INTERNATIONAL STANDARD

ISO 898-5

Third edition
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Mechanical properties of fasteners made of carbon steel and alloy steel —

Part 5: Set screws and similar threaded fasteners with specified hardness classes — Coarse thread and fine pitch thread

Caractéristiques mécaniques des éléments de fixation en acier au carbone et en acier allié

Partie 5: Vis sans tête et éléments de fixation filetés similaires de classes de dureté spécifiées — Filetages à pas gros et filetages à pas fin

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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.

International Standards are drafted in accordance with the rules given in the ISO/IEC Directives, Part 2.

The main task of technical committees is to prepare International Standards. 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.

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.

ISO 898-5 was prepared by Technical Committee ISO/TC 2, *Fastener*, Subcommittee SC 11, *Fasteners with metric external thread*.

This third edition cancels and replaces the second edition (ISO 898-5:1998), which has been technically revised.

ISO 898 consists of the following parts, under the general title *Mechanical properties of fasteners made of carbon steel and alloy steel*:

— *Part 1: Bolts, screws and studs with specified property classes — Coarse thread and fine pitch thread*

— *Part 2: Nuts with specified property classes — Coarse thread and fine pitch thread*

— *Part 5: Set screws and similar threaded fasteners with specified hardness classes — Coarse thread and fine pitch thread*

— *Part 6: Nuts with specified proof load values — Fine pitch thread*

— *Part 7: Torsional test and minimum torques for bolts and screws with nominal diameters 1 mm to 10 mm*

Mechanical properties of fasteners made of carbon steel and alloy steel —

Part 5: Set screws and similar threaded fasteners with specified hardness classes — Coarse thread and fine pitch thread

1 Scope

This part of ISO 898 specifies mechanical and physical properties of set screws and similar threaded fasteners made of carbon steel or alloy steel when tested at an ambient temperature range of 10 °C to 35 °C. Fasteners (the term used when set screws and similar threaded fasteners are considered all together) which conform to the requirements of this part of ISO 898 are evaluated at that ambient temperature range.

Fasteners in conformance with this part of ISO 898 are classified to specified hardness classes and are intended for use under compressive stress only.

NOTE Fasteners conforming to the requirements of this part of ISO 898 are used in applications ranging from −50 °C to +150 °C. It is the responsibility of users to consult an experienced fastener metallurgist for temperatures outside the range of −50 °C to +150 °C and up to a maximum temperature of +300 °C when determining appropriate choices for a given application.

This part of ISO 898 is applicable to set screws and similar threaded fasteners:

— made of carbon steel or alloy steel,

— having a triangular ISO metric screw thread in conformance with ISO 68-1,

— with a coarse pitch thread of M1,6 to M30, and a fine pitch thread of M8×1 to M30×2,

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

— having thread tolerances in conformance with ISO 965-1 and ISO 965-2.

It does not specify requirements for such properties as

— tensile strength,

— shear strength,

— weldability,

— corrosion resistance, or

— the ability to withstand temperatures above +150 °C or below −50 °C.

2 Normative references

The following referenced documents are indispensable for the application 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 225, *Fasteners — Bolts, screws, studs and nuts — Symbols and descriptions of dimensions*

ISO 965-1, *ISO general-purpose metric screw threads — Tolerances — Part 1: Principles and basic data*

ISO 965-3, *ISO general purpose metric screw threads — Tolerances — Part 3: Deviations for constructional screen threads*

ISO 6157-1, *Fasteners — Surface discontinuities — Part 1: Bolts, screws and studs for general requirements*

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 (scales A, B, C, D, E, F, G, H, K, N, T)*

ISO 16426, *Fasteners — Quality assurance system*

3 Terms and definitions

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

3.1
base metal hardness
hardness closest to the surface (when traversing from core to outside diameter) just before an increase or decrease occurs, denoting carburization or decarburization, respectively

3.2
carburization
result of increasing surface carbon to a content above that of the base metal

3.3
decarburization
loss of carbon at the surface of a steel fastener

3.4
partial decarburization
decarburization with sufficient loss of carbon to cause a lighter shade of tempered martensite and a significantly lower hardness than that of the adjacent base metal, without, however, showing ferrite grains under metallographic examination

3.5
ferritic decarburization
decarburization with sufficient loss of carbon to cause a lighter shade of tempered martensite and a significantly lower hardness than that of the adjacent base metal, with the presence of ferrite grains or grain boundary network under metallographic examination

3.6
complete decarburization
decarburization with sufficient carbon loss to show only clearly defined ferrite grains under metallographic examination

3.7
performance hardness
hardness determined on the surface as near as practicable to the centre position of the point end of the screw

4 Symbols and abbreviated terms

For the purposes of this document, the symbols and abbreviated terms given in ISO 225 and ISO 965-1 and the following apply.

