

# JIS

JAPANESE  
INDUSTRIAL  
STANDARD

Translated and Published by  
Japanese Standards Association

---

**JIS G 4051** : 2016

(JISF)

**Carbon steels for machine structural  
use**

---

ICS 77.140.10

Reference number : **JIS G 4051 : 2016 (E)**

G 4051 : 2016

Date of Establishment: 1965-07-01

Date of Revision: 2016-11-21

Date of Public Notice in Official Gazette: 2016-11-21

Investigated by: Japanese Industrial Standards Committee  
Standards Board for ISO area  
Technical Committee on Metal and Inorganic  
Materials

---

JIS G 4051:2016, First English edition published in 2017-03

Translated and published by: Japanese Standards Association  
Mita MT Building, 3-13-12, Mita, Minato-ku, Tokyo, 108-0073 JAPAN

---

In the event of any doubts arising as to the contents,  
the original JIS is to be the final authority.

© JSA 2017

All rights reserved. Unless otherwise specified, no part of this publication may be reproduced or utilized in any form or by any means, electronic or mechanical, including photocopying and microfilm, without permission in writing from the publisher.

Printed in Japan

KK/AT

PROTECTED BY COPYRIGHT

## Contents

	Page
Introduction.....	1
1 Scope.....	1
2 Normative references .....	1
3 Classification and symbols .....	2
4 Manufacturing method .....	2
5 Chemical composition .....	2
6 Appearance, shape, dimensions and dimensional tolerances .....	4
6.1 Hot-rolled steel bars and wire rods .....	4
6.2 Hot-rolled steel plates, sheets and strips .....	8
6.3 Hot-rolled flat steels .....	9
6.4 Hot-extruded sections .....	10
6.5 Other steel products.....	10
7 Tests .....	10
8 Inspection .....	10
9 Marking.....	11
10 Report.....	11
Annex JA (normative) Manufacturing method and quality requirements for hot-extruded sections.....	12
Annex JB (normative) Symbols of grades and chemical compositions only applicable to steel plates, sheets and strips .....	14
Annex JC (normative) Quality requirements for cold-rolled carbon steel plates, sheets and strips .....	15
Annex JD (informative) Comparison table between JIS and corresponding International Standards .....	17

## Foreword

This translation has been made based on the original Japanese Industrial Standard revised by the Minister of Economy, Trade and Industry through deliberations at the Japanese Industrial Standards Committee as the result of proposal for revision of Japanese Industrial Standard submitted by The Japan Iron and Steel Federation (JISF) with the draft being attached, based on the provision of Article 12 Clause 1 of the Industrial Standardization Law applicable to the case of revision by the provision of Article 14.

Consequently **JIS G 4051:2009** is replaced with this Standard.

However, **JIS G 4051:2009** may be applied in the **JIS** mark certification based on the relevant provisions of Article 19 Clause 1, etc. of the Industrial Standardization Law until November 20, 2017.

This **JIS** document is protected by the Copyright Law.

Attention is drawn to the possibility that some parts of this Standard may conflict with patent rights, applications for a patent after opening to the public or utility model rights. The relevant Minister and the Japanese Industrial Standards Committee are not responsible for identifying any of such patent rights, applications for a patent after opening to the public or utility model rights.

# Carbon steels for machine structural use

## Introduction

This Japanese Industrial Standard has been prepared based on the second edition of **ISO 683-1** published in 2012 and the first edition of **ISO 683-3** published in 2014 with some modifications of the technical contents.

The vertical lines on both sides and dotted underlines indicate changes from the corresponding International Standard. A list of modifications with the explanations is given in Annex JD.

## 1 Scope

This Standard specifies carbon steels for machine structural use (hereafter referred to as steel products) which are manufactured by hot rolling, hot forging and hot extruding. This Standard applies to steel products with a uniform cross-section, which are generally supplied for use after further processes of forging, cutting and heat treatment. This Standard is not applicable to steel tubes<sup>1)</sup>.

The manufacturing method and quality requirements for hot-extruded sections are given in Annex JA.

NOTE : The International Standards corresponding to this Standard and the symbol of degree of correspondence are as follows.

ISO 683-1:2012 *Heat-treatable steels, alloy steels and free-cutting steels—Part 1: Non-alloy steels for quenching and tempering*

ISO 683-3:2014 *Heat-treatable steels, alloy steels and free-cutting steels—Part 3: Case-hardening steels* (overall evaluation: MOD)

In addition, symbols which denote the degree of correspondence in the contents between the relevant International Standard and **JIS** are IDT (identical), MOD (modified), and NEQ (not equivalent) according to **ISO/IEC Guide 21-1**.

Note <sup>1)</sup> Steel tubes are covered in **JIS G 3478** (Carbon steel tubes for general machine structural purposes).

## 2 Normative references

The following standards contain provisions which, through reference in this text, constitute provisions of this Standard. The most recent editions of the standards (including amendments) indicated below shall be applied.

JIS G 0320 *Standard test method for heat analysis of steel products*

JIS G 0321 *Product analysis and its tolerance for wrought steel*

JIS G 0404 *Steel and steel products—General technical delivery requirements*

JIS G 0415 *Steel and steel products—Inspection documents*

JIS G 3191 *Dimensions, mass and permissible variations of hot rolled steel bars and bar in coil*

JIS G 3192 *Dimensions, mass and permissible variations of hot rolled steel sections*

JIS G 3193 *Dimensions, mass and permissible variations of hot rolled steel plates, sheets and strips*

JIS G 3194 *Dimensions, mass and permissible variations of hot rolled flat steel*

### 3 Classification and symbols

The steels are classified into 27 grades, the respective symbols of which are shown in Table 1.

**Table 1 Symbols of grades**

Classification	Symbols of grades
Carbon steel	S10C, S12C, S15C, S17C, S20C, S22C, S25C, S28C, S30C, S33C, S35C, S38C, S40C, S43C, S45C, S48C, S50C, S53C, S55C, S58C
	S60C <sup>a)</sup> , S65C <sup>a)</sup> , S70C <sup>a)</sup> , S75C <sup>a)</sup>
Case hardening steel	S09CK, S15CK, S20CK
Note <sup>a)</sup> Only applicable to plates, sheets and strips.	

