

Bolt Tightening Torque and Preload Reference — Metric 8.8, 10.9, 12.9 and Stainless A2/A4 (VDI 2230 basis, $\mu = 0.12$ and 0.14)



Reference table · VDI 2230-1 / ISO 898-1 / ISO 3506-1 / ISO 6789 · cBallast Technical Sourcing · issued 2026-09-15 · Catalogue data:
Bufab (Värnamo, Sweden) · cballast.com/documents/bolt-tightening-torque-preload-metric-8-8-10-9-12-9-stainless-vdi-2230

Torque is only a proxy for what the joint actually needs: clamping force (preload). Of the torque applied to a bolt, roughly 50 % is spent against friction under the head or nut face, 40 % against friction in the thread, and only about 10 % produces preload. That is why the same M12 × 8.8 bolt can require 60 Nm with a lubricated zinc-flake finish and 100 Nm dry and plain to reach the same clamp force, and why the friction coefficient must be stated with every torque value. The tables below follow the VDI 2230 method: preload F_M at 90 % of the minimum yield stress ($R_{p0.2}$ min from ISO 898-1) and the torque M_A that produces it for a total friction coefficient $\mu_G = \mu_K = 0.12$ and 0.14 .

Thread	8.8 — F_M (kN) / M_A $\mu 0.12$ / $\mu 0.14$ (Nm)	10.9 — F_M (kN) / M_A $\mu 0.12$ / $\mu 0.14$ (Nm)	12.9 — F_M (kN) / M_A $\mu 0.12$ / $\mu 0.14$ (Nm)
M4	4.6 / 2.8 / 3.1	6.8 / 4.1 / 4.5	8.0 / 4.8 / 5.3
M5	7.6 / 5.5 / 6.2	11.1 / 8.1 / 9.0	13.0 / 9.5 / 10.6
M6	10.7 / 9.5 / 10.6	15.7 / 14.0 / 15.5	18.4 / 16.5 / 18.2
M8	19.5 / 23 / 26	28.7 / 34 / 37	33.6 / 40 / 44
M10	31.0 / 46 / 51	45.5 / 68 / 74	53.2 / 79 / 87
M12	45.2 / 79 / 87	66.3 / 117 / 128	77.6 / 135 / 149
M14	62.0 / 126 / 138	91.0 / 185 / 203	106.5 / 216 / 238
M16	84.7 / 195 / 215	124.4 / 280 / 315	145.5 / 330 / 370
M18	107 / 280 / 305	152 / 390 / 435	178 / 460 / 510
M20	136 / 390 / 430	194 / 560 / 615	227 / 650 / 720
M22	170 / 530 / 580	242 / 750 / 830	283 / 880 / 970
M24	196 / 670 / 740	280 / 960 / 1050	327 / 1120 / 1230
M27	257 / 1000 / 1100	367 / 1400 / 1550	429 / 1650 / 1800
M30	313 / 1350 / 1500	446 / 1900 / 2100	522 / 2250 / 2450
M33	389 / 1850 / 2000	554 / 2600 / 2850	649 / 3000 / 3350
M36	458 / 2350 / 2600	652 / 3300 / 3700	763 / 3900 / 4300

Stainless A2-70 / A4-70 ("d M20) — typical values

Austenitic stainless galls; it is tightened to a lower utilisation (about 70 % of $R_{p0.2}$ min = 450 MPa) and always with an anti-seize or the supplier's lubricant. Using a K-factor of 0.20 (μ "H 0.14–0.16 lubricated): M5 "H 4.5 kN / 4.5 Nm; M6 "H 6.3 kN / 7.6 Nm; M8 "H 11.5 kN / 18 Nm; M10 "H 18.3 kN / 37 Nm; M12 "H 26.6 kN / 64 Nm; M14 "H 36 kN / 100 Nm; M16 "H 49.5 kN / 158 Nm; M20 "H 77 kN / 310 Nm. For A2-80 / A4-80 ($R_{p0.2}$ "e 600 MPa) multiply by about 1.3. Above M20 the material is normally class 50 ($R_{p0.2}$ "e 210 MPa) unless class 70 is confirmed — never take a carbon-steel 8.8 table for stainless.

What the numbers assume

- Friction — μ 0.12 corresponds to lightly oiled zinc-plated or zinc-flake-with-lubricant bolts on machined steel; μ 0.14 to plain or black-oxide bolts with light oil, or zinc plated dry. Dry unlubricated plain steel can reach 0.20 (torque +40 %); MoS₂, paste can drop to 0.08 (torque " 30 %, risk of over-stretching if a 0.14 table is used).
- Utilisation 90 % — the standard VDI 2230 assembly target, leaving 10 % of yield for the working load and scatter. Some industries (pressure equipment, cranes) specify 70–75 %.
- Coarse thread, ISO 4014/4017 head, ISO 4032 nut, plain washer — flange bolts, larger head bearing diameters and fine pitch shift the torque by 5–15 %.
- Torque wrench accuracy — ISO 6789 class ± 4 % (type II, class A) or better; calibrate at least annually or every 5 000 cycles. Impact wrenches are not torque tools.

Tightening methods compared

- Torque control — preload scatter ± 25 –30 % because friction scatter passes straight through. Adequate for most general joints.
- Torque + angle (turn-of-nut) — snug torque then a defined rotation (e.g. 90° or 120° per structural bolting rules EN 1090-2 / EN 14399); scatter ± 10 –15 %; used for hot-dip galvanised and HV structural bolts where friction is unpredictable.
- Yield-controlled — electronic tool detects the yield point; scatter ± 5 –10 %; engine and gearbox lines.

- Direct tension — hydraulic tensioners or load-indicating washers; scatter $\pm 5\%$; flange studs, large-diameter and critical joints.

Special cases

- Prevailing-torque nuts (nylon insert, all-metal) — the locking torque (typically 1–10 % of the table value, larger for small sizes) is spent before any preload is generated; add the measured prevailing torque to the table value.
- Hot-dip galvanised — friction 0.16–0.25 and scattered; use turn-of-nut, or a lubricated (waxed) oversize nut with a verified μ .
- Re-use — 8.8 bolts tightened to 90 % may be re-used a few times if undamaged; 10.9 and 12.9 bolts tightened by angle or to yield are single-use; stainless should be re-lubricated every time.
- Soft or gasketed joints — retighten after the first thermal cycle or after 24 h; embedding relaxes 5–15 % of the preload.
- Threadlockers — anaerobic adhesives (medium strength) change friction little when wet but add breakaway torque; do not compensate with a lower tightening torque unless the adhesive manufacturer specifies it.

Quick check of any torque value

The K-factor method gives a sanity check: $M_A = K \times F_M \times d$, with K 0.16–0.20 for lubricated to dry steel. For an M16 $\times$ 8.8 bolt at 84.7 kN: $0.16 \times 84.7 \times 16 = 217$ Nm, which brackets the table value of 195–215 Nm. If a supplied torque value is far outside this bracket, the friction assumption or the property class behind it is different — find out which before tightening.

Values are nominal reference data compiled from the cited standards and supplier catalogue data (Bufab). Confirm against the controlling standard revision, the manufacturer's data sheet and the joint calculation before procurement or assembly. © cBallast 2026 · cballast.com