1. STEEL FASTENERS FOR THE TEMPERATURE RANGE BETWEEN –50°C AND +150°C

1.1 Materials for fasteners

The material that is used is of decisive importance for the quality of the fasteners (screws, nuts and fittings). If there are any faults in the material used, the fastener made from it can no longer satisfy the requirements made of it.

The most important standards for screws and nuts are:
- DIN EN ISO 898-1, Mechanical properties of fasteners made of carbon steel and alloy steel, Part 1: Screws
- DIN EN 20898 Part 2 (ISO 898 Part 2), Mechanical properties of fasteners, Part 2: Nuts

These standards stipulate the material that is to be used, the marking, the properties of the finished parts and their tests and test methods.

Different materials are used for the different strength classes which are listed in the following table 1.

Strength class	Material and heat treatment	Chemical composition (molten mass analysis %)[a]					Tempering temperature
		C		P	S	B[b]	°C
		min.	max.	max.	max.	max.	min.
4.6[c, d]	Carbon steel or carbon steel with additives	–	0.55	0.050	0.060	not stipulated	–
4.8[d]							
5.6[c]		0.13	0.55	0.050	0.060		
5.8[d]		–	0.55	0.050	0.060		
6.8[d]		0.15	0.55	0.050	0.060		
8.8[f]	Carbon steel with additives (e.g. B or Mn or Cr), hardened and tempered or	0.15[e]	0.40	0.025	0.025	0.003	425
	Carbon steel, hardened and tempered or	0.25	0.55	0.025	0.025		
	Alloy steel, hardened and tempered[g]	0.20	0.55	0.025	0.025		
9.8[f]	Carbon steel with additives (e.g. B or Mn or Cr), hardened and tempered or	0.15[e]	0.40	0.025	0.025	0.003	425
	Carbon steel, hardened and tempered or	0.25	0.55	0.025	0.025		
	Alloy steel, hardened and tempered[g]	0.20	0.55	0.025	0.025		
10.9[f]	Carbon steel with additives (e.g. B or Mn or Cr), hardened and tempered or	0.20[e]	0.55	0.025	0.025	0.003	425
	Carbon steel, hardened and tempered or	0.25	0.55	0.025	0.025		
	Alloy steel, hardened and tempered[g]	0.20	0.55	0.025	0.025		

Strength class	Material and heat treatment	Chemical composition (molten mass analysis %)[a]					Tempering temperature
		C		P	S	B[b]	°C
		min.	max.	max.	max.	max.	min.
12.9[f, h, i]	Alloy steel, hardened and tempered[g]	0.30	0.50	0.025	0.025	0.003	425
12.9[f, h, i]	Carbon steel with additives (e.g. B or Mn or Cr or molybdenum), hardened and tempered	0.28	0.50	0.025	0.025	0.003	380

[a] In case of arbitration, the product analysis applies.
[b] The boron content may reach 0.005%, provided that the non-effective boron is controlled by additions of titanium and/or aluminium.
[c] In case of cold-formed screws in strength classes 4.6 and 5.6 heat treatment of the wire used for cold forming or the cold formed screw may be necessary to achieve the required ductility.
[d] Free-cutting steel with the following max. sulphur, phosphorous and lead shares is permissible for these strength classes: sulphur 0.34%; phosphorous 0.11%; lead 0.35%.
[e] A manganese content of not less than 0.6% for strength class 8.8 and 0.7% for strength classes 9.8 and 10.9 must be present in simple carbon steel with boron as an additive and a carbon content under 0.25% (molten mass analysis).
[f] Materials in these strength classes must be sufficiently hardenable to ensure that there is a martensite share of roughly 90% in the hardened state before tempering in the microstructure of the core in the threaded part.
[g] Alloy steel must contain at least one of the following alloying components in the given minimum amount: chromium 0.30%, nickel 0.30%, molybdenum 0.20%, vanadium 0.10%. If two, three or four elements are ascertained in combinations and have smaller alloy shares than those given above, the threshold value to be applied for the classification is 70% of the sum of the individual threshold values given above for the two, three or four elements concerned.
[h] In case of strength class 12.9/12.9 a metallographically detectable white layer enriched with phosphorous is not permissible. This must be verified with a suitable test procedure.
[i] Caution is necessary when strength class 12.9/12.9 is used. The suitability of the screw manufacturer, the assembly and the operating conditions must be taken into account. Special environmental conditions may lead to stress corrosion cracking of both uncoated and coated screws.

