Propellers and Moment of Inertia

Understanding MOI, and Why It Matters for Propeller Selection

Technical Note — August 2026

Introduction

Inertia is the capacity of an object to resist a variation of speed. For an object in translation, this resistance depends only on its mass, expressed in kilograms.

For a rotating object, the mass alone is not sufficient information: it must be considered together with its distance from the axis of rotation, in order to characterize the object's resistance to a variation of angular speed.

This resistance is the Moment of Inertia — MOI, expressed in kg· cm².

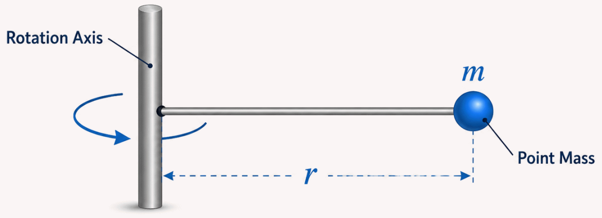
The moment of inertia is a critical parameter for propellers.

> **Scope of this note**
> This note explains what the moment of inertia of a propeller is, why it matters for the powerplant it is fitted to, and how E-Props designs and verifies the MOI of every propeller it manufactures.

What Is the Moment of Inertia?

The moment of inertia of a rotating body measures how its mass is distributed relative to its axis of rotation. For a given mass, the further that mass sits from the axis, the greater the moment of inertia, and the greater the resistance to a change in rotational speed.

Moment of Inertia of a Point Mass



$$\boxed{I = m \cdot r^2}$$

m = mass of the point mass
r = perpendicular distance from the axis to the mass
I = moment of inertia about the axis

For a propeller, this means that the diameter, the mass and the way that mass is distributed along the blades — root, mid-span, tip — all determine the resulting MOI. Two propellers of identical mass can therefore have very different moments of inertia, depending on how their mass is distributed along the blade span and hub.

A heavy hub, however, generates comparatively little moment of inertia, since it sits close to the axis of rotation: as the formula above shows, distance from the axis, much more than mass, is what drives the moment of inertia.

Why the Moment of Inertia Matters for a Propeller

Most aeronautical piston engines rely on the inertia of their rotating assembly to regularize the rotation of the crankshaft. The crankshaft is accelerated by each power stroke of the connecting rod — once every two revolutions in a 4-stroke engine — and is slowed down during the rest of the cycle. It is the inertia of the whole rotating assembly that smooths out this cycle and assists the compression of the following stroke.

The propeller constitutes by far the largest rotating inertia in the powerplant. When the propeller is driven through a reduction gearbox, the torque peaks generated by this inertia are absorbed by the gearbox. When the propeller is coupled directly to the crankshaft, the crankshaft itself absorbs the full load. In both cases, these efforts propagate through the whole system: gearbox internals can suffer if the moment of inertia of the propeller is too high, and the propeller's mounting bolts are subjected to the same cyclic loads.

Fitting a propeller whose moment of inertia is higher or lower than the range specified by the engine manufacturer reduces the service life of the affected components, and can, in extreme cases, cause the gearbox or the propeller's mounting hardware to fail.

Engine Manufacturers' Moment of Inertia Limits

Because of this, engine manufacturers specify, for each engine model, the range of acceptable propeller moments of inertia — a minimum value and a maximum value. A propeller must fall within this range to be considered compatible with the engine.

> **Compliance is not optional**
> Fitting a propeller with a moment of inertia outside the range specified by the engine manufacturer can shorten the service life of the gearbox, the crankshaft or the propeller's mounting hardware — and typically falls outside the engine manufacturer's warranty terms in the event of a resulting failure.

The E-Props Approach

The moment of inertia of every E-Props propeller is calculated during the design of the propeller. The resulting value is then verified and measured on each finished part.

The MOI value is indicated for every E-Props model in the E-Props catalogue, so that it can be checked against the limits specified by the engine manufacturer before installation.

> It is important to know the moment of inertia of the propeller being installed, and to verify that this MOI respects the limitations set by the engine manufacturer.

Conclusion

Thanks to their light weight, achieved through carbon construction and careful aerodynamic and mechanical optimization, E-Props propellers carefully respect both the maximum and the minimum moment of inertia limits recommended by engine manufacturers.

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