### 4 Manufacturing method

The manufacturing method shall be as follows. The manufacturing method for hot-extruded sections is specified in **JA.1**.

- a) The steel products shall be manufactured from killed steel.
- b) The steel products shall be manufactured by hot working such as rolling and forging with a forging ratio of not less than 4S. The forging ratio may be less than 4S if the purchaser is to perform further hot working such as rolling or forging on the steels, provided that a prior agreement is made between the purchaser and the manufacturer.
- c) The steel products shall normally be supplied as hot-rolled or hot-forged, but may be given heat treatment if specified by the purchaser <sup>2)</sup>.  
Note <sup>2)</sup> Mechanical properties values for heat-treated products may be agreed upon between the purchaser and the manufacturer.
- d) Steel plates, sheets and strips which cannot be manufactured by hot rolling due to their required thickness may be manufactured by cold rolling upon agreement between the purchaser and the manufacturer. Cold-rolled steel plates, sheets and strips shall normally be annealed after rolling.

### 5 Chemical composition

When tested in accordance with clause 7, the steel products shall satisfy the heat analysis values given in Table 2. If a product analysis is agreed between the purchaser and the manufacturer, the steel products shall be tested in accordance with clause 7 and

shall satisfy the requirements in Table 2 within the tolerances given in Table 3 of **JIS G 0321**.

Chemical composition requirements for S60C, S65C, S70C and S75C applicable to steel sheets, plates and strips are specified in Annex JB.

**Table 2 Chemical composition**

Symbols of grades	C	Si	Mn	P	S	Ni	Cr <sup>a)</sup>	Cu	Ni + Cr <sup>b)</sup>
S10C	0.08 to 0.13	0.15 to 0.35	0.30 to 0.60	0.030 max.	0.035 max.	0.20 max.	0.20 max.	0.30 max.	0.35 max.
S12C	0.10 to 0.15	0.15 to 0.35	0.30 to 0.60	0.030 max.	0.035 max.	0.20 max.	0.20 max.	0.30 max.	0.35 max.
S15C	0.13 to 0.18	0.15 to 0.35	0.30 to 0.60	0.030 max.	0.035 max.	0.20 max.	0.20 max.	0.30 max.	0.35 max.
S17C	0.15 to 0.20	0.15 to 0.35	0.30 to 0.60	0.030 max.	0.035 max.	0.20 max.	0.20 max.	0.30 max.	0.35 max.
S20C	0.18 to 0.23	0.15 to 0.35	0.30 to 0.60	0.030 max.	0.035 max.	0.20 max.	0.20 max.	0.30 max.	0.35 max.
S22C	0.20 to 0.25	0.15 to 0.35	0.30 to 0.60	0.030 max.	0.035 max.	0.20 max.	0.20 max.	0.30 max.	0.35 max.
S25C	0.22 to 0.28	0.15 to 0.35	0.30 to 0.60	0.030 max.	0.035 max.	0.20 max.	0.20 max.	0.30 max.	0.35 max.
S28C	0.25 to 0.31	0.15 to 0.35	0.60 to 0.90	0.030 max.	0.035 max.	0.20 max.	0.20 max.	0.30 max.	0.35 max.
S30C	0.27 to 0.33	0.15 to 0.35	0.60 to 0.90	0.030 max.	0.035 max.	0.20 max.	0.20 max.	0.30 max.	0.35 max.
S33C	0.30 to 0.36	0.15 to 0.35	0.60 to 0.90	0.030 max.	0.035 max.	0.20 max.	0.20 max.	0.30 max.	0.35 max.
S35C	0.32 to 0.38	0.15 to 0.35	0.60 to 0.90	0.030 max.	0.035 max.	0.20 max.	0.20 max.	0.30 max.	0.35 max.
S38C	0.35 to 0.41	0.15 to 0.35	0.60 to 0.90	0.030 max.	0.035 max.	0.20 max.	0.20 max.	0.30 max.	0.35 max.
S40C	0.37 to 0.43	0.15 to 0.35	0.60 to 0.90	0.030 max.	0.035 max.	0.20 max.	0.20 max.	0.30 max.	0.35 max.
S43C	0.40 to 0.46	0.15 to 0.35	0.60 to 0.90	0.030 max.	0.035 max.	0.20 max.	0.20 max.	0.30 max.	0.35 max.
S45C	0.42 to 0.48	0.15 to 0.35	0.60 to 0.90	0.030 max.	0.035 max.	0.20 max.	0.20 max.	0.30 max.	0.35 max.
S48C	0.45 to 0.51	0.15 to 0.35	0.60 to 0.90	0.030 max.	0.035 max.	0.20 max.	0.20 max.	0.30 max.	0.35 max.
S50C	0.47 to 0.53	0.15 to 0.35	0.60 to 0.90	0.030 max.	0.035 max.	0.20 max.	0.20 max.	0.30 max.	0.35 max.
S53C	0.50 to 0.56	0.15 to 0.35	0.60 to 0.90	0.030 max.	0.035 max.	0.20 max.	0.20 max.	0.30 max.	0.35 max.
S55C	0.52 to 0.58	0.15 to 0.35	0.60 to 0.90	0.030 max.	0.035 max.	0.20 max.	0.20 max.	0.30 max.	0.35 max.
S58C	0.55 to 0.61	0.15 to 0.35	0.60 to 0.90	0.030 max.	0.035 max.	0.20 max.	0.20 max.	0.30 max.	0.35 max.

