International Standard 898/2

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Mechanical properties of fasteners — Part 2 : Nuts with specified proof load values

Caractéristiques mécaniques des éléments de fixation — Partie 2 : Écrous avec charges d'épreuve spécifiées

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Foreword

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Draft International Standards adopted by the technical committees are circulated to the member bodies for approval before their acceptance as International Standards by the ISO Council.

International Standard ISO 898/2 was developed by Technical Committee ISO/TC 2, *Fasteners*, and was circulated to the member bodies in May 1978.

It has been approved by the member bodies of the following countries :

Australia	Hungary	South Africa, Rep. of
Austria	India	Spain
Belgium	Italy	Sweden
Bulgaria	Japan	Switzerland
Canada	Korea, rep. of	Turkey
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The member bodie of the following country expressed disapproval of the document on technical grounds :

France

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Contents

Mechanical properties of fasteners — Part 2 : Nuts with specified proof load values

1 Scope and field of application

This International Standard specifies the mechanical properties of nuts with specified proof load values,

- with nominal thread diameters up to and including 39 mm (or 100 mm);
- of triangular ISO thread and with diameters and pitches according to ISO 68 and ISO 262 (coarse thread);
- with thread tolerances 6H according to ISO 965;
- with specific mechanical requirements;
- with width across flats as specified in ISO 272 or equivalent;
- with nominal heights greater than or equal to 0,5 D;
- 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 6g/6H, there is an increased risk of stripping.

4 No recommendations are currently available for fine thread nuts. As an interim solution, for fine thread, users may consider employing nuts of one property class higher than that recommended for coarse thread, for example grade 12 nuts of grade 10.9 bolts.

5 In case of other or larger thread tolerances than 6H a decrease of the stripping strength should be considered.

Thread size		Test load, % Thread tolerances		
Above	Up 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	98,7

2 References

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

ISO/R 79, *Brinell hardness test for steel and cast iron.*

ISO/R 80, *Rockwell hardness test (B and C scales) for steel.*

ISO/R 81, *Vickers hardness test for steel.*

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

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

ISO/R 286, *ISO system of limits and fits — Part 1 : General, tolerances and deviations.*

ISO 965, *ISO general purpose metric screw threads — Tolerances.*

ISO 6157/2, *Fasteners — Surface discontinuities on nuts with thread sizes M5 to M39.*[1)]

3 Designation system

3.1 Nuts with nominal heights ⩾ 0,8 D (effective lengths of thread ⩾ 0,6 D)

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

1) At present at the stage of draft.

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 assembled with a nut of the appropriate property class, in accordance with table 1, is intended to provide an assembly capable of being tightened to the bolt proof load without thread stripping occuring.

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 his installation practice is not appropriate.

NOTE — For more detailed information on the strength of screw thread assemblies, see the annex.

Table 1 — Designation system for nuts with nominal heights ⩾ 0,8 *D*

Property class of nut	Mating bolts property class	Mating bolts diameter range
4	3.6 4.6 4.8	> M16
5	3.6 4.6 4.8	⩽ M16
	5.6 5.8	all
6	6.8	all
8	8.8	all
9	8.8	> M16 ⩽ M39
	9.8	⩽ M16
10	10.9	all
12	12.9	⩽ M39

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

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

Nuts with nominal heights ⩾ 0,5 *D* and < 0,8 *D* (effective height of thread ⩾ 0,4 *D* and < 0,6 *D*) are designated by a combination of two numbers : the second indicates the nominal proof load stress on a hardened test mandrel, while the first indicates that the loadability of a bolt-nut assembly is reduced in comparison with the loadability of 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 2 gives the designation system and the proof stresses of the nuts. Proof loads are shown in table 5. A guide for minimum expected stripping strengths of the joints when these nuts are assembled with bolts of various bolt classes is shown in table 6.

Table 2 — Designation system and proof stresses for nuts with nominal heights ⩾ 0,5 *D* < 0,8 *D*

Property class of nut	Nominal proof load stress N/mm²	Actual proof load stress 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 3.

