

JIS

This English version is for information purpose only.
The original Japanese text of this Standard was
revised in Nov., 2000

JAPANESE INDUSTRIAL STANDARD

Carbon Tool Steels

☞ JIS G 4401 - 1983

Translated and Published

by

Japanese Standards Association

**In the event of any doubt arising,
the original Standard in Japanese is to be final authority**

Errata for JIS (English edition) are printed in *Standardization Journal*, published monthly by the Japanese Standards Association.

Errata will be provided upon request, please contact:
Business Department,
Japanese Standards Association
4-1-24, Akasaka, Minato-ku,
Tokyo, JAPAN 107
TEL. 03-3583-8002
FAX. 03-3583-0462

Errata are also provided to subscribers of JIS (English edition) in *Monthly Information*.



1. Scope

This Japanese Industrial Standard specifies the carbon tool steels, hereinafter referred to as the "steels", manufactured by hot-rolling or forging.

2. Grade and Designation

The steels shall be classified into 7 grades and the designation shall be as given in Table 1.

3. Method of Manufacture

3.1 The steel shall be made of killed steel.

3.2 Unless otherwise specified, the steel shall be rolled or forged with a forming ratio of 4S and over. However, if this forming ratio is difficult to attain 4S owing to the dimension of the steel, it may be overcome by upset forging.

3.3 Unless otherwise specified, the steel shall be subjected to annealing. The plate and sheet in coils and cut lengths, however, shall be as rolled, unless otherwise specified.

4. Chemical Composition

The chemical composition of the steel shall be determined by the ladle analysis, and the values obtained shall conform to Table 1.

Table 1. Chemical Composition

Designation of grade	Chemical composition %					Example of application for reference
	C	Si	Mn	P	S	
SK 1	1.30 to 1.50	0.35 max.	0.50 max.	0.030 max.	0.030 max.	Blade file, file set
SK 2	1.10 to 1.30	0.35 max.	0.50 max.	0.030 max.	0.030 max.	Drill, small punch, razor, file, cutting tool, hacksaw and spiral spring
SK 3	1.00 to 1.10	0.35 max.	0.50 max.	0.030 max.	0.030 max.	Hacksaw, bit, gauge, spiral spring, die for press, jig and tool, and cutting tool
SK 4	0.90 to 1.00	0.35 max.	0.50 max.	0.030 max.	0.030 max.	Drill for wood working, hatchet, bit, spiral spring, pen nib, chisel, slitters knife, die for press, gauge and latch needle
SK 5	0.80 to 0.90	0.35 max.	0.50 max.	0.030 max.	0.030 max.	Steel stamp, die for press, spiral spring, band saw, jig and tool, cutting tool, circular saw, mineograph file, gauge and needle
SK 6	0.70 to 0.80	0.35 max.	0.50 max.	0.030 max.	0.030 max.	Steel stamp, snap, circular saw, spiral spring, mineograph file and die for press
SK 7	0.60 to 0.70	0.35 max.	0.50 max.	0.030 max.	0.030 max.	Steel stamp, snap, die for press and knife

Remark: The content of Cu, Cr and Ni for each grade shall not exceed 0.25 %, 0.30 % and 0.25 %, respectively, as the impurities.

5. Hardness in Annealed Condition

The annealed hardness for the steel shall conform to Table 2. Pertaining to the steel for which the measurement by Brinell hardness is difficult, however, it may be made by Rockwell B hardness or Vickers hardness. In this case, the value of Rockwell B or Vickers hardness shall be agreed upon between the purchaser and the manufacturer.

Table 2. Annealed Hardness of Steel

Designation of grade	Annealing temperature °C	Annealed hardness HB
SK 1	750 to 780 slow cooling	217 max.
SK 2	750 to 780 slow cooling	212 max.
SK 3	750 to 780 slow cooling	212 max.
SK 4	740 to 760 slow cooling	207 max.
SK 5	730 to 760 slow cooling	207 max.
SK 6	730 to 760 slow cooling	201 max.
SK 7	730 to 760 slow cooling	201 max.

Remark: For hot-rolled steel plate and sheet in coils and cut lengths, the hardness value as rolled or in annealed condition shall be agreed upon between the purchaser and the manufacturer.

6. Hardness in Quenched and Tempered Condition

The test piece which is the representative of the steel to be quenched and tempered shall be subjected to heat treatment at an appropriate temperature range selected among those as given in Table 3. And the hardness on the test piece in quenched and tempered condition shall conform to Table 3.

Table 3. Quenched and Tempered Hardness of Test Piece

Designation of grade	Heat treatment temperature °C		Quenched and tempered hardness HRC
	Quenching	Tempering	
SK 1	760 to 820 water cooling	150 to 200 air cooling	63 min.
SK 2	760 to 820 water cooling	150 to 200 air cooling	63 min.
SK 3	760 to 820 water cooling	150 to 200 air cooling	63 min.
SK 4	760 to 820 water cooling	150 to 200 air cooling	61 min.
SK 5	760 to 820 water cooling	150 to 200 air cooling	59 min.
SK 6	760 to 820 water cooling	150 to 200 air cooling	57 min.
SK 7	760 to 820 water cooling	150 to 200 air cooling	56 min.

