

JIS

JAPANESE
INDUSTRIAL
STANDARD

Translated and Published by
Japanese Standards Association

JIS B 1052 : 1998

Mechanical properties of steel nuts

ICS 21.060.20

Descriptors : nuts, internal threads, mechanical testing, unalloyed steels, alloy steels, steels, mechanical behaviour of materials

Reference number : JIS B 1052 : 1998 (E)

B 1052:1998

Foreword

This translation has been made based on the original Japanese Industrial Standard revised by the Minister of International Trade and Industry through deliberations at Japanese Industrial Standards Committee in accordance with the Industrial Standardization Law. Consequently, JIS B 1052:1991 is replaced with JIS B 1052:1998.

Date of Establishment: 1972-06-01

Date of Revision: 1998-01-20

Date of Public Notice in Official Gazette: 1998-01-20

Investigated by: Japanese Industrial Standards Committee
Divisional Council on Machine Elements

JIS B 1052:1998, First English edition published in 1998-05

Translated and published by: Japanese Standards Association
4-1-24, Akasaka, Minato-ku, Tokyo, 107-8440 JAPAN

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Printed in Japan

Mechanical properties of steel nuts

Introduction Annex 1 and Annex 2 of this Standard have been prepared on the basis of **ISO 898-2**, *Mechanical properties of fasteners – Part 2: Nuts with specified proof load values – Coarse thread*, published as the second edition in 1992 and **ISO 898-6**, *Mechanical properties of fasteners – Part 6: Nuts with specified proof load values – Fine pitch thread*, published as second edition in 1994, without making any modification on the technical contents.

Annex 3, specified the mechanical properties of steel nuts classes 4T to 12T not specified in the corresponding International Standards, will be expired on 31st December 2000.

Among the descriptions of Annexes 1 and 2, dot underlined Remarks and Informative references are not contained in the based International Standards.

1 Scope This Japanese Industrial Standard specifies mechanical properties of steel nuts.

2 Mechanical property

2.1 The mechanical property for steel nuts (Coarse thread) of property classes 04, 05 and 4 to 12 shall be according to Annex 1 (normative).

2.2 The mechanical property for steel nuts (Fine pitched thread) of property classes 04, 05 and 5 to 12 shall be according to Annex 2 (normative).

2.3 The mechanical property for steel nuts (Coarse thread and fine pitched thread) of property classes 4T to 12T shall be according to Annex 3 (normative).

Annex 1 (normative)

Nuts with specified proof load values – Coarse thread

1 Scope This Annex 1 specifies the mechanical properties of nuts with specified proof load values (coarse thread) when tested at room temperature. Properties will vary at higher and lower temperature.

It applies to nuts

- with nominal thread diameters up to and including 39 mm;
- with diameter/pitch combinations according to **JIS B 0205**;
- with thread tolerances 6H according to **JIS B 0209**;
- with specific mechanical requirements;
- with widths across flats as specified in **JIS B 1002** (excluding those meshed half-tone dot);
- 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 **JIS B 1056**);
- weldability;
- corrosion resistance (see **JIS B 1054**);
- ability to withstand temperatures above $+300\text{ }^{\circ}\text{C}$ or below $-50\text{ }^{\circ}\text{C}$.

Remarks 1 Nuts made from free-cutting steel should not be used above $+250\text{ }^{\circ}\text{C}$.

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 Annex 1 Table 1).

Annex 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

- 4 In the case of thread tolerances other or larger than 6H, a decrease of the stripping strength should be considered (see Annex 1 Table 1).
- 5 The International Standard corresponding to this Annex 1 is as follows:

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

2 Normative references The following standards contain provisions which, through reference in this Annex 1, constitute provisions of this Annex 1. The most recent editions of the standards indicated below shall be applied.

JIS B 0205 *Metric coarse screw threads*

Remarks: The cited provisions from **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* and **ISO 724 : 1978**, *ISO metric screw threads – Basic dimensions* are equivalent to the corresponding provisions of this Standard.

JIS B 0209 *Limits of sizes and tolerances for metric coarse screw threads*

JIS B 0215 *Tolerance system for metric screw threads*

Remarks: The cited provisions from **ISO 965-1 : 1980**, *ISO general purpose metric screw threads – Tolerances – Part 1: Principles and basic data* and **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* are equivalent to the corresponding provisions of this Standard.

JIS B 0401 *System of limits and fits*

Remarks: The cited provisions from **ISO 286-2: 1988**, *ISO system of limits and fits – Part 2: Tables of standard tolerance grades and limit deviations for holes and shafts* are equivalent to the corresponding provisions of this Standard.

