Bolt Tightening Torque and Preload

Bolt preload as a share of proof load from the tensile stress area and proof strength, and the wrench torque for it by the nut factor (T = K F d).

Method: Short-form torque equation T = K F d

Input parameters

Unit system: SI

Parameter	Value	Unit
Nominal bolt diameter	20.000	mm
Tensile stress area For a metric thread, work it out from the diameter and pitch with the bolt stress area calculator (M20 × 2.5 is 245 mm²).	245.00	mm²
Proof strength of the bolt From the bolt property class or grade standard.	600.00	MPa
Preload as a share of proof load	75.000	%
Nut factor About 0.2 for plain steel threads as received; lower with lubricant or anti-seize. Get it from the fastener or lubricant maker for critical joints.	0.20000	

Calculated results

Parameter	Value	Unit
Tightening torque	441.00	N·m
Bolt preload	110.25	kN
Proof load	147.00	kN
Tensile stress at preload	450.00	MPa

Notes for this case

- Torque control scatters preload by about ±25 %; where preload matters, use tension control or a load-indicating method.

Formula and method

$$F_p = S_p A_s \qquad F_i = x F_p \qquad T = K F_i d \qquad \sigma_i = x S_p$$

Variables

d	nominal diameter	m
A_s	tensile stress area	m²
S_p	proof strength	Pa
x	preload share of proof load	–
K	nut factor	–
T	tightening torque	N·m
F_i	preload	N
F_p	proof load	N
σ_i	stress at preload	Pa

Method and standards

Short-form torque–tension relation with an empirical nut factor.

Assumptions and limits

- Nut factor scatter dominates; for critical joints use tension control.
- The combined (tension plus thread torsion) stress during tightening is not checked; a preload above 90 % of proof load is flagged.

References

- Short-form torque equation T = K F d

Report details

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Release checks	3 reference cases of this calculator, computed independently, are checked on every release

Results are for engineering estimation. Verify critical designs against the referenced standards and your own data.

This calculator online

https://calc.firecad.com/mechanical/machine-design/bolt-tightening-torque

Open this case on calc.firecad.com →

Reopens the calculator with the inputs of this report.