1.2 Mechanical properties of steel screws

This chapter provides a brief overview of the methods used to stipulate and determine the mechanical properties of screws. In this context, the most common parameters and rated quantities will be discussed.

1.2.1 Tensile test

The tensile test is used to determine important parameters for screws such as tensile strength R_m, yield point R_e, 0.2% offset yield point $R_{p0.2}$, and elongation at fracture A5 (%).

A difference is made between "tensile test with turned off specimens" and "tensile test on whole screws" (DIN EN ISO 898 Part 1).

1.2.2 Tensile strength R_m (MPa)

The tensile strength R_m indicates the tensile stress from which the screw may fracture. It results from the maximum force and the corresponding cross-section. With full strength screws the fracture may only occur in the shaft or in the thread, and not in the connection between the head and the shaft.

Tensile strength on fracture in cylindrical shaft (turned off or whole screws):

R_m = maximum tensile force/cross-section area = F/S_o [MPa]

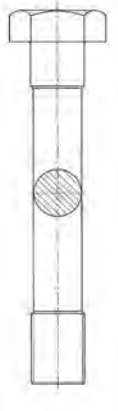
Tensile strength on fracture in thread:

R_m = maximum tensile force/tension cross-section = F/A_s [MPa]

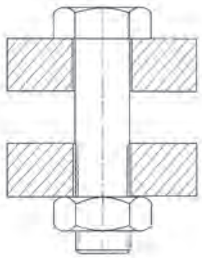
A_s tension cross-section

1.2.3 Apparent yielding point R_e (MPa)

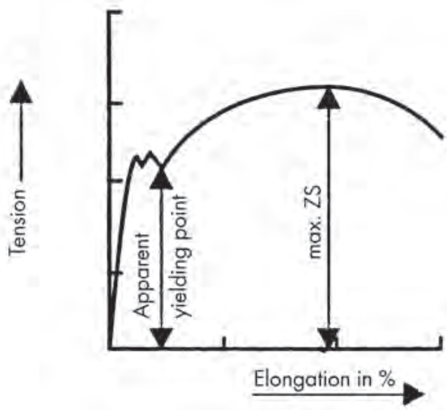
Under DIN EN ISO 898 Part 1 the exact yield point can only be determined on turned off specimens. The yield point is the point to which a material, under tensile load, can be elongated without permanent plastic deformation. It represents the transition from the elastic to the plastic range. Fig. C shows the qualitative curve of a 4.6 screw (ductile steel) in the stress-strain diagram.



Tensile test on a
turned-off screw
Fig. A



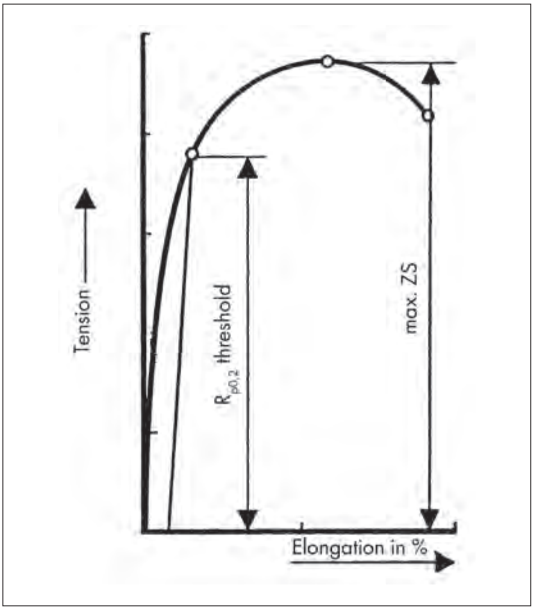
Tensile test on a
whole screw
Fig. B



Stress-strain diagram of a screw
with the strength class 4.6 (qualitative)
Fig. C

1.2.4 0.2% offset yield point $R_{p0.2}$ (MPa)

The offset yield point $R_{p0.2}$ is determined as a so-called substitute yield point, because most hardened and tempered steels do not show a marked transition from the elastic into the plastic range. The 0.2% offset yield point $R_{p0.2}$ represents the tension at which a permanent elongation of 0.2% is achieved. Fig. D shows the qualitative tension curve in the stress-strain diagram for a 10.9 screw.