**Table 2 (concluded)**

									Unit: %
Symbols of grades	C	Si	Mn	P	S	Ni	Cr <sup>a)</sup>	Cu	Ni+Cr <sup>b)</sup>
S09CK	0.07 to 0.12	0.10 to 0.35	0.30 to 0.60	0.025 max.	0.025 max.	0.20 max.	0.20 max.	0.25 max.	0.30 max.
S15CK	0.13 to 0.18	0.15 to 0.35	0.30 to 0.60	0.025 max.	0.025 max.	0.20 max.	0.20 max.	0.25 max.	0.30 max.
S20CK	0.18 to 0.23	0.15 to 0.35	0.30 to 0.60	0.025 max.	0.025 max.	0.20 max.	0.20 max.	0.25 max.	0.30 max.
<p>Elements not quoted shall not be intentionally added to steel, other than for the purpose of finishing the heat.</p> <p>Notes <sup>a)</sup> This limit may be "less than 0.30 %" upon agreement between the purchaser and the manufacturer.</p> <p><sup>b)</sup> The upper limit of Ni+Cr may be "less than 0.40 %" for S09CK, S15CK and S20CK, and "less than 0.45 %" for other grades, upon agreement between the manufacturer and the purchaser.</p>									

## 6 Appearance, shape, dimensions and dimensional tolerances

### 6.1 Hot-rolled steel bars and wire rods

#### 6.1.1 Appearance

The hot-rolled steel bars and the wire rods shall be well finished and free from defects in appearance that are detrimental to service. The coiled products may contain some defects since it is generally difficult to inspect their surfaces throughout the length and treat the defects found. Treatment of any defects detected in coils that are found to be detrimental to service, if required, shall be agreed between the purchaser and the manufacturer.

#### 6.1.2 Limit of removal of surface imperfections and permissible depth of surface imperfections remaining after repair

The limit of removal of surface imperfections and permissible depth of surface imperfections remaining after repair shall be as follows.

- a) **Steel bars for general forging** The surface imperfections of the steel bars for general forging shall be removed so as to obtain a smooth surface and to a depth not exceeding 4 % (5 mm max.) of the nominal size, and the total width not exceeding 1/4 of the circumferential length of the same cross-section. If the dressed portion is within the dimensional tolerance, however, it shall not be considered as the flaw of the portion dressed.

The maximum permissible depth of surface imperfections remaining after repair shall be as agreed between the purchaser and the manufacturer.

- b) **Round bars for direct cutting** Removal of surface imperfections of round bars for direct cutting is not generally performed. The permissible depth of surface imperfections based on the nominal size shall be as given in Table 3. If removal of surface imperfections is to be performed, the limit of removal shall be in accordance with the agreement between the purchaser and the manufacturer.

**Table 3 Permissible depth of surface imperfections based on the nominal size, for round bars for direct cutting**

Diameter mm	Permissible depth of surface imperfections based on the nominal size
Under 16	Not exceeding 4 % of the nominal size, with the maximum being 0.5 mm
16 or over to and excl. 50	Not exceeding 3 % of the nominal size, with the maximum being 1.0 mm
50 or over to and excl. 100	Not exceeding 2 % of the nominal size, with the maximum being 1.5 mm
100 or over up to and incl. 200	Not exceeding 1.5 % of the nominal size
For sizes greater than 200 mm, the permissible depth of surface imperfections shall be as agreed between the purchaser and the manufacturer.	

- c) **Steel bars for cold drawing** The surface imperfections of the steel bars for cold drawing shall be removed so as to obtain a smooth surface, and the limit of depth of surface imperfections to remove, based on the lowest limit of dimensional tolerance (see Table 6), shall be as given in Table 4. The maximum permissible depth of surface imperfections remaining after repair shall be as agreed between the purchaser and the manufacturer.

**Table 4 Limit of depth of surface imperfections to remove, based on the lowest limit of dimensional tolerance, for steel bars for cold drawing**

Diameter or width across flats mm	Limit of depth of surface imperfections to remove, based on the lowest limit of dimensional tolerance
Under 16	0.15 mm max.
16 or over to and excl. 50	Not exceeding 1 % of the nominal size, with the maximum being 0.35 mm
50 or over to and excl. 100	Not exceeding 0.7 % of the nominal size, with the maximum being 0.50 mm
100 or over up to and incl. 130	Not exceeding 0.5 % of the nominal size
For sizes greater than 130 mm, this limit shall be as agreed between the purchaser and the manufacturer.	

- d) **Other steel bars** Removal of surface imperfections of other steel bars, if required, shall be as agreed between the purchaser and the manufacturer.
- e) **Wire rods** The maximum permissible depth of surface imperfections for wire rods shall be as agreed between the purchaser and the manufacturer.

**6.1.3 Standard dimensions**

The standard dimensions shall be as follows.

- a) The standard dimensions for diameter and width across flats of the hot-rolled steel bars (round, square, and hexagonal) and wire rods shall be as given in Table 5.
- b) The length<sup>3)</sup> of the hot-rolled steel bars (round, square, and hexagonal) shall be as agreed between the purchaser and the manufacturer.

Note<sup>3)</sup> Depending on the intended purpose of the product, the bars may be cut to an equal length specified or within a specified length range (from the minimum length to the maximum length).

**Table 5 Standard dimensions for diameter and width across flats of hot-rolled steel bars and wire rods**

Unit: mm

Round bar (diameter)					Square bar (width across flats)			Hexagonal bar (width across flats)		Wire rod (diameter)		
(10)	22	42	85	160	40	95	200	(12)	41	5.5	(15)	30
11	(24)	44	90	(170)	45	100		13	46	6	16	32
(12)	25	46	95	180	50	(105)		14	50	7	(17)	34
13	(26)	48	100	(190)	55	110		17	55	8	(18)	36
(14)	28	50	(105)	200	60	(115)		19	60	9	19	38
(15)	30	55	110		65	120		22	63	9.5	(20)	40
16	32	60	(115)		70	130		24	67	(10)	22	42
(17)	34	65	120		75	140		27	71	11	(24)	44
(18)	36	70	130		80	150		30	(75)	(12)	25	46
19	38	75	140		85	160		32	(77)	13	(26)	48
(20)	40	80	150		90	180		36	(81)	(14)	28	50

Use of values in parentheses is not desirable.

