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Prevailing torque type steel hexagon nuts — Mechanical and performance properties

Écrous hexagonaux autofreinés en acier — Caractéristiques mécaniques et performances

Reference number
ISO 2320:1997(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 2320 was prepared by Technical Committee ISO/TC 2, *Fasteners*, Subcommittee SC 1, *Mechanical properties of fasteners*.

This third edition cancels and replaces the second edition (ISO 2320:1983), which has been technically revised.

Annexes A and B form an integral part of this International Standard. Annex C is for information only.

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Prevailing torque type steel hexagon nuts – Mechanical and performance properties

1 Scope

This International Standard specifies the mechanical and performance properties for prevailing torque type steel hexagon nuts (including those with flange) when tested over an ambient temperature range of 10 °C to 35 °C. Properties will vary at higher and lower temperature.

It applies to prevailing torque type nuts

- with nominal thread diameters up to and including 39 mm;
- of triangular ISO thread according to ISO 68;
- with diameter/pitch combinations according to ISO 261;
- with thread tolerances 6H according to ISO 965-2;
- with specific mechanical requirements;
- with dimensions as specified in product standards provided they make reference to this International Standard;
- within the temperature range −50 °C to +300 °C for all metal type nuts;
- within the temperature range −50 °C to +120 °C for non-metallic insert type nuts[1].

It does not apply to nuts requiring special properties which may require special materials or coatings to improve

- weldability;
- corrosion resistance;
- performance outside the above specified temperature ranges.

Prevailing torque performance decreases with increasing re-use. The nut user should consider the implications of decreased performance prior to re-use.

NOTE — Information on torque/clamping force performance requirements and testing are given in the annex C. These functional requirements and the acompanying test procedure are still under discussion and cannot be specified mandatorily for the time being.

2 Normative references

The following standards contain provisions which, through reference in this text, constitute provisions of this International Standard. At the time of publication, the editions indicated were valid. All standards are subject to revision, and parties to agreements based on this International Standard 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 68-1 : –[2], *ISO general purpose screw threads – Basic profile – Part 1: Metric screw threads.*

ISO 261 : –[3], *ISO general purpose metric threads – General plan.*

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1) By careful choice of non-metallic materials higher service temperature properties can be attained by agreement between user and manufacturer.

2) To be published. (Revision of ISO 68:1973)

3) To be published. (Revision of ISO 261:1973)

ISO 898-1:–[4], *Mechanical properties of fasteners made of carbon steel and alloy steel – Part 1: Bolts, screws and studs.*

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

ISO 898-6:1994, *Mechanical properties of fasteners – Part 6: Nuts with specified proof load values – Fine pitch thread.*

ISO 965-2:–[5], *ISO general purpose metric screw threads – Tolerances – Part 2: Limits of sizes for general purpose bolt and nut threads – Medium quality.*

ISO 4042:–[6], *Fasteners – Electroplated castings.*

ISO 4753:–[7], *Fasteners – End of parts with external metric ISO thread.*

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

ISO 6507-1:–[8], *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 Definitions

For the purposes of this International Standard the following definitions apply.

3.1 prevailing torque type nut: Nut which is not free-running on a mating thread by virtue of a self-contained prevailing torque feature, and which provides a degree of resistance to rotation independent of clamping or compression forces.

3.2 prevailing torque developed by a nut: Torque necessary to rotate the nut on its mating, externally threaded component and with no axial load in the mating component.

4 Designation system

The property classes specified for prevailing torque type nuts are the same as specified in ISO 898-2 and ISO 898-6 for hexagon nuts, namely

- nuts with nominal heights $\geqslant 0{,}8\,d$ (effective lengths of thread $\geqslant 0{,}6\,d$) are designated by a number to indicate the maximum appropriate property class of bolts with which they may be mated, see table 1;

- nuts with nominal heights $\geqslant 0{,}5\,d$ and $< 0{,}8\,d$ (effective height of thread $\geqslant 0{,}4\,d$ and $< 0{,}6\,d$) 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 table 1. Table 2 gives the designation system and the stresses under proof load of these nuts.

