Circular Flat Plate under Uniform Pressure: Stress and Deflection

Maximum deflection and bending stresses of a solid circular plate under uniform pressure with a simply supported or clamped edge, by thin-plate theory.

Method: Thin circular plate bending under uniform pressure (Kirchhoff theory)

Input parameters

Unit system: SI

Parameter	Value	Unit
Plate radius	250.00	mm
Plate thickness	12.000	mm
Uniform pressure	200.00	kPa
Elastic modulus	200.00	GPa
Poisson's ratio	0.30000	
Edge support	Clamped (fixed)	

Calculated results

Parameter	Value	Unit
Flexural rigidity $Et^3/(12(1-\nu^2))$	31,648	N·m
Maximum (centre) deflection	0.38571	mm
Radial (= tangential) stress at the centre	42.318	MPa
Radial stress at the edge	65.104	MPa
Maximum bending stress	65.104	MPa
Deflection-to-thickness ratio	0.032142	

Notes for this case

- Small-deflection thin-plate theory (Kirchhoff): valid while the deflection stays below about half the thickness and the plate is thin (a/t above about 10).

Formula and method

$$D = \frac{Et^3}{12(1-\nu^2)}, \quad \text{clamped}: \; y_{max} = \frac{qa^4}{64D}, \; \sigma_{edge} = \frac{3qa^2}{4t^2}$$

$$\text{simply supported}: \; y_{max} = \frac{(5+\nu)qa^4}{64D(1+\nu)}, \; \sigma_{centre} = \frac{3(3+\nu)qa^2}{8t^2}$$

Variables

a	Plate radius	m
t	Plate thickness	m
q	Uniform pressure	Pa
E	Elastic modulus	Pa
ν	Poisson's ratio	-
edge	Edge support	-
D	Flexural rigidity $Et^3/(12(1-\nu^2))$	N·m
y_{max}	Maximum (centre) deflection	m

σ_{centre}	Radial (= tangential) stress at the centre	Pa
σ_{edge}	Radial stress at the edge	Pa
σ_{max}	Maximum bending stress	Pa
y/t	Deflection-to-thickness ratio	-

Method and standards

Classical small-deflection bending of solid circular plates.

Assumptions and limits

- Linear elastic, small deflection, uniform thickness; not a pressure-code design.

References

Thin circular plate bending under uniform pressure (Kirchhoff theory)

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/circular-plate-bending

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Reopens the calculator with the inputs of this report.