#### 6.1.4 Shape and dimensional tolerances

The shape and dimensional tolerances of the hot-rolled steel bars and wire rods shall be in accordance with **a)** to **c)**. For heat-treated hot-rolled steel bars and wire rods, the shape and dimensional tolerances shall be as agreed between the purchaser and the manufacturer.

The tolerance on length shall be applicable to hot-rolled steel bars (round, square and hexagonal) cut to an equal length specified.

- a) The shape and dimensional tolerances for the hot-rolled round bars and square bars shall be as given in Table 6.

**Table 6 Shape and dimensional tolerances for hot-rolled round bars and square bars**

Item	Shape and dimensional tolerance	
Tolerances on diameter or width across flats	± 1.5 %, or ± 0.4 mm when the absolute value of tolerance is less than 0.4 mm.	
Out-of-round/out-of-square <sup>a)</sup>	Not exceeding 70 % of the specified range of tolerance on diameter or width across flats.	
Tolerance on length <sup>b)</sup>	Length 7 m or under	+40 0 mm
	Length over 7 m	Add 5 mm to plus tolerance for every increase of 1 m or its fraction. Minus tolerance shall be 0 mm.
Corner radius <sup>c)</sup>	Not exceeding 20 % of the width across flats.	
Twist <sup>d)</sup>	Not detrimental to practical service.	
Bend	Not exceeding 3 mm per metre, and not exceeding $3 \text{ mm} \times \frac{\text{Length (m)}}{1 \text{ m}}$ for the whole length.	
<p>Notes <sup>a)</sup> Out-of-roundness is the difference between the maximum and minimum diameters measured at the same cross-section of a round bar. Out-of-square is the difference between the maximum and minimum widths across flats, measured at the same cross-section of a square bar.</p> <p><sup>b)</sup> Plus tolerance may be as agreed between the purchaser and the manufacturer.</p> <p><sup>c)</sup> Corner radius does not apply to round bars.</p> <p><sup>d)</sup> Twist does not apply to round bars.</p>		

b) The shape and dimensional tolerances for the hot-rolled hexagonal bars shall be given in Table 7.

**Table 7 Shape and dimensional tolerances for hot-rolled hexagonal bars**

Item	Width across flats mm			
	Under 19	19 or over to and excl. 32	32 or over to and excl. 55	55 or over
Tolerance on width across flats mm	± 0.7	± 0.8	± 1.0	± 1.2
Out-of-hexagon <sup>a)</sup> mm	1.0 or under	1.1 or under	1.4 or under	1.7 or under
Tolerance on length <sup>b)</sup>	Length 7 m or under	+40 0 mm		
	Length over 7 m	Add 5 mm to plus tolerance for every increase of 1 m or its fraction. Minus tolerance shall be 0 mm.		
Twist	Not detrimental to practical service.			
Bend	Not exceeding 3 mm per metre, and not exceeding $3 \text{ mm} \times \frac{\text{Length (m)}}{1 \text{ m}}$ for the whole length.			
<p>Notes <sup>a)</sup> Out-of-hexagon is the difference between the maximum and minimum widths across flats, measured at the same cross-section of a hexagonal bar.</p> <p><sup>b)</sup> Plus tolerance may be as agreed between the purchaser and the manufacturer.</p>				

- c) The dimensional tolerances for the hot-rolled wire rods shall be as given in Table 8.

**Table 8 Dimensional tolerances for hot-rolled wire rods**

Unit: mm

Diameter	Tolerances on diameter	Out-of-roundness <sup>a)</sup>
15 or under	± 0.3	0.4 max.
Over 15 up to and incl. 25	± 0.4	0.5 max.
Over 25 up to and incl. 32	± 0.5	0.6 max.
Over 32 up to and incl. 50	± 0.6	0.7 max.
Dimensional tolerances for wire rods of diameter over 50 mm shall be as agreed between the purchaser and the manufacturer.		
Note <sup>a)</sup> Out-of-roundness is the difference between the maximum and minimum diameters measured at the same cross-section of a wire rod.		

## 6.2 Hot-rolled steel plates, sheets and strips

### 6.2.1 General

The appearance, shape, dimensions and dimensional tolerances of the hot-rolled steel plates, sheets and strips shall be as follows. For products manufactured by cold rolling upon agreement between the purchaser and the manufacturer, the requirements in Annex JC shall be referred to.

### 6.2.2 Appearance

The appearance of the hot-rolled steel plates, sheets and strips shall be in accordance with **7 a)** and **b)** of **JIS G 3193**.

### 6.2.3 Limit of removal of surface imperfections

The limit of removal of surface imperfections for the hot-rolled steel plates and sheets shall be in accordance with **7 c)** in **JIS G 3193**. Whether to apply repair by welding, and the maximum permissible depth of surface imperfections remaining after repair shall be subject to the agreement between the purchaser and the manufacturer.

### 6.2.4 Standard dimensions

The standard dimensions of the hot-rolled plates, sheets and strips shall be in accordance with clause **4** of **JIS G 3193**.

### 6.2.5 Shape and dimensional tolerances

The shape and dimensional tolerances of the hot-rolled steel plates, sheets and strips shall be as follows.

- a) The tolerances on thickness, width and length, and squareness of hot-rolled steel plates, sheets and strips shall be in accordance with clause **5** of **JIS G 3193**. Thickness tolerances specified above shall apply to products with a thickness under 160 mm, and those for products with a thickness 160 mm or greater shall be as agreed between the purchaser and the manufacturer.

b) The maximum flatness tolerance for the hot-rolled steel plates and sheets shall be as follows. The deviation from flatness is measured as the maximum warp of the plate/sheet placed on a flat surface, reduced by the product thickness. The measurement of warp shall be made at the upper surface of the plate/sheet. For as-rolled steel plates and sheets (with rims), flatness requirement may be as agreed between the purchaser and the manufacturer.

