भारतीय मानक

इस्पात के चूड़ीदार बंधकों के लिए तकनीकी पूर्ति शर्तें

भाग 14 संक्षरण-प्रतिरोधी स्टेनलैस-इस्पात बंधकों के यांत्रिक गुणधर्म

अनुभाग 1 काबले, पेंच और स्टड्स

(तीसरा पुनरीक्षण)

Indian Standard

TECHNICAL SUPPLY CONDITIONS FOR THREADED STEEL FASTENERS

PART 14 MECHANICAL PROPERTIES OF CORROSION-RESISTANT STAINLESS-STEEL FASTENERS

Section 1 Bolts, Screws and Studs

(Third Revision)

ICS 21.060.10

BUREAU OF INDIAN STANDARDS
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NATIONAL FOREWORD

This Indian Standard (Part 14/Sec 1) (Third Revision) which is identical with ISO 3506-1:1997 'Mechanical properties of corrosion-resistant stainless-steel fasteners—Part 1: Bolts, screws and studs' issued by the International Organization for Standardization (ISO) was adopted by the Bureau of Indian Standards on the recommendation of the Bolts, Nuts and Fasteners Accessories Sectional Committee and approval of the Basic and Production Engineering Division Council.

This standard was originally published in 1961 and subsequently revised in 1967 and 1984. The last revision was in conformity with ISO 3506:1979. Consequent upon the revision of ISO 3506:1979 into three parts, the Committee decided to revise this Indian Standard into three sections aligning them with ISO 3506-1:1997, ISO 3506-2:1997 and ISO 3506-3:1997 respectively.

In view of the above, IS 1367(Part 14) has been splitted into three sections by adopting Part 1, Part 2 and Part 3 of ISO 3506 respectively. The other two sections of this part are given as under:

IS 1367(Part 14/Sec 2) : 2002	Technical supply conditions for threaded steel fasteners: Part 14 Mechanical properties of corrosion-resistant stainless-steel fasteners, Section 2 Nuts (*third revision*)
IS 1367(Part 14/Sec 3) : 2002	Technical supply conditions for threaded steel fasteners: Part 14 Mechanical properties of corrosion-resistant stainless-steel fasteners, Section 3 Set screws and similar fasteners not under tensile stress (*third revision*)

The text of ISO Standard has been approved as suitable for publication as Indian Standard without deviations. Certain terminology and conventions are, however, not identical to those used in Indian Standards. Attention is drawn especially to the following:

a) Wherever the words 'International Standard' appear referring to this standard, they should be read as 'Indian Standard'.

b) Comma (,) has been used as a decimal marker while in Indian Standards, the current practice is to use a point (.) as the decimal marker.

In this adopted standard, reference appears to certain International Standards for which Indian Standards also exist. The corresponding Indian Standards which are to be substituted in their place are listed below along with their degree of equivalence for the editions indicated:

International Standard	*Corresponding Indian Standard*	*Degree of Equivalence*
ISO 68-1:[1]	IS 4218(Part 1):2001 ISO General purpose metric screw threads: Part 1 Basic profile (*second revision*)	Identical
ISO 261:[1]	IS 4218(Part 2): 2001 ISO General purpose metric screw threads: Part 2 General plan (*second revision*)	do
ISO 262:[1]	IS 4218(Part 4): 2001 ISO General purpose metric screw threads: Part 4 Selected sizes for screws, bolts and nuts (*second revision*)	do
ISO 724:1993	IS 4218(Part 3):1999 ISO General purpose metric screw threads: Part 3 Basic dimensions (*second revision*)	do

(*Continued on third cover*)

[1] Since published in 1998.

Indian Standard

TECHNICAL SUPPLY CONDITIONS FOR THREADED STEEL FASTENERS

PART 14 MECHANICAL PROPERTIES OF CORROSION-RESISTANT STAINLESS-STEEL FASTENERS

Section 1 Bolts, Screws and Studs

(Third Revision)

1 Scope

This part of ISO 3506 specifies the mechanical properties of bolts, screws and studs made of austenitic, martensitic and ferritic grades of corrosion-resistant stainless steels when tested over an ambient temperature range of 15 °C to 25 °C. Properties will vary at higher or lower temperatures.

It applies to bolts, screws and studs

— with nominal thread diameter (*d*) up to and including 39 mm;

— of triangular ISO metric threads with diameters and pitches in accordance with 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, 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 part of ISO 3506 is a classification into property classes of corrosion resistant stainless steel fasteners. Some materials can be used at temperatures down to – 200 °C, 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.

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 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 may be evident (see annex H).

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 normative documents 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 724:1993, *ISO general purpose metric screw threads – Basic dimensions.*

ISO 898-1:—4), *Mechanical properties of fasteners made of carbon steel and alloy steel – Part 1: Bolts, screws and studs.*

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: Ferrictic, 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).*

ISO 6892:—7), *Metallic materials – Tensile testing at ambient temperature.*

ISO 8044:—8), *Corrosion of metals and alloys – Basic terms and definitions.*

3 Designation, marking and finish

3.1 Designation

The designation system for stainless steel grades and property classes for bolts, screws and studs 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 letters

A for austenitic steel or

C for martensitic steel or

F for ferritic steel

which indicate 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 2 digits which indicates 1/10 of the tensile strength of the fastener.

Examples:

1) **A2-70** indicates:

   austenitic steel, cold worked, minimum 700 N/mm² (700 MPa) tensile strength.

2) **C4-70** indicates:

   martensitic steel, hardened and tempered, minimum 700 N/mm² (700 MPa) tensile strength.

