INTERNATIONAL STANDARD

ISO 898-2

Second edition
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Mechanical properties of fasteners —

Part 2:
Nuts with specified proof load values — Coarse thread

Caractéristiques mécaniques des éléments de fixation —

Partie 2: Écrous avec charges d'épreuve spécifiées — Filetages à pas gros

Reference number
ISO 898-2:1992(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 898-2 was prepared by Technical Committee ISO/TC 2, *Fasteners*, Sub-Committee SC 1, *Mechanical properties of fasteners*.

This second edition cancels and replaces the first edition (ISO 898-2:1980), 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*

Annexes A and B of this part of ISO 898 are for information only.

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Mechanical properties of fasteners —

Part 2:
Nuts with specified proof load values — Coarse thread

1 Scope

This International Standard specifies the mechanical properties of nuts with specified proof load values when tested at room temperature (see ISO 1). Properties will vary at higher and lower temperature.

It applies to nuts

- with nominal thread diameters up to and including 39 mm;
- of triangular ISO thread and with diameters and pitches according to ISO 68 and ISO 262 (coarse thread);
- with diameter/pitch combinations according to ISO 261 (coarse thread);
- with thread tolerances 6H according to ISO 965-1 and ISO 965-2;
- with specific mechanical requirements;
- with widths across flats as specified in ISO 272 or equivalent;
- with nominal heights greater than or equal to $0{,}5D$*);
- made of carbon steel or low alloy steel.

It does not apply to nuts requiring special properties such as

- locking abilities (see ISO 2320);
- weldability;
- corrosion resistance (see ISO 3506);
- ability to withstand temperatures above + 300 °C or below − 50 °C.

NOTES

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

2 For special products such as nuts for high-strength structural bolting, and overtapped nuts for use with hot-dipped galvanized bolts, see the product standards for appropriate values.

3 For assemblies with threads having tolerances wider than 6H/6g, there is an increased risk of stripping; see also table 1.

4 In the case of thread tolerances other or larger than 6H, a decrease of the stripping strength should be considered (see table 1).

Table 1 — Reduction in thread strength

Thread		**Test load, %** Thread tolerances		
greater than	less than or equal to	6H	7H	6G
—	**M2,5**	100	—	95,5
M2,5	**M7**	100	95,5	97
M7	**M16**	100	96	97,5
M16	**M39**	100	98	98,5

*) D is the nominal diameter of the internal thread in accordance with ISO 724.

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 1:1975, *Standard reference temperature for industrial length measurements.*

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 724:1978, *ISO metric screw threads — Basic dimensions.*

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:—[1], *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 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 objectionably thick to guarantee this mode in all cases.

A bolt or screw of thread M5 to M39 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.

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 5 For more detailed information on the strength of screw thread assemblies, see annex A.

1) To be published.

Table 2 — Designation system for nuts with nominal heights ⩾ 0,8D

Property class of nut	Mating bolts		Nuts	
			Style 1	Style 2
	Property class	Thread range	Thread ranges	
4	3.6; 4.6; 4.8	> M16	> M16	—
5	3.6; 4.6; 4.8	⩽ M16	⩽ M39	—
	5.6; 5.8	⩽ M39		
6	6.8	⩽ M39	⩽ M39	—
8	8.8	⩽ M39	⩽ M39	> M16 ⩽ M39
9	9.8	⩽ M16	—	⩽ M16
10	10.9	⩽ M39	⩽ M39	—
12	12.9	⩽ M39	⩽ M16	⩽ M39

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.

3.2 Nuts with nominal heights ⩾ 0,5D but < 0,8D (effective heights of thread ⩾ 0,4D but < 0,6D)

Nuts with nominal heights ⩾ 0,5D but < 0,8D (effective height of thread ⩾ 0,4D but < 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 ⩾ 0,5D but < 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.

Table 4 — Limits of chemical composition

Property class		Chemical composition limits (check analysis), %			
		C max.	Mn min.	P max.	S max.
4 1); 5 1); 6 1)	—	0,50	—	0,060	0,150
8; 9	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 these property classes 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 above M16), 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.

Table 5 — Mechanical properties

Thread: greater than	Thread: less than or equal to	04: Stress under proof load S_p N/mm2	04: Vickers hardness HV min.	04: Vickers hardness HV max.	04: Nut state	04: Nut style	05: Stress under proof load S_p N/mm2	05: Vickers hardness HV min.	05: Vickers hardness HV max.	05: Nut state	05: Nut style	4: Stress under proof load S_p N/mm2	4: Vickers hardness HV min.	4: Vickers hardness HV max.	4: Nut state	4: Nut style
—	M4															
M4	M7											—	—	—	—	—
M7	M10	380	188	302	NQT1)	thin	500	272	353	QT2)	thin					
M10	M16															
M16	M39											510	117	302	NQT1)	1

