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The original Japanese text of this Standard was
revised in Jan., 1999

JAPANESE INDUSTRIAL STANDARD

High carbon chromium bearing steels

 JIS G 4805—1990

Translated and Published

by

Japanese Standards Association

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the original Standard in Japanese is to be final authority.**



JAPANESE INDUSTRIAL STANDARD

J I S

High carbon chromium bearing steels

G 4805-1990
(Reaffirmed: 1990)1. Scope

This Japanese Industrial Standard specifies the high carbon chromium bearing steels (hereafter referred to as the "steels") to be used for rolling bearings.

Remark: The applicable standards of this standard are given in Attached Table 1.

2. Steel Grades and Symbols

The steels shall be classified into five categories and their symbols shall be as given in Table 1.

Table 1. Symbol of Steel Grade

Symbol of steel grade
SUJ 1
SUJ 2
SUJ 3
SUJ 4
SUJ 5

3. Chemical Composition

The steels shall be tested in accordance with 13.1 and their cast analysis values shall be as given in Table 2.

Reference Standards:

JIS G 0201-Glossary of Terms Used in Iron and Steel (Heat Treatment)

JIS G 0202-Glossary of Terms Used in Iron and Steel (Testing)

JIS G 0203-Glossary of Terms Used in Iron and Steel (Products and Quality)

Table 2. Chemical Composition

							Unit: %
Steel grade	C	Si	Mn	P	S	Cr	Mo
SUJ 1	0.95 to 1.10	0.15 to 0.35	0.50 max.	0.025 max.	0.025 max.	0.90 to 1.20	—
SUJ 2	0.95 to 1.10	0.15 to 0.35	0.50 max.	0.025 max.	0.025 max.	1.30 to 1.60	—
SUJ 3	0.95 to 1.10	0.40 to 0.70	0.90 to 1.15	0.025 max.	0.025 max.	0.90 to 1.20	—
SUJ 4	0.95 to 1.10	0.15 to 0.35	0.50 max.	0.025 max.	0.025 max.	1.30 to 1.60	0.10 to 0.25
SUJ 5	0.95 to 1.10	0.40 to 0.70	0.90 to 1.15	0.025 max.	0.025 max.	0.90 to 1.20	0.10 to 0.25

Remarks 1. The steels shall not contain more than 0.25 % of Ni and Cu respectively as impurities. The wire rods, however, shall not contain more than 0.20 % of Cu.

The steels SUJ 1, SUJ 2 and SUJ 3 shall not contain more than 0.08 % of Mo.

2. Elements not quoted in Table 2 may be added with a maximum of 0.25 % by agreement between the purchaser and supplier.

3. When a product analysis is carried out in accordance with 13.1, its permissible variation shall conform to Table 3 of JIS G 0321 "Permitted Variation on Product Analysis".

4. Shape, Dimensions and Tolerances

4.1 Standard Sizes The standard diameter for the hot-rolled round bars shall be as given in Table 3.

Table 3. Standard Diameter

										Unit: mm
Standard diameter										
15	16	17	18	19	20	21	22	23	24	
25	26	27	28	29	30	(31)	32	33	34	
(35)	36	37	38	(39)	40	42	44	46	(48)	
49	50	51	(54)	55	60	(64)	65	(66)	70	
75	(76)	80	83	(84)	(88)	90	93	99	104	
114	(119)	124	130							

Remark: The diameters given in () are preferably not used in a new design.

4.2 Dimensional Tolerances and Ovality of Rounds The dimensional tolerances and ovality of rounds for the cold-drawn wires and round bars shall be as given in Table 4, and those for the hot-rolled round bars, it shall be Table 5.

Table 4. Tolerances on Diameter and Ovality of Rounds
(Cold-Drawn Steels)

Unit: mm

Cold-drawn wire			Cold-drawn round bar		
Diameter	Tolerance	Ovality of rounds	Diameter	Tolerance	Ovality of rounds
2 or under	± 0.02	0.02 max.	15 or under	± 0.05	0.05 max.
Over 2 up to and incl. 7	± 0.03	0.03 max.	Over 15 up to and incl. 25	± 0.10	0.10 max.
Over 7 up to and incl. 15	± 0.04	0.04 max.	Over 25 up to and incl. 35	± 0.15	0.15 max.
Over 15 up to and incl. 20	± 0.05	0.05 max.			

