Gyroscopic Couple of a Spinning Rotor

Gyroscopic couple and bearing reaction when a spinning rotor such as a ship turbine or vehicle wheel precesses, from inertia, spin and precession.

Method: Rattan; Theory of Machines; ...

Input parameters

Unit system: SI

Parameter	Value	Unit
Polar moment of inertia of the rotor	200.00	kg·m²
Spin speed	3,000.0	rpm
Precession rate	0.050000	rad/s
Bearing span	2.0000	m

Calculated results

Parameter	Value	Unit
Spin rate	314.16	rad/s
Gyroscopic couple	3.1416	kN·m
Bearing reaction from the couple	1.5708	kN

Notes for this case

• Precession of a ship turning at radius R with speed V is ω_p = V/R; for pitching, use the maximum angular velocity of the pitching motion. Direction follows the right-hand rule.

Formula and method

$$C = I\omega_s\omega_p, \quad R = \frac{C}{b}$$

Variables

I	Polar moment of inertia of the rotor	kg·m²
N	Spin speed	1/s
ω_p	Precession rate, in rad/s (deg/s × π/180; rpm × π/30)	-
b	Bearing span	m
ω_s	Spin rate (rad/s)	-
C	Gyroscopic couple	N·m
R	Bearing reaction from the couple	N

Method and standards

Gyroscopic couple.

Assumptions and limits

- Steady precession; symmetrical rotor.
- ω_p is entered in rad/s in every unit system: multiply deg/s by π/180 or rpm by π/30.

References

• Rattan
• Theory of Machines
• 4th ed. (McGraw-Hill, 2014); Bhandari
• Design of Machine Elements
• 4th ed. (McGraw-Hill, 2017) (gyroscopic couple C = Iωω_p)

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/statics-dynamics/gyroscopic-couple

Open this case on calc.firecad.com →

Reopens the calculator with the inputs of this report.