Stress-strain diagram of a screw with strength class 10.9 (qualitative)

Fig. D

1.2.5 Tensile test on whole screws

Along with the tensile test on turned off specimens, a less complicated test of whole screws is also possible. In this test, the whole screw is clamped into the test device at the head and the thread. Because in this case the ratio of the length and the diameter of the specimen is not always the same, in deviation from the test for the proportional rod, this test can only be used to determine the tensile strength R_m, the extension to fracture A_f and the 0.004 8 d offset yield point R_{pf}.

0.004 8 d offset yield point R_{pf} (MPa) in accordance with chapter 9.3 of ISO 898-1 2009-08.

1.2.6 Strength classes

Screws are designated with strength classes, so that it is very easy to determine the tensile strength R_m and the yield point R_e (or the 0.2% offset yield point $R_{p0.2}$).

Example:

Screw 8.8

1. Determining R_m: the first number is multiplied by 100.
   → R_m = 8 x 100 = 800 Mpa
   The first number indicates 1/100 of the minimum tensile strength in MPa.
2. Determining R_e or $R_{p0.2}$:

the first number is multiplied by the second and the result is multiplied by 10; the result is the yield point R_e or 0.2% offset yield point $R_{p0.2}$. → R_e = (8 x 8) x 10 = 640 MPA.

1.2.7 Elongation at fracture A5 (%)

The elongation at fracture is an important parameter for assessing the ductility of a material and is created on the load to the screw fracturing. This is determined on turned off screws with a defined shaft range (proportional rod) (exception: rust- and acid-resistant screws, steel group A1–A5). The permanent plastic elongation is shown as a percentage and is calculated using the following equation:

$A5 = (L_u - L_o)/L_o \times 100\%$

Lo Defined length before the tensile test $L_o = 5 \times d_o$
L_u Length after fracture
d_o Shaft diameter before the tensile test

Example of a proportional rod

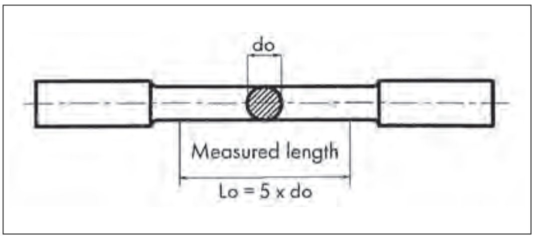


Fig. E

1.2.8 Hardness and hardness test methods

Definition:

Hardness is the resistance that a body uses to counter penetration by another, harder body.

The most important hardness test methods in practice are:

Test method	Vickers hardness HV DIN EN ISO 6507	Brinell hardness HB DIN EN ISO 6506	Rockwell hardness HRC DIN EN ISO 6508
Specimen	Pyramid	Ball	Tube

The test using the Vickers method comprises the complete hardness range for screws.

