INTERNATIONAL STANDARD

ISO 3506-3

First edition
1997-12-01

Mechanical properties of corrosion-resistant stainless-steel fasteners —

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

Caractéristiques mécaniques des éléments de fixation en acier inoxydable résistant à la corrosion —

Partie 3: Vis sans tête et éléments de fixation similaires non soumis à des contraintes de traction

Reference number
ISO 3506-3:1997(E)

Foreword

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Draft International Standards adopted by the technical committees are circulated to the member bodies for voting. Publication as an International Standard requires approval by at least 75 % of the member bodies casting a vote.

International Standard ISO 3506-3 was prepared by Technical Committee ISO/TC 2, *Fasteners*, Sub-Committee SC 1, *Mechanical properties of fasteners*.

This first edition, together with ISO 3506-1 and ISO 3506-2, cancels and replaces ISO 3506:1979, which has been technically revised.

ISO 3506 consists of the following 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*

Annexes A to F of this part of ISO 3506 are for information only.

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Printed in Switzerland

Introduction

In the preparation of this part of ISO 3506 special attention has been given to the fundamentally different property characteristics of the stainless steel fastener grades compared with those of carbon steel and low-alloy steel fasteners. Austenitic stainless steels are strengthened only by cold working and consequently the components do not have as homogeneous a condition as hardened and tempered parts. These special features have been recognized in the elaboration of the property classes and the test procedures for mechanical properties.

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Mechanical properties of corrosion-resistant stainless-steel fasteners —

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

1 Scope

This part of ISO 3506 specifies the mechanical properties of set screws and similar fasteners not under tensile stress made of austenitic stainless steel when tested over an ambient temperature range of 15 °C to 25 °C. Properties will vary at higher or lower temperatures.

It applies to set screws and similar fasteners

— with nominal thread diameters (d) from 1,6 mm up to and including 24 mm;

— of triangular ISO metric threads with diameters and pitches according to ISO 68-1, ISO 261 and ISO 262;

— of any shape.

It does not apply to screws with special properties such as weldability.

This part of ISO 3506 does not define corrosion or oxidation resistance in particular environments.

The aim of this part of ISO 3506 is a classification into property classes of corrosion resistant stainless steel fasteners. Corrosion and oxidation performances and mechanical properties for use at elevated or sub-zero temperatures must be the subject of agreement between user and manufacturer in each particular case. Annex D 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 condtition; after cold working, some magnetic properties may be evident (see annex E).

2 Normative references

The following standards contain provisions which, through reference in this text, constitute provisions of this part of ISO 3506. At the time of publication, the editions indicated were valid. All standards are subject to revision, and parties to agreements based on this part of ISO 3506 are encouraged to investigate the possibility of applying the most recent editions of the standards indicated below. Members of IEC and ISO maintain registers of currently valid International Standards.

ISO 68-1:—[1], *ISO general purpose screw threads – Basic profile – Part 1: Metric screw threads.*

ISO 261:—[2], *ISO general purpose metric screw threads – General plan.*

1) To be published. (Revision of ISO 68:1973)

2) To be published. (Revision of ISO 261:1973)

ISO 262:—[3], *ISO general purpose metric screw threads – Selected sizes for screws, bolts and nuts.*

ISO 898-5:—[4], *Mechanical properties of fasteners – Part 5: Set screws and similar threaded fasteners not under tensile stresses.*

ISO 965-3:—[5], *ISO general-purpose metric screw threads – Tolerances – Part 3: Deviations for constructional threads.*

ISO 3651-1:—[5], *Determination of resistance to intergranular corrosion 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).*

ISO 3651-2:—[6], *Determination of resistance to intergranular corrosion stainless steels – Part 2: Ferritic, austenitic and ferritic-austenitic (duplex) stainless steels – Corrosion test in media containing sulfuric acid.*

ISO 6506:1981, *Metallic materials – Hardness test – Brinell test.*

ISO 6507-1:1997, *Metallic materials – Hardness test – Vickers test – Part 1: Test method.*

ISO 6508:1986, *Metallic materials – Hardness test – Rockwell test (scales A – B – C – D – E – F– G – H – K).*

3 Designation, marking and finish

3.1 Designation

The designation system for stainless steel grades and property classes for set screws and similar fasteners is shown 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, the second block the property class.

