Technical Data [ข้อมูลทางเทคนิค] [อ้างอิงจาก ISO898-1: 2013 Fifth edition]

ISO 898-1 : Bolts, Screws and Studs with specified property classes — Coarse & Fine thread

1. Materials

Table 1. Chemical Composition limit for Steels

Property Class	Material and heat treatment	Chemical composition limit (cast analysis, %) [a]					Tempering Temperature
		C		P	S	B[b]	°C
		min.	max.	max.	max.	max.	min.
4.6[cd]	Carbon steel or carbon steel with additives	-	0.55	0.050	0.060	Not specified	-
4.8[d]		-	0.55	0.050	0.060		-
5.6[c]		0.13	0.55	0.050	0.060		-
5.8[d]		-	0.55	0.050	0.060		-
8.8[f]	Carbon steel with additives (e.g. Boron or Mn or Cr) quenched and tempered	0.15[e]	0.40	0.025	0.025	0.003	425
	Carbon steel quenched and tempered	0.25	0.55	0.025	0.025	0.003	425
	Alloy steel quenched and tempered [g]	0.20	0.55	0.025	0.025	0.003	425
10.9[f]	Carbon steel with additives (e.g. Boron or Mn or Cr) quenched and tempered	0.20[e]	0.55	0.025	0.025	0.003	425
	Carbon steel quenched and tempered	0.25	0.55	0.025	0.025	0.003	425
	Alloy steel quenched and tempered [g]	0.20	0.55	0.025	0.025	0.003	425
12.9[f h i]	Alloy steel quenched and tempered [g]	0.30	0.50	0.025	0.025	0.003	425

a In case of dispute, the product analysis applies.

b Boron content can reach 0.005 %, provided non-effective boron is controlled by the addition of titanium and/or aluminium.

c For cold forged fasteners of property classes 4.6 and 5.6, heat treatment of the wire used for cold forging or of the cold forged fastener itself may be necessary to achieve required ductility.

d Free cutting steel is allowed for these property classes with the following maximum sulfur, phosphorus and lead contents : S: 0.34 %; P: 0.11 %; Pb: 0.35 %.

e In case of plain carbon boron steel with a carbon content below 0.25 % (cast analysis), the minimum manganese content shall be 0.6 % for property class 8.8 and 0.7 % for property classes 9.8 and 10.9.

f For the materials of these property classes, there shall be a sufficient hardenability to ensure a structure consisting of approximately 90 % martensite in the core of the threaded sections for the fasteners in the "as-hardened" condition before tempering.

g This alloy steel shall contain at least one of the following elements in the minimum quantity given: chromium 0.30 %, nickel 0.30 %, molybdenum 0.20 %, vanadium 0.10 %. Where elements are specified in combinations of two, three or four and have alloy contents less than those given above, the limit value to be applied for steel class determination is 70 % of the sum of the individual limit values specified above for the two, three or four elements concerned.

h Fasteners manufactured from phosphated raw material shall be dephosphated before heat treatment; the absence of white phosphorus enriched layer shall be detected by a suitable test method.

i Caution is advised when the use of property class 12.9/12.9 is considered. The capability of the fastener manufacturer, the service conditions and the wrenching methods should be considered. Environments can cause stress corrosion cracking of fasteners as processed as well as those coated.

2. Mechanical and Physical Properties

The bolts, screws and studs of the specified property classes shall, at ambient temperature, meet all the applicable mechanical and physical properties in accordance with Tables 2 to 6, regardless of which tests are performed during manufacturing or final inspection.

Table 2. Mechanical and Physical Properties of Bolts, Screws and Studs

No.	Mechanical or Physical Property		Property Class							
			4.6	4.8	5.6	5.8	8.8 d ≤ 16 mm.[a]	8.8 d ≥ 16 mm.[b]	10.9	12.9
1	Tensile strength, R_m, MPa	nom.[c]	400	400	500	500	800	800	1,000	1,200
		min.	400	420	500	520	800	830	1,040	1,220
2	Lower yield strength, R_{eL}[d], MPa	nom.[c]	240	-	300	-	-	-	-	-
		min.	240	-	300	-	-	-	-	-
3	Stress at 0.2 % non-proportional elongation, $R_{p0.2}$, MPa	nom.[c]	-	-	-	-	640	640	900	1,080
		min.	-	-	-	-	640	660	940	1,100
	Stress under proof load, S_p[f], MPa	nom.	225	310	280	380	580	600	830	970
4	Proof strength 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	0.91	0.91	0.88	0.88
5	Percentage elongation after fracture for machined test pieces, A, %	min.	22	-	20	-	12	12	9	8
6	Percentage reduction of area after fracture for machined test pieces, Z, %	min.	-	-	-	-	52	52	48	44
7	Elongation after fracture for full-size fasteners, Af	min.	-	0.24	-	0.22	-	-	-	-
8	Rockwell hardness,	min.	67 HRB	71 HRB	79 HRB	82 HRB	22 HRC	23 HRC	32 HRC	39 HRC
		max.	95[g] HRB	95[g] HRB	95[g] HRB	95[g] HRB	32 HRC	34 HRC	39 HRC	44 HRC

a Values do not apply to structural bolting.

