

JIS

JAPANESE
INDUSTRIAL
STANDARD

Translated and Published by
Japanese Standards Association

JIS G 4051 : 2009

(JISF)

**Carbon steels for machine structural
use**

ICS 77.140.10

Reference number : **JIS G 4051 : 2009 (E)**

G 4051 : 2009

Date of Establishment: 1965-07-01

Date of Revision: 2009-11-20

Date of Public Notice in Official Gazette: 2009-11-20

Investigated by: Japanese Industrial Standards Committee
Standards Board

Technical Committee on Iron and Steel

JIS G 4051 : 2009, First English edition published in 2010-03

Translated and published by: Japanese Standards Association
4-1-24, Akasaka, Minato-ku, Tokyo, 107-8440 JAPAN

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

© JSA 2010

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

AT

PROTECTED BY COPYRIGHT

Contents

	Page
Introduction.....	1
1 Scope	1
2 Normative references	1
3 Classification and symbol	2
4 Manufacturing method	2
5 Chemical composition	2
6 Appearance, shape, dimensions and their tolerances	3
6.1 Hot rolled steel bar and wire rod	3
6.2 Hot rolled steel plate, sheet and strip; and cold reduced steel plate, sheet and strip	7
6.3 Hot rolled flat steel	8
6.4 Other steel products	9
7 Tests	9
7.1 Chemical analysis	9
7.2 Other tests	9
8 Inspection	10
9 Marking	10
10 Report	10
Annex JA (informative) Comparison table between JIS and corresponding International Standards	11

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** :2005 is replaced with this Standard.

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

Attention is drawn to the possibility that some parts of this Standard may conflict with a patent right, application for a patent after opening to the public, utility model right or application for registration of utility model after opening to the public which have technical properties. The relevant Minister and the Japanese Industrial Standards Committee are not responsible for identifying the patent right, application for a patent after opening to the public, utility model right or application for registration of utility model after opening to the public which have the said technical properties.

Carbon steels for machine structural use

Introduction

This Japanese Industrial Standard has been prepared based on the first editions of **ISO 683-1** and **ISO 683-11** published in 1987 with some modifications of the technical contents.

The portions given sidelines are the matters modified from the original International Standards. A list of modifications with the explanations is given in Annex JA (informative).

1 Scope

This Standard specifies carbon steels (hereafter referred to as “steels”) for machine structural use mainly manufactured by hot forming such as hot rolling and hot forging. Steels are generally used after further processes of forging, cutting and heat treatment.

In addition, in the case of steel plates and steel strips, those cold reduced may be included according to the thickness as well as those hot rolled.

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

ISO 683-1: 1987 *Heat-treatable steels, alloy steels and free-cutting steels — Part 1: Direct-hardening unalloyed and low-alloyed wrought steel in form of different black products*

ISO 683-11: 1987 *Heat-treatable steels, alloy steels and free-cutting steels — Part 11: Wrought case-hardening steels* (Overall evaluation: MOD)

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

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 methods 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 0551 *Steels — Micrographic determination of the apparent grain size*

JIS G 0553 *Steel — Macroscopic examination by etching*

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 *Steels — Determination of depth of decarburization*
- JIS G 0561 *Method of hardenability test for steel (End quenching method)*
- JIS G 0901 *Classification of structural rolled steel plate and wide flat for bulk ing by ultrasonic test*
- JIS G 3141 *Cold-reduced carbon steel sheet and strips*
- 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*
- JIS Z 2241 *Method of tensile test for metallic materials*
- JIS Z 2242 *Method for Charpy pendulum impact test of metallic materials*
- JIS Z 2243 *Brinell hardness test — Test method*
- JIS Z 2245 *Rockwell hardness test — Test method*
- JIS Z 2320-1 *Nondestructive testing — Magnetic particle testing — Part I: General principles*
- JIS Z 2344 *General rule of ultrasonic testing of metals by pulse echo technique*

3 Classification and symbol

The steel shall be classified into 23 grades and the respective symbols shall be as given in table 1. Three grades, namely S09CK, S15CK and S20CK, however, are used for case-hardening purposes.

