INTERNATIONAL STANDARD

ISO 898-6

Second edition
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Mechanical properties of fasteners —

Part 6:

Nuts with specified proof load values — Fine pitch thread

Caractéristiques mécaniques des éléments de fixation —

Partie 6: Écrous avec charges d'épreuve spécifiées — Filetage à pas fin

INTERNATIONAL ISO

Reference number
ISO 898-6:1994(E)

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 898-6 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 898-6:1988), which has been technically revised.

ISO 898 consists of the following parts, under the general title *Mechanical properties of fasteners*:

— *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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Mechanical properties of fasteners —

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

1 Scope

This part of ISO 898 specifies the mechanical properties of nuts with specified proof load values when tested at an ambient temperature range of + 10 °C to + 35 °C. Mechanical and physical properties will vary with respect to temperature and property class.

Products conforming to the requirements of this part of ISO 898 are evaluated only at the ambient temperature range and may not retain the specified physical properties at higher and lower temperatures.

At temperatures higher or lower than the ambient temperature range, a significant change in properties may occur. When fasteners are to be used above or below the ambient temperature range, it is the responsibility of the user to ensure that the mechanical and physical properties are suitable for his particular service conditions.

This part of ISO 898 applies to nuts

— with nominal thread diameters, d, from 8 mm up to and including 39 mm (fine pitch thread);

— of triangular ISO thread and with diameters and pitches in accordance with ISO 68 and ISO 262 (fine pitch thread);

— with diameter/pitch combinations in accordance with ISO 261 (fine pitch thread);

— with thread tolerances 6H in accordance with ISO 965-1 and 965-2 (see note 2);

— with specific mechanical requirements;

— with widths across flats as specified in ISO 272;

— with nominal heights greater than or equal to $0{,}5d$[1];

— made of carbon steel or alloy steel (see note 1).

It does not apply to nuts requiring special properties such as

— weldability;

— prevailing torque performance (see ISO 2320);

— corrosion resistance (see ISO 3506);

— ability to withstand temperatures above + 300 °C or below − 50 °C. (However, see note 1.)

NOTES

1 Nuts made from free-cutting steel should not be used above + 250 °C.

2 With thread tolerances other or larger than 6H, a decrease in the stripping strength should be considered (see table 1).

1) In ISO 898:1988, the symbol D was used.

Table 1 — Reduction in thread strength

Nominal thread diameter d mm	Test load, % Thread tolerances 6H	7H	6G
$8 \leqslant d \leqslant 16$	100	96	97,5
$16 < d \leqslant 39$	100	98	98,5

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 68:1973, *ISO general purpose screw threads — Basic profile.*

ISO 261:1973, *ISO general purpose metric screw threads — General plan.*

ISO 262:1973, *ISO general purpose metric screw threads — Selected sizes for screws, bolts and nuts.*

ISO 272:1982, *Fasteners — Hexagon products — Widths across flats.*

ISO 286-2:1988, *ISO system of limits and fits — Part 2: Tables of standard tolerance grades and limit deviations for holes and shafts.*

ISO 724:1993, *ISO general-purpose metric screw threads — Basic dimensions.*

ISO 898-2:1992, *Mechanical properties of fasteners — Part 2: Nuts with specified proof load values — Coarse thread.*

ISO 965-1:1980, *ISO general purpose metric screw threads — Tolerances — Part 1: Principles and basic data.*

ISO 965-2:1980, *ISO general purpose metric screw threads — Tolerances — Part 2: Limits of sizes for general purpose bolt and nut threads — Medium quality.*

ISO 4964:1984, *Steel — Hardness conversions.*

ISO 6157-2:—[2], *Fasteners — Surface discontinuities — Part 2: Nuts with threads M5 to M39.*

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

ISO 6507-1:1982, *Metallic materials — Hardness test — Vickers test — Part 1: HV 5 to HV 100.*

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

3 Designation system

3.1 Nuts with nominal heights $\geqslant 0{,}8d$ (effective lengths of thread $\geqslant 0{,}6d$): Nuts of style 1 and style 2

Nuts with nominal heights $\geqslant 0{,}8d$ (effective lengths of thread $\geqslant 0{,}6d$) are designated by a number to indicate the maximum appropriate property class of bolts with which they may be mated.

Failure of threaded fasteners due to over-tightening can occur by bolt shank fracture or by stripping of the threads of the nut and/or bolt. Shank fracture is sudden and therefore easily noticed. Stripping is gradual and therefore difficult to detect and this introduces the danger of partly failed fasteners being left in assemblies.