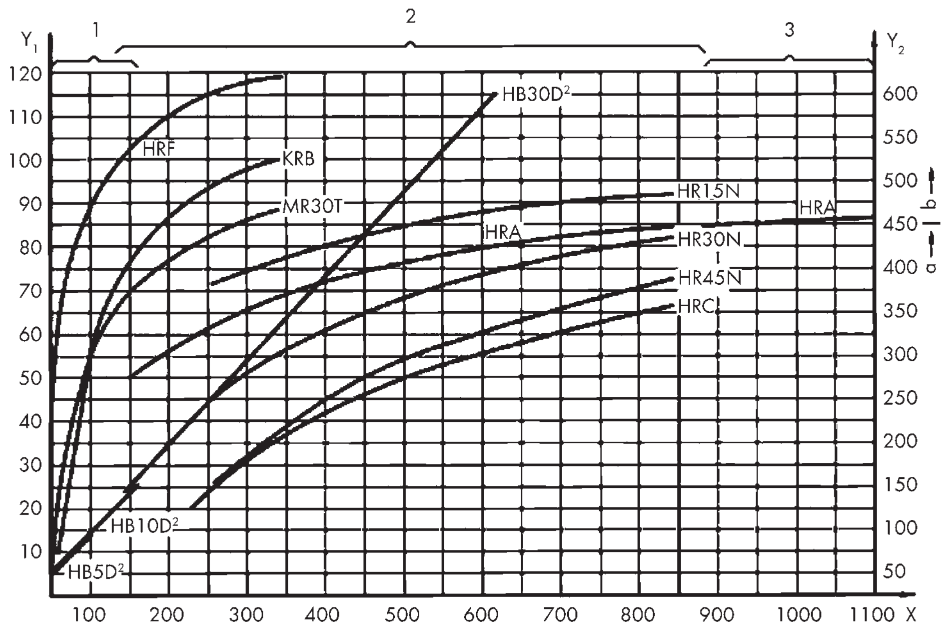
Comparison of hardness data

The following graph F applies for steels and corresponds to the hardness comparison tables in DIN EN ISO 18265. These should be used as a starting point, because an exact comparison of results is only possible with the same method and under the same conditions.

1.3 Strength classes of screws

The mechanical and physical properties of screws and nuts are described with the help of the strength classes. This is done for screws in Table 2 below by means of nine strength classes, in which each of the properties such as tensile strength, hardness, yield point, elongation at fracture, etc., are shown.

Representation of different hardness scales on the Vickers scale



Legend:
X Vickers hardness HV 30
Y_1 Rockwell hardness
Y_2 Brinell hardness

1 Hardness range for non-ferrous metals
2 Hardness range for steels
3 Hardness range for hard metals
a Brinell hardness, determined with steel ball (HBS)
b Brinell hardness, determined with hard metal tube (HBW)

Fig. F: Extract from DIN EN ISO 18265

Mechanical and physical properties of screws

No.	Mechanical or physical property		Strength class 4.6	4.8	5.6	5.8	6.8	8.8 d ≤ 16 mm[a]	8.8 d > 16 mm[b]	9.8 d ≤ 16 mm	10.9	12.9/12.9
1	Tensile strength, R_m, MPa	nom.[c]	400		500		600	800		900	1,000	1,200
		min.	400	420	500	520	600	800	830	900	1,040	1,220
2	Lower yield point, R_{eL}[d], MPa	nom.[c]	240	–	300	–	–	–	–	–	–	–
		min.	240	–	300	–	–	–	–	–	–	–
3	0.2% offset yield point $R_{p0.2}$, MPa	nom.[c]	–	–	–	–	–	640	640	720	900	1,080
		min.	–	–	–	–	–	640	660	720	940	1,100
4	0.0004 8 d offset yield point for whole screws R_{pf}, MPa	nom.[c]	–	320	–	400	480	–	–	–	–	–
		min.	–	340[e]	–	420[e]	480[e]	–	–	–	–	–
5	Tension under test force, S_p[f], MPa	nom.	225	310	280	380	440	580	600	650	830	970
	Test resistance ratio $S_{p,nom}/R_{eL\ min}$ or $S_{p,nom}/R_{p0,2}$ min or $S_{p,nom}/R_{pf\ min}$		0.94	0.91	0.93	0.90	0.92	0.91	0.91	0.90	0.88	0.88
6	Percentage elongation at fracture of a turned off specimen, A, %	min.	22	–	20	–	–	12	12	10	9	8
7	Percentage contraction at fracture of a turned off specimen, Z, %	min.	–					52		48	48	44
8	Extension to fracture of a whole screw, A_f (see Annex C as well)	min.	–	0,24	–	0,22	0,20	–	–	–	–	–
9	Head impact strength		No fracture									
10	Vickers hardness, HV F ≥ 98 N	min.	120	130	155	160	190	250	255	290	320	385
		max.	220[g]				250	320	335	360	380	435
11	Brinell hardness, HBW F = 30 D^2	min.	114	124	147	152	181	238	242	276	304	366
		max.	209[g]				238	304	318	342	361	414
12	Rockwell hardness, HRB	min.	67	71	79	82	89	–				
		max.	95.0[g]				99,5	–				
	Rockwell hardness, HRC	min.	–					22	23	28	32	39
		max.	–					32	34	37	39	44
13	Surface hardness, HV, 0.3	max.	–					h			h,i	h,j
14	Height of non-decarburised thread zone, E, mm	min.	–					$1/2H_1$			$2/3H_1$	$3/4H_1$
	Depth of complete decarburisation in the thread, G, mm	max.	–					0,015				
15	Loss of hardness following re-tempering (hardening), HV	max.	–					20				
16	Fracture torque, M_B, Nm	min.	–					nach ISO 898-7				
17	Notch impact energy, K_V[k, l], J	min.	–		27	–		27	27	27	27	m
18	Surface condition in accordance with		ISO 6157-1[n]									ISO 6157-3