4 Manufacturing method

The manufacturing method shall be as follows.

- a) The steel shall be manufactured from killed steel.
- b) The steel shall be rolled or forged from steel ingot with forging ratio of not less than 4S unless otherwise specified. The forging ratio of the billet for forging or rolling may be less than 4S, provided that a prior agreement between the purchaser and the manufacturer has been acquired.
- c) Steels shall be as hot rolled or hot forged unless otherwise specified. For steel plates and steel strips, if cold rolling is performed upon the agreement between the purchaser and the manufacturer, they shall be generally annealed after rolling.

5 Chemical composition

When steels are tested in accordance with 7.1, the heat analysis values shall be as given in table 1. When the product analysis on steels is performed upon the agreement between the purchaser and the manufacturer, steels are tested in accordance with 7.1 and allowable deviation on table 1 shall be as given in table 3 of JIS G 0321.

Table 1 Chemical composition ^{a), b)}

Unit: %

Designation of grade	C	Si	Mn	P	S
S10C	0.08 to 0.13	0.15 to 0.35	0.30 to 0.60	0.030 max.	0.035 max.
S12C	0.10 to 0.15	0.15 to 0.35	0.30 to 0.60	0.030 max.	0.035 max.
S15C	0.13 to 0.18	0.15 to 0.35	0.30 to 0.60	0.030 max.	0.035 max.
S17C	0.15 to 0.20	0.15 to 0.35	0.30 to 0.60	0.030 max.	0.035 max.
S20C	0.18 to 0.23	0.15 to 0.35	0.30 to 0.60	0.030 max.	0.035 max.
S22C	0.20 to 0.25	0.15 to 0.35	0.30 to 0.60	0.030 max.	0.035 max.
S25C	0.22 to 0.28	0.15 to 0.35	0.30 to 0.60	0.030 max.	0.035 max.
S28C	0.25 to 0.31	0.15 to 0.35	0.60 to 0.90	0.030 max.	0.035 max.
S30C	0.27 to 0.33	0.15 to 0.35	0.60 to 0.90	0.030 max.	0.035 max.
S33C	0.30 to 0.36	0.15 to 0.35	0.60 to 0.90	0.030 max.	0.035 max.
S35C	0.32 to 0.38	0.15 to 0.35	0.60 to 0.90	0.030 max.	0.035 max.
S38C	0.35 to 0.41	0.15 to 0.35	0.60 to 0.90	0.030 max.	0.035 max.
S40C	0.37 to 0.43	0.15 to 0.35	0.60 to 0.90	0.030 max.	0.035 max.
S43C	0.40 to 0.46	0.15 to 0.35	0.60 to 0.90	0.030 max.	0.035 max.
S45C	0.42 to 0.48	0.15 to 0.35	0.60 to 0.90	0.030 max.	0.035 max.
S48C	0.45 to 0.51	0.15 to 0.35	0.60 to 0.90	0.030 max.	0.035 max.
S50C	0.47 to 0.53	0.15 to 0.35	0.60 to 0.90	0.030 max.	0.035 max.
S53C	0.50 to 0.56	0.15 to 0.35	0.60 to 0.90	0.030 max.	0.035 max.
S55C	0.52 to 0.58	0.15 to 0.35	0.60 to 0.90	0.030 max.	0.035 max.
S58C	0.55 to 0.61	0.15 to 0.35	0.60 to 0.90	0.030 max.	0.035 max.
S09CK	0.07 to 0.12	0.10 to 0.35	0.30 to 0.60	0.025 max.	0.025 max.
S15CK	0.13 to 0.18	0.15 to 0.35	0.30 to 0.60	0.025 max.	0.025 max.
S20CK	0.18 to 0.23	0.15 to 0.35	0.30 to 0.60	0.025max.	0.025 max.

Notes ^{a)} Cr shall not be over 0.20 %. However, it may be specified as values under 0.30 % upon the agreement between the manufacturer and the purchaser.