Remark: The cold-drawn wires shall be those having a round cross section.

Table 5. Tolerances on Diameter and Ovality of Rounds
(Hot-Rolled Round Bars)

Unit: mm

Hot-rolled round bar		
Diameter	Tolerance	Ovality of rounds
15 or under	± 0.20	0.30 max.
Over 15 up to and incl. 25	± 0.25	0.35 max.
Over 25 up to and incl. 35	± 0.30	0.45 max.
Over 35 up to and incl. 50	± 0.35	0.50 max.
Over 50 up to and incl. 80	± 0.50	0.70 max.
Over 80 up to and incl. 100	± 0.75	1.00 max.
Over 100 up to and incl. 125	± 1.00	1.50 max.
Over 125 up to and incl. 160	± 1.50	2.00 max.

4.3 Bend The tolerances on bend for the cold-drawn round bars and the hot-rolled round bars for machining shall be as given in Table 6. In the case of round bars for forging, they shall be practically straight.

Table 6. Tolerances on Bend

Cold-drawn round bar		Hot-rolled round bar	
Diameter	Tolerance	Diameter	Tolerance
35 mm or under	1.0 mm or under in any 1000 mm, and 1.0 mm x overall length (mm)/1000 mm or under for overall length.	100 mm or under	1.5 mm or under in any 1000 mm, and 1.5 mm x overall length (mm)/1000 mm or under for overall length.
		Over 100 mm up to and incl. 160 mm	2.0 mm or under in any 1000 mm, and 2.0 mm x overall length (mm)/1000 mm or under for overall length.

4.4 Others The permissible variation of shape and dimensional tolerances for other steels than those specified in 4.2 and 4.3 shall be agreed between the purchaser and supplier.

5. Appearance

5.1 Surface Condition The surface of steels shall be free from defects that are detrimental to practical use.

5.2 Allowable Imperfections without Repairing and Limited Condition of Surface Imperfections

5.2.1 Round Bars for Machining (Hot-Rolled Round Bars) The allowable limits of depth of flaws shall be as given in Table 7.

Table 7. Allowable Limits of Depth of Flaws

Unit: mm	
Diameter	Allowable limit of depth of flaws from the surface of steel
25 or under	0.40 max.
Over 25 up to and incl. 35	0.50 max.
Over 35 up to and incl. 50	0.60 max.
Over 50 up to and incl. 80	0.80 max.
Over 80 up to and incl. 100	1.00 max.
Over 100 up to and incl. 125	1.20 max.
Over 125 up to and incl. 160	1.40 max.

5.2.2 Round Bars for Forging (Hot-Rolled Round Bars) Portions of elimination of flaws shall be smooth and the depth of the depression shall fall within 3 % of nominal diameter (maximum 5 mm) from the remainder of the surface.

The total of widths of the flaw-removed portions shall not exceed $\frac{1}{4}$ of the circumference in the same cross section. The flaw-removed portion where the depth falls within the allowable limit, however, is not deemed as the flaw-removed portion.

The allowable limit of flaws which are left after removal shall be agreed between the purchaser and supplier.

5.2.3 Others The allowable imperfections without repairing and limited conditions of surface imperfections for the steels other than those specified in 5.2.1 and 5.2.2 shall be agreed between the purchaser and supplier.

6. Total Decarburized Depth

Spheroidized round bars for machining (hot-rolled round bars) and cold-drawn steels shall be tested in accordance with 13.2, and the allowable limits of the total decarburized depth shall be as given in Table 8 or Table 9.

For the steels other than those specified in Table 8 and Table 9, the allowable limits of the total decarburized depth shall be agreed between the purchaser and supplier.

Table 8. Allowable Limit of Total Decarburized Depth
(Hot-Rolled Round Bar)

Unit: mm

Round bar for machining	
Diameter	Total decarburized depth from surface of steel
25 or under	0.40 max.
Over 25 up to and incl. 35	0.50 max.
Over 35 up to and incl. 50	0.60 max.
Over 50 up to and incl. 80	0.80 max.
Over 80 up to and incl. 100	1.00 max.
Over 100 up to and incl. 125	1.20 max.
Over 125 up to and incl. 160	1.40 max.

