Tractive Effort and Gradeability

Tractive effort at the wheels from engine torque and gearing, the adhesion limit of the driven axle, and the steepest gradient the vehicle can climb at low speed.

Method: Tractive effort and gradeability (Gillespie, Fundamentals of Vehicle Dynamics (SAE, 1992), ch. 2)

Input parameters

Unit system: SI

Parameter	Value	Unit
Engine torque	250.00	N·m
Gear ratio	3.5000	
Final drive ratio	4.1000	
Drivetrain efficiency	88.000	%
Tyre rolling radius	310.00	mm
Vehicle mass	1,500.0	kg
Rolling resistance coefficient	0.012000	
Tyre–road adhesion coefficient	0.80000	
Share of weight on the driven axle	60.000	%

Calculated results

Parameter	Value	Unit
Tractive effort from the engine	10,184	N
Adhesion limit of the driven axle	7,060.8	N
Usable tractive effort	7,060.8	N
Maximum gradeability (rise/run)	53.161	%

Notes for this case

- Low speed (aerodynamic drag neglected); solves F = mg(C_rr cos θ + sin θ). Weight shifts off the front axle on a climb, which this simple adhesion check ignores.

Formula and method

$$F_t = \frac{T_e i_g i_0 \eta_d}{r}, \quad F_\mu = \mu \phi m g, \quad F = m g (C_{rr} \cos\theta + \sin\theta)$$

Variables

T_e	Engine torque	N·m
i_g	Gear ratio	-
i_0	Final drive ratio	-
η_d	Drivetrain efficiency	-
r	Tyre rolling radius	m
m	Vehicle mass	kg
C_{rr}	Rolling resistance coefficient	-
μ	Tyre–road adhesion coefficient	-
ϕ	Share of weight on the driven axle	-
F_t	Tractive effort from the engine	N
F_μ	Adhesion limit of the driven axle	N
F	Usable tractive effort	N

G_{max}	Maximum gradeability (rise/run)	-

Method and standards

Force balance.

Assumptions and limits

- The adhesion limit uses the static share of weight on the driven axle. On a climb weight moves to the rear axle, so the limit is overstated for front-wheel drive and understated for rear-wheel drive.
- When the usable effort exceeds the vehicle weight the gradeability is unbounded and is not shown.
- Low speed; steady climb.

References

- Tractive effort and gradeability (Gillespie, Fundamentals of Vehicle Dynamics (SAE, 1992), ch. 2)

Report details

Report reference	FCC-S3SV-ASJE (the same inputs always give the same reference)
Generated	17 November 2026, 19:46 UTC
Calculator	Tractive Effort and Gradeability
Method last reviewed	13 November 2026
Software release	FireCAD Calc, release of 17 November 2026
Release checks	2 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/transmission/tractive-effort-gradeability

Open this case on calc.firecad.com →

Reopens the calculator with the inputs of this report.