INTERNATIONAL STANDARD

ISO 898-1

Fifth edition
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Mechanical properties of fasteners made of carbon steel and alloy steel

Part 1:
Bolts, screws and studs with specified property classes — Coarse thread and fine pitch thread

Caractéristiques mécaniques des éléments de fixation en acier au carbone et en acier allié

Partie 1: Vis, goujons et tiges filetées de classes de qualité spécifiées — Filetages à pas gros et filetages à pas fin

Reference number
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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.

International Standards are drafted in accordance with the rules given in the ISO/IEC Directives, Part 2.

The main task of technical committees is to prepare International Standards. 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.

Attention is drawn to the possibility that some of the elements of this document may be the subject of patent rights. ISO shall not be held responsible for identifying any or all such patent rights.

ISO 898-1 was prepared by Technical Committee ISO/TC 2, *Fasteners*, Subcommittee SC 11, *Fasteners with metric external thread*.

This fifth edition cancels and replaces the fourth edition (ISO 898-1:2009), of which it constitutes a minor revision.

ISO 898 consists of the following parts, under the general title *Mechanical properties of fasteners made of carbon steel and alloy steel*:

— *Part 1: Bolts, screws and studs with specified property classes — Coarse thread and fine pitch thread*

— *Part 2: Nuts with specified property classes — Coarse thread and fine pitch thread*

— *Part 5: Set screws and similar threaded fasteners with specified hardness classes — Coarse thread and fine pitch thread*

— *Part 7: Torsional test and minimum torques for bolts and screws with nominal diameters 1 mm to 10 mm*[1)]

[1)] It is intended that, upon revision, the main element of the title of Part 7 will be aligned with the main element of the titles of Parts 1 to 5.

Mechanical properties of fasteners made of carbon steel and alloy steel

Part 1: Bolts, screws and studs with specified property classes — Coarse thread and fine pitch thread

1 Scope

This part of ISO 898 specifies mechanical and physical properties of bolts, screws and studs made of carbon steel and alloy steel when tested at an ambient temperature range of 10 °C to 35 °C. Fasteners (the term used when bolts, screws and studs are considered all together) that conform to the requirements of this part of ISO 898 are evaluated at that ambient temperature range. They might not retain the specified mechanical and physical properties at elevated temperatures (see Annex B) and/or lower temperatures.

NOTE 1 Fasteners conforming to the requirements of this part of ISO 898 are used in applications ranging from −50 °C to +150 °C. Users are advised to consult an experienced fastener metallurgist for temperatures outside the range of −50 °C to +150 °C and up to a maximum temperature of +300 °C when determining appropriate choices for a given application.

NOTE 2 Information for the selection and application of steels for use at lower and elevated temperatures is given, for example, in EN 10269, ASTM F2281 and in ASTM A320/A320M.

Certain bolts and screws might not fulfil the tensile or torsional requirements of this part of ISO 898 because the geometry of their heads reduces the shear area in the head compared to the stress area in the thread. These include bolts and screws having a low or countersunk head (see 8.2).

This part of ISO 898 is applicable to bolts, screws and studs

— made of carbon steel or alloy steel,

— having triangular ISO metric screw thread in accordance with ISO 68-1,

— with coarse pitch thread M1,6 to M39, and fine pitch thread M8×1 to M39×3,

— with diameter/pitch combinations in accordance with ISO 261 and ISO 262, and

— having thread tolerances in accordance with ISO 965-1, ISO 965-2 and ISO 965-4.

It is not applicable to set screws and similar threaded fasteners not under tensile stress (see ISO 898-5).

It does not specify requirements for such properties as

— weldability,

— corrosion resistance,

— resistance to shear stress,

— torque/clamp force performance (for test method, see ISO 16047), or

— fatigue resistance.

2 Normative references

The following documents, in whole or in part, are normatively referenced in this document and are indispensable to its application. For dated references, only the edition cited applies. For undated references, the latest edition of the referenced document (including any amendments) applies.