Table 3 — 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	—	0,110	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 sulphur, phosphorus and lead contents are permissible :

sulphur 0,34 %; phosphorus 0,12 %; 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 > 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 4.

Table 4 — Mechanical properties (coarse thread)

Nominal size (thread diameter) mm		Property class 04					05					4				
		Proof stress S_p	Vickers hardness HV		Rockwell Hardness HRC		Proof stress S_p	Vickers hardness HV		Rockwell hardness HRC		Proof stress S_p	Vickers hardness HV		Rockwell hardness HRC	
over	to	N/mm²	min.	max.	min.	max.	N/mm²	min.	max.	min.	max.	N/mm²	min.	max.	min.	max.
–	4	380	188	302	–	30	500	272	353	27,8	36	–	–	–	–	–
4	7															
7	10															
10	16															
16	39											510	117	302	–	30
39	100	–					–					–				

Nominal size (thread diameter) mm		Property class 5					6					8				
		Proof stress S_p	Vickers hardness HV		Rockwell hardness HRC		Proof stress S_p	Vickers hardness HV		Rockwell hardness HRC		Proof stress S_p	Vickers hardness HV		Rockwell hardness HRC	
over	to	N/mm²	min.	max.	min.	max.	N/mm²	min.	max.	min.	max.	N/mm²	min.	max.	min.	max.
–	4	520	130	302	–	30	600	150	302	–	30	800	170	302	–	30
4	7	580					670					810	188		–	
7	10	590					680					830				
10	16	610					700					840				
16	39	630	146		–		720	170		–		920	233	353	–	38
39	100	–	128		–		–	142		–		–	207		–	

Nominal size (thread diameter) mm		Property class 9					10					12						
		Proof stress S_p	Vickers hardness HV		Rockwell hardness HRC		Proof stress S_p	Vickers hardness HV		Rockwell hardness HRC		Proof stress S_p	Vickers hardness HV			Rockwell hardness HRC		
over	to	N/mm²	min.	max.	min.	max.	N/mm²	min.	max.	min.	max.	N/MM²	min.		max.	min.		max.
–	4	900	170	302	–	30	1 040	272	353	28	38	1 150	295 1)	272 2)	353	31 1)	28 2)	38
4	7	915	188		–		1 040					1 150						
7	10	940					1 040					1 160						
10	16	950					1 050					1 190						
16	39	920					1 060					1 200	–			–		
39	100	–	–	–	–	–	–					–	–	–	–	–	–	–

1) Nuts (style 1) (ISO 4032).

2) Nuts (style 2) (ISO 4033).

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 provided for guidance only. Hardness values for nominal sizes (thread diameters) over 39 up to and including 100 mm are to be used for information and guidance only.

6 Proof load values

Proof load values are given in table 5.

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

d_1 being the basic minor diameter of the external thread;

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

7 Failure loads for nuts with nominal height of 0,5 D

The values of failure loads given for guidance in table 6 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 6 — 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

