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**Mechanical properties of corrosion-resistant stainless steel fasteners—
Part 1: Bolts, screws and studs**

ICS 21.060.10

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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 Research Institute for Screw Threads and Fasteners (JFRI)/Japanese Standards Association (JSA) 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 B 1054-1**:2001 is replaced with this Standard.

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JIS B 1054 series consists of the following 4 parts under the general title “*Mechanical properties of corrosion-resistant stainless-steel fasteners*”:

Part 1: Bolts, screws and studs

Part 2: Nuts

Part 3: Set screws and similar fasteners not under tensile stress

Part 4: Tapping screws

Mechanical properties of corrosion-resistant stainless steel fasteners— Part 1: Bolts, screws and studs

Introduction

This Japanese Industrial Standard has been prepared based on the second edition of **ISO 3506-1** published in 2009 without any modifications of the technical contents.

Annex JA in this Standard is not contained in the corresponding International Standard.

1 Scope

This Standard specifies the mechanical properties of bolts, screws and studs made of austenitic, martensitic and ferritic steel grades of corrosion-resistant stainless steels, when tested over an ambient temperature range of 10 °C to 35 °C. Properties vary at higher or lower temperatures.

This Standard applies to bolts, screws and studs

- with nominal thread diameter $d \leq 39$ mm,
- of **ISO** general purpose metric threads based on **JIS B 0205-1** with diameters and pitches in accordance with **JIS B 0205-2** and **JIS B 0205-3**, and
- of any shape.

It does not apply to bolts, screws and studs with special properties, such as weldability.

NOTE : The designation system of this Standard can be used for sizes outside the limits given in this clause (e.g. $d > 39$ mm), provided that all applicable mechanical and physical requirements of the property classes are met.

This Standard does not define corrosion or oxidation resistance in particular environments. However, some information on materials for particular environments is given in Annex E. Regarding definitions of corrosion and corrosion resistance, see **ISO 8044**.

The aim of this Standard is the classification of corrosion-resistant stainless steel fasteners¹⁾ into property classes. Some materials can be used at temperatures down to -200 °C, while some can be used at temperatures up to +800 °C in air. Information on the influence of temperature on mechanical properties is found in Annex F.

Note ¹⁾ The term “fasteners” is used when bolts, screws and studs are considered all together.

Corrosion and oxidation performances and mechanical properties for use at elevated or sub-zero temperatures can be agreed on between the user and the manufacturer in each particular case. Annex G shows how the risk of intergranular corrosion at elevated temperatures depends on the carbon content.

All austenitic stainless steel fasteners are normally non-magnetic in the annealed condition; after cold working, some magnetic properties can be evident (see Annex H).

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

ISO 3506-1:2009 *Mechanical properties of corrosion-resistant stainless steel fasteners—Part 1: Bolts, screws and studs* (IDT)

The 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**.

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 B 0205-1 *ISO general purpose metric screw threads—Part 1: Basic profile*

NOTE : Corresponding International Standard: ISO 68-1:1998 *ISO general purpose screw threads—Basic profile—Part 1: Metric screw threads* (IDT)

JIS B 0205-2 *ISO general purpose metric screw threads—Part 2: General plan*

NOTE : Corresponding International Standard: ISO 261:1998 *ISO general purpose metric screw threads—General plan* (IDT)

JIS B 0205-3 *ISO general purpose metric screw threads—Part 3: Selected sizes for screws, bolts and nuts*

NOTE : Corresponding International Standard: ISO 262:1998 *ISO general purpose metric screw threads—Selected sizes for screws, bolts and nuts* (IDT)

JIS B 1047 *Passivation of corrosion-resistant stainless-steel fasteners*

NOTE : Corresponding International Standard: ISO 16048:2003 *Passivation of corrosion-resistant stainless-steel fasteners* (IDT)

JIS B 1051 *Mechanical properties of fasteners made of carbon steel and alloy steel—Part 1: Bolts, screws and studs*

NOTE : Corresponding International Standard: ISO 898-1:1999 *Mechanical properties of fasteners made of carbon steel and alloy steel—Part 1: Bolts, screws and studs* (IDT)