ISO 68-1, *ISO general purpose screw threads — Basic profile — Part 1: Metric screw threads*

ISO 148-1, *Metallic materials — Charpy pendulum impact test — Part 1: Test method*

ISO 225, *Fasteners — Bolts, screws, studs and nuts — Symbols and descriptions of dimensions*

ISO 261, *ISO general purpose metric screw threads — General plan*

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

ISO 273, *Fasteners — Clearance holes for bolts and screws*

ISO 724, *ISO general-purpose metric screw threads — Basic dimensions*

ISO 898-2, *Mechanical properties of fasteners made of carbon steel and alloy steel — Part 2: Nuts with specified property classes — Coarse thread and fine pitch thread*

ISO 898-5, *Mechanical properties of fasteners made of carbon steel and alloy steel — Part 5: Set screws and similar threaded fasteners with specified hardness classes — Coarse thread and fine pitch thread*

ISO 898-7, *Mechanical properties of fasteners — Part 7: Torsional test and minimum torques for bolts and screws with nominal diameters 1 mm to 10 mm*[1)]

ISO 965-1, *ISO general-purpose metric screw threads — Tolerances — Part 1: Principles and basic data*

ISO 965-2, *ISO general purpose metric screw threads — Tolerances — Part 2: Limits of sizes for general purpose external and internal screw threads — Medium quality*

ISO 965-4, *ISO general purpose metric screw threads — Tolerances — Part 4: Limits of sizes for hot-dip galvanized external screw threads to mate with internal screw threads tapped with tolerance position H or G after galvanizing*

ISO 4042, *Fasteners — Electroplated coatings*

ISO 6157-1, *Fasteners — Surface discontinuities — Part 1: Bolts, screws and studs for general requirements*

ISO 6157-3, *Fasteners — Surface discontinuities — Part 3: Bolts, screws and studs for special requirements*

ISO 6506-1, *Metallic materials — Brinell hardness test — Part 1: Test method*

ISO 6507-1, *Metallic materials — Vickers hardness test — Part 1: Test method*

ISO 6508-1, *Metallic materials — Rockwell hardness test — Part 1: Test method (scales A, B, C, D, E, F, G, H, K, N, T)*

ISO 6892-1, *Metallic materials — Tensile testing — Part 1: Method of test at room temperature*

ISO 7500-1, *Metallic materials — Verification of static uniaxial testing machines — Part 1: Tension/compression testing machines — Verification and calibration of the force-measuring system*

ISO 10683, *Fasteners — Non-electrolytically applied zinc flake coatings*

ISO 10684:2004, *Fasteners — Hot dip galvanized coatings*

ISO 16426, *Fasteners — Quality assurance system*

3 Terms and definitions

For the purposes of this document, the following terms and definitions apply.

3.1
finished fastener
fastener for which all manufacturing steps have been completed, with or without any surface coating and with full or reduced loadability, and which has not been machined into a test piece

3.2
machined test piece
test piece machined from a fastener to evaluate material properties

3.3
full-size fastener
finished fastener with a shank diameter of $d_s \approx d$ or $d_s > d$, or screw threaded to the head, or fully threaded stud

3.4
fastener with reduced shank
finished fastener with a shank diameter of $d_s \approx d_2$

3.5
fastener with waisted shank
finished fastener with a shank diameter of $d_s < d_2$

3.6
base metal hardness
hardness closest to the surface (when traversing from core to outside diameter) just before an increase or decrease occurs, denoting, respectively, carburization or decarburization

3.7
carburization
result of increasing surface carbon to a content above that of the base metal

3.8
decarburization
loss of carbon at the surface of a steel fastener

3.9
partial decarburization
decarburization with sufficient loss of carbon to cause a lighter shade of tempered martensite and a significantly lower hardness than that of the adjacent base metal, without, however, showing ferrite grains under metallographic examination

3.10
ferritic decarburization
decarburization with sufficient loss of carbon to cause a lighter shade of tempered martensite and a significantly lower hardness than that of the adjacent base metal, with the presence of ferrite grains or grain boundary network under metallographic examination

3.11
complete decarburization
decarburization with sufficient carbon loss to show only clearly defined ferrite grains under metallographic examination

4 Symbols and abbreviated terms

For the purposes of this document, the symbols and abbreviated terms given in ISO 225 and ISO 965-1, and the following apply.

