Creep Stress Relaxation of a Bolt or Constrained Part

Stress remaining after a time in a part held at constant total strain (bolted joint, spring) relaxing by Norton power-law creep, and the time to half stress.

Method: Stress relaxation under Norton creep at constant strain

Input parameters

Unit system: SI

Parameter	Value	Unit
Initial stress	300.00	MPa
Elastic modulus at temperature	170.00	GPa
Creep rate at the initial stress	1.0000e-08	1/h
Norton stress exponent	5.0000	
Time at temperature	10,000	h

Calculated results

Parameter	Value	Unit
Remaining stress	285.06	MPa
Fraction retained	95.021	%
Time to relax to half the initial stress	661,765	h
Creep strain accumulated	87.869	με

Notes for this case

• At constant total strain, elastic strain converts into creep strain: dσ/dt = −Eε̇ with ε̇ = ε̇₀(σ/σ₀)ⁿ (Norton). Integrating gives σ(t) = σ₀[1 + (n − 1)Eε̇₀t/σ₀]^(−1/(n−1)). Relaxation is fast at first and slows as stress falls, which is why bolts in hot flanges are retightened after the first heat-up. Primary creep, ignored here, makes early relaxation faster still.

Formula and method

$$\sigma(t) = \sigma_0 \left[1 + \frac{(n-1)E\dot{\varepsilon}_0 t}{\sigma_0}\right]^{-1/(n-1)}$$

Variables

σ_0	Initial stress	Pa
E	Elastic modulus at temperature	Pa
$\dot{\varepsilon}_0$	Creep rate at the initial stress	1/s
n	Norton stress exponent	-
t	Time at temperature	s
$\sigma(t)$	Remaining stress	Pa
σ/σ_0	Fraction retained	-
$t_{1/2}$	Time to relax to half the initial stress	s
ε_c	Creep strain accumulated	-

Method and standards

Stress relaxation.

Assumptions and limits

- Secondary creep only; constant temperature; rigid joint (no follow-up).

References

Stress relaxation under Norton creep at constant strain

Report details

Report reference	FCC-VTP1-2H5H (the same inputs always give the same reference)
Generated	23 November 2026, 17:50 UTC
Calculator	Creep Stress Relaxation of a Bolt or Constrained Part
Method last reviewed	17 November 2026
Software release	FireCAD Calc, release of 22 November 2026
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/materials/properties/creep-stress-relaxation

Open this case on calc.firecad.com →

Reopens the calculator with the inputs of this report.