b For structural bolting d ≥ M12.

c Nominal values are specified only for the purpose of the designation system for property classes.

d In cases where the lower yield strength, R_{eL}, cannot be determined, it is permissible to measure the stress at 0.2 % non-proportional elongation $R_{p0.2}$.

e For the property classes 4.8, 5.8 and 6.8, the values for Rpf,min are under investigation. The values at the time of publication of this part of ISO 898 are given for calculation of the proof stress ratio only. They are not test values.

f Proof loads are specified in Tables 4 and 6.

g Hardness determined at the end of a fastener shall be 250 HV, 238 HB or 99.5 HRB maximum.

Table 3. Minimum ultimate tensile loads — ISO metric coarse pitch thread

Size [a]	Nominal Stress Area $A_{s,nom}$ [b] [mm²]	4.6	4.8	5.6	5.8	8.8	10.9	12.9
		[Proof load, $F_{m,min}$ ($A_{s,nom} \times R_{m,nom}$), N]						
M3	5.03	2,010	2,110	2,510	2,620	4,020	5,230	6,140
M3.5	6.78	2,710	2,850	3,390	3,530	5,420	7,050	8,270
M4	8.78	3,510	3,690	4,390	4,570	7,020	9,130	10,700
M5	14.2	5,680	5,960	7,100	7,380	11,350	14,800	17,300
M6	20.1	8,040	8,440	10,000	10,400	16,100	20,900	24,500
M7	28.9	11,600	12,100	14,400	15,000	23,100	30,100	35,300
M8	36.6	14,600[c]	15,400	18,300[c]	19,000	29,200[c]	38,100[c]	44,600
M10	58	23,200[c]	24,400	29,000[c]	30,200	46,400[c]	60,300[c]	70,800
M12	84.3	33,700	35,400	42,200	43,800	67,400[d]	87,700	103,000
M14	115	46,000	48,300	57,500	59,800	92,000[d]	120,000	140,000
M16	157	62,800	65,900	78,500	81,600	125,000[d]	163,000	192,000
M18	192	76,800	80,600	96,000	99,800	159,000	200,000	234,000
M20	245	98,000	103,000	122,000	127,000	203,000	255,000	299,000
M22	303	121,000	127,000	152,000	158,000	252,000	315,000	370,000
M24	353	141,000	148,000	176,000	184,000	293,000	367,000	431,000
M27	459	184,000	193,000	230,000	239,000	381,000	477,000	560,000
M30	561	224,000	236,000	280,000	292,000	466,000	583,000	684,000
M33	694	278,000	292,000	347,000	361,000	576,000	722,000	847,000
M36	817	327,000	343,000	408,000	425,000	678,000	850,000	997,000
M39	976	390,000	410,000	488,000	508,000	810,000	1,020,000	1,200,000

a Where no thread pitch is indicated in a thread designation, coarse pitch is specified.

b To calculate $A_{s,nom}$, see $A_{s,nom} = \frac{\pi}{4}\left(\frac{d_2 \times d_3}{2}\right)^2$

c For fasteners with thread tolerance 6az in accordance with ISO 965-4 subject to hot dip galvanizing, reduced values in accordance with ISO 10684:2004.

d For structural bolting 70,000 N (for M12), 95,500 N (for M14) and 130,000 N (for M16).

Table 4. Proof loads — ISO metric coarse pitch thread

Size [a]	Nominal Stress Area $A_{s,nom}$ [b] [mm²]	4.6	4.8	5.6	5.8	8.8	10.9	12.9
		[Minimum ultimate tensile load, F_p ($A_{s,nom} \times S_{p,min}$), N]						
M3	5.03	1,130	1,560	1,410	1,910	2,920	4,180	4,880
M3.5	6.78	1,530	2,100	1,900	2,580	3,940	5,630	6,580
M4	8.78	1,980	2,720	2,460	3,340	5,100	7,290	8,520
M5	14.2	3,200	4,400	3,980	5,400	8,230	11,800	13,800
M6	20.1	4,520	6,230	5,630	7,640	11,600	16,700	19,500
M7	28.9	6,500	8,960	8,090	11,000	16,800	24,000	28,000
M8	36.6	8,240[c]	11,400	10,200[c]	13,900	21,200[c]	30,400[c]	35,500
M10	58	13,000[c]	18,000	16,200[c]	22,000	33,700[c]	48,100[c]	56,300
M12	84.3	19,000	26,100	23,600	32,000	48,900[d]	70,000	81,800
M14	115	25,900	35,600	32,200	43,700	66,700[d]	95,500	112,000
M16	157	35,300	48,700	44,000	59,700	91,000[d]	130,000	152,000
M18	192	43,200	59,500	53,800	73,000	115,000	159,000	186,000
M20	245	55,100	76,000	68,600	93,100	147,000	203,000	238,000
M22	303	68,200	93,900	84,800	115,000	182,000	252,000	294,000
M24	353	79,400	109,000	98,000	134,000	212,000	293,000	342,000
M27	459	103,000	142,000	128,000	174,000	275,000	381,000	445,000
M30	561	126,000	174,000	157,000	213,000	337,000	466,000	544,000
M33	694	156,000	215,000	194,000	264,000	416,000	576,000	573,000
M36	817	184,000	253,000	229,000	310,000	490,000	678,000	792,000
M39	976	220,000	303,000	273,000	371,000	586,000	810,000	947,000