^{b)} As impurities, Cu, Ni, and Ni+Cr for grades S09CK, S15CK and S20CK shall not exceed respectively 0.25 %, 0.20 %, and 0.30 %, and Cu, Ni, and Ni+Cr for all other grades shall not exceed respectively 0.30 %, 0.20 %, and 0.35 %. However, the upper limit of Ni+Cr can be specified under 0.40 % for S09CK, S15CK and S20CK, and may be specified under 0.45 % for other grades upon the agreement between the manufacturer and the purchaser.

6 Appearance, shape, dimensions and their tolerances

6.1 Hot rolled steel bar and wire rod

6.1.1 Appearance

The hot rolled steel bar and the wire rod shall be well finished and free from defects detrimental to use in appearance. However, for the steels furnished in coil form, the detection of defects for the whole length of materials is difficult and there are no chance to remove them, and there may be those abnormal parts. Therefore, the treatment for the abnormal part shall be upon the agreement between the purchaser and the manufacturer.

6.1.2 Reference of flaw dressing and permissible depth of remaining flaws

The reference of flaw dressing and permissible depth of remaining flaws shall be as follows:

- a) **Steel bar for general forging** The flaw dressing of the steel bar for general forging shall be made smoothly and to the depth not exceeding 4% of nominal size (5 mm max.) below nominal size, and the total width not exceeding 1/4 of the circumferential length of the same section. If the dressed portion is within the dimensional tolerance, however, it shall not be considered as the flaw of the portion dressed.

The permissible amount of remaining flaw shall be as agreed upon between the purchaser and the manufacturer.

- b) **Round bar for direct cutting** Removing of the defects from round bar of direct cut materials are generally not allowed. In the case of removal of defects, the reference of flaw dressing shall be in accordance with the agreement between the purchaser and the manufacturer. The permissible depth of flaw on the round bar for direct cutting shall conform to the value given in table 2 deducted from the nominal size.

Table 2 Permissible depth of flaw of round bar for direct cutting (hot rolled steel bar) deducted from the nominal size

Diameter mm	Permissible depth of flaw deducted from the nominal size
Under 16	Not exceeding 4 % of nominal size with the maximum of 0.5 mm
16 or over to and excl. 50	Not exceeding 3 % of nominal size with the maximum of 1.0 mm
50 or over to and excl. 100	Not exceeding 2 % of nominal size with the maximum of 1.5 mm
100 or over	Not exceeding 1.5% of nominal size with the maximum of 3.0 mm

- c) **Steel bar for cold drawing** The flaw dressing of the steel bar for cold drawing shall be made smoothly and the flaw dressing depth limit from the lowest limit of dimensional tolerance shall be as given in table 3. The permissible amount of remaining flaw shall be as agreed upon between the purchaser and the manufacturer.

Table 3 Flaw dressing depth limit from the lowest limit of dimensional tolerance of steel bars for cold draw (hot rolled steel bar)

Diameter or width across flats mm	Flaw dressing depth limit from the lowest limit of dimensional tolerance
Under 16	0.15 mm
16 or over to and excl. 50	Not exceeding 1% of nominal size with the maximum of 0.35 mm
50 or over to and excl. 100	Not exceeding 0.7 % of nominal size with the maximum of 0.50 mm
100 or over up to and incl. 130	Not exceeding 0.5 % of nominal size

- d) **Other steel bars** For the other steel bars, if necessary to dress, it shall depend upon the agreement between the purchaser and the manufacturer.

- e) **Wire rod** For flaw dressing depth limit for the wire rod, it shall depend upon the agreement between the purchaser and the manufacturer.

6.1.3 Standard dimension

The standard dimensions of the hot rolled steel bar (round, square, hexagonal) and wire rod shall conform to table 4.

Table 4 Standard dimensions of hot rolled steel bar and wire rod

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

NOTE : It is desirable to use the figures that are not in parentheses.

6.1.4 Shape and dimensional tolerance

The shape and dimensional tolerances of the hot rolled steel bar and wire rod shall conform to a) to c). However, the shape and dimensional tolerances of those heat treated shall be upon the agreement between the purchaser and the manufacturer.

In addition, the specified tolerances of the length shall apply unless otherwise agreed between the purchaser and the manufacturer.