Table 9. Allowable Limit of Total Decarburized Depth (Cold-Drawn Steels)

Unit: mm

Cold-drawn wire		Cold-drawn round bar	
Diameter	Total decarburized depth from surface of steel	Diameter	Total decarburized depth from surface of steel
7 or under	0.05 max.	15 or under	0.20 max.
Over 7 up to and incl. 15	0.08 max.	Over 15 up to and incl. 25	0.25 max.
Over 15 up to and incl. 20	0.10 max.	Over 25 up to and incl. 35	0.30 max.

7. Hardness

The hot-finished steels for machining shall be tested in accordance with 13.3, and the hardness of the hot-finished steels after spheroidizing shall be as given in Table 10. The hardness of cold-drawn steels and that of low-temperature annealed steels for forging shall be agreed upon between the purchaser and supplier.

Table 10. Hardness of Spheroidized Steels

Steel grade	Hardness of hot-finished steels for machining	
	HB	HRB
SUJ 1, SUJ 2, SUJ 4	201 max.	94 max.
SUJ 3, SUJ 5	207 max.	95 max.

8. Microstructure

When specified by the purchaser, the microstructure of steel shall be examined in accordance with 13.4, and its microstructure shall be as follows:

- (1) In the microstructure of the spheroidized steels, the carbides shall be fully spheroidized, distribution of the carbides be substantially uniform and be free from such defects as segregation bands and huge carbides. The level of structure shall be agreed between the purchaser and supplier.
- (2) In the microstructure of the steels for forging, this shall be free from such defects as dense segregation bands and huge carbides. The level of structure shall be agreed between the purchaser and supplier.

9. Macrostructure

When specified by the purchaser, the macrostructure of steel shall be examined in accordance with 13.5. The macrostructure shall be free from defects such as pipes, hair cracks, forging cracks caused by lack of deformability and blow holes, and also excessive segregations, dendrites, pits and porosity. The level of structure shall be agreed between the purchaser and supplier.

10. Non-metallic Inclusions

The steels shall be examined in accordance with 13.6 and the index of cleanliness shall conform to Table 11.

Table 11. Index of Cleanliness

Type of non-metallic inclusions	Index of cleanliness
Type A	0.15 % max.
Type B + Type C	0.05 % max.
Type A + Type B + Type C	0.18 % max.

11. Macro-Streak-Flaws

The steels shall be tested in accordance with 13.7, and the number of macro-streak-flaws shall conform to Table 12. The steels, however, shall be free from any macro-streak-flaw longer than 4.0 mm.

Table 12. Number of Macro-Streak-Flaws

Length of macro-streak-flaw (mm)	Average value of number of macro-streak-flaws (for each step)
Over 0.5 up to and incl. 1.0	5.0 max.
Over 1.0 up to and incl. 2.0	1.0 max.
Over 2.0 up to and incl. 4.0	0.5 max.

12. Method of Manufacture

The method of manufacture of the steels shall be as follows:

- (1) The steels shall be made of killed steel which is applied vacuum degassing to the molten metal or the killed steel produced by the process agreed upon between the purchaser and supplier.
- (2) The steels shall be manufactured by rolling, forging or other process with the forging ratio of 6 S or more for steels for machining, and 4 S or more for steels for forging.

- (3) Unless otherwise specified, the steels shall be spheroidized.
- (4) For the cold-worked steels, the hot-finished steels shall be used and the cold-worked steels shall be manufactured by cold drawing, machining, grinding, etc., or combination of these processes in accordance with the specification.

13. Test

13.1 Chemical Analysis The chemical analysis shall be carried out as follows:

- (1) General requirements for chemical analysis and the sampling method of specimen for cast analysis shall be as specified in 3. "Chemical Composition" of JIS G 0303.
- (2) The sampling method of specimen for product analysis shall be as specified in 3. "Sampling Method of Specimen for Chemical Analysis" of JIS G 0321.
- (3) The method for chemical analysis shall conform to one of the following standards:

JIS G 1211	JIS G 1212	JIS G 1213	JIS G 1214
JIS G 1215	JIS G 1216	JIS G 1217	JIS G 1218
JIS G 1219	JIS G 1252	JIS G 1253	JIS G 1256
JIS G 1257	JIS G 1258		

13.2 Determination of Total Decarburized Depth The determination of the total decarburized depth shall be carried out as follows:

- (1) For the steels which have been spheroidized, the sampling method for specimens and the number of test pieces shall be in accordance with Table 13, and for the cold-drawn steels, it shall be agreed between the purchaser and supplier.
- (2) The method for determination shall conform to JIS G 0558.

