Principal Stresses and Mohr's Circle (2D)

Principal stresses, maximum in-plane shear stress and the principal angle for a plane stress state from σx, σy and τxy, as on Mohr's circle.

Method: Textbook mechanics (stress transformation, Mohr 1882)

Input parameters

Unit system: SI

Parameter	Value	Unit
Normal stress in x	80.000	MPa
Normal stress in y	-40.000	MPa
Shear stress	30.000	MPa

Calculated results

Parameter	Value	Unit
Major principal stress	87.082	MPa
Minor principal stress	-47.082	MPa
Maximum in-plane shear stress (circle radius)	67.082	MPa
Centre of the circle (σx + σy)/2	20.000	MPa
Angle from x to the major principal axis	13.283	°

Notes for this case

• Plane stress; tension positive. Absolute maximum shear including the out-of-plane principal stress (zero): 67.082 MPa, larger than the in-plane value when σ_1 and σ_2 have the same sign.

Formula and method

$$\sigma_{1,2} = \frac{\sigma_x + \sigma_y}{2} \pm \sqrt{\left(\frac{\sigma_x - \sigma_y}{2}\right)^2 + \tau_{xy}^2}, \quad \tan 2\theta_p = \frac{2\tau_{xy}}{\sigma_x - \sigma_y}$$

Variables

σ_x	Normal stress in x	Pa
σ_y	Normal stress in y	Pa
τ_{xy}	Shear stress	Pa
σ_1	Major principal stress	Pa
σ_2	Minor principal stress	Pa
τ_{max}	Maximum in-plane shear stress (circle radius)	Pa
σ_c	Centre of the circle (σx + σy)/2	Pa
θ_p	Angle from x to the major principal axis	rad

Method and standards

Stress transformation.

Assumptions and limits

• Plane stress. The absolute maximum shear max(|σ₁|, |σ₂|, |σ₁ − σ₂|)/2 (third principal stress zero) is given in a note.

References

• Textbook mechanics (stress transformation, Mohr 1882)

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/mohr-circle-stress

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Reopens the calculator with the inputs of this report.