4) To be published. (Revision of ISO 898-1:1988)

5) To be published. (Revision of ISO 965-2:1980)

6) To be published. (Revision of ISO 4042:1989)

7) To be published. (Revision of ISO 4753:1983)

8) To be published. (Revision of ISO 6507-1:1982; ISO 6507-2:1983; ISO 6507-3:1989; ISO 409-1:1982; ISO 409-2:1983 and ISO/DIS 409-3)

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

Property class of the nut							
	Coarse thread	**5**	**6**	**8**	**9**	**10**	**12**
	Fine pitch thread	–	**6**	**8**	–	**10**	**12**
Property class of the mating bolt or screw		⩽ 5.8	⩽ 6.8	⩽ 8.8	9.8 ⩽ 8.8	10.9 9.8 8.8	12.9 10.9 8.8

NOTE — In general, nuts of a higher property class can replace nuts of lower property class. However it is not recommended that a heat-treated all-metal nut be combined with a bolt of lower property class.

Table 2 — Designation system and stresses under proof load for nuts with nominal heigths ⩾ 0,5 d and < 0,8 d

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

5 Materials and processes

5.1 Materials

Nuts shall be made of steel conforming to the chemical composition limits specified in table 3. The prevailing torque element of insert-type nuts may be made of a material other than steel. It is recommended that users and manufacturers consider the maximum limits for sulphur, manganese, boron and other intentionally added elements which may result in component failure, when in excessive amounts.

Table 3 — Limits of chemical composition

Property class		**Chemical composition limit** (check analysis), %			
Coarse thread	Fine pitch thread	**C** max.	**Mn** min.	**P** max.	**S** min.
5[1]**; 6**[1]	**6**	0,50	–	0,060	0,150
8; 9; 04[1]	**8**	0,58	0,25	0,060	0,150
10[2]**; 05**[2]	**10**[2]	0,58	0,30	0,048	0,058
12[2]	**12**[2]	0,58	0,45	0,048	0,058

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

S 0,34 %, P 0,11 % and Pb 0,35 %.

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

5.2 Heat treatment

5.2.1 Nuts with coarse thread

Nuts of property classes 05, 8 (style 1, > M16), 10 and 12 shall be quenched and tempered. Case hardening is not allowed for any property class.

5.2.2 Nuts with fine pitch thread

Nuts of property classes 05, 8 (style 1), 10 and 12 shall be quenched and tempered. Case hardening is not allowed for any property class.

5.3 Thread

The thread of the prevailing torque type nuts must conform to ISO 965-2 except for the prevailing torque element.

In the case of prevailing torque type nuts with non-metallic insert, the go gauge must be capable of being screwed in freely by hand as far as the insert.

In the case of all-metal nuts the go gauge must be capable of being screwed in freely by hand for at least one thread.

5.4 Finish

All-metal nuts shall be lubricated and nuts with non-metallic insert may be lubricated to meet the stated performance requirements. The lubricant shall not constitute a health hazard to the user, nor emit an unpleasant odour during assembly and shall be suitable for automatic or robotic assembly.

Lubricant, when used, must be suitable for assembly speeds from 10 to 500 r/min.

The performance of nuts which are supplied with a protective coating and/or lubricant shall not deteriorate when the nuts are stored indoors for a period of six months. The storage temperature shall be within the range −5 °C to +40 °C.

NOTE — In the case where nuts are given a protective coating or cleaning following delivery to the user, the nut manufacturer shall not be held responsible for failure of the nut to meet dimensional, mechanical or performance properties traceable to the plating or coating.

5.5 Hydrogen embrittlement

For hydrogen embrittlement see ISO 4042.

6 Mechanical properties

When tested by methods described in 8.1 and 8.2, the nuts shall have the mechanical properties set out in tables 4 and 5.

Nuts shall withstand the proof load values specified in tables 6 and 7 for the applicable property class when tested as specified in 8.1.

Table 4 — Mechanical properties, coarse thread

Thread mm		Property class 04					05				
		Stress under proof load S_p	Vickers hardness HV		Nut		Stress under proof load S_p	Vickers hardness HV		Nut	
over	to	N/mm²	min.	max.	state	style	N/mm²	min.	max.	state	style
–	M4	380	188	302	neither quenched nor tempered	thin	500	272	353	quenched and tempered	thin
M4	M7										
M7	M10										
M10	M16										
M16	M39										

