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Stainless steel has been in use for more than one hundred years. It comprises a wide range of iron-based alloys, but unlike conventional steel they are resistant to corrosion and do not rust when exposed to water alone. The alloying element that makes steel 'stainless' is chromium; however it is the addition of nickel that enables stainless steel to become such a versatile alloy.

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.

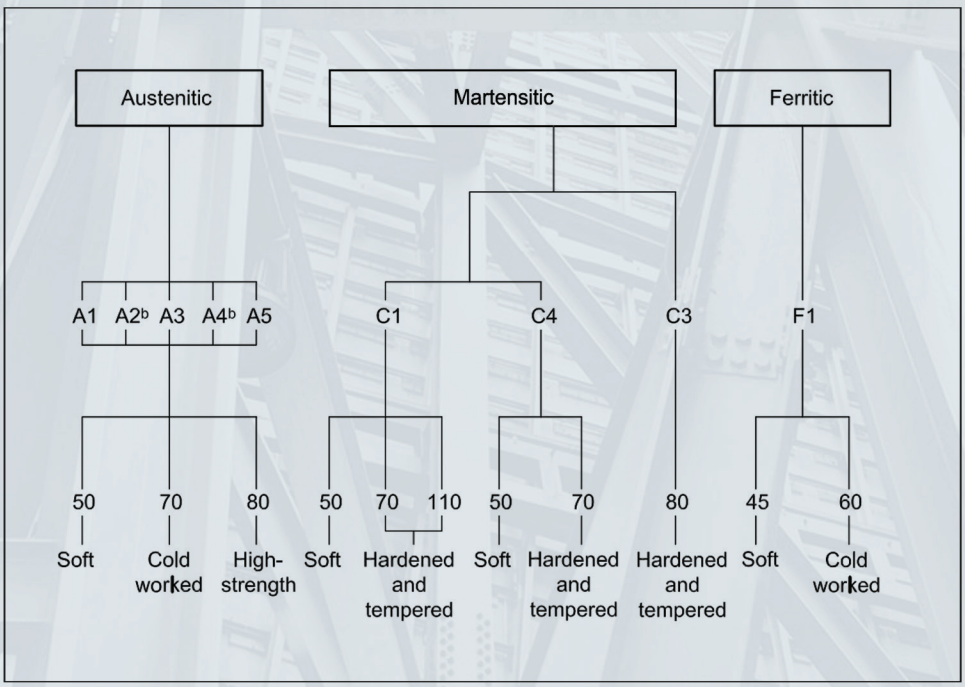
The designation of the steel grade (first block) consists of one of the letters

- **A for austenitic steel,**
- **C for martensitic steel, or**
- **F for ferritic 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
EXAMPLE 1 A2-70 indicates: austenitic steel, cold worked, minimum 700 MPa tensile strength.

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



a. The steel groups and steel grades classified in Figure 1 are described in Annex B and specified by the chemical com position given in Table 1

b. Low-carbon austenitic stainless steels with carbon content not exceeding 0,03 % may additionally be marked with an alphabet "L".

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CHEMICAL COMPOSITION

Stainless steel has been in use for more than one hundred years. It comprises a wide range of iron-based alloys, but unlike conventional steel they are resistant to corrosion and do not rust when exposed to water alone. The alloying element that makes steel 'stainless' is chromium; however it is the addition of nickel that enables stainless steel to become such a versatile alloy.

TABLE 1 — STAINLESS STEEL GRADES — CHEMICAL COMPOSITION

Steel grade	Steel grade	Chemical composition[a] mass fraction %									Footnotes
		C	Si	Mn	P	S	Cr	Mo	Ni	Cu	
Austenitic	A 1	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	bcd
	A 2	0,10	1	2	0,05	0,03	15 to 20	_e	8 to 19	4	fg
	A 3	0,08	1	2	0,045	0,03	17 to 19	_e	9 to 12	1	h
	A 4	0,08	1	2	0,045	0,03	16 to 18,5	2 to 3	10 to 15	4	gi
	A 5	0,08	1	2	0,045	0,03	16 to 18,5	2 to 3	10,5 to 14	1	hi

a) Values are maximum, unless otherwise indicated.

b) Sulfur may be replaced by selenium.

c) If the nickel content is below 8 %, the minimum manganese content shall be 5 %.