JIS B 1092 *Fasteners—Quality assurance system*

NOTE : Corresponding International Standard: ISO 16426:2002 *Fasteners—Quality assurance system* (IDT)

JIS G 0573 *Method of 65 per cent nitric acid test for stainless steels*

NOTE : Corresponding International Standard: ISO 3651-1:1998 *Determination of resistance to intergranular corrosion of stainless steels—Part 1: Austenitic and ferritic-austenitic (duplex) stainless steels—Corrosion test in nitric acid medium by measurement of loss in mass (Huey test)* (MOD)

JIS G 0575 *Method of copper sulfate-sulfuric acid test for stainless steels*

NOTE : Corresponding International Standard: ISO 3651-2:1998 *Determination of resistance to intergranular corrosion of stainless steels—Part 2: Ferritic, austenitic and ferritic-austenitic (duplex) stainless steels—Corrosion test in media containing sulfuric acid* (MOD)

JIS Z 2241 *Metallic materials—Tensile testing—Method of test at room temperature*

NOTE : Corresponding International Standard: ISO 6892-1:2009 *Metallic materials—Tensile testing—Part 1: Method of test at room temperature* (MOD)

JIS Z 2243 *Brinell hardness test—Test method*

NOTE : Corresponding International Standard: ISO 6506-1:2005 *Metallic materials—Brinell hardness test—Part 1: Test method* (MOD)

JIS Z 2244 *Vickers hardness test—Test method*

NOTE : Corresponding International Standard: ISO 6507-1:2005 *Metallic materials—Vickers hardness test—Part 1: Test method* (MOD)

JIS Z 2245 *Rockwell hardness test—Test method*

NOTE : Corresponding International Standard: ISO 6508-1:2005 *Metallic materials—Rockwell hardness test—Part 1: Test method (scales A, B, C, D, E, F, G, H, K, N, T)* (MOD)

3 Symbols

For the purpose of this Standard, the following symbols apply.

A	elongation after fracture
$A_{s,nom}$	nominal stress area
d	nominal thread diameter
d_1	basic minor diameter of external thread
d_2	basic pitch diameter of external thread
d_3	minor diameter of external thread (for stress calculation)
H	height of the fundamental triangle of the thread
L_1	total length of fastener
L_2	total length of fastener after fracture
L_3	distance between the underside of the head and the threaded adapter
l	nominal length of the fastener
l_s	plain shank length
M_B	breaking torque
P	pitch of the thread
R_{eL}	lower yield stress
R_m	tensile strength
$R_{p0.2}$	stress at 0.2 % permanent strain

α wedge angle

μ_r permeability value in a magnetic field

4 Designation, marking and finish

4.1 Designation

The designation system for stainless steel grades and property classes for bolts, screws and studs is given in figure 1. The designation of the material consists of two blocks, which are separated by a hyphen. The first block designates the steel grade and the second block, the property class.

The designation of the steel grade (first block) consists of one of the letters

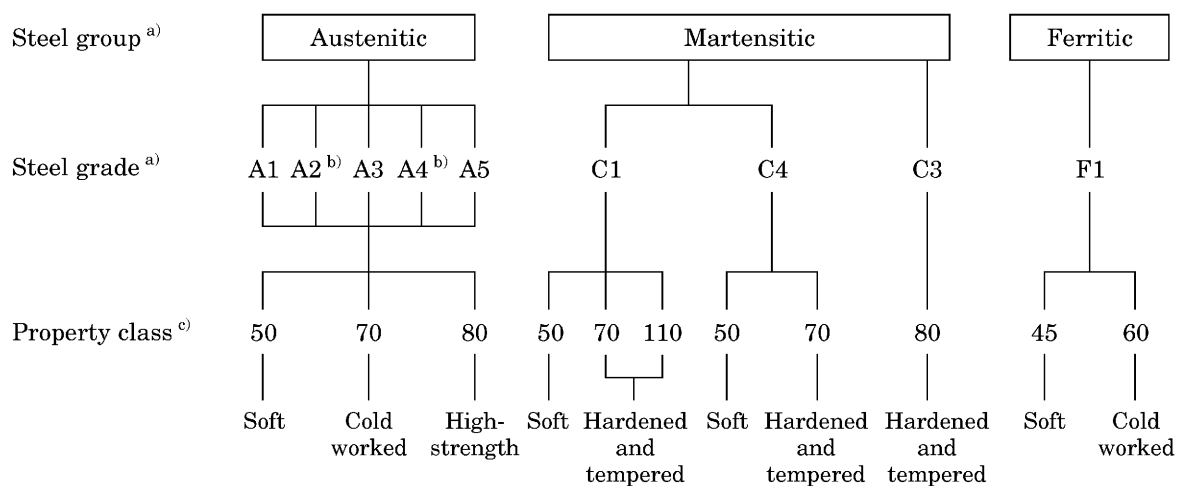
- A: austenitic stainless steel
- C: martensitic stainless steel
- F: ferritic stainless steel