Remark: For the steel which have not been annealed, it shall be subjected to annealing according to Table 2 and subsequently quenching and tempering.

7. Appearance, Shape, Dimensions and Tolerances

7.1 Hot-rolled Round Steel Bar

7.1.1 Appearance The hot-rolled round steel bar shall have a well workmanlike finish, and shall be free from defects that are detrimental to practical use.

7.1.2 Preferred Dimension The preferred diameter of the hot-rolled round steel bar shall be as given in Table 4.

Table 4. Preferred Diameter

Unit: mm

10	20	30	50	100
11	21	32	55	110
12	22	34	60	120
13	23	36	65	130
14	24	38	70	140
15	25	40	75	150
16	26	42	80	
17	27	44	85	
18	28	46	90	
19	29	48	95	

7.1.3 Dimensional Tolerances The tolerances on diameter for the hot-rolled round steel bar shall conform to Table 5.

Table 5. Tolerances on Diameter

Unit: mm

Specified diameter	Tolerance on diameter	Permissible deviation on ovality
10 and over, up to 16	+ 0.6 - 0.3	Up to and incl. 70 % of the full range of tolerance on diameter
16 and over, up to 30	+ 0.7 - 0.3	
30 and over, up to and incl. 150	+ 2.5 % - 1.0 %	

Remark: The tolerances on diameter for the round steel bar whose diameter is up to 10 mm or over 150 mm shall be agreed upon between the purchaser and the manufacturer.

7.2 Hot-rolled Steel Plate and Sheet in Coils and Cut Lengths

7.2.1 Appearance The appearance of the hot-rolled steel plate and sheet in coils and cut lengths shall be in accordance with 7. in JIS G 3193.

7.2.2 Preferred Dimension The preferred dimension of the hot-rolled steel plate and sheet in coils and cut lengths shall conform to (1) and (2) of the following:

- (1) The preferred thickness of the hot-rolled steel plate and sheet in coils and cut lengths shall be in accordance with 4.1 in JIS G 3193.
- (2) The preferred width and length of the hot-rolled steel plate and sheet in coils and cut lengths shall be in accordance with 4.2 and 4.3 in JIS G 3193.

7.2.3 Tolerances on Shape and Dimension The tolerances on shape and dimension for the hot-rolled steel plate and sheet in coils and cut lengths shall conform to (1) and (2) of the following:

- (1) The tolerances on shape and dimension for the hot-rolled steel plate and sheet in coils and cut lengths shall conform to 5. in JIS G 3193. In this case, the thickness tolerances shall be applied to those up to not including 160 mm in thickness, and for plates thicker than 160 mm, it shall be agreed upon between the purchaser and the manufacturer.
- (2) The upper limit of flatness tolerances for hot-rolled steel plate and sheet in cut lengths shall conform to (a) and (b) of the following:
 - (a) The tolerances for the steel plate and sheet up to 160 mm in thickness shall conform to Table 6.
 - (b) The tolerances for the steel plate 160 mm and over in thickness shall be the subject of agreement between the purchaser and the manufacturer.

Table 6. Upper Limit of Flatness Tolerances for Hot-rolled Steel Plate and Sheet

Unit: mm

Width Thickness	Up to 1250	1250 and over, up to 1600	1600 and over, up to 2000	2000 and over, up to 2500	2500 and over, up to 3000	3000 and over
Up to 1.60	27	30	-	-	-	-
1.60 and over, up to 4.00	24	27	30	-	-	-
4.00 and over, up to 6.30	21	24	27	33	39	42
6.30 and over, up to 10.0	18	21	24	30	36	39
10.0 and over, up to 25.0	15	18	21	24	27	30
25.0 and over, up to 63.0	12	15	18	21	24	27
63.0 and over, up to 160	12	12	15	18	21	24

- Remarks
1. This table shall not apply to the steel plate and sheet supplied as stretcher levelled condition.
 2. This table shall be applied in any 4000 mm length. When the length of the steel plate or sheet is up to 4000 mm, this table shall be applied to the whole length.
 3. The value of flatness shall be determined by subtracting the thickness of the steel plate or sheet from the maximum value of strain, and shall be applied to the upper surface of the steel plate or sheet.
 4. This table shall not apply to as-rolled (mill edged) steel plate and sheet.
 5. Measurement on flatness should be made, as a rule, on a flat horizontal plate.

7.3 The appearance, dimensions and dimensional tolerances for the steels whose profiles are other than those specified in 7.1 and 7.2, shall be agreed upon between the purchaser and the manufacturer.

8. Decarburization

The steel shall be free from appreciable decarburization. In this case, the allowable limit of decarburized depth of the hot-rolled round steel bar shall conform to Table 7.

