Anti-Roll Bar Torsional, Wheel and Roll Stiffness

Torsional stiffness of a solid or tubular anti-roll bar, its wheel rate with one wheel moving and the roll stiffness it adds to an axle, from bar and lever geometry.

Method: Torsion bar statics applied to roll

Input parameters

Unit system: SI

Parameter	Value	Unit
Bar outside diameter	22.000	mm
Inside diameter (0 for solid)	0	mm
Shear modulus	79.300	GPa
Active torsion length	1,000.0	mm
Lever arm length	250.00	mm
Track width	1,500.0	mm
Link-to-wheel motion ratio	0.70000	

Calculated results

Parameter	Value	Unit
Torsional stiffness	1,823.7	N·m
Wheel rate (one wheel moving)	14.298	N/mm
Roll stiffness added (per radian)	32,171	N·m
Roll stiffness per degree	561.49	N·m

Notes for this case

• Torsion of the bar: K_t = GJ/L, J = π(d⁴ − d_i⁴)/32. In roll each wheel moves ±(t/2)φ and the links ±MR(t/2)φ, twisting the bar by tφMR/a, so the roll stiffness added is K_φ = K_t(tMR/a)². With one wheel moving, the wheel rate is K_tMR²/a². Lever-arm bending and bushing compliance typically reduce the real stiffness by 10–30 %, so test or model them for design.

Formula and method

$$K_t = \frac{GJ}{L}, \quad J = \frac{\pi(d^4 - d_i^4)}{32}, \quad K_\phi = K_t \left(\frac{t\,MR}{a}\right)^2$$

Variables

d	Bar outside diameter	m
d_i	Inside diameter (0 for solid)	m
G	Shear modulus	Pa
L	Active torsion length	m
a	Lever arm length	m
t	Track width	m
MR	Link-to-wheel motion ratio	-
K_t	Torsional stiffness	N·m
k_w	Wheel rate (one wheel moving)	N/m
K_ϕ	Roll stiffness added (per radian)	N·m
K_ϕ/deg	Roll stiffness per degree	N·m

Method and standards

Anti-roll bar.

Assumptions and limits

- Rigid arms and mounts; small angles.

References

Torsion bar statics applied to roll

Report details

Report reference	FCC-XC33-FTK2 (the same inputs always give the same reference)
Generated	23 November 2026, 18:00 UTC
Calculator	Anti-Roll Bar Torsional, Wheel and Roll Stiffness
Method last reviewed	17 November 2026
Software release	FireCAD Calc, release of 22 November 2026
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/automotive/vehicle-dynamics/anti-roll-bar-stiffness

Open this case on calc.firecad.com →

Reopens the calculator with the inputs of this report.