a Where no thread pitch is indicated in a thread designation, coarse pitch is specified.

b To calculate $A_{s,nom}$, see $A_{s,nom} = \frac{\pi}{4}\left(\frac{d_2 \times d_3}{2}\right)^2$

c For fasteners with thread tolerance 6az in accordance with ISO 965-4 subject to hot dip galvanizing, reduced values in accordance with ISO 10684:2004.

d For structural bolting 50,000 N (for M12), 68,800 N (for M14) and 94,500 N (for M16).

Table 5. Minimum ultimate tensile loads — ISO metric fine pitch thread

Size d x P	Nominal Stress Area $A_{s,nom}$ [mm²]	4.6	4.8	5.6	5.8	8.8	10.9	12.9
		[Minimum ultimate tensile load, $F_{m,min}$ ($A_{s,nom} \times R_{m,min}$), N]						
M8x1.0	39.2	15,700	16,500	19,600	20,400	31,360	40,800	47,800
M10x1.25	61.2	24,500	25,700	30,600	31,800	49,000	63,600	74,700
M10x1.0	64.5	25,800	27,100	32,300	33,500	51,600	67,100	78,700
M12x1.5	88.1	35,200	37,000	44,100	45,800	70,500	91,600	107,000
M12x1.25	92.1	36,800	38,700	46,100	47,900	73,700	95,800	112,000
M14x1.5	125	50,000	52,500	62,500	65,000	100,000	130,000	152,000
M16x1.5	167	66,800	70,100	83,500	86,800	134,000	174,000	204,000
M18x1.5	216	86,400	90,700	108,000	112,000	179,000	225,000	264,000
M20x1.5	272	109,000	114,000	136,000	141,000	226,000	283,000	332,000
M22x1.5	333	133,000	140,000	166,000	173,000	276,000	346,000	406,000
M24x2.0	384	154,000	161,000	192,000	200,000	319,000	399,000	469,000
M27x2.0	496	198,000	208,000	248,000	258,000	412,000	516,000	605,000
M30x2.0	621	248,000	261,000	310,000	323,000	515,000	646,000	758,000
M33x2.0	761	304,000	320,000	380,000	396,000	632,000	791,000	928,000
M36x3.0	865	346,000	363,000	432,000	450,000	718,000	900,000	1,055,000
M39x3.0	1,030	412,000	433,000	515,000	536,000	855,000	1,070,000	1,260,000

Table 6. Proof loads — ISO metric fine pitch thread

Size d x P	Nominal Stress Area $A_{s,nom}$ [mm²]	4.6	4.8	5.6	5.8	8.8	10.9	12.9
		[Minimum ultimate tensile load, Fm,min (As,nom × Rm,min), N]						
M8x1.0	39.2	8,820	12,200	11,000	14,900	22,700	32,500	38,000
M10x1.25	61.2	13,800	19,000	17,100	23,300	35,500	50,800	59,400
M10x1.0	64.5	14,500	20,000	18,100	24,500	37,400	53,500	62,700
M12x1.5	88.1	19,800	27,300	24,700	33,500	51,100	73,100	85,500
M12x1.25	92.1	20,700	28,600	25,800	35,000	53,400	76,400	89,300
M14x1.5	125	28,100	38,800	35,000	47,500	72,500	104,000	121,000
M16x1.5	167	37,600	51,800	46,800	63,500	96,900	139,000	16,200
M18x1.5	216	48,600	67,000	60,500	82,100	130,000	179,000	210,000
M20x1.5	272	61,200	84,300	76,200	103,000	163,000	226,000	264,000
M22x1.5	333	74,900	103,000	93,200	126,000	200,000	276,000	323,000
M24x2.0	384	86,400	119,000	108,000	146,000	230,000	319,000	372,000
M27x2.0	496	112,000	154,000	139,000	188,000	298,000	412,000	481,000
M30x2.0	621	140,000	192,000	174,000	236,000	373,000	515,000	602,000
M33x2.0	761	171,000	236,000	213,000	289,000	457,000	632,000	738,000
M36x3.0	865	195,000	268,000	242,000	329,000	519,000	718,000	839,000
M39x3.0	1,030	232,000	319,000	288,000	391,000	618,000	855,000	999,000