Fatigue Safety Factor: Goodman, Soderberg and Gerber

Fatigue factor of safety for a fluctuating stress from alternating and mean stress, endurance limit, ultimate and yield strength: Goodman, Soderberg, Gerber.

Method: Shigley's Mechanical Engineering Design (Budynas and Nisbett); ch. 6 (fluctuating stresses: modified Goodman, Soderberg, Gerber)

Input parameters

Unit system: SI

Parameter	Value	Unit
Alternating stress	80.000	MPa
Mean stress (negative = compressive)	120.00	MPa
Endurance limit (corrected for size, surface, etc.)	200.00	MPa
Ultimate tensile strength	600.00	MPa
Yield strength	400.00	MPa

Calculated results

Parameter	Value	Unit
Factor of safety, Goodman	1.6667	
Factor of safety, Soderberg	1.4286	
Factor of safety, Gerber	2.0711	
Factor of safety against first-cycle yield S_y/(σ_a + σ_m)	2.0000	

Notes for this case

- Load line through the origin (proportional loading). Goodman is the usual design line; Gerber fits test data best; Soderberg is conservative.
- Design factor: the smaller of the chosen fatigue factor and n_y (Shigley pairs Goodman or Gerber with the Langer yield line).

Formula and method

$$\frac{1}{n_G} = \frac{\sigma_a}{S_e} + \frac{\sigma_m}{S_{ut}}, \quad \frac{1}{n_S} = \frac{\sigma_a}{S_e} + \frac{\sigma_m}{S_y}$$

$$\frac{n\sigma_a}{S_e} + \left(\frac{n\sigma_m}{S_{ut}}\right)^2 = 1 \ \text{(Gerber)}$$

Variables

σ_a	Alternating stress	Pa
σ_m	Mean stress (negative = compressive)	Pa
S_e	Endurance limit (corrected for size, surface, etc.)	Pa
S_{ut}	Ultimate tensile strength	Pa
S_y	Yield strength	Pa
n_G	Factor of safety, Goodman	-
n_S	Factor of safety, Soderberg	-
n_{Ger}	Factor of safety, Gerber	-
n_y	Factor of safety against first-cycle yield S_y/(σ_a + σ_m)	-

Method and standards

Mean-stress fatigue criteria along a proportional load line.

Assumptions and limits

- Proportional loading, infinite life.
- S_y and S_e may not exceed S_ut.
- For a compressive mean stress all three fatigue factors are S_e/σ_a and the yield factor uses |σ_m|.
- The design factor is the smaller of the fatigue factor and n_y.

References

- Shigley's Mechanical Engineering Design (Budynas and Nisbett)
- ch. 6 (fluctuating stresses: modified Goodman, Soderberg, Gerber)

Report details

Report reference	FCC-J7RQ-TVCC (the same inputs always give the same reference)
Generated	17 November 2026, 19:46 UTC
Calculator	Fatigue Safety Factor: Goodman, Soderberg and Gerber
Method last reviewed	12 November 2026
Software release	FireCAD Calc, release of 17 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/mechanical/strength-of-materials/fatigue-goodman-soderberg

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Reopens the calculator with the inputs of this report.