Weibull Failure Probability of a Brittle Material

Failure probability of a brittle part from Weibull characteristic strength and modulus with a size effect, and the stress for a target probability.

Method: Weibull (1951) weakest-link distribution P_f = 1 − exp[−(V/V₀)(σ/σ₀)^m] (Dowling, Mechanical Behavior of Materials, 4th ed. (Pearson, 2013), ch. 8)

Input parameters

Unit system: SI

Parameter	Value	Unit
Applied stress	250.00	MPa
Characteristic strength (63.2 %) of the test volume	300.00	MPa
Weibull modulus	10.000	
Stressed volume relative to the test volume	1.0000	
Target failure probability	1.0000	%

Calculated results

Parameter	Value	Unit
Failure probability at σ	14.914	%
Stress for the target probability	189.38	MPa

Notes for this case

• Weibull weakest-link statistics; larger parts are weaker because they contain more flaws. Modulus 5–15 for ceramics, 20 or more for good engineering ceramics.

Formula and method

$$P_f = 1 - \exp\left[-\frac{V}{V_0}\left(\frac{\sigma}{\sigma_0}\right)^m\right], \quad \sigma_t = \sigma_0\left[\frac{-\ln(1-P_t)}{V/V_0}\right]^{1/m}$$

Variables

σ	Applied stress	Pa
σ_0	Characteristic strength (63.2 %) of the test volume	Pa
m	Weibull modulus	-
V/V_0	Stressed volume relative to the test volume	-
P_t	Target failure probability	-
P_f	Failure probability at σ	-
σ_t	Stress for the target probability	Pa

Method and standards

Weibull distribution.

Assumptions and limits

- Uniform stress; volume flaws. σ₀ from flexural tests belongs to the effective (stressed) volume of the test bar, which is much smaller than its geometric volume; using geometric volumes for a tensile part understates the size effect. Use effective volumes in V/V₀.

References

• Weibull (1951) weakest-link distribution P_f = 1 − exp[−(V/V₀)(σ/σ₀)^m] (Dowling, Mechanical Behavior of Materials, 4th ed. (Pearson, 2013), ch. 8)

Report details

Report reference	FCC-BAPM-JX5R (the same inputs always give the same reference)
Generated	17 November 2026, 19:44 UTC
Calculator	Weibull Failure Probability of a Brittle Material
Method last reviewed	13 November 2026
Software release	FireCAD Calc, release of 17 November 2026
Release checks	2 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/weibull-strength

Open this case on calc.firecad.com →

Reopens the calculator with the inputs of this report.