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

e) Molybdenum 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 content is below 17 %, the minimum nickel content should be 12 %.

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

h) This shall contain titanium W 5 x C up to 0,8 % maximum for stabilization and be marked appropriately as specified in this table, or shall contain niobium (columbium) and/or tantalum W 10 x 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 steels.

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

k) This may contain titanium W 5 X C up to 0,8 % maximum.

l) This may contain niobium (columbium) and/or tantalum W 10 x C up to 1 % maximum.

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MECHANICAL PROPERTIES

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

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

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 group	Property class	Tensile strength min MPa	Stress at 0,2% permanent strain $R_{p0,2}$[a] min MPa	Elongation after fracture A[b] min mm
	A1, A2,	50	500	210	0,6d
	A3, A4	70	700	450	0,4d
	A5	80	800	600	0,3d

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.

Table 3 — Mechanical Properties of Nuts for Different Stainless Steel Grades in accordance with ISO 3506-2:1997 are given below.

Group	Grade	Property class		Range of thread diameter d mm	Stress under proof load Sp min N/mm2	
		Nuts style 1 { m ≥ 0.8 d}	This nuts {0.5 d ≤ m< 0.8d}		Nuts style 1 { m ≥ 0.8 d}	This nuts {0.5 d ≤ m< 0.8d}
Austenitic	A1	50	025	≤ 39	500	250
	A2, A3	70	035	≤ 24 [1]	700	350
	A4, A5	80	040	≤ 24 [1]	800	400
For fastener 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 4 — Minimum breaking torque, MB,min., for austenitic steel grade bolts and screws M1,6 to M16 (coarse thread)

Thread	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 steel grade fasteners shall be agreed upon between the manufacturer and the user.

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TESTING

The tests that shall be performed, depending on steel grade and bolt, screw or stud length, are given in Table 5.

Table 5 — Test programme

Steel grade	Tensile strength[a]	Breaking torque[b]	Stress at 0,2 % permanent strain $R_{p0,2}$	Elongation after fracture A[a]	Hardness	Strength under wedge loading
A1	l W 2,5d[c]	$l < 2{,}5d$	l W 2,5d[c]	l W 2,5d[c]	—	—
A2	l W 2,5d[c]	$l < 2{,}5d$	l W 2,5d[c]	l W 2,5d[c]	—	—
A3	l W 2,5d[c]	$l < 2{,}5d$	l W 2,5d[c]	l W 2,5d[c]	—	—
A4	l W 2,5d[c]	$l < 2{,}5d$	l W 2,5d[c]	l W 2,5d[c]	—	—
A5	l W 2,5d[c]	$l < 2{,}5d$	l W 2,5d[c]	l W 2,5d[c]	—	—
C1	l W 2,5d[cd]	—	l W 2,5d[c]	l W 2,5d[c]	Required	l_s W 2d
C3	l W 2,5d[cd]	—	l W 2,5d[c]	l W 2,5d[c]	Required	l_s W 2d
C4	l W 2,5d[cd]	—	l W 2,5d[c]	l W 2,5d[c]	Required	l_s W 2d
F1	l W 2,5d[cd]	—	l W 2,5d[c]	l W 2,5d[c]	Required	—

a For all sizes W M5.

b For sizes M1,6 u d < M5, the test applies to all lengths.

c For studs, the requirement is l W 3,5d.

d For $l < 2{,}5d$, testing shall be agreed on between the manufacturer and the purchaser.

Magnetic properties for austenitic stainless steels

Where specific magnetic properties are required, an experienced metallurgist should be consulted.

All austenitic stainless steel fasteners are normally non-magnetic; after cold working, it is possible for some magnetic properties to be evident.