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3) To be published. (Revision of ISO 262:1973)

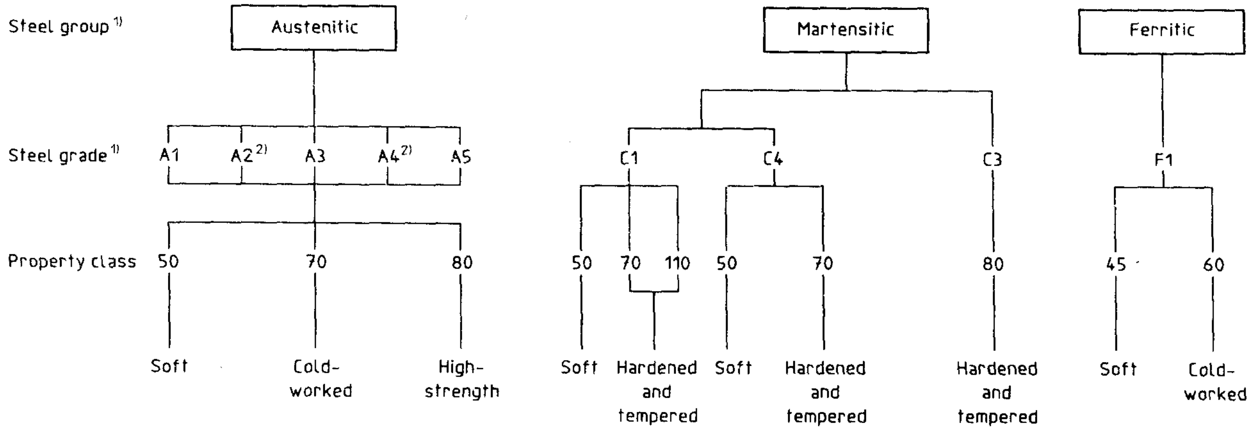
4) To be published. (Revision of ISO 898-1:1988)

5) To be published. (Revision of ISO 3651-1:1976)

6) To be published. (Revision of ISO 3651-2:1976)

7) To be published. (Revision of ISO 6892:1984)

8) To be published. (Revision of ISO 8044:1988)



1) 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.

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

Example: A4L – 80

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

3.2 Marking

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.

3.2.1 Bolts and screws

All hexagon head bolts and screws and hexagon or hexalobular socket head cap screws of nominal thread diameter $d \geqslant 5$ mm shall be clearly marked in accordance with 3.1, figure 1 and figure 2. The marking shall include the steel grade and property class and also the manufacturer's identification mark. 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.

3.2.2 Studs

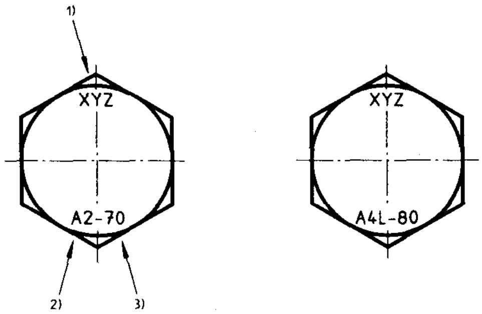
Studs of nominal thread diameter $d \geqslant 6$ mm shall be clearly marked in accordance with 3.1, figure 1 and figure 2. The marking shall be on the unthreaded part of the stud and shall contain the manufacturer's identification mark, steel grade and property class. If marking on the unthreaded portion is not possible, marking of steel grade only on the nut end of the stud is allowed, see figure 2.

3.2.3 Packages

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

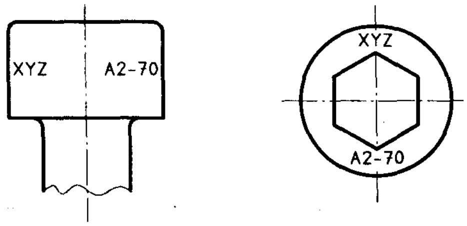
3.3 Finish

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.

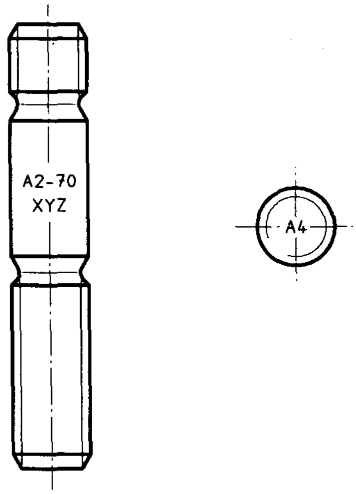


1) manufacturer's identification mark
2) steel grade
3) property class

Marking of hexagon head bolts and screws



Marking of hexagon and hexalobular socket head cap screws (alternative forms)



Marking of studs (alternative forms, see 3.2.2)

NOTE — For marking of left-hand thread, see ISO 898-1.

Figure 2 — Marking of bolts, screws and studs

4 Chemical composition

The chemical compositions of stainless steels suitable for fasteners in accordance with this part of ISO 3506 are given in table 1.

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 1 — 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	7) 8)
	A3	0,08	1	2	0,045	0,03	17 to 19	– 5)	9 to 12	1	9)
	A4	0,08	1	2	0,045	0,03	16 to 18,5	2 to 3	10 to 15	1	8) 10)
	A5	0,08	1	2	0,045	0,03	16 to 18,5	2 to 3	10,5 to 14	1	9) 10)
Martensitic	C1	0,09 to 0,15	1	1	0,05	0,03	11,5 to 14	–	1	–	10)
	C3	0,17 to 0,25	1	1	0,04	0,03	16 to 18	–	1,5 to 2,5	–	
	C4	0,08 to 0,15	1	1,5	0,06	0,15 to 0,35	12 to 14	0,6	1	–	2) 10)
Ferritic	F1	0,12	1	1	0,04	0,03	15 to 18	– 6)	1	–	11) 12)

NOTES

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

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

3 Certain materials for specific application are given in annex E.

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) Molybdenum may be present at the discretion of the manufacturer.

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

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

9) Must contain titanium ≥ 5 × 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 ≥ 10 × C up to 1,0 % maximum for stabilization and be marked appropriately in accordance with this table.

10) 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 % for austenitic steels.

11) May contain titanium ≥ 5 × C up to 0,8 % maximum.

12) May contain niobium (columbium) and/or tantalum ≥ 10 × C up to 1 % maximum.

5 Mechanical properties

The mechanical properties of bolts, screws and studs in accordance with this part of ISO 3506 shall conform to the values given in table 2, 3 or 4.

For bolts and screws made of martensitic steel the strength under wedge loading shall not be smaller than 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 6.

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

Group	Grade	Property class	Thread diameter range	Tensile strength R_m 1) min. N/mm²	Stress at 0,2 % permanent strain $R_{p\,0,2}$ 1) min. N/mm²	Elongation after fracture A 2) min. mm
Austenitic	A1, A2, A3, A4, A5	50	≤ M39	500	210	0,6 d
		70	≤ M24 3)	700	450	0,4 d
		80	≤ M24 3)	800	600	0,3 d

1) The tensile stress is calculated on the stress area (see annex A).
2) To be determined according to 6.2.4 on the actual screw length and not on a prepared test piece; d is the nominal thread diameter.
3) For fasteners with nominal thread diameters $d > 24$ mm the mechanical properties shall be agreed upon between user and manufacturer and marked with grade and property class according to this table.