which indicates the group of steel and a digit, which indicates a range of chemical compositions within this steel group (see table 1).

The designation of the property class (second block) consists of two or three digits representing 1/10 of the tensile strength of the fastener, according to table 2 or table 3.

Example 1 A2-70 indicates: austenitic stainless steel, cold worked, minimum 700 MPa tensile strength.

Example 2 C4-70 indicates: martensitic stainless steel, hardened and tempered, minimum 700 MPa tensile strength.



Notes ^{a)} The steel groups and steel grades classified in figure 1 are described in Annex B and specified by the chemical composition given in table 1.

^{b)} Low-carbon austenitic stainless steels with carbon content not exceeding 0.03 % may additionally be marked with an "L".

Example: A4L-80

^{c)} Fasteners passivated in accordance with **JIS B 1047** may additionally be marked with a "P".

Example: A4-80P

Figure 1 Designation system for stainless steel grades and property classes for bolts, screws and studs

4.2 Marking

4.2.1 General

Fasteners manufactured according to the requirements of this Standard shall be designated in accordance with the designation system described in 4.1 and marked in accordance with 4.2.2 and 4.2.3 or 4.2.4, as applicable. However, the designation system described in 4.1 and the provisions for marking according to 4.2.3 or 4.2.4 shall be used only if all relevant requirements of this Standard are met.

Unless otherwise specified in the product standard, the height of embossed markings on the top of the head shall not be included in the head height dimensions.

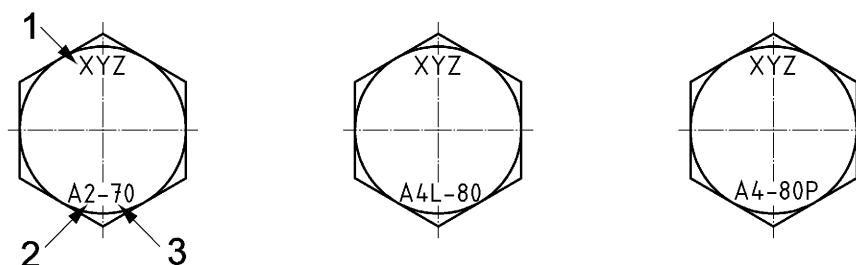
NOTE : For marking of left-hand threads, see **JIS B 1051**.

4.2.2 Manufacturer's identification mark

A manufacturer's identification mark shall be included during the manufacturing process on all fasteners which are marked with a property class symbol. Manufacturer's identification marking is also recommended on fasteners which are not marked with a property class symbol.

4.2.3 Bolts and screws

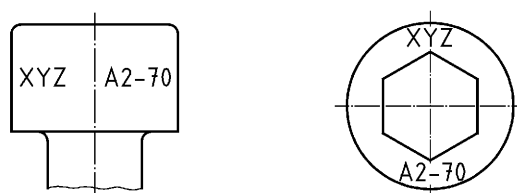
All hexagon head bolts and screws, and hexagon or hexalobular socket head cap screws of nominal thread diameter $d \geq 5$ mm shall be clearly marked in accordance with figure 1, as shown in figure 2 and figure 3. The marking is mandatory and shall include the steel grade and property class.



