BS EN ISO 3506-1:2020

BSI Standards Publication

# Fasteners – Mechanical properties of corrosion-resistant stainless steel fasteners

Part 1: Bolts, screws and studs with specified grades and property classes

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# National foreword

This British Standard is the UK implementation of EN ISO 3506-1:2020. It is identical to ISO 3506-1:2020. It supersedes BS EN ISO 3506-1:2009, which is withdrawn.

The UK participation in its preparation was entrusted to Technical Committee FME/9, Fasteners.

A list of organizations represented on this committee can be obtained on request to its secretary.

This publication does not purport to include all the necessary provisions of a contract. Users are responsible for its correct application.

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April 2020

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English Version

# Fasteners - Mechanical properties of corrosion-resistant stainless steel fasteners - Part 1: Bolts, screws and studs with specified grades and property classes (ISO 3506-1:2020)

Fixations - Caractéristiques mécaniques des fixations en acier inoxydable résistant à la corrosion - Partie 1: Vis, goujons et tiges filetées de grades et classes de qualité spécifiés (ISO 3506-1:2020)

Mechanische Verbindungselemente - Mechanische Eigenschaften von Verbindungselementen aus korrosionsbeständigen nichtrostenden Stählen - Teil 1: Schrauben mit festgelegten Stahlsorten und Festigkeitsklassen (ISO 3506-1:2020)

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## European foreword

This document (EN ISO 3506-1:2020) has been prepared by Technical Committee ISO/TC 2 "Fasteners" in collaboration with Technical Committee CEN/TC 185 “Fasteners” the secretariat of which is held by BSI.

This European Standard shall be given the status of a national standard, either by publication of an identical text or by endorsement, at the latest by October 2020, and conflicting national standards shall be withdrawn at the latest by October 2020.

Attention is drawn to the possibility that some of the elements of this document may be the subject of patent rights. CEN shall not be held responsible for identifying any or all such patent rights.

This document supersedes EN ISO 3506-1:2009.

According to the CEN-CENELEC Internal Regulations, the national standards organizations of the following countries are bound to implement this European Standard: Austria, Belgium, Bulgaria, Croatia, Cyprus, Czech Republic, Denmark, Estonia, Finland, France, Germany, Greece, Hungary, Iceland, Ireland, Italy, Latvia, Lithuania, Luxembourg, Malta, Netherlands, Norway, Poland, Portugal, Republic of North Macedonia, Romania, Serbia, Slovakia, Slovenia, Spain, Sweden, Switzerland, Turkey and the United Kingdom.

## Endorsement notice

The text of ISO 3506-1:2020 has been approved by CEN as EN ISO 3506-1:2020 without any modification.

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# Foreword

ISO (the International Organization for Standardization) is a worldwide federation of national standards bodies (ISO member bodies). The work of preparing International Standards is normally carried out through ISO technical committees. Each member body interested in a subject for which a technical committee has been established has the right to be represented on that committee. International organizations, governmental and non-governmental, in liaison with ISO, also take part in the work. ISO collaborates closely with the International Electrotechnical Commission (IEC) on all matters of electrotechnical standardization.

The procedures used to develop this document and those intended for its further maintenance are described in the ISO/IEC Directives, Part 1. In particular, the different approval criteria needed for the different types of ISO documents should be noted. This document was drafted in accordance with the editorial rules of the ISO/IEC Directives, Part 2 (see www.iso.org/directives).

Attention is drawn to the possibility that some of the elements of this document may be the subject of patent rights. ISO shall not be held responsible for identifying any or all such patent rights. Details of any patent rights identified during the development of the document will be in the Introduction and/or on the ISO list of patent declarations received (see www.iso.org/patents).

Any trade name used in this document is information given for the convenience of users and does not constitute an endorsement.

For an explanation of the voluntary nature of standards, the meaning of ISO specific terms and expressions related to conformity assessment, as well as information about ISO's adherence to the World Trade Organization (WTO) principles in the Technical Barriers to Trade (TBT), see www.iso.org/iso/foreword.html.

This document was prepared by Technical Committee ISO/TC 2, *Fasteners*.

This third edition cancels and replaces the second edition (ISO 3506-1:2009), which has been technically revised.