Table 3 — Mechanical properties for bolts, screws and studs - Martensitic and ferritic grades

Group	Grade	Property class	Tensile strength R_m 1) min. N/mm²	Stress at 0,2 % permanent strain $R_{p\,0,2}$ 1) min. N/mm²	Elongation after fracture A 2) min. mm	Hardness HB	Hardness HRC	Hardness HV
Martensitic	C1	50	500	250	0,2 d	147 to 209	–	155 to 220
		70	700	410	0,2 d	209 to 314	20 to 34	220 to 330
		110 3)	1 100	820	0,2 d	–	36 to 45	350 to 440
	C3	80	800	640	0,2 d	228 to 323	21 to 35	240 to 340
	C4	50	500	250	0,2 d	147 to 209	–	155 to 220
		70	700	410	0,2 d	209 to 314	20 to 34	220 to 330
Ferritic	F1 4)	45	450	250	0,2 d	128 to 209	–	135 to 220
		60	600	410	0,2 d	171 to 271	–	180 to 285

1) The tensile stress is calculated on the stress area (see annex A).
2) To be determined according to 6.2.4 on the actual screw length and not on a prepared test piece. d is the nominal thread diameter.
3) Hardened and tempered at a minimum tempering temperature of 275 °C.
4) Nominal thread diameter $d \leq 24$ mm.

Table 4 — Minimum breaking torque, $M_{B,min}$ for austenitic grade bolts and screws M1,6 to M16 (coarse thread)

Thread	Minimum breaking torque, $M_{B,min}$ Nm — Property class 50	70	80
M1,6	0,15	0,2	0,24
M2	0,3	0,4	0,48
M2,5	0,6	0,9	0,96
M3	1,1	1,6	1,8
M4	2,7	3,8	4,3
M5	5,5	7,8	8,8
M6	9,3	13	15
M8	23	32	37
M10	46	65	74
M12	80	110	130
M16	210	290	330

Minimum breaking torque values for martensitic and ferritic grade fasteners shall be agreed upon between manufacturer and user.

6 Testing

6.1 Test programme

The tests to be performed, depending on material grade and bolt or stud length, are given in table 5.

Table 5 — Test programme

Grade	Tensile strength 1)	Breaking torque 2)	Stress at 0,2 % permanent strain $R_{p\,0,2}$ 1)	Elongation after fracture 1)	Hardness	Strength under wedge loading
A1	$l \geqslant 2{,}5\,d$ 3)	$l < 2{,}5\,d$	$l \geqslant 2{,}5\,d$ 3)	$l \geqslant 2{,}5\,d$ 3)	–	–
A2	$l \geqslant 2{,}5\,d$ 3)	$l < 2{,}5\,d$	$l \geqslant 2{,}5\,d$ 3)	$l \geqslant 2{,}5\,d$ 3)	–	–
A3	$l \geqslant 2{,}5\,d$ 3)	$l < 2{,}5\,d$	$l \geqslant 2{,}5\,d$ 3)	$l \geqslant 2{,}5\,d$ 3)	–	–
A4	$l \geqslant 2{,}5\,d$ 3)	$l < 2{,}5\,d$	$l \geqslant 2{,}5\,d$ 3)	$l \geqslant 2{,}5\,d$ 3)	–	–
A5	$l \geqslant 2{,}5\,d$ 3)	$l < 2{,}5\,d$	$l \geqslant 2{,}5\,d$ 3)	$l \geqslant 2{,}5\,d$ 3)	–	–
C1	$l \geqslant 2{,}5\,d$ 3)	–	$l \geqslant 2{,}5\,d$ 3)	$l \geqslant 2{,}5\,d$ 3)	Required	$l_s \geqslant 2\,d$
C3	$l \geqslant 2{,}5\,d$ 3)	–	$l \geqslant 2{,}5\,d$ 3)	$l \geqslant 2{,}5\,d$ 3)	Required	$l_s \geqslant 2\,d$
C4	$l \geqslant 2{,}5\,d$ 3)	–	$l \geqslant 2{,}5\,d$ 3)	$l \geqslant 2{,}5\,d$ 3)	Required	$l_s \geqslant 2\,d$
F1	$l \geqslant 2{,}5\,d$ 3)	–	$l \geqslant 2{,}5\,d$ 3)	$l \geqslant 2{,}5\,d$ 3)	Required	–

l is the length of bolt
d is the nominal diameter of thread
l_s is the plain shank length

1) For all sizes $\geqslant$ M5
2) For sizes < M5 the test applies to all lengths.
3) For studs the requirement is $l \geqslant 3{,}5\,d$

6.2 Test methods

6.2.1 General

All length measurements shall be made to an accuracy of $\pm$ 0,05 mm or better.

All tensile and load tests shall be performed with testing machines equipped with self-aligning grips in order to prevent any non-axial loading, see figure 3. The lower adapter shall be hardened and threaded for tests according to 6.2.2, 6.2.3 and 6.2.4. The hardness of the lower adapter shall be 45 HRC minimum. Internal thread tolerance shall be 5H6G.

6.2.2 Tensile strength, R_m

The tensile strength shall be determined on fasteners with a length equal to 2,5 $\times$ the nominal thread diameter (2,5 d) or longer in accordance with ISO 6892 and ISO 898-1.

A free threaded length at least equal to the nominal thread diameter (d) shall be subject to the tensile load.

The fracture shall occur between the bearing face of the screw head and the end of the adapter.

The obtained value for R_m shall meet the values given in table 2 or 3.

6.2.3 Stress at 0,2 % permanent strain $R_{p0,2}$

The stress at 0,2 % permanent strain $R_{p0,2}$ shall be determined only on complete bolts and screws in the finished condition. This test is applicable only to fasteners of lengths equal to 2,5 × the nominal thread diameter (2,5 d) or longer.

The test shall be carried out by measuring the extension of the bolt or screw when subjected to axial tensile loading (see figure 3).

The component under test shall be screwed into a hardened threaded adapter to a depth of one thread diameter d (see figure 3).

A curve of load against elongation shall be plotted as shown in figure 4.