It would therefore be desirable to design threaded connections so that their mode of failure would always be by shank fracture but, unfortunately, because of the many variables which govern stripping strength (nut and bolt material strengths, thread clearances, across-flats dimensions, etc.), nuts would have to be excessively thick to guarantee this mode in all cases.

A bolt or screw of thread diameter 8 mm to 39 mm assembled with a nut of the appropriate property class, in accordance with table 2, is intended to provide an assembly capable of being tightened to the bolt proof load without thread stripping occurring.

2) To be published.

Table 2 — Designation system for nuts with nominal heights $\geqslant 0{,}8d$

Property class of nut	Mating bolts		Nuts	
			style 1	style 2
	Property class	Nominal thread diameter range mm	Nominal thread diameter range mm	
5	3.6; 4.6; 4.8	$d \leqslant 39$	$d \leqslant 39$	—
	5.6; 5.8			
6	6.8	$d \leqslant 39$	$d \leqslant 39$	—
8	8.8	$d \leqslant 39$	$d \leqslant 39$	$d \leqslant 16$
10	10.9	$d \leqslant 39$	$d \leqslant 16$	$d \leqslant 39$
12	12.9	$d \leqslant 16$	—	$d \leqslant 16$

NOTE — In general, nuts of a higher property class can replace nuts of a lower property class. This is advisable for a bolt/nut assembly going into a stress higher than the yield stress or the stress under proof load of the bolt.

However, should tightening beyond bolt proof load take place, the nut design is intended to ensure at least 10 % of the over-tightened assemblies fail through bolt breakage in order to warn the user that the installation practice is not appropriate.

NOTE 3 For more detailed information on the strength of screw thread assemblies and for the styles of nuts, see ISO 898-2:1992, annex A.

3.2 Nuts with nominal heights $\geqslant 0{,}5d$ and $< 0{,}8d$ (effective heights of thread $\geqslant 0{,}4d$ and $< 0{,}6d$)

Nuts with nominal heights $\geqslant 0{,}5d$ and $< 0{,}8d$ (effective height of thread $\geqslant 0{,}4d$ and $< 0{,}6d$) are designated by a combination of two numbers: the second indicates the nominal stress under proof load on a hardened test mandrel, while the first indicates that the loadability of a bolt-nut assembly is reduced in comparison with the loadability on a hardened test mandrel and also in comparison with a bolt-nut assembly described in 3.1. The effective loading capacity is not only determined by the hardness of the nut and the effective height of thread but also by the tensile strength of the bolt with which the nut is assembled. Table 3 gives the designation system and the stresses under proof load of the nuts. Proof loads are shown in table 6. A guide for minimum expected stripping strengths of the joints when these nuts are assembled with bolts of various property classes is shown in table 7.

Table 3 — Designation system and stresses under proof load for nuts with nominal heights $\geqslant 0{,}5d$ and $< 0{,}8d$

Property class of nut	Nominal stress under proof load N/mm²	Actual stress under proof load N/mm²
04	400	380
05	500	500

4 Materials

Nuts shall be made of steel conforming to the chemical composition limits specified in table 4. The chemical composition shall be analysed in accordance with relevant International Standards.

Table 4 — Limits of chemical composition

Property class		Chemical composition limits (check analysis), % C max.	Mn min.	P max.	S max.
5 [1]; **6**	—	0,50	—	0,060	0,150
8 [2]	**04** [1]	0,58	0,25	0,060	0,150
10 [2]	**05** [2]	0,58	0,30	0,048	0,058
12 [2]	—	0,58	0,45	0,048	0,058

1) Nuts of this property class may be manufactured from free-cutting steel unless otherwise agreed between the purchaser and the manufacturer. In such cases, the following maximum sulfur, phosphorus and lead contents are permissible:

sulfur 0,34 %; phosphorus 0,11 %; lead 0,35 %

2) Alloying elements may be added, if necessary, to develop the mechanical properties of the nuts.

Nuts of property classes 05, 8 (style 1), 10 and 12 shall be hardened and tempered.

5 Mechanical properties

When tested by the methods described in clause 8, the nuts shall have the mechanical properties set out in table 5.

6 Proof load values

Proof load values are given in table 6.

The nominal stress area, A_s, is calculated as follows:

$$A_s = \frac{\pi}{4}\left(\frac{d_2 + d_3}{2}\right)^2$$

where

d_2*) is the basic pitch diameter of the external thread;

d_3 is the minor diameter of the external thread

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

where

d_1[1]) is the basic minor diameter of the external thread;

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

*) See ISO 724.