The main changes compared to the previous edition are as follows:

— annexes common to several parts of the ISO 3506 series have been withdrawn from this document and are now included in a new document (ISO 3506-6);

— duplex (austenitic-ferritic) stainless steels for property classes 70, 80 and 100 have been added (see Figure 1);

— property class 100 for austenitic stainless steel grades as well as grade A8 have been added (see Figure 1);

— finish (see 6.3) has been added;

— the matching of stainless steel bolt and nut grades (see 6.4) has been added;

— calculated minimum ultimate tensile loads and minimum loads at 0,2 % non-proportional elongation (see Tables 4 to 7) and rounding rules have been added;

— reduced loadability for fasteners due to head or shank design (see 8.2) has been added;

— requirements and guidance for inspection procedures (see 8.3 to 8.6) have been added;

— operational temperature ranges (see Clause 1) have been clarified;

— the applicability of test methods (see Clause 8), also in relation to full and reduced loadability, has been added;

— the tensile test procedure (see 9.1) has been entirely amended, and application to fasteners with reduced loadability (see 9.2 and 9.3) has been added;

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— the wedge tensile test (see 9.4) and hardness test (see 9.6) have been improved;

— marking and labelling (see Clause 10) have been improved, and fasteners with reduced loadability have been included;

— mechanical properties at elevated temperatures and application at low temperatures (see Annex A) have been improved;

— the structure and content of this document have been brought in line with ISO 898-1.

A list of all parts in the ISO 3506 series can be found on the ISO website.

Any feedback or questions on this document should be directed to the user's national standards body. A complete listing of these bodies can be found at www.iso.org/members.html.


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# Introduction

The ISO 3506 series consists of the following parts, under the general title *Fasteners — Mechanical properties of corrosion-resistant stainless steel fasteners*:

— *Part 1: Bolts, screws and studs with specified grades and property classes*

— *Part 2*: *Nuts with specified grades and property classes*

— *Part 3*[1]*: Set screws and similar fasteners not under tensile stress*

— *Part 4*[1]*: Tapping screws*

— *Part 5*[2]*: Special fasteners (also including fasteners from nickel alloys) for high temperature applications*

— Part 6: *General rules for the selection of stainless steels and nickel alloys for fasteners*

The properties of stainless steel fasteners result from the chemical composition of the material (especially corrosion resistance) and from the mechanical properties due to the manufacturing processes. Ferritic, austenitic and duplex (austenitic-ferritic) stainless steel fasteners are generally manufactured by cold working; they consequently do not have homogeneous local material properties when compared to quenched and tempered fasteners.

Austenitic-ferritic stainless steels referred to as duplex stainless steels were originally invented in the 1930s. Standard duplex grades used today have been developed since the 1980s. Fasteners made of duplex stainless steels have been long established in a range of applications. This document was revised to reflect their standardization.

All duplex stainless steel grades show improved resistance to stress corrosion cracking compared to the commonly used A1 to A5 austenitic grades. Most duplex grades also show higher levels of pitting corrosion resistance, where D2 matches at least A2 and where D4 matches at least A4.

Complementary detailed explanations about definitions of stainless steel grades and properties are specified in ISO 3506-6.

1) It is intended to revise ISO 3506-3 and ISO 3506-4 in the future in order to include the reference to ISO 3506-6.

2) Under preparation.

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# Fasteners — Mechanical properties of corrosion-resistant stainless steel fasteners —

## Part 1: Bolts, screws and studs with specified grades and property classes

## 1 Scope

This document specifies the mechanical and physical properties of bolts, screws and studs, with coarse pitch thread and fine pitch thread, made of corrosion-resistant stainless steels, when tested at the ambient temperature range of 10 °C to 35 °C. It specifies property classes in relation to austenitic, martensitic, ferritic and duplex (austenitic-ferritic) steel grades for fasteners.

The term "fasteners" is used in this document when bolts, screws and studs are considered all together.

ISO 3506-6 provides general rules and additional technical information on suitable stainless steels and their properties.

Fasteners conforming to the requirements of this document are evaluated at the ambient temperature specified in paragraph 1. It is possible that they do not retain the specified mechanical and physical properties at elevated and/or lower temperatures.