a Values do not apply to steel construction screws.
b For steel construction screws d ≥ M12.
c Nominal values are stipulated only for the designation system of the strength classes. See Annex 5.
d If the lower yield point R_{eL} cannot be determined, the 0.2% offset yield point $R_{p0.2}$ may be determined.
e The values for Rpf min are examined for strength classes 4.8, 5.8 and 6.8. The current values are shown only for the calculation of the test stress ratio. They are not test values.
f Test forces are stipulated in tables 5 and 7.
g The hardness measured at the end of a screw may not exceed max. 250 HV, 238 HB or 99.5 HRB.
h The surface hardness at the respective screw may not exceed 30 Vickers points of the measured core hardness, if both the surface hardness and the core hardness are determined with HV 0.3.
i An increase of the surface hardness to over 390 HV is not permissible.
j An increase of the surface hardness to over 435 HV is not permissible.
k The values are determined at a test temperature of −20 °C, cf. 9.14.
l Applies for d ≥ 16 mm.
m Values for KV are examined.
n ISO 6157-3 may apply instead of ISO 6157-1 by agreement between the manufacturer and the customer.

Tab. 2: Extract from DIN EN ISO 898-1, mechanical and physical properties of screws

1.3.1 Test forces

In the tensile test the test force shown in tables 3 and 4 is applied axially to the screw and held for 15 s. The test is regarded as successful if the screw length after measuring coincides with the length before the test. A tolerance of ±12.5 µm applies. The following tables are an important help for the user for choosing suitable screws.

ISO metric standard thread

Thread[a d]	Nominal tension cross-section t $A_{s,nom}$[b], mm²	Strength class								
		4.6	4.8	5.6	5.8	6.8	8.8	9.8	10.9	12.9/12.9
		Test force, F_p ($A_{s,nom} \times S_p$), N								
M3	5.03	1,130	1,560	1,410	1,910	2,210	2,920	3,270	4,180	4,880
M3.5	6.78	1,530	2,100	1,900	2,580	2,980	3,940	4,410	5,630	6,580
M4	8.78	1,980	2,720	2,460	3,340	3,860	5,100	5,710	7,290	8,520
M5	14.2	3,200	4,400	3,980	5,400	6,250	8,230	9,230	11,800	13,800
M6	20.1	4,520	6,230	5,630	7,640	8,840	11,600	13,100	16,700	19,500
M7	28.9	6,500	8,960	8,090	11,000	12,700	16,800	18,800	24,000	28,000
M8	36.6	8,240[c]	11,400	10,200[c]	13,900	16,100	21,200[c]	23,800	30,400[c]	35,500
M10	58	13,000[c]	18,000	16,200[c]	22,000	25,500	33,700[c]	37,700	48,100[c]	56,300
M12	84.3	19,000	26,100	23,600	32,000	37,100	48,900[d]	54,800	70,000	81,800
M14	115	25,900	35,600	32,200	43,700	50,600	66,700[d]	74,800	95,500	112,000
M16	157	35,300	48,700	44,000	59,700	69,100	91,000[d]	102,000	130,000	152,000
M18	192	43,200	59,500	53,800	73,000	84,500	115,000	–	159,000	186,000
M20	245	55,100	76,000	68,600	93,100	108,000	147,000	–	203,000	238,000
M22	303	68,200	93,900	84,800	115,000	133,000	182,000	–	252,000	294,000
M24	353	79,400	109,000	98,800	134,000	155,000	212,000	–	293,000	342,000
M27	459	103,000	142,000	128,000	174,000	202,000	275,000	–	381,000	445,000
M30	561	126,000	174,000	157,000	213,000	247,000	337,000	–	466,000	544,000
M33	694	156,000	215,000	194,000	264,000	305,000	416,000	–	576,000	673,000
M36	817	184,000	253,000	229,000	310,000	359,000	490,000	–	678,000	792,000
M39	976	220,000	303,000	273,000	371,000	429,000	586,000	–	810,000	947,000