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

EXAMPLE 1 A2: μr ~ 1,8

EXAMPLE 2 A4: μr ~ 1,015

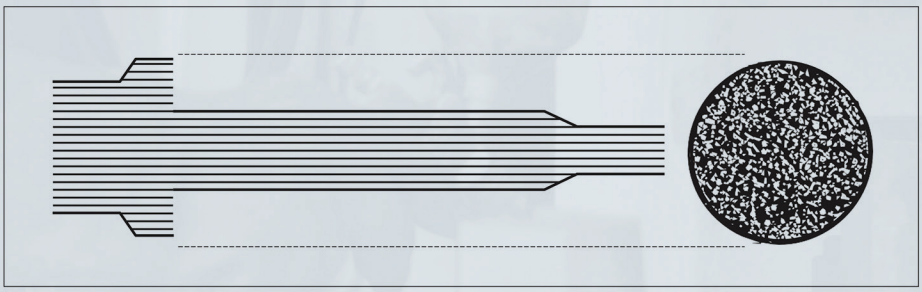
Cold Heading -v- Machining

Cold Heading

Below is a cold headed part formed from the diameter of wire shown below.
Unbroken metal flow lines (grain) greatly increase fatigue life and enhance load-carrying ability.

Machining

Illustrated below is a representation of a bolt produced by machining a large diameter bar or wire. Grain or metal flowlines are broken through the head and washer section, which creates planes of weakness.



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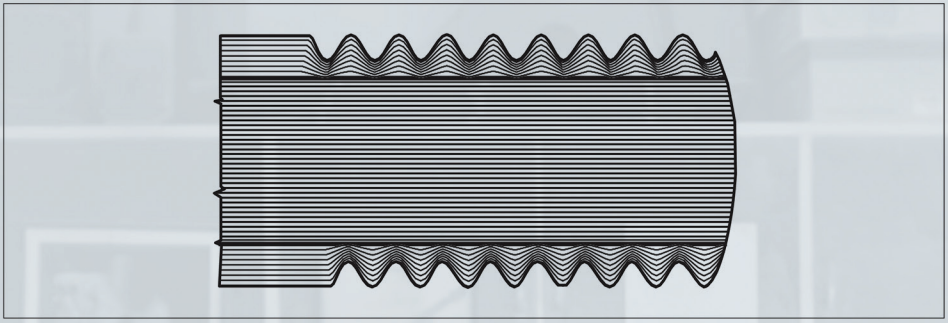
Thread Rolling -v- Thread Cutting

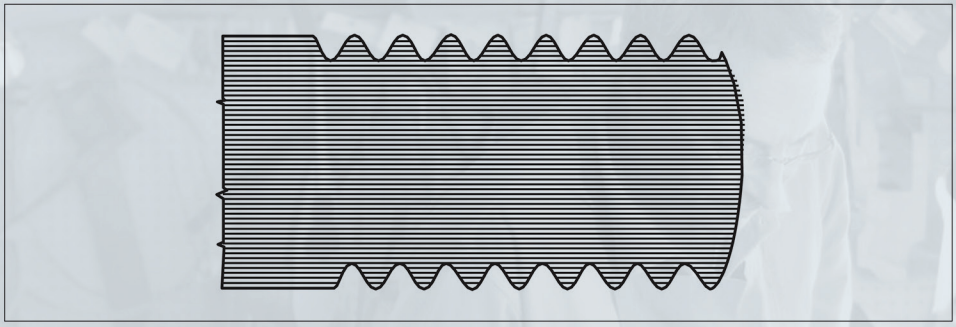
Thread Rolling

No metal is cut away, the grain flow lines are unbroken and curve around the thread profiles.
The cold rolling stresses the roots in compression, significantly increasing fatigue strength. Smooth roll dies create burnished roots and smooth flanks free from cutter tool marks, reducing potential galling and stress risers.



Thread Cutting

The grain flow lines are cut and planes of weakness are created.