- 1) The flatness of steel plates and sheets of S10C to S25C with a thickness under 160 mm shall be in accordance with **5 f)** in **JIS G 3193**.
- 2) The flatness of steel plates and sheets of S28C to S75C with a thickness under 160 mm shall be as given in Table 9.

The values in Table 9 apply to any 4 000 mm, in measured length, of the steel plate/sheet, and to the full product length if the plate/sheet is less than 4 000 mm in length.

- 3) The flatness of steel plates and sheets with a thickness 160 mm and over shall be as agreed upon between the purchaser and the manufacturer.

NOTE : For measurement of flatness, refer to Figure 3 of **JIS G 3193**.

**Table 9 Maximum flatness tolerances for steel plates and sheets (S28C to S75C)**

Unit: mm

Thickness	Width					
	Under 1 250	1 250 or over to and excl. 1 600	1 600 or over to and excl. 2 000	2 000 or over to and excl. 2 500	2 500 or over to and excl. 3 000	3 000 or over
Under 1.60	27	30	—	—	—	—
1.60 or over to and excl. 4.00	24	27	30	—	—	—
4.00 or over to and excl. 6.30	21	24	27	33	39	42
6.30 or over to and excl. 10.0	18	21	24	30	36	39
10.0 or over to and excl. 25.0	15	18	21	24	27	30
25.0 or over to and excl. 63.0	12	15	18	21	24	27
63.0 or over to and excl. 160	12	12	15	18	21	24

### 6.2.6 Mass

The mass of the hot-rolled steel plates, sheets and strips shall be in accordance with clause **6** of **JIS G 3193**.

## 6.3 Hot-rolled flat steels

### 6.3.1 Appearance

The appearance of the hot-rolled flat steels shall be in accordance with **10 a)** of **JIS G 3194**.

### **6.3.2 Limit of removal of surface imperfections**

The limit of removal of surface imperfections for the hot-rolled flat steels shall be in accordance with **10 b)** of **JIS G 3194**. Whether to apply repair by welding, and the maximum permissible depth of surface imperfections remaining after repair shall be subject to the agreement between the purchaser and the manufacturer.

### **6.3.3 Standard dimensions**

The standard dimensions of the hot-rolled flat steels shall be in accordance with clause **5** of **JIS G 3194**.

### **6.3.4 Shape and dimensional tolerances**

The shape and dimensional tolerances of the hot-rolled flat steels shall be in accordance with clause **7** of **JIS G 3194**.

### **6.4 Hot-extruded sections**

The appearance, shape, dimensions and dimensional tolerances of the hot-extruded sections shall be in accordance with **JA.2**.

### **6.5 Other steel products**

For steel products with a uniform cross-section that are not specified in **6.1** to **6.4**, the appearance, limit of removal of surface imperfections, maximum permissible depth of surface imperfections remaining after repair, shape, dimensions and dimensional tolerances shall be as agreed between the purchaser and the manufacturer. Steel tubes do not fall under this category.

NOTE : Products under this category include forged steel bars and rolled sections, etc.

## **7 Tests**

The tests on steel products shall be as follows.

- a) The chemical composition of products shall be determined by heat analysis. The general requirements for the chemical analysis and the sampling method for the heat analysis are specified in clause **8** of **JIS G 0404**.
- b) The sampling method for the product analysis shall be in accordance with clause **4** of **JIS G 0321**.
- c) The heat analysis shall be in accordance with **JIS G 0320**. The product analysis shall be in accordance with **JIS G 0321**.

NOTE : Where required, an ultrasonic testing may also be carried out. In this case, the test method or other related matters shall be agreed between the purchaser and the manufacturer.

## **8 Inspection**

The inspection on steel products shall be as follows.

- a) The general requirements of the inspections are specified in **JIS G 0404**.

- b) The chemical composition shall conform to the requirements in clause 5.
- c) The appearance, shape, dimensions and dimensional tolerances shall conform to the requirements in clause 6.

## 9 Marking

Each steel product having passed the inspection shall be marked with the following information by a suitable means. Steel plates, steel sheets, steel strips, flat steels, and steel bars with a diameter or width across flats less than 30 mm may be bound together in bundles, and the marking given on each bundle by a suitable means. For steel bars 30 mm or over in diameter or width across flats, the marking may be given on each bundle by suitable means, upon agreement between the purchaser and the manufacturer. Part of the following particulars may be omitted upon agreement between the purchaser and the manufacturer, as far as the identification of the product is possible.

- a) Symbol of grade. In the case of cold-rolled steel plates, sheets and strips, the symbol of grade shall be followed by the symbol, -C, unless it is omitted upon agreement between the purchaser and the manufacturer.
- b) Heat number or other manufacturing (inspection) number
- c) Name of manufacturer or its identifying brand
- d) Mass (applicable to steel plates, sheets and strips)
- e) Dimensions. The marking of dimensions shall be in accordance with **JIS G 3191**, **JIS G 3192**, **JIS G 3193** and **JIS G 3194**. For wire rods, see the method of expression of dimensions for bars in coil specified in **JIS G 3191**.

## 10 Report

Upon request from the purchaser, the manufacturer shall submit an inspection report containing information on the specified items. The report shall be in accordance with clause 13 in **JIS G 0404**. Unless otherwise specified in the order, the type of the inspection document to be submitted shall be in accordance with 5.1 of **JIS G 0415**.

## **Annex JA (normative)**

### **Manufacturing method and quality requirements for hot-extruded sections**

#### **JA.1 Manufacturing method**

The hot-extruded sections shall be manufactured from killed steel by hot extrusion<sup>1)</sup>, and formed to an forging ratio<sup>2)</sup> of 4S or greater.

Notes <sup>1)</sup> Hot extrusion is a method of forming in which heated billets are forced through a die or series of dies, resulting in a specific shape of product.

<sup>2)</sup> The forging ratio is a ratio of the cross-sectional area of the ingot slab or bloom to that of the finished forging.

#### **JA.2 Appearance, shape, dimensions and dimensional tolerances**

##### **JA.2.1 Appearance**

The appearance of hot-extruded sections shall be as agreed upon between the purchaser and the manufacturer.