a If a thread pitch is not indicated in the thread designation, the standard thread is stipulated.
b See 9.1.6.1 for the calculation of $A_{s,nom}$.
c In accordance with ISO 10684:2004, Annex A, reduced values apply for screws with thread tolerance 6az in accordance with ISO 965-4 that are to be hot-galvanised.
d For steel construction screws 50700 N (for M12), 68800 N (for M14) and 94500 N (for M16).

Tab. 3: Extract from DIN EN ISO 898-1, Test forces for ISO metric standard thread

Metric ISO fine thread

Thread d x P	Nominal tension cross-section t $A_{s,\,nom}$[b], mm²	Strength class								
		4.6	4.8	5.6	5.8	6.8	8.8	9.8	10.9	12.9/ 12.9
		Test force, F_p ($A_{s,\,nom} \times S_p$), N								
M8 x 1	39.2	8,820	12,200	11,000	14,900	17,200	22,700	25,500	32,500	38,000
M10 x 1.25	61.2	13,800	19,000	17,100	23,300	26,900	35,500	39,800	50,800	59,400
M10 x 1	64.5	14,500	20,000	18,100	24,500	28,400	37,400	41,900	53,500	62,700
M12 x 1.5	88.1	19,800	27,300	24,700	33,500	38,800	51,100	57,300	73,100	85,500
M12 x 1.25	92.1	20,700	28,600	25,800	35,000	40,500	53,400	59,900	76,400	89,300
M14 x 1.5	125	28,100	38,800	35,000	47,500	55,000	72,500	81,200	104,000	121,000
M16 x 1.5	167	37,600	51,800	46,800	63,500	73,500	96,900	109,000	139,000	162,000
M18 x 1.5	216	48,600	67,000	60,500	82,100	95,000	130,000	–	179,000	210,000
M20 x 1.5	272	61,200	84,300	76,200	103,000	120,000	163,000	–	226,000	264,000
M22 x 1.5	333	74,900	103,000	93,200	126,000	146,000	200,000	–	276,000	323,000
M24 x 2	384	86,400	119,000	108,000	146,000	169,000	230,000	–	319,000	372,000
M27 x 2	496	112,000	154,000	139,000	188,000	218,000	298,000	–	412,000	481,000
M30 x 2	621	140,000	192,000	174,000	236,000	273,000	373,000	–	515,000	602,000
M33 x 2	761	171,000	236,000	213,000	289,000	335,000	457,000	–	632,000	738,000
M36 x 3	865	195,000	268,000	242,000	329,000	381,000	519,000	–	718,000	839,000
M39 x 3	1,030	232,000	319,000	288,000	391,000	453,000	618,000	–	855,000	999,000

a See 9.1.6.1 for the calculation of $A_{s,nom}$

Tab. 4: Extract from DIN EN ISO 898-1, Test forces for ISO metric fine thread

1.3.2 Properties of screws at increased temperatures

The values shown apply only as an indication for the reduction of the yield points in screws that are tested under increased temperatures. They are not intended for the acceptance test of screws.