Symbol or abbreviated term	Meaning	Unit
D	Diameter of indenter for Brinell hardness test	mm
d	Nominal thread diameter	mm
E	Height of non-decarburized zone in thread	mm
e	Width across corners	mm
F	Applied force to determine Brinell hardness	N
G	Depth of complete decarburization in thread	mm
H	Height of fundamental triangle	mm
H_1	Height of external thread in maximum material condition	mm
P	Pitch of thread	mm
s	Width across flats	mm
t	Depth of the internal driving feature	mm
min	Abbreviated subscript added to symbol to denote minimum value	–

5 Designation system

The hardness classes are designated as specified in Table 1.

The numerical part of the designation represents 1/10 of the minimum Vickers hardness.

The letter H refers to the hardness.

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

Hardness class designation	**14H**	**22H**	**33H**	**45H**
Vickers hardness, HV min	140	220	330	450

The designation system of this part of ISO 898 may be used for sizes outside the limits laid down in this clause (e.g. $d > 30$ mm), provided all applicable mechanical and physical requirements in accordance with Tables 2 and 3 are met.

6 Materials

Table 2 specifies limits for the chemical composition of steels for the different hardness classes of fasteners. The chemical composition shall be assessed in accordance with the relevant International Standards.

NOTE National regulations imposing a restriction or prohibition on certain chemical elements can apply; they are expected to be taken into account in the countries or regions concerned.

Table 2 — Steel specifications

Hardness class	Material	Heat treatment[a]	Chemical composition limit (cast analysis, %)[b]			
			C		P	S
			max.	min.	max.	max.
14H	Carbon steel[c]	—	0,50	—	0,11	0,15
22H	Carbon steel[d]	Quenched and tempered	0,50	0,19	0,05	0,05
33H	Carbon steel[d]	Quenched and tempered	0,50	0,19	0,05	0,05
45H	Carbon steel[de]	Quenched and tempered	0,50	0,45	0,05	0,05
	Carbon steel with additives[d] (e.g. Boron or Mn or Cr)	Quenched and tempered	0,50	0,28	0,05	0,05
	Alloy steel[df]	Quenched and tempered	0,50	0,30	0,05	0,05

[a] Case hardening is not allowed.

[b] In case of dispute, the product analysis applies.

[c] Free-cutting steel may be used, with maximum lead content 0,35 %, maximum phosphorus content 0,11 % and maximum sulfur content 0,34 %.

[d] Steel with a maximum lead content of 0,35 % may be used.

[e] For $d \leq$ M16 only.

[f] This alloy steel shall contain at least one of the following elements in the minimum quantity given: chromium 0,30 %, nickel 0,30 %, molybdenum 0,20 %, vanadium 0,10 %. Where elements are specified in combinations of two, three or four and have lower alloy contents than those given above in this footnote, the limit value to be applied for steel class determination is 70 % of the sum of the individual limit values shown above in this footnote for the two, three or four elements concerned.

7 Mechanical and physical properties

The fasteners of the specified hardness classes shall, at ambient temperature, meet all the applicable mechanical and physical properties of Tables 3 to 5, regardless of the tests performed during manufacturing or final inspection.

Table 3 — Mechanical and physical properties

No.	Mechanical and physical properties				Hardness class			
					14H	22H	33H	45H
1	Performance hardness (see 9.1.2)							
	1.1	Vickers hardness, HV 10		min.	140	220	330	450
				max.	290	300	440	560
	1.2	Brinell hardness HBW, $F = 30\ D^2$		min.	133	209	314	428
				max.	276	285	418	532
	1.3	Rockwell hardness	HRB	min.	75	95	—	—
				max.	105	[a]	—	—
			HRC	min.	—	[a]	33	45
				max.	—	30	44	53
2	Torque strength				—	—	—	see Table 5
3	Height of non-decarburized thread zone, E, mm			min.	—	$1/2H_1$	$2/3H_1$	$3/4H_1$
4	Depth of complete decarburization, G, mm			max.	—	0,015	0,015	[b]
5	Surface hardness HV 0,3 (see 9.1.3)			max.	—	320	450	580
6	Non-carburization, HV 0,3			max.		[c]	[c]	[c]
7	Surface integrity in accordance with				ISO 6157-1			

[a] For hardness class 22H: if hardness is tested in Rockwell, it is necessary to test the minimum value in HRB and the maximum value in HRC.

[b] No complete decarburization permitted in hardness class 45H.

