Euler Column Buckling Load and Critical Stress

Critical buckling load and stress of a slender column by Euler's formula for the four classic end conditions, with radius of gyration and slenderness ratio.

Method: L. Euler (1757); effective length factors (Timoshenko and Gere, Theory of Elastic Stability)

Input parameters

Unit system: SI

Parameter	Value	Unit
Modulus of elasticity	200.00	GPa
Least second moment of area of the section	100.00	cm^4
Cross-section area	2,000.0	mm^2
Yield strength (0 = not checked) With a yield strength, a critical stress at or above it is flagged: the column is not slender and Euler does not apply.	0	MPa
Column length	3.0000	m
End condition (effective length factor)	Pinned at both ends (K = 1)	

Calculated results

Parameter	Value	Unit
Critical buckling load	219.32	kN
Critical stress	109.66	MPa
Least radius of gyration	22.361	mm
Effective length K L	3.0000	m
Slenderness ratio	134.16	

Notes for this case

- Elastic buckling of a perfectly straight column. If the critical stress is near or above the yield stress the column is not slender: use an inelastic (Johnson) or design-code column curve with a safety factor.

Formula and method

$$P_{cr} = \frac{\pi^2 E I}{(KL)^2}, \quad \sigma_{cr} = \frac{P_{cr}}{A}$$

$$r = \sqrt{I/A}, \quad L_e = KL, \quad \lambda = L_e / r$$

Variables

E	Modulus of elasticity	Pa
I	Least second moment of area of the section	m^4
A	Cross-section area	m^2
σ_y	Yield strength (0 = not checked)	Pa
L	Column length	m
K	End condition (effective length factor)	-
P_{cr}	Critical buckling load	N
σ_{cr}	Critical stress	Pa
r	Least radius of gyration	m
L_e	Effective length K L	m

L_e/r	Slenderness ratio	-

Method and standards

Euler's elastic buckling load for an ideal straight column; the effective length factor K gives the theoretical values for the classic end conditions.

Assumptions and limits

- Elastic, perfectly straight, centrally loaded column.
- No safety factor applied.
- With a yield strength entered, a critical stress at or above it is flagged.
- Theoretical K values. Design practice uses larger recommended values for imperfect fixity (for example 0.65 fixed–fixed, 0.80 fixed–pinned and 2.1 fixed–free).

References

- L. Euler (1757); effective length factors (Timoshenko and Gere, Theory of Elastic Stability)

Report details

Report reference	FCC-TN2B-MR66 (the same inputs always give the same reference)
Generated	17 November 2026, 19:46 UTC
Calculator	Euler Column Buckling Load and Critical Stress
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/euler-column-buckling

Open this case on calc.firecad.com →

Reopens the calculator with the inputs of this report.