Table 13. Sampling Method for Specimens and Number of Test Pieces

Name of test	Sampling method for specimens and number of test pieces
Determination of total decarburized depth, Hardness test, Microstructure test ⁽¹⁾	Each one test piece shall be taken from each of two or more pieces from one lot of steels of the same heat rolled or forged to the same diameter group ⁽²⁾ under the same annealing conditions, in the case of a batch furnace, and one test piece from each of two or more pieces from every 20 t or fracture thereof in the case of a continuous furnace.
Non-metallic inclusion test, Macro-streak-flaw test, Macrostructure test ⁽¹⁾	Each one test piece shall be taken from each of two or more pieces from one lot of steels of the same heat rolled to or forged to the same diameter group ⁽²⁾ .

Notes ⁽¹⁾ The micro-and macro structure tests shall be applied when so specified.

⁽²⁾ The same diameter group means a group of steels having diameters which fall within the ranges given in Table 4 for cold-drawn steels and that given in Table 5 for hot-rolled round bars. For the hot-rolled round bars having a diameter of more than 160 mm, it shall be agreed upon between the purchaser and supplier.

13.3 Hardness Test The hardness test shall be carried out as follows:

- (1) The sampling method and the number of test pieces shall conform to Table 13 for the hot-rolled or forged steels, and shall be agreed between the purchaser and supplier for the cold-drawn steels.
- (2) The test method shall be in accordance with JIS Z 2243 and JIS Z 2245.

13.4 Microstructure Test Microstructure test shall be carried out as follows:

- (1) The sampling method and the number of test pieces shall conform to Table 13.
- (2) In testing of spheroidized steels, the test surface shall be a longitudinal section including the axis of the steels and the microstructure shall be observed in diametrical direction. For the steels having a diameter of 15 mm and under, however, the cross section may be subjected to the test surface.

For steels which are machined out into ring form, the central portion (within a circle having a diameter of within 25 % of the diameter of the steel) may be exempted from this test.

The test of steels for forging shall be carried out in the same manner as the test of spheroidized steels.

13.5 Macrostructure Test The macrostructure test shall be carried out as follows:

- (1) The sampling method and the number of test pieces shall conform to Table 13.
- (2) The test method shall be as specified in JIS G 0553.

13.6 Non-metallic Inclusion Test The non-metallic inclusion test shall be carried out as follows:

- (1) The sampling method and the number of test pieces shall conform to Table 13.
- (2) The test method shall be as specified in JIS G 0555.

13.7 Macro-Streak-Flaw Test The macro-streak-flaw test shall be carried out as follows:

- (1) The sampling method and the number of test pieces shall conform to Table 13.
- (2) The specimen shall be turned to have a first-step diameter given in Table 14 (roughness of the finished surface shall be usually 5a), and the lengths and number of macro-streak-flaws shall be determined in accordance with JIS G 0556. With this respect, each value mentioned above shall be expressed as that per 100 cm² of the test area. However, this test shall not be applied to the wire rods and steels of 15 mm and under in diameter.

For steels of 160 mm and over in diameter, the test shall be agreed upon between the purchaser and supplier.

Table 14. Dimensions of Step Machining

Unit: mm

Hot-rolled round bars					Cold-drawn steels		
Diameter (D)	Diameter of first step	Diameter of second step	Diameter of third step	Length of each step	Diameter (D)	Diameter of first step	Length of a step
Over 15 up to and incl. 25	$D-2.0$	—	—	63.6	Over 15 up to and incl. 35	$D-1.0$	63.6
Over 25 up to and incl. 50	$D-2.5$	$D \times \frac{1}{2}$	—	63.6			
Over 50 up to and incl. 70	$D-3.0$	$D \times \frac{1}{2}$	—	63.6			
Over 70 up to and incl. 100	$D-3.0$	$D \times \frac{2}{3}$	$D \times \frac{1}{3}$	63.6			
Over 100 up to and incl. 160	$D-4.0$	$D \times \frac{2}{3}$	$D \times \frac{1}{3}$	63.6			

Remark: The macro-streak-flaw test in the second and third steps shall be performed when they are specified.

