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Fasteners — Heat treated tapping screws — Mechanical and physical properties

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Foreword

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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).

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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*, Subcommittee SC 13, *Fasteners with non-metric thread*, in collaboration with the European Committee for Standardization (CEN) Technical Committee CEN/TC 185, *Threaded and nonthreaded mechanical fasteners and accessories*, in accordance with the Agreement on technical cooperation between ISO and CEN (Vienna Agreement).

This fourth edition cancels and replaces the third edition (ISO 2702:2011), which has been technically revised.

The main changes are as follows:

— document newly structured with regard to requirements and test methods;

— new Table 1 for mechanical and physical properties and related test methods (see 5.1);

— maximum case-hardened depth increased to 0,12 mm for ST2,2 and ST2,6 (see 5.3);

— maximum core hardness changed from 370 HV back to 390 HV and core hardness test specified more precisely (see 5.4 and 6.4);

— new clauses for ductility and ductility test added (see 5.8 and 6.8);

— test method for case-hardened depth determination modified (see 6.3);

— torsional test specified more precisely (see 6.7);

— new Clause 7 for inspection added;

— new Clause 8 for marking and labelling added.

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.

Fasteners — Heat treated tapping screws — Mechanical and physical properties

1 Scope

This document specifies the mechanical and physical properties of heat treated tapping screws made of steel, with thread sizes ST2,2 to ST9,5 in accordance with ISO 1478, when tested at the ambient temperature range of 10 °C to 35 °C, and the related test methods.

Tapping screws are designed to form mating threads in sheet metals, without their own threads being deformed. Tapping screws are not intended to be pretensioned by design, even though they can experience varying degrees of low-level tensile stress after installation.

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 1478, *Tapping screws thread*

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

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

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 terminology databases for use in standardization at the following addresses:

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

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

3.1
tapping screw
sheet metal screw
screw with thread in accordance with ISO 1478 which, when driven into a hole, creates its own mating threads in the materials of the parts being assembled (usually thin metal sheets) without deforming its own thread

4 Materials

Tapping screws shall be made from cold heading steel that can be case-hardened (see e.g. ISO 4954, EN 10263-3, ASME B18.6.3, GB/T 6478, JIS G 3507-2).

5 Mechanical and physical properties

5.1 General

When tested by the methods specified in Clause 6, tapping screws shall meet the mechanical and physical properties specified in Clause 5, see also Table 1.

The requirements of this Clause shall apply to fasteners as delivered by the supplier, i.e. without alteration from the as-delivered condition. In case of alteration or further processing performed by the purchaser, the purchaser shall assume responsibility for conformance of all characteristics altered by such processing.

Table 1 — Mechanical and physical properties, related test methods and relevant clauses

Property and clause number		Clause number of related test method
Material	4	—
Surface hardness	5.2	6.2
Case-hardened depth	5.3	6.3
Core hardness	5.4	6.4
Microstructure	5.5	6.5
Thread-forming ability	5.6	6.6
Torsional strength	5.7	6.7
Ductility [a]	5.8	6.8
[a] Only as a routine test for in-process control.		

5.2 Surface hardness

The minimum surface hardness after heat treatment shall be 450 HV 0,3.

Upon request of the purchaser before the order, a maximum surface hardness can be specified to mitigate the risk of environmental hydrogen embrittlement (EHE).

5.3 Case-hardened depth

The case-hardened depth, CHD, shall conform to the values specified in Table 2.

Table 2 — Case-hardened depth

Thread				Case-hardened depth CHD mm	
				min.	max.
ST2,2	**ST2,6**			0,04	0,12
ST2,9	**ST3,3**	**ST3,5**		0,05	0,18
ST3,9	**ST4,2**	**ST4,8**	**ST5,5**	0,10	0,23
ST6,3	**ST8**	**ST9,5**		0,15	0,28

5.4 Core hardness

The core hardness after heat treatment shall be:

— 270 HV 5 to 390 HV 5 for threads ≤ ST3,9;

— 270 HV 10 to 390 HV 10 for threads > ST3,9.

Upon request of the purchaser before the order, the maximum core hardness can be limited to a lower value to mitigate the risk of environmental hydrogen embrittlement (EHE).

5.5 Microstructure

The microstructure shall show no band of free ferrite between the case-hardened zone and the core.

5.6 Thread-forming ability

Tapping screws shall form a mating thread without deforming their own thread when driven into the test plate.

5.7 Torsional strength

Tapping screws shall meet the minimum breaking torque values specified in Table 3.

Table 3 — Minimum breaking torque

Thread	Minimum breaking torque Nm
ST2,2	0,45
ST2,6	0,9
ST2,9	1,5
ST3,3	2,0
ST3,5	2,7
ST3,9	3,4
ST4,2	4,4
ST4,8	6,3
ST5,5	10,0
ST6,3	13,6
ST8	30,5
ST9,5	68,0

5.8 Ductility

The head of the tapping screw shall not separate from the shank, (see “Passed test” in Figure 4 b).

6 Test methods

6.1 General

The tapping screw being tested shall be tested as received (coated or uncoated), and when necessary, after a suitable preparation.

