Fatigue Crack Growth Life (Paris Law)

Cycles for a fatigue crack to grow from an initial to a final size under a constant stress range by the Paris law, with ΔK at both sizes.

Method: Paris and Erdogan (1963); Barsom and Rolfe; Fracture and Fatigue Control in Structures (steel constants); Dowling; ...

Input parameters

Unit system: SI

Parameter	Value	Unit
Paris coefficient (m/cycle, ΔK in MPa√m) Always in m/cycle with ΔK in MPa√m, whatever the unit system. A constant in in/cycle with ΔK in ksi√in converts as C = C_US × 0.0254 / 1.0988^m.	6.9000e-12	
Paris exponent	3.0000	
Geometry factor	1.1200	
Stress range	100.00	MPa
Initial crack size	1.0000	mm
Final (critical) crack size	20.000	mm

Calculated results

Parameter	Value	Unit
Cycles to grow a_0 → a_c	909,670	
ΔK at a_0 (MPa√m)	6.2776	
ΔK at a_c (MPa√m)	28.074	

Notes for this case

• Constant Y; for large cracks Y changes and the integral should be done numerically. Below the threshold ΔK_th (about 2–8 MPa√m for steels) cracks do not grow. Barsom–Rolfe: C = 6.9 × 10^{-12}, m = 3 for ferrite–pearlite steels.

Formula and method

$$\frac{da}{dN} = C(\Delta K)^m, \quad \Delta K = Y\Delta\sigma\sqrt{\pi a}, \quad N = \frac{a_c^{1-m/2} - a_0^{1-m/2}}{(1-m/2)C(Y\Delta\sigma\sqrt{\pi})^m}$$

Variables

C	Paris coefficient (m/cycle, ΔK in MPa√m)	-
m	Paris exponent	-
Y	Geometry factor	-
$\Delta\sigma$	Stress range	Pa
a_0	Initial crack size	m
a_c	Final (critical) crack size	m
N	Cycles to grow a_0 → a_c	-
ΔK_0	ΔK at a_0 (MPa√m)	-
ΔK_c	ΔK at a_c (MPa√m)	-

Method and standards

Integrated Paris law.

Assumptions and limits

- Constant amplitude; constant Y; m ≠ 2.
- C is a plain number for da/dN in m/cycle and ΔK in MPa√m in every unit system. Constants in in/cycle and ksi√in convert as C =

C_US × 0.0254 / 1.0988^m (1 ksi√in = 1.0988 MPa√m).

References

- Paris and Erdogan (1963); Barsom and Rolfe
- Fracture and Fatigue Control in Structures (steel constants); Dowling
- Mechanical Behavior of Materials
- 4th ed. (Pearson, 2013)
- ch. 11

Report details

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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/paris-crack-growth-life

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Reopens the calculator with the inputs of this report.