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

**Part 5:**

**Set screws and similar threaded fasteners not  
under tensile stresses**

*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 non soumis à  
des contraintes de traction*



## 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.

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.

International Standard ISO 898-5 was prepared by Technical Committee ISO/TC 2, *Fasteners*, Subcommittee SC 1, *Mechanical properties of fasteners*.

This second edition cancels and replaces the first edition (ISO 898-5:1980), 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*
- *Part 2: Nuts with specified proof load values — Coarse thread*
- *Part 5: Set screws and similar threaded fasteners not under tensile stresses*
- *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*

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International Organization for Standardization  
Case postale 56 • CH-1211 Genève 20 • Switzerland  
Internet iso@iso.ch

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

## Part 5:

### Set screws and similar threaded fasteners not under tensile stresses

#### 1 Scope

This part of ISO 898 specifies the mechanical properties of set screws and similar threaded fasteners not under tensile stresses with nominal thread diameters from 1,6 mm up to and including 24 mm, which are made of carbon steel or alloy steel.

The mechanical and physical properties apply when tested at an ambient temperature of 10 °C to 35 °C and will vary at higher or lower temperatures.

This part of ISO 898 does not apply to set screws requiring special properties such as

- specified tensile stresses (see ISO 898-1);
- weldability;
- corrosion resistance;
- ability to withstand temperatures above + 300 °C or below – 50 °C.

NOTE — Set screws made from free-cutting steel should not be used above + 250 °C.

#### 2 Normative references

The following standards contain provisions which, through reference in this text, constitute provisions of this part of ISO 898. 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 898 are encouraged to investigate the possibility of applying the most recent editions of the standards indicated below. Members of IEC and ISO maintain registers of currently valid International Standards.

ISO 965-3:1998, *ISO general purpose metric screw threads — Tolerances — Part 3: Deviations for constructional threads.*

ISO 4948-1:1982, *Steels — Classification — Part 1: Classification of steels into unalloyed and alloy steels based on chemical composition.*

ISO 6506:1981, *Metallic materials — Hardness test — Brinell test.*

ISO 6507-1:1997, *Metallic materials — Vickers hardness test — Part 1: Test method.*

ISO 6508:1986, *Metallic materials — Hardness test — Rockwell test (scales A - B - C - D - E - F - G - H - K).*

### 3 Designation system

The property classes are designated by the symbols shown in table 1.

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

The letter H in the symbol refers to hardness.

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

Property class	14H	22H	33H	45H
Vickers hardness, HV min.	140	220	330	450

### 4 Materials

Set screws shall be made of steel conforming to the requirements specified in table 2.

For property class 45H, other materials may be used provided that the proof torque requirements in 6.3 are met.

**Table 2 — Steel specifications**

Property class	Material	Heat treatment	Chemical composition % (m/m)			
			C		P	S
			max.	min.	max.	max.
14H	Carbon steel <sup>1,2)</sup>	—	0,50	—	0,11	0,15
22H	Carbon steel <sup>3)</sup>	Quenched and tempered	0,50	—	0,05	0,05
33H	Carbon steel <sup>3)</sup>	Quenched and tempered	0,50	—	0,05	0,05
45H	Alloy steel <sup>3,4)</sup>	Quenched and tempered	0,50	0,19	0,05	0,05

1) Free-cutting steel may be used, with lead content 0,35 % maximum, phosphorus content 0,11 % maximum and sulphur content 0,34 % maximum.

2) Case hardening is allowed in the case of square-head set screws.

3) Steel with lead content 0,35 % maximum may be used.

4) Shall contain one or more of alloying elements chromium, nickel, molybdenum, vanadium or boron, see ISO 4948-1.

## 5 Mechanical properties

When tested by the methods specified in clause 6, the set screws shall have, at ambient temperature, the mechanical properties specified in table 3.