Strength class	Temperature				
	+ 20 °C	+ 100 °C	+ 200 °C	+ 250 °C	+ 300 °C
	Lower yield point R_{eL} or 0.2% offset yield point $R_{p\,0.2}$ MPa				
5.6	300	250	210	190	160
8.8	640	590	540	510	480
10.9	940	875	790	745	705
12.9	1,100	1,020	925	875	825

Tab. 5: Extract from DIN EN ISO 898-1 1999-11, hot yield strength

1.4 Strength classes for nuts

With nuts, the test stress and the test forces calculated from it are usually indicated as parameters (04 to 12), because the yield point does not have to be stated. Up to the test forces shown in table 6 a tensile load on a screw is possible without problems (take note of pairing 1.5). The strength class of a nut is described through a test stress in relation to a hardened test mandrel and divided by 100.

Example:

M6, test stress 600 MPa

600/100 = 6 strength class 6

Test forces for ISO metric standard thread (nuts)

Thread	Thread pitch	Nominal stressed cross section of the test mandrel A_s	Strength class										
			04	05	4	5	6	8		9	10	12	
			Test force ($A_s \times S_p$), 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	58.0	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	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	330,550	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

Tab. 6: Extract from DIN EN 20898-2, Test forces for ISO metric standard thread (nuts)

The test force FP is calculated as follows with the help of the test stress Sp (DIN EN 20898 Part 2) and the nominal stressed cross section A_s: $F_p = A_s \times S_p$

The nominal tension cross-section is calculated as follows:

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

where:

d_2 is the flank diameter of the external thread (nominal size) d_3 is the core diameter of the production profile of the external thread (nominal size)

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

with

d_1 Core diameter of the base profile of the external thread

H = height of the profile triangle of the thread

1.5 Pairing of screws and nuts:

Rule:

If a screw has strength class 8.8, a nut with a strength class 8 has to be chosen as well.

To avoid the danger of stripping threads when tightening with modern assembly technology methods, screws and nuts have to be paired in accordance with the above rule. In addition, a screw assembly of this type is fully loadable.

Note:

In general nuts in the higher strength class can be used instead of nuts in the lower strength class. This is advisable for a screws-nut connection with loads above the yield point or above the test stress (expansion screws).

Pairing of screws and nuts (nominal heights ≥ 0.8 D)

Strength class of the nuts	Appropriate screw		Nuts	
			Style 1	Style 2
	Strength class	Thread range	Thread range	
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

Tab. 7: Extract from DIN EN 20898 Part 2

1.5.1 Information for steel nuts

A screw in strength class 8.8 is paired with a nut in strength class 8 or higher. Thanks to this connection, the screw can be loaded to the yield point.

If nuts with a limited loadability are used – for example in strength class 04, 05; nuts with hardness details 14H, 22H – this is not the case. There are test forces for these nuts in accordance with DIN EN 20898-2.

1.5.2 Stripping resistance for nuts with a nominal height ≥ 0.5 d and < 0.8 d (in accordance with DIN EN 20898, Part 2)

If nuts are paired with screws in a higher strength class, stripping of the nut's thread can be expected.

The reference value show here for the stripping resistance refers to the strength class shown in the table.

Strength class of the nuts	Test stress of the nuts	Minimum stress in the screw before stripping when paired with screws in strength classes in N/mm²			
	N/mm²	6.8	8.8	10.9	12.9
04	380	260	300	330	350
05	500	290	370	410	480

Tab. 8: Extract from DIN EN 20898 Part 2

There is limited loadability as well for nuts in accordance with DIN 934 that are marked I8I, and I4I, I5I, I6I, I9I, I10I, I12I. When a screw in strength class 8.8 and a nut in accordance with DIN 934 (nominal height approx. 0.8 x d) are used, this connection is not to be loaded with certainty to the screw's yield point. To mark and differentiate them, these nuts are marked with a bar before and after the "8" (I8I) instead of just "8".

1.6 Mechanical properties of threaded pins (in accordance with DIN EN ISO 898, Part 5)

The mechanical properties apply for threaded pins and similar threaded **parts not subject to tensile stress** that are made of alloyed and unalloyed steel.

