Mechanical & Physical properties of bolts, screws

Mechanical properties

* **Grade** 4.6, 4.8, 5.6, 6.8, 8.8, 9.8, 10.9, 12.9
* **Threads** Metric
* **Values** MM

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
								$d \leqslant$ 16 mm [a]	$d >$ 16 mm [b]	$d \leqslant$ 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 0,0048 d 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									
10	Vickers hardness, HV $F \geqslant 98$ 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-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				
15	Reduction of hardness after retempering, HV	max.	—					20				
16	Breaking torque, M_B, N·m	min.	—					in accordance with ISO 898-7				
17	Impact strength, K_V [k, l], J	min.	—		27		—	27	27	27	27	m
18	Surface integrity in accordance with		ISO 6157-1 [n]									ISO 6157-3

[a] Values do not apply for structural bolting.

[b] For structural bolting $d \geqslant$ 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 present values 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 core hardness of the fastener when determination of both surface hardness and core hardness are carried out with HV 0,3.

[i] Any increase in hardness at the surface which indicates that the surface hardness exceeds 390 HV is not acceptable.

[j] Any increase in hardness at the surface which indicates that the surface hardness exceeds 435 HV is not acceptable.

[k] Values are determined at a test temperature of –20 °C, see 9.14.

[l] Applies to $d \geqslant$ 16 mm.

[m] Value for K_V is under investigation.

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

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