NOTE 1 Fasteners conforming to the requirements of this document are used without restriction in applications ranging from –20 °C to +150 °C; however, fasteners conforming to this document are also used for applications outside this range down to –196 °C and up to +300 °C. For more details, see Annex A and ISO 3506-6.

Outside the temperature range of –20 °C to +150 °C, it is the responsibility of the user to determine the appropriate choice for a given application in consultation with an experienced fastener metallurgist and by taking into account e.g. stainless steel composition, duration of exposure at elevated or low temperature, the effect of the temperature on the fasteners mechanical properties and clamped parts, and the corrosive service environment of the bolted joint.

NOTE 2 ISO 3506-5 is developed in order to assist in the selection of appropriate stainless steel grades and property classes intended for use at temperatures up to +800 °C.

This document applies to bolts, screws and studs:

— with ISO metric thread in accordance with ISO 68-1,

— with diameter/pitch combinations in accordance with ISO 261 and ISO 262,

— with coarse pitch thread M1,6 to M39, and fine pitch thread M8×1 to M39×3,

— with thread tolerances in accordance with ISO 965-1 and ISO 965-2,

— with specified property classes, and

— of any shape.

Stainless steel grades and property classes can be used for sizes outside the diameter limits of this document (i.e. for $d$ < 1,6 mm or $d$ > 39 mm), provided that all applicable chemical, mechanical and physical requirements are met.

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Certain bolts, screws and studs might not fulfil the tensile or torsional requirements of this document because of the geometry of their head or unthreaded shank, thus resulting in reduced loadability (e.g. when shear area in the head is less than the stress area in the thread; see 8.2.2).

This document does not apply to set screws and similar threaded fasteners not under tensile stress (see ISO 3506-3).

It does not specify requirements for functional properties such as:

— torque/clamp force properties,

— shear strength,

— fatigue resistance, or

— weldability.

## 2 Normative references

The following documents are referred to in the text in such a way that some or all of their content constitutes requirements of this document. For dated references, only the edition cited applies. For undated references, the latest edition of the referenced document (including any amendments) applies.

ISO 1891-4, *Fasteners — Vocabulary — Part 4: Control, inspection, delivery, acceptance and quality*

ISO 3506-6, *Fasteners — Mechanical properties of corrosion-resistant stainless steel fasteners — Part 6: General rules for the selection of stainless steels and nickel alloys for fasteners*

ISO 6506-1, *Metallic materials — Brinell hardness test — Part 1: Test method*

ISO 6507-1, *Metallic materials — Vickers hardness test — Part 1: Test method*

ISO 6508-1, *Metallic materials — Rockwell hardness test — Part 1: Test method*

ISO 6892-1, *Metallic materials — Tensile testing — Part 1: Method of test at room temperature*

ISO 7500-1, *Metallic materials — Calibration and verification of static uniaxial testing machines — Part 1: Tension/compression testing machines — Calibration and verification of the force-measuring system*

ISO 9513, *Metallic materials — Calibration of extensometer systems used in uniaxial testing*

ISO 16228, *Fasteners — Types of inspection documents*

## 3 Terms and definitions

For the purposes of this document, the following terms and definitions apply.

ISO and IEC maintain terminological databases for use in standardization at the following addresses:

— ISO Online browsing platform: available at https://www.iso.org/obp

— IEC Electropedia: available at http://www.electropedia.org/

**3.1**
**stainless steel bolt and screw with full loadability**
bolt and screw with head stronger than the threaded and unthreaded shanks (with unthreaded shank diameter $d_s \approx d_2$ or $d_s > d_2$) or screw threaded to the head, and fulfilling the minimum ultimate tensile load

**3.2**
**stainless steel stud with full loadability**
stud with unthreaded shank diameter $d_s \approx d_2$ or $d_s > d_2$, and fulfilling the minimum ultimate tensile load


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**3.3**
**stainless steel bolt and screw with reduced loadability**
bolt and screw with head weaker than the threaded and unthreaded shanks, or with an unthreaded shank diameter $d_s < d_2$

**3.4**
**stainless steel stud with reduced loadability**
stud with unthreaded shank diameter $d_s < d_2$

**3.5**
**stainless steel**
steel with at least 10,5 % (mass fraction) of chromium (Cr) and maximum 1,2 % (mass fraction) of carbon (C)