14. Inspection

The inspection shall be carried out as follows:

- (1) The general requirements for inspection shall be as specified in JIS G 0303.
- (2) The chemical composition shall conform to the requirements of 3.
- (3) The shape and dimensions shall conform to the requirements of 4.
- (4) The appearance shall conform to the requirements of 5.
- (5) The total decarburized depth shall conform to the requirements of 6.
- (6) The hardness shall conform to the requirements of 7.
- (7) The non-metallic inclusions shall conform to the requirements of 10.
- (8) The macro-streak-flaws shall conform to the requirements of 11.

Taking into account the usage of steels, however, a part of inspection items listed in (2) to (8) may be omitted by agreement between the purchaser and supplier.

- (9) The microstructure shall be applied when specified by the purchaser, and it shall conform to the requirements of 8.
- (10) The macrostructure shall be applied when specified by the purchaser, and it shall conform to the requirements of 9.

15. Marking

The steels which have passed the inspection shall be marked for each bundle with the following details by suitable means. The steels of 30 mm and over in diameter or distance between the parallel faces, however, shall be marked for each piece on request by the purchaser.

By agreement between the purchaser and supplier, a part of the following details may be omitted.

- (1) Symbol of steel grade
- (2) Heat number or other manufacturing number
- (3) Manufacturer's name or its identifying brand

16. Report

The report shall be in accordance with the requirements of 8. "Report" of JIS G 0303. The report on the microstructure and macrostructure, however, shall be agreed between the purchaser and supplier.

Attached Table 1

JIS G 0303	General Rules for Inspection of Steel
JIS G 0321	Product Analysis and its Tolerances for Wrought Steel
JIS G 0553	Macrostructure Detecting Method for Steel
JIS G 0555	Microscopic Testing Method for the Non-Metallic Inclusions in Steel
JIS G 0556	Method of Macro-Streak-Flaw Test for Steel
JIS G 0558	Methods of Measuring Decarburized Depth for Steel
JIS G 1211	Methods for Determination of Carbon in Iron and Steel
JIS G 1212	Methods for Determination of Silicon in Iron and Steel
JIS G 1213	Methods for Determination of Manganese in Iron and Steel
JIS G 1214	Methods for Determination of Phosphorus in Iron and Steel
JIS G 1215	Methods for Determination of Sulfur in Iron and Steel
JIS G 1216	Methods for Determination of Nickel in Iron and Steel
JIS G 1217	Methods for Determination of Chromium in Iron and Steel

- JIS G 1218 Methods for Determination of Molybdenum in Iron and Steel
- JIS G 1219 Methods for Determination of Copper in Iron and Steel
- JIS G 1252 Emission-Spectroscopic Analysis for Carbon Steel and Low Alloy Steel
- JIS G 1253 Method for Photoelectric Emission Spectrochemical Analysis of Iron and Steel
- JIS G 1256 Method for X-Ray Fluorescence Spectrometric Analysis of Iron and Steel
- JIS G 1257 Methods for Atomic Absorption Spectrochemical Analysis of Iron and Steel
- JIS G 1258 Methods for Inductively Coupled Plasma Emission Spectrochemical Analysis of Steel
- JIS Z 2243 Method of Brinell Hardness Test
- JIS Z 2245 Method of Rockwell and Rockwell Superficial Hardness Test

G 4805-1990
Edition 2

Japanese Text

Established by Minister of International Trade and Industry

Date of Establishment: 1950-05-16

Date of Revision: 1990-07-01

Date of Reaffirmation: 1990-07-01

Date of Public Notice in Official Gazette: 1990-07-17

Investigated by: Japanese Industrial Standards Committee

Divisional Council on Iron and Steel

Technical Committee on Special Steel

This English translation is published by:
Japanese Standards Association
1-24, Akasaka 4, Minato-ku,
Tokyo 107 Japan
© JSA, 1991

Printed in Tokyo by
Hohbunsha Co., Ltd.