The clamping length from which $R_{p0,2}$ is calculated is taken as the distance L_3 between the underside of the head and the threaded adapter, see figure 3 and also note 2 below tables 2 and 3. Of this value 0,2 % is then applied to the scale on the horizontal (strain) axis of the load-elongation curve, OP, and the same value is plotted horizontally from the straight-line portion of the curve as QR. A line is then drawn through P and R and the intersection, S, of this line with the load-elongation curve corresponds to a load at point T on the vertical axis. This load, when divided by the thread stress area, gives the stress at 0,2 % permanent strain ($R_{p0,2}$).

The value of elongation is determined between the bearing face of the bolt head and the end of the adapter.

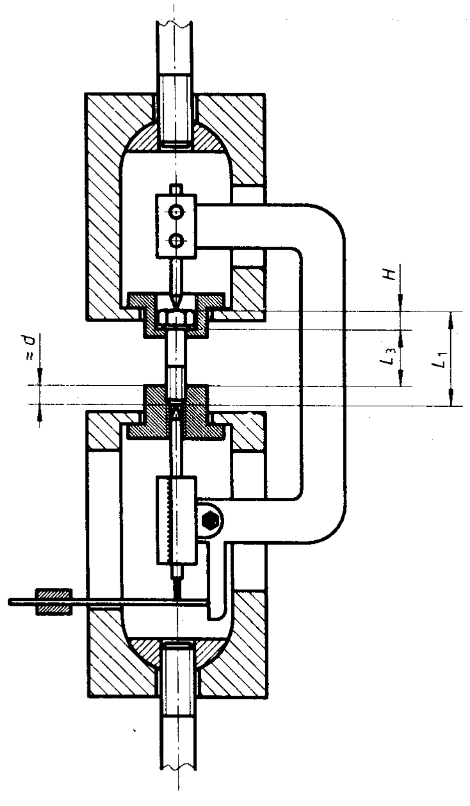


Figure 3 — Bolt extensiometer with self-aligning grips

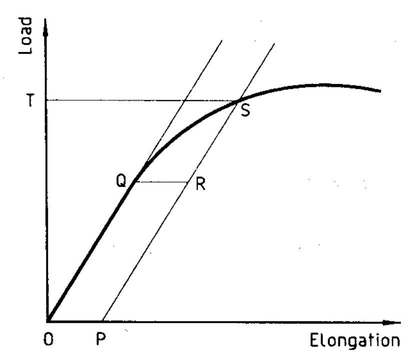


Figure 4 — Load-elongation curve for determination of stress at 0,2 % permanent strain, $R_{p0.2}$ (see 6.2.3)

6.2.4 Elongation after fracture, A

The elongation after fracture shall be determined on fasteners with lengths equal to 2,5 × the nominal diameter (2,5 d) or longer.

The screw length (L_1) shall be measured, see figure 5. The fastener shall then be screwed into the threaded adapter to a depth of one diameter (d), see figure 3.

After the fastener has been fractured the pieces shall be fitted together and the length (L_2) measured, see figure 5.

The elongation after fracture is then calculated using the formula

$$A = L_2 - L_1$$

The obtained value for A shall exceed the values given in tables 2 and 3.

If this test is required on machined samples, the test values should be specially agreed.

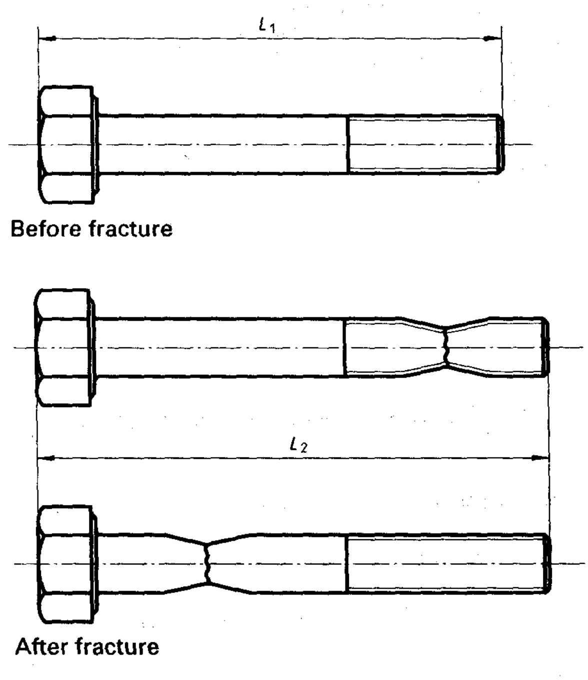


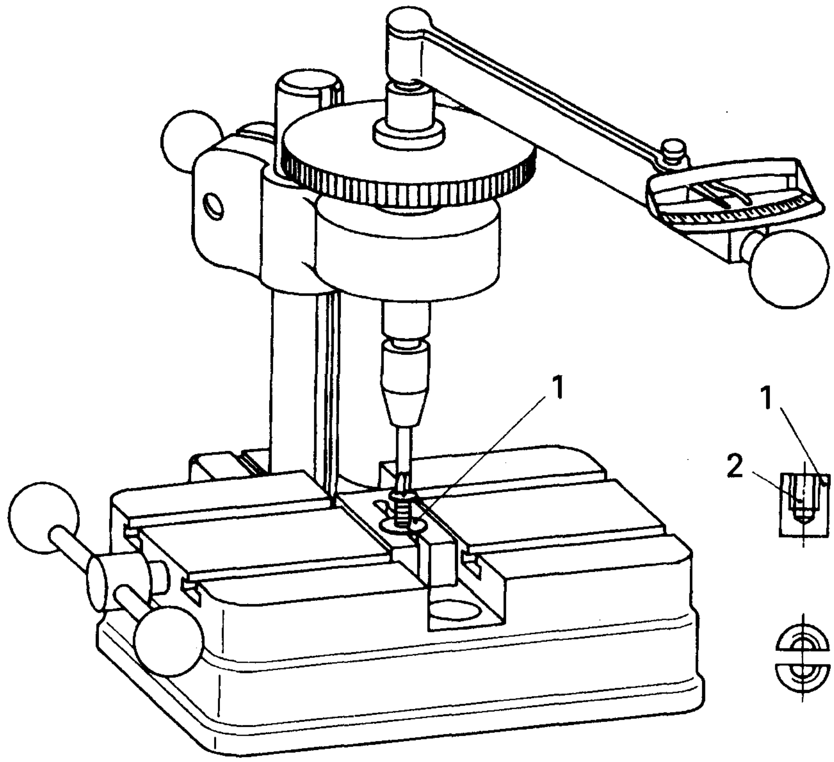
Figure 5 — Determination of elongation after fracture, A (see 6.2.4)

6.2.5 Breaking torque, M_B

The breaking torque shall be determined using an apparatus as shown in to figure 6, the torque-measuring device of which shall have an accuracy of at least 7 % of the minimum values specified in table 4.