**3.6**
**austenitic stainless steel**
*stainless steel* (3.5) with high amounts of chromium and nickel which usually cannot be hardened by heat treatment, providing excellent resistance to corrosion, good ductility, and usually low or non-magnetic properties

**3.7**
**martensitic stainless steel**
*stainless steel* (3.5) with high amounts of chromium but very little nickel or other alloying elements, which can be hardened by heat treatment for increasing strength but with reduced ductility, and with highly magnetic properties

**3.8**
**ferritic stainless steel**
*stainless steel* (3.5) containing less than 0,1 % carbon and typically 11 % to 18 % chromium, which usually cannot be hardened by heat treatment, and with highly magnetic properties

**3.9**
**duplex stainless steel**
*stainless steel* (3.5) with a micro-structure that includes both austenitic and ferritic phases providing excellent resistance to corrosion, containing a higher amount of chromium and a reduced quantity of nickel compared to austenitic steel, with high strength, and with magnetic properties

## 4 Symbols

For the purposes of this document, the following symbols apply.

| | |
|---|---|
| $A$ | total elongation after fracture, mm |
| $A_{s,nom}$ | nominal stress area in thread, mm$^2$ |
| $A_{ds}$ | cross-sectional area of waisted shank, mm$^2$ |
| $b$ | thread length, mm |
| $d$ | nominal thread diameter of the fastener, mm |
| $d_1$ | basic minor diameter of external thread, mm |
| $d_2$ | basic pitch diameter of external thread, mm |
| $d_3$ | minor diameter of external thread (for nominal stress area calculation), mm |
| $d_a$ | inner diameter of the bearing face, mm |

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| | |
|---|---|
| $d_h$ | hole diameter for adaptors and wedge, mm |
| $d_s$ | diameter of unthreaded shank, mm |
| $F_{mf}$ | ultimate tensile load, N |
| $F_{pf}$ | load at 0,2 % non-proportional elongation for full-size fastener, N |
| $H$ | height of the fundamental triangle of the thread, mm |
| $k$ | height of the head, mm |
| $l$ | nominal length of fastener, mm |
| $L_0$ | total length of fastener before tensile test, mm |
| $L_1$ | total length of fastener after fracture, mm |
| $L_2$ | clamping length before tensile test, mm |
| $l_s$ | length of unthreaded shank, mm |
| $l_t$ | overall length of stud, mm |
| $l_{th}$ | free threaded length of fastener in testing device, mm |
| $M_B$ | breaking torque, Nm |
| $P$ | pitch of the thread, mm |
| $R_{mds}$ | tensile strength for fastener with reduced loadability due to shank design, MPa |
| $R_{mf}$ | tensile strength for full-size fastener, MPa |
| $R_{pf}$ | stress at 0,2 % non-proportional elongation for full-size fastener, MPa |
| $\alpha$ | wedge angle, ° |

# 5 Designation system for stainless steel grades and property classes

## 5.1 General

The standardized combinations of stainless steel grades and property classes are specified in Clause 7, Table 2 or 3.

The designation system for stainless steel grades and property classes for bolts, screws and studs consists of two blocks, separated by a hyphen, as specified in Figure 1. The first block designates the stainless steel grade, and the second block the property class of the fastener.