Table 3 — Mechanical properties

Mechanical properties			Property class <sup>1)</sup>			
			14H	22H	33H	45H
Vickers hardness HV 10	min.		140	220	330	450
	max.		290	300	440	560
Brinell hardness HB, $F = 30 D^2$	min.		133	209	314	428
	max.		276	285	418	532
Rockwell hardness	HRB	min.	75	95	—	—
		max.	105	2)	—	—
	HRC	min.	—	2)	33	45
		max.	—	30	44	53
Torque strength			—	—	—	see table 5
Minimum height of non-decarburized thread zone, $E$			—	$\frac{1}{2} H_1$	$\frac{2}{3} H_1$	$\frac{3}{4} H_1$
Maximum depth of complete decarburization, $G$		mm	—	0,015	0,015	3)
Surface hardness HV 0,3		max.	—	320	450	580
<p>1) Property classes 14H, 22H and 33H are not for hexagon socket set screws.</p> <p>2) For property class 22H, it is necessary to test the minimum value in HRB and the maximum value in HRC, if Rockwell hardness is tested.</p> <p>3) No complete decarburization permitted in property class 45H.</p>						

## 6 Test methods for determination of mechanical properties

### 6.1 Hardness tests

Hardness tests shall be conducted as near as practicable to the centre position of the point end of the screw. If the maximum hardness as given in table 3 is exceeded, a retest shall be conducted on a cross-section  $0,5 d$  back from the point end where  $d$  is the nominal thread diameter. In case of doubt, the Vickers hardness test is decisive for acceptance.

Hardness readings for the surface hardness shall be taken on the end of the screw, which will be prepared by slightly grinding or polishing to ensure reproducible readings.

#### 6.1.1 Vickers hardness test

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

#### 6.1.2 Brinell hardness test

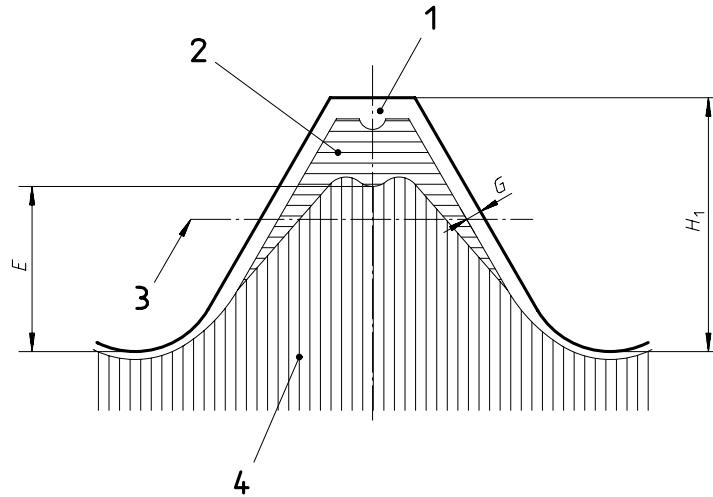
The Brinell hardness test shall be carried out in accordance with the provisions of ISO 6506.

6.1.3 Rockwell hardness test

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

6.2 Decarburization test — evaluation of the surface carbon condition

Using the appropriate measuring method (6.2.2.1 or 6.2.2.2 as applicable), the longitudinal section of the thread shall be examined to determine that the height of the zone of base metal ( $E$ ) and the depth of the zone with complete decarburization ( $G$ ) are within specified limits, (see figure 1). The minimum values for  $E$  and the maximum values for  $G$  are specified in table 3.



- Key**
- 1 Completely decarburized
  - 2 Partially decarburized
  - 3 Pitch line
  - 4 Base metal

$H_1$  is the external thread height in the maximum metal condition

Figure 1 — Zones of decarburization

6.2.1 Definitions

**6.2.1.1 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.

**6.2.1.2 decarburization:** Generally, loss of carbon at the surface of commercial ferrous materials (steels).

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

**6.2.1.4 complete decarburization:** Decarburization with sufficient carbon loss to show only clearly defined ferrite grains under metallographic examination.

**6.2.1.5 carburization:** Process of increasing surface carbon to a content above that of the base metal.

## 6.2.2 Measurement methods

### 6.2.2.1 Microscopic method

This method allows the determination of both  $E$  and  $G$ .

The specimens to be used are longitudinal sections taken through the thread axis approximately half a nominal diameter from the end of the screw, after all heat treatment operations have been performed on the product. The specimen shall be mounted for grinding and polishing in a clamp or plastic mount, the latter being the preferred method.

After mounting, grind and polish the surface in accordance with good metallographic practice.

Etching in a 3 % nital (concentrated nitric acid in ethanol) solution is usually suitable for showing changes in microstructure caused by decarburization.

