Elliptical Hole Stress Concentration (Inglis)

Stress concentration factor and peak stress at an elliptical hole or crack-like flaw in a wide plate under tension, with the root radius of curvature.

Method: Inglis' elliptical hole solution

Input parameters

Unit system: SI

Parameter	Value	Unit
Semi-axis perpendicular to the load (half crack length)	5.0000	mm
Semi-axis parallel to the load	1.0000	mm
Remote tensile stress	100.00	MPa

Calculated results

Parameter	Value	Unit
Stress concentration factor	11.000	
Root radius of curvature b²/a	0.20000	mm
Peak stress at the hole edge	1,100.0	MPa
Stress at the top and bottom of the hole	-100.00	MPa

Notes for this case

• Inglis (1913): in a wide plate under remote tension σ, an elliptical hole with semi-axis a across the load and b along it has peak stress σ(1 + 2a/b) = σ(1 + 2√(a/ρ)), ρ = b²/a the root radius. A circle gives 3; a sharp crack (ρ → 0) gives unlimited stress, which is why cracks are treated by fracture mechanics instead. The top and bottom of the hole see −σ.

Formula and method

$$K_t = 1 + \frac{2a}{b} = 1 + 2\sqrt{\frac{a}{\rho}}, \quad \rho = \frac{b^2}{a}$$

Variables

a	Semi-axis perpendicular to the load (half crack length)	m
b	Semi-axis parallel to the load	m
σ	Remote tensile stress	Pa
K_t	Stress concentration factor	-
ρ	Root radius of curvature b²/a	m
σ_{max}	Peak stress at the hole edge	Pa
σ_{side}	Stress at the top and bottom of the hole	Pa

Method and standards

Elliptical hole.

Assumptions and limits

- Infinite plate; linear elastic; uniaxial remote tension.

References

Inglis' elliptical hole solution

Report details

Report reference	FCC-F26C-09MH (the same inputs always give the same reference)
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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/materials/properties/elliptical-hole-stress-concentration

Open this case on calc.firecad.com →

Reopens the calculator with the inputs of this report.