The thread of the screw shall be clamped in a mating split blind hole die for a length of one nominal thread diameter, exclusive of the point and so that at least two full threads project above the clamping device.

The torque shall be applied to the screw until failure occurs. The screw shall meet the minimum breaking torque requirements given in table 4.



Key

1 Split die

2 Blind hole

Figure 6 — Apparatus for determination of breaking torque, M_B (see 6.2.5)

6.2.6 Test for strength under wedge loading of full size martensitic bolts and screws (not studs)

This test shall be performed in accordance with ISO 898-1 with wedge dimensions as given in table 6.

Table 6 — Wedge dimensions

Nominal thread diameter d mm	α	
	Bolts and screws with plain shank lengths $l_s \geqslant 2\,d$	Bolts and screws threaded to the head or with plain shank lengths $l_s < 2\,d$
$d \leqslant 20$	10°±30'	6°±30'
$20 < d \leqslant 39$	6°±30'	4°±30'

6.2.7 Hardness HB, HRC or HV

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

The hardness tests on bolts shall be made at the end of the bolt, mid-radius position between the centre and the circumference. For refereeing purposes, this zone shall be 1 d from the end.

The hardness values shall be within the limits given in table 3.

Annex A
(normative)

External thread – Calculation of stress area

The nominal stress area $A_{s,nom}$ is calculated by the formula

$$A_{s,nom} = \frac{\pi}{4}\left(\frac{d_2 + d_3}{2}\right)^2$$

where

d_2 [9] is the basic pitch diameter of the thread;

d_3 is the nominal minor diameter of the thread

$$d_3 = d_1 - \frac{H}{6}$$

where

d_1 is the basic minor diameter of the thread;

H is the height of the fundamental triangle of the thread.

Table A.1 — Nominal stress areas for coarse and fine pitch threads

Coarse thread (d)	Nominal stress area $A_{s,nom}$ mm²
M1,6	1,27
M2	2,07
M2,5	3,39
M3	5,03
M4	8,78
M5	14,2
M6	20,1
M8	36,6
M10	58
M12	84,3
M14	115
M16	157
M18	192
M20	245
M22	303
M24	353
M27	459
M30	561
M33	694
M36	817
M39	976

Fine pitch thread ($d \times P$ [1])	Nominal stress area $A_{s,nom}$ mm²
M8 × 1	39,2
M10 × 1	64,5
M10 × 1,25	61,2
M12 × 1,25	92,1
M12 × 1,5	88,1
M14 × 1,5	125
M16 × 1,5	167
M18 × 1,5	216
M20 × 1,5	272
M22 × 1,5	333
M24 × 2	384
M27 × 2	496
M30 × 2	621
M33 × 2	761
M36 × 3	865
M39 × 3	1 030

1) P is the pitch of the thread.

9) See ISO 724.

Annex B
(informative)

Description of the groups and grades of stainless steels

B.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.

B.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 steel grades A1 to A5 as specified in table 1.

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 G.)

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.

B.2.1 Steel grade A1

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

B.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.

B.2.3 Steel grade A3

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

B.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.

B.2.5 Steel grade A5

Steels of grade A5 are stabilized "acid proof steels" with properties of steels in grade A4.

B.3 Steel group F (ferritic structure)

One ferritic steel grade (F1) is included in ISO 3506-1, ISO 3506-2 and ISO 3506-3. The steels within grade F1 cannot be hardened normally and should not be hardened even if possible in certain cases. The F1 steels are magnetic.

B.3.1 Steel grade F1

Steel grade F1 is normally used for simpler equipment with the exeption of the superferrites which have extremely low C and N contents. The steels within grade F1 can, if need be, replace steels of grades A2 and A3 and be used at higher chloride content.

B.4 Steel group C (martensitic structure)

Three types of martensitic steel grades, C1, C3 and C4, are included in ISO 3506-1, ISO 3506-2 and ISO 3506-3. They can be hardened to an excellent strength and are magnetic.

B.4.1 Steel grade C1

Steels within grade C1 have limited resistance to corrosion. They are used in turbines, pumps and for knives.

B.4.2 Steel grade C3

Steels within grade C3 have limited resistance to corrosion though better resistance than C1. They are used in pumps and valves.

B.4.3 Steel grade C4

Steels within grade C4 have limited resistance to corrosion. They are intended for machining, otherwise they are similar to steels of grade C1.

B.5 Steel group FA (ferritic-austenitic structure)

Steel group FA is not included in ISO 3506-1, ISO 3506-2 and ISO 3506-3 but will most probably be included in the future.

Steels of this steel group are the so-called duplex steels. The first FA steels to be developed had some drawbacks that have been eliminated in the recently developed steels. FA steels have better properties than steels of the types A4 and A5 especially as far as strength is concerned. They also exhibit superior resistance to pitting and crack corrosion.

Examples of composition are shown in table B.1

Table B.1 — Ferritic-austenitic steels - Chemical composition

Group	Chemical composition, % (*m*/*m*)						
	C max.	Si	Mn	Cr	Ni	Mo	N
Ferritic-	0,03	1,7	1,5	18,5	5	2,7	0,07
austenitic	0,03	< 1	< 2	22	5,5	3	0,14

Annex C
(informative)

Stainless steel composition specifications
(Extract from ISO 683-13:1986)

