Shoe (Block) Brake: Braking Torque and Lever Force

Braking torque of a single short-shoe block brake on a drum and the lever force needed, for the drum turning either way, with the self-energising effect.

Method: Rattan; Theory of Machines; ...

Input parameters

Unit system: SI

Parameter	Value	Unit
Required braking torque	300.00	N·m
Drum radius	150.00	mm
Friction coefficient	0.35000	
Lever length (pivot to applied force)	600.00	mm
Pivot to shoe centre (along the lever)	200.00	mm
Offset of the friction line from the pivot	40.000	mm

Calculated results

Parameter	Value	Unit
Normal force on the shoe	5,714.3	N
Lever force, b + μc case (friction moment opposing the applied force when c > 0)	2,038.1	N
Lever force, b − μc case (friction moment assisting when c > 0)	1,771.4	N
Self-locking in one direction of rotation (1 = yes)	0	

Notes for this case

- Short shoe: pressure taken as uniform. For long shoes (contact angle over about 60°), use the equivalent friction coefficient μ' = 4μ sin(θ/2)/(θ + sin θ).

Formula and method

$$R_N = \frac{T}{\mu r}, \quad P = \frac{R_N(b \pm \mu c)}{a}$$

Variables

T	Required braking torque	N·m
r	Drum radius	m
μ	Friction coefficient	-
a	Lever length (pivot to applied force)	m
b	Pivot to shoe centre (along the lever)	m
c	Offset of the friction line from the pivot	m
R_N	Normal force on the shoe	N
P_1	Lever force, friction moment opposing the applied force	N
P_2	Lever force, friction moment assisting	N
$\text{self}-\text{locking}$	Self-locking in the assisting direction (1 = yes)	-

Method and standards

Lever statics with shoe friction.

Assumptions and limits

- Short shoe; uniform pressure. The long-shoe equivalent friction μ' = 4μ sin(θ/2)/(θ + sin θ) is mentioned in the note but not applied (there is no contact-angle input): enter μ' as μ for a long shoe.

- With a negative offset c the roles of P_1 and P_2 swap: P_1 then has the assisting friction moment. Self-locking is flagged when either lever force is zero or negative.

References

- Rattan
- Theory of Machines
- 4th ed. (McGraw-Hill, 2014); Bhandari
- Design of Machine Elements
- 4th ed. (McGraw-Hill, 2017) (single block brake)
- Budynas and Nisbett
- Shigley's Mechanical Engineering Design
- 10th ed. (McGraw-Hill, 2015)
- ch. 16

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/block-brake-torque

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Reopens the calculator with the inputs of this report.