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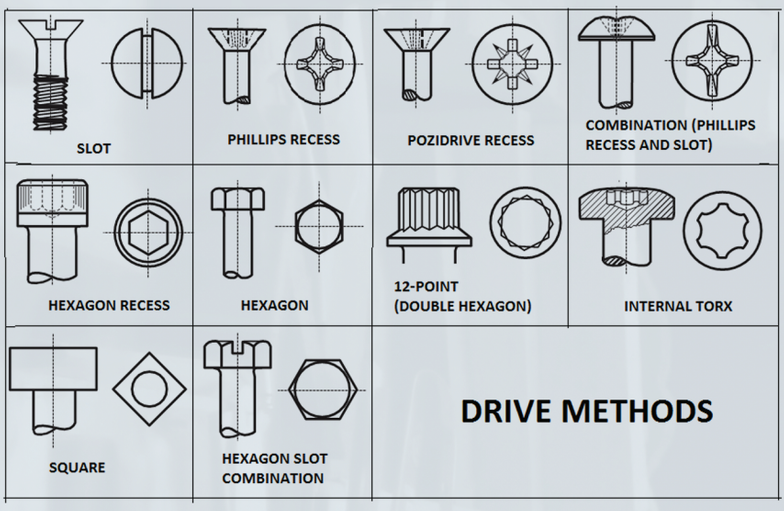
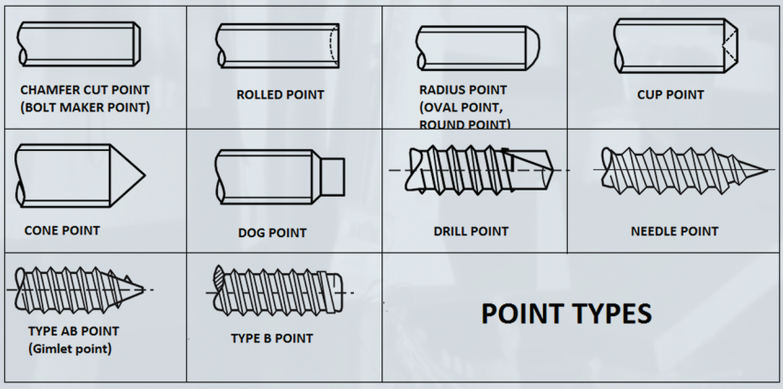
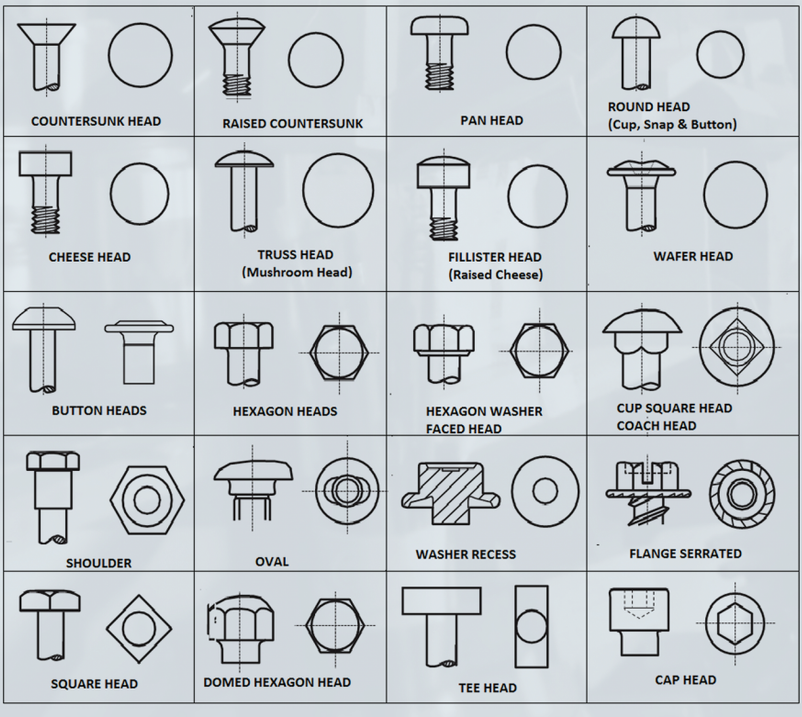
BASIC CHARACTERISTICS OF FASTENERS

The drive on a fastener is the feature through which rotational torque is applied. All threaded fasteners will have a drive feature or will have a retention feature to prevent rotation whilst the mating part is rotated - eg: a nut.





HEAD STYLES



MARKINGS

All hexagon head bolts and screws, and hexagon or hexalobular socket head cap screws of nominal thread diameter d W 5 mm shall be clearly marked in accordance with 4.1, Figure 1, Figure 2 and Figure 3. The marking is mandatory and shall include the steel grade and property class.