JIS B 1002 *Dimensions of widths across flats*

Remarks: The cited provisions from **ISO 272: 1982**, *Fasteners – Hexagon products – Widths across flats* are equivalent to the corresponding provisions of this Standard.

JIS B 1042 *Fasteners – Surface discontinuities – Part 2: Nuts with threads M5 to M39*

Remarks: **ISO 6157-2: 1995**, *Fasteners – Surface discontinuities – Part 2: Nuts* is identical with this Standard.

JIS B 1051 *Mechanical properties of steel bolts and screws*

Remarks: The cited provisions from **ISO 898-1: 1988**, *Mechanical properties of fasteners – Part 1: Bolts, screws and studs* are equivalent to the corresponding provisions of this Standard.

JIS B 1054 *Specification for corrosion-resistant stainless steel fasteners*

Remarks: The cited provisions from **ISO 3506: 1979**, *Corrosion-resistant stainless*

steel fasteners – Specifications are equivalent to the corresponding provisions of this Standard.

JIS B 1056 Mechanical and performance properties for prevailing torque type steel nuts

Remarks: The cited provisions from **ISO 2320: 1983**, *Prevailing torque type steel hexagon nuts – Mechanical and performance properties* are equivalent to the corresponding provisions of this Standard.

JIS Z 2243 Method of Brinell hardness test

Remarks: The cited provisions from **ISO 6506: 1981**, *Metallic materials – Hardness test – Brinell test* are equivalent to the corresponding provisions of this Standard.

JIS Z 2244 Method of Vickers hardness test

Remarks: The cited provisions from **ISO 6507-1: 1982**, *Metallic materials – Hardness test – Vickers test – Part 1: HV5 to HV100* are equivalent to the corresponding provisions of this Standard.

JIS Z 2245 Method of Rockwell and Rockwell superficial hardness test

Remarks: The cited provisions from **ISO 6508: 1986**, *Metallic materials – Hardness test – Rockwell test (scales A–B–C–D–E–F–G–H–K)* are equivalent to the corresponding provisions of this Standard.

3 Designation system

3.1 Nuts with nominal heights $\geq 0.8d$ (effective lengths of thread $\geq 0.6d$)

Nuts with nominal heights $\geq 0.8d$ (effective lengths of thread $\geq 0.6d$) 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 Annex 1 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.

Remarks: For more detailed information on the strength of screw thread assemblies, see Annex 1A.

Annex 1 Table 2 Property classification of nuts with nominal heights $\geq 0.8d$ and their mating bolts

Property class of nut	Mating bolts		Nuts	
	Property class	Thread range	Style 1	Style 2
			Thread ranges	
4	3.6, 4.6, 4.8	$> M16$	$> M16$	—
5	3.6, 4.6, 4.8	$\leq M16$	$\leq M39$	—
	5.6, 5.8	$\leq M39$		
6	6.8	$\leq M39$	$\leq M39$	—
8	8.8	$\leq M39$	$\leq M39$	$> M16$ $\leq M39$
9	9.8	$\leq M16$	—	$\leq M16$
10	10.9	$\leq M39$	$\leq M39$	—
12	12.9	$\leq M39$	$\leq M16$	$\leq M39$
Remarks: 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 $\geq 0.5d$ but $< 0.8d$ (effective heights of thread $\geq 0.4d$ but $< 0.6d$) (Thin nut) Nuts with nominal heights $\geq 0.5d$ but $< 0.8d$ (effective height of thread $\geq 0.4d$ but $< 0.6d$) are designated by a combination of two numbers as shown in Annex 1 Table 3.

The second (4 and 5) indicates the nominal stress under proof load on a hardened test mandrel, while the first (0) 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.

Annex 1 Table 3 gives the designation system and the stresses under proof load of the nuts. Proof loads are shown in Annex 1 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 Annex 1 Table 7.

Annex 1 Table 3 Designation system and stresses under proof load for thin nuts

Property class of nut	Nominal stress under proof load N/mm ²	Actual stress under proof load N/mm ²
04	400	380
05	500	500

4 Materials Nuts shall be made of steel conforming to the chemical composition limits specified in Annex 1 Table 4.

Nuts of property classes 05, 8 (style 1 above M16), 10 and 12 shall be hardened and tempered.

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
Notes⁽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 (S), phosphorus (P), and lead (Pb) contents are permissible: S: 0.34 % P: 0.11 %, Pb: 0.35 % ⁽²⁾ Alloying elements may be added, if necessary, to develop the mechanical properties of the nuts.					

5 Mechanical properties When tested by the methods described in clause 8, the mechanical properties of nuts shall conform to Annex 1 Table 5.