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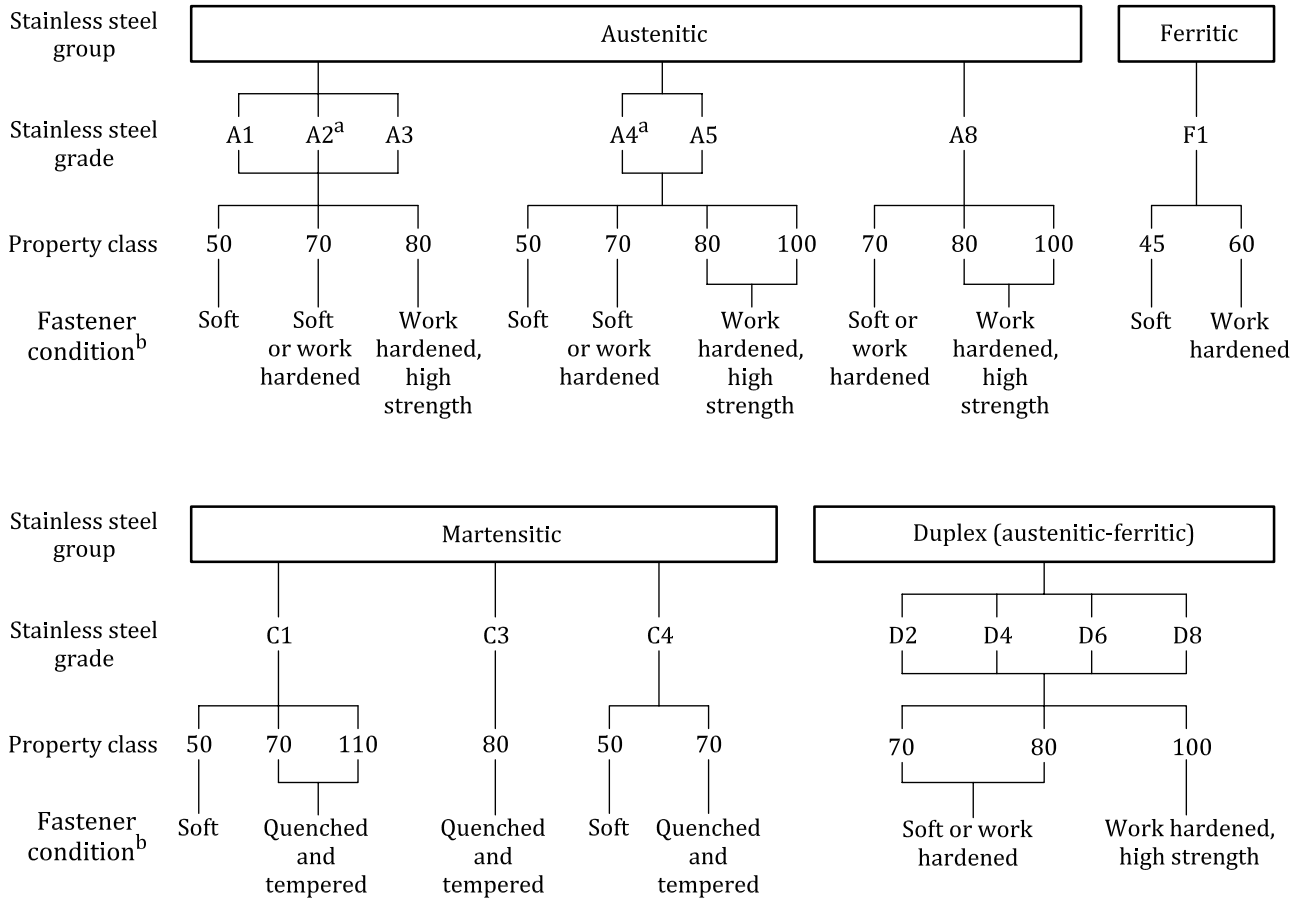


a For low carbon austenitic stainless steels with carbon content not exceeding 0,030 %, fasteners can additionally be marked or designated with the letter "L" just after the grade. Example: A4L-80.

b For information only.

**Figure 1 — Designation system for stainless steel grades and property classes for fasteners**

The marking, labelling and designation of fasteners with stainless steel grade and property class shall be as specified in Clause 10. For bolts, screws and studs with reduced loadability which can be tensile tested in the threaded shank, the digit "0" shall precede the property class as specified in 10.1.3. For fasteners with reduced loadability which cannot be tensile tested due to a too short thread length ($b < 3d$), the property class shall not be referenced.

The designation system of this document may be used for sizes outside the diameter limits specified in Clause 1 (i.e. $d < 1{,}6$ mm or $d > 39$ mm), provided that all applicable chemical, mechanical and physical requirements are met.

## 5.2 Designation of stainless steel grades (first block)

The designation of the stainless steel grade (first block) consists of one letter which specifies the stainless steel group:

— **A** for austenitic,

— **C** for martensitic,

— **F** for ferritic,

— **D** for duplex (austenitic-ferritic),

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