A Percentage elongation after fracture (of machined test piece), %

A_f Elongation after fracture for full-size fastener

$A_{s,nom}$ Nominal stress area in thread, mm^2

A_{ds} Cross-sectional area of waisted shank, mm^2

b Thread length, mm

b_m Thread length of stud metal end, mm

d Nominal thread diameter, mm

d_0 Diameter of machined test piece, mm

d_1 Basic minor diameter of external thread, mm

d_2 Basic pitch diameter of external thread, mm

d_3 Minor diameter of external thread, mm

d_a Transition diameter (internal diameter of the bearing face), mm

d_h Hole diameter of wedge or block, mm

d_s Diameter of unthreaded shank, mm

E Height of non-decarburized zone in thread, mm

F_m Ultimate tensile load, N

$F_{m,min}$ Minimum ultimate tensile load, N

F_p Proof load, N

F_{pf} Load at 0,0048d non-proportional elongation for full-size fastener, N

G Depth of complete decarburization in thread, mm

H Height of fundamental triangle, mm

H_1 Height of external thread in maximum material condition, mm

k Height of the head, mm

K_v Impact strength, J

l	Nominal length, mm
l_0	Total length of fastener before loading, mm
l_1	Total length of fastener after first unloading, mm
l_2	Total length of fastener after second unloading, mm
l_s	Length of unthreaded shank, mm
l_t	Overall length of stud, mm
l_{th}	Free threaded length of fastener in testing device, mm
L_c	Length of straight portion (of machined test piece), mm
L_o	Original gauge length (of machined test piece), mm
L_t	Total length of machined test piece, mm
L_u	Final gauge length (of machined test piece), mm
ΔL_p	Plastic elongation, mm
M_B	Breaking torque, Nm
P	Pitch of thread, mm
r	Fillet radius, mm
R_{eL}	Lower yield strength for machined test piece, MPa
R_m	Tensile strength, MPa
$R_{p0,2}$	Stress at 0,2 % non-proportional elongation for machined test piece, MPa
R_{pf}	Stress at 0,0048d non-proportional elongation for full-size fastener, MPa
s	Width across flats, mm
S_o	Cross-sectional area of machined test piece before tensile test, mm^2
S_p	Stress under proof load, MPa
S_u	Cross-sectional area of machined test piece after fracture, mm^2
Z	Percentage reduction of area after fracture for machined test piece, %
α	Wedge angle for tensile test under wedge loading
β	Angle of the solid block for head soundness test
max	Subscript added to symbol to denote maximum value
min	Subscript added to symbol to denote minimum value
nom	Subscript added to symbol to denote nominal value

5 Designation system for property classes

The symbol for property classes of bolts, screws, and studs consists of two numbers, separated by a dot (see Tables 1 to 3):

a) the number to the left of the dot consists of one or two digits and indicates 1/100 of the nominal tensile strength, $R_{m,nom}$, in megapascals (see Table 3, No. 1);

b) the number to the right of the dot indicates 10 times the ratio between the nominal yield strength and the nominal tensile strength, $R_{m,nom}$, as specified in Table 1 (yield strength ratio). The nominal yield strength, as specified in Table 3 (Nos. 2 to 4), is:

— lower yield strength $R_{eL,nom}$, or

— nominal stress at 0,2 % non-proportional elongation $R_{p0,2\ nom}$, or

— nominal stress at 0,0048d non-proportional elongation $R_{pf,nom}$.

Table 1 — Ratio of nominal yield strength and nominal tensile strength

Number to the right of dot	.6	.8	.9
$\frac{R_{eL,nom}}{R_{m,nom}}$ or $\frac{R_{p0,2,nom}}{R_{m,nom}}$ or $\frac{R_{pf,nom}}{R_{m,nom}}$	0,6	0,8	0,9

c) an additional zero to the left of the property class designation indicates that fasteners have reduced loadability (see 8.2 and 10.4).