6.2 Surface hardness test

The surface hardness test shall be carried out in accordance with ISO 6507-1, using a Vickers indenter with a test force of 2,942 N (HV 0,3). The impression of the pyramid shall be made on a flat surface, preferably on the screw head.

Surface hardness shall meet the requirements specified in 5.2.

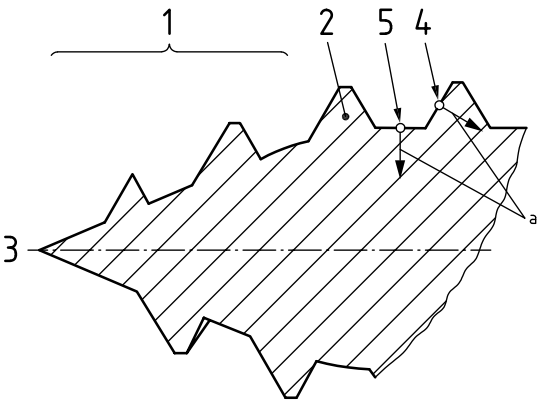
6.3 Case-hardened depth determination

The case-hardened depth (CHD) shall be determined on a longitudinal section through the screw axis. Hardness determination shall be carried out in accordance with ISO 6507-1. A Vickers indenter with a test force of 2,942 N (HV 0,3) shall be used.

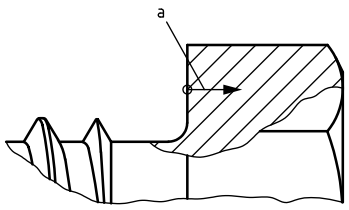
A hardness plot shall be performed perpendicular to the surface, beginning at the thread flank mid-point between crest and root (see point 4 in Figure 1 a) for screws with thread above ST4,2 or, in the case of smaller tapping screws up to and including ST4,2, beginning at the root of the thread (see point 5 in Figure 1 a).

When the threaded area does not allow a reliable measurement (e.g. complete carburization in the threads, thread laps), the bearing surface under the head of the screw shall be taken as reference location for case-hardened depth determination (see Figure 1 b).

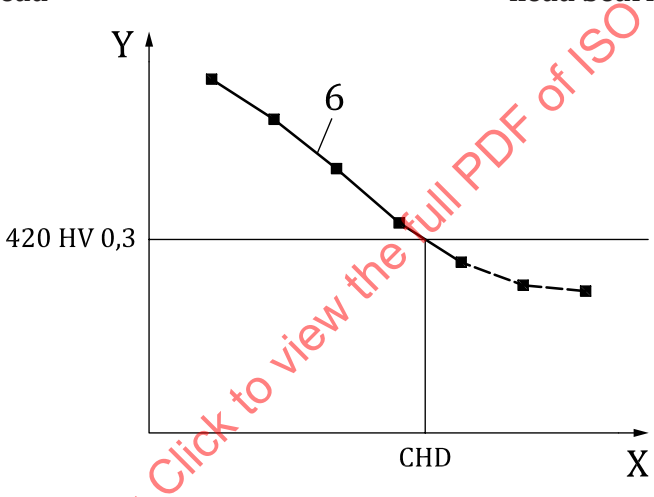
The case-hardened depth shall be the distance from the surface to the point at which the recorded hardness is 420 HV 0,3 (see Figure 1 c).



a) Case-hardened depth determination in the thread



b) Case-hardened depth determination in the head bearing surface



c) Determination of the case-hardened depth (CHD) at a hardness of 420 HV 0,3

Key

X	distance from surface	4	thread flank mid-point
Y	hardness	5	thread root
1	thread end	6	hardness plot
2	first fully formed thread	a	Direction of hardness plot.
3	axis of the screw		

Figure 1 — Determination of case-hardened depth

Case-hardened depth shall meet the requirements specified in 5.3.

6.4 Core hardness test

The core hardness test shall be carried out in accordance with ISO 6507-1:

— in the area of the fully formed thread,

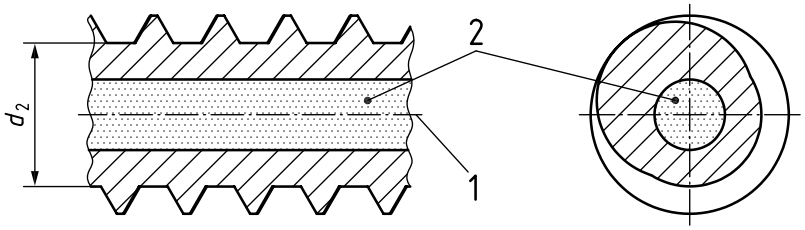
— at a distance sufficiently behind the thread end,

— between the axis and the half-radius position,

— either on a longitudinal section through the screw axis or on (a) transverse section(s).

HV 5 shall be used for threads ≤ ST3,9 and HV 10 for threads > ST3,9.

The core hardness shall be determined in accordance with Figure 2 by taking three readings in the area between the axis and the half-radius position. The hardness value shall be the average of these three readings.



