Torsion of a Solid Rectangular Section: Shear Stress and Twist

Maximum shear stress, torsion constant and angle of twist of a solid rectangular bar in torsion, by the Saint-Venant series approximation.

Input parameters

Unit system: SI

Parameter	Value	Unit
Section width (longer side)	60.000	mm
Section thickness (shorter side)	20.000	mm
Torque	800.00	N·m
Bar length	1.5000	m
Shear modulus	79.300	GPa

Calculated results

Parameter	Value	Unit
Aspect ratio	3.0000	
Torsion constant	126,435	mm^4
Maximum shear stress (middle of the long side)	124.61	MPa
Angle of twist	6.8575	°
Stress coefficient τ = T/(α w t²)	0.26749	
Stiffness coefficient K = β w t³	0.26341	

Notes for this case

• Saint-Venant torsion with Roark's fits (within about 4 % of the exact series): the largest shear is at the middle of the longer sides; corners carry no shear. For thin strips (w/t > 10) α and β approach 1/3.

Formula and method

$$K = ab^3\left[\frac{16}{3} - 3.36\frac{b}{a}\left(1 - \frac{b^4}{12a^4}\right)\right], \quad \tau_{max} = \frac{3T}{8ab^2}\left[1 + 0.6095\frac{b}{a} + 0.8865\left(\frac{b}{a}\right)^2 - 1.8023\left(\frac{b}{a}\right)^3 + 0.9100\left(\frac{b}{a}\right)^4\right]$$

$$\theta = \frac{TL}{KG} \quad (a, b = \text{half} - \text{width and half} - \text{thickness}, a \geq b)$$

Variables

w	Section width (longer side)	m
t	Section thickness (shorter side)	m
T	Torque	N·m
L	Bar length	m
G	Shear modulus	Pa
w/t	Aspect ratio	-
K	Torsion constant	m^4
τ_{max}	Maximum shear stress (middle of the long side)	Pa
θ	Angle of twist	rad
α	Stress coefficient τ = T/(α w t²)	-
β	Stiffness coefficient K = β w t³	-

Method and standards

Saint-Venant torsion of solid rectangular sections.

Assumptions and limits

- Elastic, uniform section, free warping.

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/rectangular-section-torsion

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