##### **JA.2.2 Limit of removal of surface imperfections**

The limit of removal of surface imperfections for hot-extruded sections shall be as agreed upon between the purchaser and the manufacturer.

##### **JA.2.3 Applicable dimensions**

The side length or height of hot-extruded sections shall be as given in Table JA.1.

**Table JA.1 Side length or height of hot-extruded sections**

Steel product	Side length or height
Hot-extruded section	250 mm max.

##### **JA.2.4 Shape and dimensional tolerances**

###### **JA.2.4.1 Shape**

The shape of the hot-extruded section shall be as specified by the purchaser. If the specified shape cannot be achieved, the purchaser shall change the shape specification through agreement between the purchaser and the manufacturer.

NOTE : Hot extruded sections are mainly used as components described in the design documents based on the technical criteria such as various specifications used by the manufacturers of machine parts and industrial machines.

### JA.2.4.2 Shape and dimensional tolerances

The shape and dimensional tolerances of the hot-extruded sections shall be in accordance with Table JA.2.

The tolerance on length shall be applicable to products cut to an equal length specified.

**Table JA.2 Shape and dimensional tolerances for hot-rolled hexagonal bars**

	Item	Shape and dimensional tolerances
Tolerance on side length, height and thickness <sup>a)</sup> mm	Under 50	± 1.5
	50 or over to and excl. 100	± 2.0
	100 or over to and excl. 200	± 3.0
	200 or over	± 4.0
Tolerances on length <sup>b)</sup>	Length 7 m or under	+ 40 0 mm
	Length over 7 m	Add 5 mm to plus tolerance for every increase of 1 m or its fraction. Minus tolerance shall be 0 mm.
Squareness of the cross-section mm	Maximum side length 100 or under	1.6 max.
	Maximum side length over 100	3.0 max.
Bend		0.5 % max. of length <sup>c)</sup>
<p>Notes <sup>a)</sup> Upon agreement between the purchaser and the manufacturer, the side length, height and thickness tolerances may be entirely shifted to either plus or minus side by the range equal to the whole tolerance range specified in the table, ensuring to include the reference dimension (i.e. tolerance zero).</p> <p><sup>b)</sup> Plus tolerance may be as agreed between the purchaser and the manufacturer.</p> <p><sup>c)</sup> Applicable to both vertical and lateral bends.</p>		

## Annex JB (normative)

### Symbols of grades and chemical compositions only applicable to steel plates, sheets and strips

**Table JB.1 Symbols of grades and chemical compositions only applicable to steel plates, sheets and strips**

Unit: %

Symbols of grades	C	Si	Mn	P	S	Ni	Cr <sup>a)</sup>	Cu	Ni+Cr <sup>b)</sup>
S60C	0.55 to 0.65	0.15 to 0.35	0.60 to 0.90	0.030 max.	0.035 max.	0.20 max.	0.20 max.	0.30 max.	0.35 max.
S65C	0.60 to 0.70	0.15 to 0.35	0.60 to 0.90	0.030 max.	0.035 max.	0.20 max.	0.20 max.	0.30 max.	0.35 max.
S70C	0.65 to 0.75	0.15 to 0.35	0.60 to 0.90	0.030 max.	0.035 max.	0.20 max.	0.20 max.	0.30 max.	0.35 max.
S75C	0.70 to 0.80	0.15 to 0.35	0.60 to 0.90	0.030 max.	0.035 max.	0.20 max.	0.20 max.	0.30 max.	0.35 max.

This table is applicable to hot-rolled steel plates, sheets and strips, and cold-rolled steel plates, sheets and strips.

Elements not quoted shall not be intentionally added to steel, other than for the purpose of finishing the heat.

If a product analysis is agreed between the purchaser and the manufacturer, the steel products shall be tested in accordance with clause 7 and shall satisfy the requirements in this table within the tolerances given in Table 3 of **JIS G 0321**.

Notes <sup>a)</sup> This limit may be “less than 0.30 %” upon agreement between the purchaser and the manufacturer.

<sup>b)</sup> The upper limit of Ni+Cr may be “less than 0.45 %” upon agreement between the manufacturer and the purchaser.

## **Annex JC (normative)**

### **Quality requirements for cold-rolled carbon steel plates, sheets and strips**

#### **JC.1 Lubrication**

The cold-rolled carbon steel plates, sheets and strips shall be coated with lubricant unless otherwise specified.

#### **JC.2 Appearance**

The appearance of the cold-rolled steel plates, sheets and strips shall be as follows.

- a) The steel plates, sheets and strips shall be free from defects detrimental to service. The steel strips may contain some minor defects since the normal procedures do not afford the manufacturer the opportunity to remove the defects. Treatment of any defects found in the steel strip, if required, may be agreed upon between the purchaser and the manufacturer.

The defects requirement, unless otherwise specified, shall apply to one of the surfaces<sup>1)</sup> of the steel plates, sheets and strips.

NOTE : “Defects” include pores, lamination, surface discontinuities, etc.

Note <sup>1)</sup> “One of the surfaces” refers to the top surface of steel plates and sheets in package, or the outer surface of the coil of steel strips.

- b) Bucking, edge creases, or other defects of as-annealed steel plates, sheets and strips that occurred due to not performing temper-rolling shall not be treated as detrimental defects.
- c) Rust, scratches or other defects of non-lubricated steel plates, sheets and strips that were generated due to not performing lubrication shall not be treated as detrimental defects.

#### **JC.3 Limit of removal of surface imperfections**

The cold-rolled steel plates, sheets and strips shall not be given surface grinding or repaired by welding.

#### **JC.4 Standard dimensions**

The standard dimensions of the cold-rolled steel plates, sheets and strips shall be as follows.

- a) The standard dimensions for width and length shall be in accordance with clause 4 of **JIS G 3193**.
- b) The standard thicknesses shall be as given in Table JC.1.

