Elastic Buckling of Flat Plates in Compression or Shear

Critical elastic buckling stress of a flat rectangular plate under uniform edge compression or shear, from the plate buckling coefficient for its edge supports.

Method: Bryan's elastic buckling of rectangular plates with the classical coefficients

Input parameters

Unit system: SI

Parameter	Value	Unit
Loading and edges	Compression, all edges simply supported	
Plate length (in the load direction)	1,200.0	mm
Plate width (loaded edge)	400.00	mm
Plate thickness	6.0000	mm
Elastic modulus	200.00	GPa
Poisson's ratio	0.30000	
Yield strength	250.00	MPa

Calculated results

Parameter	Value	Unit
Buckling coefficient	4.0000	
Critical elastic stress	162.69	MPa
Width-to-thickness ratio	66.667	
Critical load per unit width σ_cr t	976.11	kN/m
Critical stress relative to yield (shear: to f_y/√3)	0.65074	
Number of half-waves along the length	3.0000	

Notes for this case

- Elastic (Bryan) plate buckling: σ_cr = kπ²E/[12(1 − ν²)](t/b)². Cases 1 to 3 use the long-plate minimum of k.
- The elastic critical stress exceeds half the yield: buckling is inelastic and the real strength is lower than this value; apply a plasticity reduction or the effective-width method.

Formula and method

$$\sigma_{cr} = k\frac{\pi^2 E}{12(1-\nu^2)}\left(\frac{t}{b}\right)^2, \quad k = \min_m \left(\frac{mb}{a} + \frac{a}{mb}\right)^2$$

$$k = 6.97,\ 0.425,\ 1.277\ \text{(long plates)}, \quad k_s = 5.35 + 4\left(\frac{b}{a}\right)^2\ \text{(shear)}$$

Variables

case	Loading and edges	-
a	Plate length (in the load direction)	m
b	Plate width (loaded edge)	m
t	Plate thickness	m
E	Elastic modulus	Pa
ν	Poisson's ratio	-
f_y	Yield strength	Pa

k	Buckling coefficient	-
σ_{cr}, τ_{cr}	Critical elastic stress	Pa
b/t	Width-to-thickness ratio	-
N_{cr}	Critical load per unit width σ_cr t	N/m
σ_{cr}/f_y	Critical stress relative to yield (shear: to f_y/√3)	-
m	Number of half-waves along the length	-

Method and standards

Elastic stability of thin rectangular plates.

Assumptions and limits

- Perfectly flat, elastic, uniform edge loads; simply supported or clamped edges as stated.

References

Bryan's elastic buckling of rectangular plates with the classical coefficients

Report details

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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/plate-buckling-stress

Open this case on calc.firecad.com →

Reopens the calculator with the inputs of this report.