Thread mm		Property class 5[1)]					6					8									
		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		Stress under proof load S_p	Vickers hardness HV		Nut	
over	to	N/mm²	min.	max.	state	style	N/mm²	min.	max.	state	style	N/mm²	min.	max.	state	style	N/mm²	min.	max.	state	style
–	M4	520	130	302	neither quenched nor tempered	1	600	150	302	neither quenched nor tempered	1	800	180	302	neither quenched nor tempered	1	–	–	–	–	–
M4	M7	580					670					855	200								
M7	M10	590					680					870									
M10	M16	610					700					880									
M16	M39	630	146				720	170				920	233	353	quenched and tempered		890	180	302	neither quenched nor tempered	2

Table 4 (*concluded*)

Thread mm		Property class 9[1)]					10					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		Stress under proof load S_p	Vickers hardness HV		Nut	
over	to	N/mm²	min.	max.	state	style	N/mm²	min.	max.	state	style	N/mm²	min.	max.	state	style	N/mm²	min.	max.	state	style
–	M4	900	170	302	neither quenched nor tempered	2	1 040	272	353	quenched and tempered	1	1 140	295	353	quenched and tempered	1	1 150	272	353	quenched and tempered	2
M4	M7	915	188				1 040					1 140					1 150				
M7	M10	940					1 040					1 140					1 160				
M10	M16	950					1 050					1 170					1 190				
M16	M39	920					1 060					–	–	–	–	–	1 200				

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 quenched and tempered, and which satisfy the proof load test, minimum hardness shall not be cause for rejection.

1) 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 as 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.

Table 5 — Mechanical properties, fine pitch thread

Nominal thread diameter d mm	Property class 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	Property class 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
$8 \leqslant d \leqslant 39$	380	188	302	neither quenched nor tempered	thin	500	272	353	quenched and tempered	thin

Nominal thread diameter d mm	Property class 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	Property class 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
$8 \leqslant d \leqslant 10$	770	188	302	neither quenched nor tempered[1)]	1	955	250	353	quenched and tempered	1	890	195	302	neither quenched nor tempered	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: Stress under proof load S_p N/mm²	10: Vickers hardness HV min.	10: Vickers hardness HV max.	10: Nut state	10: Nut style	10: Stress under proof load S_p N/mm²	10: Vickers hardness HV min.	10: Vickers hardness HV max.	10: Nut state	10: Nut style	Property class 12: Stress under proof load S_p N/mm²	12: Vickers hardness HV min.	12: Vickers hardness HV max.	12: Nut state	12: Nut style
$8 \leqslant d \leqslant 10$	1 100	295	353	quenched and tempered	1	1 055	250	353	quenched and tempered	2	1 200	295	353	quenched and tempered	2
$10 < d \leqslant 16$	1 100														
$16 < d \leqslant 39$	–	–	–	–	–	1 080	260				–	–	–	–	–

NOTE — Minimum hardness is mandatory for heat-treated nuts and for 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 quenched and tempered, and which satisfy the proof-load test, minimum hardness shall not be cause for rejection.

1) For thread diameters above 16 mm, nuts may be quenched and tempered at the discretion of the manufacturer.

Table 6 — Proof load values – Coarse thread
(see also ISO 898-2)

Thread	Pitch of the thread	Nominal stress area of the mandrel A_s	Property class									
			04	05	5	6	8		9	10	12	
			Proof load ($A_s \times S_p$) N									
	mm	mm²	thin	thin	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
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	58,0	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	121 000	138 200	176 600	170 900	176 000	203 500	–	230 400
M20	2,5	245	93 100	122 500	154 400	176 400	225 400	218 100	225 400	259 700	–	294 000
M22	2,5	303	115 100	151 500	190 900	218 200	278 800	269 700	278 800	321 200	–	363 600
M24	3	353	134 100	176 500	222 400	254 200	324 800	314 200	324 800	374 200	–	423 600
M27	3	459	174 400	229 500	289 200	330 500	422 300	408 500	422 300	486 500	–	550 800
M30	3,5	561	213 200	280 500	353 400	403 900	516 100	499 300	516 100	594 700	–	673 200
M33	3,5	694	263 700	347 000	437 200	499 700	638 500	617 700	638 500	735 600	–	832 800
M36	4	817	310 500	408 500	514 700	588 200	751 600	727 100	751 600	866 000	–	980 400
M39	4	976	370 900	488 000	614 900	702 700	897 900	868 600	897 900	1 035 000	–	1 171 000

Table 7 — Proof load values – Fine pitch thread
(see also ISO 898-6)

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

P is the pitch of thread