EXAMPLE 1 A fastener of nominal tensile strength $R_{m,nom}$ = 800 MPa and with a yield strength ratio of 0,8 has the property class designation 8.8.

EXAMPLE 2 A fastener with material properties of property class 8.8 but with reduced loadability is designated by 08.8.

The multiplication of the nominal tensile strength and the yield strength ratio gives the nominal yield strength in megapascals (MPa).

Marking and labelling of bolts, screws and studs with property classes shall be as specified in 10.3. For fasteners with reduced loadability, specific marking symbols are specified in 10.4.

The designation system of this part of ISO 898 may be applied to sizes outside the scope of this part of ISO 898 (e.g. $d > 39$ mm), provided all applicable requirements in accordance with Tables 2 and 3 are met.

Information on the relationship between the nominal tensile strength and elongation after fracture for each property class is given in Annex A.

6 Materials

Table 2 specifies limits for the chemical composition of steels and minimum tempering temperatures for the different property classes of bolts, screws and studs. The chemical composition shall be assessed in accordance with the relevant International Standards.

NOTE National regulations for the restriction or prohibition of certain chemical elements might also have to be taken into account in the countries or regions concerned.

For fasteners that are to be hot dip galvanized, the additional material requirements given in ISO 10684 apply.

Table 2 — Steels

Property class	Material and heat treatment	Chemical composition limit (cast analysis, %)[a] C min.	C max.	P max.	S max.	B[b] max.	Tempering temperature °C min.
4.6[c d]	Carbon steel or carbon steel with additives	—	0,55	0,050	0,060	Not specified	—
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. Boron or Mn or Cr) quenched and tempered	0,15[e]	0,40	0,025	0,025	0,003	425
	or Carbon steel quenched and tempered	0,25	0,55	0,025	0,025		
	or Alloy steel quenched and tempered[g]	0,20	0,55	0,025	0,025		
9.8[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
	or Carbon steel quenched and tempered	0,25	0,55	0,025	0,025		
	or Alloy steel quenched and tempered[g]	0,20	0,55	0,025	0,025		
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
	or Carbon steel quenched and tempered	0,25	0,55	0,025	0,025		
	or Alloy steel quenched and tempered[g]	0,20	0,55	0,025	0,025		
12.9[f h i]	Alloy steel quenched 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. Boron or Mn or Cr or Molybdenum) quenched and tempered	0,28	0,50	0,025	0,025	0,003	380

[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.

7 Mechanical and physical properties

The bolts, screws and studs of the specified property classes shall, at ambient temperature[2)], meet all the applicable mechanical and physical properties in accordance with Tables 3 to 7, regardless of which tests are performed during manufacturing or final inspection.

Clause 8 sets forth the applicability of test methods for verifying that fasteners of different types and dimensions fulfil the properties in accordance with Table 3 and Tables 4 to 7.

NOTE 1 Even if the steel properties of the fasteners meet all relevant requirements specified in Tables 2 and 3, some types of fasteners have reduced loadability due to dimensional reasons (see 8.2, 9.4 and 9.5).

NOTE 2 Although a great number of property classes are specified in this part of ISO 898, this does not mean that all classes are appropriate for all fasteners. Further guidance for application of the specific property classes is given in the relevant product standards. For non-standard fasteners, it is advisable to follow as closely as possible the choice already made for similar standard fasteners.

Table 3 — Mechanical and physical properties of bolts, screws and studs

No.	Mechanical or physical property		Property class									
			4.6	4.8	5.6	5.8	6.8	8.8		9.8	10.9	12.9/ 12.9
								$d \le$ 16 mm[a]	$d >$ 16 mm[b]	$d \le$ 16 mm		
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 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	720	900	1 080
		min.	—	—	—	—	—	640	660	720	940	1 100
4	Stress at 0,0048d non-proportional elongation for full-size fasteners, R_{pf}, MPa	nom.[c]	—	320	—	400	480	—	—	—	—	—
		min.	—	340[e]	—	420[e]	480[e]	—	—	—	—	—
5	Stress under proof load, S_p[f], MPa	nom.	225	310	280	380	440	580	600	650	830	970
	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	0,92	0,91	0,91	0,90	0,88	0,88
6	Percentage elongation after fracture for machined test pieces, A, %	min.	22	—	20	—	—	12	12	10	9	8
7	Percentage reduction of area after fracture for machined test pieces, Z, %	min.	—					52		48	48	44
8	Elongation after fracture for full-size fasteners, A_f (see also Annex C)	min.	—	0,24	—	0,22	0,20	—	—	—	—	—
9	Head soundness		No fracture									