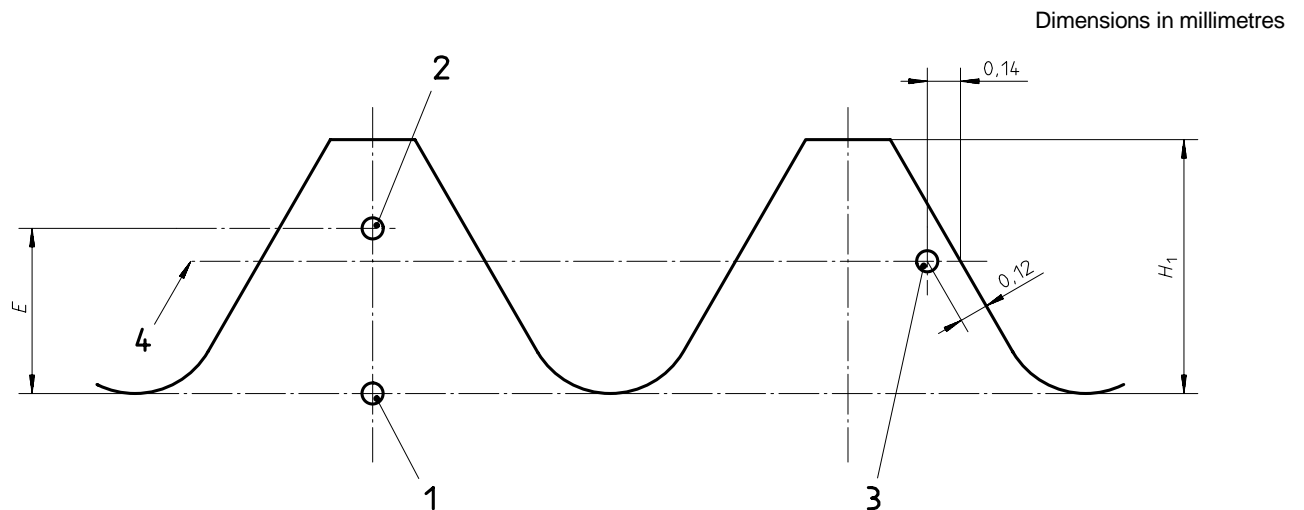
Unless otherwise agreed between the interested parties, a  $100\times$  magnification shall be used for examination.

If the microscope is of a type with a ground glass screen, the extent of decarburization can be measured directly with a scale. If an eyepiece is used for measurement, it should be of an appropriate type, containing a cross-hair or a scale.

### 6.2.2.2 Hardness method (referee method for partial decarburization and carburization)

The decarburization test by the hardness measurement method is applicable only for threads with pitches,  $P$ , of 1,25 mm and larger, except for property class 45H, where it is applicable for all sizes.

The hardness measurements are made at three points in accordance with figure 2. Values for  $E$  are given in table 4. The load shall be 300 g.



$$HV_2 \geq HV_1 - 30$$

$$HV_3 \leq HV_2 + 30$$

#### Key

1, 2, 3 Measurement points

4 Pitch line

Figure 2 — Hardness measurements for decarburization test

Table 4 — Values for  $H_1$  and  $E$ 

Pitch of the thread	$P$ mm	0,5	0,6	0,7	0,8	1	1,25	1,5	1,75	2	2,5	3	3,5	4	
$H_1$	mm	0,307	0,368	0,429	0,491	0,613	0,767	0,920	1,074	1,227	1,534	1,840	2,147	2,454	
$E$ min. mm	Property class	22H	0,154	0,184	0,215	0,245	0,307	0,384	0,460	0,537	0,614	0,767	0,920	1,074	1,227
		33H	0,205	0,245	0,286	0,327	0,409	0,511	0,613	0,716	0,818	1,023	1,227	1,431	1,636
		45H	0,230	0,276	0,322	0,368	0,460	0,575	0,690	0,806	0,920	1,151	1,380	1,610	1,841

Hardness determination for point 3 shall be made on the pitch line of the thread adjacent to the thread on which determinations at points 1 and 2 are made.

The Vickers hardness value at point 2 ( $HV_2$ ) shall be equal to or greater than that at point 1 ( $HV_1$ ) minus 30 Vickers units. In this case the height of the non-decarburized zone  $E$  is at least as specified in table 4.