Table 5 — Proof load values — Coarse thread

Nominal thread diameter mm	Pitch of the thread mm	Nominal stress area of the mandrel A_s mm²	Property class								
			04	05	4	5	6	8	9	10	12
			Proof load ($A_s \times S_p$), N								
3	0,5	5,03	1 910	2 500	—	2 600	3 000	4 000	4 500	5 200	5 800
3,5	0,6	6,78	2 580	3 400	—	3 550	4 050	5 400	6 100	7 050	7 800
4	0,7	8,78	3 340	4 400	—	4 550	5 250	7 000	7 900	9 150	10 100
5	0,8	14,2	5 400	7 100	—	8 250	9 500	11 500	13 000	14 800	16 300
6	1	20,1	7 640	10 000	—	11 700	13 500	16 300	18 400	20 900	23 100
7	1	28,9	11 000	14 500	—	16 800	19 400	23 400	26 400	30 100	33 200
8	1,25	36,6	13 900	18 300	—	21 600	24 900	30 400	34 400	38 100	42 500
10	1,5	58,0	22 000	29 000	—	34 200	39 400	48 100	54 500	60 300	67 300
12	1,75	84,3	32 000	42 200	—	51 400	59 000	70 800	80 100	88 500	100 300
14	2	115	43 700	57 500	—	70 200	80 500	96 000	109 300	120 800	136 900
16	2	157	59 700	78 500	—	95 800	109 900	131 900	149 200	164 900	186 800
18	2,5	192	73 000	96 000	97 900	121 000	138 200	176 600	176 600	203 500	230 400
20	2,5	245	93 100	122 500	125 000	154 400	176 400	225 400	225 400	259 700	294 000
22	2,5	303	115 100	152 000	154 500	190 900	218 200	278 800	278 800	321 200	363 600
24	3	353	134 100	176 500	180 000	222 400	254 200	324 800	324 800	374 200	423 600
27	3	459	174 400	229 500	234 100	289 200	330 500	422 300	422 300	486 500	550 800
30	3,5	561	213 200	280 500	286 100	353 400	403 900	516 100	516 100	594 700	673 200
33	3,5	694	263 700	347 000	353 900	437 200	499 700	638 500	638 500	735 600	832 800
36	4	817	310 500	408 500	416 700	514 700	588 200	751 600	751 600	866 000	980 400
39	4	976	370 900	488 000	497 800	614 900	702 700	897 900	897 900	1 035 000	1 171 000

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 figure 1 or 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 threads of the mandrel are 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 is is restricted to one half turn and that the nut is then removable by the fingers.)

The hardness of the test mandrel shall be Rockwell C45 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.

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 HV30 shall be applied.

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

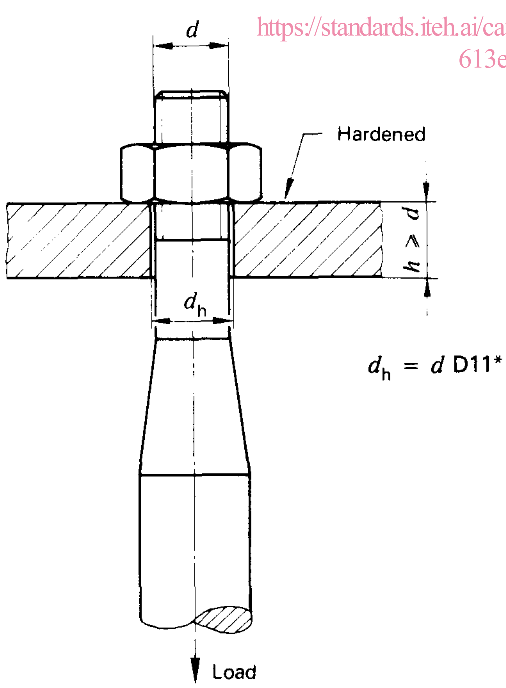
The Vickers hardness test shall be carried out in accordance with the provisions of ISO/R 81.

The Brinell hardness test shall be carried out in accordance with the provisions of ISO/R 79.

The Rockwell hardness test shall be carried out in accordance with the provisions of ISO/R 80.

8.3 Surface integrity test

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



* D11 is extracted from ISO/R 286

Figure 1 — Axial tensile test

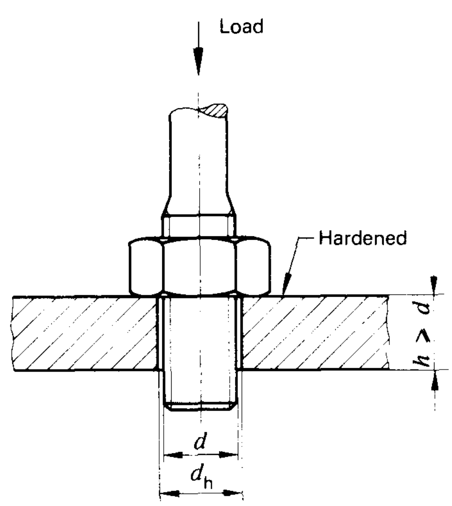


Figure 2 — Axial compressive test