Table 5 — Mechanical properties

Nominal thread diameter d mm	Property class 04					Property class 05					Property class 5				
	Stress under proof load, S_p N/mm²	Vickers hardness, HV min.	Vickers hardness, HV max.	Nut state	Nut style	Stress under proof load, S_p N/mm²	Vickers hardness, HV min.	Vickers hardness, HV max.	Nut state	Nut style	Stress under proof load, S_p N/mm²	Vickers hardness, HV min.	Vickers hardness, HV max.	Nut state	Nut style
$8 \leqslant d \leqslant 16$	380	188	302	NQT[1]	thin	500	272	353	QT[2]	thin	690	175	302	NQT[1]	1
$16 < d \leqslant 39$											720	190			

Nominal thread diameter d mm	Property class 6					Property class 8					Property class 8				
	Stress under proof load, S_p N/mm²	Vickers hardness, HV min.	Vickers hardness, HV max.	Nut state	Nut style	Stress under proof load, S_p N/mm²	Vickers hardness, HV min.	Vickers hardness, HV max.	Nut state	Nut style	Stress under proof load, S_p N/mm²	Vickers hardness, HV min.	Vickers hardness, HV max.	Nut state	Nut style
$8 \leqslant d \leqslant 10$	770	188	302	NQT[1][3]	1	955	250	353	QT[2]	1	890	195	302	NQT[1]	2
$10 < d \leqslant 16$	780														
$16 < d \leqslant 33$	870	233				1 030	295				—	—	—		—
$33 < d \leqslant 39$	930					1 090									

Nominal thread diameter d mm	Property class 10					Property class 10					Property class 12				
	Stress under proof load, S_p N/mm²	Vickers hardness, HV min.	Vickers hardness, HV max.	Nut state	Nut style	Stress under proof load, S_p N/mm²	Vickers hardness, HV min.	Vickers hardness, HV max.	Nut state	Nut style	Stress under proof load, S_p N/mm²	Vickers hardness, HV min.	Vickers hardness, HV max.	Nut state	Nut style
$8 \leqslant d \leqslant 10$	1 100	295	353	QT[2]	1	1 055	250	353	QT[2]	2	1 200	295	353	QT[2]	2
$10 < d \leqslant 16$	1 110														
$16 < d \leqslant 39$	—	—	—	—	—	1 080	260				—	—	—	—	—

NOTE — Minimum hardness is mandatory only for heat-treated nuts and nuts too large to be proof-load tested. For all other nuts, minimum hardness is not mandatory but is provided for guidance only. For nuts which are not hardened and tempered, and which satisfy the proof-load test, minimum hardness shall not be cause for rejection.

1) NQT = Not quenched and tempered.

2) QT = Quenched and tempered.

3) Nuts with nominal thread diameters $d > 16$ mm may be quenched and tempered at the discretion of the manufacturer.

Thread $d \times P$	Nominal stress area of mandrel A_s mm²	Property class 04	05	5	6	8		10		12
		Proof load ($A_s \times S_p$) N								
				style 1	style 1	style 1	style 2	style 1	style 2	style 2
M8 × 1	39,2	14 900	19 600	27 000	30 200	37 400	34 900	43 100	41 400	47 000
M10 × 1	64,5	24 500	32 200	44 500	49 700	61 600	57 400	71 000	68 000	77 400
M10 × 1,25	61,2	23 300	30 600	44 200	47 100	58 400	54 500	67 300	64 600	73 400
M12 × 1,25	92,1	35 000	46 000	63 500	71 800	88 000	82 000	102 200	97 200	110 500
M12 × 1,5	88,1	33 500	44 000	60 800	68 700	84 100	78 400	97 800	92 900	105 700
M14 × 1,5	125	47 500	62 500	86 300	97 500	119 400	111 200	138 800	131 900	150 000
M16 × 1,5	167	63 500	83 500	115 200	130 300	159 500	148 600	185 400	176 200	200 400
M18 × 1,5	215	81 700	107 500	154 800	187 000	221 500	—	—	232 200	—
M18 × 2	204	77 500	102 000	146 900	177 500	210 100	—	—	220 300	—
M20 × 1,5	272	103 400	136 000	195 800	236 600	280 200	—	—	293 800	—
M20 × 2	258	98 000	129 000	185 800	224 500	265 700	—	—	278 600	—
M22 × 1,5	333	126 500	166 500	239 800	289 700	343 000	—	—	359 600	—
M22 × 2	318	120 800	159 000	229 000	276 700	327 500	—	—	343 400	—
M24 × 2	384	145 900	192 000	276 500	334 100	395 500	—	—	414 700	—
M27 × 2	496	188 500	248 000	351 100	431 500	510 900	—	—	535 700	—
M30 × 2	621	236 000	310 500	447 100	540 300	639 600	—	—	670 700	—
M33 × 2	761	289 200	380 500	547 900	662 100	783 800	—	—	821 900	—
M36 × 3	865	328 700	432 500	622 800	804 400	942 800	—	—	934 200	—
M39 × 3	1 030	391 400	515 000	741 600	957 900	1 123 000	—	—	1 112 000	—

