

Propellor load factor

Unless we fly warbirds, propellers are always two bladed. There is a good reason for this. The fewer the blades the better the efficiency. Apparently a single blade, balanced with a weight is best of all. However we mostly settle for two.

Warbirds often have three, four or more blades, no doubt to reduce the diameter and improve ground clearance. Mosquitoes had three bladers. Fortunately Tony Nijhuis did the sums for the one-ninth machine that I am building. However if I can fly that, I am going to build a one-fifth scale one. So of course the question was how heavy and what motors? I guess somewhere between 15 and 20 kg. I tend to build light so I think top of the range 4Max motors should be powerful enough. The specified propeller for the 4Max PO-6366-230 on 10S lipos is 20 x 10. What I needed to know was what three-blader would be equivalent.

It turns out that you need to find something called 'Load Factor' (LF). This is the load the prop puts on the motor or engine. I like Master Airscrew propellers so decided to see if their largest prop would do. Please excuse the use of ancient imperial dimensions. Props are always specified in inches and I find propellor conversions to metric prone to error.

The formula is load factor (LF) = $d^3 \times p \times (n-1)^{-2}$
where d is diameter, p is pitch, and n is the number of blades (can be metric of course).

For the specified 20 x 10 two-blader:

$$\begin{aligned} \text{LF} &= 20^3 \times 10 \times 1 \\ &= 80\,000 \end{aligned}$$

To give the same LF the diameter of the three-blader should be:

$$\begin{aligned} &(80000/(10 \times (2)^{-2}))^{-3} \\ &= 17.8" \end{aligned}$$

The biggest three blade Master Airscrew prop is 16 x 10

$$\begin{aligned} \text{LF} &= 16^3 \times 10 \times (2)^{-2} \\ &= 40960 \times 1.414 \\ &= 58\,000 \text{ (approx)} \end{aligned}$$

So the 16" prop is too light a load. However Master Airscrew (MA) blades are wide so impose a greater load. MA don't make a larger propellor so I will have to use it.

Using my motor tester, I will test the 16 x 10 on the 4Max motor using two 4S lipos in series to find the thrust, rpm and power. I want to get the thrust to around 6kg on each motor if possible. I can go up to two 5S lipos if necessary. I will report on the test results.

Peter Scott © 2019

Last edit 16 August 2021