Key

- 1 manufacturer's identification mark
- 2 steel grade
- 3 property class

Figure 2 Marking of hexagon head bolts and screws



Either of the markings is shown.

Figure 3 Marking of hexagon and hexalobular socket head cap screws—Alternative forms

Other types of bolts and screws can be marked in the same way, where it is possible to do so and on the head portion only. Additional marking is allowed, provided it does not cause confusion.

Fasteners that do not fulfil the tensile or torsional requirements because of the geometry (see clause 6) may be marked with the steel grade, but shall not be marked with the property class (see figure 4).

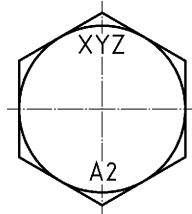
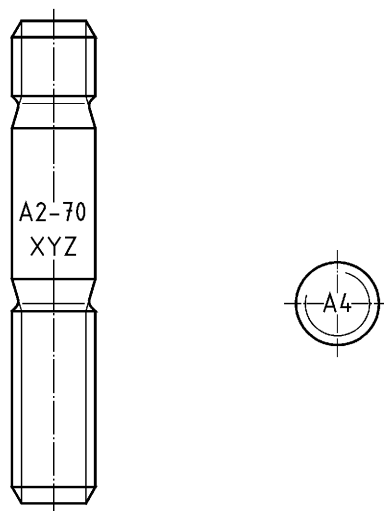


Figure 4 Marking of fasteners not fulfilling tensile or torsional requirements because of the geometry

4.2.4 Studs

Studs of nominal thread diameter $d \geq 6$ mm shall be clearly marked in accordance with figure 1 as shown in figure 5. The marking shall be on the unthreaded part of the stud and shall contain the steel grade and property class. If marking on the unthreaded portion is not possible, marking of steel grade only on the nut end of the stud is allowed (see figure 5).



Either of the markings is shown.

Figure 5 Marking of studs—Alternative forms

4.2.5 Packages

All packages for all types of fasteners of all sizes shall be marked (e.g. through labelling). The marking or labelling shall include the manufacturer's and/or distributor's identification and the marking symbol of the steel grade and property class according to figure 1 and the manufacturing lot number, as defined in **JIS B 1092**.

4.3 Finish

Unless otherwise specified, fasteners in accordance with this Standard shall be supplied clean and bright. For maximum corrosion resistance, passivation is recommended. When passivation is required, it shall be performed in accordance with **JIS B 1047**. Fasteners that are passivated may additionally be marked with the symbol “P” after the symbols for steel grade and property class [see Note ^{c)} of figure 1].

For fasteners manufactured to a specific order, the additional marking should be applied to both the fastener and the label. For fasteners delivered from stock, the additional marking should be applied to the label.

5 Chemical composition

The chemical compositions of stainless steels suitable for fasteners in accordance with this Standard are given in table 1.

The final choice of the chemical composition within the specified steel grade is at the discretion of the manufacturer, otherwise by prior agreement between the purchaser and the manufacturer.

In applications where risk of intergranular corrosion is present, testing in accordance with **JIS G 0573** or **JIS G 0575** is recommended. In such cases, stabilized stainless steels of grades A3 and A5 or stainless steels of grades A2 and A4 with carbon content not exceeding 0.03 % are recommended.

Table 1 Stainless steel grades—Chemical composition

Steel group	Steel grade	Chemical composition ^{a)} mass fraction, %								
		C	Si	Mn	P	S	Cr	Mo	Ni	Cu
Austenitic	A1 ^{b) c) d)}	0.12	1	6.5	0.2	0.15 to 0.35	16 to 19	0.7	5 to 10	1.75 to 2.25
	A2 ^{f) g)}	0.10	1	2	0.05	0.03	15 to 20	— ^{e)}	8 to 19	4
	A3 ^{h)}	0.08	1	2	0.045	0.03	17 to 19	— ^{e)}	9 to 12	1
	A4 ^{g) i)}	0.08	1	2	0.045	0.03	16 to 18.5	2 to 3	10 to 15	4
	A5 ^{h) i)}	0.08	1	2	0.045	0.03	16 to 18.5	2 to 3	10.5 to 14	1
Martensitic	C1 ⁱ⁾	0.09 to 0.15	1	1	0.05	0.03	11.5 to 14	—	1	—
	C3	0.17 to 0.25	1	1	0.04	0.03	16 to 18	—	1.5 to 2.5	—
	C4 ^{b) i)}	0.08 to 0.15	1	1.5	0.06	0.15 to 0.35	12 to 14	0.6	1	—
Ferritic	F1 ^{k) l)}	0.12	1	1	0.04	0.03	15 to 18	— ^{j)}	1	—

