Stress in a Rotating Ring and Solid Disc

Hoop stress in a thin rotating ring and the maximum stresses in a solid rotating disc of uniform thickness from speed, radius, density and Poisson's ratio.

Method: Shigley's Mechanical Engineering Design (Budynas and Nisbett); ch. 3 (rotating rings and discs, (3 + ν)/8 ρ ω² r²)

Input parameters

Unit system: SI

Parameter	Value	Unit
Outer radius	400.00	mm
Speed	3,000.0	rpm
Density	7,850.0	kg/m³
Poisson's ratio	0.30000	

Calculated results

Parameter	Value	Unit
Rim speed	125.66	m/s
Hoop stress in a thin ring ρ v²	123.96	MPa
Maximum stress in a solid disc (centre)	51.134	MPa
Hoop stress at the rim of the solid disc	21.693	MPa

Notes for this case

- Uniform thickness, elastic, plane stress. A central hole doubles the hoop stress at the bore.

Formula and method

$$\sigma_{ring} = \rho v^2, \quad \sigma_{max} = \frac{3+\nu}{8}\rho\omega^2 r_o^2, \quad \sigma_{t,rim} = \frac{1-\nu}{4}\rho\omega^2 r_o^2$$

Variables

r_o	Outer radius	m
N	Speed	1/s
ρ	Density	kg/m³
ν	Poisson's ratio	-
v	Rim speed	m/s
σ_{ring}	Hoop stress in a thin ring ρ v²	Pa
σ_{max}	Maximum stress in a solid disc (centre)	Pa
$\sigma_{t,rim}$	Hoop stress at the rim of the solid disc	Pa

Method and standards

Elastic solution for a rotating disc.

Assumptions and limits

- Solid disc, uniform thickness. A disc with a central bore is not covered: even a small hole about doubles the hoop stress at the bore compared with the solid-disc centre value.
- Stresses are not compared with an allowable stress or a burst speed; check them against the material's strength with your design margin.

References

- Shigley's Mechanical Engineering Design (Budynas and Nisbett)
- ch. 3 (rotating rings and discs, (3 + ν)/8 ρ ω² r²)

Report details

Report reference	FCC-9Q2K-CJ1D (the same inputs always give the same reference)
Generated	17 November 2026, 19:50 UTC
Calculator	Stress in a Rotating Ring and Solid Disc
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/rotating-disc-stress

Open this case on calc.firecad.com →

Reopens the calculator with the inputs of this report.