- a) The shape and dimensional tolerances of the hot rolled round bar and the square bar shall conform to table 5.

Item		Shape and dimensional tolerance
Tolerances on diameter or width across flats		+ 1.5% with the minimum value of +0.4 mm.
Deviation of diameter or deviation ^{a)}		Not exceeding 70 % of range of tolerance on diameter or width across flats.
Tolerances on length	For length not exceeding 7 m	+40 0 mm
	For length exceeding 7 m	Add 5 mm to plus side tolerance for every increase of 1 m or its fraction. Tolerances for minus side shall be 0 mm.
Radius on corners (R)		10 % to 20 % of width across flats, as a rule.
Twist		Within the extent where it is not detrimental to practical use.
Bend		Not exceeding 3 mm for every 1m and not exceeding $3 \text{ mm} \times \frac{\text{length (m)}}{1 \text{ m}}$ for total length.
Note ^{a)} Deviation of diameter means the difference of the maximum and the minimum diameters of the same section of steel materials of round bars. Deviation means the difference of the maximum and the minimum values of the width across flats of the same section of steel materials of square bars.		

b) The shape and the dimensional tolerances on the hot rolled hexagonal bar shall conform to table 6.

Item	Width across flats mm			
	Under 19	19 or over to and excl. 32	32 or over to and excl. 55	55 min.
Tolerance on width across flats mm	10.7	10.8	11.0	11.2
Deviation ^{a)} mm	1.0 max.	1.1 max.	1.4 max.	1.7 max.
Tolerance on length	For length not exceeding 7 m	+40 0 mm		
	For length exceeding 7 m	Add 5 mm to plus side tolerance for every increase of 1 m or its fraction. Tolerances for minus side shall be 0 mm.		
Twist		Within the extent where it is not detrimental to practical use.		
Bend		Not exceeding 3 mm for every 1m and not exceeding $3 \text{ mm} \times \frac{\text{length (m)}}{1 \text{ m}}$ for total length.		
Note ^{a)} Deviation means the difference of the maximum and the minimum values of the width across flats of the same section of steel materials of hexagonal bars.				

c) The dimensional tolerances on the hot rolled wire rod shall conform to table 7

Table 7 Dimensional tolerances on hot rolled wire rod

Unit: mm

Diameter	Tolerances on diameter	Deviation
15 max.	$i0.3$	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	$i0.6$	0.7 max.
Wire rods of diameter over 50 mm shall depend upon the agreement between the purchaser and the manufacturer.		

6.2 Hot rolled steel plate, sheet and strip; and cold reduced steel plate, sheet and strip

6.2.1 Appearance

The appearance of the hot rolled steel plate, sheet and strip shall conform to clause 7 in **JIS G 3193**. The appearance of the cold reduced steel plate, sheet and strip shall conform to clause 12 in **JIS G 3141**.

6.2.2 Reference of flaw dressing

The reference of flaw dressing of the hot rolled steel plate and sheet shall conform to 7 c) in **JIS G 3193**. However, the application of repairing by welding and the permissible amount of remaining flaws shall be as agreed upon between the purchaser and the manufacturer.

6.2.3 Standard dimension

The standard dimension of the hot rolled steel plate, sheet and strip shall be as given in clause 4 of **JIS G 3193**. The standard dimension of the cold reduced steel plate, sheet and strip shall be as given in clause 7 of **JIS G 3141**.

6.2.4 Shape and dimensional tolerances

The shape and dimensional tolerances of the hot rolled steel plate, sheet and strip; and cold reduced steel plate, sheet and strip shall be as follows:

- a) The shape and dimensional tolerances of the hot rolled steel plate, sheet and strip shall conform to clause 5 in **JIS G 3193**. In this case, the tolerances on thickness apply to those under 160 mm. However, in the case of 160 mm and over, it shall be agreed upon between the purchaser and the manufacturer.
- b) The permissible maximum values for flatness of the hot rolled steel plate and sheet; and cold reduced steel plate and sheet shall be as given in 1) to 3).
 - 1) The steel plate and sheet S10C to S25C of the thickness under 160 mm shall conform to 5 f) in **JIS G 3193**.
 - 2) The steel plate and sheet S28C to S58C of the thickness under 160 mm shall conform to table 8.
 - 3) The steel plate and sheet of the thickness 160 mm and over shall be as agreed upon between the purchaser and the manufacturer.

