0.30	0.30	0.08	0.30	0.05
A2	0.50	0.50	1.20	0.04	0.04	0.30	0.30	0.08	0.30	0.05
A3	0.40	0.50	1.60	0.04	0.04	0.50	0.30	0.40	0.30	0.10
A4	0.30	0.50	0.80	0.04	0.04	1.20	0.30	0.35	0.30	0.10

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	% 0.30 up to and including 0.50	+ 0.03 – 0
Silicon	Up to and including 0.50	+ 0.03 – 0
Manganese	Up to and including 1.00 Over 1.0, up to and including 1.50 Over 1.50	+ 0.04 – 0 + 0.08 – 0 + 0.10 – 0
Phosphorus	Up to and including 0.04	+ 0.006 – 0
Sulfur	Up to and including 0.04	+ 0.006 – 0

Table 3 — Heat treatment condition and mechanical properties

Grade of steel	Heat treatment in delivery condition (see 4.2)	Mechanical properties			
		Tensile strength	0.2 % proof strength,	Elongation	Minimum Charpy U impact value at 20 °C
		R	R , min.	A , min. ^a	KU^b
		N/mm ²	N/mm ²	%	J
A1	N	520 to 650	300	22	25
	T	550 to 700	350	$\overline{A_2}$ 24 $\overline{A_2}$	40
A2	N	600 to 750	360	17	20
	T	620 to 770	390	19	25
A3	T	650 to 800	420	19	40
A4	T	650 to 800	420	19	40

^a 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.

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

Table 4 — Heat treatment after straightening

Heat treatment of the axles before straightening	Heat treatment to be carried out after straightening
Untreated axles which are to be delivered in the normalized or quenched and tempered condition	No additional heat treatment other than that required by the order is necessary
Normalized axles	Stress relieve at a temperature between 500 °C and 650 °C or normalize again
Quenched and tempered axles	Stress relieve at a temperature between 500 °C and $t_T - 30$ °C (t_T is the actual tempering temperature) or quench and temper again

5.2 Manufacture of the axles

$\overline{A_2}$ The axles can be made from ingots by hot working using forging, rolling, or rolling followed by forging, or they can be made from continuously cast steel which has been rolled and then forged. $\overline{A_2}$

a) **Forging.** The maximum cross-sectional area of the rough forged axles shall be not greater than one-third of the minimum cross-sectional area of the original ingot.

b) **Rolling.** The maximum cross-sectional area of the rough rolled axles shall be not greater than one-fifth of the minimum cross-sectional area of the original ingot.

c) **Rolling followed by forging.** The maximum cross-sectional area of the axles produced by rolling followed by forging shall be not greater than one-quarter of the minimum cross-sectional area of the original ingot $\overline{A_2}$ or continuously cast bar. $\overline{A_2}$

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

NOTE Generally forging should not be done at temperatures above 1 260 °C and should terminate between 850 °C and 1 000 °C.

5.3 Hydrogen cracking (flakes)

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

5.4 Identification of axles during manufacture

All ingots, $\overline{A_2}$ continuously cast bars, $\overline{A_2}$ rolled bars and forgings shall be marked at each stage of manufacture so that each axle 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 axle after machining.

5.5 Heat treatment

After hot working, axles 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.

The required heat treatment operations shall ensure:

- a) uniformity of structure and properties of comparable parts of the same axle;
- b) uniformity of structure and properties between all axles from the same heat treatment batch;
- c) that the forging is sufficiently straight to enable the finished axle to be produced as specified in 10.5.

5.6 Straightening of rough axles

Straightening of rough forged and/or rolled axles shall be performed before any machining and before the test pieces for the mechanical tests are taken and other examinations carried out.

At straightening temperatures of less than 500 °C the axles shall be heat treated after straightening as stated in Table 4.

At straightening temperatures of 500 °C and over, the conditions chosen shall be such that the mechanical properties and the structure are not adversely affected.

5.7 Dimensions

Unless otherwise specified on the drawing and order, the machining allowances, tolerances and surface finish shall be those given in Table 5, Table 6 and Table 7 for the specified finished condition [see item f) of clause 3, 4.3 and Figure 1 to Figure 3].

Table 5 — Machining allowances and dimensional tolerances for unmachined^a forged and rolled axles

Designation	Symbol for dimension	Tolerances	Symbol for Machining allowance	Machining allowance
Wheelseat diameter	<i>c</i>	^{mm} + 15 – 0	<i>C</i>	^{mm} 5
Gearwheel seat diameter, motor suspension bearing seat diameter	<i>d</i>	+ 15 – 0	<i>D</i>	5
Abutment and journal diameter	<i>a</i>	+ 15 – 0	<i>A</i>	5
Axle body diameter	<i>e</i>	+ 15 – 0	<i>E</i>	5
Length	<i>g</i>	± 1	—	—
Wheelseat length (also length of other seats, e.g. gearwheel seat, motor suspension bearing seats)	<i>l</i>	+ 30 – 0	<i>L</i>	20
^a The term “unmachined” is defined in 2.3.				