**Table JC.1 Standard thicknesses of cold-rolled steel plates, sheets and strips**

Unit: mm

Standard thicknesses	0.4	0.5	0.6	0.7	0.8	0.9	1.0	1.2	1.4
	1.6	1.8	2.0	2.3	2.5	(2.6)	2.8	(2.9)	3.2
Use of values in parentheses is not desirable.									

**JC.5 Shape and dimensional tolerances**

The shape and dimensional tolerances of the cold-rolled steel plates, sheets and strips shall be as follows.

- a) The tolerances on width and length, and bend and squareness of the steel plates, sheets and strips shall be in accordance with clause **5** of **JIS G 3193**.
- b) The tolerances on thickness of the steel plates, sheets and strips shall be as given in Table JC.2.
- c) The flatness of the steel plates and sheets shall be in accordance with **6.2.5 b)**.

**Table JC.2 Tolerances on thickness**

Unit: mm

Thickness	Width				
	Under 630	630 or over to and excl. 1 000	1 000 or over to and excl. 1 250	1 250 or over to and excl. 1 600	1 600 or over
Under 0.25	±0.03	±0.03	±0.03	—	—
0.25 or over to and excl. 0.40	±0.04	±0.04	±0.04	—	—
0.40 or over to and excl. 0.60	±0.05	±0.05	±0.05	±0.06	—
0.60 or over to and excl. 0.80	±0.06	±0.06	±0.06	±0.06	±0.07
0.80 or over to and excl. 1.00	±0.06	±0.06	±0.07	±0.08	±0.09
1.00 or over to and excl. 1.25	±0.07	±0.07	±0.08	±0.09	±0.11
1.25 or over to and excl. 1.60	±0.08	±0.09	±0.10	±0.11	±0.13
1.60 or over to and excl. 2.00	±0.10	±0.11	±0.12	±0.13	±0.15
2.00 or over to and excl. 2.50	±0.12	±0.13	±0.14	±0.15	±0.17
2.50 or over to and excl. 3.15	±0.14	±0.15	±0.16	±0.17	±0.20
3.15 or over	±0.16	±0.17	±0.19	±0.20	—
Thickness shall be measured at an arbitrary position not less than 25 mm from the side edge in the case of mill-edged products, and not less than 15 mm in the case of cut-edged products.					

**JC.6 Mass**

The mass of the cold-rolled steel plates, sheets and strips shall be in accordance with clause **6** in **JIS G 3193**.

**Annex JD (informative)**  
**Comparison table between JIS and corresponding International Standards**

<b>JIS G 4051:2016</b> <i>Carbon steels for machine structural use</i>		<b>ISO 683-1:2012</b> <i>Heat-treatable steels, alloy steels and free-cutting steels—Part 1: Non-alloy steels for quenching and tempering</i> <b>ISO 683-3:2014</b> <i>Heat-treatable steels, alloy steels and free-cutting steels—Part 3: Case-hardening steels</i>					
(I) Requirements in <b>JIS</b>		(II) International Standard number	(III) Requirements in International Standard		(IV) Classification and details of technical deviation between <b>JIS</b> and the International Standard by clause		(V) Justification for the technical deviation and future measures
No. and title of clause	Content		No. of clause	Content	Classification by clause	Detail of technical deviation	
1	Scope	<b>ISO 683-1</b> <b>ISO 683-3</b>	1	Applicable products: semi-finished products, bars, wire rods, hot-formed flat products, and forgings, that are manufactured from non-alloy or low-alloy steels. Heat treatment: ( <b>ISO 683-1</b> ) • Q-T or austempering, partly normalizing ( <b>ISO 683-3</b> ) • Case hardening	Deletion	Difference in standard structure. <b>ISO</b> gives specifications according to heat treatment, while <b>JIS</b> gives specifications according to steel grades. The scopes of both standards are practically the same.	<b>JIS</b> structure is established based on the premise that one steel product (one steel grade) can be given more than one type of heat treatment before being supplied for use. Domestic users are accustomed to selecting material and heat treatment suitable for the intended use of their product. In this sense, the conventional <b>JIS</b> standard structure allows for more freedom (in other words, provides less stringent provisions) and therefore, is more desirable. This benefit of <b>JIS</b> structure will be continuously communicated to <b>ISO</b> .

(I) Requirements in <b>JIS</b>		(II) International Standard number	(III) Requirements in International Standard		(IV) Classification and details of technical deviation between <b>JIS</b> and the International Standard by clause		(V) Justification for the technical deviation and future measures
No. and title of clause	Content		No. of clause	Content	Classification by clause	Detail of technical deviation	
2	Normative references						
3	Classification and symbols		4.1	Symbols according to <b>ISO</b> 's system of designation. 13 grades of carbon steels.	Alteration	Difference in the system of designation used	Various nations use their own unique system of designation which is widely accepted in their local market, as this is permitted by <b>ISO/TS 4949</b> established in 2003.
4	Manufacturing method		6	<b>ISO</b> Standard • Killed steel • Condition at delivery: basically untreated, i.e. hot-worked condition. However, heat treatment condition and surface condition can be determined by agreement.	Deletion	<ul style="list-style-type: none"> <li>• The basic condition at delivery is “as-rolled” in both standards.</li> <li>• <b>ISO</b> specifies special conditions that can be adopted upon agreement.</li> <li>• <b>JIS</b> specifies forging ratio.</li> <li>• <b>JIS</b> specifically states that the steel plates, sheets and strips of which the desired thickness is not suitable for hot-rolling may be cold-rolled upon agreement.</li> </ul>	Whether to include optional product requirements in <b>JIS</b> is a question that concerns the whole standard structure of <b>JIS</b> . This matter, however, will not be a cause of substantial deviation from <b>ISO</b> in terms of actual business dealings.