- c) The shapes and dimensional tolerances of cold reduced steel plate and steel strip shall be in accordance with clause **5** of **JIS G 3193**. The tolerances on thickness of cold reduced steel plate and steel strip shall be in accordance with table **16** of **JIS G 3141**. Thickness shall be measured at any point not less than **25** mm from a side edge for the mill edge and at any point not less than 15 mm from a side edge for the cut edge. The tolerances on thickness shall not be applied to the irregular portions of both ends of the steel strip.

Table 8 Permissible maximum values for flatness of hot rolled steel plate and sheet, and cold reduced steel plate and sheet (S28C to S58C)

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

— The above table shall be applicable to any 4 000 mm in length of steel plates and sheets, and to full length of plates and sheets under 4 000 mm in length.

— The values for flatness of steel plates and sheets shall be measured from the maximum warping of the upper surface of the plates by reducing the thickness thereof.

— The flatness of as rolled steel plate and sheet (those having rims) shall be agreed between the purchaser and the manufacturer.

NOTE : The measurement of flatness of steel plates and sheets shall generally be done on a surface plate.

6.3 Hot rolled flat steel

6.3.1 Appearance

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

6.3.2 Reference of flaw dressing

The reference of flaw dressing on the hot rolled flat steel shall conform to **10 b)** of **JIS G 3194**. However, the application of welding repair and the tolerances on remaining flaws shall depend upon the agreement between the purchaser and the manufacturer.

6.3.3 Standard dimension

The standard dimension of the hot rolled flat steel shall conform to clause **5** of **JIS G 3194**.

6.3.4 Shape and dimensional tolerances

The shape and dimensional tolerances of the hot rolled flat steel shall conform to clause 7 of **JIS G 3194**.

6.4 Other steel products

The appearance, reference of flaw dressing, allowance for remaining flaw, shape, dimension and dimensional tolerances on steel other than those specified in **6.1**, **6.2** and **6.3** shall be as agreed upon between the purchaser and the manufacturer.

7 Tests

7.1 Chemical analysis

The chemical analysis shall be as follows:

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

7.2 Other tests

Upon the agreement between the purchaser and the manufacturer, the purchaser may designate the following tests, provided that the sampling method and others shall preliminarily be agreed with the manufacturer.

Magnetic particle test, ultrasonic test, depth of decarburization, nonmetallic inclusion, grain size, mechanical properties, hardenability, macrostructure, macro-streak flaw and microscopic structure.

Test methods for other than the microscopic structure shall be in accordance with the following.

Magnetic particle test	JIS Z 2320-1
Ultrasonic test	JIS G 0901, JIS Z 2344
Depth of decarburization	JIS G 0558
Non-metallic inclusion	JIS G 0555
Grain size	JIS G 0551
Mechanical properties	JIS Z 2241, JIS Z 2242, JIS Z 2243, JIS Z 2244, JIS Z 2245
Hardenability	JIS G 0561
Macrostructure	JIS G 0553
Macro-streak flaw	JIS G 0556

The testing method of microscopic structure shall be upon the agreement between the purchaser and the manufacturer.

8 Inspection

The inspection shall be as follows:

- a) The general matters for the inspection shall be in accordance with **JIS G 0404**.
- b) The chemical composition shall be in accordance with the requirements in clause **5**.
- c) The appearance, shape, dimension and dimensional tolerances shall be in accordance with the requirements in clause **6**.
- d) Other inspections. When any one of the tests specified in **7.2** is performed, the test result shall comply with the criteria of acceptance upon the agreement between the purchaser and the manufacturer.

9 Marking

The marking on each steel shall be done with the following items by a suitable method. The steel plates, steel sheets, steel strips, flat steels, and, in the case of steel bars and wire rods, those having a diameter or width across flats under **30 mm**, may be bound up, and the marking may be made on each bundle by a suitable method. For steel bars **30 mm** or over in diameter or in width across flats, they may be bound up and marked in a suitable way upon the agreement between the purchaser and the manufacturer.