Table C.1

Type[2] of steel	Chemical composition[1] % (*m/m*) C	Si max.	Mn max.	P max.	S	N	Al	Cr	Mo	Nb[3]	Ni	Se min.	Ti	Cu	Fastener grade identification[4]
								Ferritic steels							
8	0,08 max.	1,0	1,0	0,040	0,030 max.	—	—	16,0 to 18,0	—	—	1,0 max.	—	—	—	**F1**
8b	0,07 max.	1,0	1,0	0,040	0,030 max.	—	—	16,0 to 18,0	—	—	1,0 max.	—	7 × % C ≤ 1,10	—	**F1**
9c	0,08 max.	1,0	1,0	0,040	0,030 max.	—	—	16,0 to 18,0	0,90 to 1,30	—	1,0 max.	—	—	—	**F1**
F1	0,025 max. [5]	1,0	1,0	0,040	0,030 max.	0,025 max. [5]	—	17,0 to 19,0	1,75 to 2,50	— [6]	0,60 max.	—	— [6]	—	**F1**
								Martensitic steels							
3	0,09 to 0,15	1,0	1,0	0,040	0,030 max	—	—	11,5 to 13,5	—	—	1,0 max.	—	—	—	**C1**
7	0,08 to 0,15	1,0	1,5	0,060	0,15 to 0,35	—	—	12,0 to 14,0	0,60 max. [7]	—	1,0 max.	—	—	—	**C4**
4	0,16 to 0,25	1,0	1,0	0,040	0,030 max.	—	—	12,0 to 14,0	—	—	1,0 max.	—	—	—	**C1**
9a	0,10 to 0,17	1,0	1,5	0,060	0,15 to 0,34	—	—	15,5 to 17,5	0,60 max. [7]	—	1,0 max.	—	—	—	**C3**
9b	0,14 to 0,23	1,0	1,0	0,040	0,030 max.	—	—	15,0 to 17,5	—	—	1,5 to 2,5	—	—	—	**C3**
5	0,26 to 0,35	1,0	1,0	0,040	0,030 max.	—	—	12,0 to 14,0	—	—	1,0 max.	—	—	—	**C1**
								Austenitic steels							
10	0,030 max.	1,0	2,0	0,045	0,030 max	—	—	17,0 to 19,0	—	—	9,0 to 12,0	—	—	—	**A2** [8]
11	0,07 max.	1,0	2,0	0,045	0,030 max.	—	—	17,0 to 19,0	—	—	8,0 to 11,0	—	—	—	**A2**
15	0,08 max.	1,0	2,0	0,045	0,030 max.	—	—	17,0 to 19,0	—	—	9,0 to 12,0	—	5 × % C ≤ 0,80	—	**A3** [9]
16	0,08 max.	1,0	2,0	0,045	0,030 max.	—	—	17,0 to 19,0	—	10 × % C ≤ 1,0	9,0 to 12,0	—	—	—	**A3** [9]
17	0,12 max.	1,0	2,0	0,060	0,15 to 0,35	—	—	17,0 to 19,0	— [10]	—	8,0 to 10,0 [11]	—	—	—	**A1**
13	0,10 max.	1,0	2,0	0,045	0,030 max.	—	—	17,0 to 19,0	—	—	11,0 to 13,0	—	—	—	**A2**
19	0,030 max.	1,0	2,0	0,045	0,030 max.	—	—	16,5 to 18,5	2,0 to 2,5	—	11,0 to 14,0	—	—	—	**A4**
20	0,07 max.	1,0	2,0	0,045	0,030 max.	—	—	16,5 to 18,5	2,0 to 2,5	—	10,5 to 13,5	—	—	—	**A4**
21	0,08 max.	1,0	2,0	0,045	0,030 max.	—	—	16,5 to 18,5	2,0 to 2,5	—	11,0 to 14,0	—	5 × % C ≤ 0,80	—	**A5** [9]
23	0,08 max.	1,0	2,0	0,045	0,030 max.	—	—	16,5 to 18,5	2,0 to 2,5	10 × % C ≤ 1,0	11,0 to 14,0	—	—	—	**A5** [9]
19a	0,030 max.	1,0	2,0	0,045	0,030 max.	—	—	16,5 to 18,5	2,5 to 3,0	—	11,5 to 14,5	—	—	—	**A4**
20a	0,07 max.	1,0	2,0	0,045	0,030 max.	—	—	16,5 to 18,5	2,5 to 3,0	—	11,0 to 14,0	—	—	—	**A4**
10N	0,030 max.	1,0	2,0	0,045	0,030 max.	0,12 to 0,22	—	17,0 to 19,0	—	—	8,5 to 11,5	—	—	—	**A2**
19N	0,030 max.	1,0	2,0	0,045	0,030 max.	0,12 to 0,22	—	16,5 to 18,5	2,0 to 2,5	—	10,5 to 13,5	—	—	—	**A4** [8]
19aN	0,030 max.	1,0	2,0	0,045	0,030 max.	0,12 to 0,22	—	16,5 to 18,5	2,5 to 3,0	—	11,5 to 14,5	—	—	—	**A4** [8]

1) Elements not quoted in this table shall not be intentionally added to the steel without the agreement of the purchaser, other than for the purpose of finishing the heat. All reasonable precautions shall be taken to prevent the addition, from scrap or other material used in manufacture, of such elements which affect the hardenability, mechanical properties and applicability.
2) The type numbers are tentative and will be subject to alteration when the relevant International Standards have been established.
3) Tantalum determined as niobium.
4) Not part of ISO 683-13.
5) (C + N) max. 0,040 % (*m/m*).
6) 8 × (C + N) ≤ (Nb + Ti) ≤ 0,80 % (*m/m*).
7) After agreement at the time of enquiry and order the steel may be supplied with a Mo content of 0,20 to 0,60 % (*m/m*).
8) Excellent resistance to intergranular corrosion.
9) Stabilized steels.
10) The manufacturer has the option of adding molybdenum up to 0,70 % (*m/m*).

Annex D
(informative)

Stainless steels for cold heading and extruding
(Extract from ISO 4954:1993)