6 Proof load values Proof load values are given in Annex 1 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^* : the basic pitch diameter of the external thread;

d_3 : the minor diameter of the external thread;

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

d_1^* : the basic minor diameter of the external thread;

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

Note*: d_1 and d_2 shall be in accordance with **JIS B 0205**.

Annex 1 Table 5 Mechanical properties

Thread		Property class																			
		04					05					4					5 ⁽⁵⁾				
		Stress under proof load Sp N/mm ²		Vickers hardness HV		Nut		Stress under proof load Sp N/mm ²		Vickers hardness HV		Nut		Stress under proof load Sp N/mm ²		Vickers hardness HV		Nut			
greater than	less than or equal to	Min.	Max.	State	Style	Min.	Max.	State	Style	Min.	Max.	State	Style	Min.	Max.	State	Style	Min.	Max.	State	Style
—	M4	380	188 302	NQT ⁽³⁾	thin	500	272 353	QT ⁽⁴⁾	thin		—	—	—	—	520	130 302	NQT ⁽³⁾	1			
M4	M7														580						
M7	M10														590						
M10	M16														610						
M16	M39													510	117 302	NQT ⁽⁴⁾	1	630	146		

Thread		Property class																			
		6					8										9				
		Stress under proof load Sp N/mm ²		Vickers hardness HV		Nut		Stress under proof load Sp N/mm ²		Vickers hardness HV		Nut		Stress under proof load Sp N/mm ²		Vickers hardness HV		Nut			
greater than	less than or equal to	Min.	Max.	State	Style	Min.	Max.	State	Style	Min.	Max.	State	Style	Min.	Max.	State	Style	Min.	Max.	State	Style
—	M4	600	150 302	NQT ⁽³⁾	1	800	180 302	NQT ⁽³⁾	1	—	—	—	—	900	170 302	NQT ⁽³⁾	2				
M4	M7	670				855	200							915	188						
M7	M10	680				870								940							
M10	M16	700				880								950							
M16	M39	720	170			920	233 353	QT ⁽⁴⁾		890	180 302	NQT ⁽³⁾	2	920							

Annex 1 Table 5 Mechanical properties (Continued)

Thread		Property class														
		10					12									
		Stress under proof load S_p N/mm ²	Vickers hardness HV Min. Max.		Nut State Style		Stress under proof load S_p N/mm ²	Vickers hardness HV Min. Max.		Nut State Style		Stress under proof load S_p N/mm ²	Vickers hardness HV Min. Max.		Nut State Style	
greater than	less than or equal to															
—	M4	1 040	272	353	QT ⁽⁴⁾	1	1 140	295	353	QT ⁽⁴⁾	1	1 150	272	353	QT ⁽⁴⁾	2
M4	M7	1 040					1 140					1 150				
M7	M10	1 040					1 140					1 160				
M10	M16	1 050					1 170					1 190				
M16	M39	1 060					—					—				
Notes ⁽³⁾ NQT=Not quenched or tempered. ⁽⁴⁾ QT=Quenched and tempered. ⁽⁵⁾ The values of stress under proof load of property class 5 are based on the maximum bolt hardness of 220 HV. The maximum bolt hardness of property classes 5, 6 and 5.8, while specified as 250 HV in JIS B 1051-1991, will be changed to be 220 HV in the next revision. This value of 220 HV 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. Remarks: 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.																

Annex 1 Table 6 Proof load values

Thread	Thread pitch	Nominal stress area of the mandrel A_s	Property class										
			04	05	4	5	6	8	9	10	12		
			Proof load ($A_s \times S_p$)										
			Thin	Thin	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 minimum bolt stress when stripping occurs are given in Annex 1 Table 7 for guidance of using thin nuts with 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.

Annex 1 Table 7 Minimum bolt stress when stripping occurs

Property class of the nut	Proof load stress of the nut N/mm ²	Minimum stress in the core of bolt when stripping occurs N/mm ²			
		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 test shall be used wherever the capacity of available testing equipment permits, and shall be the referee method of Annex 1 for sizes $\geq M5$.

For the test, the nut shall be assembled on a hardened and threaded test mandrel as shown in Annex 1 Figs. 1 and 2. For referee purposes to Annex 1 Table 6, the axial tensile test in Annex 1 Fig. 1 is decisive.

For this test, the proof load given in Annex 1 Table 6 shall be applied against the nut in an axial direction, and shall be held for 15s. 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 test mandrel shall be hardened at 45 HRC minimum, and 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.

Informative reference: The thread tolerances (Major diameter and pitch diameter) of testing mandrel for M3 to M39 are shown in Annex 1 Informative Table 1.