Mechanical property		Strength class[1)]			
		14H	22 H	33 H	45H
Vickers hardness HV	min. max.	140 290	220 300	330 440	450 560
Brinell hardness HB, $F = 30\ D^2$	min. max.	133 276	209 285	314 418	428 532
Rockwell hardness HRB	min. max.	75 105	95		
Rockwell hardness HRC	min. max.		30	33 44	45 53
Surface hardness HV 0.3			320	450	580

[1)] Strength classes 14H, 22H and 33H do not apply to threaded pins with a hexagonal socket

Tab. 9: Extract from EN ISO 898-5

1.7 Marking of screws and nuts

Marking screws with full loadability

Hexagon head screws:

Marking hexagon head screws with the manufacturer's mark and the strength class is prescribed for all strength classes and a nominal thread diameter of d ≥ 5 mm.

The screw must be marked at a point where its shape permits.

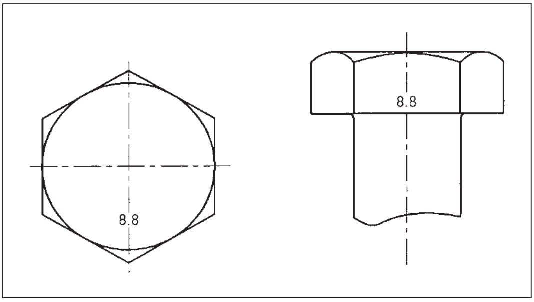


Fig. G: Example for the marking of hexagon head screws

Socket head cap screws:

Marking socket head cap screws with the manufacturer's mark and the strength class is prescribed for strength classes ≥ 8.8 and a thread diameter of d ≥ 5 mm.

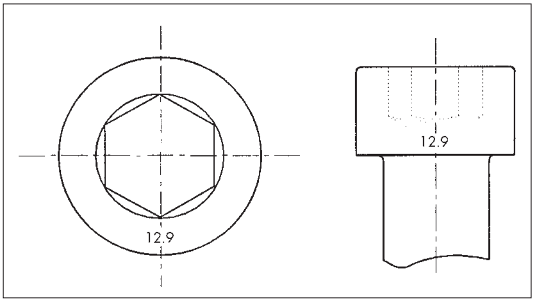


Fig. H: Example for the marking of socket head cap screws

Marking nuts

Strength class	04	05	4	5	6	8	9	10	12
Mark	04	05	4	5	6	8	9	10	12

Tab. 10: Extract from EN 20898-2

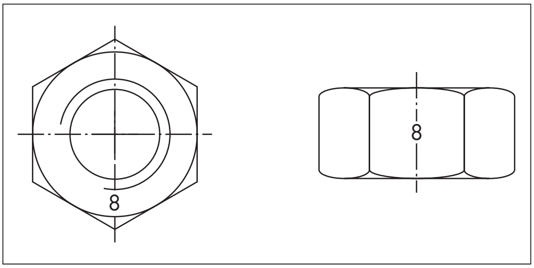


Fig. I: Example of marking with the code number of the strength class

Marking of hexagonal nuts with the manufacturer's mark and the strength class is prescribed for all strength classes and with a thread ≥ M5. Hexagonal nuts must be marked on the bearing surface or on a flat with a recessed mark or on the chamfer with a raised mark. Raised marks may not project beyond the nut's bearing surface. As an alternative to the marking with the code number of the strength class, marking can also be done with the help of the clockwise system (for more information see DIN EN 20898 Part 2).

Marking screws with reduced loadability

Screws with reduced loadability have an "0" before the strength class mark, e.g. 8.8. The point between the digits may be omitted so that the variants "08.8" and "088" are possible. This marking is possible for all strength classes.

1.8 Inch thread conversion table inch/mm

Inch	1/4"	5/16"	3/8"	7/16"	1/2"	5/8"	3/4"	7/8"	1"	1.1/4"
mm	6.3	7.9	9.5	11.1	12.7	15.9	19.1	22.2	25.4	31.8

Inch	1.1/2"	1.3/4"	2"	2.1/4"	2.1/2"	2.3/4"	3"	3.1/2"	4"	
mm	38.1	44.5	50.8	57.1	63.5	69.9	76.2	88.9	102.0	

Number of threads per 1" UNC/UNF

0-inch	1/4"	5/16"	3/8"	7/16"	1/2"	5/8"	3/4"	
Thread pitch UNC	20	18	16	14	13	11	10	
Thread pitch UNF	28	24	24	20	20	18	16	

Tab. 11: Thread pitch UNC/UNF