PRINTABLE REFERENCE CHART

Column buckling: K factors, Euler and Johnson formulas

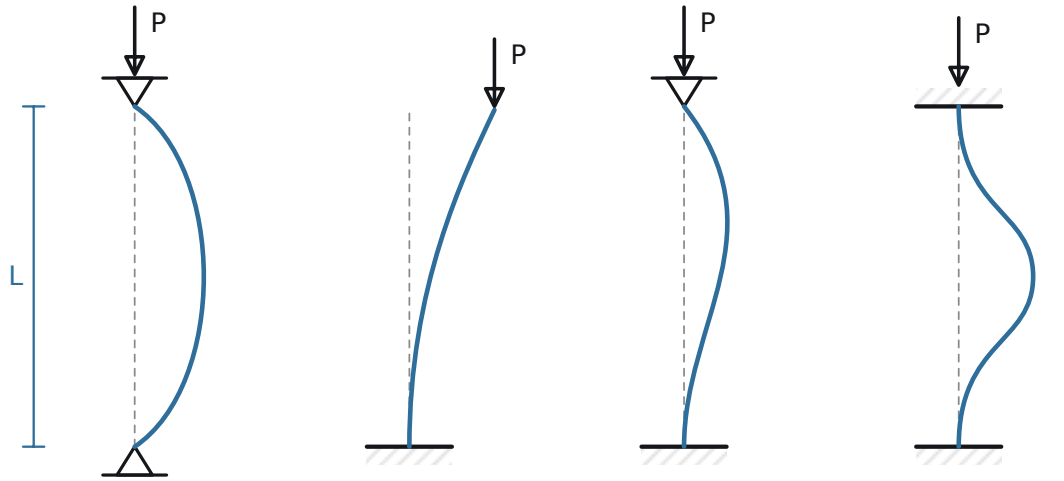
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2. End conditions and K factor

The effective length is $\mathbf{L_e = K \cdot L}$: the length of the half-wave of the buckled shape. Theoretical values assume perfect fixity; since no fixing is perfect, the commentary of the AISC 360 specification gives more cautious recommended values. "Guided" means an end that cannot rotate but can move sideways.

End conditions (end 1 – end 2)	Theoretical K	Recommended K (AISC)	Critical load / pinned case
Fixed – fixed	0.5	0.65	× 4
Fixed – pinned	0.7	0.80	× 2.04
Fixed – guided	1.0	1.2	× 1
Pinned – pinned	1.0	1.0	× 1 (reference)
Fixed – free (flagpole)	2.0	2.1	÷ 4
Pinned – guided	2.0	2.0	÷ 4

The last column compares the theoretical critical load with that of the pinned-pinned column of the same length: it varies as $1/K^2$.



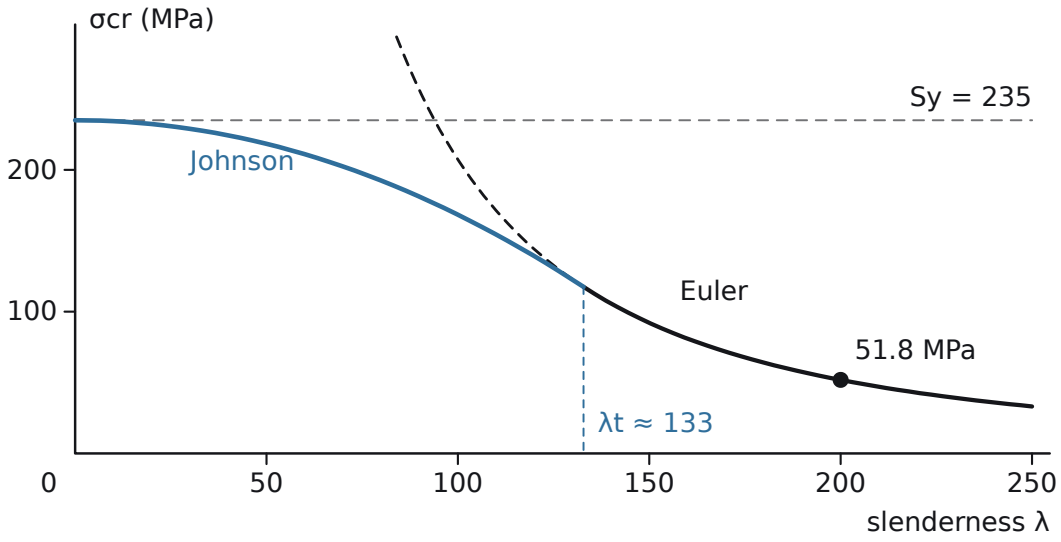
pinned – pinned **K = 1** | fixed – free **K = 2** | fixed – pinned **K = 0.7** | fixed – fixed **K = 0.5**

3. Slenderness, Euler's limit and the Johnson parabola

The slenderness ratio $\boldsymbol{\lambda = K \cdot L / r}$, with the radius of gyration $\mathbf{r = \sqrt{(I/A)}}$, sums up how prone the column is to buckling. The Euler critical stress is $\boldsymbol{\sigma_{cr} = \pi^2 \cdot E / \lambda^2}$. It only makes sense well below the yield strength S_y: for a stocky column, yielding, not elastic buckling, limits the load.

Quantity	Formula
Euler critical load	$\pi^2 \cdot E \cdot I / (K \cdot L)^2$
Radius of gyration	$r = \sqrt{(I / A)}$
Slenderness ratio	$\lambda = K \cdot L / r$
Euler critical stress	$\pi^2 \cdot E / \lambda^2$
Transition slenderness (Johnson)	$\lambda_t = \pi \cdot \sqrt{(2 \cdot E / R_e)}$
Johnson critical stress ($\lambda < \lambda_t$)	$R_e - R_e^2 \cdot \lambda^2 / (4 \cdot \pi^2 \cdot E)$

The Johnson parabola starts at S_y for a very short column and meets the Euler curve, tangentially, at λ_t, where the critical stress is $S_y/2$. With E = 210,000 MPa, λ_t is about **133 for S235** and **108 for S355** steel. Above it, Euler applies; below it, use Johnson. Structural steel yield strengths are in the S235, S275 and S355 reference.



Reference values taken from the article https://www.baouch.fr/en/blog/flambement-euler-charge-critique/, which explains the assumptions, formulas and edge cases. For critical use, check the current standard or the manufacturer's documentation. Free to print and share with credit to the source.