[c] Surface hardness shall not be more than 30 Vickers points above the measured base metal hardness of the fastener when determination of both the surface hardness and base metal hardness are carried out with HV 0,3 (see Figure 3).

8 Applicability of test methods

8.1 Manufacturer's inspection

Fasteners produced in accordance with this part of ISO 898 shall be capable of conforming to all applicable requirements of Tables 3 to 5.

This part of ISO 898 does not mandate which of the tests the manufacturer shall perform on each manufacturing lot. It is the responsibility of the manufacturer to apply suitable methods of his choice, such as in-process testing or inspection, to ensure that the manufactured lot meets all the applicable requirements.

In case of dispute, the test methods specified in Clause 9 shall apply.

8.2 Supplier's inspection

The supplier tests the fasteners he/she provides using methods of their choice (periodic evaluation of manufacturer, checking/verification of test results from manufacturer, tests on fasteners, etc.), provided the mechanical and physical properties specified in Tables 3, 4 and 5 are met.

In case of dispute, the test methods specified in Clause 9 shall apply.

8.3 Purchaser's inspection

The purchaser may test the delivered fasteners using the test methods given in Clause 9.

In case of dispute, the test methods specified in Clause 9 shall apply, unless otherwise agreed at the time of the order.

9 Test methods

9.1 Hardness test

9.1.1 General

The purpose of the hardness test is

a) to determine the performance hardness on the surface (see Table 3, Nos. 1.1 to 1.3) using the test method given in 9.1.2;

b) to determine the surface hardness (see Table 3, No. 5) using the test method given in 9.1.3.

9.1.2 Performance hardness

9.1.2.1 Applicability

This test applies to all sizes of fasteners having a hardness class of 14H to 45H.

9.1.2.2 Test methods

Hardness may be determined using the Vickers, Brinell or Rockwell hardness tests.

a) Vickers hardness test

The Vickers hardness test shall be carried out in accordance with the provisions of ISO 6507-1.

b) Brinell hardness test

The Brinell hardness test shall be carried out in accordance with the provisions of ISO 6506-1.

c) Rockwell hardness test

The Rockwell hardness test shall be carried out in accordance with the provisions of ISO 6508-1.

9.1.2.3 Test procedure

Hardness tests shall be conducted as near as practicable to the centre position of the point end of the screw.

If the pointed end of the screw is suitable to ensure reproducible readings, fasteners used for hardness tests shall be tested as received.

If not, a flat surface on the end of the fastener shall be prepared by minimal grinding or polishing, maintaining the original properties of the surface base metal, in order to ensure reproducible readings.

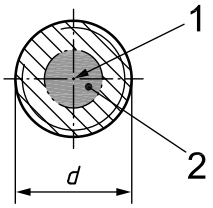
The hardness test shall be carried out by applying the load specified in Table 3.

In case of doubt, the Vickers hardness test shall be the method used for acceptance.

9.1.2.4 Requirements

The hardness shall be within the hardness range specified in Table 3.

If the maximum hardness specified in Table 3 is exceeded, a new test shall be conducted on a cross-section located at a distance 0,5 d from the point end and between the axis and the half-radius position (see Figure 1). The hardness shall be within the hardness range specified in Table 3.



Key

1 axis of the fastener

2 half-radius area (radius of 0,25d)

Figure 1 — Half-radius area for hardness readings

9.1.3 Surface hardness

9.1.3.1 Applicability

This method applies to fasteners with a hardness class of 22H to 45H.

9.1.3.2 Test procedure

A suitable flat surface on the end of the fastener shall be prepared by light (minimal) grinding or polishing in order to ensure reproducible readings and maintain the original properties of the surface layer of the material.

The surface hardness shall be determined on the prepared surface. The test force shall be 2,942 N (Vickers hardness test HV 0,3).

9.1.3.3 Requirements

The hardness value taken on the surface shall not exceed the maximum value specified in Table 3.

9.2 Decarburization test

9.2.1 General

The purpose of the decarburization test is to detect if the surface of quenched and tempered fasteners is decarburized and to determine the depth of the completely decarburized zone (see Figure 2).

NOTE A loss of carbon content (decarburization), caused by the heat treatment process, beyond the limits specified in Table 3, can reduce the strength of the thread and can cause failure.

The surface carbon condition shall be determined by the following two methods:

— microscopic method;

— hardness method.

The microscopic method is used to determine ferritic decarburization, the completely decarburized zone, G, if it exists, and the height of the base metal zone, E (see Figure 2).

The hardness method is used to determine whether the requirement for the minimum height of the base metal zone, E, has been met and for detecting decarburization (see Figure 2).