Vehicle Road Load: Rolling, Aerodynamic and Gradient Power

Rolling, aerodynamic and gradient resistance of a vehicle at a speed, and the power needed at the wheels and from the engine or motor.

Method: Road-load equation (Gillespie, Fundamentals of Vehicle Dynamics (SAE, 1992), ch. 4)

Input parameters

Unit system: SI

Parameter	Value	Unit
Vehicle mass	1,500.0	kg
Rolling resistance coefficient	0.012000	
Drag coefficient	0.32000	
Frontal area	2.2000	m²
Speed	90.000	km/h
Road gradient (rise/run)	2.0000	%
Air density	1.2000	kg/m³
Drivetrain efficiency	90.000	%

Calculated results

Parameter	Value	Unit
Rolling resistance	176.48	N
Aerodynamic drag	264.00	N
Gradient resistance	294.14	N
Total road load	734.63	N
Power at the wheels	18.366	kW
Power from the engine or motor	20.406	kW

Notes for this case

- Steady speed, still air. Aerodynamic drag grows with v², so above about 60–80 km/h it dominates for cars.

Formula and method

$$F = mgC_{rr}\cos\theta + \frac{1}{2}\rho C_d A v^2 + mg\sin\theta, \quad P_e = \frac{Fv}{\eta_d}\ (Fv \geq 0), \quad P_e = Fv\,\eta_d\ (Fv < 0)$$

Variables

m	Vehicle mass	kg
C_{rr}	Rolling resistance coefficient	-
C_d	Drag coefficient	-
A	Frontal area	m²
v	Speed	m/s
G	Road gradient (rise/run)	-
θ	Road angle, arctan G	rad
g	Standard gravity, 9.806 65	m/s²
ρ	Air density	kg/m³
η_d	Drivetrain efficiency	-
F_r	Rolling resistance	N
F_a	Aerodynamic drag	N

F_g	Gradient resistance	N
F	Total road load	N
P_w	Power at the wheels	W
P_e	Power from the engine or motor	W

Method and standards

Road-load equation.

Assumptions and limits

- Steady speed; still air.
- Downhill with a negative total load, P_e is the wheel power reduced by the drivetrain efficiency: the power that reaches the engine or motor, not the power it must supply.

References

- Road-load equation (Gillespie, Fundamentals of Vehicle Dynamics (SAE, 1992), ch. 4)

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/automotive/vehicle-dynamics/road-load-power

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Reopens the calculator with the inputs of this report.