Table 6 — Proof load values

7 Failure loads for nuts with nominal heights of $\geqslant 0{,}5d$ and $< 0{,}8d$

The values of failure loads given for guidance in table 7 apply to different bolt classes. Bolt stripping is the expected failure mode for lower strength bolts, while nut stripping can be expected for bolts of higher property classes.

Table 7 — Minimum stripping strength of nuts as a percentage of the proof load of bolts

Property class of the nut	Minimum stripping strength of nuts as a percentage of the proof load of bolts with property classes			
	6.8	8.8	10.9	12.9
04	85	65	45	40
05	100	85	60	50

8 Test methods

8.1 Proof load test

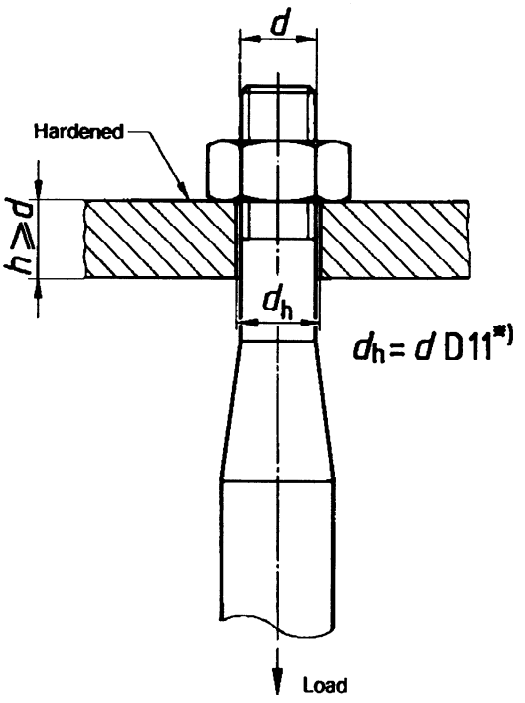
The proof load test shall be used wherever the capacity of available testing equipment permits, and shall be the referee method.

The nut shall be assembled on a hardened and threaded test mandrel as shown in figures 1 and 2. For referee purposes, the axial tensile test is decisive.

The proof load shall be applied against the nut in an axial direction, and shall be held for 15 s. The nut shall resist the load without failure by stripping or rupture, and shall be removable by the fingers after the load is released. If the thread of the mandrel is damaged during the test, the test should be discarded. It may be necessary to use a manual wrench to start the nut in motion. Such wrenching is permissible provided that it is restricted to one half turn and that the nut is then removable by the fingers.

The hardness of the test mandrel shall be 45 HRC minimum.

Mandrels used shall be threaded to tolerance class 5h6g except that the tolerance of the major diameter shall be the last quarter of the 6g range on the minimum material side.



*) D11 is taken from ISO 286-2.

Figure 1 — Axial tensile test

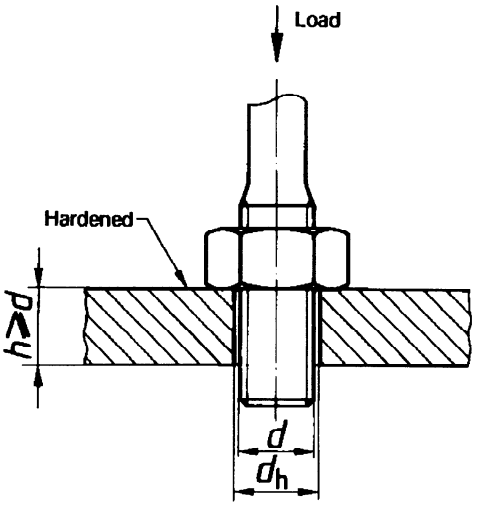


Figure 2 — Axial compressive test