The Vickers hardness value at point 3 ( $HV_3$ ) shall be equal to or less than that at point 1 ( $HV_1$ ) plus 30 Vickers units. An increase of more than 30 Vickers units indicates that carburization is not permissible.

Complete decarburization up to the maximum specified in table 3 cannot be detected by the hardness measurement method.

NOTE — Careful differentiation should be made between an increase in hardness caused by carburization and that due to heat treatment or cold working of the surface.

### 6.3 Proof torque test for hexagon socket set screws of property class 45H

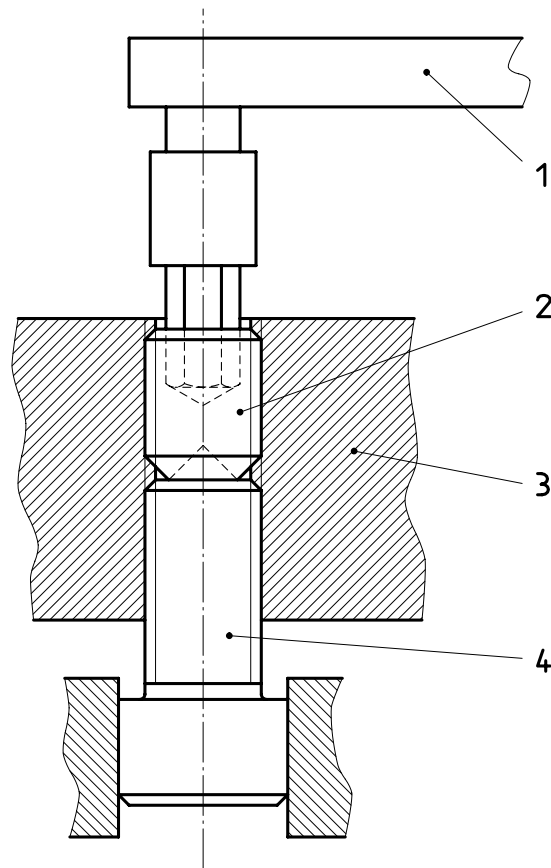
Hexagon socket set screws class 45H shall conform to the proof torque requirements given in table 5.

Table 5 — Proof torque requirements

Nominal thread diameter	Minimum length of screw for test mm				Proof torque N·m
	Flat point	Cone point	Dog point	Cup point	
3	4	5	6	5	0,9
4	5	6	8	6	2,5
5	6	8	8	6	5
6	8	8	10	8	8,5
8	10	10	12	10	20
10	12	12	16	12	40
12	16	16	20	16	65
16	20	20	25	20	160
20	25	25	30	25	310
24	30	30	35	30	520

The set screw shall be inserted in a test block as shown in figure 3 at least until the top surface of the screw face is flush with the test block and the point bears on a firm base, for example a backing screw inserted from the other side.



**Key**

- 1 Torque wrench
- 2 Set screw under test
- 3 Test block: hardness min. 50 HRC, tolerance class of the internal thread 5H (see ISO 965-3)
- 4 Backing screw: hardness 450 HV to 570 HV

**Figure 3 — Torque test fixture**

Using a hexagon test bit with a tolerance class of h9 for the widths across flats,  $s$ , with a minimum width across corners  $\geq 1,13 s_{\min}$  and a hardness of 55 HRC to 60 HRC, engaging the full depth of the set screw socket, the screw shall withstand the proof torque given in table 5 without splitting or cracking.

For this proof torque test, a calibrated torque measuring instrument shall be used.

Visual marks at the socket due to torque testing shall not be cause for rejection.

**7 Marking****7.1 Marking of set screws with the property class**

Marking of set screws with property classes as described in clause 3 is not generally required. If in special cases marking is agreed between the interested parties the symbol of the property class should be used as the marking symbol.

**7.2 Trade marking**

The manufacturer's identification marking is not required.

## **Annex A** (informative)

### **Bibliography**

- [1] ISO 898-1:1998, *Mechanical properties of fasteners made of carbon steel and alloy steel — Part 1: Bolts, screws and studs.*
- [2] ISO 6507-2:1997, *Metallic materials — Vickers hardness test — Part 2: Verification of testing machines.*



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## ICS 21.060.10

**Descriptors:** fasteners, screws, set screws, specifications, materials specifications, mechanical properties, tests, mechanical tests, hardness tests, marking, designation.

Price based on 8 pages

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