2) Impact strength is tested at a temperature of −20 °C (see 9.14).

Table 3 *(continued)*

No.	Mechanical or physical property		Property class									
			4.6	4.8	5.6	5.8	6.8	8.8		9.8	10.9	12.9/ 12.9
								$d \leq$ 16 mm[a]	$d >$ 16 mm[b]	$d \leq$ 16 mm		
10	Vickers hardness, HV $F \geq 98$ 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	245	250	286	316	380
		max.	209[g]				238	316	331	355	375	429
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.	—					—			390	435
14	Non-carburization, HV 0,3	max.	—					h			h	h
15	Height of non-decarburized thread zone, E, mm	min.	—					$^1/_2 H_1$			$^2/_3 H_1$	$^3/_4 H_1$
	Depth of complete decarburization in the thread, G, mm	max.	—					0,015				
16	Reduction of hardness after retempering, HV	max.	—					20				
17	Breaking torque, M_B, Nm	min.	—					in accordance with ISO 898-7				
18	Impact strength, K_V [i,j], J	min.	—		27	—		27	27	27	27	k
19	Surface integrity in accordance with		ISO 6157-1[l]									ISO 6157-3

[a] Values do not apply to structural bolting.

[b] For structural bolting $d \geq$ M12.

[c] Nominal values are specified only for the purpose of the designation system for property classes. See Clause 5.

[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 $R_{pf,min}$ 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 5 and 7.

[g] Hardness determined at the end of a fastener shall be 250 HV, 238 HB or 99,5 HRB maximum.

[h] Surface hardness shall not be more than 30 Vickers points above the measured base metal hardness of the fastener when determination of both surface hardness and base metal hardness are carried out with HV 0,3 (see 9.11).

[i] Values are determined at a test temperature of –20 °C (see 9.14).

[j] Applies to $d \geq 16$ mm.

[k] Value for K_V is under investigation.

[l] Instead of ISO 6157-1, ISO 6157-3 may apply by agreement between the manufacturer and the purchaser.

Table 4 — Minimum ultimate tensile loads — ISO metric coarse pitch thread

Thread[a] d	Nominal stress area $A_{s,nom}$[b] mm^2	Property class								
		4.6	4.8	5.6	5.8	6.8	8.8	9.8	10.9	12.9/<u>12.9</u>
		Minimum ultimate tensile load, $F_{m,min}$ ($A_{s,nom} \times R_{m,min}$), N								
M3	5,03	2 010	2 110	2 510	2 620	3 020	4 020	4 530	5 230	6 140
M3,5	6,78	2 710	2 850	3 390	3 530	4 070	5 420	6 100	7 050	8 270
M4	8,78	3 510	3 690	4 390	4 570	5 270	7 020	7 900	9 130	10 700
M5	14,2	5 680	5 960	7 100	7 380	8 520	11 350	12 800	14 800	17 300
M6	20,1	8 040	8 440	10 000	10 400	12 100	16 100	18 100	20 900	24 500
M7	28,9	11 600	12 100	14 400	15 000	17 300	23 100	26 000	30 100	35 300
M8	36,6	14 600[c]	15 400	18 300[c]	19 000	22 000	29 200[c]	32 900	38 100[c]	44 600
M10	58	23 200[c]	24 400	29 000[c]	30 200	34 800	46 400[c]	52 200	60 300[c]	70 800
M12	84,3	33 700	35 400	42 200	43 800	50 600	67 400[d]	75 900	87 700	103 000
M14	115	46 000	48 300	57 500	59 800	69 000	92 000[d]	104 000	120 000	140 000
M16	157	62 800	65 900	78 500	81 600	94 000	125 000[d]	141 000	163 000	192 000
M18	192	76 800	80 600	96 000	99 800	115 000	159 000	—	200 000	234 000
M20	245	98 000	103 000	122 000	127 000	147 000	203 000	—	255 000	299 000
M22	303	121 000	127 000	152 000	158 000	182 000	252 000	—	315 000	370 000
M24	353	141 000	148 000	176 000	184 000	212 000	293 000	—	367 000	431 000
M27	459	184 000	193 000	230 000	239 000	275 000	381 000	—	477 000	560 000
M30	561	224 000	236 000	280 000	292 000	337 000	466 000	—	583 000	684 000
M33	694	278 000	292 000	347 000	361 000	416 000	576 000	—	722 000	847 000
M36	817	327 000	343 000	408 000	425 000	490 000	678 000	—	850 000	997 000
M39	976	390 000	410 000	488 000	508 000	586 000	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 9.1.6.1.

