Wind Turbine Gravity Foundation: Overturning and Bearing Pressure

Eccentricity, overturning safety factor and maximum soil bearing pressure of a square gravity foundation under the turbine weight, overturning moment and base shear.

Method: Rigid-footing eccentric loading

Input parameters

Unit system: SI

Parameter	Value	Unit
Foundation width (square)	18.000	m
Foundation depth	2.5000	m
Turbine and tower weight	4,000.0	kN
Unit weight of foundation and backfill	22.000	kN/m³
Overturning moment at tower base	80,000	kN·m
Base shear	800.00	kN

Calculated results

Parameter	Value	Unit
Total vertical load	21,820	kN
Moment at the foundation base	82,000	kN·m
Eccentricity M_b/W	3.7580	m
Safety factor against overturning W·B/2/M_b	2.3949	
Maximum bearing pressure	154.17	kPa
Fraction of base in contact	87.366	%

Notes for this case

• Rigid square base, moment about one axis: within the middle third (e ≤ B/6) pressure is trapezoidal, q = (W/B²)(1 + 6e/B); beyond it the base lifts and q = 2W/[3B(B/2 − e)]. Design standards also check sliding, soil stiffness for tower frequency, fatigue and buoyancy with groundwater.

Formula and method

$$e = \frac{M + Vt}{W}, \quad q_{max} = \frac{W}{B^2}\left(1 + \frac{6e}{B}\right) \ (e \le B/6), \quad q_{max} = \frac{2W}{3B(B/2 - e)} \ (e > B/6)$$

Variables

B	Foundation width (square)	m
t	Foundation depth	m
W_t	Turbine and tower weight	N
γ	Unit weight of foundation and backfill	N/m³
M	Overturning moment at tower base	N·m
V	Base shear	N
W	Total vertical load	N
M_b	Moment at the foundation base	N·m
e	Eccentricity M_b/W	m
FS	Safety factor against overturning W·B/2/M_b	-
q_{max}	Maximum bearing pressure	Pa

A'/A	Fraction of base in contact	-

Method and standards

Eccentric footing.

Assumptions and limits

- Rigid square footing; uniaxial moment; no buoyancy.

References

Rigid-footing eccentric loading

Report details

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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-turbine-gravity-foundation

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Reopens the calculator with the inputs of this report.