Mine Rail Haulage: Train Resistance, Tractive Effort and Adhesion

Total train resistance from friction, grade, curvature and acceleration, locomotive tractive effort from power, the adhesion limit and the net tractive effort.

Input parameters

Unit system: SI

Parameter	Value	Unit
Locomotive weight	30.000	t
Gross trailing weight of the cars	300.00	t
Locomotive friction resistance (7.5 kg/t antifriction)	7.5000	kg/t
Car friction resistance	6.2500	kg/t
Grade (+ up, − down)	1.0000	%
Track curvature (degrees of curve)	0	
Acceleration	0.16000	km/(h·s)
Engine power	220.00	kW
Power to auxiliaries	15.000	kW
Transmission efficiency	82.000	%
Train speed	16.000	km/h
Coefficient of adhesion	0.30000	

Calculated results

Parameter	Value	Unit
Total tractive resistance	7,036.8	kgf
Tractive effort from power	3,856.8	kgf
Tractive effort allowed by adhesion	9,000.0	kgf
Net tractive effort	-3,180.0	kgf
Acceleration resistance factor	4.9600	kg/t

Notes for this case

- The net tractive effort is negative: the train cannot start or accelerate as entered; reduce the trailing load or the acceleration.

Formula and method

$$TR = LW \cdot FRF_L + TW \cdot FRF_C + GTW(GRF + CRF + ARF)$$

$$TE = \frac{(EP - EP_a)EFF}{V}, \quad TE_A = C_A \cdot LW, \quad NTE = \min(TE, TE_A) - TR$$

Variables

LW	Locomotive weight	kg
TW	Gross trailing weight of the cars	kg
FRF_L	Locomotive friction resistance (7.5 kg/t antifriction)	kg/kg
FRF_C	Car friction resistance	kg/kg
i	Grade (+ up, − down)	-
C	Track curvature (degrees of curve)	-

ACC	Acceleration	m/s²
EP	Engine power	W
EP_a	Power to auxiliaries	W
EFF	Transmission efficiency	-
V	Train speed	m/s
C_A	Coefficient of adhesion	-
TR	Total tractive resistance	N
TE	Tractive effort from power	N
TE_A	Tractive effort allowed by adhesion	N
NTE	Net tractive effort	N
ARF	Acceleration resistance factor	kg/kg

Method and standards

Rail haulage equations.

Assumptions and limits

- Wind resistance neglected at mine speeds.

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/civil/mine-design/rail-haulage-tractive-effort

Open this case on calc.firecad.com →

Reopens the calculator with the inputs of this report.