A part of following particulars may be omitted when agreed upon between the purchaser and the manufacturer.

- a) Symbol of grade. In the case of cold reduced steel sheets and strips, **-C** shall be marked after the symbol of grade. However, **-C** may be omitted upon the agreement between the purchaser and the manufacturer.
- b) Heat No. or other manufacturing No.
- c) Name of manufacturer or its abbreviation
- d) Mass (in the case of steel plate, sheet and strip)
- e) Dimensions The marking method of dimensions shall be in accordance with **JIS G 3141, JIS G 3191, JIS G 3192, JIS G 3193** and **JIS G 3194**. The expression of dimension of wire rod shall be in accordance with the expression of dimension of bar in coil of **JIS G 3191**.

10 Report

The report shall conform to clause **13** in **JIS G 0404**. In the case where there is no special specification at the time of order, the type of inspection document shall be in accordance with **2.3** or **3.1.B** of table **1** in **JIS G 0415**.

The report of **8 d)** shall depend upon the agreement between the purchaser and the manufacturer.

Annex JA (informative)

Comparison table between JIS and corresponding International Standards

JIS G 4051:2009 <i>Carbon, steels for machine structural use</i>		ISO 683-1 : 1987 <i>Heat-treatable steels, alloy steels and free-cutting steels — Part 1: Direct-hardening unalloyed and low-alloyed wrought steel in form of different black products</i> ISO 683-11 : 1987 <i>Heat-treatable steels, alloy steels and free-cutting steels — Part 11: wrought case-hardening steels</i>					
(I) Requirements in JIS		(II) International Standard numbers	(III) Requirements in International Standards		(IV) Classification and details of technical deviation between JIS and the International Standards by clause		(V) Justification for the technical deviation and future measures
No. and title of clause	Content		Clause No.	Content	Classification by clause	Detail of technical deviation	
1 Scope	Carbon steels for machine structural use manufactured by hot rolling, hot forging and further processes (forging, cutting, cold drawing, etc.) and heat treatment (quenching and tempering, normalizing, carburizing, etc.). For plates and strips those cold reduced may be included according to the thickness.	ISO 683-1 ISO 683-11	1	Field of application: semi-finished products, bars, wire rod, hot-rolled plates and forgings of carbon steels or low alloyed steels (ISO 683-1) <ul style="list-style-type: none"> • Q-T or austempering, partially normalizing for machine parts (ISO 683-11) • Case-hardening machine parts 	Deletion	The standard systems are different. ISO specifies for each heat treatment and uses. JIS specifies for the grade regardless of heat treatment and uses.	“Plural heat treatments are applied and used for one grade of material” is considered in the system of JIS . Domestic users are familiar with the selection of materials and heat treatments for their uses. From these reasons the current standard system for each grade has a wider latitude of selection (in the other words, less severe regulation) and is favourable. The merit to prepare the specification for each grade will be proposed to ISO for the future.
2 Normative references							

(I) Requirements in JIS		(II) International Standard numbers	(III) Requirements in International Standards		(IV) Classification and details of technical deviation between JIS and the International Standards by clause		(V) Justification for the technical deviation and future measures
No. and title of clause	Content		Clause No.	Content	Classification by clause	Detail of technical deviation	
3	Classification and symbol		5.2	In accordance with ISO system. 13 grades are specified as carbon steels.	Alteration	Designation systems are different.	Each country has unique designation system of grades and they are firmly in place in their markets. ISO/TS 4949 established in 2003 allows to obey each designation system in each country.
4	Manufacturing method		5.1	ISO • Killed steel • Condition at delivery: Basically as rolled. However, heat treatment condition and surface condition are able to be decided with an agreement.	Deletion	<ul style="list-style-type: none"> • Condition at delivery are basically as rolled in JIS and ISO. • ISO specifies special conditions upon the agreement between the purchaser and the manufacturer. • JIS specifies the ratio of forging. 	Whether to specify optional items directly affects the whole JIS standard system. However, from this point, the essential deviation is not estimated to occur.
5	Chemical composition		5.2	For carbon steel, ISO 683-1 specifies 8 grades (24 grades when including different levels of P and S). ISO 683-11 specifies 3 grades (5 grades when including different levels of S)	Alteration	Equivalent grades are 9 grades. 2 grades of them are for case-hardening.	For similar 9 grades given in the left column, JIS specifies them so that lowering of quality and meaningless cost increase are avoided. The P and S ranges to affect the quality deterioration (JIS : 0.030 or under, and ISO : 0.035 or under) will be proposed to ISO at next revision.