The designation of the steel grade (first block) consists of the letter

A for austenitic steel

which indicates the group of steel and a digit which indicates a range of chemical compositions within this steel group.

The designation of the property class (second block) consists of two digits representing 1/10 of the minimum Vickers hardness and the letter H referring to hardness, see table 1.

Table 1 —Designations of property classes in relation to Vickers hardness

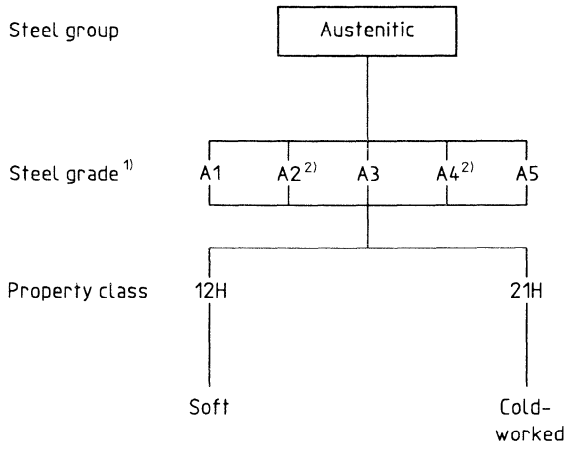
Property class	12H	21H
Vickers hardness, HV min.	125	210

EXAMPLE:

A1-12H indicates:

austenitic stainless steel, soft, minimum hardness 125 HV.

3) To be published. (Revision of ISO 262:1973)
4) To be published. (Revision of ISO 898-5:1980)
5) To be published. (Revision of ISO 965-3:1980)
6) To be published. (Revision of ISO 3651-1:1976)
7) To be published. (Revision of ISO 3651-2:1976)



1) The steel grades classified in figure 1 are described in the informative annex A and specified by the chemical composition in table 2.

2) Low carbon stainless steels with carbon content not exceeding 0,03 % may additionally be marked with an L.

Example: A4L – 21H

Figure 1 — Designation system for stainless steel grades and property classes for set screws and similar fasteners

3.2 Marking

3.2.1 Set screws

Marking of set screws is not mandatory.

Only if all requirements in this part of ISO 3506 are met, parts shall be marked and/or described according to the designation system described in 3.1.

3.2.2 Packages and containers

Marking with the designation and manufacturer's identification mark is mandatory on all packages of all sizes.

3.3 Finish

Unless otherwise specified, fasteners in accordance with this part of ISO 3506 shall be supplied clean and bright. For maximum corrosion resistance passivation is recommended.

4 Chemical composition

The chemical compositions of stainless steels suitable for fasteners in accordance with this part of ISO 3506 are given in table 2.

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

In applications where risk of intergranular corrosion is present, testing in accordance with ISO 3651-1 or ISO 3651-2 is recommended. In such cases, stabilized stainless steels A3 and A5 or stainless steels A2 and A4 with carbon content not exceeding 0,03 % are recommended.

Table 2 — Stainless steel grades — Chemical composition

Group	Grade	Chemical composition % (*m/m*) [1]									Notes
		C	Si	Mn	P	S	Cr	Mo	Ni	Cu	
Austenitic	**A1**	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	2) 3) 4)
	A2	0,1	1	2	0,05	0,03	15 to 20	— [5]	8 to 19	4	6) 7)
	A3	0,08	1	2	0,045	0,03	17 to 19	— [5]	9 to 12	1	8)
	A4	0,08	1	2	0,045	0,03	16 to 18,5	2 to 3	10 to 15	1	7) 9)
	A5	0,08	1	2	0,045	0,03	16 to 18,5	2 to 3	10,5 to 14	1	8) 9)

NOTES

1 A description of the groups and grades of stainless steels also entering into their specific properties and application is given in annex A.