Thread: greater than	Thread: less than or equal to	5 3): Stress under proof load S_p N/mm2	5 3): Vickers hardness HV min.	5 3): Vickers hardness HV max.	5 3): Nut state	5 3): Nut style	6: Stress under proof load S_p N/mm2	6: Vickers hardness HV min.	6: Vickers hardness HV max.	6: Nut state	6: Nut style	8: Stress under proof load S_p N/mm2	8: Vickers hardness HV min.	8: Vickers hardness HV max.	8: Nut state	8: Nut style	8: Stress under proof load S_p N/mm2	8: Vickers hardness HV min.	8: Vickers hardness HV max.	8: Nut state	8: Nut style
—	M4	520					600					800	180								
M4	M7	580	130				670	150				855		302	NQT1)						
M7	M10	590		302	NQT1)	1	680		302	NQT1)	1	870	200			1	—	—	—	—	—
M10	M16	610					700					880									
M16	M39	630	146				720	170				920	233	353	QT2)		890	180	302	NQT1)	2

Thread		Property class 9					Property class 10					Property class 12				
		Stress under proof load S_p	Vickers hardness HV		Nut		Stress under proof load S_p	Vickers hardness HV		Nut		Stress under proof load S_p	Vickers hardness HV		Nut	
greater than	less than or equal to	N/mm2	min.	max.	state	style	N/mm2	min.	max.	state	style	N/mm2	min.	max.	state	style
—	M4	900	170				1 040					1 140					1 150	
M4	M7	915					1 040					1 140	295	353	QT2)	1	1 150	
M7	M10	940	188	302	NQT1)	2	1 040	272	353	QT2)	1	1 140					1 160
M10	M16	950					1 050					1 170					1 190
M16	M39	920					1 060					—	—	—	—	—	1 200

Thread		Property class 12				
		Stress under proof load S_p	Vickers hardness HV		Nut	
greater than	less than or equal to	N/mm2	min.	max.	state	style
—	M4	1 150				
M4	M7	1 150				
M7	M10	1 160	272	353	QT2)	2
M10	M16	1 190				
M16	M39	1 200				

1) NQT = Not quenched or tempered.

2) QT = Quenched and tempered.

3) The maximum bolt hardness of property classes 5.6 and 5.8 will be changed to be 220 HV in the next revision of ISO 898-1:1988. This is the maximum bolt hardness in the thread engagement area whereas only the thread end or the head may have a maximum hardness of 250 HV. Therefore the values of stress under proof load are based on a maximum bolt hardness of 220 HV.

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.

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 is the basic minor diameter of the external thread;

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

*) See ISO 724.

Table 6 — Proof load values — Coarse thread

Thread	Thread pitch	Nominal stress area of the mandrel A_s	Property class 04	05	4	5	6	8	8	9	10	12	12
			Proof load ($A_s \times S_p$) N										
	mm	mm²			style 1	style 1	style 1	style 1	style 2	style 2	style 1	style 1	style 2
M3	0,5	5,03	1 910	2 500	—	2 600	3 000	4 000	—	4 500	5 200	5 700	5 800
M3,5	0,6	6,78	2 580	3 400	—	3 550	4 050	5 400	—	6 100	7 050	7 700	7 800
M4	0,7	8,78	3 340	4 400	—	4 550	5 250	7 000	—	7 900	9 150	10 000	10 100
M5	0,8	14,2	5 400	7 100	—	8 250	9 500	12 140	—	13 000	14 800	16 200	16 300
M6	1	20,1	7 640	10 000	—	11 700	13 500	17 200	—	18 400	20 900	22 900	23 100
M7	1	28,9	11 000	14 500	—	16 800	19 400	24 700	—	26 400	30 100	32 900	33 200
M8	1,25	36,6	13 900	18 300	—	21 600	24 900	31 800	—	34 400	38 100	41 700	42 500
M10	1,5	58	22 000	29 000	—	34 200	39 400	50 500	—	54 500	60 300	66 100	67 300
M12	1,75	84,3	32 000	42 200	—	51 400	59 000	74 200	—	80 100	88 500	98 600	100 300
M14	2	115	43 700	57 500	—	70 200	80 500	101 200	—	109 300	120 800	134 600	136 900
M16	2	157	59 700	78 500	—	95 800	109 900	138 200	—	149 200	164 900	183 700	186 800
M18	2,5	192	73 000	96 000	97 900	121 000	138 200	176 600	170 900	176 600	203 500	—	230 400
M20	2,5	245	93 100	122 500	125 000	154 400	176 400	225 400	218 100	225 400	259 700	—	294 000
M22	2,5	303	115 100	151 500	154 500	190 900	218 200	278 800	269 700	278 800	321 200	—	363 600
M24	3	353	134 100	176 500	180 000	222 400	254 200	324 800	314 200	324 800	374 200	—	423 600
M27	3	459	174 400	229 500	234 100	289 200	330 500	422 300	408 500	422 300	486 500	—	550 800
M30	3,5	561	213 200	280 500	286 100	353 400	403 900	516 100	499 300	516 100	594 700	—	673 200
M33	3,5	694	263 700	347 000	353 900	437 200	499 700	638 500	617 700	638 500	735 600	—	832 800
M36	4	817	310 500	408 500	416 700	514 700	588 200	751 600	727 100	751 600	866 000	—	980 400
M39	4	976	370 900	488 000	497 800	614 900	702 700	897 900	868 600	897 900	1 035 000	—	1 171 000

