Roll Stiffness from Springs and Anti-Roll Bars, and Roll Gradient

Front and rear roll stiffness from wheel rates, track widths and anti-roll bars, the roll gradient per g and the front share of roll stiffness.

Method: Roll stiffness and roll gradient

Input parameters

Unit system: SI

Parameter	Value	Unit
Sprung mass	1,350.0	kg
CG height above roll axis	450.00	mm
Front wheel rate (each)	30.000	N/mm
Rear wheel rate (each)	28.000	N/mm
Front track	1.5500	m
Rear track	1.5500	m
Front anti-roll bar stiffness (at wheels)	25,000	N·m
Rear anti-roll bar stiffness (at wheels)	8,000.0	N·m

Calculated results

Parameter	Value	Unit
Front roll stiffness (per rad)	61,038	N·m
Rear roll stiffness (per rad)	41,635	N·m
Roll gradient (per g)	3.5294	°
Front roll stiffness share	59.449	%

Notes for this case

• K_φ = k_wt²/2 + K_bar per axle (N·m per radian of body roll). Roll gradient φ/a_y = m_sgh'/(K_φf + K_φr − m_sgh') per g, the second term allowing for the CG moving sideways as the body rolls. Road cars run about 3–7°/g; a larger front share of roll stiffness pushes more load transfer to the front and adds understeer.

Formula and method

$$K_{\varphi} = \frac{k_w t^2}{2} + K_b, \quad \frac{\varphi}{a_y} = \frac{m_s g h'}{K_{\varphi f} + K_{\varphi r} - m_s g h'}$$

Variables

m_s	Sprung mass	kg
h'	CG height above roll axis	m
k_{wf}	Front wheel rate (each)	N/m
k_{wr}	Rear wheel rate (each)	N/m
t_f	Front track	m
t_r	Rear track	m
K_{bf}	Front anti-roll bar stiffness (at wheels)	N·m
K_{br}	Rear anti-roll bar stiffness (at wheels)	N·m
$K_{\varphi f}$	Front roll stiffness (per rad)	N·m

$K_{\varphi r}$	Rear roll stiffness (per rad)	N·m
φ / a_y	Roll gradient (per g)	rad
$K_{\varphi f} / K_{\varphi}$	Front roll stiffness share	-

Method and standards

Roll stiffness.

Assumptions and limits

- Linear springs; small roll angles; tyre compliance ignored.

References

Roll stiffness and roll gradient

Report details

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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/automotive/vehicle-dynamics/roll-stiffness-gradient

Open this case on calc.firecad.com →

Reopens the calculator with the inputs of this report.