Wind Turbine Blade Root Flapwise and Gravity Moments

Rotor thrust and the flapwise bending moment at the blade root from thrust loading on the rotor, with the edgewise moment from blade weight.

Method: Uniform-loading blade root moments

Input parameters

Unit system: SI

Parameter	Value	Unit
Thrust coefficient	0.80000	
Wind speed	11.000	m/s
Rotor radius	60.000	m
Hub (blade root) radius	1.5000	m
Number of blades	3.0000	
Air density	1.2250	kg/m³
Blade mass	18.000	t
Blade centre of gravity from the root	20.000	m

Calculated results

Parameter	Value	Unit
Rotor thrust	670.14	kN
Flapwise root moment per blade	8,605.5	kN·m
Edgewise root moment from blade weight (blade horizontal)	3,530.4	kN·m
Effective thrust arm from the root	38.524	m

Notes for this case

• Thrust spread uniformly over the swept annulus (dT ∝ r dr, as for ideal loading); flap moment about the root M = ∫(r − r_h)dT/B, giving 2TR/3B with no hub. Gravity gives a cyclic edgewise moment m_b g r_cg once per revolution, a main fatigue load on large blades.

Formula and method

$$T=\frac{1}{2}\rho\pi(R^2-r_h^2)U^2C_T,\quad M_{flap}=\frac{2T}{B(R^2-r_h^2)}\left[\frac{R^3-r_h^3}{3}-\frac{r_h(R^2-r_h^2)}{2}\right],\quad M_{edge}=m_b g r_{cg}$$

Variables

C_T	Thrust coefficient	-
U	Wind speed	m/s
R	Rotor radius	m
r_h	Hub (blade root) radius	m
B	Number of blades	-
ρ	Air density	kg/m³
m_b	Blade mass	kg
r_{cg}	Blade centre of gravity from the root	m
T	Rotor thrust	N
M_{flap}	Flapwise root moment per blade	N·m
M_{edge}	Edgewise root moment from blade weight (blade horizontal)	N·m
r_T	Effective thrust arm from the root	m

Method and standards

Blade root load estimates.

Assumptions and limits

- Steady uniform thrust loading; no dynamics or gusts.

References

Uniform-loading blade root moments

Report details

Report reference	FCC-ER2E-ZMGV (the same inputs always give the same reference)
Generated	23 November 2026, 17:34 UTC
Calculator	Wind Turbine Blade Root Flapwise and Gravity Moments
Method last reviewed	17 November 2026
Software release	FireCAD Calc, release of 22 November 2026
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-blade-root-flap-moment

Open this case on calc.firecad.com →

Reopens the calculator with the inputs of this report.