7 Failure loads for nuts with nominal height $\geq 0{,}5D$ but $< 0{,}8D$

The values of failure loads given in table 7 for guidance 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 bolt stress when stripping occurs

Property class of the nut	Proof load stress of the nut N/mm²	Minimum stress in the core of bolt when stripping occurs N/mm² for bolts with property class			
		6.8	8.8	10.9	12.9
04	380	260	300	330	350
05	500	290	370	410	480

8 Test methods

8.1 Proof load test

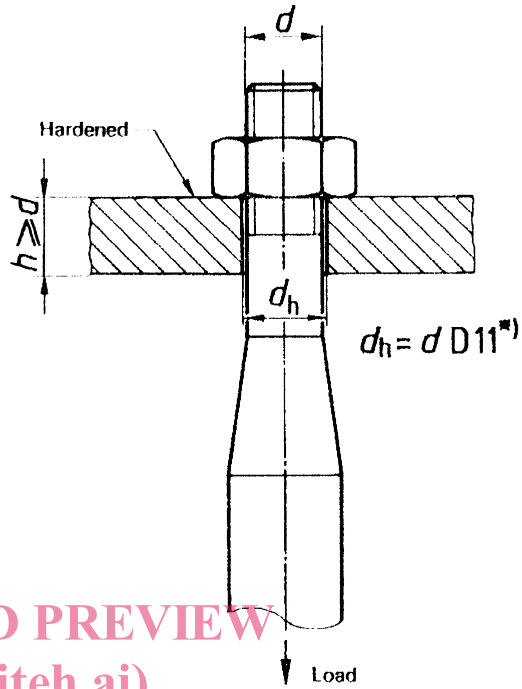
The proof load test shall be used wherever the capacity of available testing equipment permits, and shall be the referee method for sizes ≥ M5.

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

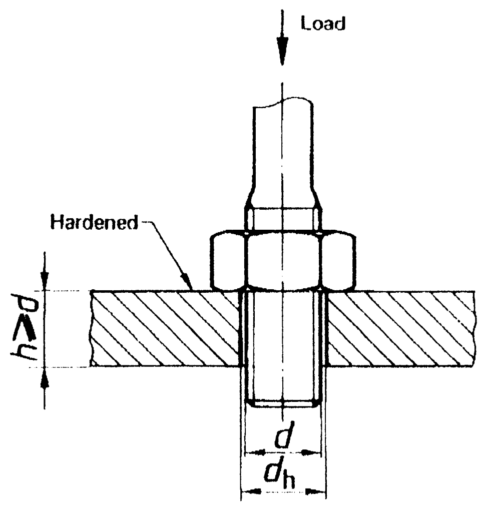


Figure 2 — Axial compressive test

8.2 Hardness test

For routine inspection, hardness tests shall be carried out on one bearing surface of the nut and the hardness shall be taken as the mean of three values spaced 120° apart. In case of dispute, the hardness tests shall be carried out on a longitudinal section through the nut axis and with impressions placed as close as possible to the nominal major diameter of the nut thread.

The Vickers hardness test is the referee test, and where practicable a load of HV 30 shall be applied.

If Brinell and Rockwell hardness tests are applied, the conversion tables in accordance with ISO 4964 shall be used.

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

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

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

8.3 Surface integrity test

For the surface integrity test, see ISO 6157-2.

9 Marking

9.1 Symbols

Marking symbols are shown in tables 8 and 9.

9.2 Identification

Hexagon nuts of threads ⩾ M5 and all property classes shall be marked in accordance with the designation system described in clause 3, by indenting on the side or bearing surface, or by embossing on the chamfer. See figures 3 and 4. Embossed marks shall not protrude beyond the bearing surface of the nut.

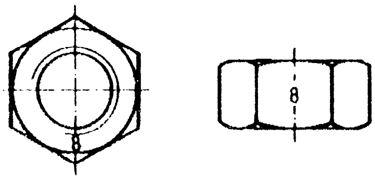


Figure 3 — Examples of marking with designation symbol

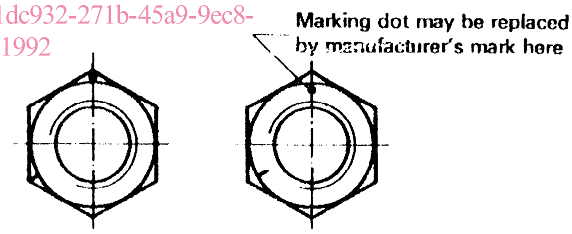


Figure 4 — Examples of marking with code symbol (clock-face system)