Wind Turbine Tower Base Moment from Rotor Thrust and Tower Drag

Overturning moment and shear at the tower base from rotor thrust at hub height and wind drag on the tower with a power-law wind profile.

Method: Rotor thrust and tower drag with a power-law profile

Input parameters

Unit system: SI

Parameter	Value	Unit
Rotor thrust	600.00	kN
Hub height	100.00	m
Mean tower diameter	4.5000	m
Tower drag coefficient	0.60000	
Wind speed at hub height	12.000	m/s
Wind shear exponent	0.14000	
Air density	1.2250	kg/m³

Calculated results

Parameter	Value	Unit
Drag on the tower	18.605	kN
Base shear	618.60	kN
Moment from tower drag	1,044.5	kN·m
Moment from rotor thrust	60,000	kN·m
Total base overturning moment	61,044	kN·m

Notes for this case

• Tower drag ∫½ρC_dD U(z)² dz with U = U_h(z/H)^α gives F = qH/(2α + 1) and M = qH²/(2α + 2), q = ½ρC_dDU_h². Design loads add gusts, dynamics and safety factors; the parked extreme-wind case often governs.

Formula and method

$$F_t = \frac{qH}{2\alpha + 1}, \quad M = TH + \frac{qH^2}{2\alpha + 2}, \quad q = \frac{1}{2}\rho C_d D_t U_h^2$$

Variables

T	Rotor thrust	N
H	Hub height	m
D_t	Mean tower diameter	m
C_d	Tower drag coefficient	-
U_h	Wind speed at hub height	m/s
α	Wind shear exponent	-
ρ	Air density	kg/m³
F_t	Drag on the tower	N
V	Base shear	N
M_t	Moment from tower drag	N·m
M_r	Moment from rotor thrust	N·m

M	Total base overturning moment	N·m

Method and standards

Tower base loads.

Assumptions and limits

- Steady loads; uniform tower diameter.

References

Rotor thrust and tower drag with a power-law profile

Report details

Report reference	FCC-NBCN-EPHY (the same inputs always give the same reference)
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Release checks	3 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/environmental/wind-power/wind-tower-base-moment-drag

Open this case on calc.firecad.com →

Reopens the calculator with the inputs of this report.