Table 7. Decarburized Depth of Hot-rolled
Round Steel Bar

Unit: mm

Specified diameter	Allowable limit
Up to 15	0.30
15 and over, up to 25	0.50
25 and over, up to 50	0.80
50 and over, up to 75	1.10
75 and over, up to 100	1.40
100 and over, up to 130	1.80
130 and over, up to and incl. 150	2.00

Remark: The allowable limit of decarburized depth for the steel plate and sheet in coils and cut lengths shall be agreed upon between the purchaser and the manufacturer.

9. Test

9.1 Chemical Analysis

9.1.1 The general requirements for chemical analysis and sampling method of specimen for analysis shall be in accordance with the specification of 3. in JIS G 0303.

9.1.2 The analytical method shall comply with appropriate standard among the following ones:

JIS G 1211, JIS G 1212, JIS G 1213, JIS G 1214, JIS G 1215,
JIS G 1216, JIS G 1217, JIS G 1219, JIS G 1253, JIS G 1256,
JIS G 1257

9.2 Hardness Test

9.2.1 The measurement of hardness on the annealed steel shall be made at arbitrary place of the steel.

9.2.2 Pertaining to the sampling plan, one test specimen for quenched and tempered hardness test shall be taken from each heat of the steel.

9.2.3 The test piece for quenched and tempered hardness test shall be made from the test specimen prepared according to 9.2.2 to furnish approximately 15 mm square and 20 mm length.

When it is difficult to apply these dimension, it shall be agreed upon between the purchaser and the manufacturer.

9.2.4 The test method shall conform to the following standards:

JIS Z 2243, JIS Z 2244, JIS Z 2245

9.3 Measurement of Decarburized Depth The measurement of decarburized depth shall be made by the total decarburized depth (DM-T) according to the microscopic measuring method specified in 4. of JIS G 0558.

10. Inspection

10.1 The test results on chemical composition, hardness in annealed condition, hardness in quenched and tempered condition, appearance, shape, dimensions and decarburization shall conform to the requirements specified in 4., 5., 6., 7. and 8.

10.2 In addition to the inspection items specified in 10.1, any necessary items among those special requirements as given in the following may be specified. In this case, the purchaser shall previously be agreed with the manufacturer on the inspection items, sampling method, test method and acceptance criteria.

Macro-structure examination

Micro-structure examination

Non-metallic inclusions examination

Macro-streak-flaw examination

Magnetic particle examination

Ultrasonic flaw detection examination

However, the sampling method of the test specimen, test piece, test method, etc. shall conform to the following standards:

JIS G 0303, JIS G 0553, JIS G 0555, JIS G 0556, JIS G 0565,
JIS Z 2344

11. Marking

11.1 Steel Bar, Flat Steel Bar and Steel Wire Rod Pertaining to the marking of the steel bar, flat steel bar and steel wire rod, the following items shall be marked by suitable means on each steel product. However, the steel product and flat steel bar whose diameter or distance between parallel faces is up to 30 mm may be bundled, and the items may be marked on each bundle by suitable means. Furthermore, a part of the following items may be omitted, when approved by the purchaser.

- (1) Designation of grade
- (2) Heat number or alternative manufacturing number
- (3) Manufacturer's name or its identifying brand

11.2 Steel Plate and Sheet in Coils and Cut Lengths Pertaining to the marking of the steel plate and sheet in coils and cut lengths, the following items shall be legibly marked by suitable means on each steel product or each bundle. When approved by the purchaser, however, a part of the items may be omitted.

- (1) Designation of grade
- (2) Heat number or alternative manufacturing number
- (3) Dimension
- (4) Manufacturer's name or its identifying brand

12. Report

The manufacturer shall submit to the purchaser the report in which the designation of grade, heat number or alternative manufacturing number, chemical composition, dimension and delivery conditions for the steel are entered. However, pertaining to submission of the test results report prepared according to 10.2, it shall be agreed upon between the purchaser and the manufacturer.

Applicable Standards:

- JIS G 0303-General Rules for Inspection of Steel
- JIS G 0553-Macro-Structure 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 0565-Methods for Magnetic Particle Testing of Ferromagnetic Materials and Classification of Magnetic Particle Indication
- 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 1219-Methods for Determination of Copper in Iron and 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-Atomic Absorption Spectrochemical Analysis of Iron and Steel
- JIS G 3193-Dimensions, Weight and Permissible Variations of Hot Rolled Steel Plates, Sheets and Strip
- JIS Z 2243-Method of Brinell Hardness Test
- JIS Z 2244-Method of Vickers Hardness Test
- JIS Z 2245-Method of Rockwell and Rockwell Superficial Hardness Test
- JIS Z 2344-Ultrasonic Testing of Metals by the Pulse Echo Technique

G 4401-1983
Edition 5

Japanese Text

Established by Minister of International Trade and Industry

Date of Establishment: 1950-10-24

Date of Revision: 1983-03-01

Date of Reaffirmation: 1994-06-01

Date of Public Notice in Official Gazette: 1994-06-07

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, 1983**

**Printed in Tokyo by
Hohbunsha Co., Ltd.**