Table D.1

Type of steel Designation[1)]			Chemical composition[2)] % (m/m)									Fastener grade identification[3)]
No.	Name	according to ISO 4954:1979	C	Si max.	Mn max.	P max.	S max.	Cr	Mo	Ni	Other	
	Ferritic steels											
71	X 3 Cr 17 E	—	≤ 0,04	1,00	1,00	0,040	0,030	16,0 to 18,0		≤ 1,0		F1
72	X 6 Cr 17 E	D 1	≤ 0,08	1,00	1,00	0,040	0,030	16,0 to 18,0		≤ 1,0		F1
73	X 6 CrMo 17 1 E	D 2	≤ 0,08	1,00	1,00	0,040	0,030	16,0 to 18,0	0,90 to 1,30	≤ 1,0		F1
74	X 6 CrTi 12 E	—	≤ 0,08	1,00	1,00	0,040	0,030	10,5 to 12,5		≤ 0,50	Ti: 6 × % C ≤ 1,0	F1
75	X 6 CrNb 12 E	—	≤ 0,08	1,00	1,00	0,040	0,030	10,5 to 12,5		≤ 0,50	Nb: 6 × % C ≤ 1,0	F1
	Martensitic steels											
76	X 12 Cr 13 E	D 10	0,90 to 0,15	1,00	1,00	0,040	0,030	11,5 to 13,5		≤ 1,0		C1
77	X 19 CrNi 16 2 E	D 12	0,14 to 0,23	1,00	1,00	0,040	0,030	15,0 to 17,5		1,5 to 2,5		C3
	Austenitic steels											
78	X 2 CrNi 18 10 E	D 20	≤ 0,030	1,00	2,00	0,045	0,030	17,0 to 19,0		9,0 to 12,0		A2 [4)]
79	X 5 CrNi 18 9 E	D 21	≤ 0,07	1,00	2,00	0,045	0,030	17,0 to 19,0		8,0 to 11,0		A2
80	X 10 CrNi 18 9 E	D 22	≤ 0,12	1,00	2,00	0,045	0,030	17,0 to 19,0		8,0 to 10,0		A2
81	X 5 CrNi 18 12 E	D 23	≤ 0,07	1,00	2,00	0,045	0,030	17,0 to 19,0		11,0 to 13,0		A2
82	X 6 CrNi 18 16 E	D 25	≤ 0,08	1,00	2,00	0,045	0,030	15,0 to 17,0		17,0 to 19,0		A2
83	X 6 CrNiTi 18 10 E	D 26	≤ 0,08	1,00	2,00	0,045	0,030	17,0 to 19,0		9,0 to 12,0	Ti: 5 × % C ≤ 0,80	A3
84	X 5 CrNiMo 17 12 2 E	D 29	≤ 0,07	1,00	2,00	0,045	0,030	16,5 to 18,5	2,0 to 2,5	10,5 to 13,5		A4
85	X 6 CrNiMoTi 17 12 2 E	D 30	≤ 0,08	1,00	2,00	0,045	0,030	16,5 to 18,5	2,0 to 2,5	11,0 to 14,0	Ti: 5 × % C ≤ 0,80	A5
86	X 2 CrNiMo 17 13 3 E	—	≤ 0,030	1,00	2,00	0,045	0,030	16,5 to 18,5	2,5 to 3,0	11,5 to 14,5		A4 [4)]
87	X 2 CrNiMoN 17 13 3 E	—	≤ 0,030	1,00	2,00	0,045	0,030	16,5 to 18,5	2,5 to 3,0	11,5 to 14,5	N: 0,12 to 0,22	A4 [4)]
88	X 3 CrNiCu 18 9 3 E	D 32	≤ 0,04	1,00	2,00	0,045	0,030	17,0 to 19,0		8,5 to 10,5	Cu: 3,00 to 4,00	A2

1) The designations given in the first column are consecutive numbers. The designations given in the second column are in accordance with the system proposed by ISO/TC 17/SC 2. The designations given in the third column represent the antiquated numbers used in ISO 4954:1979 (revised in 1993).

2) Elements not quoted in this table should not be intentionally added to the steel without the agreement of the purchaser, other than for finishing the heat. All reasonable precautions should be taken to prevent the addition, from scrap or other materials used in manufacture, of elements which affect mechanical properties and applicability.

3) Not part of ISO 4954.

4) Excellent resistance to intergranular corrosion.

Annex E
(informative)

Austenitic stainless steels with particular resistance to chloride induced stress corrosion
(Extract from EN 10088-1:1995)

The risk of failure of bolts, screws and studs by chloride induced stress corrosion (for example in indoor swimming pools) can be reduced by using materials as given in table E.1.

Table E.1

Austenitic stainless steel (Symbol/material number)	**Chemical composition** % (*m*/*m*)									
	C max.	**Si** max.	**Mn** max.	**P** max.	**S** max.	**N**	**Cr**	**Mo**	**Ni**	**Cu**
X2CrNiMoN17-13-5 (1.4439)	0,03	1,0	2,0	0,045	0,015	0,12 to 0,22	16,5 to 18,5	4,0 to 5,0	12,5 to 14,5	
X1NiCrMoCu25-20-5 (1.4539)	0,02	0,7	2,0	0,030	0,010	≤ 0,15	19,0 to 21,0	4,0 to 5,0	24,0 to 26,0	1,2 to 2,0
X1NiCrMoCuN25-20-7 (1.4529)	0,02	0,5	1,0	0,030	0,010	0,15 to 0,25	19,0 to 21,0	6,0 to 7,0	24,0 to 26,0	0,5 to 1,5
X2CrNiMoN22-5-3 [1)] (1.4462)	0,03	1,0	2,0	0,035	0,015	0,10 to 0,22	21,0 to 23,0	2,5 to 3,5	4,5 to 6,5	

1) Austenitic-ferritic stainless steel

Annex F
(informative)

Mechanical properties at elevated temperatures; application at low temperatures

NOTE — If the bolts, screws or studs are properly calculated the mating nuts will automatically meet the requirements. Therefore, in the case of application at elevated or low temperatures, it is sufficient to consider the mechanical properties of bolts, screws and studs only.

F.1 Lower yield stress or stress at 0,2 % permanent strain at elevated temperatures

The values given in this annex are for guidance only. Users should understand that the actual chemistry, loading of the installed fastener and the environment may cause significant variation. If loads are fluctuating and operating periods at elevated temperatures are great or the possibility of stress corrosion is high the user should consult the manufacturer.

For values for lower yield stress (R_{eL}) and stress at 0,2 % permanent strain ($R_{p0,2}$) at elevated temperatures in % of the values at room temperature, see table F.1.

Table F.1 — Influence of temperature on R_{eL} and $R_{p0,2}$

Steel grade	R_{eL} and $R_{p0,2}$ % Temperature			
	+ 100 °C	+ 200 °C	+ 300 °C	+ 400 °C
A2 A4	85	80	75	70
C1	95	90	80	65
C3	90	85	80	60
NOTE — This applies to property classes 70 and 80 only.				

F.2 Application at low temperatures

For application of stainless steel bolts, screws and studs at low temperatures, see table F.2.