2 Examples for stainless steels which are standardized in ISO 683-13 and in ISO 4954 are given in annexes B and C respectively.

1) Values are maximum unless otherwise indicated.

2) Sulfur may be replaced by selenium.

3) If the nickel content is below 8 %, the minimum manganese content must be 5 %.

4) There is no minimum limit to the copper content provided that the nickel content is greater than 8 %.

5) Molybdenum may be present at the discretion of the manufacturer. However, if for some applications limiting of the molybdenum content is essential, this must be stated at the time of ordering by the purchaser.

6) If the chromium content is below 17 %, the minimum nickel content should be 12 %.

7) For austenitic stainless steels having a maximum carbon content of 0,03 %, nitrogen may be present to a maximum of 0,22 %.

8) Must contain titanium $\geq 5 \times C$ up to 0,8 % maximum for stabilization and be marked appropriately in accordance with this table, or must contain niobium (columbium) and/or tantalum $\geq 10 \times C$ up to 1 % maximum for stabilization and be marked appropriately in accordance with this table.

9) At the discretion of the manufacturer the carbon content may be higher where required to obtain the specified mechanical properties at larger diameters but shall not exceed 0,12 %.

5 Mechanical properties

The mechanical properties of set screws in accordance with this part of ISO 3506 shall conform to the values given in tables 3 and 4.

For acceptance purposes the mechanical properties specified in 5.1 and 5.2 apply and shall be tested in accordance with 6.1 and 6.2 respectively.

5.1 Proof torque of hexagon socket set screws

Hexagon socket set screws shall conform to the torque requirements given in table 3.

Table 3 — Proof torque requirements

Nominal thread diameter (d)	Minimum length[1] of set screws for test, mm				Proof torque, Nm min.	
					Property class	
	Flat point	Cone point	Dog point	Cup point	12H	21H
1,6	2,5	3	3	2,5	0,03	0,05
2	4	4	4	3	0,06	0,1
2,5	4	4	5	4	0,18	0,3
3	4	5	6	5	0,25	0,42
4	5	6	8	6	0,8	1,4
5	6	8	8	6	1,7	2,8
6	8	8	10	8	3	5
8	10	10	12	10	7	12
10	12	12	16	12	14	24
12	16	16	20	16	25	42
16	20	20	25	20	63	105
20	25	25	30	25	126	210
24	30	30	35	30	200	332

1) The minimum lengths to be tested are the lengths below the dotted line in the product standard, i.e. the lengths having the normal hexagon socket depth.

5.2 Hardness

Set screws shall conform to the hardness requirements given in table 4.

Table 4 — Hardness

Test method	Property class	
	12H	21H
	Hardness	
Vickers hardness HV	125 to 209	210 min.
Brinell hardness HB	123 to 213	214 min.
Rockwell hardness HRB	70 to 95	96 min.

6 Test methods

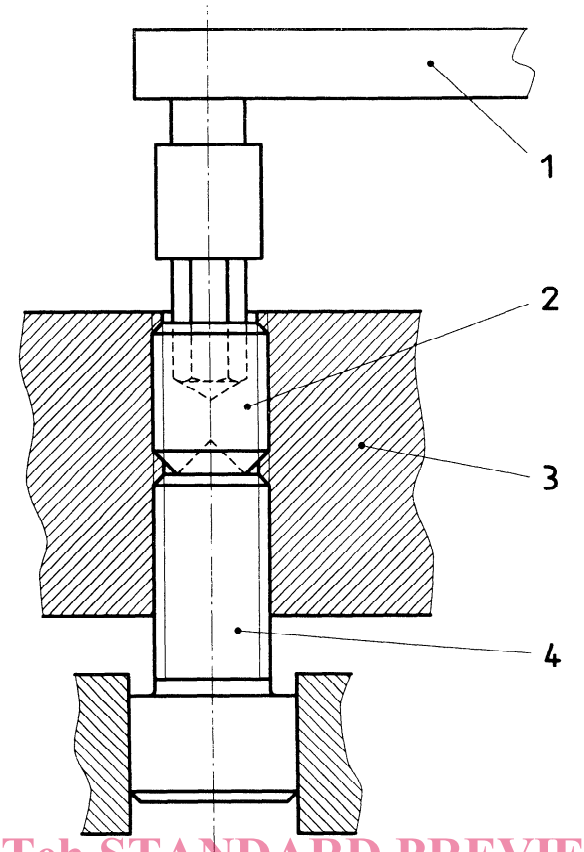
6.1 Proof torque test for hexagon socket set screws

The set screw shall be inserted in a test block as shown in figure 2 until the top surface of the screw face is flush with the test block and the point bears on a firm base, for example a backing screw inserted from the other side.