(I) Requirements in JIS		(II) International Standard numbers	(III) Requirements in International Standards		(IV) Classification and details of technical deviation between JIS and the International Standards by clause		(V) Justification for the technical deviation and future measures
No. and title of clause	Content		Clause No.	Content	Classification by clause	Detail of technical deviation	
6 Appearance, shape, dimensions and their tolerances	Specifies appearance, reference of flaw dressing, standard dimensions, shapes, dimensional tolerances on steel bars, wire rods, steel plates and steel strips.		5.6	Surface condition and decarburization	Alteration	The contents are almost the same except for the specification for decarburization in ISO .	In JIS , decarburization is specified in 7.2 , so there is no technical deviation.
			5.7	Shapes, dimensions and their tolerances			
7 Tests	Specifies heat analysis and product analysis in 7.1 and other tests in 7.2 .		5.2	Chemical analysis, hardness and mechanical properties	Deletion	ISO specifies hardness and mechanical properties (tensile test and impact test) for the materials required heat treatment.	
8 Inspection	Inspection <ul style="list-style-type: none"> • Chemical composition • Appearance, shape, dimension and their tolerances • Other inspection Magnetic particle test, ultrasonic test, depth of decarburization test, austenitic grain size test, macrostructure test, non-metallic inclusion test, macro-streak flaw test, hardenability test, tensile test and hardness test.		6	Inspection and conforming of products	Alteration	In JIS requirements about test and inspection other than chemical composition, appearance, dimensions and their tolerances are specified upon the agreement between the purchaser and the manufacturer and the actual values are not specified. On the contrary, ISO specifies hardenability, hardness, shearability, tensile test after heat treatment and Charpy impact.	JIS focuses on supplying materials suitable for carbon steels for machine structural use and does not specify properties of materials after heat treatment performed by the user. The reason is that the mechanical properties after quenching and tempering by the user largely depend upon the equipment and technology of quenching and therefore specifying the mechanical properties may lead to misunderstanding.
		5.7	Shapes, dimensions and tolerances				
		5.3	Maximum hardness after annealing is specified.				
		5.4	Shearability is specified.				
		5.5	Grain size, non-metallic inclusion content Internal soundness (ultrasonic test)				
		5.6	Surface quality and decarburization				

(I) Requirements in JIS		(II) International Standard numbers	(III) Requirements in International Standards		(IV) Classification and details of technical deviation between JIS and the International Standards by clause		(V) Justification for the technical deviation and future measures
No. and title of clause	Content		Clause No.	Content	Classification by clause	Detail of technical deviation	
8 (concluded)							On the other hand, ISO specifies the material properties after heat treatment in details. However, properties may differ according to the user's equipment and technological capability, and so specifying values in a single uniform way may cause problems. For this reason JIS does not specify values as before.
9 Marking	Designation of grade, heat number, manufacturer's name, mass and dimensions.		7	Upon the agreement.	Alteration	JIS specifies them concretely. ISO depends upon the agreement.	
10 Report	Standard reporting form is specified.			Upon the agreement.	Addition	JIS specifies them concretely. ISO depends upon the agreement.	

Overall degree of correspondence between **JIS** and International Standards (**ISO 683-1 : 1987, ISO 683-11 : 1987**): MOD

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

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

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 Journal*, 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:
Standards Publishing Department, Japanese Standards Association
4-1-24, Akasaka, Minato-ku, Tokyo, 107-8440 JAPAN
TEL. 03-3683-8002 FAX. 03-3583-0462