NOTE 1 A description of the groups and grades of stainless steels also entering into their specific properties and applications is given in Annex B.

NOTE 2 Examples of stainless steels standardized in accordance with **ISO 683-13** and **ISO 4954** are given in Annexes C and D, respectively.

NOTE 3 Certain materials for specific application are given in Annex E.

Notes ^{a)} Values are maximum, unless otherwise indicated.

^{b)} Sulfur (S) may be replaced by selenium (Se).

^{c)} If the nickel (Ni) content is below 8 %, the minimum manganese (Mn) content shall be 5 %.

^{d)} There is no minimum limit to the copper (Cu) content, provided that the nickel (Ni) content is greater than 8 %.

^{e)} Molybdenum (Mo) may be present at the discretion of the manufacturer. However, if for some applications limiting of the molybdenum content is essential, this shall be stated at the time of ordering by the purchaser.

^{f)} If the chromium (Cr) content is below 17 %, the minimum nickel (Ni) content should be 12 %.

^{g)} For austenitic stainless steels having a maximum carbon (C) content of 0.03 %, nitrogen (N) may be present to a maximum of 0.22 %.

^{h)} This shall contain titanium (Ti) $\geq 5 \times C$ up to 0.8 % maximum for stabilization and be marked appropriately as specified in this table, or shall contain niobium (Nb) and/or tantalum (Ta) $\geq 10 \times C$ up to 1.0 % maximum for stabilization and be marked appropriately as specified in this table.

ⁱ⁾ At the discretion of the manufacturer, the carbon content may be higher where required in order to obtain the specified mechanical properties at larger diameters, but shall not exceed 0.12 % for austenitic stainless steels.

^{j)} Molybdenum (Mo) may be present at the discretion of the manufacturer.

^{k)} This may contain titanium (Ti) $\geq 5 \times C$ up to 0.8 % maximum.

^{l)} This may contain niobium (Nb) and/or tantalum (Ta) $\geq 10 \times C$ up to 1 % maximum.

6 Mechanical properties

The mechanical properties of bolts, screws and studs in accordance with this Standard shall conform to the values given in tables 2, 3 and 4.

For bolts and screws made of martensitic stainless steel, the strength under wedge loading shall not be below the minimum values for tensile strength shown in table 3.

For acceptance purposes, the mechanical properties specified in this clause apply and shall be tested according to the test programme in clause 7.

Even if the material of the fasteners meets all relevant requirements, it is possible that certain fasteners would not fulfil the tensile or torsional requirements because of the geometry of the head, which reduces the shear area in the head compared to the stress area in the thread such as countersunk, raised countersunk and cheese heads.

NOTE : Although a great number of property classes are specified in this Standard, this does not mean that all classes are appropriate for all fasteners. Further guidance for application of the specific property classes is given in the relevant product standards.

For non-standard fasteners, the choice already made for similar standard fasteners should be followed as closely as possible.

**Table 2 Mechanical properties for bolts, screws and studs—
Austenitic steel grades**

Steel group	Steel grade	Property class	Tensile strength $R_m^{a)}$ min. MPa	Stress at 0.2 % permanent strain $R_{p0.2}^{a)}$ min. MPa	Elongation after fracture $A^{b)}$ min. mm
Austenitic	A1, A2, A3, A4, A5	50	500	210	0.6 <i>d</i>
		70	700	450	0.4 <i>d</i>
		80	800	600	0.3 <i>d</i>
Notes ^{a)} The tensile stress is calculated on the stress area (see Annex A).					
^{b)} This is determined according to 7.2.4 , on the actual screw length and not on a prepared test piece.					