Table F.2 — Application of stainless steel bolts, screws and studs at low temperatures (austenitic steel only)

Steel grade	Lower limits of operational temperature at continuous operation	
A2	– 200 °C	
A4	bolts and screws[1)]	– 60 °C
	studs	– 200 °C
1) In connection with the alloying element Mo the stability of the austenite is reduced and the transition temperature is shifted to higher values if a high degree of deformation during manufacturing of the fastener is applied.		

Annex G
(informative)

Time-temperature-diagram of intergranular corrosion in austenitic stainless steels, grade A2 (18/8 steels)

Figure G.1 gives the approximate time for austenitic stainless steels, grade A2 (18/8 steels), with different carbon contents in the temperature zone between 550 °C and 925 °C before risk of intergranular corrosion occurs.

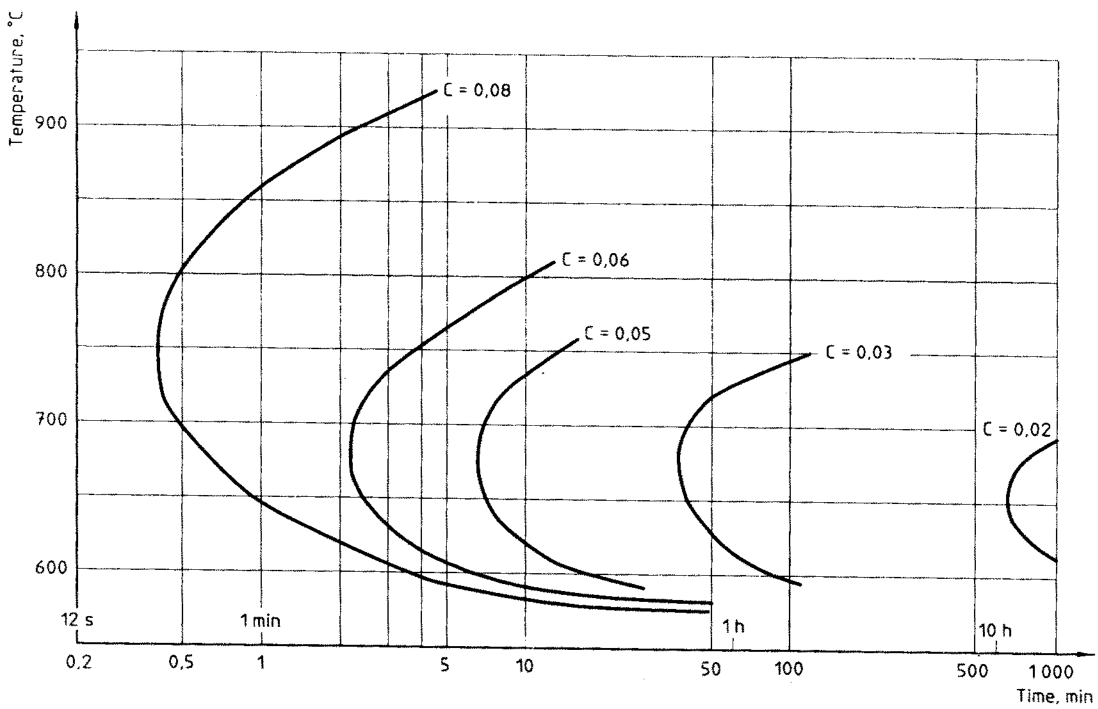


Figure G.1

Annex H
(informative)

Magnetic properties for austenitic stainless steels

All austenitic stainless steel fasteners are normally non-magnetic; after cold working, some magnetic properties may be evident.

Each material is characterized by its ability to be magnetized, which applies even to stainless steel. Only a vacuum will probably be entirely non-magnetic. The measure of the material's permeability in a magnetic field is the permeability value μ_r for that material in relation to a vacuum. The material has low permeability if μ_r becomes close to 1.

EXAMPLES

A2: $\mu_r \approx 1,8$

A4: $\mu_r \approx 1,015$

A4L: $\mu_r \approx 1,005$

F1: $\mu_r \approx 5$

Annex I
(informative)

Bibliography

[1] ISO 683-13: 1986, *Heat-treated steels, alloy steels and free cutting steels – Part 13: Wrought stainless steels.*[10]

[2] ISO 4954:1993, *Steels for cold heading and cold extruding.*

[3] EN 10088-1:1995, *Stainless steels — Part 1: List of stainless steels.*

10) International Standard withdrawn.

(*Continued from second cover*)

International Standard	*Corresponding Indian Standard*	*Degree of Equivalence*
ISO 898-1:[1]	IS 1367(Part 3):2002 Technical supply conditions for threaded steel fasteners : Part 3 Mechanical properties of fasteners made of carbon steel and alloy steel — Bolts, screws and studs (*fourth revision*)	Identical
ISO 6506:1981	IS 1500:1983 Method for Brinell hardness test for metallic materials (*second revision*)	Technically equivalent
ISO 6507-1: 1997	IS 1501(Part 1):1984 Method for Vickers hardness test for metallic materials : Part 1 HV 5 to HV 100 (*second revision*)	do
ISO 6508:1986	IS 1586:1988 Method for Rockwell hardness test for metallic materials (Scales A-B-C-D-E-F-G-H-K, 15N, 30N, 45N, 15T, 30T and 45T) (*third revision*)	do
ISO 6892:[2]	IS 1608:1995 Mechanical testing of metals — Tensile testing (*second revision*)	Related
ISO 8992:1986	IS 1367(Part 1):2002 Technical supply conditions for threaded steel fasteners : Part 1 Introduction and general information (*third revision*)	Identical
ISO 8044:[3]	IS 3531:1997 Glossary of terms relating to corrosion of metals (*second revision*)	Technically equivalent

The concerned Technical Committee has reviewed the provisions of the following ISO Standards referred in this adopted standard and has decided that they are acceptable for use in conjunction with this standard:

ISO Standard	*Title*
ISO 3651-1:[4]	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:[5]	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

In reporting the results of a test or analysis made in accordance with this standard, if the final value, observed or calculated, is to be rounded off, it shall be done in accordance with IS 2:1960 'Rules for rounding off numerical values (*revised*)'.

[1] Since published in 1999.
[2] To be published (Revision of ISO 6892).
[3] To be published (Revision of ISO 8044:1988).
[4] To be published (Revision of ISO 3651-1:1976).
[5] To be published (Revision of ISO 3651-2:1976).

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