[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, Annex A, apply.

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

Table 5 — Proof loads — ISO metric coarse pitch thread

Thread[a] d	Nominal stress area $A_{s,nom}$[b] mm²	Property class								
		4.6	4.8	5.6	5.8	6.8	8.8	9.8	10.9	12.9/<u>12.9</u>
		Proof load, F_p ($A_{s,nom} \times S_{p,nom}$), 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 Where no thread pitch is indicated in a thread designation, coarse pitch is specified.

b To calculate $A_{s,nom}$, see 9.1.6.1.

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, Annex A, apply.

d For structural bolting 50 700 N (for M12), 68 800 N (for M14) and 94 500 N (for M16).

Table 6 — Minimum ultimate tensile loads — ISO metric fine pitch thread

Thread $d \times P$	Nominal stress area $A_{s,nom}$[a] mm²	Property class								
		4.6	4.8	5.6	5.8	6.8	8.8	9.8	10.9	12.9/<u>12.9</u>
		Minimum ultimate tensile load, $F_{m,min}$ ($A_{s,nom} \times R_{m,min}$), N								
M8×1	39,2	15 700	16 500	19 600	20 400	23 500	31 360	35 300	40 800	47 800
M10×1,25	61,2	24 500	25 700	30 600	31 800	36 700	49 000	55 100	63 600	74 700
M10×1	64,5	25 800	27 100	32 300	33 500	38 700	51 600	58 100	67 100	78 700
M12×1,5	88,1	35 200	37 000	44 100	45 800	52 900	70 500	79 300	91 600	107 000
M12×1,25	92,1	36 800	38 700	46 100	47 900	55 300	73 700	82 900	95 800	112 000
M14×1,5	125	50 000	52 500	62 500	65 000	75 000	100 000	112 000	130 000	152 000
M16×1,5	167	66 800	70 100	83 500	86 800	100 000	134 000	150 000	174 000	204 000
M18×1,5	216	86 400	90 700	108 000	112 000	130 000	179 000	—	225 000	264 000
M20×1,5	272	109 000	114 000	136 000	141 000	163 000	226 000	—	283 000	332 000
M22×1,5	333	133 000	140 000	166 000	173 000	200 000	276 000	—	346 000	406 000
M24×2	384	154 000	161 000	192 000	200 000	230 000	319 000	—	399 000	469 000
M27×2	496	198 000	208 000	248 000	258 000	298 000	412 000	—	516 000	605 000
M30×2	621	248 000	261 000	310 000	323 000	373 000	515 000	—	646 000	758 000
M33×2	761	304 000	320 000	380 000	396 000	457 000	632 000	—	791 000	928 000
M36×3	865	346 000	363 000	432 000	450 000	519 000	718 000	—	900 000	1 055 000
M39×3	1 030	412 000	433 000	515 000	536 000	618 000	855 000	—	1 070 000	1 260 000

a To calculate $A_{s,nom}$, see 9.1.6.1.