Disc Brake Torque, Clamping Force and Energy Absorbed

Torque of a caliper disc brake from clamping force, friction and effective radius, with stopping time, energy absorbed and disc temperature rise.

Method: Budynas and Nisbett; Shigley's Mechanical Engineering Design; ...

Input parameters

Unit system: SI

Parameter	Value	Unit
Clamping force per pad	8.0000	kN
Pad friction coefficient	0.35000	
Effective radius of the pads	120.00	mm
Friction faces	2.0000	
Rotating inertia being stopped	10.000	kg·m²
Initial speed	1,000.0	rpm
Disc mass	8.0000	kg
Disc specific heat	0.46000	kJ/(kg·K)

Calculated results

Parameter	Value	Unit
Braking torque	672.00	N·m
Stopping time	1.5583	s
Energy absorbed	54.831	kJ
Disc temperature rise (all heat to the disc)	14.900	K

Notes for this case

- Single stop with constant torque and no heat loss during the stop; repeated stops need a heat balance over the duty cycle.

Formula and method

$$T = \mu F r_e n_f, \quad t_s = \frac{I\omega}{T}, \quad E = \frac{1}{2} I\omega^2, \quad \Delta T = \frac{E}{m_d c_d}$$

Variables

F	Clamping force per pad	N
μ	Pad friction coefficient	-
r_e	Effective radius of the pads	m
n_f	Friction faces	-
I	Rotating inertia being stopped	kg·m²
N	Initial speed	1/s
m_d	Disc mass	kg
c_d	Disc specific heat	J/(kg·K)
T	Braking torque	N·m
t_s	Stopping time	s
E	Energy absorbed	J
ΔT	Disc temperature rise (all heat to the disc)	K

Method and standards

Friction torque and energy balance.

Assumptions and limits

- Constant torque; adiabatic stop.
- The stopping time uses the brake torque on the inertia alone: a load torque that also resists (or drives) the shaft during the stop shortens (or lengthens) it.

References

- Budynas and Nisbett
- Shigley's Mechanical Engineering Design
- 10th ed. (McGraw-Hill, 2015)
- ch. 16 (disc brakes; energy considerations)

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/mechanical/machine-design/disc-brake-torque-energy

Open this case on calc.firecad.com →

Reopens the calculator with the inputs of this report.