Von Mises Equivalent Stress and Factor of Safety

Von Mises (distortion energy) equivalent stress from plane-stress components, and the factor of safety against yield by von Mises and by Tresca.

Method: Shigley's Mechanical Engineering Design (Budynas and Nisbett); ch. 5 (distortion energy and maximum shear stress theories)

Input parameters

Unit system: SI

Parameter	Value	Unit
Normal stress in x	120.00	MPa
Normal stress in y	40.000	MPa
Shear stress	50.000	MPa
Yield strength	250.00	MPa

Calculated results

Parameter	Value	Unit
Von Mises stress	136.75	MPa
Factor of safety by von Mises S_y/σ'	1.8282	
Tresca equivalent stress (largest principal difference)	144.03	MPa
Factor of safety by Tresca	1.7357	

Notes for this case

- Ductile materials under static load. Tresca is slightly conservative compared with von Mises.

Formula and method

$$\sigma_T = \max(|\sigma_1 - \sigma_2|, |\sigma_1|, |\sigma_2|)$$

One further formula is shown on the calculator page: https://calc.firecad.com/mechanical/strength-of-materials/von-mises-stress

Variables

σ_x	Normal stress in x	Pa
σ_y	Normal stress in y	Pa
τ_{xy}	Shear stress	Pa
S_y	Yield strength	Pa
\sigma'	Von Mises stress	Pa
n_{vm}	Factor of safety by von Mises S_y/σ'	-
σ_T	Tresca equivalent stress (largest principal difference)	Pa
n_T	Factor of safety by Tresca	-

Method and standards

Distortion energy and maximum shear stress criteria.

Assumptions and limits

- Plane stress, ductile material.

References

- Shigley's Mechanical Engineering Design (Budynas and Nisbett)
- ch. 5 (distortion energy and maximum shear stress theories)

Report details

Report reference	FCC-Y1HG-AJB2 (the same inputs always give the same reference)
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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/von-mises-stress

Open this case on calc.firecad.com →

Reopens the calculator with the inputs of this report.