(I) Requirements in <b>JIS</b>		(II) International Standard number	(III) Requirements in International Standard		(IV) Classification and details of technical deviation between <b>JIS</b> and the International Standard by clause		(V) Justification for the technical deviation and future measures
No. and title of clause	Content		No. of clause	Content	Classification by clause	Detail of technical deviation	
5	Chemical composition		7.1.2	Non-alloy steels: 12 grades in <b>ISO 683-1</b> (20 grades, if adding the sub-classifications according to P and S levels); 2 grades in <b>ISO 683-3</b> (4 grades, if adding the sub-classifications according to S levels).	Alteration	14 common steel grades, 2 of which is for case hardening.	These 14 steel grades equivalent to <b>ISO</b> steel grades are specified for <b>JIS</b> ensuring maintenance of both the quality level and the reasonable manufacturing cost.
6	Appearance, shape, dimensions and dimensional tolerances		7.7	Surface condition	Alteration	Decarburization being a matter of agreement in <b>ISO</b> , there is no technical deviation between <b>JIS</b> and <b>ISO</b> .	
			7.8	Decarburization			
			7.9	Shape, dimensions, and dimensional tolerances			
		<b>ISO 683-1</b>	7.8	Shape, dimensions, and dimensional tolerances			
		<b>ISO 683-3</b>					
7	Tests	<b>ISO 683-1</b> <b>ISO 683-3</b>	9.1 9.2	Chemical analysis Mechanical tests	Deletion	<b>ISO</b> specifies hardness and mechanical properties (tensile test, impact test) requirements for products ordered with heat treatment conditions.	As opposed to the <b>ISO</b> Standards which contain heat treatment specifications, <b>JIS</b> is only concerned with quality of steel products before heat treatment, and does not specify heat treatment conditions. The mechanical properties values after heat treatment, therefore, are not specified in <b>JIS</b> .

(I) Requirements in <b>JIS</b>		(II) International Standard number	(III) Requirements in International Standard		(IV) Classification and details of technical deviation between <b>JIS</b> and the International Standard by clause		(V) Justification for the technical deviation and future measures
No. and title of clause	Content		No. of clause	Content	Classification by clause	Detail of technical deviation	
8 Inspection	<p>Inspection</p> <ul style="list-style-type: none"> <li>• Chemical composition</li> <li>• Appearance, shape, dimensions and dimensional tolerances</li> </ul>		8	<p>Inspection, conformance of tested product, shape, dimensional tolerances, and maximum hardness after annealing.</p> <p>Cold shearability</p> <p>Grain size, non-metallic inclusions, and internal soundness (ultrasonic examination)</p> <p>Surface condition</p>	Alteration	<p><b>JIS</b> only provides requirements for chemical composition, appearance, shape and dimensions, and excludes tests and inspections for further material requirements which can vary widely depending on the intended purpose of each product. The <b>ISO</b> Standards, on the other hand, provide tensile and Charpy impact properties after heat treatment, as well as hardenability, hardness, and shearability requirements.</p>	<p><b>JIS</b> is mainly focused on providing requirements for carbon steel products that are suitable for machine structural use, and material properties after heat treatment performed by the users are set outside its scope. This is because the post heat-treatment properties in the case where users perform the heat treatment are significantly dependent on the quality of the heat treating equipment or technique that is available to individual users, and setting requirements for them may lead to confusion in dealings.</p> <p>The <b>ISO</b> specifications, which set specific value requirements for post heat-treatment properties, are problematic because the said variation due to the individual users' capacities is not taken into consideration. Therefore, no change will be made in the conventional <b>JIS</b> specifications.</p>

(I) Requirements in <b>JIS</b>		(II) International Standard number	(III) Requirements in International Standard		(IV) Classification and details of technical deviation between <b>JIS</b> and the International Standard by clause		(V) Justification for the technical deviation and future measures
No. and title of clause	Content		No. of clause	Content	Classification by clause	Detail of technical deviation	
9 Marking	Symbol of grade, heat number, manufacturer's name, mass and dimensions.		10	Subject to agreement.	Alteration	<b>JIS</b> specifies marking requirements. <b>ISO</b> leaves marking details to agreement.	Deviation due to difference in business customs.
10 Report	Basic format for report.		8.1	Basic format for report.	Identical	<b>JIS</b> has modified its contents in light of the revision made in the <b>ISO</b> Standards.	None in particular.
Annex JA (normative)	Manufacturing method and quality requirements for hot-extruded sections		—		Addition	<b>JIS</b> has added specific requirements for hot-extruded sections.	This content regards the products that are generally not given further processes of forging, cutting and heat treatment, and is therefore separately given in Annex.
Annex JB (normative)	Symbols of grades and chemical compositions applicable to steel plates, sheets and strips only		—		Addition	<b>JIS</b> has added specific requirements for designation and chemical composition of steel plates, sheets and strips.	This content regards the special steel grades limited to steel plates, sheets and strips, and is therefore separately given in Annex.
Annex JC (normative)	Quality requirements for cold-rolled steel plates, sheets and strips		—		Addition	<b>JIS</b> has added specific requirements for cold-rolled steel plates, sheets and strips.	This content regards the cold-rolled products that are specified as alternative for hot-rolled products, and is therefore separately given in Annex.

Overall degree of correspondence between **JIS** and International Standards (**ISO 683-1**:2012, **ISO 683-3**:2014): MOD

NOTE 1 Symbols in sub-columns of classification by clause in the above table indicate as follows:

- Identical: Identical in technical contents.
- Deletion: Deletes the specification item(s) or content(s) of International Standard.
- Addition: Adds the specification item(s) or content(s) which are not included in International Standard.
- Alteration: Alters the specification content(s) which are included in International Standard.

NOTE 2 Symbol in column of overall degree of correspondence between **JIS** and International Standards in the above table indicates as follows:

- MOD: Modifies International Standards.

Errata for JIS (English edition) are printed in *Standardization and Quality Control*, published monthly by the Japanese Standards Association, and also provided to subscribers of JIS (English edition) in *Monthly Information*.

Errata will be provided upon request, please contact:

**Publishing Group, Japanese Standards Association**

Mita MT Building, 3-13-12, Mita, Minato-ku, Tokyo, 108-0073 JAPAN

TEL. 03-4231-8550 FAX. 03-4231-8665