Wheel Imbalance Force and Vibration Frequency

Rotating force from an unbalanced mass on a road wheel at a vehicle speed, its frequency and its size relative to the static wheel load.

Method: Rotating imbalance force

Input parameters

Unit system: SI

Parameter	Value	Unit
Unbalanced mass	30.000	g
Radius of the unbalanced mass	190.00	mm
Vehicle speed	120.00	km/h
Tyre rolling radius	310.00	mm
Static wheel load	4,000.0	N

Calculated results

Parameter	Value	Unit
Wheel speed	1,026.8	rpm
Excitation frequency	17.113	Hz
Rotating imbalance force	65.904	N
Force relative to wheel load	1.6476	%

Notes for this case

• F = m_ur_uω², ω = v/R. Force rises with speed squared; at highway speed a 30 g imbalance at the rim produces a force of a few percent of the wheel load, felt as steering shake when the wheel frequency (about 12–16 Hz) meets the suspension's wheel-hop resonance.

Formula and method

$$F_u = m_u r_u \omega^2, \quad \omega = \frac{v}{R}, \quad f = \frac{\omega}{2\pi}$$

Variables

m_u	Unbalanced mass	kg
r_u	Radius of the unbalanced mass	m
v	Vehicle speed	m/s
R	Tyre rolling radius	m
F_z	Static wheel load	N
n	Wheel speed	rad/s
f	Excitation frequency	1/s
F_u	Rotating imbalance force	N
F_u/F_z	Force relative to wheel load	-

Method and standards

Wheel imbalance.

Assumptions and limits

- Static imbalance only; rigid wheel.

References

Rotating imbalance force

Report details

Report reference	FCC-57AY-P71A (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/automotive/tyres-wheels/wheel-imbalance-force

Open this case on calc.firecad.com →

Reopens the calculator with the inputs of this report.