Key

1 axis of the screw

2 half-radius area (radius of $0{,}25 d_{2,\min}$ with $d_{2,\min}$ as specified in ISO 1478)

Figure 2 — Half-radius area for core hardness determination

Core hardness shall meet the requirements specified in 5.4.

6.5 Microstructure test

The microstructure test shall be carried out by metallographic examination on a longitudinal section through the screw axis.

Microstructure shall meet the requirements specified in 5.5.

6.6 Drive test

The drive test serves to evaluate thread-forming ability of tapping screws by driving them into a test plate.

The test plate shall be made from low carbon steel with a carbon content of maximum 0,23 %. The hardness of the test plate shall be 130 HV to 170 HV determined in accordance with ISO 6507-1. The thickness of the test plate shall conform to the values specified in Table 4.

The test hole shall be drilled, or punched and redrilled, or reamed to the hole diameter specified in Table 4.

The tapping screw being tested shall be driven into the test plate until a fully formed thread protrudes through the plate.

Table 4 — Test plate thickness and hole diameter for drive test

Thread	Plate thickness mm		Hole diameter mm	
	min.	max.	min.	max.
ST2,2	1,17	1,30	1,905	1,955
ST2,6	1,17	1,30	2,185	2,235
ST2,9	1,17	1,30	2,415	2,465
ST3,3	1,17	1,30	2,680	2,730
ST3,5	1,85	2,06	2,920	2,970
ST3,9	1,85	2,06	3,240	3,290
ST4,2	1,85	2,06	3,430	3,480
ST4,8	3,10	3,23	4,015	4,065
ST5,5	3,10	3,23	4,735	4,785
ST6,3	4,67	5,05	5,475	5,525
ST8	4,67	5,05	6,885	6,935
ST9,5	4,67	5,05	8,270	8,330

The drive test result shall meet the requirements specified in 5.6.

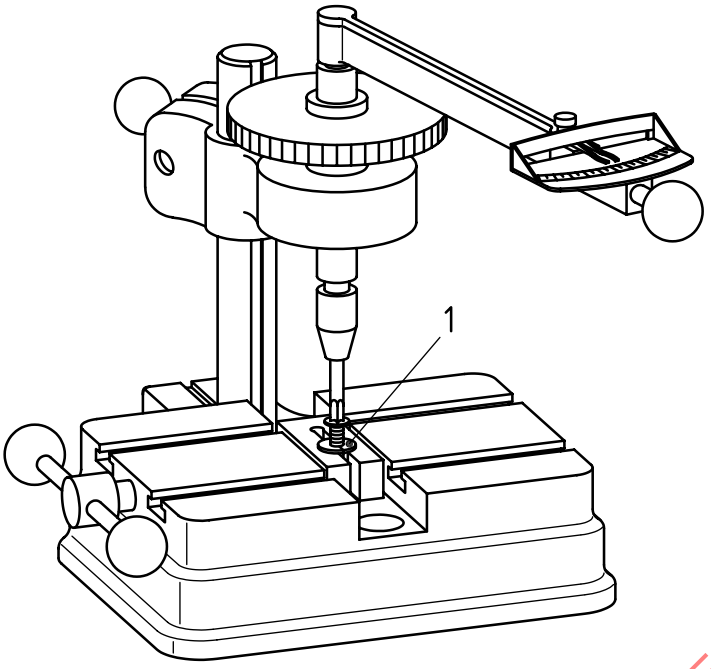
6.7 Torsional test

The tapping screw being tested shall be clamped in a mating, split, threaded die or other similar device so that the clamped portion of the screw is not damaged. At least two fully formed threads shall project above the clamping device. At least two fully formed threads exclusive of the screw end shall be held within the clamping device.

A threaded insert with a blind hole may be used in place of the clamping device (see Figure 3) provided the hole depth is such as to ensure that breakage occurs beyond the screw end.

The clamping device and driving tool shall be aligned with the axis of the screw. A calibrated torque-measuring device with an accuracy of ±4 % of the minimum breaking torque of the screw to be tested shall be used. A continuously increasing torque shall be applied until failure occurs. The maximum torque occurring during the test shall be recorded.

Torsional test result shall meet the requirements specified in 5.7.



Key

1 split threaded die or threaded insert

2 threaded insert with a blind hole

3 split threaded die

Figure 3 — Torsional testing device

6.8 Ductility test

This test is only intended as a routine test for in-process control.

This test does not apply to countersunk head screws. For such screws an alternative test (e.g. bending test in the shank) may be applied at the manufacturer's discretion.

The tapping screw being tested shall be inserted into a hardened wedge block (e.g. 55 HRC minimum), having a wedge angle of 10°, as illustrated in Figure 4 a). The results of a passed or a failed test is shown in Figure 4 b) and 4 c), respectively. The diameter of the hole in the wedge block, d_h, shall be 0,5 mm to 1,0 mm larger than the thread diameter, d_1, of the tapping screw.

The head shall be bent by applying an axial compressive load on the top of the screw head with a suitable device, e.g. a hammer (with single or repeated blows), until the plane of the underhead bearing surface is bent permanently against the block.