Using a hexagon test bit with a tolerance of h9 for the width across flats, with a minimum width across corners equal to 1,13 s_{min} and a hardness of 50 HRC to 55 HRC, engaging the full depth of the set screw socket, the screw shall withstand the proof torque given in table 3 without splitting, cracking or thread stripping.

For this proof torque test, a calibrated torque measuring instrument shall be used.

NOTE — Visual marks at the socket due to torque testing shall not be cause for rejection.



Key

1 Torque wrench
2 Screw under test
3 Test block minimum 50 HRC, tolerance 5H (ISO 965-3) for the internal thread
4 Backing screw 450 HV to 570 HV

Figure 2 — Torque test equipment

6.2 Hardness test HB, HRB or HV for set screws

The hardness test shall be carried out in accordance with ISO 6506 (HB), ISO 6508 (HRB), or ISO 6507-1 (HV). In case of doubt, the Vickers hardness test is decisive for acceptance (see table 4).

The test procedure shall be as specified in ISO 898-5.

Annex A
(informative)

Description of the groups and grades of stainless steels

A.1 General

In ISO 3506-1, ISO 3506-2 and ISO 3506-3 reference is made to steel grades A1 to A5, C1 to C4 and F1 covering steels of the following groups:

Austenitic steel	A1 to A5
Martensitic steel	C1 to C4
Ferritic steel	F1

In this annex the characteristics of the above mentioned steel groups and grades are described.

This annex also gives some information on the non-standardized steel group FA. Steels of this group have a ferritic-austenitic structure.

A.2 Steel group A (austenitic structure)

Five main grades of austenitic steels, A1 to A5, are included in ISO 3506-1, ISO 3506-2 and ISO 3506-3. They cannot be hardened and are usually non-magnetic. In order to reduce the susceptibility to work hardening copper may be added to the steel grades A1 to A5 as specified in table 2.

For non-stabilized steel grades A2 and A4 the following applies.

As chromic oxide makes steel resistant to corrosion, low carbon content is of great importance to non-stabilized steels. Due to the high affinity of chrome to carbon, chrome carbide is obtained instead of chromic oxide which is more likely at elevated temperature. (See annex D.)

For stabilized steel grades A3 and A5 the following applies.

The elements Ti, Nb or Ta affect the carbon and chromic oxide is produced to its full extent.

For offshore or similar applications, steels with Cr and Ni contents of about 20 % and Mo of 4,5 % to 6,5 % are required.

When risk of corrosion is high experts should be consulted.

A.2.1 Steel grade A1

Steel grade A1 is especially designed for machining. Due to the high sulfur content of the steels within this grade have lower resistance to corrosion than corresponding steels with normal sulfur content.

A.2.2 Steel grade A2

Steels of grade A2 are the most frequently used stainless steels. They are used for kitchen equipment and apparatus for the chemical industry. Steels within this grade are not suitable for use in non-oxidizing acid and agents with chloride content, i.e. swimming pools and sea water.

A.2.3 Steel grade A3

Steels of grade A3 are stabilized "stainless steels" with properties of steels in grade A2.

A.2.4 Steel grade A4

Steels of grade A4 are "acid proof steels", which are Mo alloyed and give considerably better resistance to corrosion. A4 is used to a great extent by the cellulose industry as this steel grade is developed for boiling sulfuric acid (thus given the name "acid proof") and is, to a certain extent, also suitable in an environment with chloride content. A4 is also frequently used by the food industry and by the ship-building industry.