Eccentrically Loaded Column (Secant Formula)

Maximum compressive stress in a column with an eccentric axial load by the secant formula, from load, eccentricity, section and effective length.

Method: Shigley's Mechanical Engineering Design (Budynas and Nisbett); ch. 4 (secant column formula)

Input parameters

Unit system: SI

Parameter	Value	Unit
Axial load	100.00	kN
Eccentricity of the load	10.000	mm
Cross-sectional area	2,850.0	mm²
Radius of gyration about the bending axis	41.500	mm
Distance from the axis to the extreme fibre	75.000	mm
Effective length	3.0000	m
Young's modulus	207.00	GPa

Calculated results

Parameter	Value	Unit
Eccentricity ratio	0.43548	
Secant argument	0.47058	
Maximum compressive stress	52.231	MPa
Direct stress	35.088	MPa

Formula and method

$$\sigma_{max} = \frac{P}{A}\left[1 + \frac{ec}{k^2}\sec\left(\frac{L_e}{2k}\sqrt{\frac{P}{AE}}\right)\right]$$

Variables

P	Axial load	N
e	Eccentricity of the load	m
A	Cross-sectional area	m²
k	Radius of gyration about the bending axis	m
c	Distance from the axis to the extreme fibre	m
L_e	Effective length	m
E	Young's modulus	Pa
ec/k^2	Eccentricity ratio	-
$\frac{L_e}{2k}\sqrt{\frac{P}{AE}}$	Secant argument	-
σ_{max}	Maximum compressive stress	Pa
P/A	Direct stress	Pa

Method and standards

Elastic bending of a column with eccentric load.

Assumptions and limits

- Elastic, pin-ended effective length.

- σ_max is not compared with the yield strength and no factor of safety is applied: check σ_max against your allowable, or solve for the load that makes it reach yield divided by the factor.

References

- Shigley's Mechanical Engineering Design (Budynas and Nisbett)
- ch. 4 (secant column formula)

Report details

Report reference	FCC-5J4F-QJ1F (the same inputs always give the same reference)
Generated	17 November 2026, 19:46 UTC
Calculator	Eccentrically Loaded Column (Secant Formula)
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/eccentric-column-secant

Open this case on calc.firecad.com →

Reopens the calculator with the inputs of this report.