Rankine–Gordon Column Crippling Load

Crippling and safe load of a column by the Rankine–Gordon formula from area, second moment, effective length, crushing stress and Rankine's constant, against Euler.

Method: Rankine–Gordon column formula

Input parameters

Unit system: SI

Parameter	Value	Unit
Cross-section area	2,000.0	mm²
Least second moment of area	200.00	cm⁴
Effective length	3.0000	m
Crushing stress	320.00	MPa
Rankine's constant	Mild steel, 1/7500	
Young's modulus (for Euler)	210.00	GPa
Factor of safety	3.0000	

Calculated results

Parameter	Value	Unit
Least radius of gyration	31.623	mm
Slenderness ratio	94.868	
Rankine crippling load	290.91	kN
Safe load	96.970	kN
Euler load	460.58	kN

Notes for this case

• Rankine and Gordon combined crushing and buckling: 1/P = 1/P_c + 1/P_E, written P = σ_cA/[1 + a(L_e/k)²] with Rankine's constant a ≈ σ_c/(π²E). It approaches the crushing load for short columns and the Euler load for long ones, so a single formula covers the whole range. Use the least radius of gyration and the effective length for the end conditions (L for pinned ends, L/2 fixed–fixed, 2L for a cantilever).

Formula and method

$$P_R = \frac{\sigma_c A}{1 + a\left(\frac{L_e}{k}\right)^2}, \quad k = \sqrt{\frac{I}{A}}, \quad P_E = \frac{\pi^2 E I}{L_e^2}$$

Variables

A	Cross-section area	m²
I	Least second moment of area	m⁴
L_e	Effective length	m
σ_c	Crushing stress	Pa
a	Rankine's constant	-
E	Young's modulus (for Euler)	Pa
FS	Factor of safety	-
k	Least radius of gyration	m
L_e/k	Slenderness ratio	-
P_R	Rankine crippling load	N

P_s	Safe load	N
P_E	Euler load	N

Method and standards

Rankine–Gordon.

Assumptions and limits

- Axial load; straight column.

References

Rankine–Gordon column formula

Report details

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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/mechanical/strength-of-materials/rankine-gordon-column

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Reopens the calculator with the inputs of this report.